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Safe and Reliable Drinking Water by the Ecological Filter of Slow Sand Filtration

Ecological Purification System

New Concept of Slow Sand Filtration System

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Safe and Reliable Drinking Water by the Biological Filter of Slow Sand Filtration

Ecological Water Purification System

New Concept of Slow Sand Filtration System

*Are you sure!
This water is Safe?*

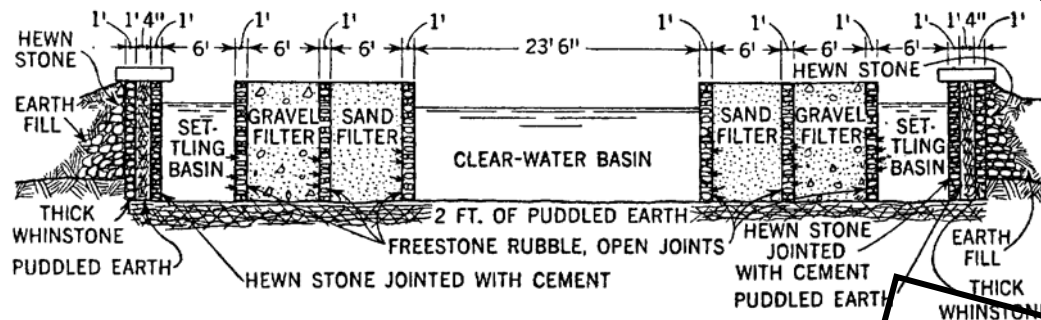
Which is more safe?



Seepage water in flood plain : clear water: Mechanical separation by sand and gravel layer

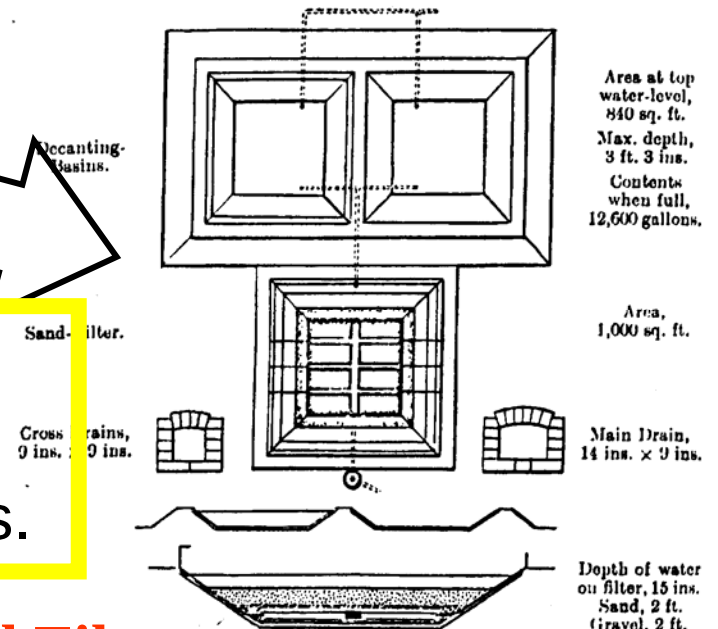
Origin of Public Water

Supply : at Paisley, Scotland, in
1804, by John Gibb.



James Simpson's Filter of
1827-28. at London, UK

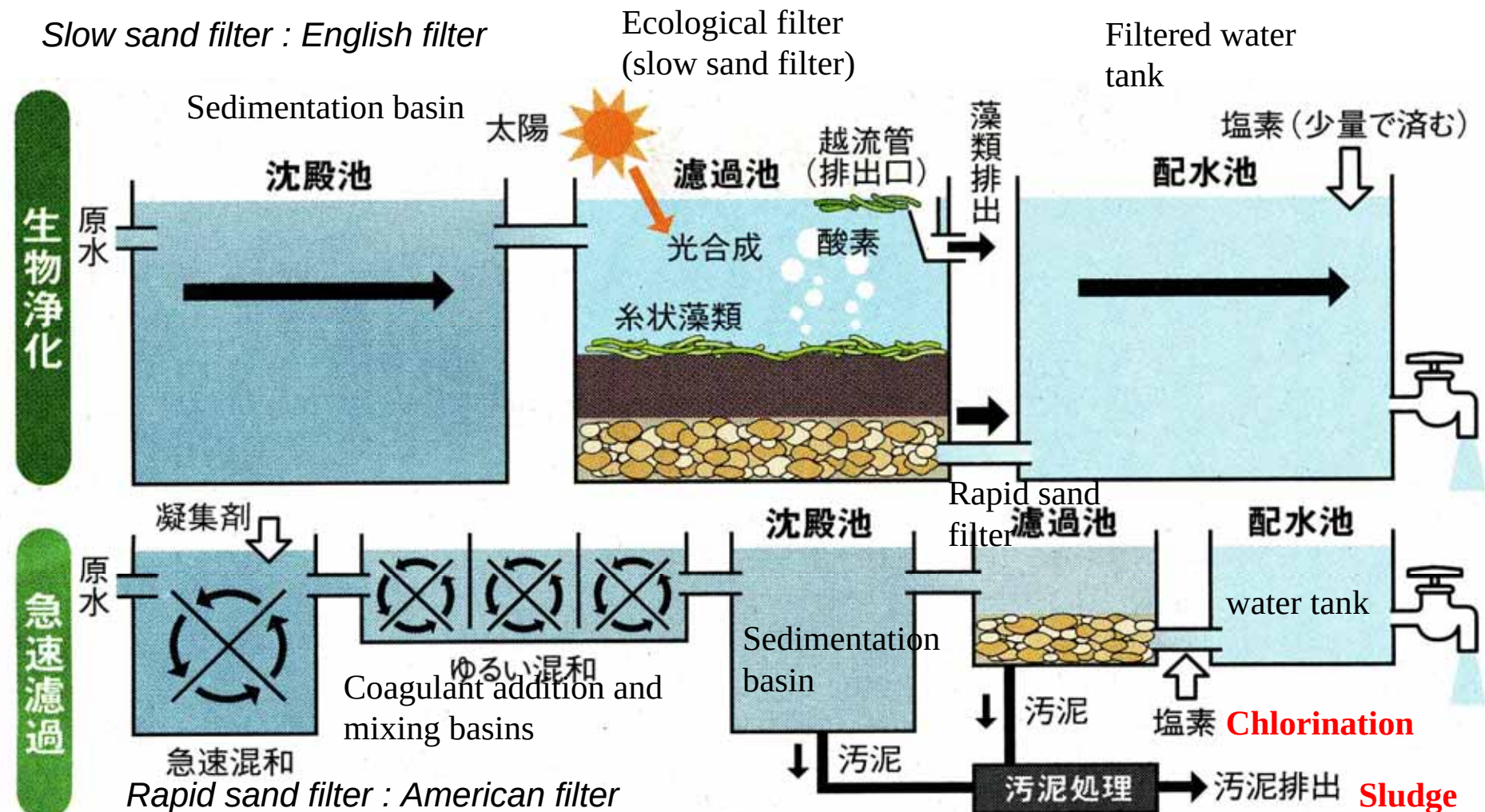
They believed that clear bacteria free
water was produced by mechanical
filtration using fine sand and slow process.

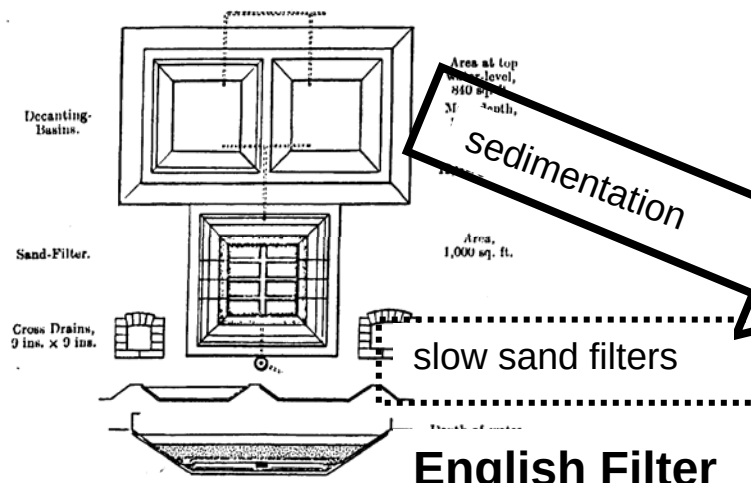


Origin of the process name: Slow Sand Filter

Slow Sand Filtration : Not Mechanical Filter→Biological Filter →Ecological Water Purification System

Fine small sand is not important. Faster flow water current is necessary to keep aerobic environment for small animals.





