Physical Factors Implicated in Reduced Barnacle (*Balanus glandula* Darwin) populations at the Squamish Estuary, B.C.

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PHYSICAL FACTORS IMPLICATED IN REDUCED BARNACLE (*BALANUS GLANDULA* DARWIN) POPULATIONS AT THE SQUAMISH ESTUARY, B.C.

by

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ABSTRACT

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The survival, growth and fecundity of a transplanted barnacle population at the Squamish estuary, British Columbia, were studied for one year. The transplanted barnacles were found to show poor survival, fecundity and growth compared to a control population in West Vancouver. These were related to the prevailing stress conditions of low, fluctuating salinity and high turbidity at the estuary.

Key words: estuary; field experiment; survival; filter feeders; sedimentation; salinity.

RESUME

Wu, R. S. S. and C. D. Levings. 1979. Physical factors implicated in reduced barnacle (Balanus glandula) populations at the Squamish estuary, B.C. Fish. Mar. Serv. MS Rep. 1535: 13 p.

La survie, la croissance et la fécondité d'une population de bernacles transplantée dans l'estuaire de la Squamish, en Colombie-Britannique, ont été étudiées pendant une année. On a noté que les bernacles transplantées montraient des taux faibles de survie, de fécondité et de croissance par rapport à une population témoin se trouvant dans la région de West Vancouver. Ces observations été mises en rapport avec les conditions de stress que constituent la salinité basse et fluctuante et la forte turbidité qui prévalent dans l'estuaire.

Mots cles: estuaire; expérience sur le terrain; survie; filtreurs; sédimentation; salinité.

INTRODUCTION

Field observations (Levings and McDaniel 1976) indicated that the intertidal communities were much less diverse at the Squamish delta compared to those from southern Howe Sound. Surprisingly, the barnacle (*Balanus glandula* Darwin), which has been reported to be extremely euryhaline (Bergen 1968), was abundant on beaches at the lower part of Howe Sound but was scarce on the Squamish estuary intertidal zone.

This report investigates the mortality, growth and fecundity of a transplanted barnacle (*Balanus glandula*) population at the Squamish delta, with an aim to explain the scarcity of the barnacle in these estuarine habitats. From May to September, the Squamish river adds to the waters of the estuary a heavy glacial silt load (50 to 200 mg L^{-1}; Zrymiak and Durette 1979). Moreover, the heavy rainfall (205 mm $year^{-1}$) and the large river runoff (mean annual flow 242 m^3 s^{-1}) contribute to large fluctuations in salinity, especially at the upper part of Howe Sound. Salinities in the upper water layer can be as low as $0^{o}/oo$ near the Squamish delta during the summer runoff (Levings et al. 1976). These conditions may impose stress on marine filter-feeders such as barnacles.

MATERIALS AND METHODS

Experiments were designed to compare the growth, fecundity and mortality of a barnacle population at the West Vancouver Laboratory, West Vancouver (the "control" station) with that of a transplanted barnacle population at the Squamish delta (Fig. 1). The former location is near the southern part of Howe Sound, about 35 km from Squamish.

In June 1975, 2000 barnacle individuals were allowed to settle in an "isolated" pattern (with individuals 1.75 cm apart from each other) on a 0.61 m^2 (78 x 78 cm) plexiglass plate secured on the piling at the West Vancouver Laboratory at 3 m tidal level, using the same technique as described by Wu et al. (1977). In July, 1975, the panel was taken out of the water and cut into two halves. One half was returned to the piling at the West Vancouver Laboratory and the other half was transplanted and secured at the same tidal level on a piling situated at the central channel of the Squamish delta (Fig. 1). The panel was established in the "shadow" of the training wall constructed in 1972. This structure deflects the main flow of the Squamish River from the central sector of the estuary.

Fifteen barnacles were sampled from both stations for each month over the period July 1975 to May 1976. The number of barnacle survivors at both stations were also counted during each sampling. The body tissue and eggs of each barnacle individual were dissected and their dry weight determined after drying in an oven at 100°C for 48 hours. The rostro-carinal diameters (length) of the barnacles were measured with a caliper.

