URBANIZATION, ARTHROPOD AND RODENT PESTS AND HUMAN HEALTH

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Abstract - By the year 2025 about 61% of the world's population will be living in urban areas, especially in developing countries. The urban population will double from 2.4 billion in 1995 to 5 billion in 2025. The world's urban population is growing 2.5 times faster than the rural population. The impact on health in the urban conglomerations is visible with a significant spread of communicable diseases or new syndromes such as drug resistant tuberculosis. Many of these infections and diseases are carried by arthropod pests and rodents. A number of diseases are also found in urban areas of the developed world, among them tick-borne diseases such as Lyme disease, Ehrlichiosis, spotted fevers and tick-borne encephalitis. Murine typhus and lymphocytic choriomeningitis virus with rodent reservoirs and cat scratch-disease with flea vectors are widespread and trench fever with body louse vectors is reappearing. Mosquito-borne arboviruses such as St. Louis encephalitis and eastern equine encephalitis can occur in urban residential areas. In the tropical, developing world, rapid, unplanned, urbanization has exceeded the ability of health services to cope with degraded environmental conditions and vector and rodent-borne diseases often occur in epidemic proportions particularly dengue, dengue haemorrhagic fever, malaria, leishmaniasis, sandfly fever, plague and even Chagas disease.
Key words - Urban, diseases, population, disease

INTRODUCTION

In the last few decades the global process of urbanization has greatly accelerated; in 1975, about one third of the world's population lived in urban areas; by 2025 more than half of the world's population will live in urban areas and most of the urban growth will occur in the developing countries in Latin America, Africa and Asia where today about one third of the population already lives in urban areas. By the year 2025 half of the population in these regions will live in urban areas. By 2015, the 10 largest cities in the world will be in Asia, Latin America and Africa. Nine of them will be in developing countries: Bombay, India - 27.4 million; Lagos, Nigeria - 24.4; Shanghai, China - 23.4; Jakarta, Indonesia - 21.2; Sao Paulo, Brazil - 20.8; Karachi, Pakistan - 20.6; Beijing, China - 19.4; Dhaka, Bangladesh - 19; Mexico City, Mexico - 18.8. The only city in a developed country that will be in the top ten is Tokyo, Japan - 28.7 million. Most of the population growth will take place in small and medium-sized towns and cities. The world's mega-cities of more than 10 million inhabitants currently hold only 4 per cent of all the world's people. Urbanization is occurring as a result of a continuing rural-urban migration and through the gradual transformation of rural areas to urban centres.

While living in a large city can confer economic and social advantages, it can frequently increase the threat to the human health, particularly in the cities of the developing countries and in the developed world as well. This paper will examine the threats to the quality of human life in the developing and developed world with reference to arthropod and animal vectors of diseases and nuisances.

Arthropods, rodents, and human diseases in developing cities

By the year 2000, 40% of the population of sub-Saharan Africa will live in urban areas. There has been a rapid expansion of cities at a rate much faster than that with which municipal environmental services are able to cope; many cities lack an adequate sewage network and are unable to supply piped water to each house. Solid waste disposal of the cities and accumulated waste and trash provide food and harbourage for rodents. Breeding places exist for insect vectors of disease, particularly mosquitoes, and an abundance of solid organic waste provides food for rodents. The poor level of housing offers easy access to rodents. Inadequate water supplies make it necessary for many of urban dwellers to store

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water in containers; these containers make ideal larval habitats for mosquito vectors of dengue and chickungunya virus and even yellow fever.

Many of the people arriving in the cities from rural areas may carry infections which are transmitted by vectors that breed in and around their homes. The situation is particularly acute in Africa but is also serious in many cities of Latin America and southeast Asia. The number of diseases associated with arthropods and rodents is so substantial that only the most important of these will be considered below.

Mosquitoes

The reduction in the populations of *Anopheles* mosquitoes in African cities and towns as a result of the pollution of the surface waters has reduced one problem while creating another. A lack of adequate underground sewage has resulted in the presence of dense populations of *Culex quinquefasciatus* in almost all tropical cities. This species is the main vector of *Wuchereria bancrofti* which causes human lymphatic filariasis.

A survey carried out in Malaysia in urban, suburban and rural areas showed that mosquitoes, cockroaches, ants and house flies were considered the common arthropod pests and rats and geckos the most common vertebrate pests. Only the arthropod pests were considered important from health and nuisance viewpoint. *Aedes* and *Cx. quinquefasciatus* were the most common pests in the city of Georgetown. The majority of the households used aerosols, mosquito coils, and electric mosquito mats (Yap and Foo, 1984).