English Filter
Ecological Purification System
Natural Filter



American Filter

Rapid Sand Filter :
Mechanical and
Chemical Treatment

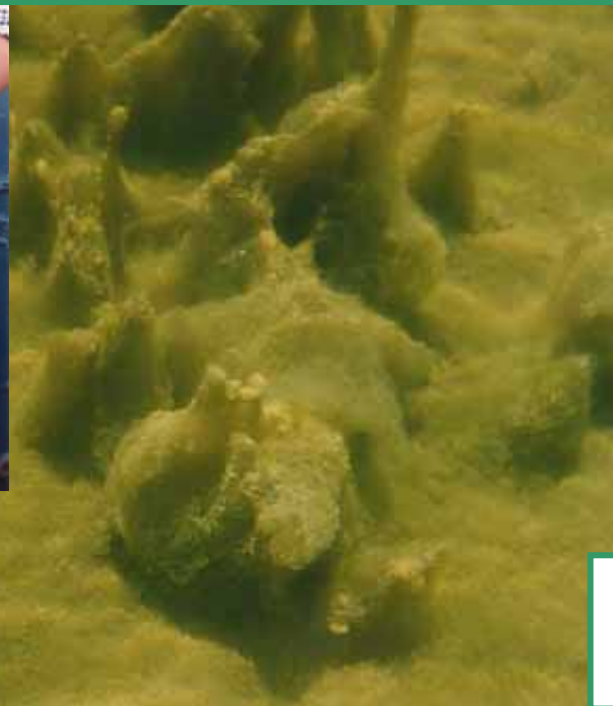
Commercial
Filter



Continuous culture system of filamentous algae

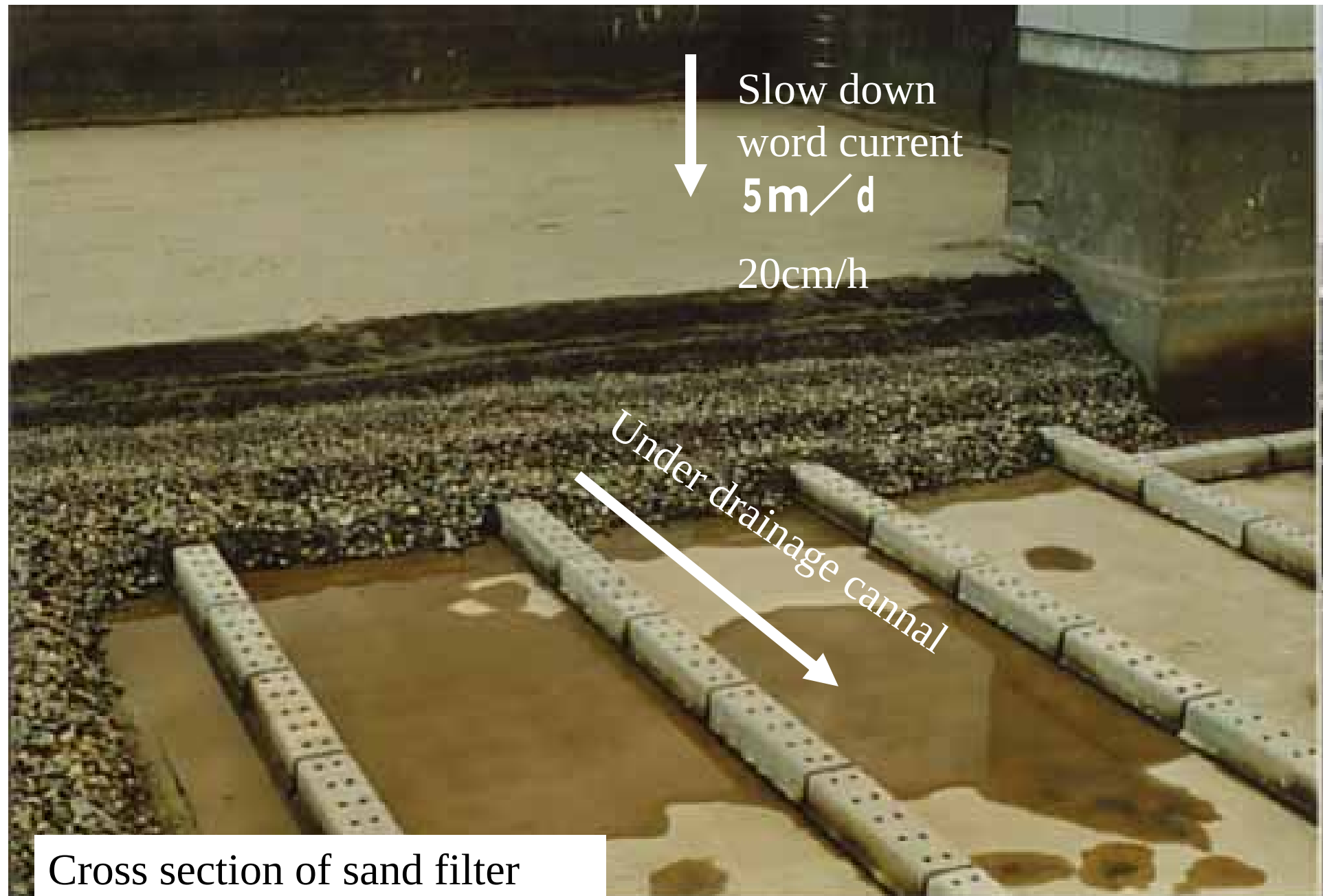


Float by bubbles produced by photosynthesis.

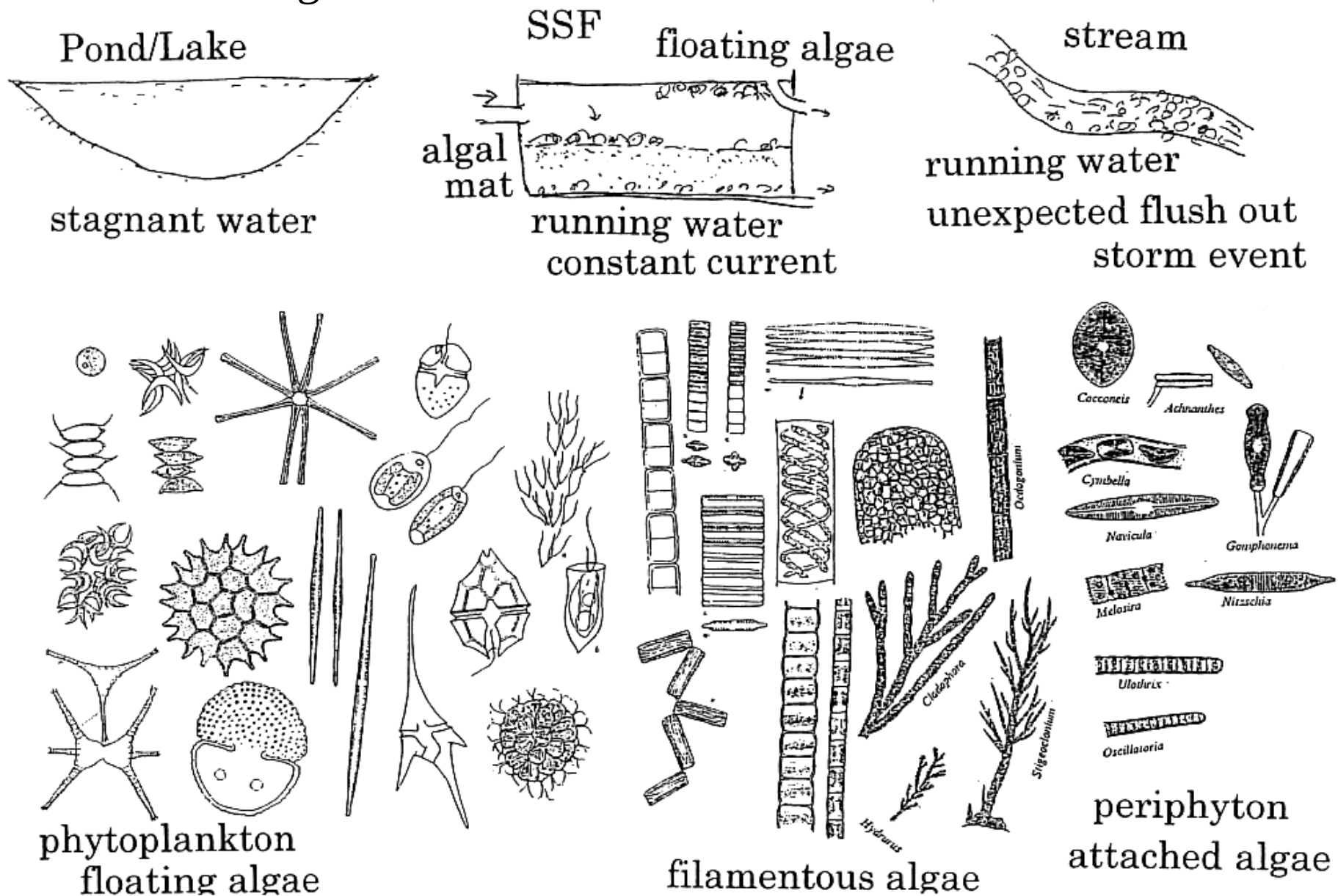


Trap SS on filamentous algae

Slow sand filter = make a sub-surface (ground) water in flood plain



SSF(Ecological Purification System) is the suitable environment for filamentous algae.

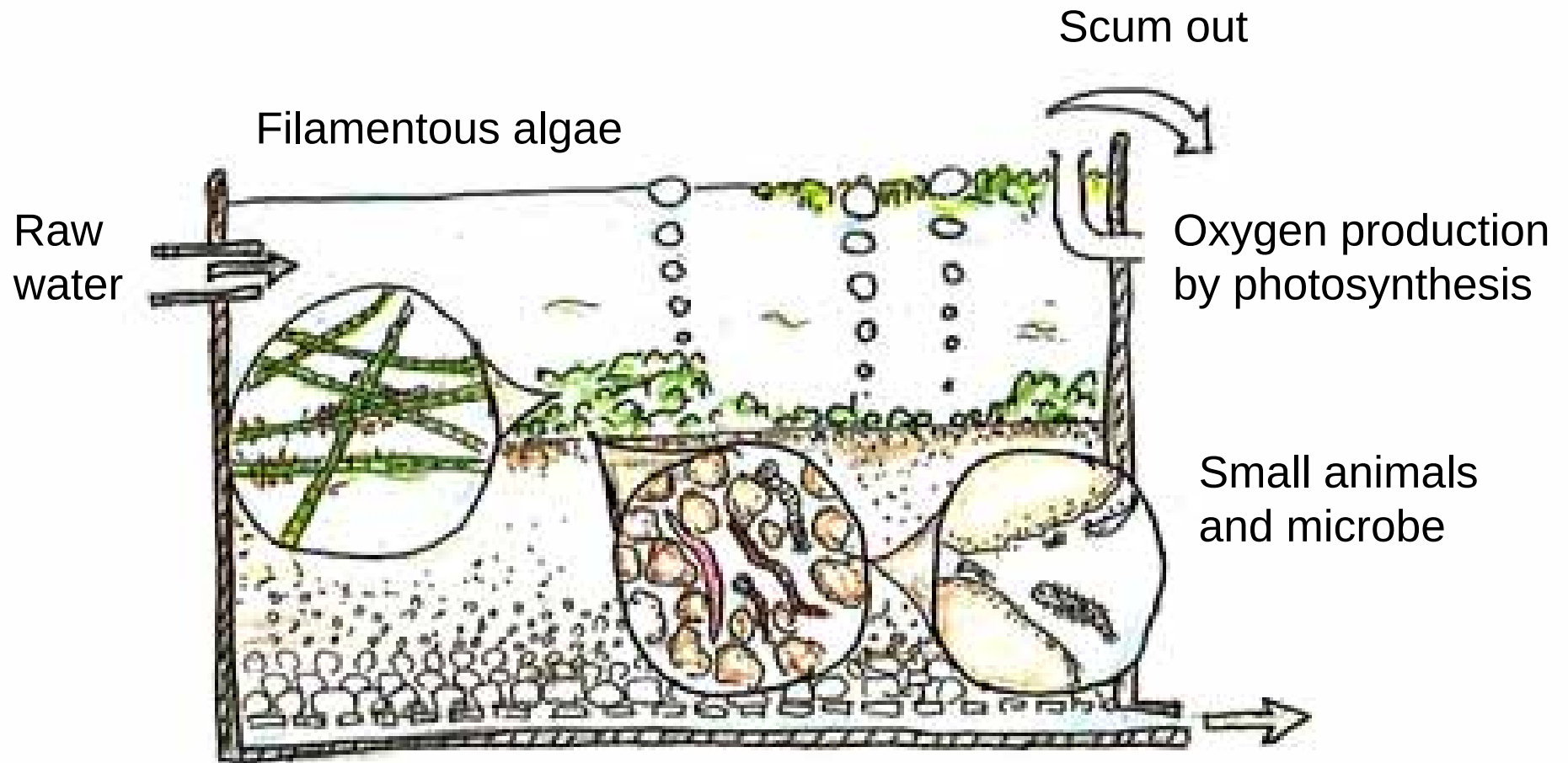




Slow Sand Filtration (*Mechanical Filter*)