RESULTS

Percentage survival of barnacles on the panels at both stations was calculated for each month and is shown in Fig. 2. The mortality of the transplanted barnacles at Squamish was much higher than that at West Vancouver.

The monthly mean rostro-carinal diameter of the barnacles at both stations is shown in Fig. 3. A student t-test ($p = 0.05$) showed that the mean rostro-carinal diameter of the barnacles at West Vancouver was significantly larger than that at Squamish for every month.

The monthly mean standing crop of body tissue and eggs of the barnacles at both stations are shown in Fig. 4 and 4, respectively. A student t-test ($p = 0.05$) showed that the barnacles at the West Vancouver Laboratory showed a significantly higher standing crop of body tissue and egg when compared with that of the transplanted barnacles at Squamish.

A light barnacle settlement (1200 m^{-2}) was found on the panel at Squamish in May 1976, while a much higher intensity of settlement (22000 m^{-2}) was recorded at the West Vancouver site at the same time.

All the barnacle samples at the West Vancouver Laboratory were found to carry mature naupliar embryos in May 1976. However, only a small portion (<20%) of barnacles in the transplanted population was found to carry mature naupliar embryos at this time.

DISCUSSION

Food and temperature are the most important factors in affecting the growth and reproduction of barnacles (Barnes and Barnes 1967). The result of the present study indicated that both the growth (in terms of rostro-carinal diameter, dry weight of body tissue) and fecundity of the transplanted barnacles at Squamish were significantly lower than that at West Vancouver. Bergen (1968) found that *Balanus glandula* was able to tolerate a wide range of salinity, although the barnacles would close their opercular plates at salinity lower than 50% sea water (about 15°/oo). The low salinity at Squamish may have therefore significantly reduced the feeding time of the transplanted barnacles. The high silt content and excessive turbidity may have also reduced the primary productivity and hence the availability of phytoplankton at the Squamish estuary.

The mortality of the transplanted barnacles was significantly higher than that of the barnacles at the West Vancouver Laboratory. It would appear that the estuary conditions at Squamish may exert a limiting effect on the survival of the barnacle adults. The reproductive activities of the transplanted barnacles were retarded to a considerable extent, as indicated by the low standing crop of eggs. It appears that the reduction in feeding time as well as the low availability of food in the waters may lead to a slow growth and low fecundity of the barnacles at Squamish. The light barnacle

settlement found on the panel at Squamish indicated that few cyprids can settle normally at Squamish, even though the surface salinity was extremely low at this time ($5^{o}/oo$). Heavy silt deposition, as evidenced on the transplanted barnacle plate, may have also modified the substratum and made it unfavourable for cypris settlement. Natural populations of barnacles on solid surfaces (pilings, logs) were best developed in the central sector of the estuary, in the habitats "protected" from main river flows by the training wall (Levings and McDaniel 1976).

In conclusion, the scarcity of the barnacles *Balanus glandula* in the Squamish estuary may be related to the poor survival and fecundity of the residing population in the estuary. The maintenance of the present low density population of *Balanus glandula* in Squamish appears to depend on the recruitment of larvae from the lower part of Howe Sound, where stress conditions of fluctuating salinity and turbidity are less severe.

