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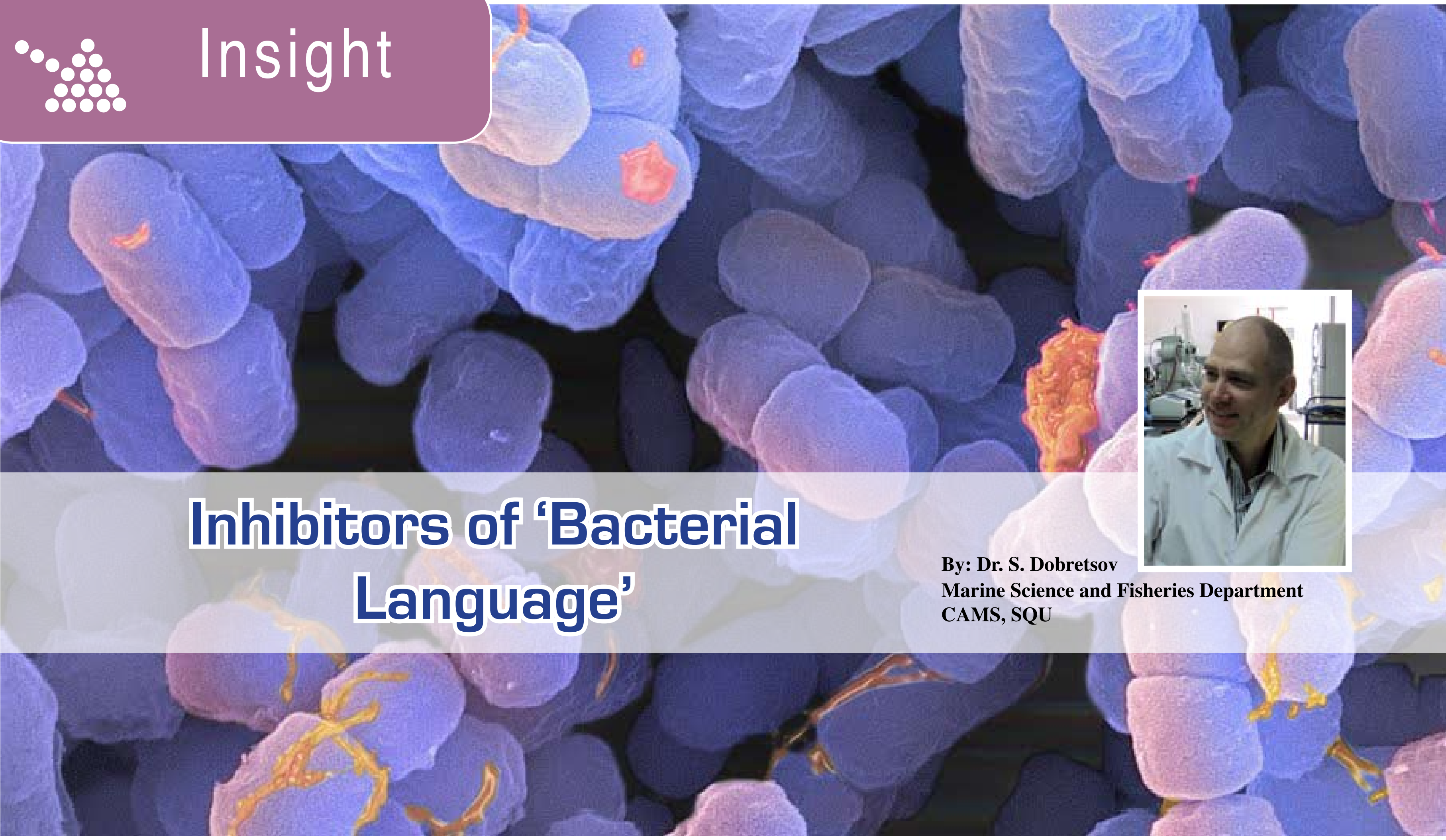

Inhibitors of 'Bacterial Language'

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Bacteria can communicate among one another using chemical signal molecules. The information supplied by these molecules is critical for synchronizing the activities of large groups of cells. In bacteria, chemical communication involves production, release, detection, and response to small chemical molecules. This decision making process, called quorum sensing, allows bacteria to monitor the environment for other bacteria and to alter behaviour on a population-wide scale in response to environmental changes. In other words, quorum sensing bacteria (one-cellular organism) can act like multi-cellular organisms.