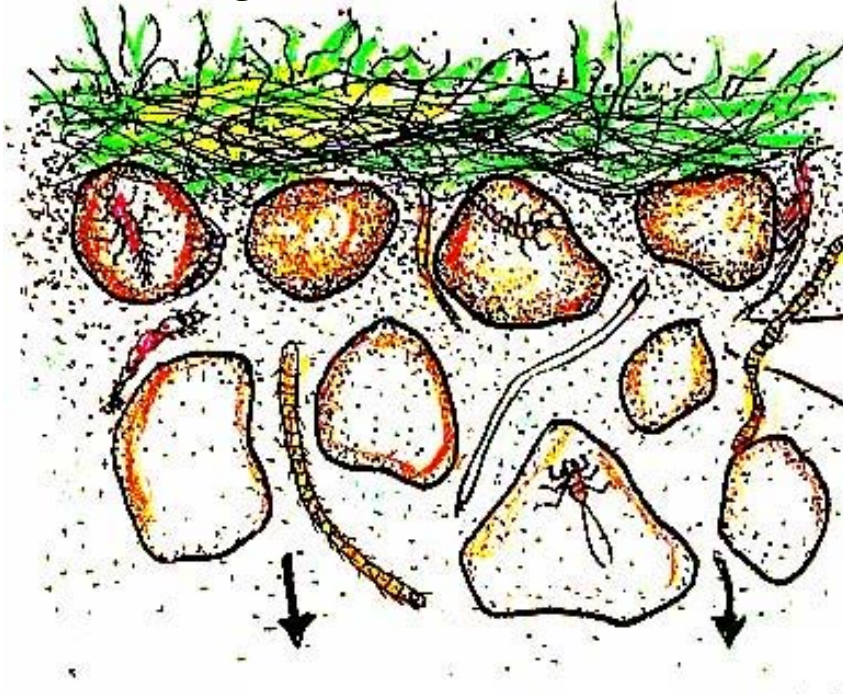


Ecological Purification System

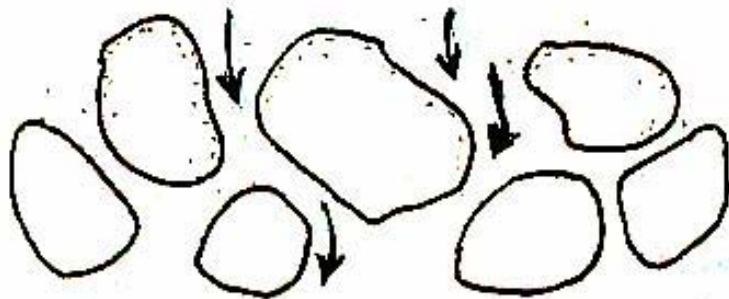


Safe and delicious drinking water by biological activity

Algae: food for animals

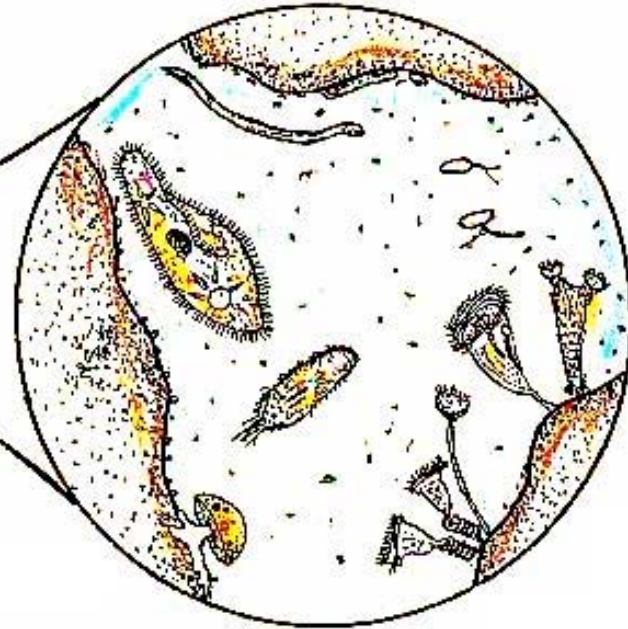


Natural flow



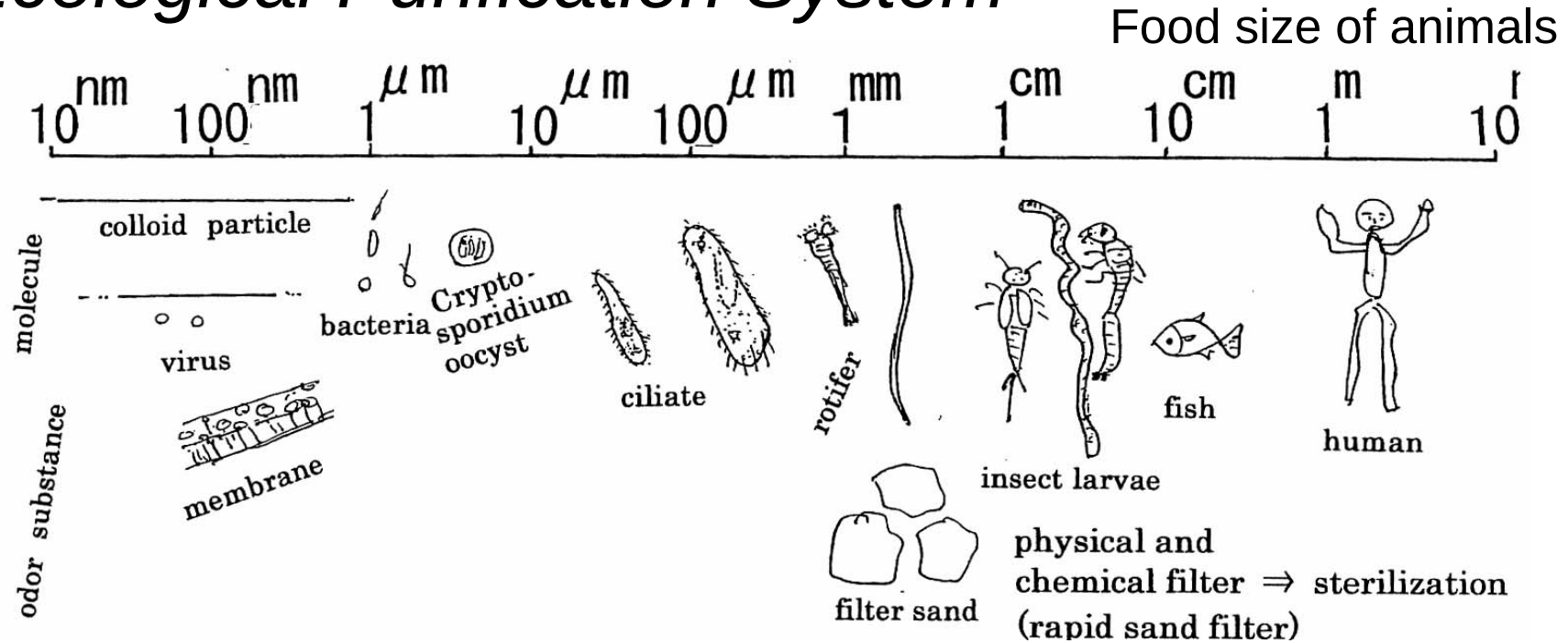
Particle free water: ready to drink as safe water

Remove particulate and dissolved matters.



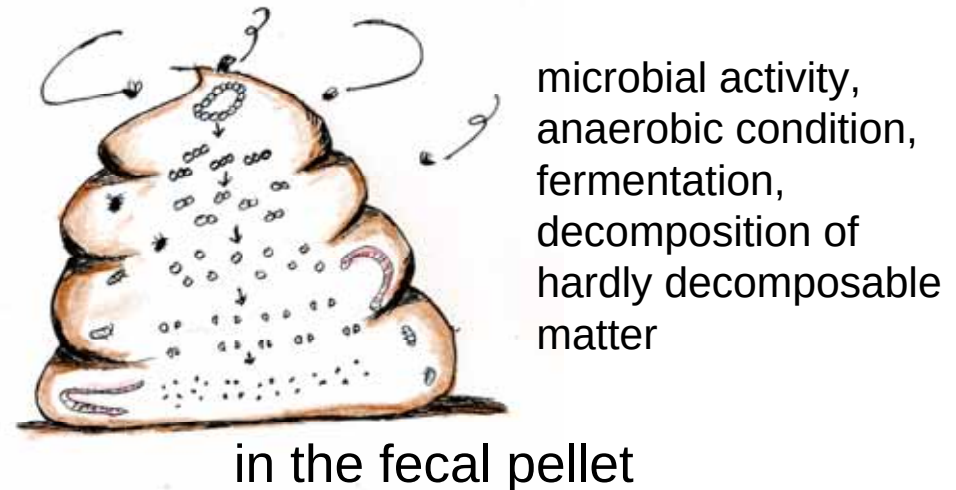
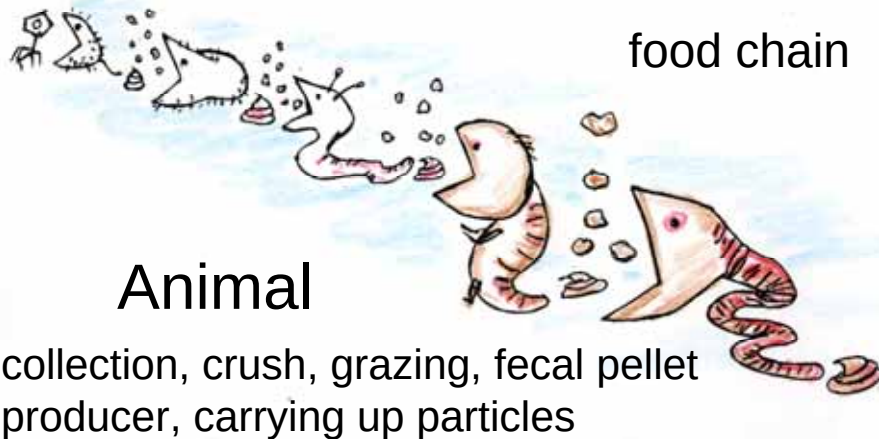
It is essential that presence of oxygen for biological community. Small animals are catcher of particulate matter. Food chain is important. Dissolved oxygen in the fecal pellet is almost consumed up. It becomes anaerobic condition.

