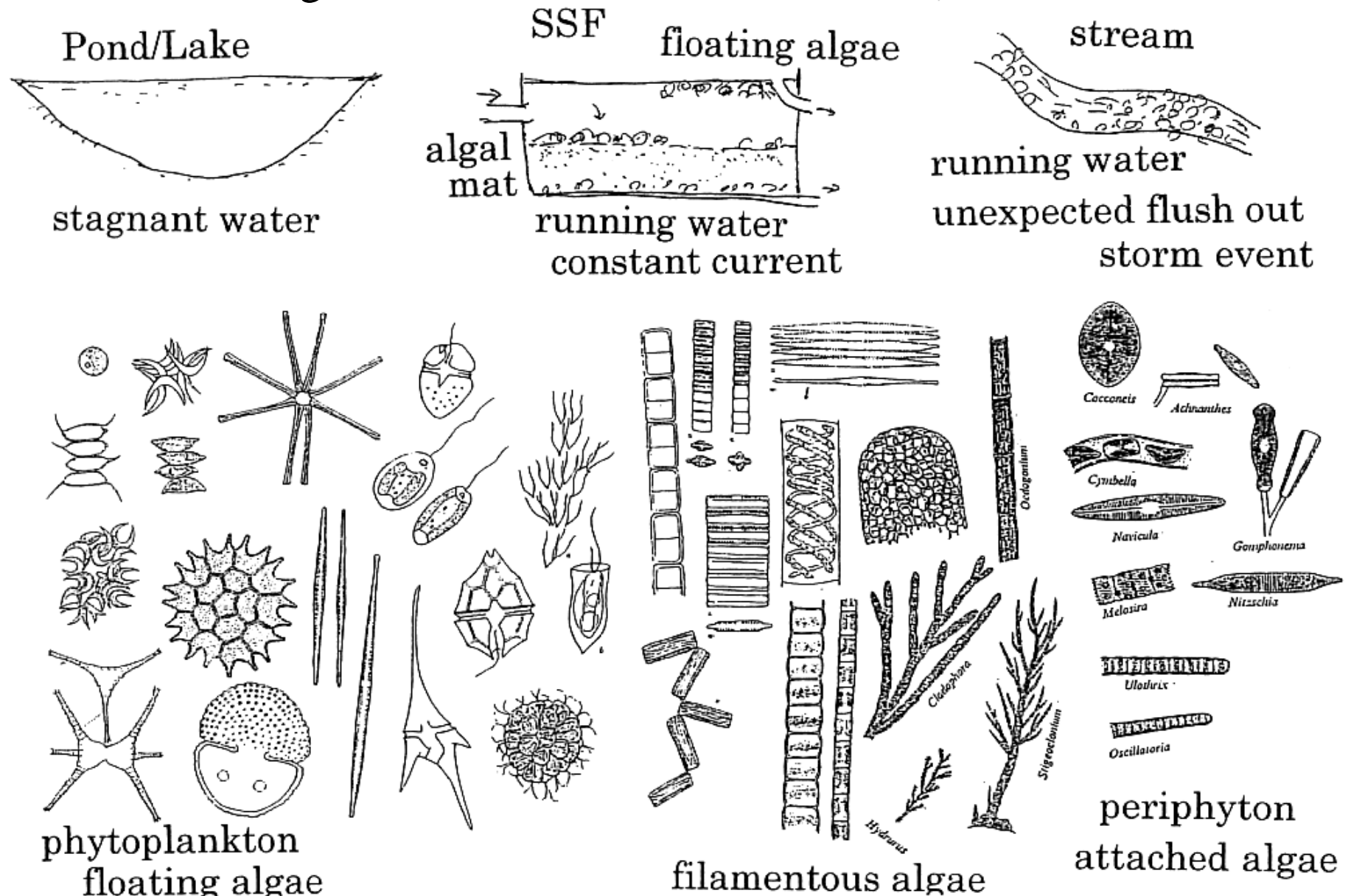


SSF(Ecological Purification System) is the suitable environment for filamentous algae.





Continuous culture system of filamentous algae

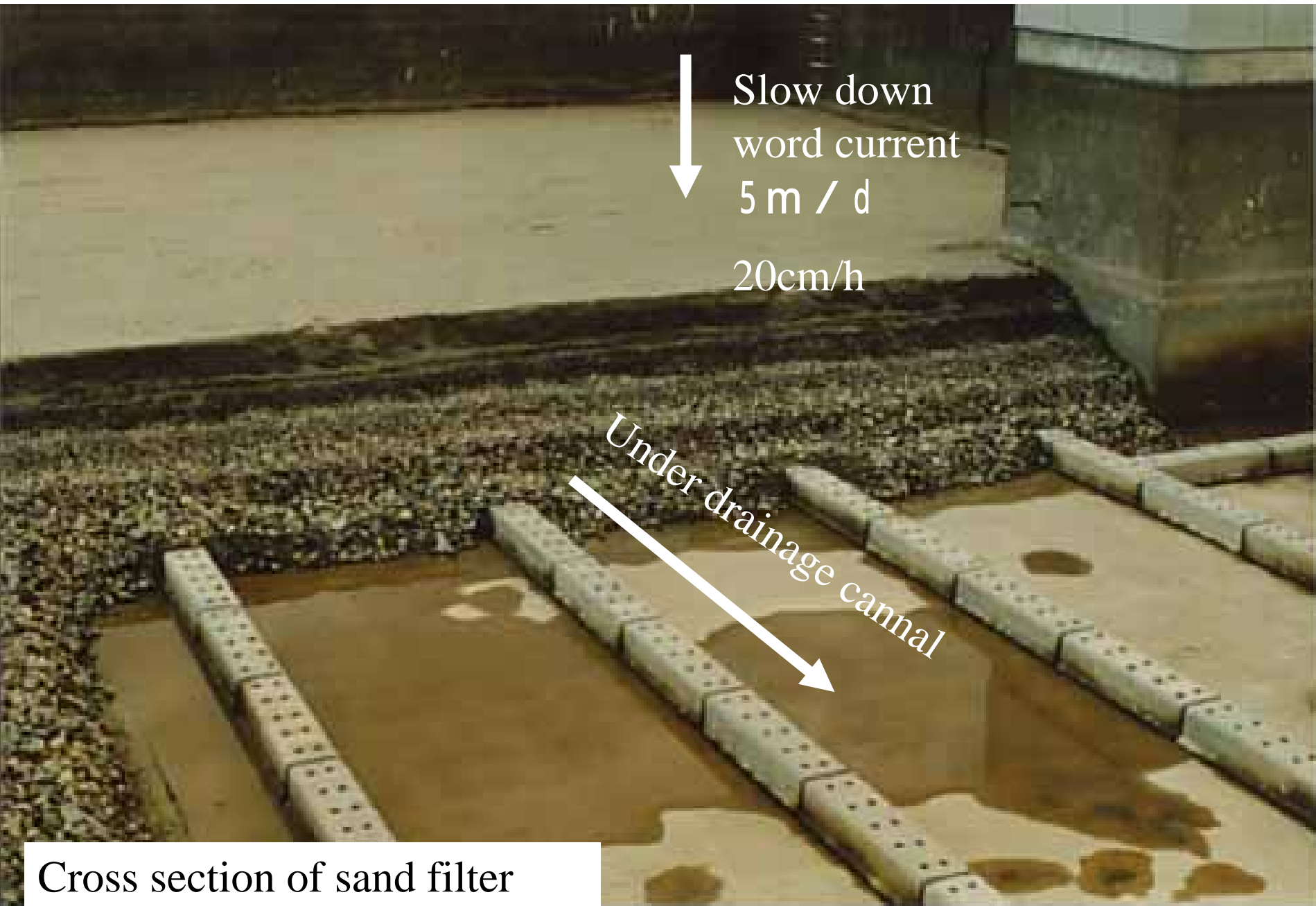


Float by bubbles produced by photosynthesis.



Trap SS on filamentous algae

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





Floating algal scum is often observed on the surface of slow sand filter pond.



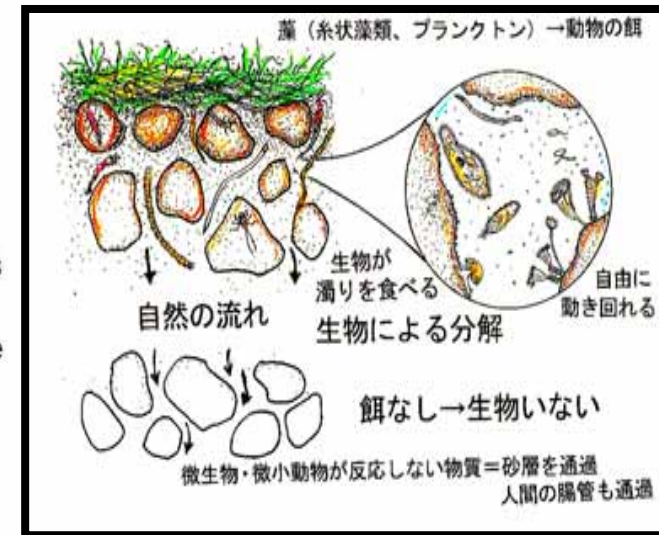
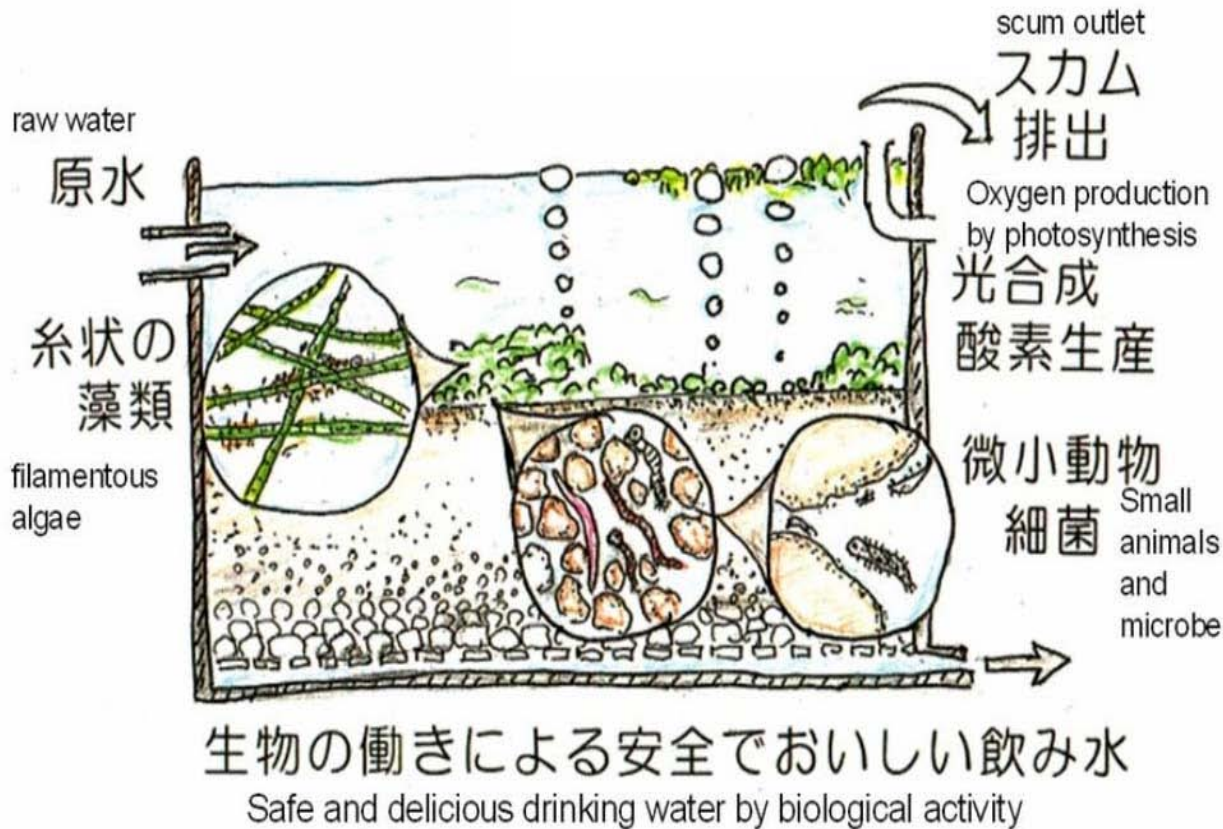
ゆっくりの砂ろ過
Slow sand filtration

