RECOLONIZATION OF *BITHYNIA TENTACULATA* (LINNAEUS) (MOLLUSCA, GASTROPODA, PROSOBRANCHIA) IN THE ZONE AFFECTED BY HEATED WATER OVERFLOWS FROM THE GENTILLY NUCLEAR PLANT, QUEBEC, CANADA

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ABSTRACT

Following the shutdown of the reactor of the Gentilly (Quebec) nuclear generating plant, we have studied, during the years 1973 and 1974, the recolonization of Bithynia tentaculata in the hot water receptive zone. Our results were compared with those obtained in a zone farther upstream. It appears that the effects of thermal pollution are more than instantaneous and may still be present two years after the return to initial conditions.

INTRODUCTION

Since June 1970, we have had the opportunity of studying the fauna and flora of a given segment of the Saint Lawrence River, before, during, and after the beginning of operation of the Gentilly nuclear plant. Our studies have permitted us, among other things, to notice that the molluscan fauna had been unable to tolerate a temperature increase of the order of 10° C. The death rates observed in the gastropod and bivalve populations inhabiting the heated water receptive zone were of 100 percent after only three months of operation.

In November 1972, owing to a heavy water shortage, the Gentilly I nuclear plant ceased operations. With the closing down of the reactor, an exceptional situation arose, affecting studies on recolonization, by mollusks, of the zone affected by hot water.

Studies of this nature are rarely found in literature on the subject. This study had the advantage of enabling us to determine thermic effects in relation to time and consequently to verify the possible existence of a recolonization process. Where this existed, it was possible to determine the recolonization rate.

We studied the species *Bithynia tentaculata* (Linnaeus), formerly the most abundant in this bay; this species, incidentally, has always been numerically the best represented in surrounding biotopes.

MATERIALS AND METHODS

We have sampled on three transects (Fig. 1), each comprising 2 sample points. They are: transect A, situated upstream from the nuclear plant, whose depths at points 1 and 2 were respectively 1 and 1.5 m and transect B, located in the hot water receptive zone, where the depths are similar to those measured at transect A. Both transects are situated in zones characterized by similar biotopes, meaning that the distribution of aquatic plants in these stations is identical, the vegetation is composed of the same plant species and the substratum is composed mainly of mire. We are therefore in the presence of two zones capable of supporting a population of gastropods which are qualitatively and quantitatively similar. Transect C, situated 1200 m downstream from the effluent canal, is free from the lethal effects of the thermal impact; this has already been demonstrated by the use of infrared aerial photographs (Vaillancourt *et al.*, 1974). Not having studied the principal physical, chemical, and biological characteristics of this transect, we cannot compare it with transects A and B. However, mollusk sampling in this zone enables us to notice the presence of gastropods towards the downstream area and out of reach of the heated overflow.

The frequency of sampling is established as follows: one sampling at two-week intervals from May 1 to August 20, and a monthly sampling from September to December.

The gathering of benthos was carried out with a 1260 cm^2 Petersen dredge. At least four samples were taken from each station. After being brought to the laboratory, the samples were screened and the gastropods were sorted out and classified. They were then measured and weighed.

RESULTS

The density of *B. tentaculata* in the samples of transect A from stations 1 and 2 is constant from year to year (Table I). We have thus collected dur-