Ecological Purification System

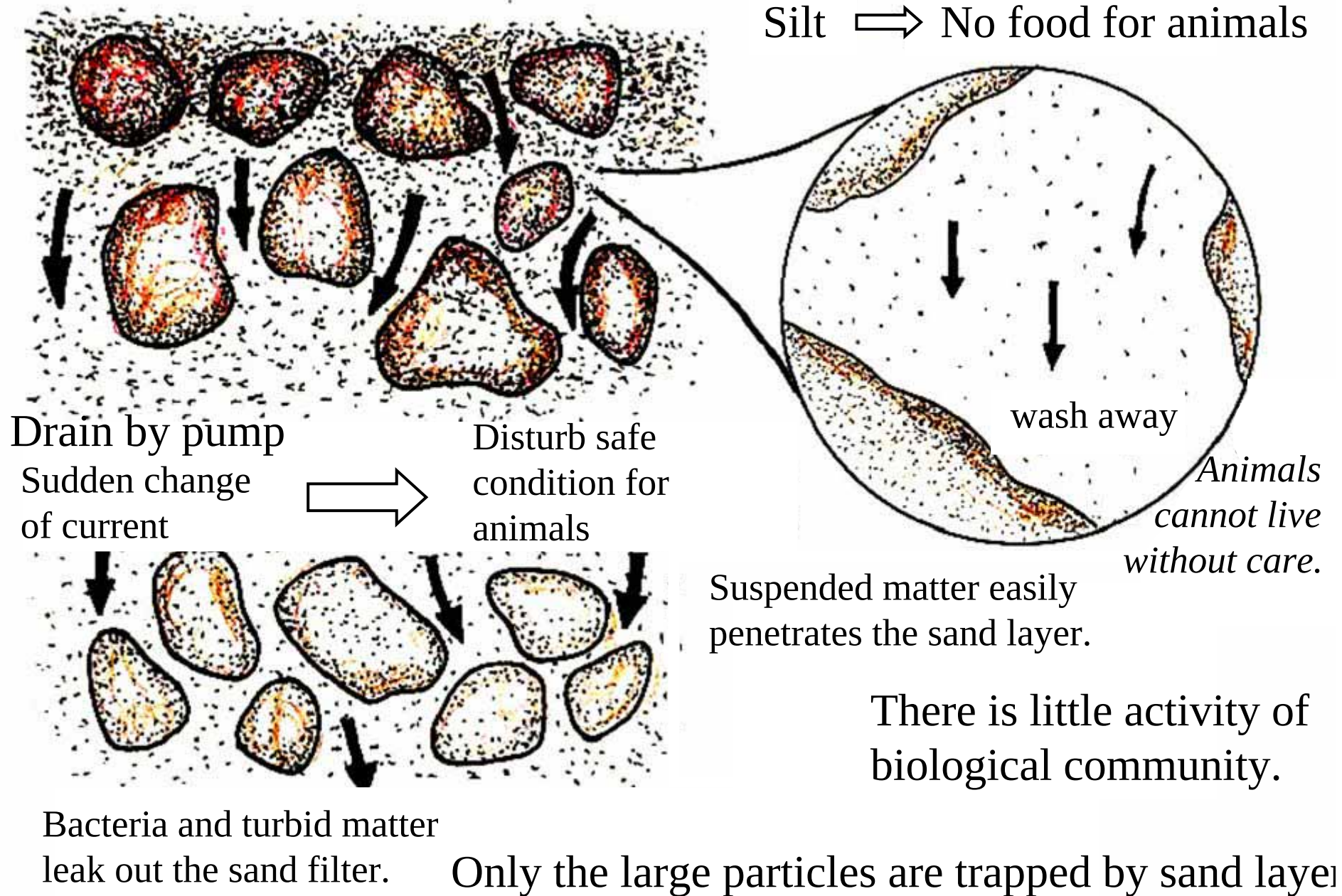


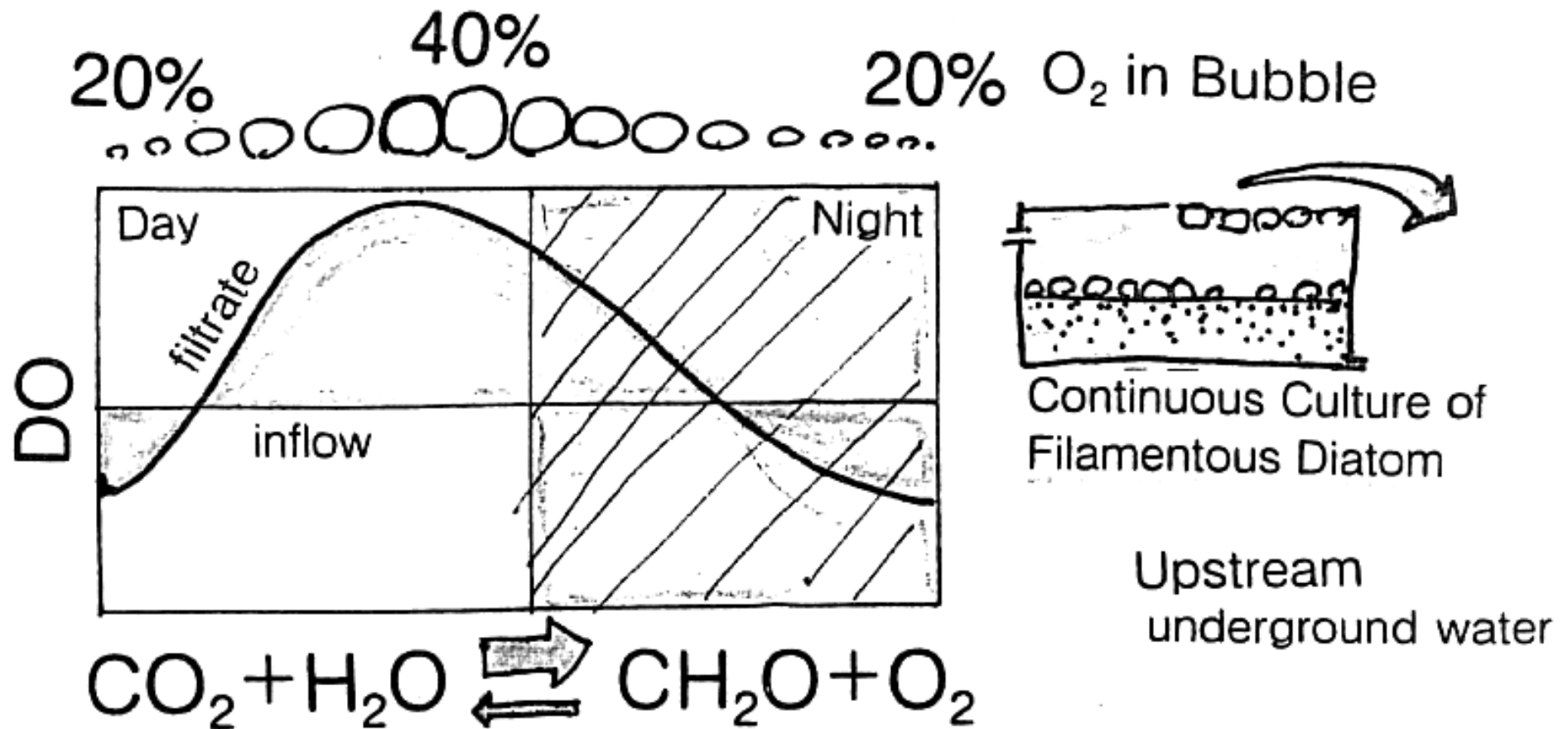
Short term work

Long term action



Silt $\Rightarrow$ No food for animals



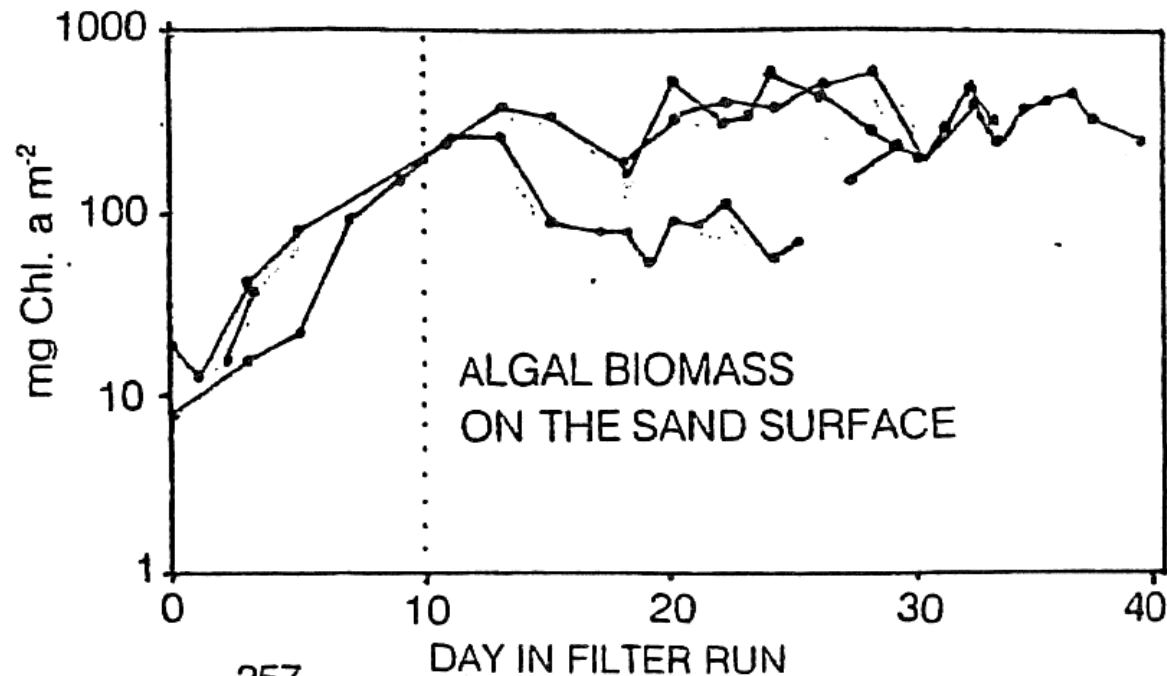


Active growth of algae makes better condition of effluent.

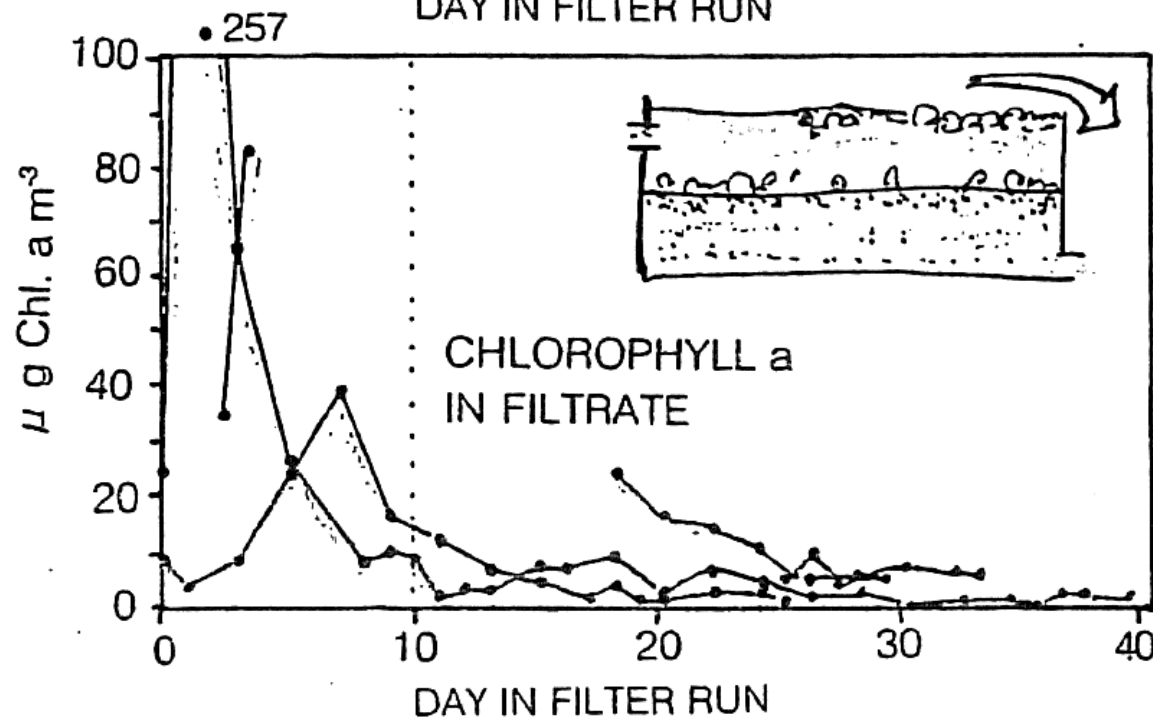
Continuous culture system of algae is important to keep better condition.

Partial pressure of oxygen in bubbles reaches about 40 % under sunshine due to photosynthesis. And it decreases during the night. Oxygen in the bubble released into the water.

Therefore, the daily harvest of floating algae acts is a better treatment.