かんそく 緩速ろ過法

⇒ 生物浄化法

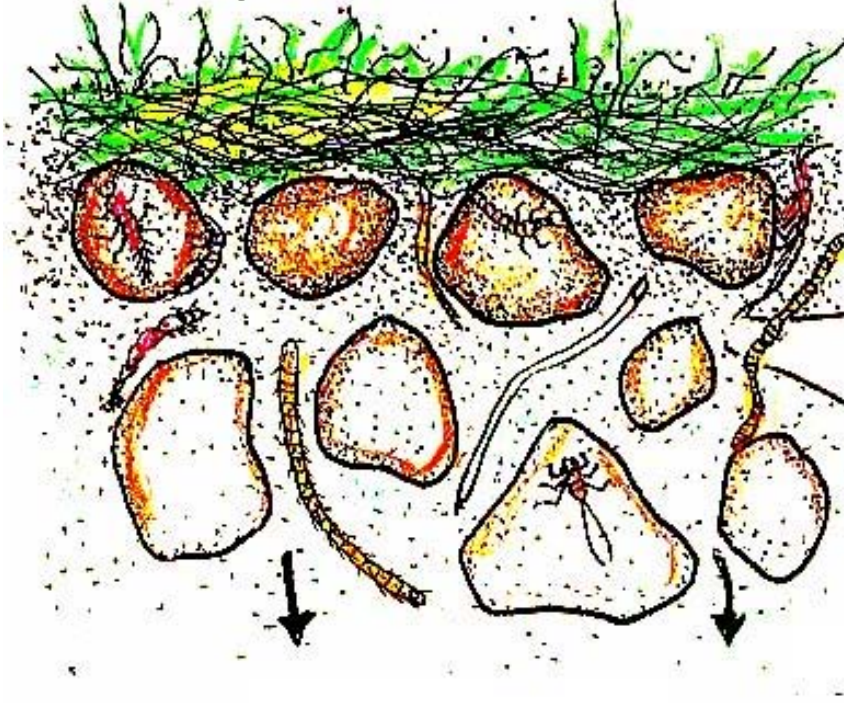
Ecological Purification System

Remove particulate and dissolved matters.



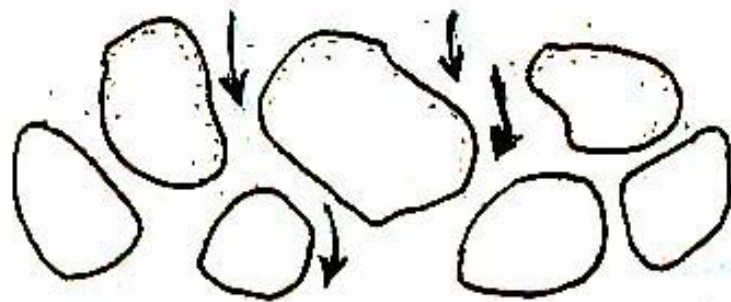
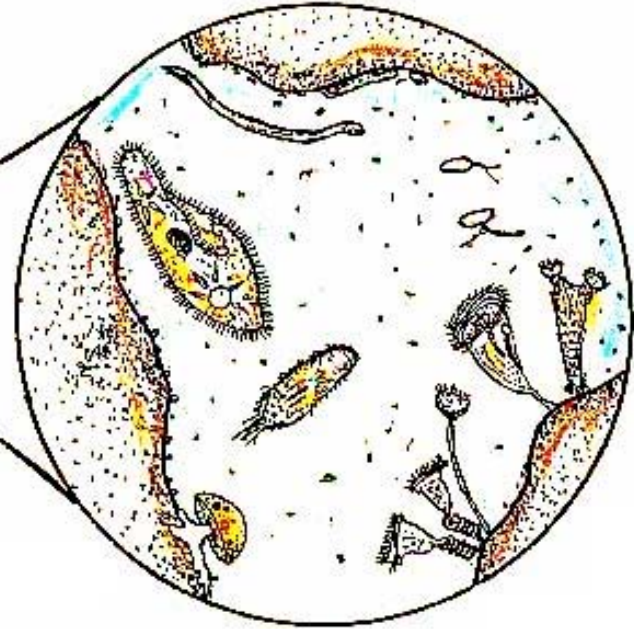
It is essential that presence of oxygen for biological community. Small animals are catcher of particulate matter. Food chain is important. In the fecal pellet is under anaerobic condition.

Algae: food for animals



Natural flow

Remove particulate and dissolved matters.



Particle free water: ready to drink as safe water

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.

algae photosynthesis oxygen production

food for animals

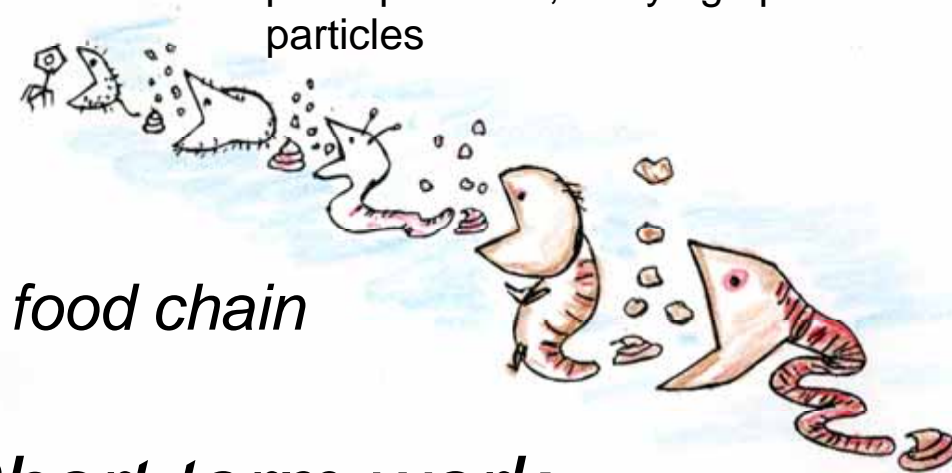
Small animals catch small particles.

Animal

collection, crush, grazing, fecal
pellet producer, carrying up
particles

Fecal pellet

microbial activity,
anaerobic condition,
fermentation,
decomposition of
hardly
decomposable
matter



