FOOD FILTERING PROCESS OF *DAPHNIA CARINATA* KING TO ASSESS THE WATER SOLUBLE DETERGENT

by: *Soelaksono Sastrodihardjo* and Hilda Zulkifli**

ABSTRACT

Water organisms such as zooplankton and fish were used quite often as indicators for water quality in connection with chemically toxic substance in water. Several criteria could be use such as LC_{50}, population index, and physiological phenomena. Bioassay that rely on this physiological phenomena was meant to measure the sublethal effect of the suspected toxic substance on the organisms.

Further development of sublethal bioassay using filtering rate of *Daphnia carinata* (Cooley, 1977; McMahon, 1966) has taken place for a certain detergent. Yeasts cells tagged with ^{32}P were used as food for *Daphnia carinata* and the filtering rate was measured from the radioactivity of these crustaceans after a certain period of feeding time. Comparison was made between the feeding rate in the medium with and without the detergent and they appeared to be different.

SARI

Organisme air seperti zooplankton dan ikan telah sering digunakan untuk menafsirkan kehadiran senyawa kimia yang terlarut dalam air sehubungan dengan masalah kualitas air. Kriteria untuk menyatakan kehadiran tersebut dapat dinyatakan dalam bentuk LC_{50}, indeks populasi, dan gejala fisiologis. Uji hayati yang menggantungkan pada gejala fisiologis ini mempunyai sasaran untuk mengukur dampak subletal suatu senyawa terhadap organisme.

Perkembangan lebih lanjut adalah penggunaan laju penyaringan dari *Daphnia carinata* (Cooley, 1977; McMahon 1966) untuk menafsirkan kehadiran sejenis detergen. Dalam hal ini laju penyaringan diukur dengan menghitung jumlah ragi yang bertanda ^{32}P yang termakan oleh udang tersebut. Dilakukan pembandingan antara laju penyaringan *Daphnia* yang berada pada medium tanpa dan dengan detergen.

* Department of Biology, Institut Teknologi Bandung

INTRODUCTION

Water quality monitoring has been developed quite extensively side by side with the physico-chemicals methods (Swartz, 1972; Cairns & Dickson, 1973).

It was mentioned that there were several approaches in the development of biological monitoring methods for water quality such as bioassay, condition indices, population dynamics, community structure, and community metabolism (Swartz, 1972).

Within the framework of water quality assessment, especially in connection with the development of quantitative measurement of chemicals such as detergent and pesticides, we are interested in using *Daphnia carinata* as a tool.

Aside from the fact that *Daphnia* (Crustacea: Cladocera) has been widely used in several advanced countries in toleration studies, this species are available in our vicinities and could be cultured without difficulties.

The material to be tested has been a certain type of detergent that was often discussed by several environmental people lately. It is expected that this crustacean could be used as reliable assay animals especially for sublethal bioassay.

This work has been based on two papers by McMahon (1968) and Cooley (1977).

MATERIALS AND METHODS

Daphnia carinata King has been kept for several generations in the Biology Department of ITB. The original stock came from the Department of Civil Works, a department dealing with water management (DPMA); the daily food consist of yeasts.

The chemical to be tested was 'AD pasta unbleached', i.e. the material used for a certain kind of detergent (surfactant). It belongs to the group of alkylbenzene sulfonate (ABS).

a *Acute (LC–5)*
To start a sublethal assay, a lethal experiment was carried out, using the following pasta concentrations (48 hrs); 0; 10; 13,5; 18; 24; 32; 42; 56; and 100 ppm.

b *Sublethal*
Cooley (1977) has shown the relationship between filtering rate of *Daphnia retrocurva* and pulp mill effluent. The measurement of filtering rate is based on the quantity of tagged yeasts (^{32}P) taken by individual *Daphnia retrocurva*.

In our experiment, yeasts are tagged with 5 mCi ^{32}P (from National Atomic Energy Agency) within 50 cc of culture. Incubated 48 hrs at 20°C, it was centrifuged afterwards, and rinsed with aquadest four times.

The number of cells in the culture was 2.10^5 cell/cc, 5 cc of yeast suspension was used to measure its radioactivity after filtered through millipore.

