IN recent years, the number of deaths caused by antibiotic-resistant bacteria has been found to exceed the total number of deaths caused by influenza, human immunodeficiency virus and traffic accident. Bacterial strains, virtually resistant to all the clinically useful antibiotics, have been isolated so far.

By 2050, 10 million people are likely to die due to the failure of antibiotics. The ability of bacteria to disseminate the resistance-conferring genes among antibiotic-sensitive bacteria adds to the complexity of the problem. Increase in the frequency of resistance to the antibiotics is found to be correlated with their use for clinical purpose. Non-therapeutic use of antibiotics (e.g. as a growth-promoter in animal feed) is also believed to promote emergence of resistant strains.

The all-pervading nature of antibiotic resistance is a matter of serious concern to scientists. Antibiotic resistance is detected even in bacteria occurring in the very thinly-populated and totally uninhabited places.

At both the North and South Poles, occurrence of various forms of life is well-documented. Needless to say, they are highly sturdy in nature. They survive the subzero temperatures of the polar atmosphere. During the past three decades, extensive studies were performed at the Centre for Cellular and Molecular Biology (CSIR), Hyderabad, involving some cold-tolerant bacteria, obtained from different types of samples (soil, snow, cyanobacterial mat, water) that were collected from the Schirmacher Oasis, Adelie Land and McMurdo Valley of Antarctica.

While some of the organisms belonged to the bacterial genera that are found also in the temperate regions, some novel bacteria were also discovered. All of them were habituated to grow in low-nutrient conditions. A number of clues to their cold-tolerant nature were obtained. Out of the 72 organisms belonging to different genera, 45 were resistant to β-lactam antibiotics (penicillin G, ampicillin, amoxicillin, carbenicillin, cephalosporin), 45 to polypeptide antibiotics (bacitracin, colistin, polymyxin B), 19 were resistant to chloramphenicol, 24 to sulphonamides, 21 to vancomycin, 37 to fluoroquinolones (norfleroxacin, ciprofloxacin) and 14 were resistant to aminoglycosides (streptomycin, kanamycin, amikacin, gentamycin, tobramycin).

Varying amount of resistance to some therapeutically useful antibiotics (chloramphenicol, ampicillin, streptomycin, kanamycin, tetracycline) and heavy metals (mercury, cadmium, chromium, zinc) was observed in some aquatic Antarctic bacteria, by a research team working at the CSIR-National Institute of Oceanography, Goa. Resistance to ampicillin and chloramphenicol was demonstrated by a group of scientists at the University of Messina, Italy in majority of the isolates obtained from Antarctic sediments that were collected from two stations at Terra Nova Bay and Ross Bay. Antibiotic resistance was also observed in different types of Arctic bacteria studied at CCMB and other laboratories.

Occurrence of antibiotic-resistance in polar bacteria has raised a number of questions. Presence of heavy metals in the Arctic and Antarctic environments is well-known. Many of them are toxic to bacteria. Genes conferring resistance to antibiotics and heavy metals most often co-occur on the same genetic elements in bacteria. Therefore, organisms surviving in presence of heavy metals are also resistant to some antibiotics. Thus, selection of antibiotic-resistant organisms in the Antarctic soil might be promoted even in absence of antibiotics in the environment.
**SHORT FEATURE**

Presence of heavy metals in the Arctic and Antarctic environments is well-known. Many of them are toxic to bacteria.

In 2010, it was reported by a group of investigators that Antarctic ice was virtually free from resistance-conferring genes. However, subsequent investigations revealed the occurrence of mef A/E genes, which confer resistance to macrolide-type of antibiotics (e.g. erythromycin, azithromycin, clarithromycin), in samples of Antarctic ice collected from Patriotic Hill. This site is being used for research activities since 1986.

Presence of the resistance was attributed to human activities. Besides scientific expeditions, increase in tourism during the recent past is also believed to contribute significantly to the influx of antibiotic-resistant organisms into Antarctica. Though the gross impact of anthropogenic introduction of micro-organisms to the indigenous microbial communities of Antarctica is believed to be insignificant by some scientists, the issue warrants further in-depth studies.

It is well-known that exposure to antibiotics is not a prerequisite for the emergence of resistance. Antibiotic-resistance is known to occur in bacteria isolated from the high-altitude, uninhabited places and also from humans and animals, which are never exposed to any antibiotic. Resistance to as many as 14 commercially available antibiotics was noted in bacterial isolates obtained from a cave (New Mexico, USA) which was detached from human civilization for millions of years.

Similarly, chloramphenicol resistance was observed in some lake isolates in Germany where chloramphenicol was banned from clinical practice decades ago. So antibiotic-tolerance in polar bacteria might be an outcome of evolution. It has also been known that antibiotic-resistance in bacteria evolved long ago before antibiotics were introduced into clinical practice. Hence, the ability of bacteria to defy the antibiotics might have some significance. Resistance in polar bacteria should be looked into also from this point of view.

Antibiotic-resistance of polar bacteria offers a very challenging field for investigation. Possible impact of these organisms on the health of the research workers stationed in different Arctic and Antarctic camps deserves serious attention. Contamination of food materials with these cold-tolerant and antibiotic-resistant organisms may pose serious health hazards. In-depth investigation is essential also on this aspect. Collaborative effort in a global scale seems to be the need of the hour to minimise the anthropogenic contamination of the Arctic and Antarctic flora.

Antibiotic-resistant bacteria detected in the Antarctic and Arctic environments may also have origin in other parts of the world. In an investigation, genes conferring resistance to a number of antibiotics (ampicillin, sulfamethoxazole, trimethoprim, chloramphenicol and tetracycline) were detected in the colon bacterium *Escherichia coli* isolated from the faecal and cloacal samples of migratory birds in north-eastern Siberia, Point Barrow, Alaska, USA and northern Greenland. Thus, resistant organisms might be carried by birds from other places to the Arctic regions. Evidences are also available suggesting long-distance aerial transport of microorganisms to Antarctica.

Intercontinental transfer of microorganisms through flying dust particles is a well-known phenomenon. In 1832, Charles Darwin collected some air-borne dust from the atmosphere over the Atlantic Ocean and sent it to Christian Gottfried Ehrenberg in Berlin. Geochemical analysis of the dust located their origin in the Western Sahara region and presence of viable microorganisms in the dust particle was evidenced using molecular-microbiological methods.

It was evident thus that microorganisms could survive long distance aerial travel by getting attached to the dust particles. In 1912, pollens from some South American plants were reported to occur in the snow in maritime Antarctic region. Subsequently, Antarctic snow was found to contain some microorganisms which are not found as living cells in Antarctica. During the recent past (1988) it was demonstrated that non-maritime Antarctic habitats contained different types of microorganisms that were cosmopolitan in nature. These evidences indicate that antibiotic-resistant bacteria might be carried by dust particles to Antarctica from the temperate regions.