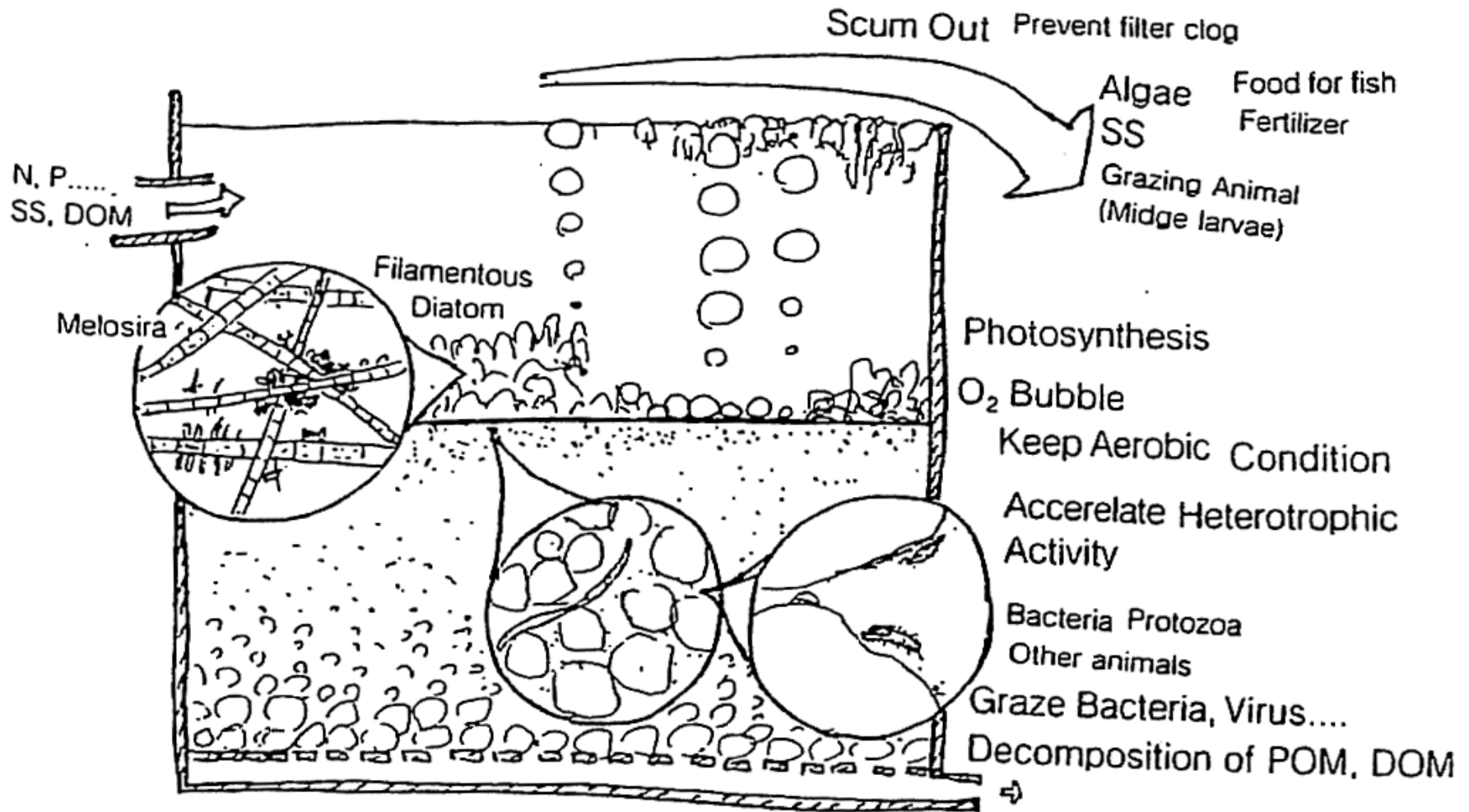
food chain



Long term action

Short term work

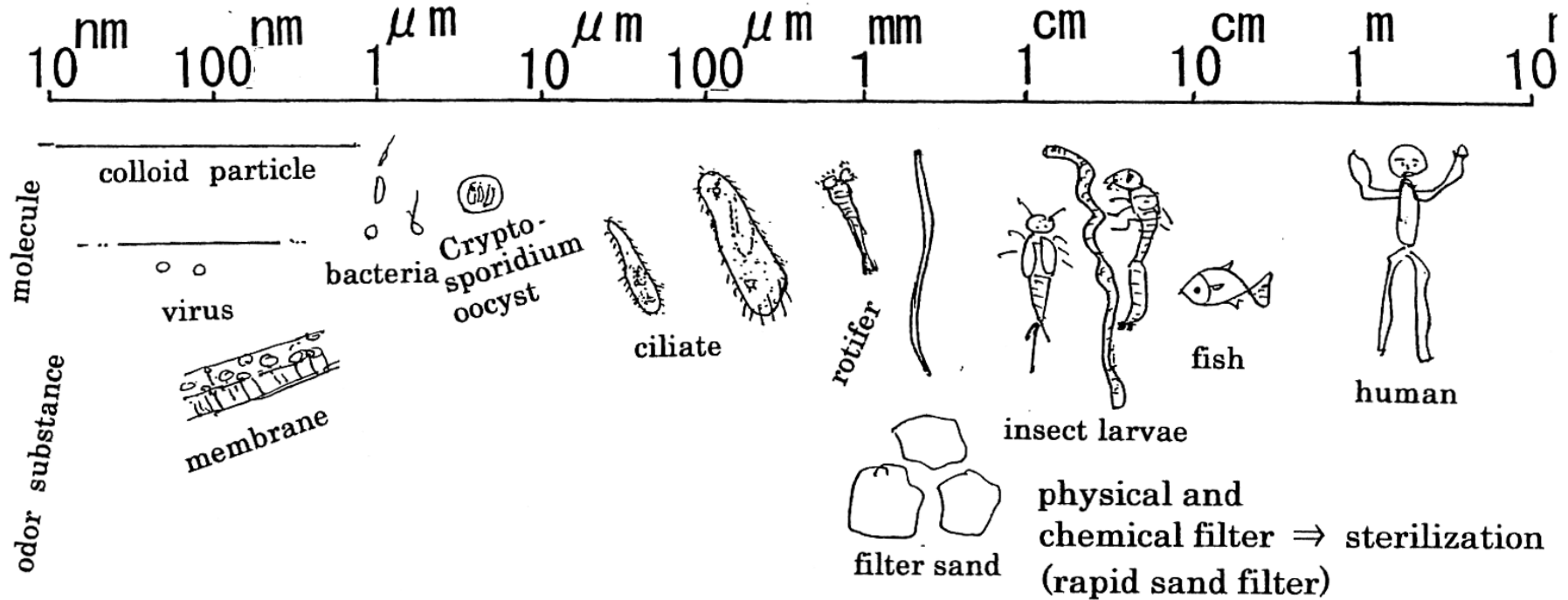
Ecological Purification System



Phenomena of Ecological Purification System

All the organisms; plants, animals, microbes are active.

Food Size and Organisms Size



Particle size of food is 1/10 to 1/100 of the body size of each grazer. And organisms can easily move the distance of several times to 10 times of body size.

Importance : Organisms move freely around without care.

Biological purification : absorption, grazing, decomposition etc.

$5\text{m/d} = 20\text{cm/h} = 0.3\text{cm/min} = 50\text{ }\mu\text{m/s}$ = Ciliate can move freely under this flow rate.



Reservoir for waterworks. In case of slow sand filter, people are not afraid of cryptosporidium.

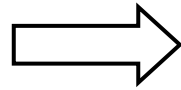
New York, USA.

Swan is popular at the Thames waterworks. Bird flu virus is not care.

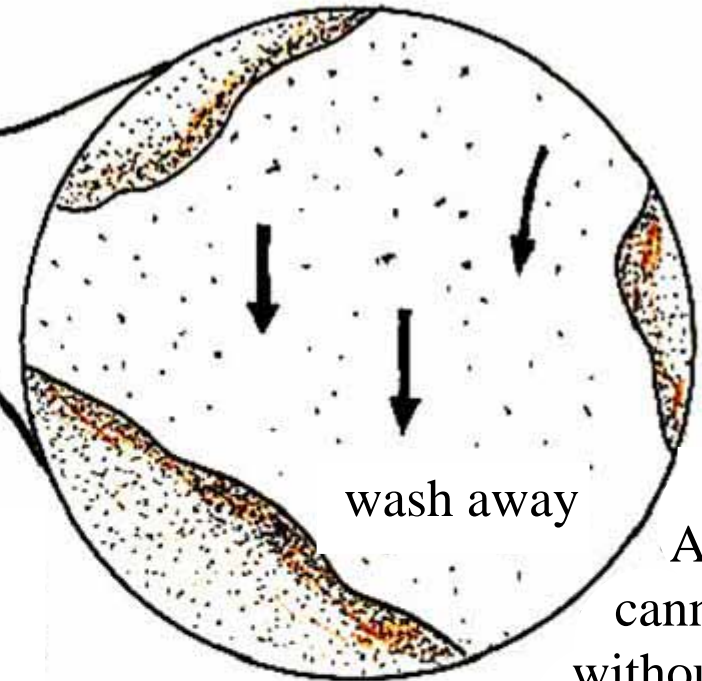


Silt \Rightarrow No food for animals

Drain by pump
Sudden change
of current



Disturb safe
condition for
animals

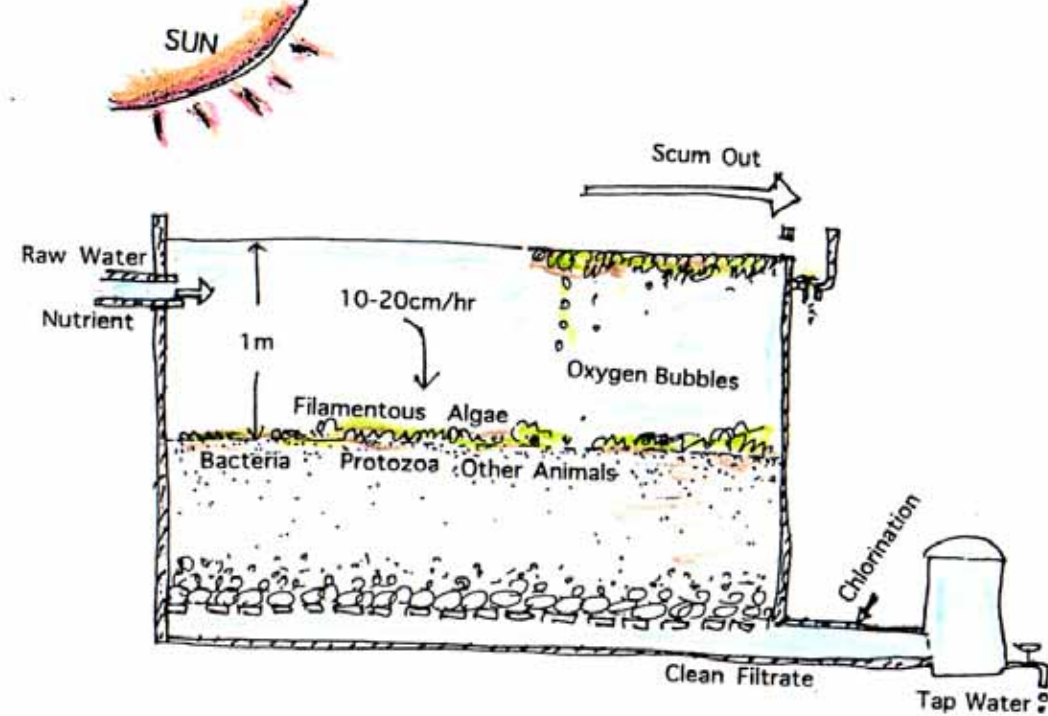


Suspended matter easily
penetrates the sand layer.

There is little activity of
biological community.

Bacteria and turbid matter
leak out the sand filter.