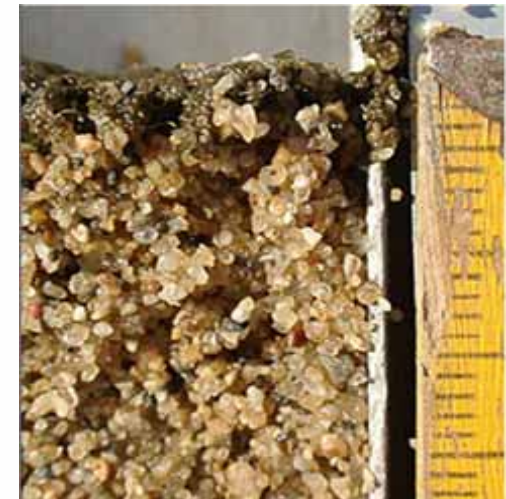
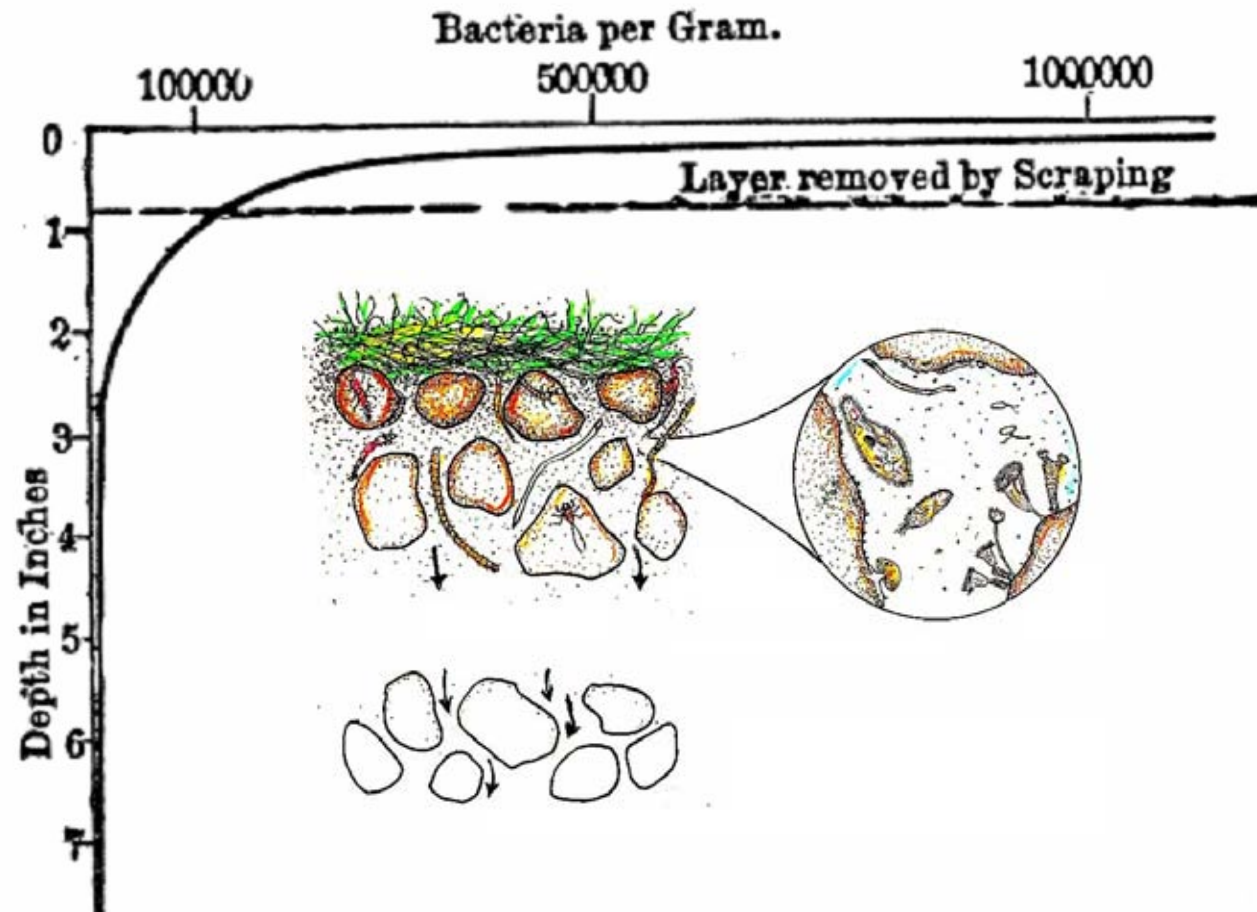
Algae grow well in summer. Continuous culture system of filamentous algae becomes after 10 days.



Filtrate water becomes clear water in 10 days. In summer, scrapping of surface mud is not necessary.

Passing through the active layer where microbe live in the upper sand layer of 1 to 2 cm. It takes only several minutes. It means really instant process.

One meter of sand layer means insurance.





Even cold winter, filamentous diatom can grow well. There is enough sun shine. Suspension free water is essential.





Filamentous diatom of *Melosira*



Ecdysis case of midge larvae are remarkable in warm period. Grazing activity is higher than cold season.



In the short filter run, filamentous diatom dominates. This is the pioneer stage.

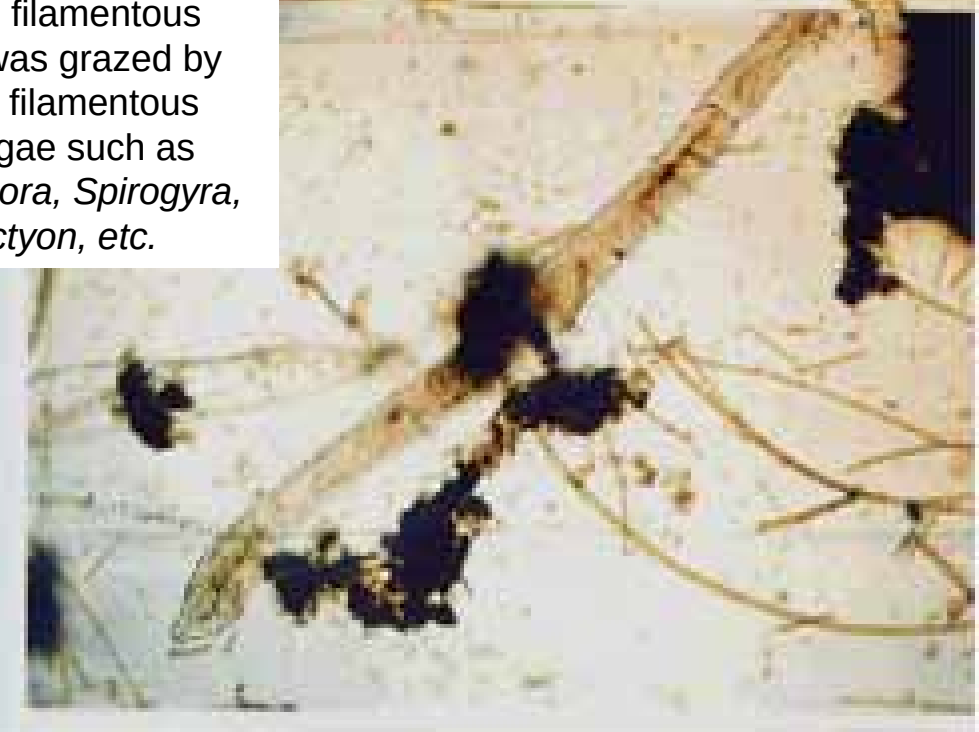


After the filamentous diatom was grazed by animals, filamentous green algae such as *Cladophora*, *Spirogyra*, *Hydrodictyon*, etc.





After the filamentous diatom was grazed by animals, filamentous green algae such as *Cladophora*, *Spirogyra*, *Hydrodictyon*, etc.



Algal succession caused by grazing animals.

Photosynthetic
Organisms



Filamentous diatom

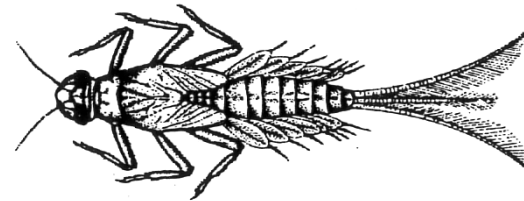
Melosira, Flagiralia

Grazing animals

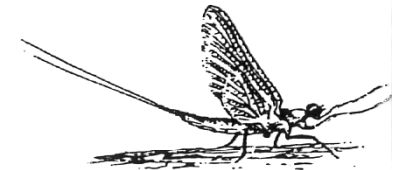
Poikirothermal animal



Midge :
Chironomus



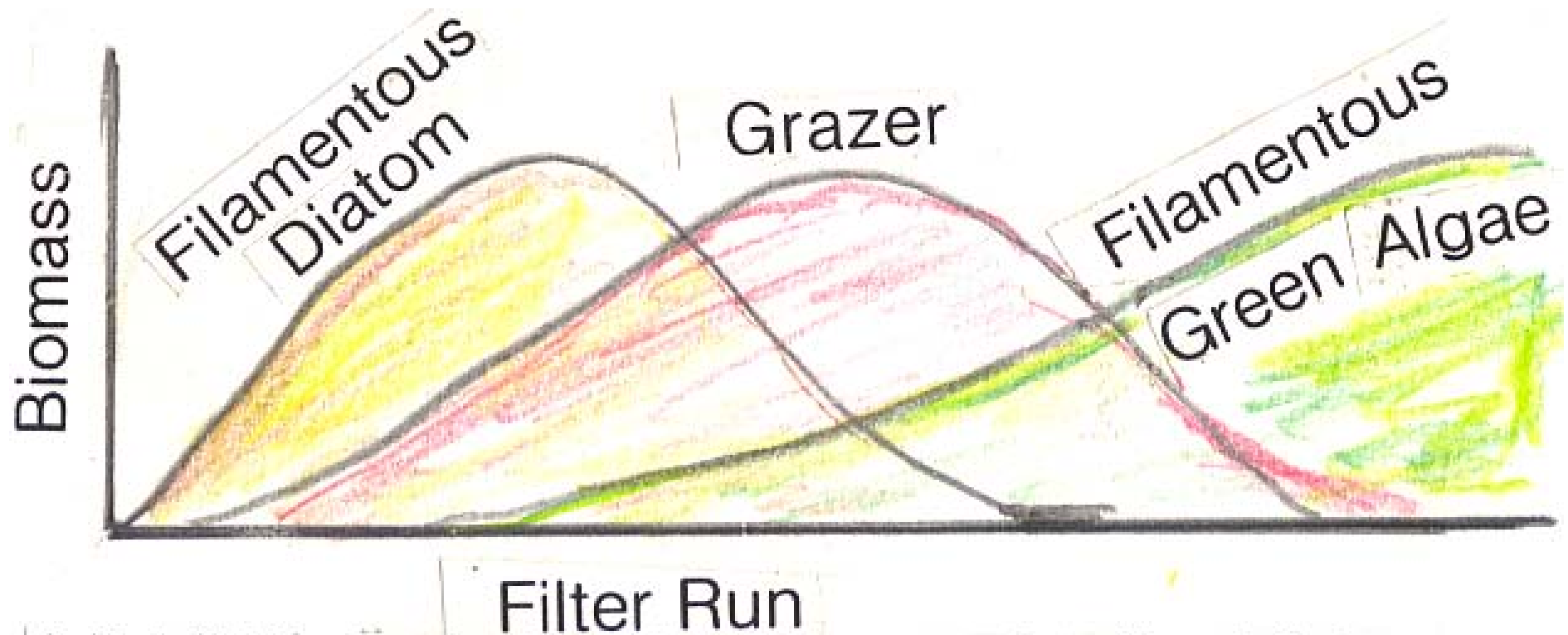
Insect larvae : Mayfly nymph



Filamentous green algae
Spirogyra, Cladophora

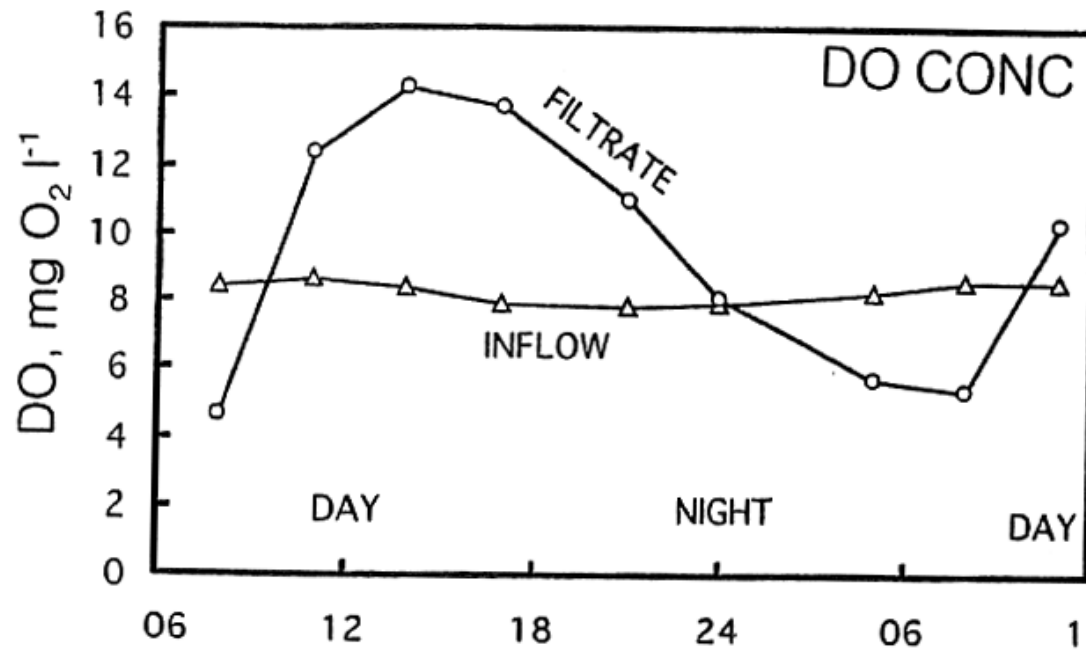
In case of long filter run, green algae dominates.