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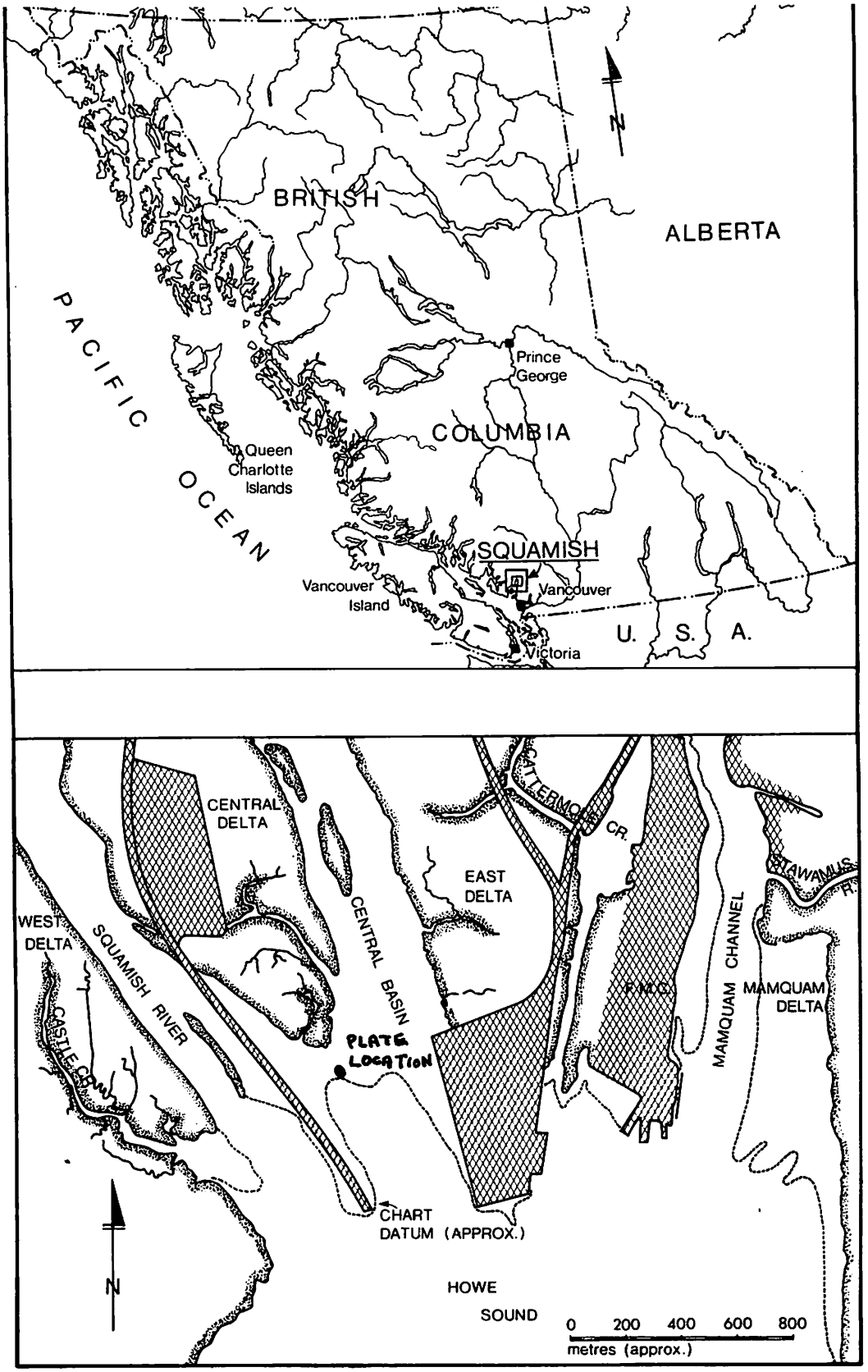


Fig. 1. Chart of the Squamish estuary showing location of the transplanted barnacle populations.