Only the large particles are trapped by sand layer



Algal Problems:

Short filter run: filter clog

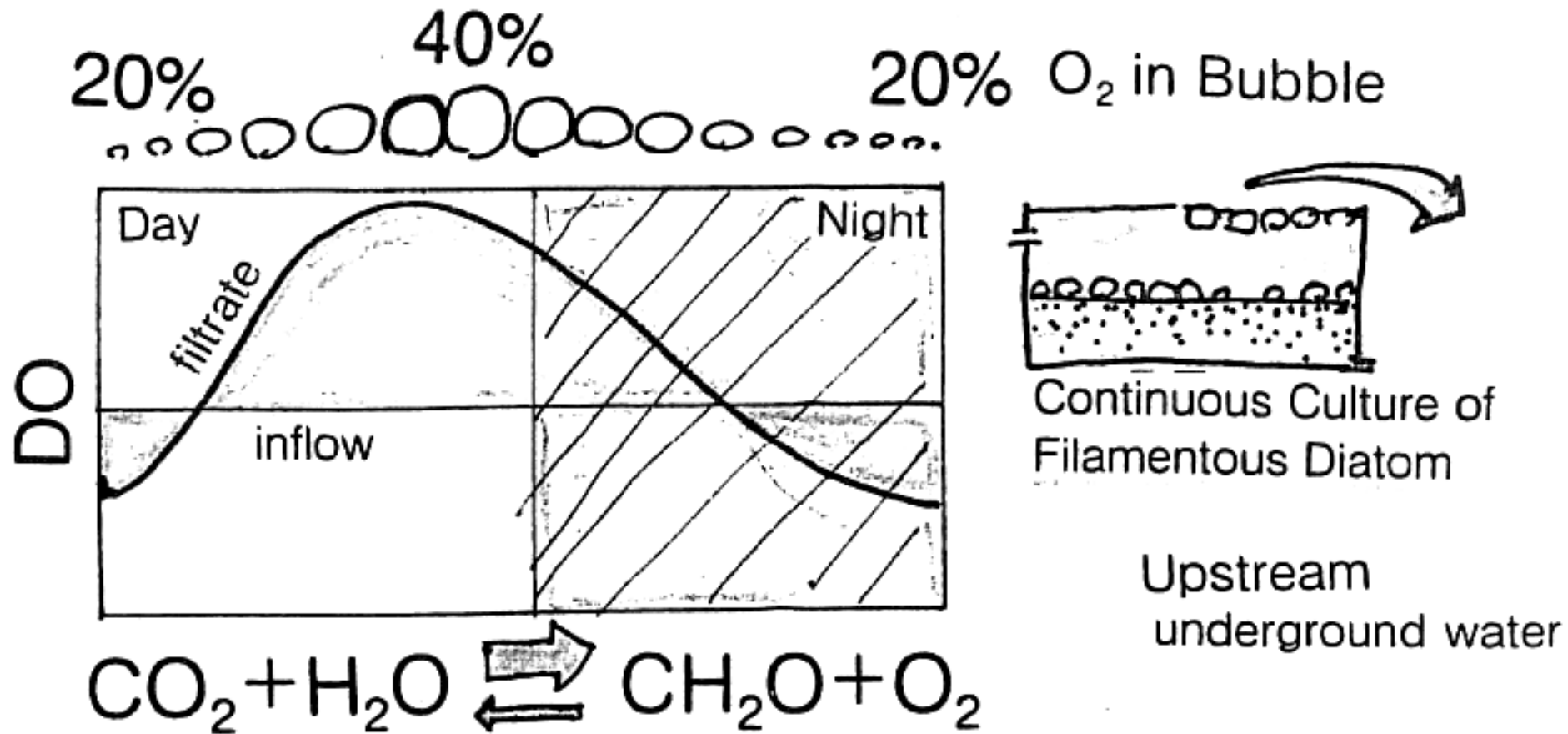
Damage (pull off) filter skin

Anaerobic condition in night (Odor problem, make unpalatable effluent)

Un-correct knowledge

Beneficial Effect of Algae: **Correct knowledge**

Prevent filter clog, Promote heterotrophic activity, Nutrient remover, Production of food and energy source for heterotrophic organisms (grazer of suspended matter: bacteria, virus etc.), Shift to high pH and high DO concentration; metal ions are easily changed to hydroxide compounds; easily precipitate, reduction of metal ions.

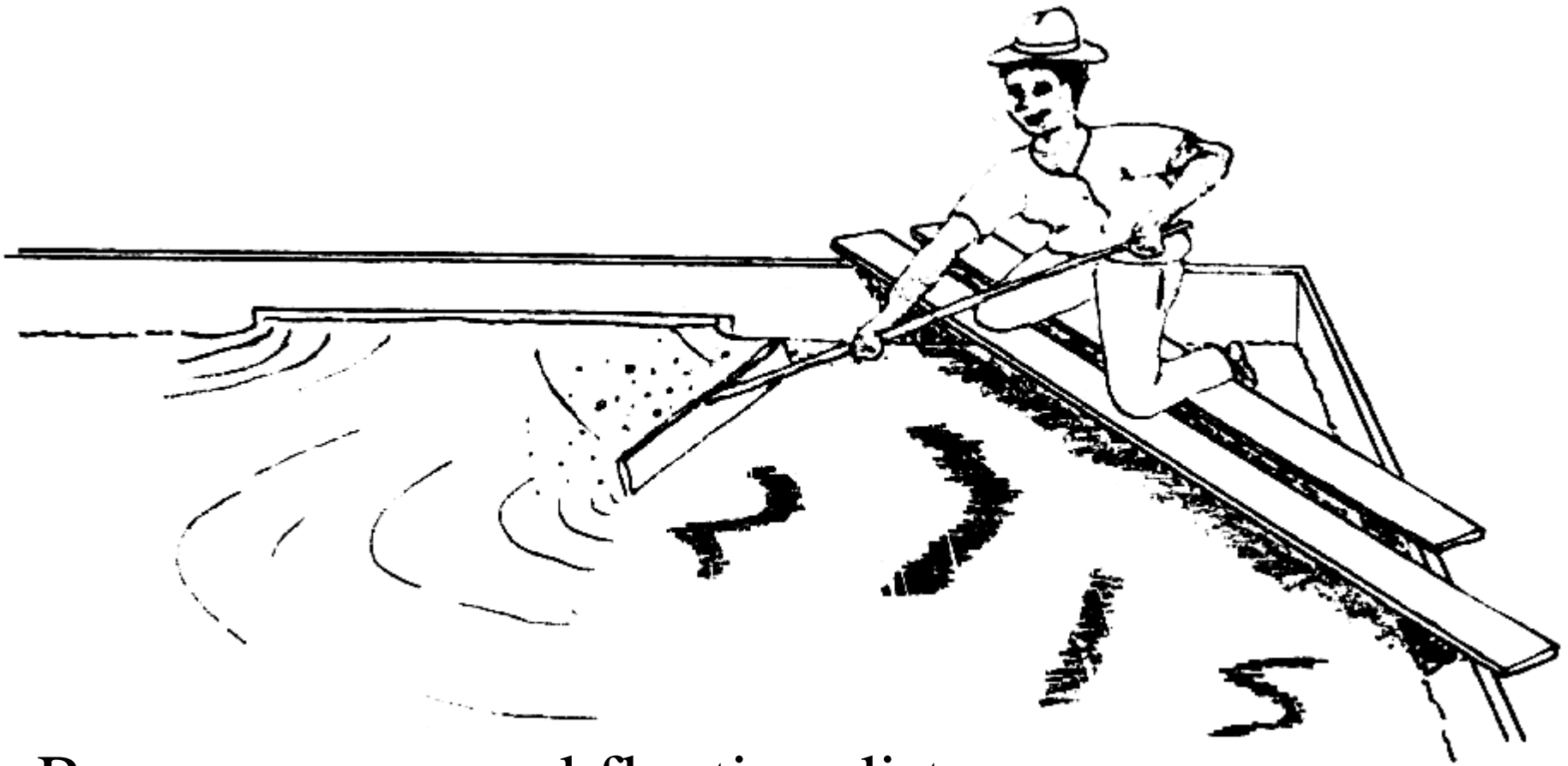


Active growth of algae makes better condition of effluent.

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.

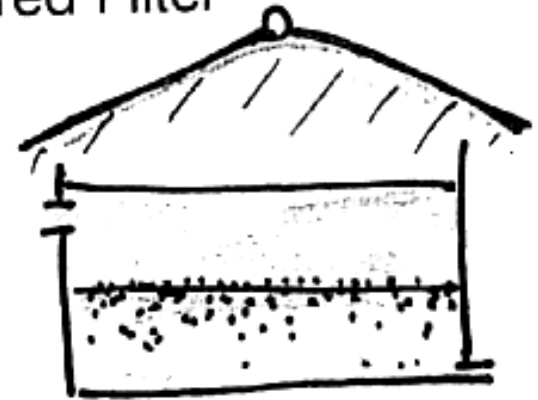
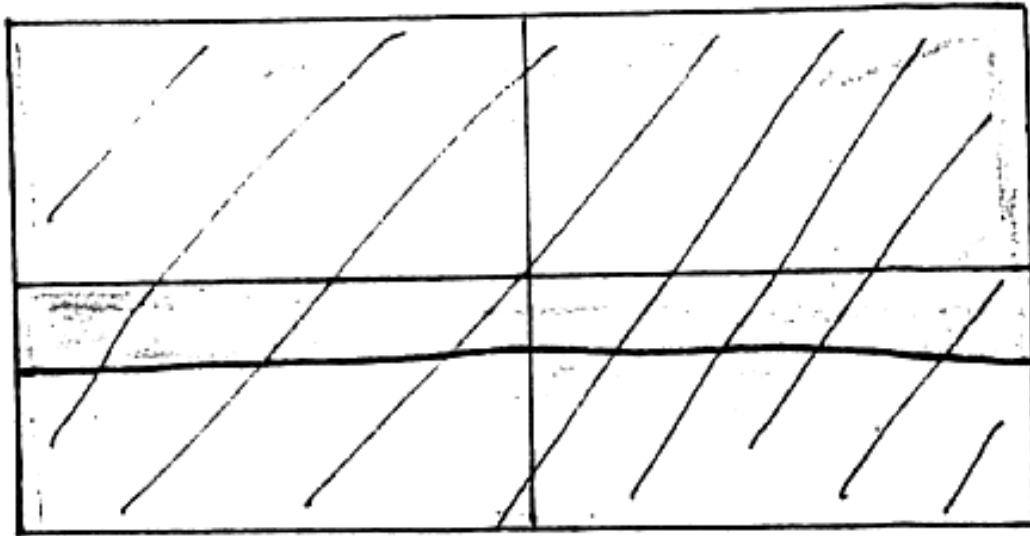
Therefore, the daily harvest of floating algae acts is a better treatment.



Remove scum and floating dirt.

