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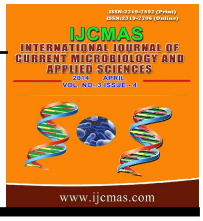

Original Research Article

Urbanisation leading to high risk of gene pollution

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A B S T R A C T

The increasing number of human settlements mostly in developing nation result in homogenizing of plant diversity and diminish insects and animal diversity. Increasing urbanisation create anthropological disturbances leading to alteration of habitat, ecological processes and biotic interaction. Native species reduce and exotic species, some human adapted native species and species from early successional stages often increase with urbanisation leading to gene pollution. With invasive urbanisation because of industrialisation the food resources of a nation decreases and demand of food product increases sharply. This encourages use of genetically engineer organisms for high agriculture yields. But this practice leads to irreparable loss or changes in species diversity or genetic diversity within species. Increasing amount of waste, both solid and liquid, are being generated as a result of the rapid rate of urbanisation. Polluted water contain hospital, industrial, domestic, agricultural and sewage waste containing residues of antibiotics administered to human and animal reach through urine or faeces creating a selection pressure condition for aquatic organism. As observed in microbes, they undergoes horizontal gene transfer to adapt and survive in the polluted environment, and large number of antibiotic resistant species is observed than the native species. Study shows that air pollutant like sulphur dioxide and nitrogen dioxide (aeroallegens) cause genetic alteration leading to high risk of allergy and asthma particularly in children. Children with high risk genotype and exposed to air pollutants like heavy metals are at high risk to CNS detrimental effects. The objective here is to review the available literature about rising urbanisation leading to high risk of gene pollution at all the levels of biota in order to derive lessons and apply the insights to analysis the field situation and create awareness about it.

Introduction

The world of environment is in the likeness of a house where all the biotic and abiotic ecological components are intimately interdependent for sustenance (Joshi, 2009). According to Clarke, (1954) a satisfactory environment is the one which fulfils all the requirements for life and does not exert any incompatible influence on any of its constituents. Ideally the natural environment supplies all the necessity of the organisms living and has favourable influence on their development, reproduction, genetics, behaviour etc (Joshi , 2009). So, preservation of the natural environment is quintessential for maintaining a sustainable community.

However, the increase of civilization has negatively affected the natural environment in the form of pollution. Increasing amount of pollutants with rapid urbanisation disposed into the natural resources(air, water, land) has caused degradation of the natural habitats and made it unfit for the biota (Balanarayanan and Vetrivel, 2012)Excessive urbanisation encourages deforestation, use of pesticides and genetically modified organisms to obtain high agriculture yields, rapid constructions of building, combustion of more fuels by the increasing number of vehicles and industries ,disposal of hospital, sewage, domestic and industrial waste into the water bodies. All these causes air, water, noise and land pollution and disturbance of the natural environment of the organisms which underwent stress and natural selection causing genotypic and phenotypic alteration.

The present article aim at reviewing the impact of rapid urbanisation on the biological diversity leading to biota homogenization so that we can mitigate any negative effect of it and aid in sustainable urban planning.

Urbanisation leading to antrhropological disturbances

With the exploding increase of human population, especially in developing nations, large number of people are being forced to move into cities in search of employment and better living conditions subsequently overcrowding the habitat and leading to rapid use and misuse of natural resources. The process of unplanned urbanisation has resulted in the fragmentation and disturbance of the natural habitat, alteration of quality of air, water and soil as a result of pollution and changes in the climate of the area (Kühn and Klotz *et al.*, 2006). Urbanisation is considered as a threat to the biological diversity (Kühn and Klotz *et al.*, 2006). Human settlements tend to reduce diversity for several reasons, for example the native species survival and reproduction declines as they are unable to adapt in the new urban settings and the rare native species get extinct (EMBO, 2007). Exotic species, invasive species introduced by human and human adapted native species often increase with urban developments. But these invasive species hybridize with the native species causing gene pollution. Extensive agricultural and horticultural activities degrade and simplify the ground cover while homogenizing plant diversity (Reichard and White, 2001). In turn this is likely to diminish diversity among the insects and animals that rely on plants for food or cover (EMBO, 2007). The polluted natural resources also result in the homogenization of diversity for example water polluted by untreated sewage and hospital waste has an increasing number of antibiotic resistant micro organisms than the native form (Mishra *et al.*, 2013).