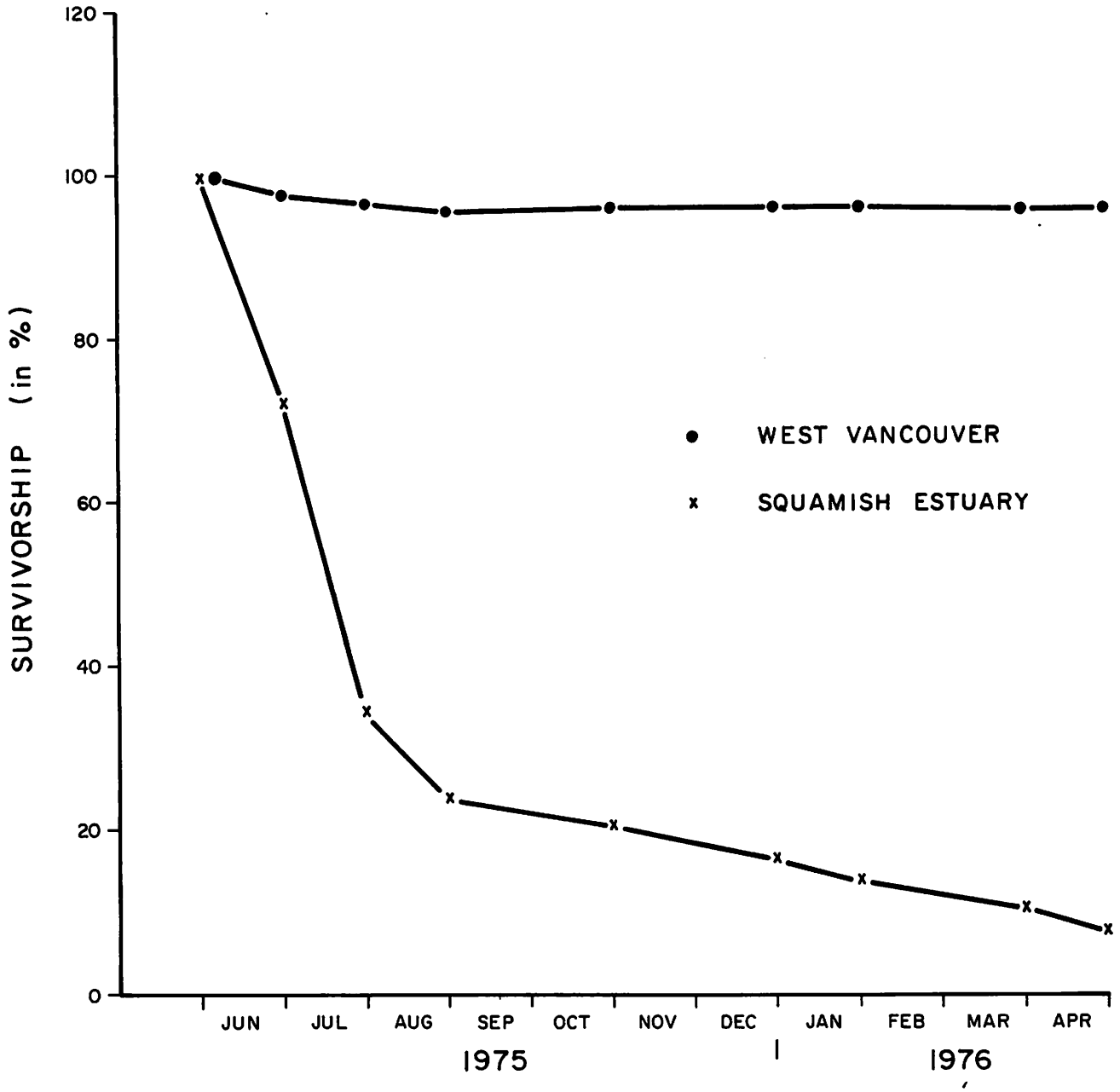


Fig. 2. Percentage survival of the barnacle populations transplanted at the Squamish estuary and the "control" station at West Vancouver over the period June 1975 to April 1976.

Fig. 3. Increases in rostro-carinal diameter (cm) of the barnacle population transplanted to the Squamish estuary and the "control" station at West Vancouver over the period June 1975 to April 1976. Mean values and standard deviation (15 specimens) are shown.