Culture of female *Daphnia* aged 9 days are used for the assay. For acclimation, untagged yeasts are added for the first 30 minutes after *Daphnia* has been treated with 'AD pasta unbleached'. They are then filtered and returned to the aquarium, but this time the food added are tagged yeasts for as long as 10 minutes. Once again they are filtered and returned to the aquarium without tagged yeasts. A certain number of *Daphnia* are taken, killed with 10% urethan and fixed in 4% formalin; the individual lengths are measured and the radioactivity are counted with G. M. Counter.

Treatments of 'AD pasta unbleached' are 0 ppm (control), 10 ppm, 50 ppm, and 100 ppm. Time exposures are 1, 2, 4, and 24 hrs.

Formula for the filtering rate:

$$Y = \frac{\text{radioactivity/1 Daphnia}}{\text{radioactivity/ml yeast suspension}} \times \frac{1440}{\text{feeding time}} \text{ cc/animal/day}$$

RESULT AND DISCUSSION

While it was mentioned (Abel, 1974) that 'ABS' could kill *Idus idus*, of which the 48 hrs LC_{50} also depended on the chains length, 'AD pasta unbleached' also caused a certain mortality on *Daphnia carinata*; 48 hrs LC_{50} was 17.55 ppm. (fig 1).

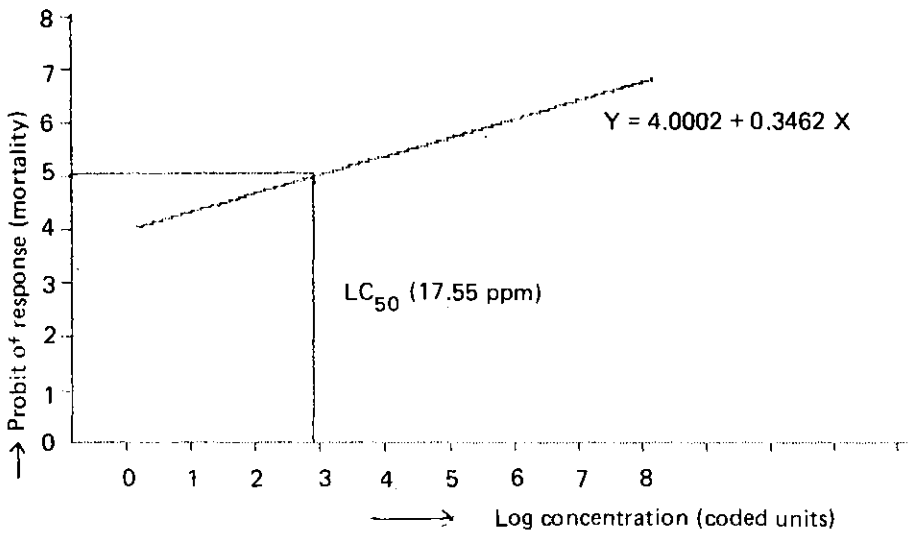

Figure 1 LC_{50} of 'AD Pasta Unbleached' on *Daphnia carinata* King

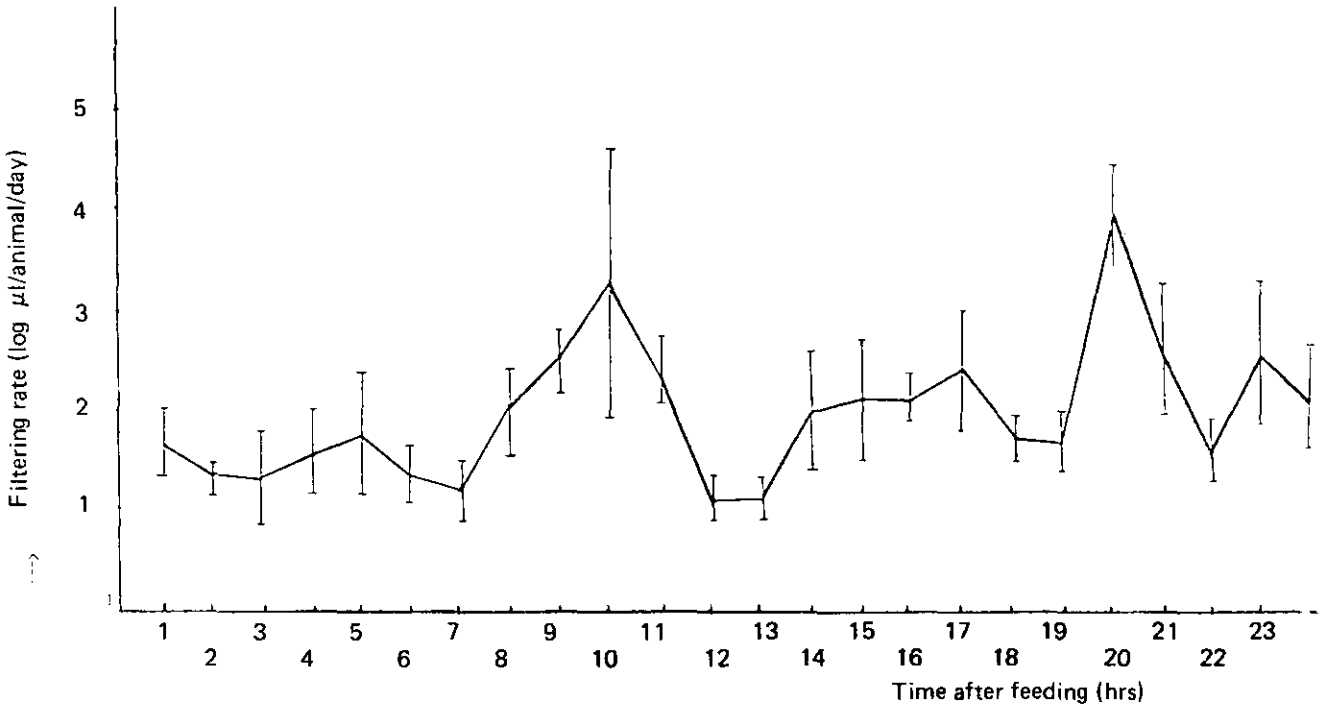

Figure 2 The variation of food filtering process *of Daphnia carinata*

As was expected in hourly measurements of tagged food taken within a period of 24 hours, the filtering process of this crustacean varies with minimum value of 1.147 cc/animal/day and maximum of 2.692 cc/day (fig 2). There seems to be a peak of filtering activity for every 10 hours. In measuring the effect of AD pasta, it was decided to execute the experiments at 1, 2, 4 and 24 hours after the treatment.