Urbanisation increases demand of resources

Urbanisation is generally accompanied by many activities and settlements that dramatically affect the abundance and diversity of species (Devictor *et al.*, 2006).According to UN World Prospects report (2005) about 60%(4.9 billion) of the world population will be living in urbanised areas by 2030.It is also estimated that about 93% of the urban growth will occur in developing nations, with 80% of urban growth occurring in Asia and Africa. So, looking to the future there are major challenges ahead due to rapid urbanisation. Demand of land for

construction of building, road and industrial uses will increase with urbanisation which will result in the deforestation and destruction of natural environment of many biological species. In some regions, the proximity between protected areas and cities will increase greatly. For example, in Eastern Asia the average distance from a city to a protected area will be 14 miles by 2030, as compared to 27 miles in 1995. Such proximity will increase the pressures on natural resources and increase the likelihood of resource extraction and other threats to these protected places.

The July, 2013 report issued by the United Nations Department of Economic and Social Affairs, however warns that with the additional 2.4 billion people by 2050, the amount of food produced will have to increase by 70 percent straining food resources. So there will be large demand of land for horticulture and agriculture which lead to biotic homogenization. Also because of the high pressure to produce high yield experimentation and use of GM organisms and crops will increase. But this causes irreparable loss or changes in species diversity and genetic diversity within species. These GM crops invade over the native species and hybridize with the native causing loss of gene pool. The use of GM organism lead to development of more vigour's pests species after hybridization of native and transgenic organism (Snow *et al.*, 2005).

With the rapid urbanisation emission from increasing number of vehicles and industries cause a high rate of air pollution observed especially in developing nations. The species which survive in the polluted air survive and the native species unable to adapt die. The effect of global warming due to green house gases is clearly seen in the change of temperature and climate globally. The sudden changing climate pattern leads to decline in biodiversity. It is estimated that more than 1 billion people are exposed to outdoor air pollution annually. (UNEP,2012).Study shows that air pollutant like sulphur dioxide and nitrogen dioxide (aero-allegens) cause genetic alteration leading to high risk of allergy and asthma particularly in children. Children with high risk genotype and exposed to air pollutants like heavy metals are at high risk to CNS detrimental effects.

The UN has reported the daily influx of 2 million tons of sewage and wastewater into the world's water (UN-WWAP, 2003; Ross, 2010). It has been estimated that globally 1.2 billion people defecate in the open, thus significantly compromising quality of water in the nearby water bodies and posing extreme human health risk (UNICEF and WHO, 2008). 70% of industrial wastes have been estimated to be disposed untreated into the water supplies in developing countries (UN-Water, 2009). The increasing use of antibiotics in medical, veterinary and agricultural sectors has almost been synonymous with the increased resistance of bacteria to these rampant antibiotics as they undergoes horizontal gene transfer to survive in the polluted water. (Dhanorkar and Tambekar, 2004 and Ahmed *et al.*, 2010 Mishra, 2013). More and more use of chemicals, pesticides mutates or replaces the native species population leading to depletion of a gene pool. These when washed away cause eutrophication and loss of native species. Also introduction of non native species cause disturbance and even extinction of rare species. The World Conservation Union (IUCN; Gland, Switzerland , 2006) now includes more than 16,000 entries in its Red List of Threatened Species: 5,624

vertebrates,2,101 invertebrates and 8,390 plants. The extinction rates are now 50 to 500 times higher than previous rates calculated form fossil record (EMBO 2007).

Urbanisation leading to biotic homogenization

The urbanisation is a major cause of biotic homogenization has being highlighted recently (Devictor *et al.,* 2006). Homogenization is one of the most prominent forms of biotic impoverishment worldwide and is likely to cause negative genetic, functional, and evolutionary impacts on communities (Devictor *et al.,* 2006). Biotic homogenization conjures the image of Quammen's(1988) dystopian "Planet of Weeds" scenario and the prospect of kunstler's(1993)"The Geography of Nowhere" in which biotic distinctiveness gradually dissolves over time. If the same human dominated local settings were replicated everywhere, species that do not like the conditions would disappear together with their ecological niches (EMBO 2007).Biotic Homogenization refer to an increase in the taxonomic similarity of two or more species pools through time as the result of species invasions and extinctions caused due to rapid urbanisation. (Olden and Rooney, 2006).

