Atmospheric and Oceanic Science Letters 15 (2022) 100135

Contents lists available at ScienceDirect

Atmospheric and Oceanic Science Letters

journal homepage: http://www.keaipublishing.com/en/journals/atmospheric-and-oceanic-science-letters/

Perspective

Possible link between new coronavirus variants and atmospheric lightning and seawater intrusion

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ARTICLE INFO

Keywords:
Coronavirus variants
Lightning
Seawater
Nitrite
Nitrate
Nitric oxide
关键词:
新型冠状病毒肺炎变异毒株
闪电
海水
亚硝酸盐
硝酸盐
一氧化氮

ABSTRACT

SARS-CoV-2 (COVID-19) has been affecting the world for more than one year. The appearance of the new coronavirus variants makes the current situation full of uncertainty. In this respect, the authors discuss the connection between virus mutation and atmospheric factors. Based on the process of nitrogen fixation and transformation of nitrate inside the human body, the authors propose that the new coronavirus variants might be related to lightning and seawater intrusion. This study provides a new perspective in terms of the possible mechanism underlying the emergence of new coronavirus variants.

摘要

自新型冠状病毒肺炎暴发一年多以来, 已经对全球产生深远影响. 新型冠状病毒肺炎变异毒株的出现使当前疫情发展充满了不确定性. 从这方面出发, 我们讨论病毒变异与大气因素之间的联系. 根据固氮过程和硝酸盐在人体中的转化过程, 我们提出了新型冠状病毒肺炎变异毒株的出现或许和闪电以及海水入侵有联系. 我们的研究对新型冠状病毒肺炎变异毒株可能的产生原因提供新的观点.

Since the first large-scale spread of the new coronavirus variant known as Alpha lineage, identified in Kent in the UK, there have been four further main lineages identified so far—namely, Beta lineage (Nelson Mandela Bay, South Africa), Gamma lineage (Manaus, Brazil), Eta lineage (Osun, Nigeria and the UK), and Delta lineage (Maharashtra, India). So, including Alpha lineage, five new variants in total. The new features of these new variants, such as higher transmissibility and antibody resistance, have led to them spreading rapidly throughout the world, and might cause a third wave of the pandemic (Zhao et al., 2021).

The principles of virus mutation have been widely investigated by biologists. From the biological perspective, mutation happens when the structure of RNA is destroyed. Nitric oxide (NO) plays an important role in the immune system (Bogdan, 2001), but overproduction of NO can cause health problems for humans—for example, it can cause RNA mutation inside human cells (Wurtmann and Wolin, 2009). Researchers have put a great deal of effort into studying the underlying mechanism of mutation from a biological point of view. However, the relationship between the environment and mutation has rarely been mentioned. Inspired by the idea that NO can cause RNA mutation, we studied the generation of NO from the environmental perspective, and discuss here the possible mechanism underlying the appearance of new coronavirus variants.

It has been proven that high concentrations of nitrate in the human body can increase the risk of health problems. Researchers have found that oxidative stress induced by NO can accelerate the mutation of virus RNA, including that of HIV, influenza virus, and Sendai virus (Akaike and Maeda, 2000; Akaike et al., 2000). NO, as a free radical inside cells, is involved in physiological and pathological conditions, whereas overproduction of free radicals can cause damage to cells, thus leading to mutation (Phaniendra et al., 2014). Fig. 1 illustrates the process of nitrogen fixation and transformation of nitrate inside the human body. The circulation of NO follows a nitrate–nitrite–nitric oxide (NO_3^-–NO_2^-–NO) pathway inside the human body (Lundberg and Weitzberg, 2008; Weitzberg et al., 2010). Dietary intake, such as green leafy vegetables, drinking water, and cured meat, is considered the main source of nitrate (Wu et al., 2019). Nitrate can be reduced to nitrite by oral commensal bacteria, and the nitrite in blood and tissues will then be transformed to NO by certain enzymes in tissues (Lundberg and Weitzberg, 2008). Other than following the NO circulation, NO synthase (NOS) is another source of NO for humans, where NO is produced directly by NOS in cells (Forstermann and Sessa, 2011). Nitrogen circulation in nature indicates that when lightning takes place, the high temperatures it produces can break the nitrogen in the air into nitrogen oxides (NO_x), which will dissolve in rain and combine with oxygenated water in the rain to turn into nitrate. Nitrate will be carried down to earth, and

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https://doi.org/10.1016/j.aosl.2021.100135
Received 5 November 2021; Revised 11 November 2021; Accepted 12 November 2021
Available online 24 November 2021

