SIMULATION ON THE DISPERSAL OF PLANKTONIC LARVAE OF HANASAKI CRAB IN THE OKHOTSK SEA

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Fig. – 8, ref. – 5.

OBJECTIVES

Because of overfishing, stock of Hanasaki crab is shrinking these ten years. In order to keep a sustainable catch, the identification of its ecology, especially the initial recruitment of the crab, is important task. Ikeda et al. (2005) developed the Micro-Satellite DNA Marker of Hanasaki crab and examined the genetic diversity of local populations of Sakhalin and of Nemuro. There are significant genetic differences between Sakhalin population and Nemuro population. The present study intends to identify possible mechanism that causes the genetic difference between Sakhalin population and Nemuro population using numerical simulation, and to contribute to resource management of Hanasaki crab.

MODEL DESCRIPTION

Physical model (POM)

We used POM (Princeton Ocean Model) ver. 3 as a physical model. **Figure 1** shows model domain, 34°N to 63°N, 127°E to 166°E, together with the initial position of larvae of model crab. The horizontal grid scale of numerical model is 1/6 degree and the vertical grids are divided into 20 layers, upper 10 of which are in a Cartesian coordinate with 2m thickness, and lower 10 of which are in sigma coordinate. The simulation was conducted for 3 years from 1999 to 2001, with a spin-up from 1997 to 1998. Oyashio, Kuroshio, or Soya warm current are not taken into consideration as a boundary condition but time dependent temperature and salinity are given as boundary conditions, which means the effects of these currents are explicitly taken into consideration.

Particle tracking model (Lagrangean model)

In order to pursue the transport mechanism of crab larvae, we use Lagrangean model as ecosystem model. Its model domain is the same as in physical model. The horizontal resolution is 1/36 degree although the gird size of physical model is 1/6 degree. Physical information such as velocity, temperature is interpolated. For Lagrangean tracking, we used the current field in upper 20m layer calculated by the physical model. We set initial particles on shallow coastal areas of Sakhalin and Nemuro as shown in fig. 1. The time dependent positions of particle are calculated from daily averaged current. These particles are divided into 11groups according to their initial position, and are shown by using 11 colors in order in figures. We assumed that larvae were hatched out every day from May 1st to May 10th. We supposed that larvae can settle safely on ocean bottom if they arrive to shallow waters in the period between 40 and 50 days after release. Moving ability of larvae and their mortality by prey are not taken into consideration.

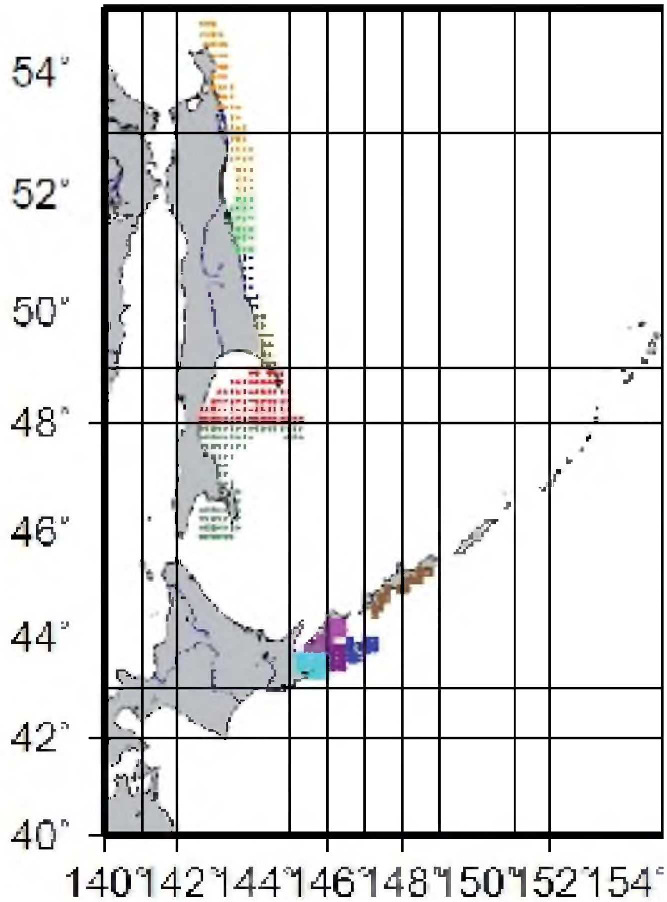

Fig. 1. Initial distribution of particles, which are regarded as crab larvae

The growth is also calculated after Nakanishi (1981) (**fig. 2**), in which the growth of larvae is a function of water temperature. We simulated dispersal of particles without tidal current and with tidal current. Tidal currents are significantly large in coastal regions under consideration. Tidal currents are hard to produce on