Scum floating on the surface of the water and filamentous algae must be removed. **Un-correct knowledge:** *Algae may interfere with the purification process.* **Correct knowledge:** *Algal growth does not interfere the process. Algae are beneficial for purification process.*

Covered Filter

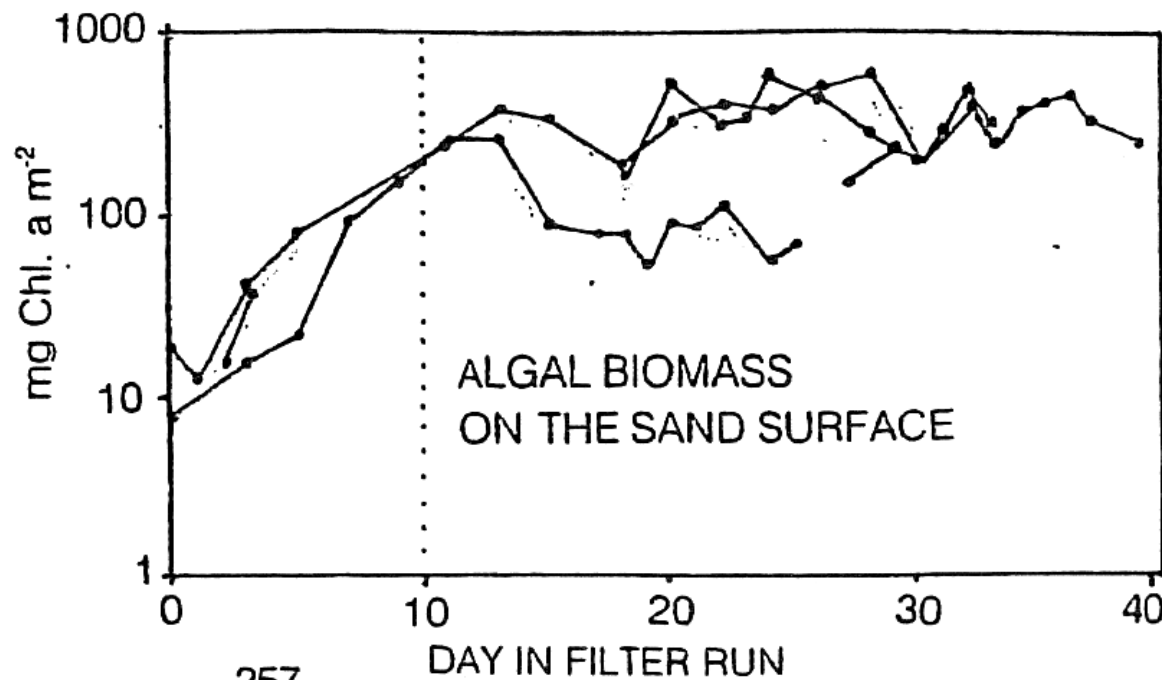


Decomposition only
Selfpurification in stream

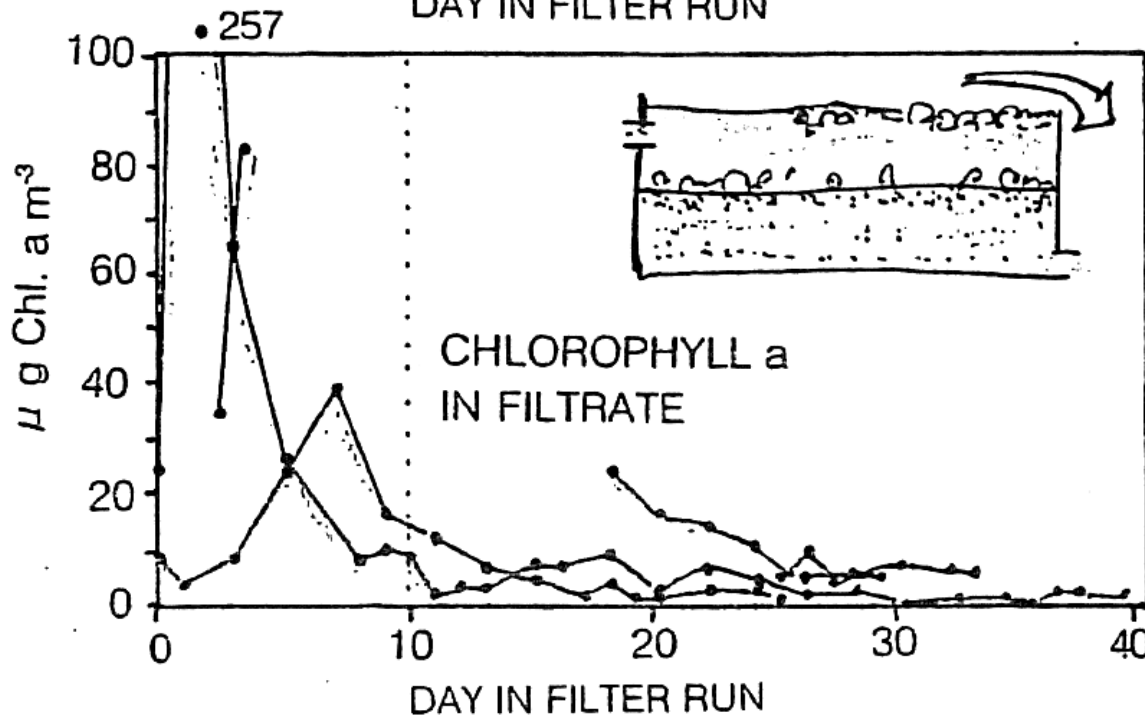


Downstream
underground water

In case of covered filter, only the mineralization happens. This is not good for ecological purification system. This system does not produce energy sources and foods for heterotrophic organisms.

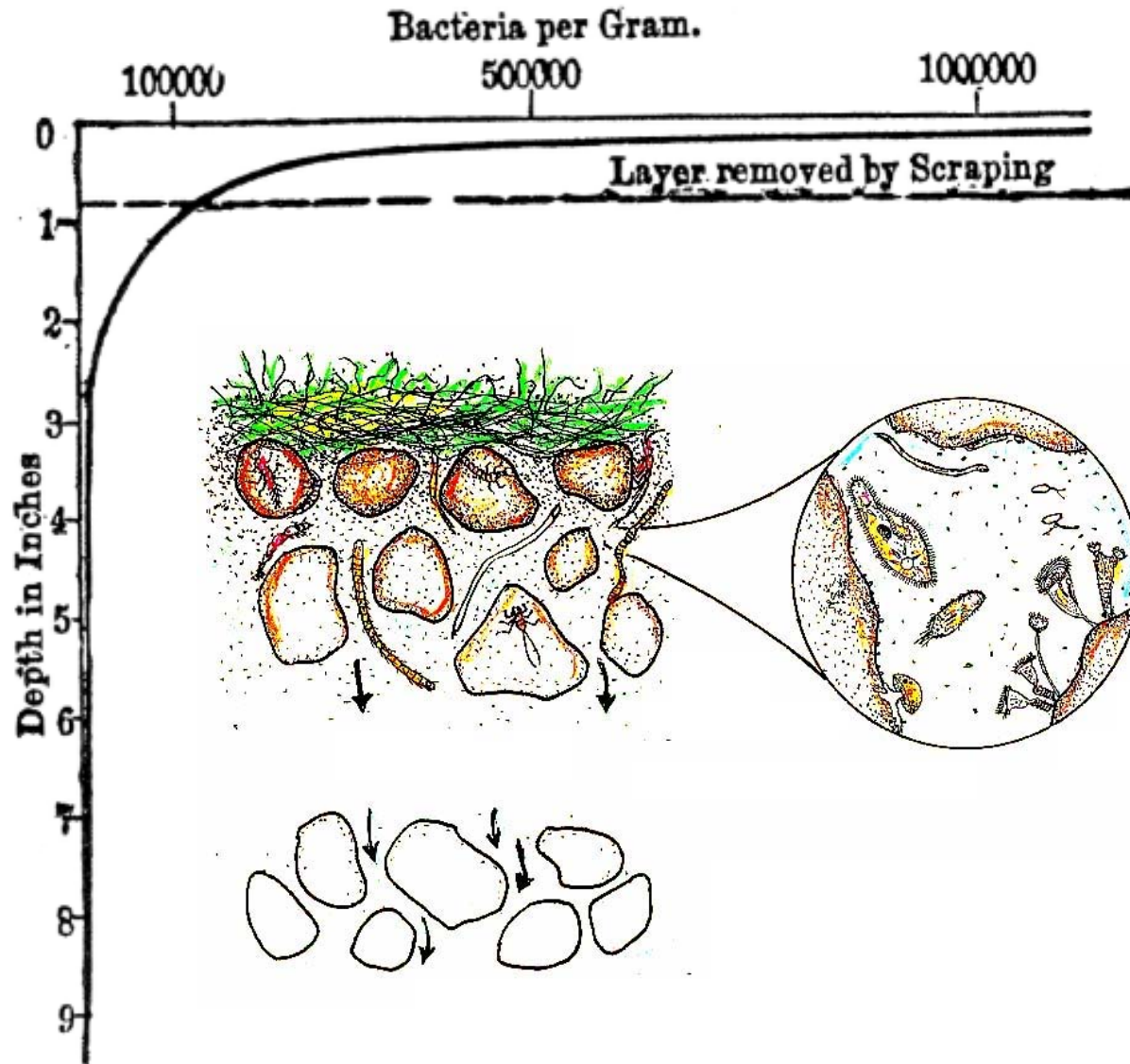


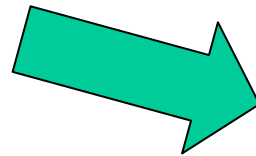
Algae grow well in summer. Continuous culture system of filamentous algae becomes after 10 days.



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

Top of sand is only active. 100years ago, in Berlin.
.Hazen 1905:The Filtration of Public Water-Supply

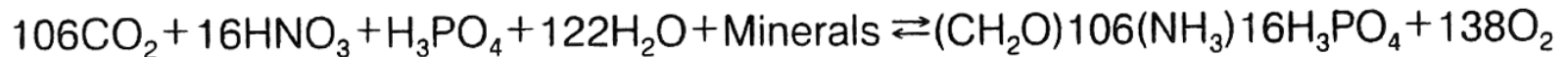
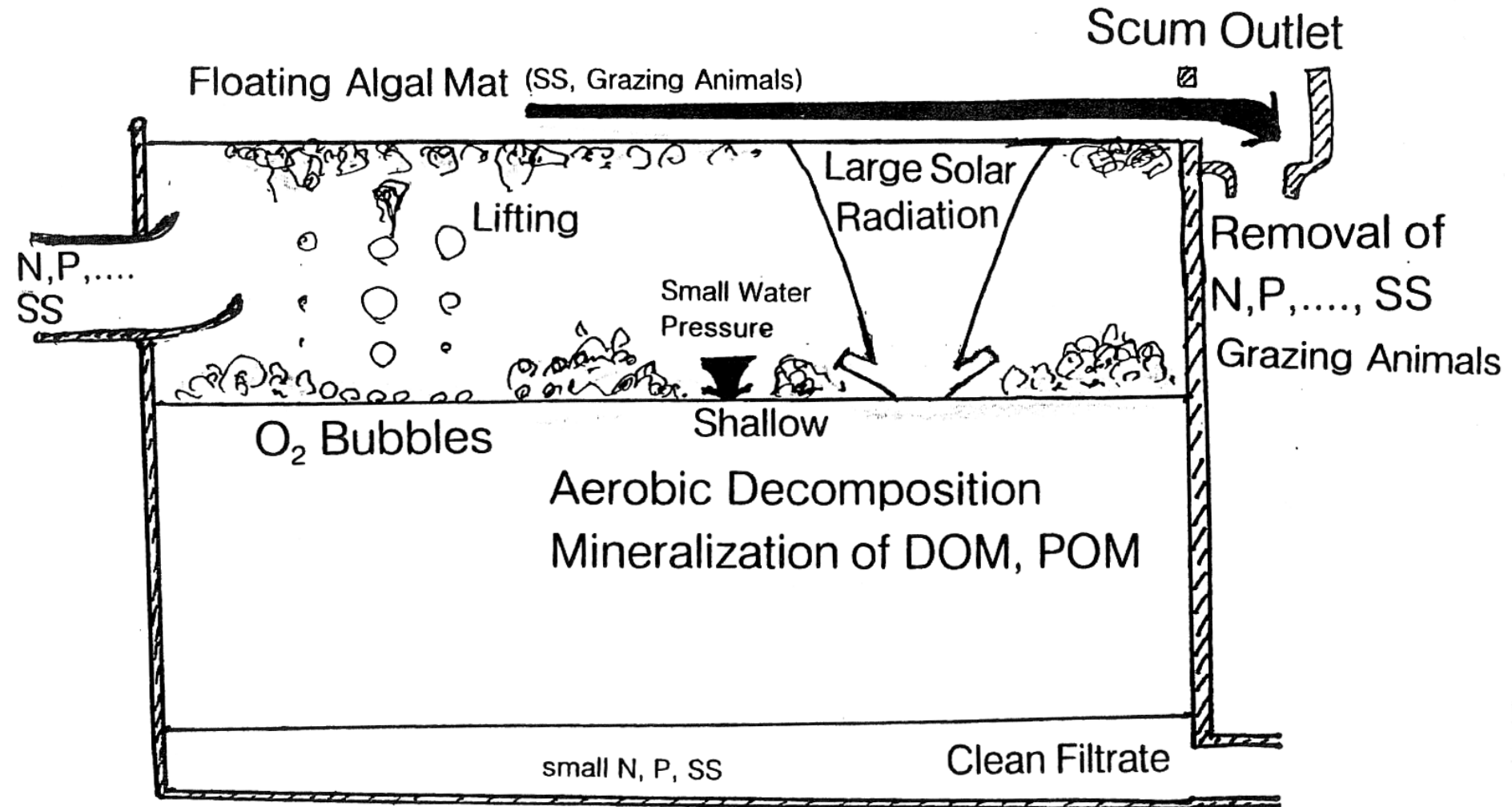