Plant biotic homogenization among plants

More dense urban environment tend to reduce overall diversity among smaller animals and plants (EMBO, 2007). Rapid construction for human settlement and agriculture and horticulture activities lead to natural habitat degradation and destruction. The process of urbanisation has resulted in an expansion of alien plant species and declines of native species, particularly rare species (Mc Kinney *et al.,* 2006;Kühn *et al.,* 2006).However, on local and regional scales, species richness may be increased following range expansion of alien species lead to differentiation.(Mc Kinney *et al.,* 2006). Work done by Kuhu and Klotz *et al.,* 2006 also showed similar results. There study revealed that urbanisation result in increase in common native plant species and declines and local extinctions of different and rare native species has led to homogenization for native plant species and for pre-1500 alien plant species. Post 1500-alien species assemblages show differentiation explained by invasion of different alien species within different observed urban areas.

Biotic homogenization among birds

Habitats undergo human-induced fragmentation caused by urbanization which leads to changes in the species diversity and community similarity, not only in space, but also over time. Functional homogenization was positively linked with community urbanization (Devictor *et al.,* 2006). For birds the best urban adapter include certain guild feeding birds including omnivores, insectivores, sea eaters adapted to various aspect of human (Mc Kinney *et al.,* 2006).For instance changes in landscape structure, such as an increase in urban patches, alter the ability of some organism to disperse. This leads to the prediction that communities composed of species with specific habitat requirements (specialist species) should have higher local extinction and turnover rates whereas widespread and broadly tolerant species (generalist species) should, on the contrary, benefit from the landscape disturbance and demonstrate higher

stability (Julliard *et al* 2006).Worked done by Devictor and his co-workers in 2006 also indicate similar results. The higher urbanization level communities were mainly composed of ubiquitous generalist species and that, at this stage, specialist generalist composition remained constant. Songbirds phenotypic adapted to urban noise pollution by raising the frequency of their lower notes (EMBO, 2007).Urbanization leads to natural selection of species resulting in the pollution of the gene pool of species. Genotypic adaptation, for example dark eyed junco, a common North America species of sparrow, show significant decrease in the amount of white in its tail feather to adapt to San Siego, California (EMBO, 2007). Further it was observed that a higher level of corticosterone found in urban birds than the forest living birds suggesting genetically determined (EMBO, 2007).

Animal biotic homogenization among animals

Urban environment lead to the homogenization of animal biota by increasing the number of synanthropic species (example rock dove, house mouse, feral house cats) and extinction of urbanophobic species (Mc Kinney, *et al.,* 2006).The species in dense urban areas are mostly exploiters which can exploit the resources, such as food, shelter, from human settlement. Also the migration and extinction of carnivorous, predator, result in their large number (Mc Kinney *et al.,* 2006).Intentional or unintentional introduction of alien species cause gene pool depletion because of gene pollution. For example, native captive Asiatic Lions in till recently were genetically polluted with genes of Circus confiscated African Lions which had been randomly hybridized with them leading to widespread genetic pollution in the captive Asiatic Lion population. Many herds of surviving American Bison, even though they look exactly the same, were hybridized with genes of beef cattle by landowners in a short-sighted effort to improve their meat quality leading to widespread genetic pollution in the surviving bisons in America (Familypedia).

Remedial measures

Recent studies supports the hypotheses that urbanization induced community homogenization have destabilizing impact on communities over time (Devictor *et al* 2006). So urban planning is required encompassing proper waste management and use of non renewable natural resources. Urban and landscape planning should be done after studying the natural habitat and its biological diversity and should include the protection of mainstream high local diversity, not only the endangered species. Human infrastructures are threatening biodiversity worldwide and will increase in the future. Hence conservation of non-urban habitat within the urban areas should be considered and connection among the non-urban patches should be monitored to prevent local extinction of specialist species (Devictor *et al.,* 2006).

Conclusion

Urbanisation can be a mark of modernization but it is a threat created by human for the biodiversity, ultimately adversely affecting the human itself (EMBO, 2007). If the developments goes on keeping in consideration requirement of only one species there will be nothing else left. The preservation of indigenous

species in urban habitats is important for not only retaining the biological distinctiveness of urban areas but also for the future development. For conservation goals, it is also important as a way of educating the large numbers of people who inhabit cities about the importance of the local indigenous biodiversity (Mc Kinney *et al.,* 2006). Also making them aware about the threat of increasing amount of pollutants degrading the natural habitat. It's a challenge for the concern authorities and environmentalist to encourage urban planning with the conservation of the native biodiversity and habitat.

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