Succession: from filamentous diatom to filamentous green algae caused by grazing animals.

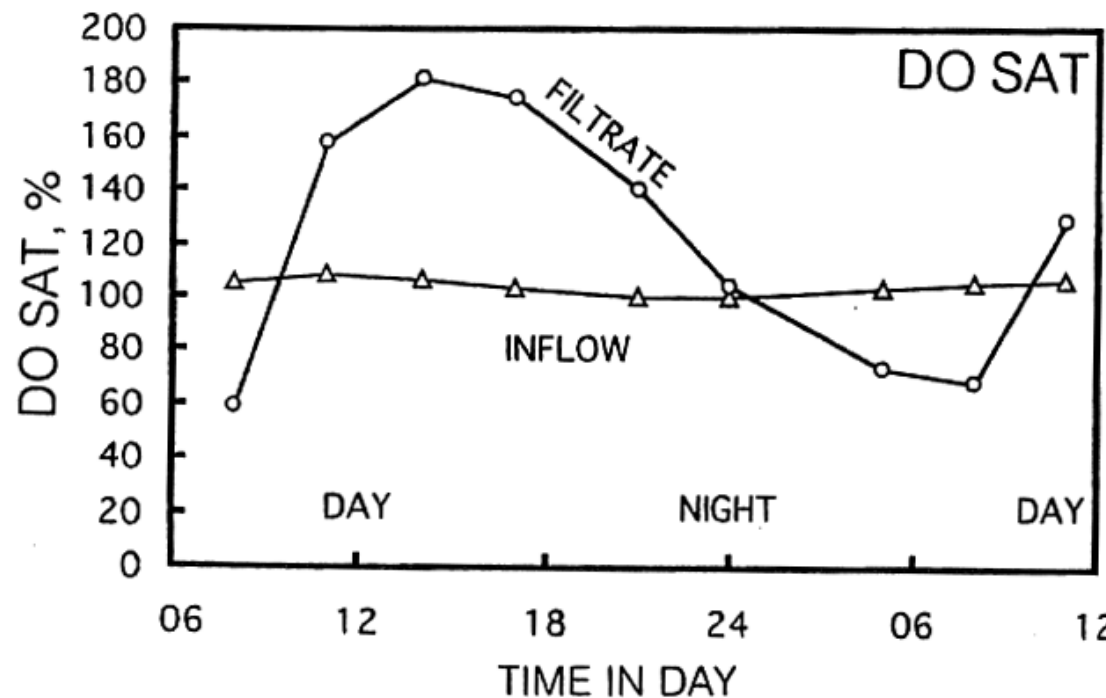
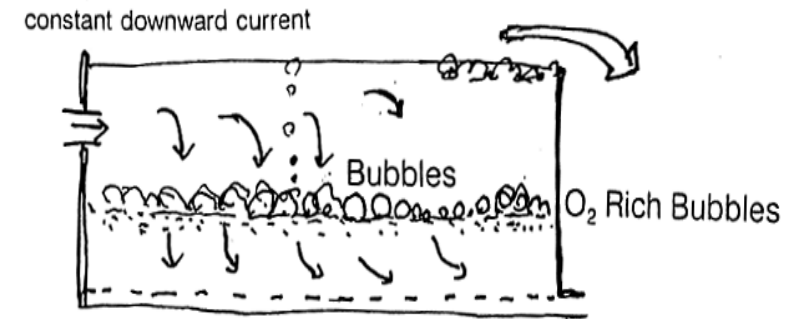


糸状珪藻がユスリカ幼虫に捕食されると糸状緑藻に遷移する。

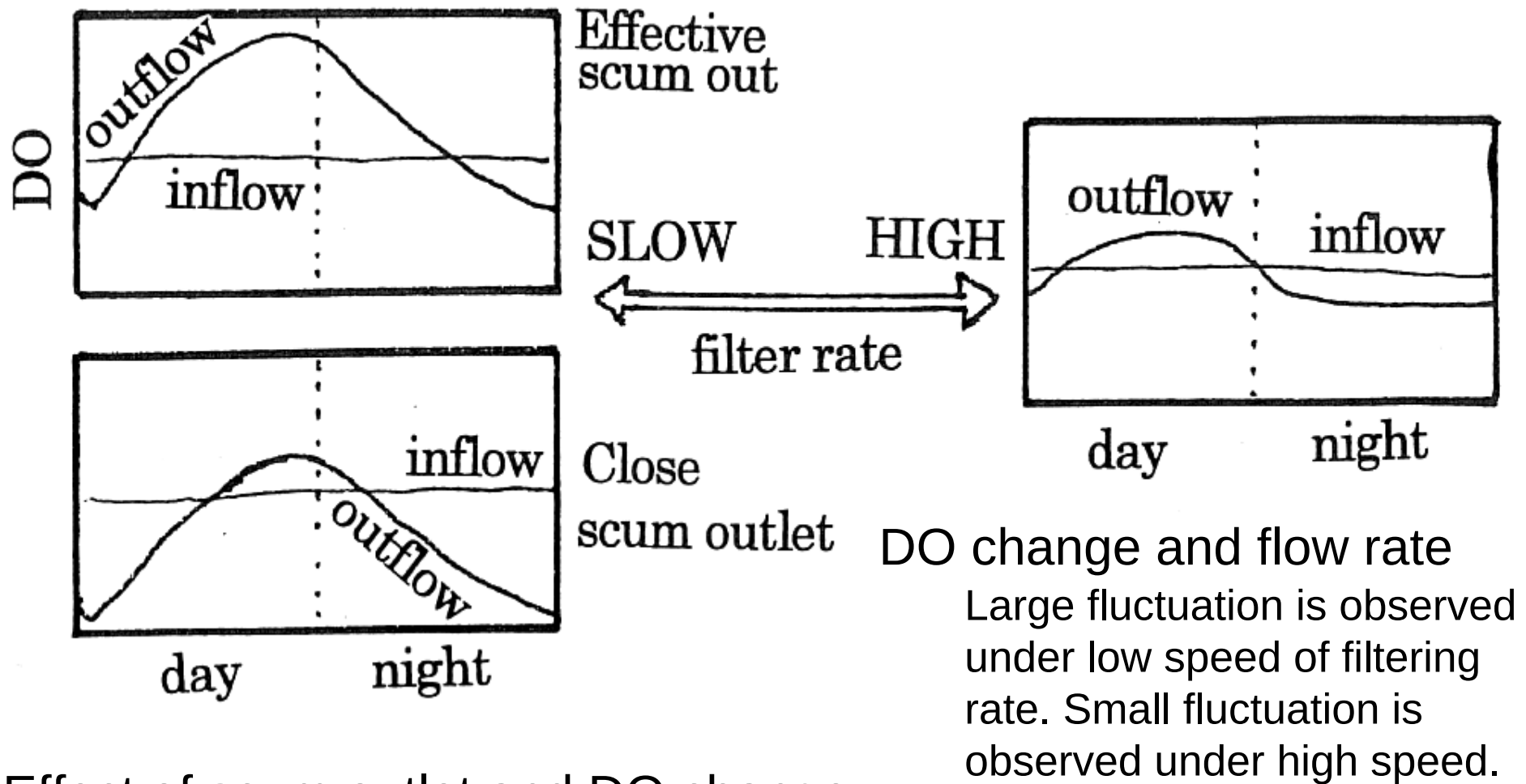
In case of long filter run, mollusk appears and other carnivorous animals are also seen.



Diurnal DO changes in inflow water and in outflow water.



Inflow DO is almost constant. Outflow DO shows a large diurnal fluctuation. Passing time is about 2 or 3 hrs. DO concentration rapidly increases after the sunrise. High concentration of DO in outflow water remains after the sunset. Oxygen in bubbles keeps high concentration after the sunset.



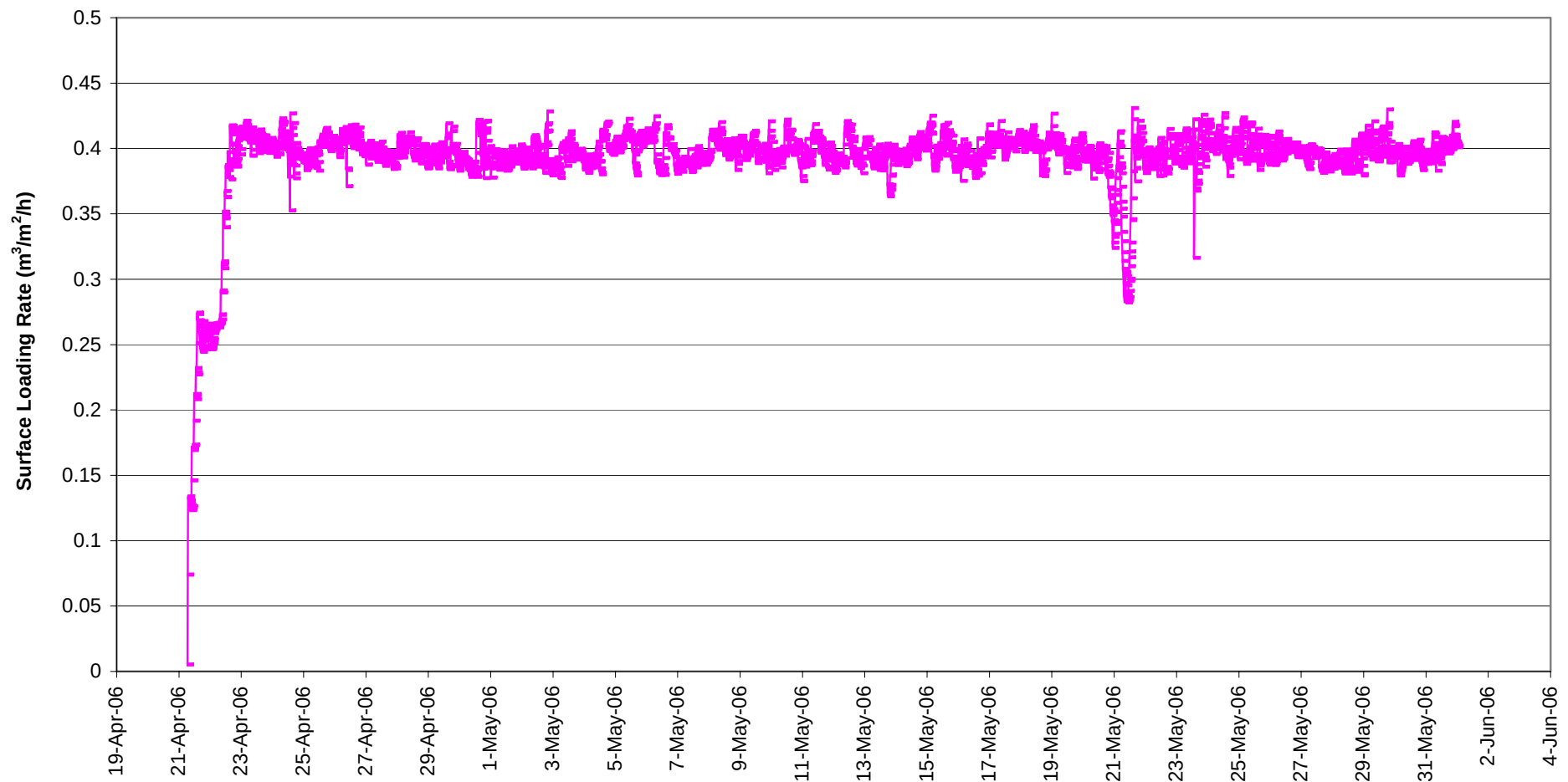
Effect of scum outlet and DO change

Effective removal of floating scum is necessary to keep favorable DO condition in night. Algae produce oxygen when they grow. When they die, they consume much oxygen. Oxygen releases from the surface to atmosphere. During the night, oxygen consumption becomes high. Sometimes, low oxygen makes unpalatable effluent water under low DO concentration.