Depth of supernatant water is changed to shallow for algal growth.

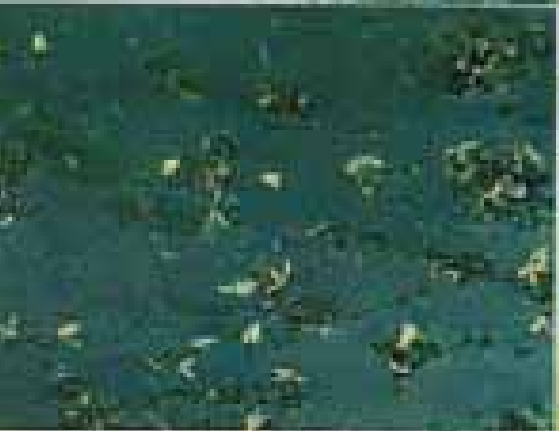


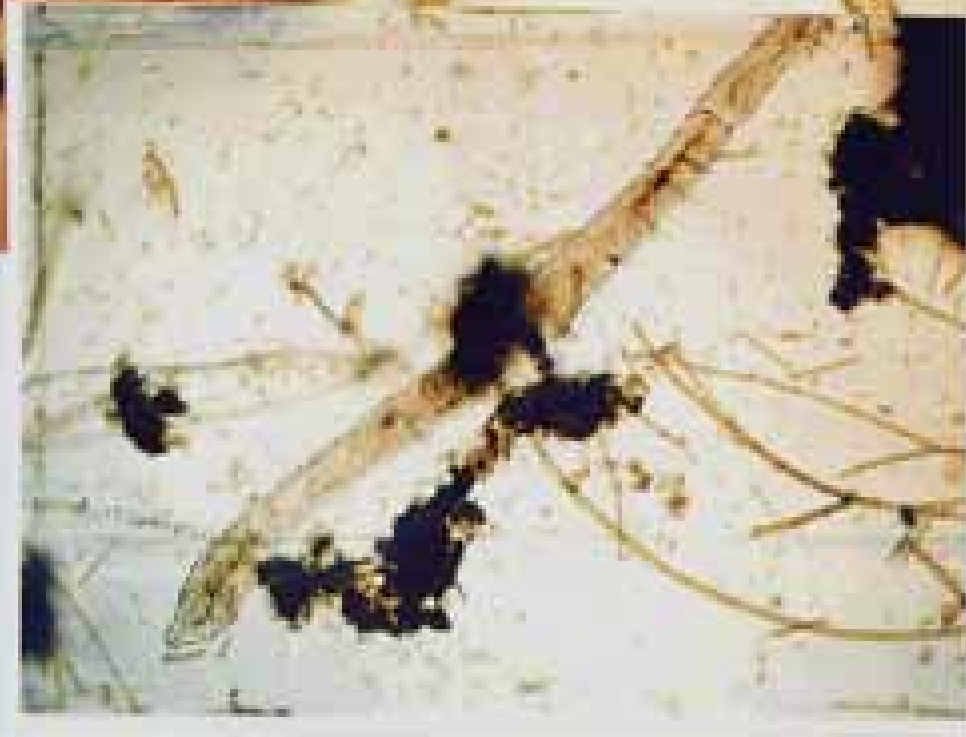
Depth is important for algal activity.



Continuous Culture System of Filamentous Diatom as an Automatic Purifier

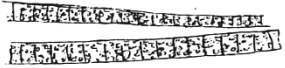
Promote Heterotrophic Activity, Nutrient and Suspended Matter Remover, Prevention of Filter Clogging.





Algal Succession and Grazing Animals

Photosynthetic
Organisms

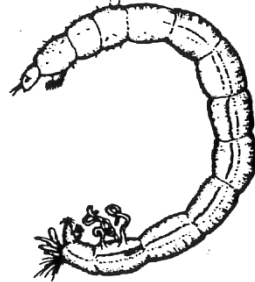


Filamentous diatom

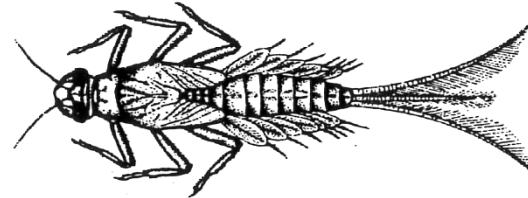
Melosira, Flagiralia

Grazing animals

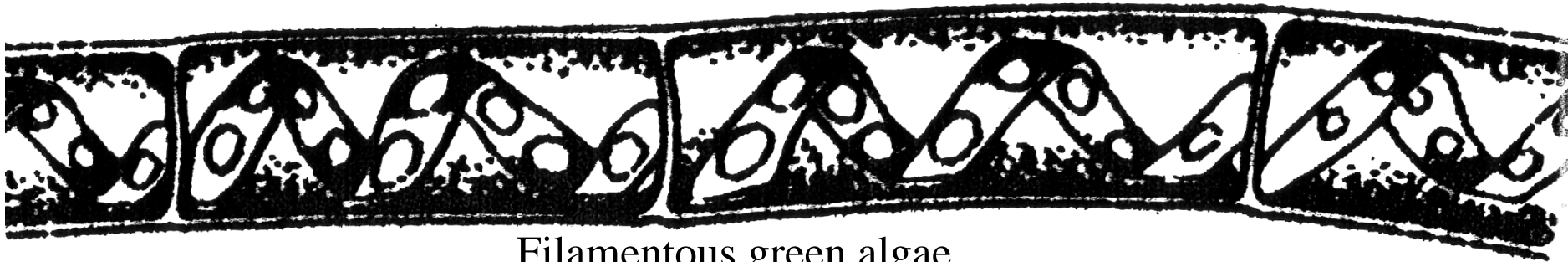
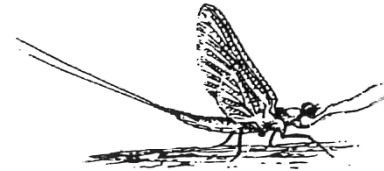
Poikirothermal animal



Midge :
Chironomus

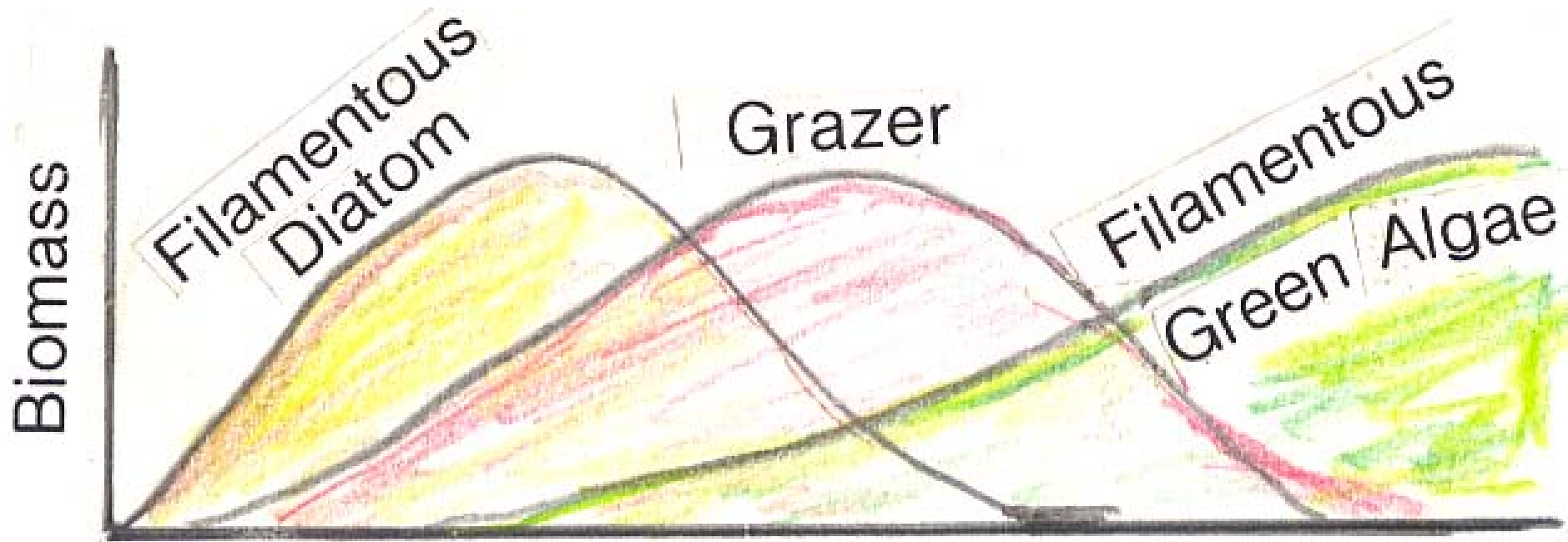


Insect larvae : Mayfly nymph



Filamentous green algae
Spirogyra, Cladophora

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



Filter Run

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.



