

No.11 Nitrogen Circulation

It is considered that nitrogen was taken in the global system around 4.6 billions years ago, when the solar system was formed from cosmic dusts. Then, the circulation of nitrogen from non-organisms to organisms began to function along with the birth of life about 3.8 billions years ago. The nitrogen circulation system has been established two billions years later (Mizutani, 1987).

Nitrogen is a component of proteins and DNA and one of the basic elements of organisms. It exists with a great amount on the earth, same as carbon. There is 3,800 trillions tons of nitrogen in the air (78 % of the atmospheric composition), 14,000 trillions tons in the earth's crust, 4,000 trillions tons in soils and deposits (sediments), and 20 trillions tons in the ocean. Nitrogen also exists in our body as a component of organic matters. It circulates in a large scale among big and small storerooms, or reservoirs. The average time that nitrogen remains in organic nitrogen is 430 years, 3 years in ammonia, and 520 years in nitrate nitrogen. On the contrary, nitrogen remains in atmospheric nitrogen (N_2) for 39 millions years, which is much longer compared with above-mentioned nitrogen compounds. However, most of the organisms cannot use the atmospheric nitrogen itself. Nitrogen is taken to and used by organisms only when it is included to molecules such as ammonia and nitrate nitrogen, which is called nitrogen fixation.

Microorganisms, such as and root nodule bacteria and marine plankton, are ones that take nitrogen into the organisms' nitrogen circulation from the air through nitrogen fixation. Fixed nitrogen by microorganisms move from plants to animals through a food chain and flow into the food network.

Recently human beings confuse the nitrogen circulation system on the earth by rapidly increasing the amount of fixed nitrogen as the results of the technological revolution. Especially after the 1950s, the amount of nitrogen circulating the biosphere has rapidly increased for the last 50 years.

As compared with the fact that the amount of nitrogen fixation in the nature is 140 millions tons per year (only in the land area), it is 210 millions tons of nitrogen that is emitted to the air through human activities, almost 1.5 times of the amount in the nature.

Why has the amount of nitrogen emission increased so much?

First, the technology of nitrogen fixation has been developed for the fertilizer use. Chemical fertilizers developed in the 1940s are currently consumed about 130 millions ton per year. However, the farmland in both advanced and developing countries is saturated with chemical fertilizers and is getting superfluous with them. Overproduced nitrogen is emitted to the air with the form of NO_x, which causes air pollution. Moreover, that nitrogen emitted into rivers causes environmental pollution, such as red water (or red river) and groundwater pollution.

The second cause is the nitrogen emission from the stockbreeding industries. A dairy cattle discharges 2.2 tons of excreta per year, or 60 kg per day, a pig discharges 2 tons (estimating that one sow bears 20 piglets per year). Nowadays 80 millions tons of excreta are discharged from 2.5 billions of caws and pigs (30 millions tons from human beings).

The third cause is dilapidation of forests and bogs (or wetlands) due to exploitations of nature resources, through which 30 millions tons of nitrogen is emitted per year.

The fourth cause is, same as carbonic acid gas, the combustion of fossil fuels, in which 20 millions tons of nitrogen is emitted per year. Fossil fuels, made from the ancient plants' remains, include not only carbon but also much amount of nitrogen. Therefore, huge consumption of fossil fuels confuses not only the carbonic circulation but also the nitrogen circulation system.

On the other hand, the amount of nitrogen that human beings take in their life from the global environment is 20 millions tons per year. Therefore, it is estimated that about more than 200 millions tons of nitrogen compounds is annually emitted into the global environment. These nitrogen compounds overflow from the anthroposphere to the bio-ecosphere and begin to threaten organisms' existence including human beings.

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