1/6 degree grid scale, and massive computation time would be required to conduct by using POM. We conducted the simulation of tidal current separately. Then, we added the resulted tidal current field to those calculated by POM without tides. We examined effects of tides on dispersal of larvae by comparing the results without tide with those with tides.

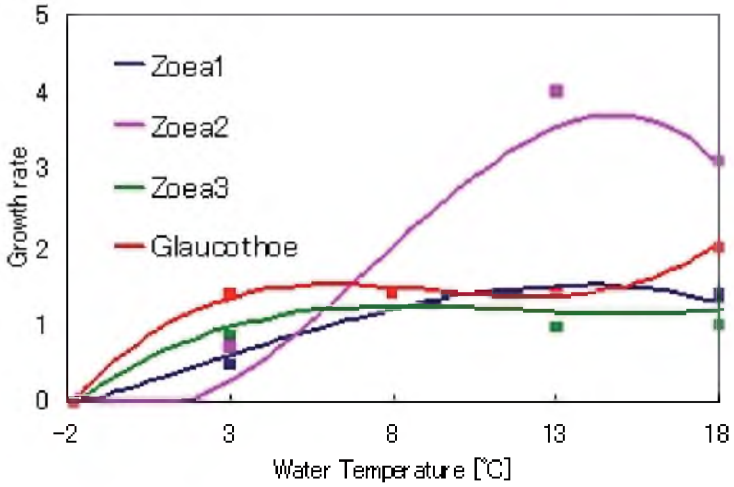

Fig. 2. Relationship between water temperature and terms of stage

RESULTS AND DISCUSSIONS

The results of particle tracking experiments are shown for 1999, 2000 and 2001 in **figures 3-1, 3-2, and 3-3,** respectively. The particles originated from Sakhalin arrive to the northern coast of Shiretoko Peninsula. The number of particles arriving to Shiretoko is significantly larger in case with tidal currents than in case without tidal currents. This is because the tidal currents have the effect to enhance diffusion. The particles in the East Sakhalin Current would more easily be transferred by tidal effect into the Soya Warm Current in the region near southern edge of Sakhalin.

In **fig.4** the settling ratio of the particles originated from Sakhalin and Hokkaido are shown for 1999, 2000, and 2001. In 2000, the settling ratio of model larvae originated from Hokkaido is lower than that in the other two years. In 2000, the northern wind was strong in June and particles along the southern coast of Hokkaido are advected offshore-ward. **Figure 5** show the sea surface currents on June 15–16 in 1999 (left) and 2000 (right) and in 1999. The wind blows toward coast in the southern Hokkaido in 1999 (**fig. 6**) and in 1999 the particles were advected toward coast and settling ratio was higher. **Figure 7** shows the time dependent feature of catch of male crab year class at Nemuro port. The catch of 1999 year class is higher and our results support this data. As Johnson (1985) and Hobbs et al. (1992) pointed out the effects of wind driven transport of crab larvae, Hanasaki crab must be influenced by wind driven current especially in the season of larvae settlement.

Growth of model larvae is shown in **fig. 8.** Due to the low temperature, the growth of larvae originated from Sakhalin is worse than that from Hokkaido. They never grow up to the weight of settlement during simulation period (60 days). They must spend more time until the settlement.