For 1 hour observation, the treatments with 10, 50, and 100 ppm AD pasta lowered the filtering process by 91.20, 87.65, and 87.4 percent respectively. The result of 2 hours observation showed the decrease of the filtering process were 86.32, 57.54, and 86.66 percent for the respective treatments.

For 1 hour observation, the treatments with 10,50 and 100 ppm AD pasta lowered the filtering process by 91.20 and 87.4 percent respectively. The result of 2 hours observation showed that the decrease of the filtering process were 86.32, 57.54, and 86.66 percent for the respective treatments. In the 4 and 24 hours observations, the 100 ppm killed the animals and the lowering of the filtering process were 87.31, 88.11 and 65.43, 60.51 percent for 10 and 50 ppm treatments respectively.

Apparently 10 ppm AD pasta depressed the filtering process of *Daphnia* for a period up to 24 hrs. The reduction of the filtering process by AD pasta at the concentration higher than 10 ppm killed the treated animals.

While the size of the experimental animals is important in this bioassay works, a correlation was made between the length of *Daphnia* and the filtering process of the treated animals. For 1, 2, 4, and 24 hours observations at 10 ppm treatment, the results were respectively (Y = food filtering process, X = body length):

$Y = 20.7\ X^{1.32}$ (1 hr)

$Y = 9.54\ X^{1.45}$ (2 hrs)

$Y = 28.4\ X^{1.45}$ (4 hrs)

$Y = 3.94\ X^{6.08}$ (24 hrs)

The overall picture on the correlation between the body length, the consentration of AD pasta, and the time of observation did not show any clear cut results (fig 3, 4, 5 and 6). However, Cooley (1977) reported that there was a correlation between the body length of *Daphnia retrocurva* and the food filtering process which were $Y = 2.46\ X^{1.63}$ for control and $Y = 1.92\ X^{1.26}$ for treatment.

