

BIOLOGICAL CONTAMINATION OF WATER

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Summary

Water normally contains a wide range of biological organisms which are outlined in this article. Their metabolism is also discussed. They cause fouling of clean surfaces in water, which includes successive events of initiation, transport, attachment, removal, and aging.

1. Range of Biological Organisms Present in Water

1.1. Types of Organisms

- (a) Bacteria: these are the most numerous of all living things and are also the most widely distributed organisms in water.
- (b) Algae and plant-like flagellate protozoa: they are widely present in rain, surface, and ground waters.
- (c) Pathogenic protozoa: viruses, larvae of flukes, cercariae of schistosomes, hookworms, tapeworms, and roundworms.

1.2. Types of Bacteria in Water

- (a) Natural water bacteria.
- (b) Soil bacteria.
- (c) Intestinal bacteria, sewage bacteria, and pathogens.

1.2.1. Natural Water Bacteria

The most common among these are of the genus *Pseudomonas* (*Pseudomonas fluorescens* and *Pseudomonas aeruginosa* or *pyocyanea*), which produce a water-soluble, green, fluorescent pigment and generally liquefy gelatin. Also included are various species of the genus *Serratia* and flavobacterium and chromobacterium, which produce water-insoluble, red, yellow to orange and violet pigments, respectively. These natural water bacteria are regarded as non-pathogenic to man. However, the fluorescent forms, which frequently survive the water purification process, have been responsible for “off” flavors in food products and are therefore of industrial significance. Furthermore, it is possible that *P. aeruginosa* may be associated with waterborne enteric disturbances.

1.2.2. Soil Bacteria

During times of flood and after heavy rain, numerous soil bacteria are found in surface waters. Usually, they do not persist for very long periods outside their natural environment, since their removal from water is hastened by sedimentation of the turbidity which accompanies their entry into the water. Among the more common species are those of the gram-positive, aerobic, spore-producing genus *Bacillus* (*Bacillus Cereus* var. *mycoides* and *Bacillus subtilis* - the latter is commonly called hay bacillus), which do not produce gas from carbohydrates and spore-bearing, facultative, Gram-negative subgenus *Aerobacillus* (*Bacillus macerans* and *Bacillus Polymyxa*), which are gas formers. *Sphaerotilus dictotomas*, one of the thread bacteria, may be found in both fresh and stagnant waters. These organisms are generally considered to have no particular sanitary significance in water, but the presence of the subgenus *Aerobacillus* may confuse both presumptive and complicated tests for *Coliform* bacteria. Another group of bacteria found particularly in groundwaters may be classified as pests. The best known member of this group is *Crenothrix polyspora*, one of the so-called iron bacteria, which has the power to oxidize certain forms of iron, causing deposits of iron oxide to accumulate in water pipes. Manganese bacteria, which have the power to form manganese oxide from manganese dioxide, are also encountered in some groundwaters. Although these forms are not pathogenic, they are of considerable interest to water works personnel since they markedly detract from the aesthetic qualities of water, causing deposits which clog water conduits and discoloration of drinking waters.

1.2.3. Intestinal and Sewage Bacteria and Pathogens

The following are among the most commonly encountered organisms in the intestinal tract of man and animal and are considered possible indicators of pollution.

- (a) Genus *Clostridium*: Gram-positive, spore-forming, anaerobic and gas producing.
- (b) Genera *Escherichia*: Gram-negative rods which do not produce spores.
- (c) *Aerobacter* and *Proteus*: generally considered to be non-pathogenic.
- (d) Genera *Salmonella* and *Shigella*: pathogenic species.
- (e) *Clostridium Sporogenes*: non-pathogenic, widely distributed in nature and found in the intestinal tract of man and animals and in sewage, dust, milk, and dried foodstuffs.
- (f) *Clostridium perfringens*: pathogenic if they find their way into tissues, i.e. through wounds. Widely distributed and offer resistance to treatment; not satisfactory indicators of potability or extent of pollution.
- (g) Sewage *Streptococcus* (*Streptococcus faecalis*): their presence is an indication of recent pollution, because they die rapidly outside the human body.
- (h) Genus *Proteus* (*Proteus vulgaris* and *Proteus mirafilis*): Gram-negative, non-spore-forming type, frequently encountered, usually motile, generally liquefy gelatin, produce gas from dextrose and from sucrose, but not from lactose.
- (i) Genera *Escherichia* and *Aerobacter*: non-spore-forming rods, either motile or non-motile, only a few species liquefy gelatin, produce gas from lactose; the most common one of this group is *Escherichia coli*.
- (j) *Salmonella*: Gram-negative short rods, produce gas from dextrose and mannitol, but not from lactose or sucrose; cause waterborne enteric fever (i.e. typhoid fever), food poisoning, bacillus dysentery; some produce acid from alcohol mannitol (mannite).

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