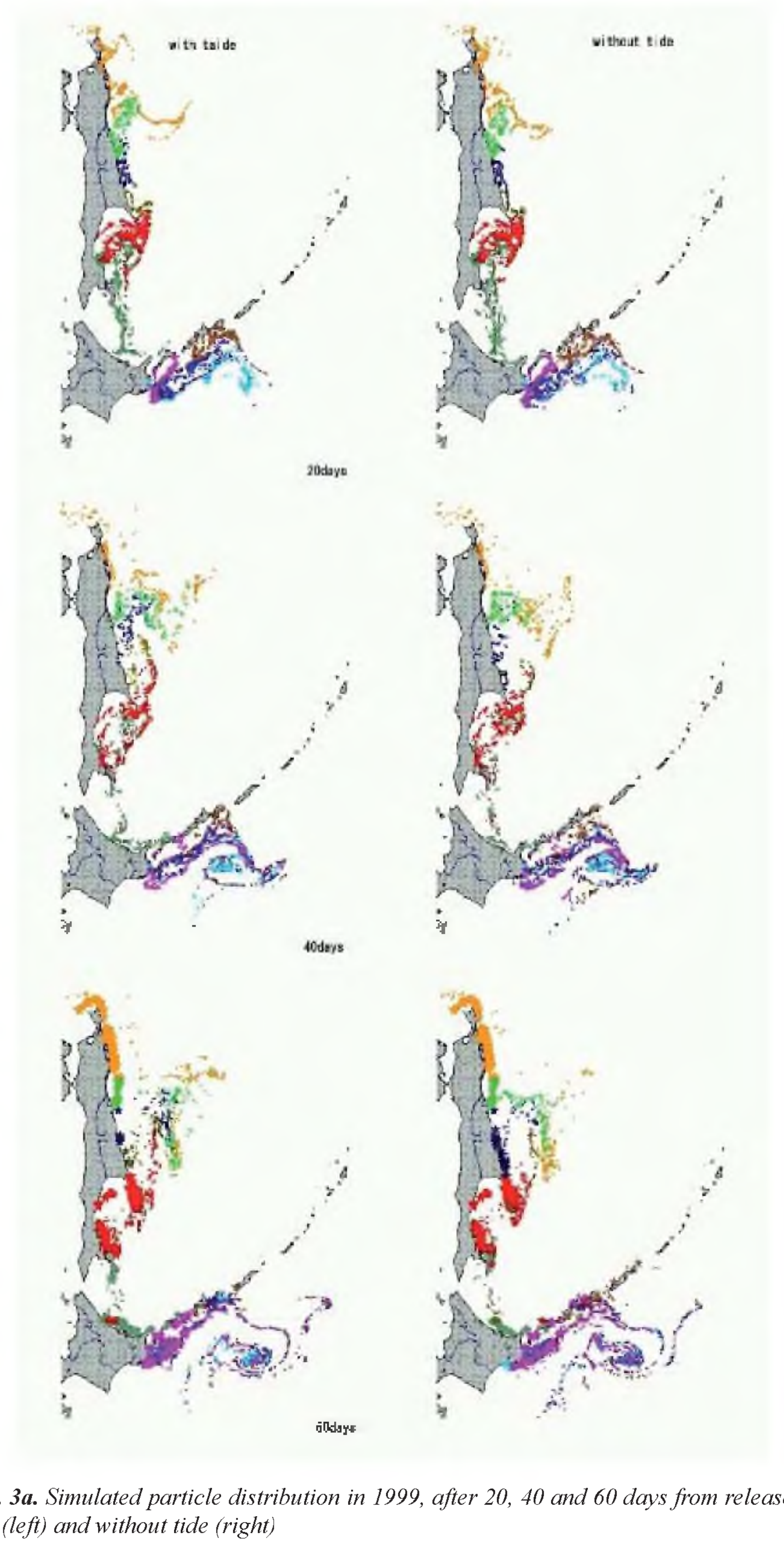

Fig. 3a. *Simulated particle distribution in 1999, after 20, 40 and 60 days from release, in case with tide (left) and without tide (right)*