Arboviruses

The incidence of dengue is increasing in most tropical cities throughout the world and it is one of the most important of all the communicable diseases in urban areas of southeast Asia and the Americas. The spread of dengue and dengue haemorrhagic fever is closely linked with the spread of *Ae. aegypti* and *Ae. albopictus* and is closely linked with rapid urbanization (Knudsen and Slooff, 1992). In many tropical cities of the world piped water supplies to homes is inadequate and water is stored for household use in containers which are sources of breeding of *Ae. aegypti* (Barrera *et al.*, 1993). Used tires and other discarded, waste containers which everywhere accumulate and become prolific breeding sources of dengue vectors.

Populations of *Ae. aegypti* constitute a risk for the recrudescence of urban yellow fever in the Americas (Mondat *et al.*, 1996). In Africa outbreaks have occurred in cities where dense vector populations are found (Pinto and Filipe, 1973). Chikungunya virus is transmitted by *Ae. aegypti*. There have been large urban epidemics of chikungunya in Africa (Moore *et al.*, 1974, Tomori *et al.*, 1975) and India (Rao and Anderson, 1964; Carey, 1969).

Malaria

Trape and Zoulani (1987) reviewed the urbanization of Brazzaville, Congo and concluded that it resulted in the absorption of the last remaining open spaces within the city; because of the accompanying domestic pollution, urbanization tends to eliminate *Anopheles gambiae* breeding places and by limiting the dispersion of anopheles from breeding sites, it also focuses malaria transmission.

Urbanization in Ghana has reduced *An. gambiae* populations by pollution of much of its larval habitats (Chinery, 1995). Similar processes have been made in other African cities (Robert *et al.*, 1986; Le Bras, 1986; Trape 1992). Although malaria transmission has been reduced in most Africa cities, it remains high in their suburbs. Carnavale *et al.* (1993) points out that malaria in the peri-urban areas is severe as most of the inhabitants have less immunity to the disease than those who live in rural areas. Although malaria transmission has declined in most cities, no one is completely free from the risk of malaria (Robert *et al.*, 1997). Probably another factor in the relatively low risk of malaria in African cities has been the greater use of coils, aerosols and bednets than in the rural areas (Lindsay, 1990).

Urban malaria remains a serious problem in India. One of the most important differences in the incidence of urban malaria between India and Africa is the presence in the cities of the Indian sub-continent of a vector highly adapted to urban conditions, *Anopheles stephensi*. In India, urban malaria has

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emerged as a major public health problem in cities of all sizes. Malaria is the outcome of rapid urbanization, inadequate piped water supply, storage of water in cisterns, disuse or scarce use of wells, development activities, migration and population movements. Urban malaria is a growing problem in a number of large cities of the Americas. Transmission in cities of Brazil, particularly those in the Amazon region (Camargo *et al.*, 1996) and in Colombia as been increasing (Olano, 1997). Stingl, (1990), presents a graphic description of the state of the city inhabitants for slum-dwellers in Colombia.

Leishmaniasis

A shift in the occurrence of leishmaniasis from predominantly rural to urban areas is occurring in many cities in both the New and Old World. An epidemic outbreak occurred in Khartoum, Sudan in 1986 where scutaneous leishmaniasis occurred due to a mass population movement of people from endemic areas of cutaneous leishmaniasis into Khartoum (El-Safi and Peters, 1991). In some urban areas of Brazil, leishmaniasis transmission is occurring among inhabitants who have had no contact with the forest and its sand fly vectors, (Passos *et al.*, 1993). Visceral leishmaniasis is now appearing on the outskirts of Rio de Janerio probably due to an extension of the range of a sandfly, *Lutzomyia longipalpis* (Marzochi *et al.*, 1994). An outbreak of visceral leishmaniasis has also occurred in the city of Natel, Brazil (Jeronimo *et al.*, 1994). In Jordan, building activity was actually found to increase the number of sandflies (Kamawi *et al.*, 1991). Much of the increase in urban leishmaniasis in India is due to the influx of immigrants from rural areas into previously unsettled areas surrounding cities (Magill, 1995).