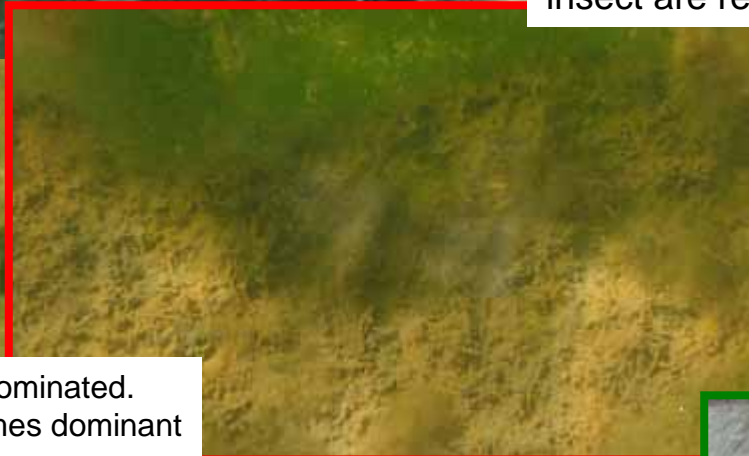
Filamentous diatom of *Melosira* in cold season.



Abundant casting skin of insect and adult insect are remarkable in warm period.

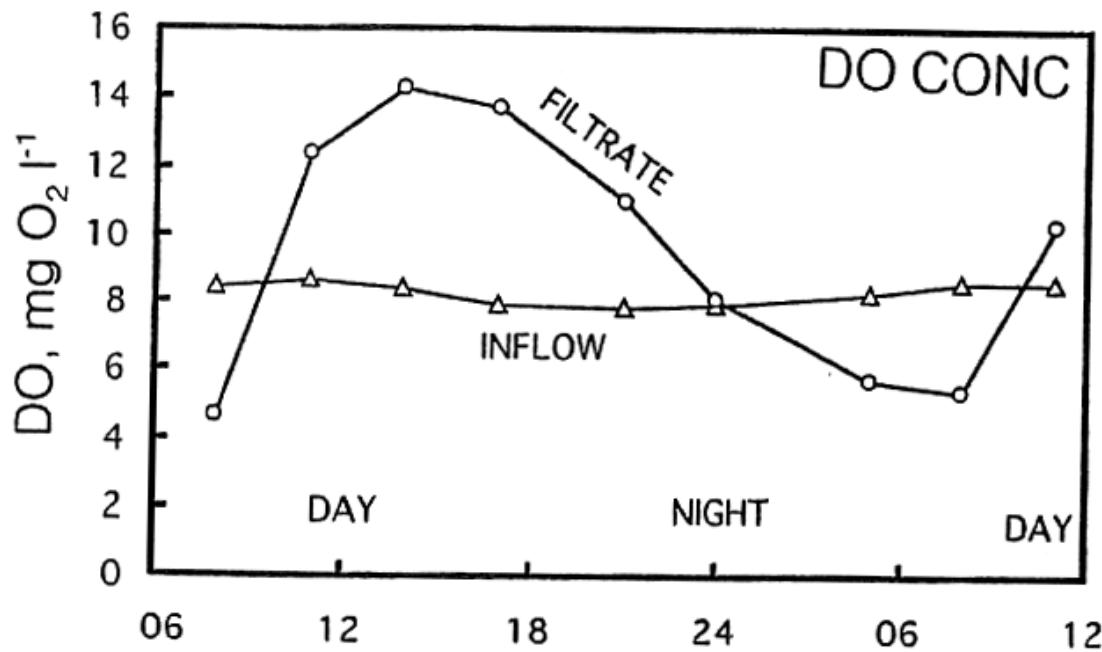


At the beginning, filamentous diatom is dominated. However, filamentous green algae becomes dominant in the long filter run.



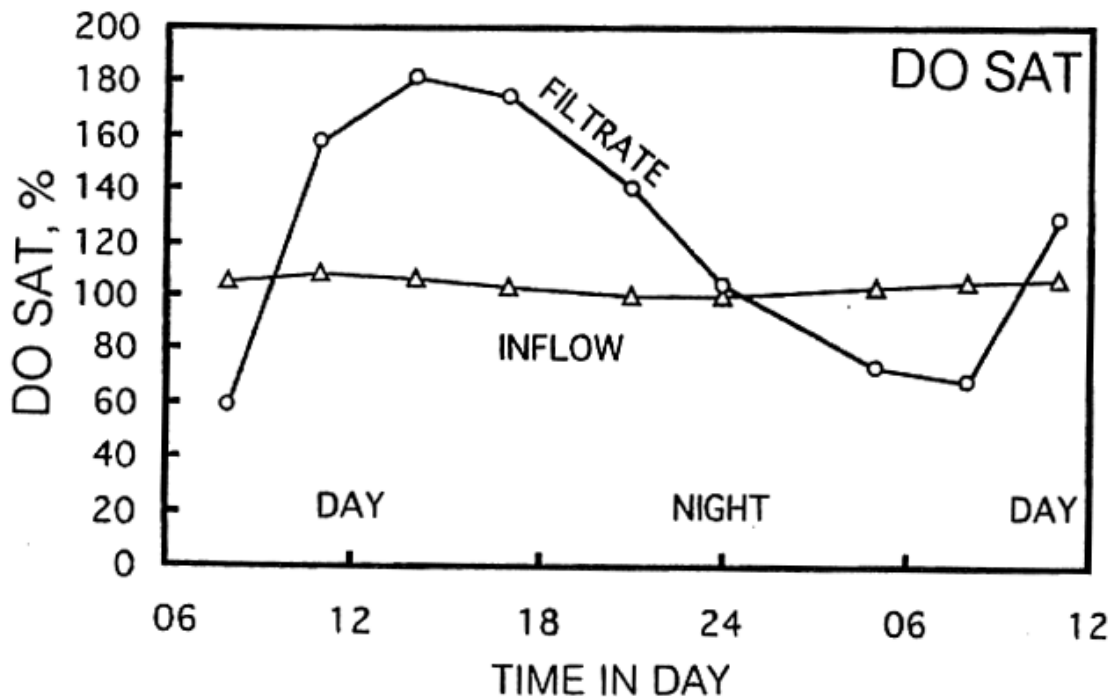
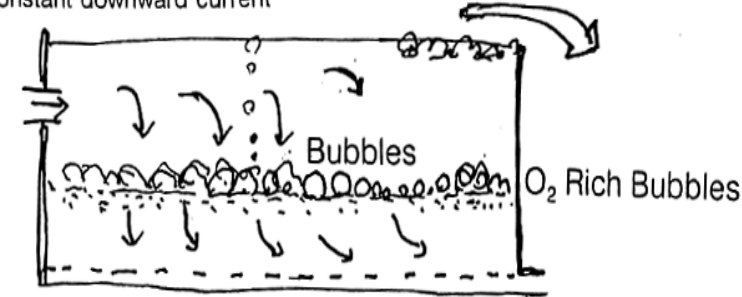
After diatom is grazed by small animals, filamentous green algae (*Cladophora*, *Spirogyra*, *Hydrodictyon*, etc.) are remarkable algae. After that, Mollusk appears.



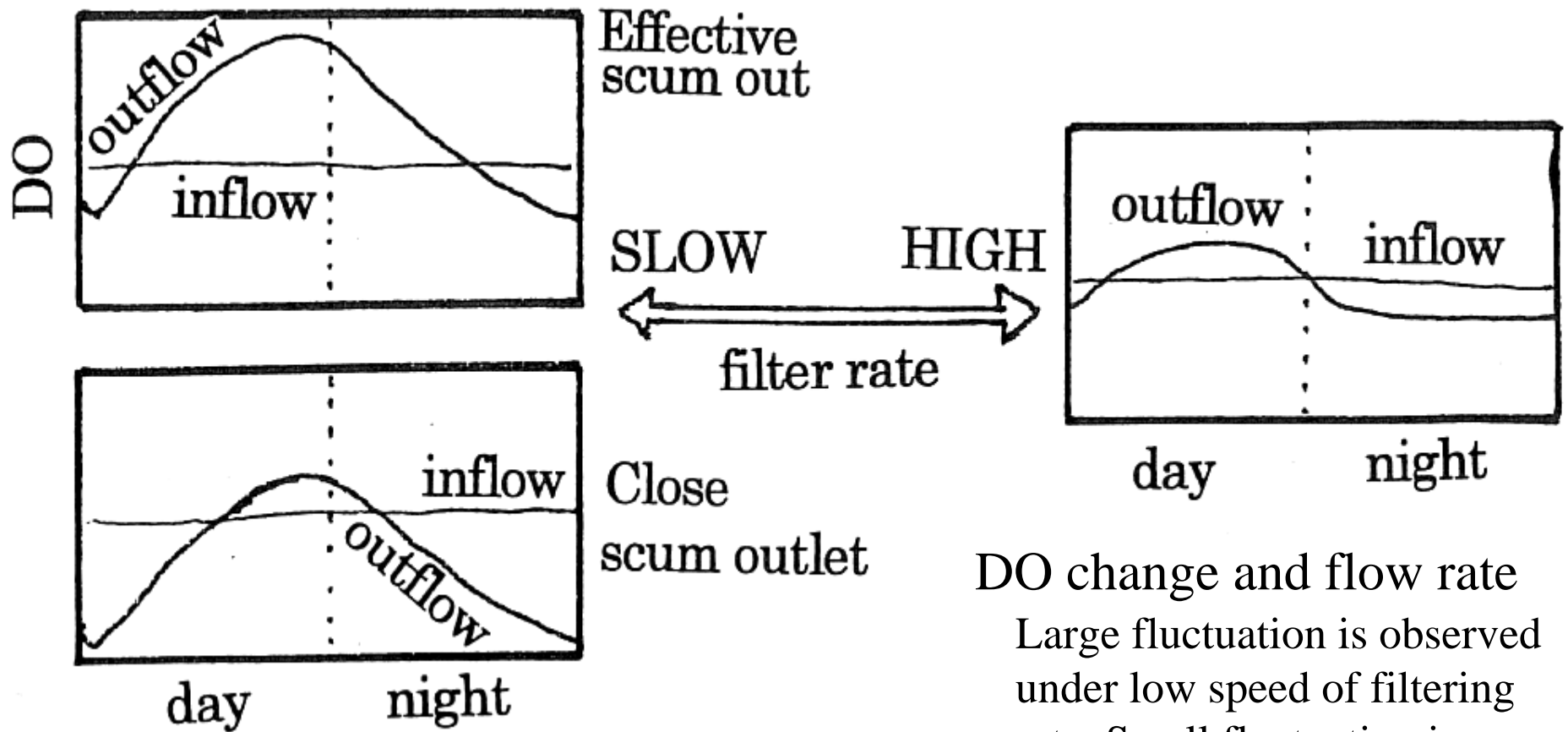


Diurnal DO changes in inflow water and in outflow water.

constant downward current



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.