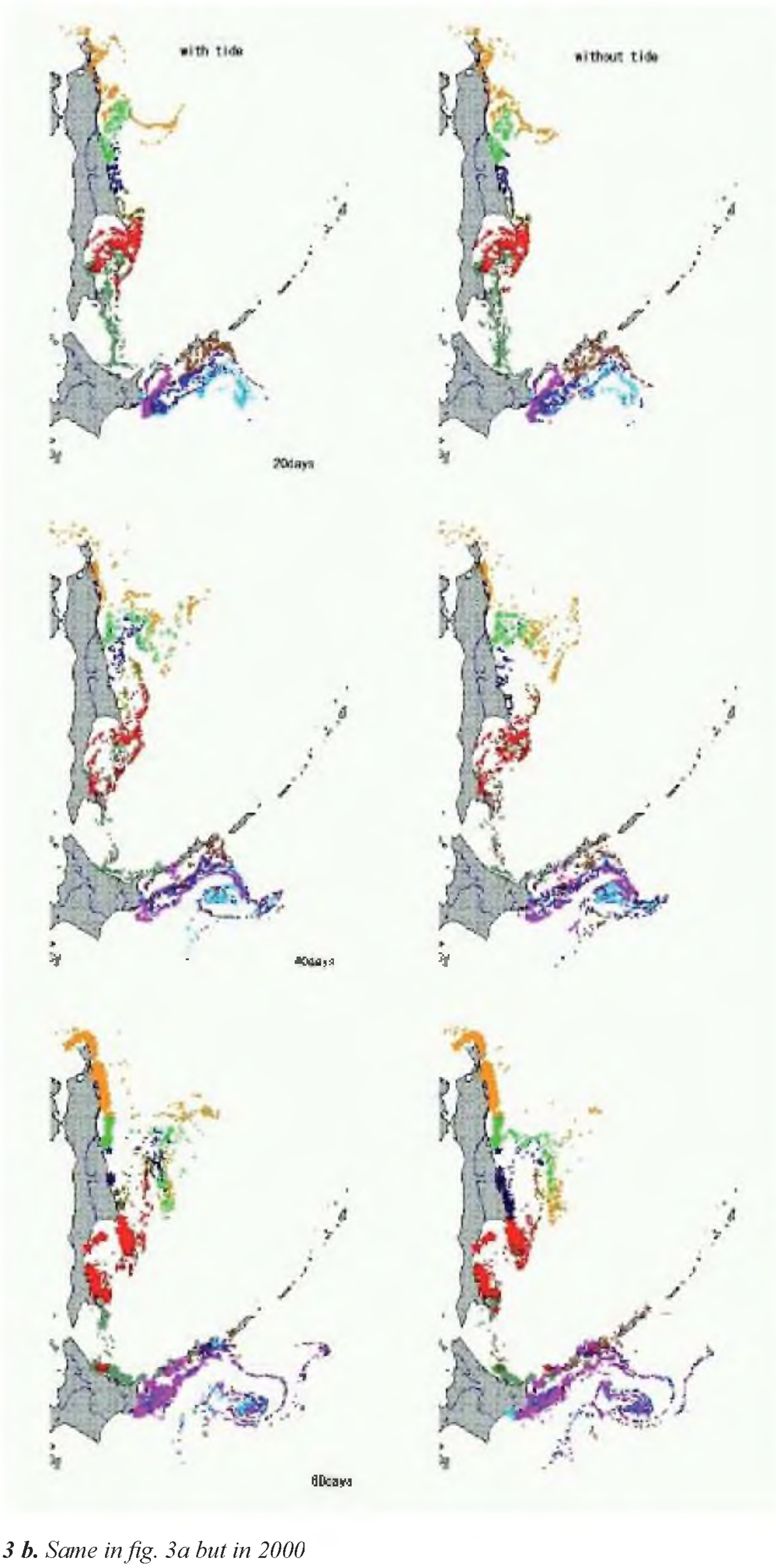

Fig. 3 b. *Same in fig. 3a but in 2000*

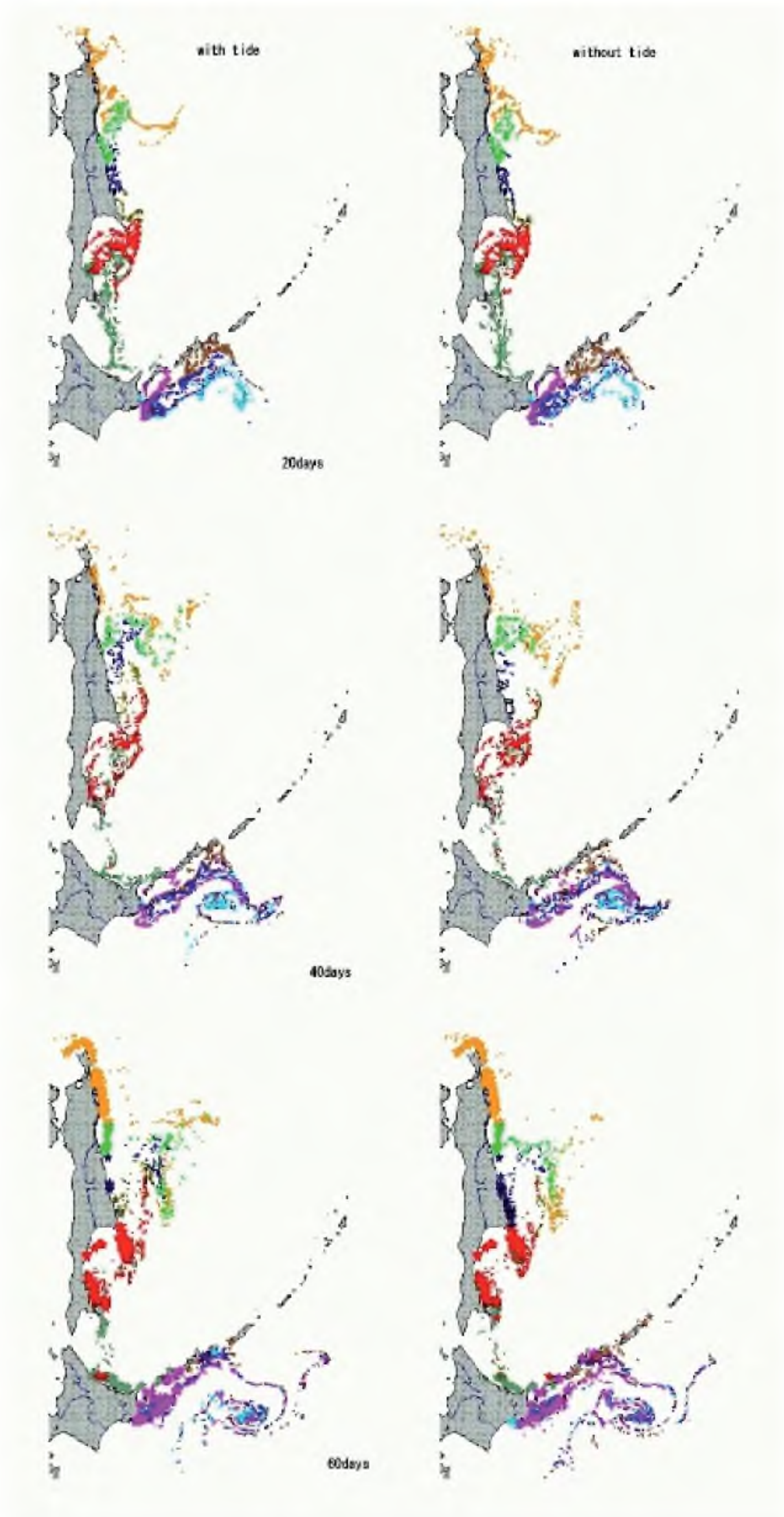

Fig. 3c. *Same in fig. 3a but in 2001*