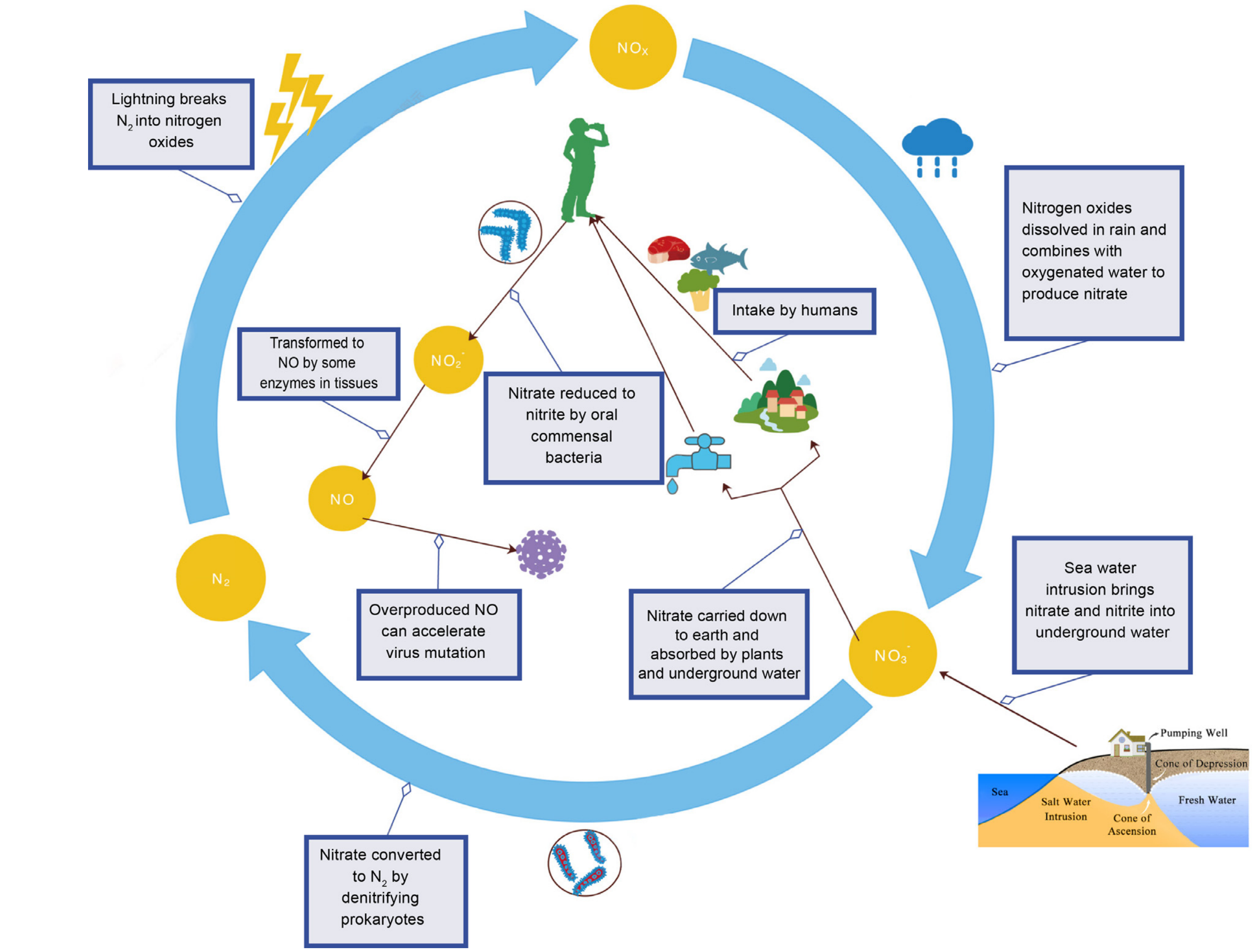

Fig. 1. The process of nitrate–nitrite circulation from nature into the human body.

becomes the natural fertilizer for plants. Other than lightning-produced NO_x entering the human body, sea water also contains large quantities of NO_x. We researched geographical information on each location and found that some of the places are located along the coastline, such as Kent (UK), Nelson Mandela Bay (South Africa), and California (USA). Underground water is an important water resource for people who live near the coastline. Researchers have pointed out that the concentration of nitrate in coastal groundwater is high (Ma et al., 2018), suggesting that people living near the coastline can face nitrate pollution issues. This finding might partly explain the fact that most of the new coronavirus variants were found in places located along the coastline. Nitrogen oxides produced by lightning contribute an important part to the total NO_x budget, and sometimes even become the dominant source of NO_x (Labrador et al., 2005). It was found that the lightning activity in Manaus city (Brazil) has been increasing throughout the last four decades (Pinto Jr. et al., 2013). The coastal areas of Japan are more likely to be hit by lightning in winter (Matsui et al., 2020). It has been recorded that Kent suffers from a high frequency of thunderstorms in the UK (Lees, 1997). South Africa is one of the countries most frequently bit by lightning, especially in summer (October to March) (Gijben, 2012). These areas are all the original places for the new coronavirus variants, and were hit by lightning frequently at the same time.

These findings suggest that it is worthwhile investigating the relationship between COVID-19 and environmental factors. Our study provides a link between the atmosphere and virus mutation, but as a preliminary investigation of course has its limitations. For example, the sources of atmospheric NO_x are various; transportation, power plants, and industrial activity will also produce NO_x. In some areas, these sources might contribute more NO_x than lightning does. Moreover, lightning and seawater intrusion may not necessarily cause the virus mutation, but promote the possibility. Nonetheless, our study highlights a new direction for researchers to elucidate more connections between environmental factors and virus mutation in the future.

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