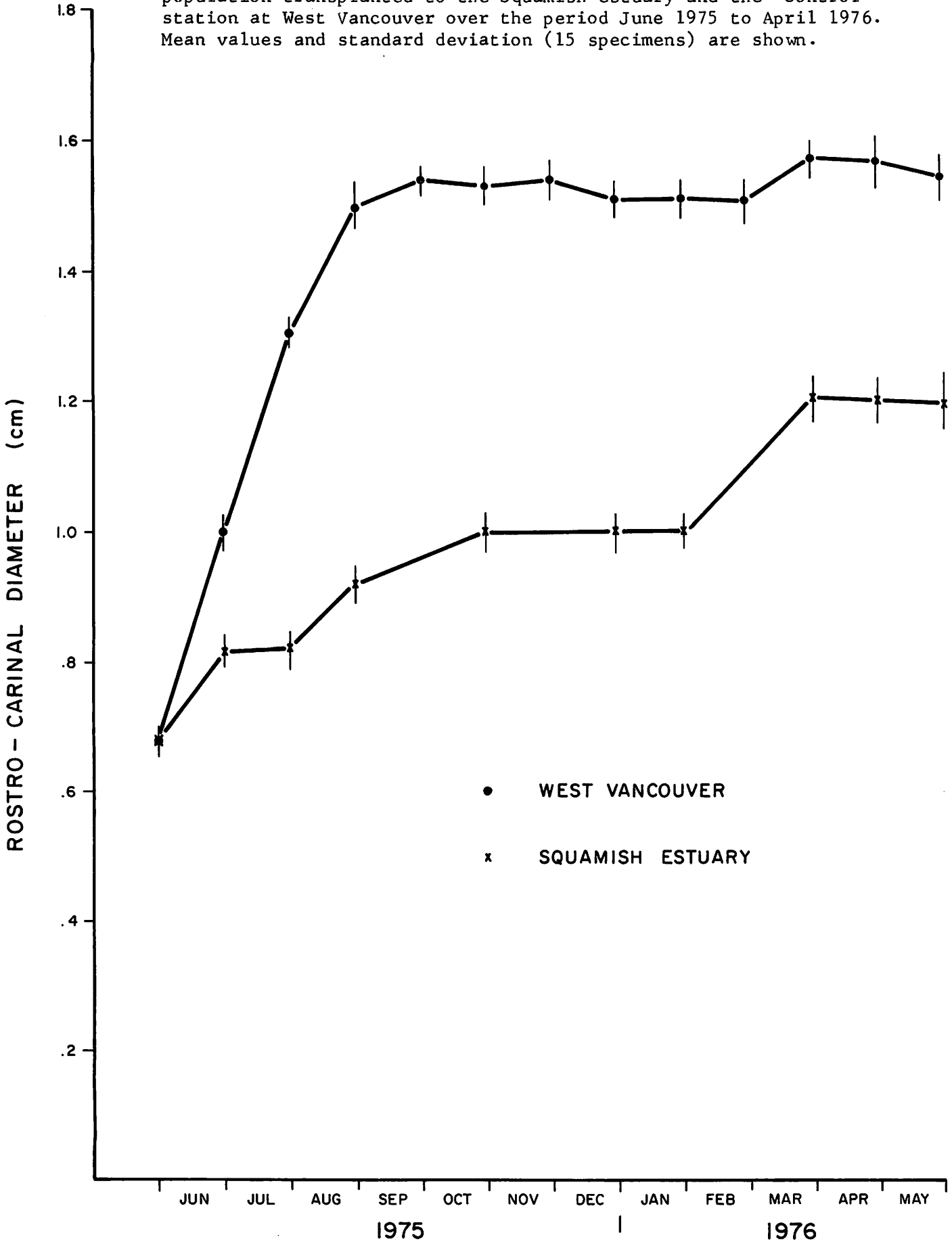