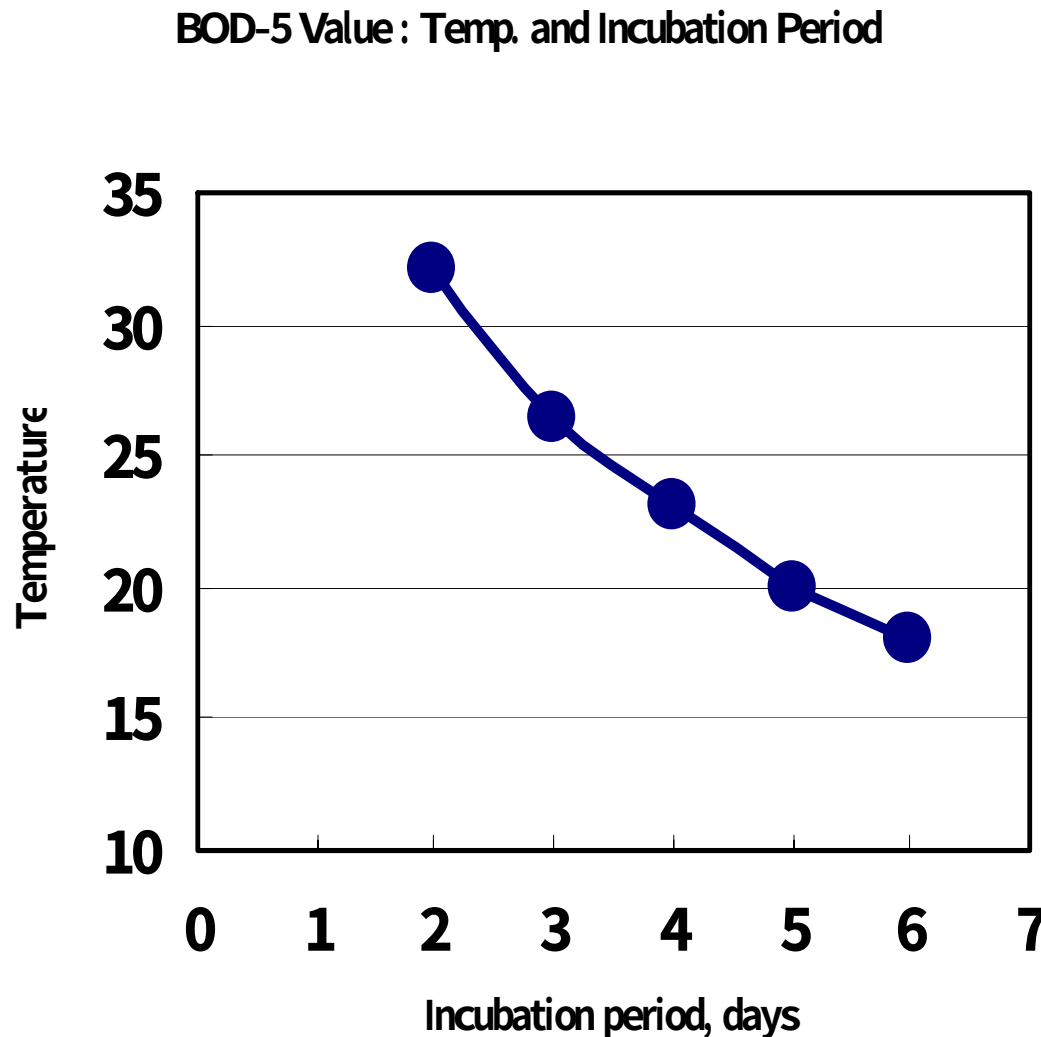
100 % of tap water in London city is supplied by slow sand filter. Thames river water is eutrophic water. At first, river water stock for about one month in a reservoir. Then it is treated by a gravity rapid sand filter without any chemical reagent to eliminate plankton. And ozone treatment, slow sand filtration are done. It flow rate is 9.6 m/d (40cm/hour). This is double rate of traditional standard rate.

Surface Loading Rates for a SSF at Ashford Common AWTW during April and May 2006



All the plant of Thames waterworks adopted 9.6m/d (0.4m/h).
Higher flow rate makes better quality in the filtered water.
Diurnal change of DO in effluent water becomes small. It is
better to avoid low oxygen concentration in the morning.

Biological activity of microbe is related with temperature. BOD-5 (days) is invented to evaluate at the most worst condition in London canal at the warm summer.

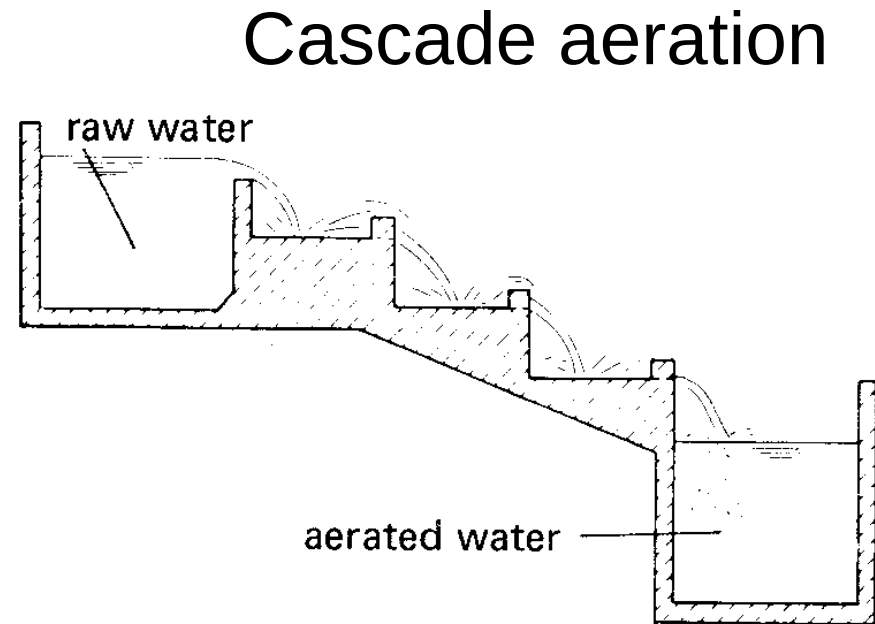
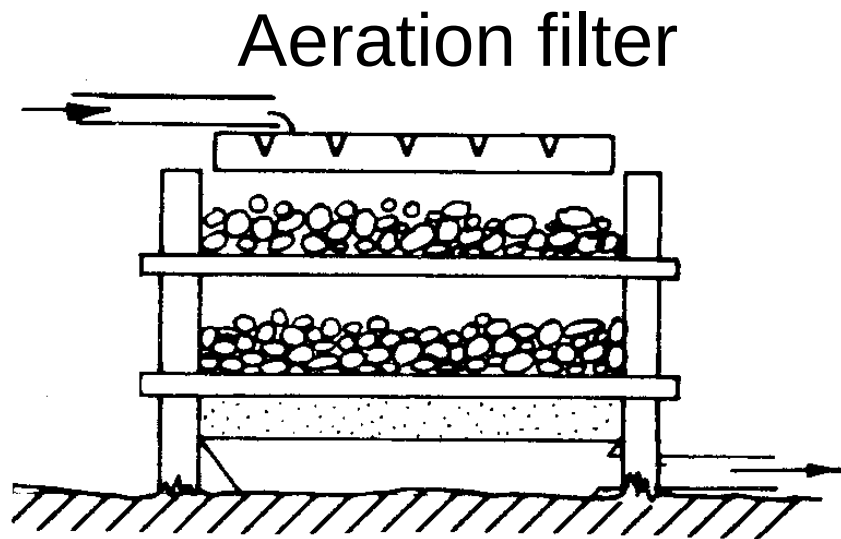


BOD-5 (days) is a common bio-assay test to evaluate the amount of available organic matter in water. This assay is the amount of oxygen consumption by microbe at 20 C and during 5 days.

However, microbial activity is high at the high temperature. Same amount of organic matter is consumed up during a shorter incubation period under the higher temperature.

This means, dissolved oxygen in the polluted river in the tropical region easily consumed up during short period.

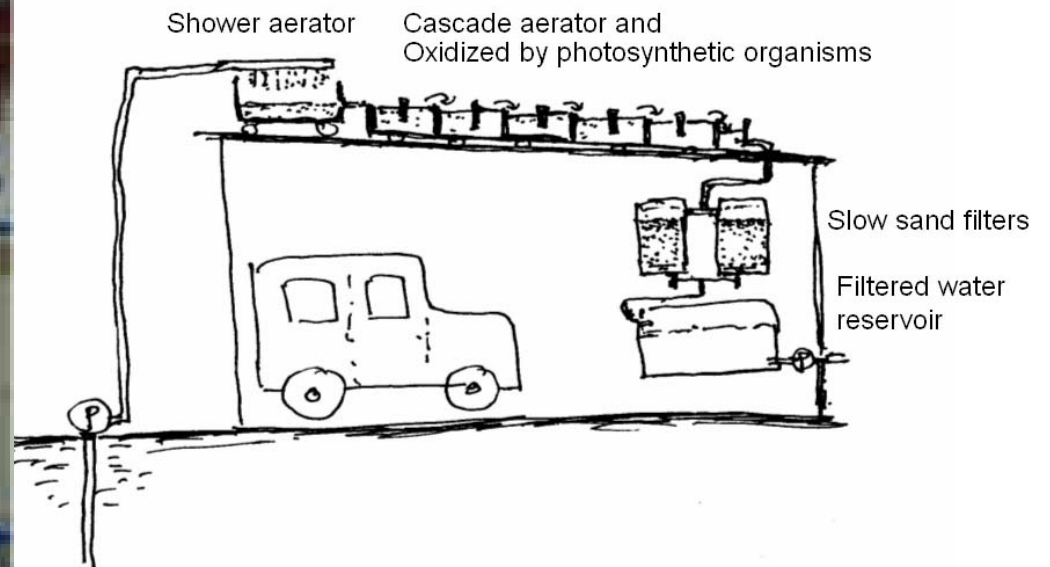
Addition of oxygen: Aeration is frequently used for treatment of groundwater (reduction of unpleasant tastes and odors, discoloration, precipitation of iron and manganese).