Chagas disease

The infection is normally a rural problem and in Brazil, Argentina and Chile where the vector is primarily *Triatoma infestans*. Three species of vector bugs have been detected in urban areas infesting poor housing in Brazil (Brazil *et al.*, 1993), in Venezuela (Sampson-Ward and Urdaneta Morales, 1988), and in Argentina (Bar *et al.*, 1993).

Filariasis

Filariasis in urban areas is caused by *Wuchereria bancrofti*. In the endemic cities of southeast Asia, the Americas and Africa the vector is *Cx. quinquefasciatus* breeding in polluted water in high densities. In most of rural Africa the vectors of bancroftian filariasis are *An. gambiae* and *An. funestus* while on the east African coast both *Cx. quinquefasciatus* and the anophelines are vectors. Filariasis has increased in some urban areas in Brazil (Maciel *et al.*, 1994), Egypt (Harb *et al.*, 1993), and India (Manoharan *et al.*, 1997).

Tick-borne and rodent diseases

On the African continent, Lyme disease has been reported from urban areas in Mali, Mozambique, South Africa, Tanzania and Tunisia. In Asia, Lyme disease is wide spread in China, mainly in forested or mountainous areas where the reservoirs are rodent species and the vectors *Ixodes* ticks; however, it has been reported from Beijing, (Feng *et al.*, 1994).

In Asia, isolations have been made or antibodies found to haemorrhagic fever with renal syndrome (HFRS) in urban centres in China where *Rattus*- borne forms can be serious (Chen *et al.*, 1986). Rats in the suburb of Tokyo were seropositive against Hantaan viruses, (Morita *et al.*, 1989). In Korea, Korean haemorrhagic is an urban problem (Lee, 1989). Seoul virus isolates of HFRS have been isolated from *Rattus* spp in two port areas of Indonesia (Ibrahim *et al.*, 1996) and have also been isolated from *R. norvegicus* in Sri Lanka (Vitaran, 1994). In slum areas of Bangkok, Thailand, *R. norvegicus*, were seropositive for hantaviruses (Surang Tantivanich *et al.*, 1992). In the cities of Africa, antibodies to HFRS has been present almost everywhere (Gratz, 1997; Rodier, 1993). The antibody rates among *R. rattus* and *R. norvegicus* in Tananarive, the capitol of Madagascar, were high as they were in 5 other cities in the country (Rollin *et al.*, 1985). Urban cases of plague is increasing in Madagascar (Chanteau et al 1997). Despite an active plague control programme in the cities, the high densities of rats provides a reservoir for the infection.

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Pest control

A survey of 395 houses in Malaysia showed that more than 95% of households used at least one type of insecticide, primarily for mosquito control, 74% used aerosols, 55% coils, 8% oil-based liquids, and 6% electric mats. Industrial sources indicate that 100 million ringgit are spent on household insecticides for 1986 - 1987 (Yap, 1989). Households in the city Kinshasa, Republic of Congo, 92.4% of the families considered mosquitoes as a nuisance and 83.8% said that something should be done about it. Of this latter group, 43.5% spent money for their own protection, 85.6% on coils, 55.5% on insecticide sprays, and 38.6% to buy bednets (Zandu *et al.*, 1991).

ARTHROPODS, RODENTS, HUMAN DISEASES AND PESTS IN DEVELOPED CITIES

Vector and rodent-borne diseases are much less common in the cities of the developed world than those of the developing world. One of the most important capabilities of urban populations in the developed countries to take measures against what they perceive as unacceptable nuisances.

Mosquito-borne arboviruses

The presence of a number of mosquito-borne arboviruses remains wide-spread in cities of the developed world and in the areas surrounding them. Cases due to these infections are sporadic though there has recently been an outbreak of West Nile Virus in urban and peri-urban areas of Romania (Tsai *et al.*, 1998); the vector was the urban mosquito *Cx. pipiens*. In the continental USA, dengue fever was once common in cities with Ae. aegypti populations and, after disappearing for several years the infections has now reappeared in southern Texas (Rawlings *et al.*, 1998). In Puerto Rico, both dengue and dengue hameorrhagic fever are common and a major public health problem.

Ae. aegypti, and *Ae. albopictus* are now common urban mosquitoes throughout the Americas breeding in discarded tires and other waste containers. The incidence of dengue/ DHF has risen and seems likely to continue to do so. With the introduction of *Ae. albopictus*, a potential dengue vector into Europe, that continent is also at risk from the infection (Mitchell, 1995). St. Louis encephalitis is distributed in the USA; its main vector is *Cx. tarsalis* which usually breeds in rural habitats; however, the infection has occurred in urban areas of Texas, Alabama and Arkansas where the vector is *Cx. quinquefasciatus* or *Cx. pipiens* (McClean *et al.*, 1988).