DO change and flow rate
Large fluctuation is observed under low speed of filtering rate. Small fluctuation is observed under high speed.

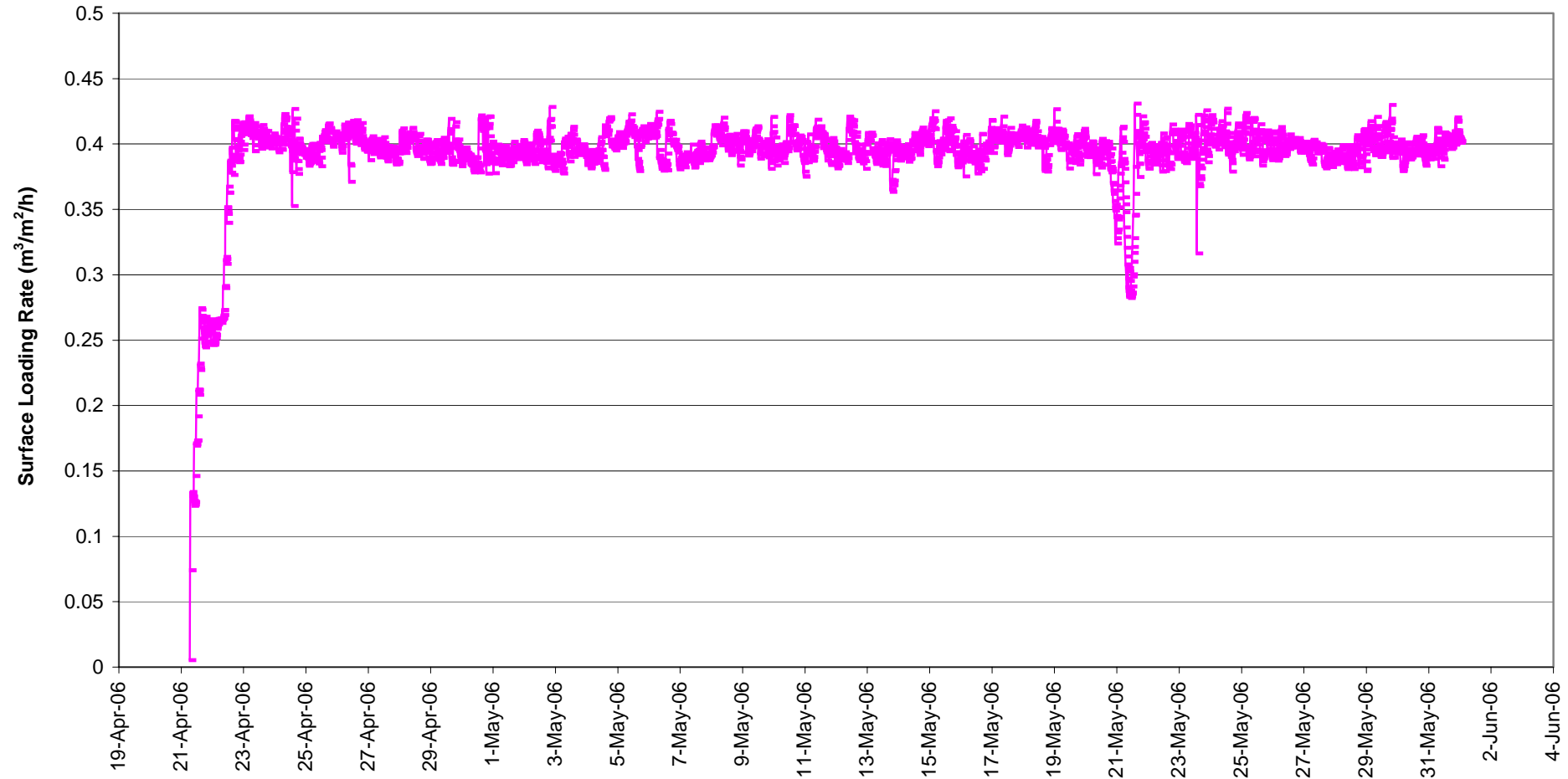
Effect of scum outlet and DO change

Effective removal of floating scum is necessary to keep favorite 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. Its 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.

THE



TIMES

WEDNESDAY JULY 10 2002

2002.7.10.タイムズ(ロンドン) www

Forget the bottle, for purest water turn on the tap

By Anthony Browne
Environment Editor

IT'S purer. It's gentler. It's Yorkshire. Water wars have broken out as Yorkshire Water and United Utilities have bottled their tap water to launch themselves as brands to take on Perrier, Evian and Highland Spring.

They are taking up a gauntlet thrown down by the chief inspector of drinking water, Michael Rouse, who says that British tap water has reached

Tap v Cap: the soft sell

Yorkshire Water, Pennines: "Softer, purer, cheaper"
United Utilities, Lake District: "High quality, very tasty"
Highland Spring, Perthshire: "Untreated, as nature intended"
Buxton, Peak District: "Found purely in Britain"
Perrier, South of France: "Bubbles like no others"

almost perfect purity, and that water companies should take on the bottles.

"People do not need to buy bottled water," he said. "They don't need it for health

grounds, and people generally can't taste the difference."

Mr Rouse also wants manufacturers to make fridges with jug space. He believes bottled water has an unfair advantage

because people drink it cooled from the fridge, while tap water comes out warm.

United Utilities is responding by giving away 100,000 bottles of tap water and Yorkshire wants people to ask for its water by name in pubs and restaurants. It is also giving away 100,000 empty branded bottles for customers to fill at a tap "so they can always have Yorkshire water with them".

"Yorkshire Water is softer and gentler than some mineral waters, it's purer than bottled

waters, and it's 10,000 times cheaper," said the company's spokesman Richard Emmott.

United Utilities said: "We're doing it so that people realise they don't need to buy expensive brands to get an excellent drink. It's tasty and makes a lovely cup of tea."

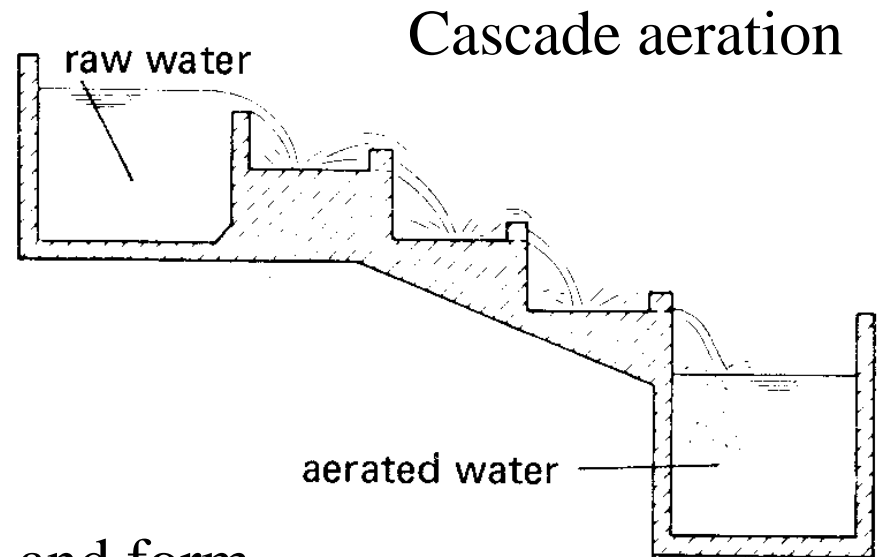
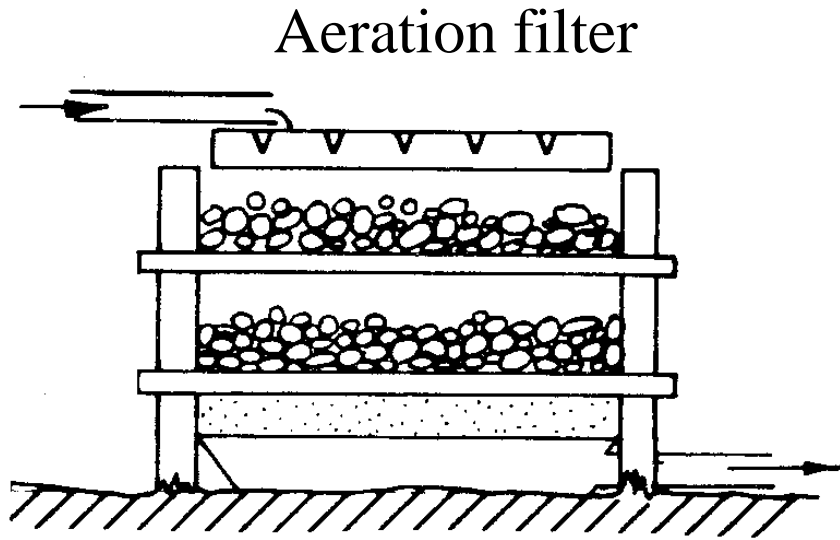
However, the bottled water industry appeared to shrug off the challenge, with a spokeswoman saying: "It endorses the importance of bottles. The fact is you can't take a tap around with you."

ボトルは必要ない。最純水の水が必要なら水道水があるー水道水とボトルの戦い。

英国の水道水はほぼ完璧な清澄度に達したので、水道会社はボトル水に対抗すべきだ。ボトルの水を買う必要ない。健康にも良い。冷蔵庫に水差しをいれるスペースをと冷蔵庫会社に注文すべきだ。水道会社は瓶詰め水道水をパブやレストランに無料で配布してその水質の良さをアピールすべきだ。水道会社は、そのブランドの空瓶を無料で各家庭に配り、水道水を入れ冷蔵庫で冷やしてもらうようにすべきだ。そうすれば、簡単に水道水を持ち歩ける。売られているミネラルウォーターと比べてもよりソフトで、よりおいしい。水道水はおいしいし、おいしい紅茶もできる。値段も1万分の1と安い。ロンドンは100%緩速ろ過、残塩の考えはない。

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 sludges. They can be removed in a settling tank (a coarse filter).

Family use of an ecological purification plant.



We don't like chlorinated tap water. We made a tube well. But this water contains abundant of manganese and iron. He made an ecological purification system on the roof of car port. In this channel algae and animals are active under sunshine. At the end, the water becomes ready for slow sand filter



Shower aerator

Cascade aerator and
Oxidized by photosynthetic organisms



Slow sand filters

Filtered water
reservoir