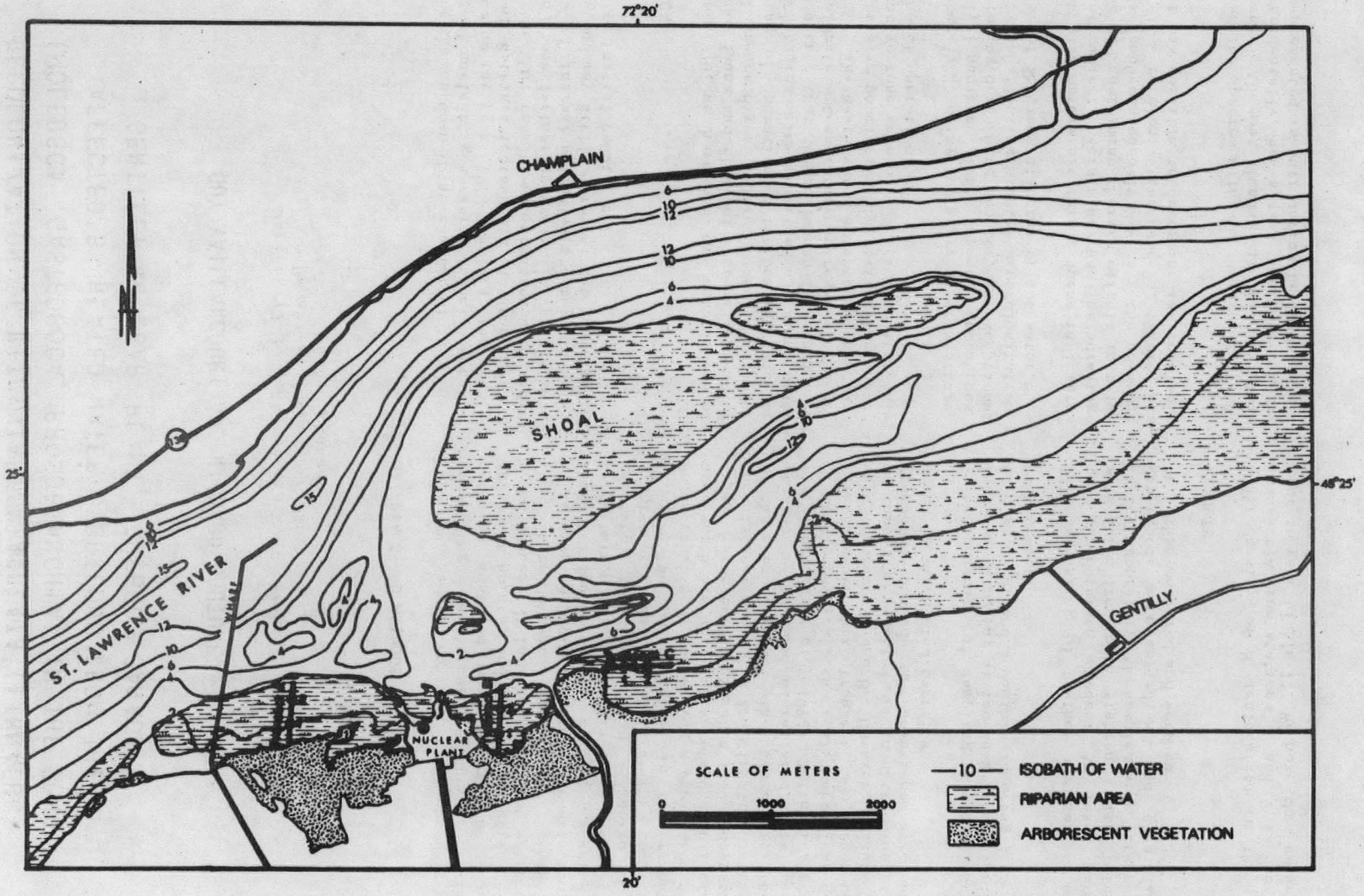

Figure 1. Region of the Gentilly nuclear plant.

ing the years 1973 and 1974 an average of 33.5 and 34.7 individuals per sampling. On the other hand, the density at station 1 is slightly inferior to the estimated density at station 2. Indeed, in 1973, we have gathered an average of 24 specimens at station 1, compared with 53.1 at station 2. However, in 1974 we obtain an average of 31.6 specimens at station 1 and 37.8 at station 2. These variations during the same season are the result of normal monthly variations which are, as demonstrated by Vaillancount and Couture (1974), related to local displacements and reproduction phenomena.

TABLE I. Monthly mean average per sampling of the number of living *Bithynia tentaculata* (Linnaeus) for the stations of transect A.

	1973		1974	
MONTH	St. 1	St. 2	St. 1	St. 2
May	30	77	56	5
June	10	45	6	13
July	19	17	5	24
August	21	75	66	89
September	--	--	5	16
October	21	51	56	80
November	43	54	--	--
	24	53.2	31.6	37.8
Mean	33.5		34.7	

Table II illustrates clearly the very low density of *B. tentaculata* in the zone affected by the thermal overflows. Indeed, in 1973, we find no specimens living at station 1; it is not until October that 7 individuals are found at station 2. However, in 1974, the first specimens taken into inventory were collected in October at station 1. At station 2, we sampled 3 individuals in May, 8 in June, 1 in August, and 8 in October, for a total of 20 specimens, compared with 7 in 1973. Therefore, only station 2 of transect B possesses enough living specimens capable of setting off the repopulating process of the little bay of Gentilly.

TABLE II. Monthly mean average per sampling of the number of living *Bithynia tentaculata* (Linnaeus) for the stations of transect B.

	1973		1974	
MONTH	St. 1	St. 2	St. 1	St. 2
May	0	0	0	3
June	0	0	0	8
July	0	0	0	0
August	0	0	0	1
September	-	-	0	0
October	0	7	2	8
November	-	-	-	-
	0.0	1.4	0.33	3.33
Mean	0.7		1.8	

- : no sample

We observe the presence of *B. tentaculata* at stations 1 and 2 of transect C (Table III). This sampling zone, situated 1200 m downstream from the heated overflow, is not affected by the hot water. This enables us to define the boundaries of the thermal effects of the Gentilly I nuclear plant; it would seem that the effects of the hot water are not felt beyond the Gentilly River.

TABLE III. Monthly mean average per sampling of the number of living *Bithynia tentaculata* (Linnaeus) for the Stations of transect C.

	1973		1974	
MONTH	St. 1	St. 2	St. 1	St. 2
May	-	-	14	16
June	-	-	6	6
July	13	5	2	9
August	9	8	27	3
September	-	-	2	1
October	14	5	52	4
November	15	21	-	-
	12.8	9.8	17.2	6.5
MEAN	11.3		11.9	

- : no sample

DISCUSSION AND CONCLUSION

The effects of thermal pollution are more than instantaneous and they may still be present two years after a return to initial conditions. In fact, two years after the end of operations at the Gentilly nuclear plant, the density of mollusks estimated in transect B is in marked contrast with the densities of transects A and C by the almost total absence of life. Nevertheless, the presence of 22 individuals in the summer of 1974 has permitted us to hope for the repopulation of *B. tentaculata* in this sector, as well as that of other species such as *Helisoma trivolvis* (Say), *Gyraulus parvus* (Say), and *Physa gyrina* (Say), which are widely distributed in the zones outside the cone of dejection.

We must note, however, that the geographic configuration of the zone affected by the hot water could slow down the rate of the process of recolonization which should normally take place by means of recruitment and migrations. Another factor likely to slow down the rate of recolonization could be the presence of disequilibrium inside the biota of this zone, even though we have not been able to detect it.

We have demonstrated in our previous works (Vaillancourt and Couture, 1972) that the density of *B.*

tentaculata was in a ratio of 3/2 at transect A in relation to transect B. Taking this ratio into account, as well as the rate of growth of the population of transect B in 1973 and 1974, we can predict, using the population growth formula

$$N_t = N_o e^{rt}$$

N_t : number of individuals at time t

N_o : number of individuals

e : base of natural logarithms

r : rate of population increase

t : elapsed time

that it will take 3.45 years (1977) to reach the normal density of *B. tentaculata* at transect B.

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