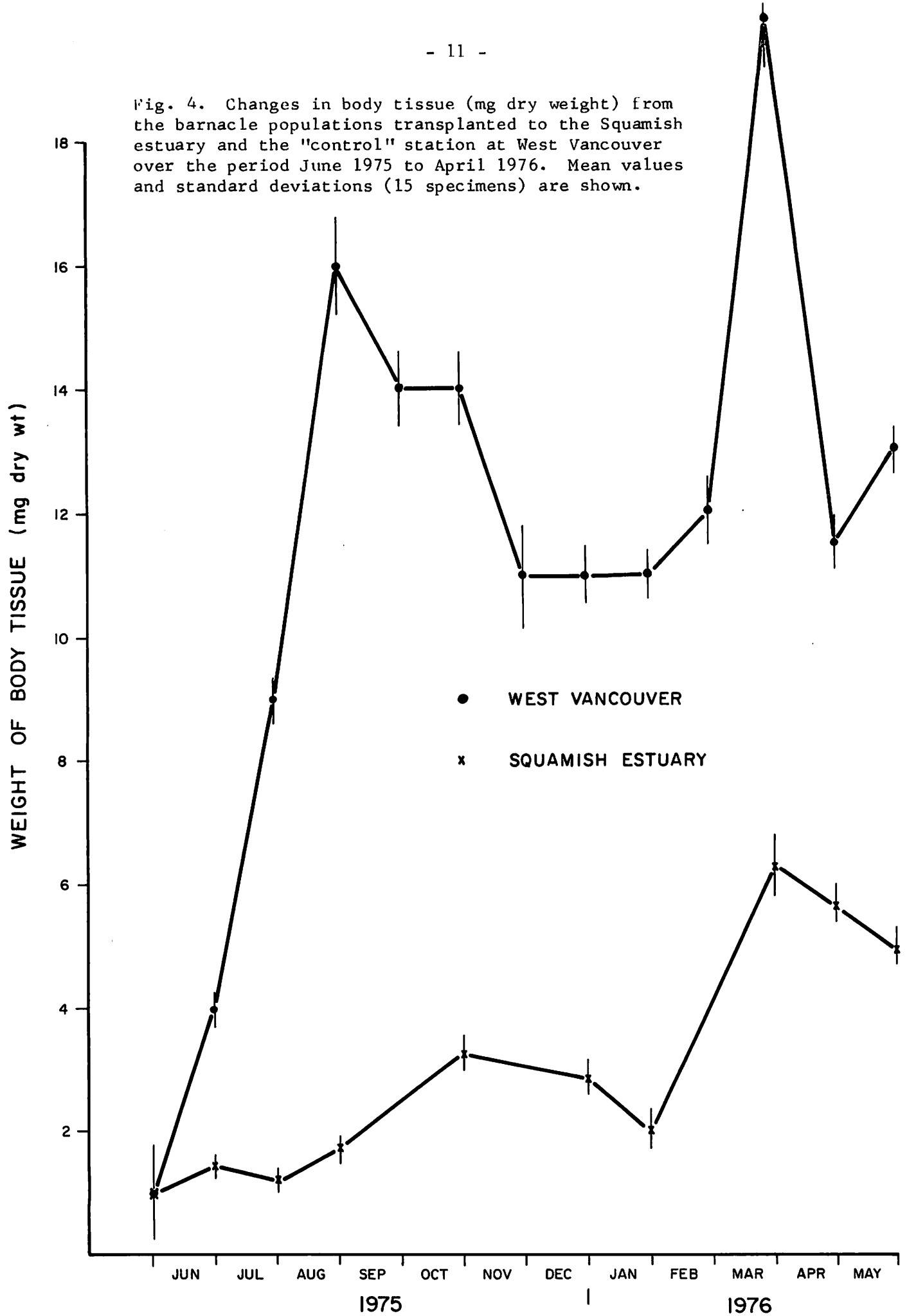