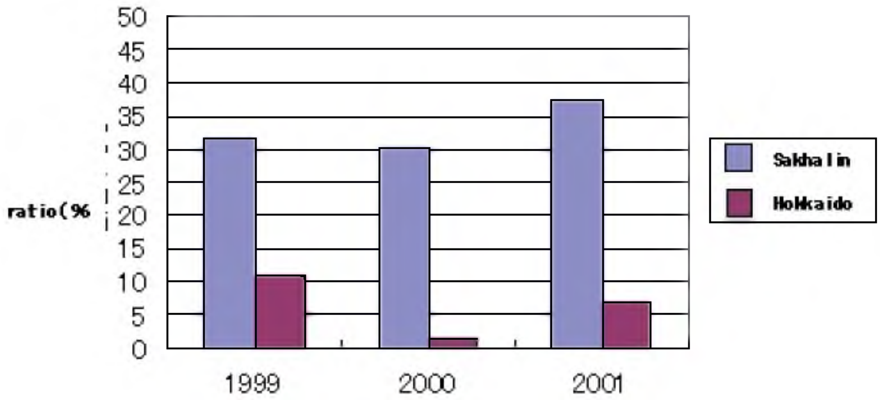

Fig. 4. *Settlement ratio of larvae originated from Sakhalin and Hokkaido. Number of settled particles is divided by all particles released from both areas*