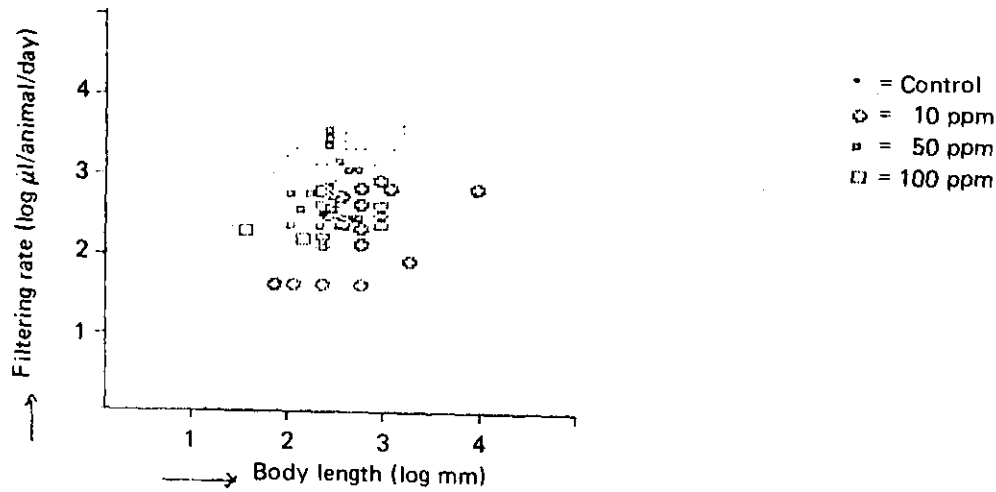

Figure 3 Filtering rates of *Daphnia carinata* King after one hour treatment with 'AD Pasta Unbleached'