Iron and manganese are oxidized and form nearly insoluble hydroxide sludge. They can be removed in a settling tank (a coarse filter).

Heber 1985

Family use of an ecological purification plant.



Indonesia

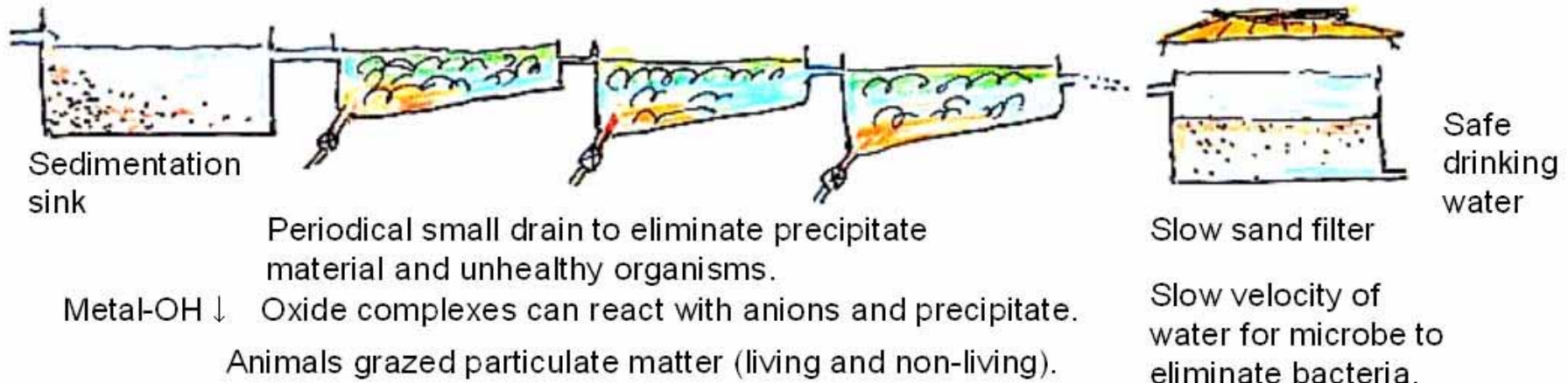


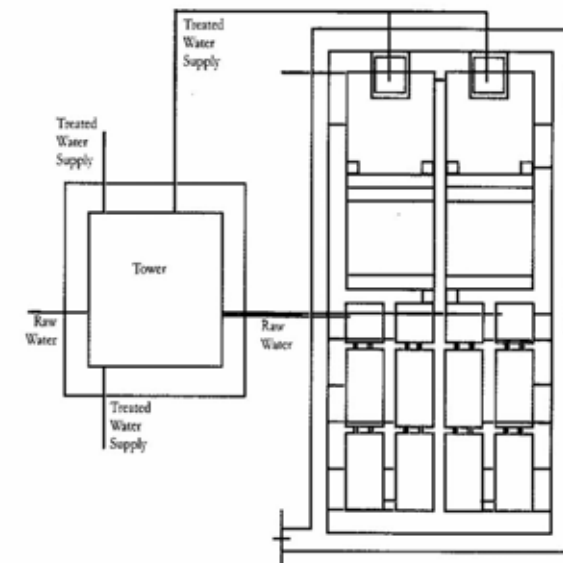
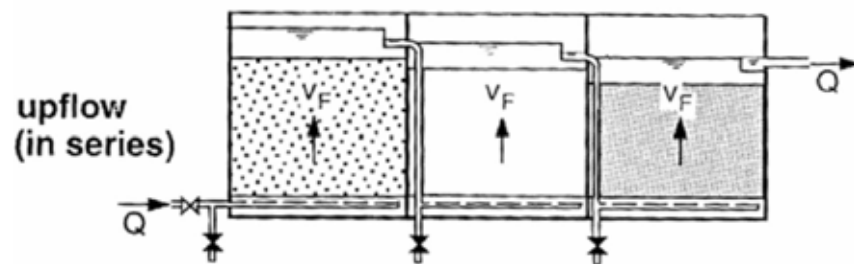
New biological pre-treatment for SSF

Active growth of algae : holding stick (code) for filamentous algae

$O_2 \uparrow \rightarrow$ bubbles $\rightarrow$ keep aerobic condition

$pH \uparrow \rightarrow$ precipitate oxide and hydroxide complexes.





Upflow roughing filter is easy to maintenance to remove trapped particle among the gravel chamber.



Bangladesh: water source is surface water of an eutrophic oxbow lake

Nigeria, Africa: SSF plant was completed 2004.7: Niger delta.



Artificial subsurface water.

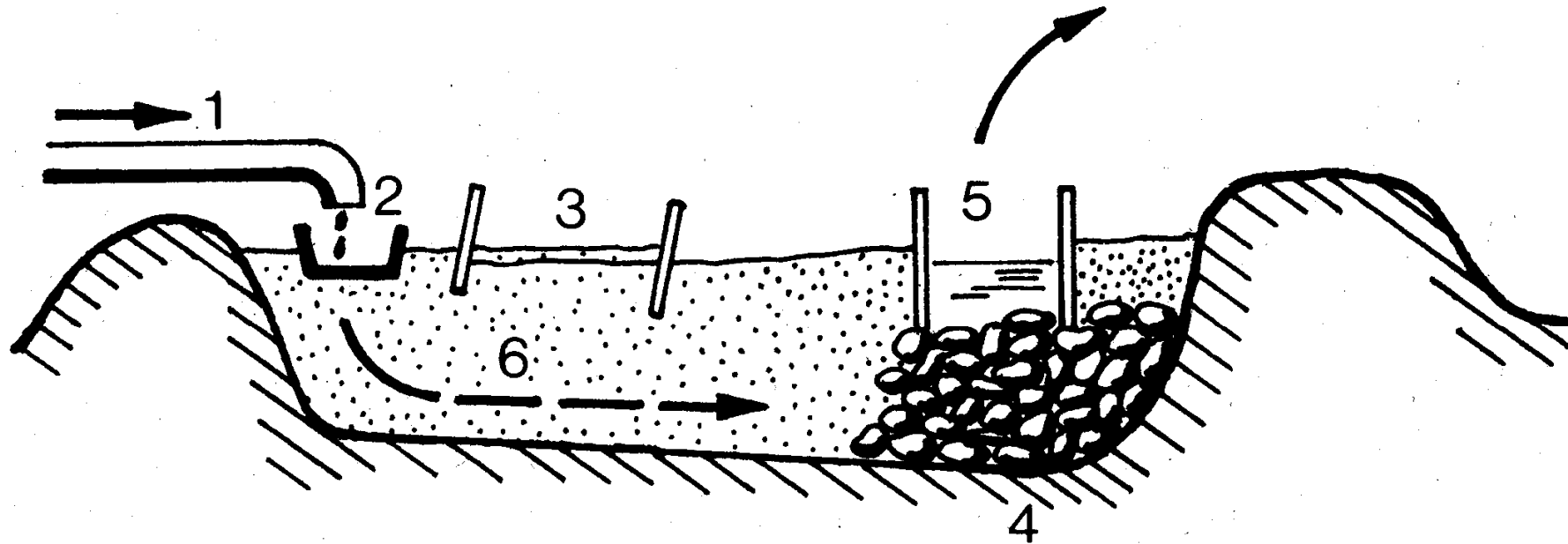
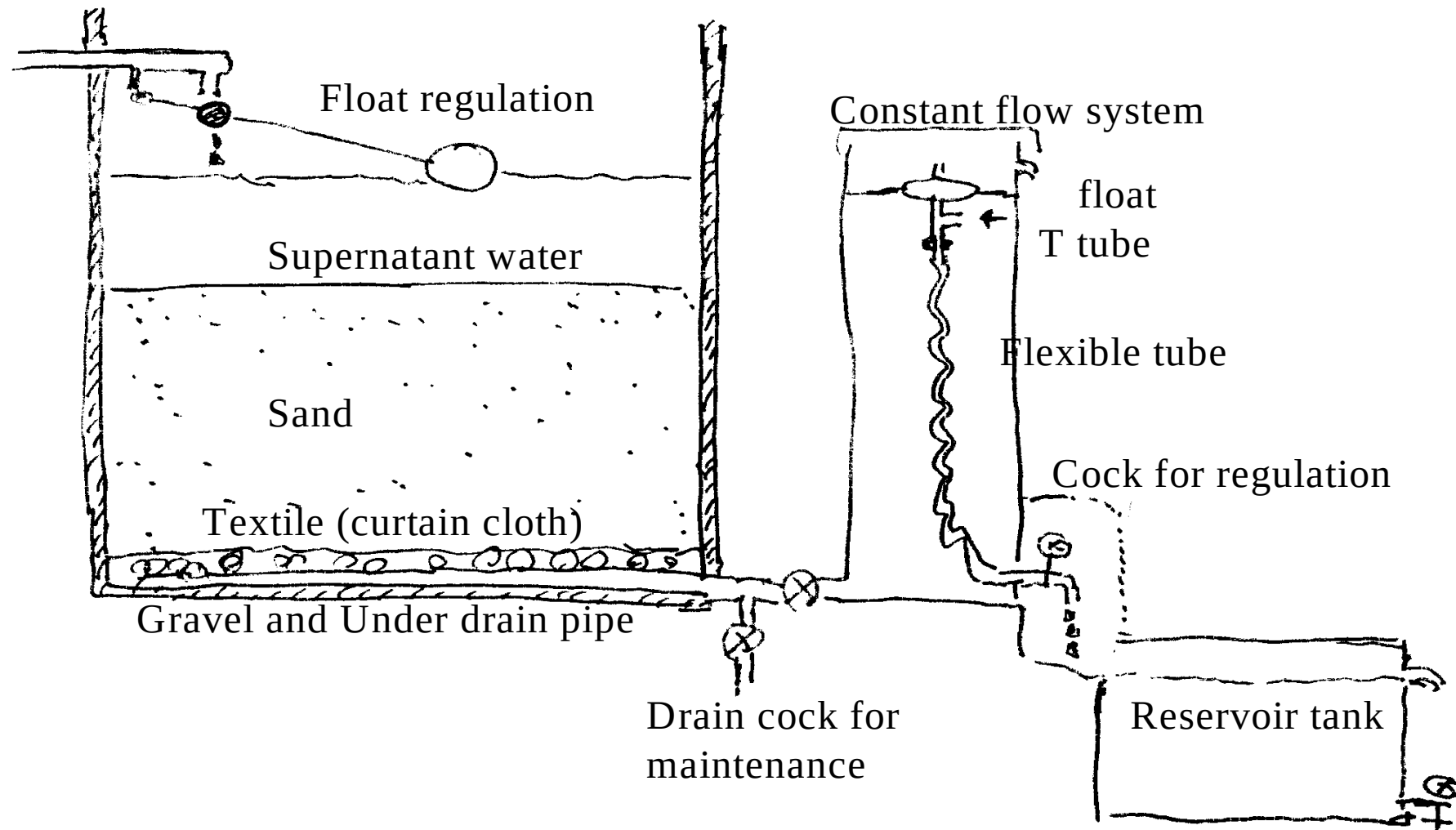


Fig. 27: Horizontal flow sand filter [46, 77, 81]. 1 Inlet pipe, 2 inlet trough to prevent scouring, 3 barriers, 4 gravel 50 mm, 5 outlet trough, 6 flow direction

G. Heber 1985 Simple Methods for the Treatment of Drinking Water.



It is necessary to keep some water level of supernatant on the sand filter. This is one of the idea to keep the water level by an float and flexible pipe. Almost constant flow is important in this system.