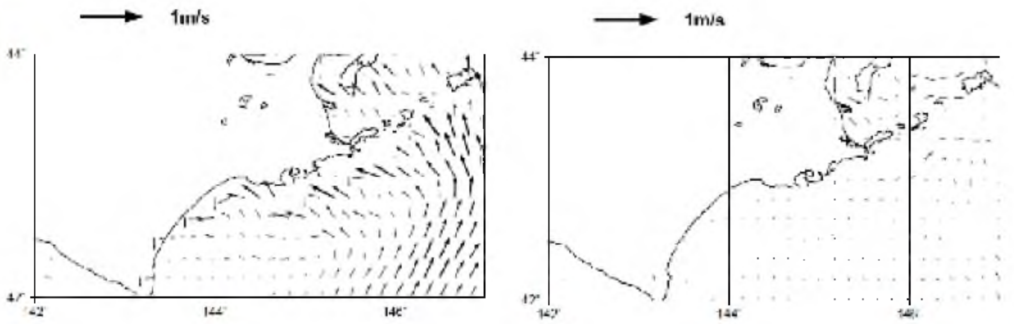

Fig. 5. *Calculated averaged sea surface current on June 15 and 16, in 1999 (left) and in 2000 (right)*

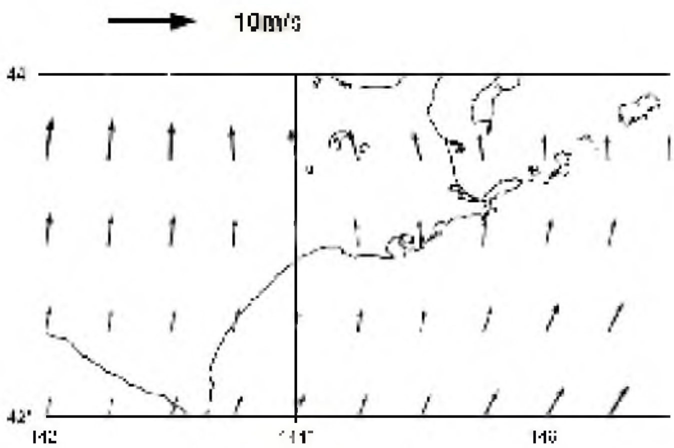

Fig. 6. *Observed sea surface wind on June 15 in 1999*

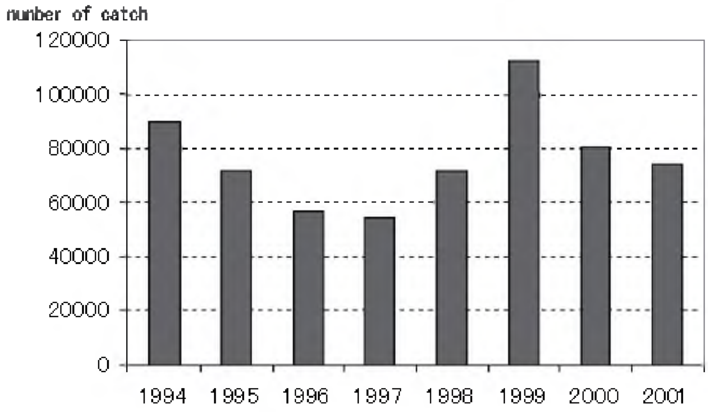

Fig. 7. *Inter-annual variability of male catch of Hanasaki crab at Nemuro*

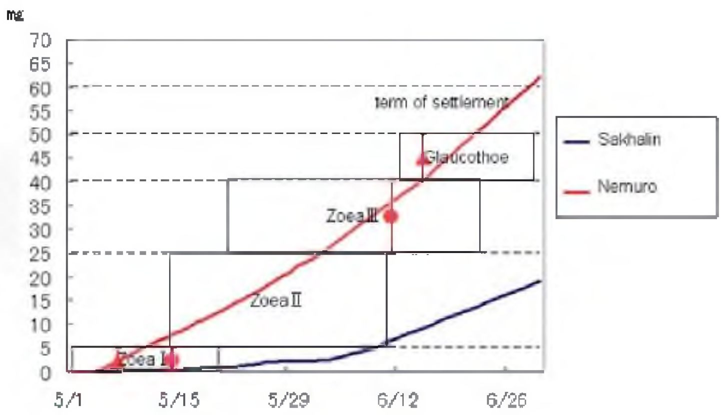

Fig. 8. *Averaged growth of model larvae released from Sakhalin and Nemuro peninsula*

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