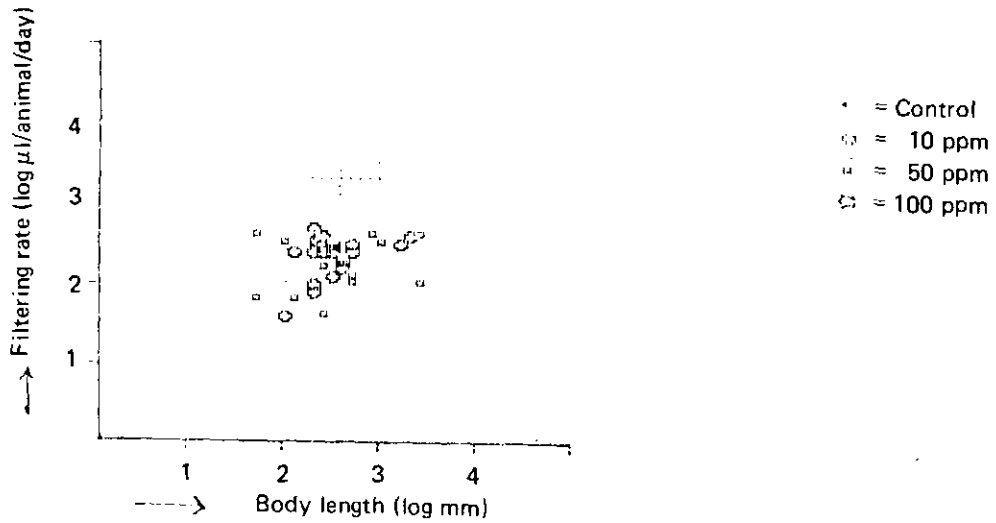

Figure 4 Two hours treatment

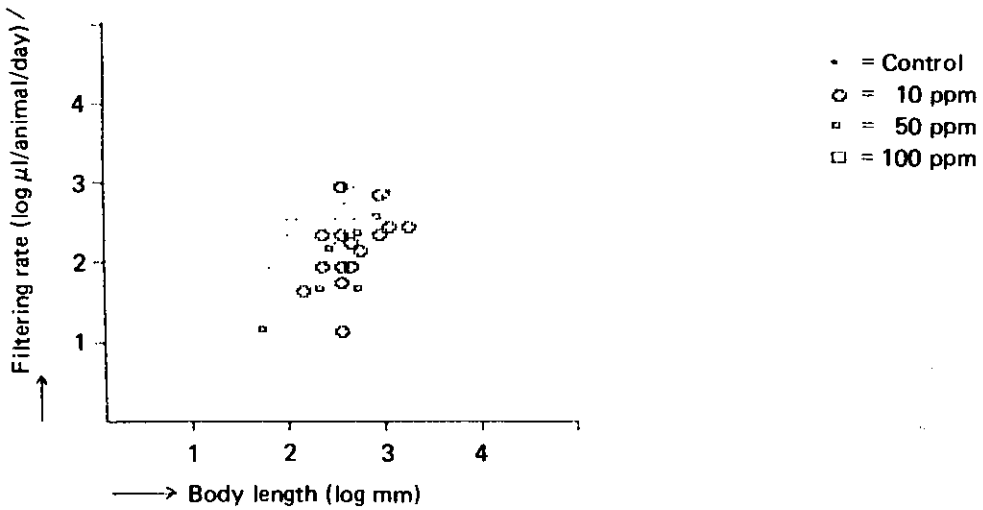

Figure 5 Four hours treatment

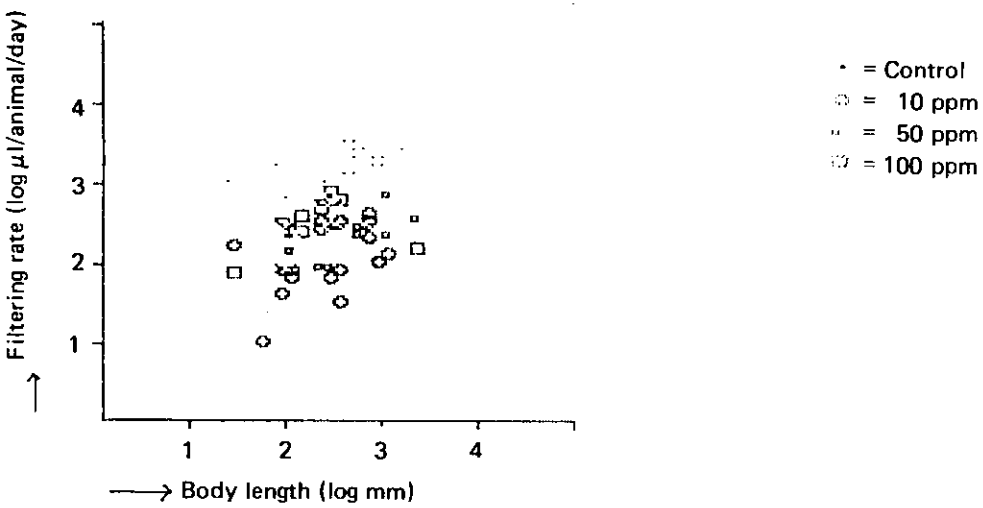

Figure 6 Twenty four hours treatment

REFERENCES

Abel, P. D. 1974, Toxicity of Synthetic Detergent to Fish and Aquatic Invertebrates, *J. Fish Biol*, 6(3): 279–298.

Cairns, J. J. and K. L. Dickson, ed. 1973. Biological Methods for the Assessment of Water Quality, *ASTM Special Technical publication* 528; American Soc. for Testing and Materials.

Cooley, J. M. 1977. Filtering Rate Performance of *Daphnia Retrocurva* in Pulp Mill Effluent, *Journ. of the Fisheries Research of Canada.* Special Issues; vol. 34, no. 6.: 863–868.

McMahon, J. W. 1968. Environmental Factors influencing the Feeding Behaviour of *Daphnia magma* Strauss, *Canadian Journal of Zoology*, Vol. 46.

Swartz, R. C. 1972. Biological Criteria of Environmental Change in the Chesapeake by, *Chesapeake Science*. vol. 13: 17–41.