The discovery that bacteria are able to communicate with each other changed our general perception about this simple organisms. Investigation of "bacterial language" allows investigators discover that bacteria use chemical signals instead of "words". Concentration of these signals in the environment increases with increase of bacterial density. The bacteria are able to measure the concentration of these signals and once it reaches a certain level, the bacteria launch different programs that alter their behaviour, such as adhesion and production of certain compounds. Different bacteria are using different chemical signals. As they employ different "languages" they cannot necessarily talk to all other bacteria.

First quorum sensing bacteria have been discovered only two decades ago. Scientists have found that a symbiotic bacterium living inside a deep sea Hawaiian squid produce light. Squid light organ cells promote the growth of the symbionts and actively reject any other competitors. Bacteria produce light only when they are present at high density. At this stage bacterial symbionts produce chemical signals that are responsible for light production. Later, scientists discovered other bacteria use chemical signals for their communication as well. Common plants, such as alpha-alpha and pea, "cultivate" nitrogen fixating bacteria in their roots that utilize quorum sensing signals. Most of pathogens use quorum sensing in order to successfully control their behaviour and bypass the immune response of the host. Scientists have found that more than 50% of known bacteria use quorum sensing signals to alter their behaviour.

Nowadays, most of the bacteria that cause infections are resistant to at least one of the drugs commonly used for their treatment. Few bacteria are resistant to all antibiotics and their infections cannot be treated by any drugs. An increase in resistance of common bacteria causes severe infections and high mortality from some common diseases, like pneumonia. Antibiotic resistance of bacteria is due to the mechanism in which antibiotics work. All current antibiotics aim to kill specific groups of bacteria. These forces bacteria to mutate and the few that are resistant to antibiotics are going to survive and multiply.

Recent quorum sensing investigations demonstrated that some bacteria, plants and animals are capable of production of compounds that can disrupt the bacteria's ability to communicate and thereby disable bacterial growth and ability to become pathogenic. Organisms are using this quorum sensing inhibitors in order to prevent bacterial infections. Quorum sensing inhibitors are having certain advantages in treatment of bacterial infections. First, they suppress the growth of pathogens and production of their toxins, thus giving the body an extra time to eradicate these bacteria through the natural immune defence. Second, since these inhibitors are not killing the bacteria they also do not force them to mutate and resistant strains will be unlikely to occur.

The author of this article has been investigating bacterial quorum sensing for several years. He has demonstrated that many marine invertebrates and microorganisms in Oman are capable of production of inhibitors of this "bacterial language". Recently, he studied together with Dr. Raeid M. M. Abed from the Biology Department of SQU's College of Science, cyanobacterial mats from Oman hot springs. According to the researchers, microorganisms inhabiting these mats produce quorum sensing inhibitors under natural conditions. Among four investigated springs (Hammam, Bowshar, Nakhl and Rustaq) the mats from the Nakhl were the most active. In comparison with other springs, Nakhl mats had the lowest microbial diversity. This is an important discovery suggesting that cyanobacterial mats are good sources of novel quorum sensing inhibitors. Samiha Al Kharusi, an MSc student of Biology department, has been investigating microbial diversity and bioactivity of microorganisms living in extremely saline pools of Wadi Maqshan in south-eastern Oman in Al Wuusta province under the supervision of Drs. Abed and Dobretsov. This investigation revealed that most of microbial isolates produce different quorum sensing inhibitors. SQU researchers are planning to isolate these bioactive compounds and further investigate their potential in the future.

The author of this article was the first one who isolated a quorum sensing inhibitor from a cyanobacterium. This compound was identified as malyngolide with a help of scientists from Fort Pierce Smithsonian Research Station located in Florida, USA. The "alga-like" cyanobacterium Lyngbia majuscula produce malyngolide at the concentrations sufficient to prevent growth of other bacteria on its surface. Malyngolide has the capacity to inhibit the growth of dangerous human pathogens by interfering with their quorum sensing. It is interesting that at a high concentration malyngolide works as an antibiotic. It is a known phenomenon and according to my study, about 20% of antibiotics are inhibiting "bacterial language" at extremely low nano- and milli- molar concentrations.

The study done by SQU team highlights the high biotechnological potential of microorganisms inhabiting the Sultanate and suggests that their quorum sensing inhibitors can be used for as new drugs to control antibiotic resistant infections in the future.