Fig. 4. Changes in body tissue (mg dry weight) from the barnacle populations transplanted to the Squamish estuary and the "control" station at West Vancouver over the period June 1975 to April 1976. Mean values and standard deviations (15 specimens) are shown.



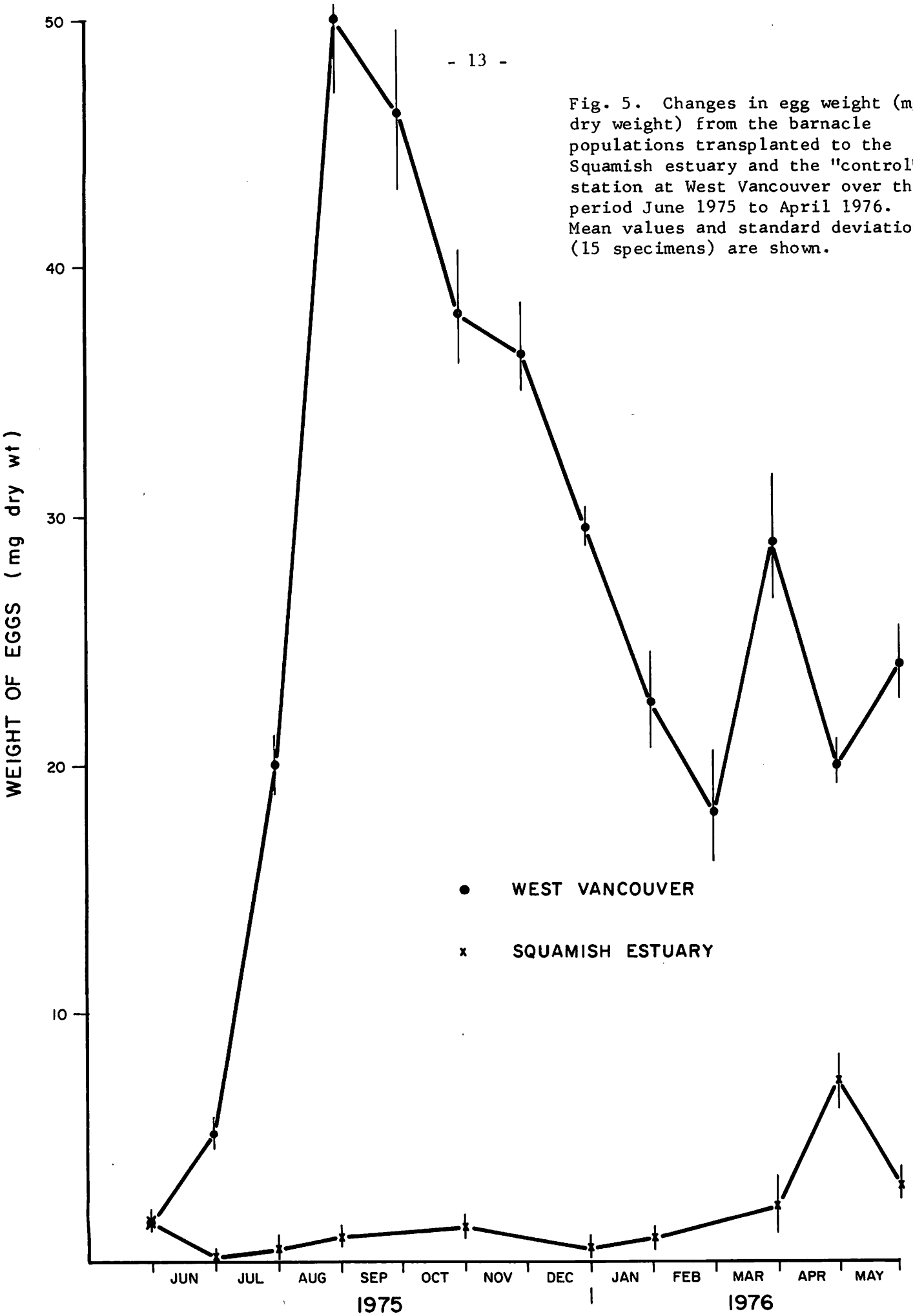


Fig. 5. Changes in egg weight (mg dry weight) from the barnacle populations transplanted to the Squamish estuary and the "control" station at West Vancouver over the period June 1975 to April 1976. Mean values and standard deviations (15 specimens) are shown.