Tick-borne arboviruses and diseases

The most important of the tick-borne arboviruses in Europe is tick-borne encephalitis (TBE). The primary vectors, *Ixodes persulcatus* and *I. ricinus* feed upon small mammal species and by far the majority of the cases of this disease are found in rural areas. Korenberg *et al.* (1984) considered the influence of urbanization on *I. ricinus* and *I. persulcatus*, and showed that under favorable conditions the populations of these tick species can exist for a long time not only in towns and new housing estates, but also in the old residential districts. This was confirmed in the Czech Republic by Daniel and Cerny (1990). The *Ixodes* ticks appear to adapt to green spaces such parks in urban areas providing that there are small mammal hosts available (Magnarelli *et al.*, 1995).

Lyme disease, caused by infection with *Borrelia burgdorferi*, is the most frequently reported arthropod-borne disease in the United States. The tick vectors are the same as those for TBE and are adapting to urban areas especially to parks, (Daniels *et al.*, 1997). In Russia, Kondrat'ev *et al.*, (1998) found that there were active natural foci of Lyme disease in Tomsk. Matuschka *et al.*, (1996) studied the risk of transmission of urban Lyme disease in Germany in relation to rodent populations in city parks. Matuschka *et al.* (1997) studied the frequency with which *I. ricinus* ticks attached themselves to *Rattus norvegicus* and *R. rattus* in city parks. Rats appear to be competent reservoir hosts of Lyme disease spirochetes in urban sites. Vector ticks may be so frequent in many urban parks in European cities that *B. burgdorferi* infects all rats in the sites. *B. afzelii* genospecies is also well adapted to these reservoir hosts and reservoir ticks tend to detach in a manner that would concentrate them in rodent burrows.

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The vectors of ehrlichia (ehrlichiosis) are Ixodid ticks and the reservoirs hosts are probably wild rodents, deer and sheep. In each host the illness presents as a febrile illness which can be followed by immuno-suppression leading to secondary infection and possibly death. Daniels *et al.* (1997) trapped rodents and sampled tick populations in Van Cortland Park in New York City. Their collection yielded all stages of *I. scapularis* the vector of both Lyme disease and HGE. PCR analysis of the ticks showed *B. burgdorferi* and the *Ehrlichia* species that causes HGE. One pool of 2 larvae removed from the white-footed mice (*Peromyscus leucopus*) was positive for *Ehrlichia*.

Malaria

Cases of malaria have occurred in urban areas such as New York, (Iftikhar and Roistacher, 1995) and Houston (Mundy *et al.*, 1996) in the USA. Transmission may have occurred either as a result of the importation of infected mosquitoes aboard aircraft coming from malaria endemic countries or by travelers from such countries infecting local vectors. Since 1969, 63 cases of airport malaria have been reported in Western Europe, 24 of which occurred in France. Most were due to *Plasmodium falciparum* (Guillet *et al.*, 1998).

Rodent-borne diseases

The number of rodent-borne diseases in urban areas is high and relates to the high rodent population densities found in both the developing and developed world. The higher the density of a rodent population, the more frequent will be the contact between rodents and man and the higher the likelihood of disease transmission. The circumstances facilitating transmission of an infectious agent from rodent to man are varied: they can act, alone or together with other animals, as natural reservoirs, or may be only occasionally infected. Transmission can occur by direct contact, by bite through the environment, or with the help of an arthropod vector (Rodhain, 1996). The rodent-borne hantaviruses comprise a genus of the family Bunyaviridae. Hantaviruses are etiologic agents for two acute and severe illnesses of man, haemorrhagic fever with renal syndrome (HFRS) and hantavirus pulmonary syndrome (HPS). Each hantavirus is primarily associated with a single rodent host species or genus, and is transmitted to man through accidental inhalation or ingestion of virus-contaminated rodent excreta.

The reservoir for Rickettsialpox is the house mouse and the infection has been found in other urban areas of the USA and in Europe and Asia. The infectious agent is transmitted from mice to man by the mite *Allodermanyssus sanguineus*. Frequency of the disease is related to the frequency of house mouse infestations. Commensal rats are the principal reservoir for murine typhus and the vector is *Xenopsylla cheopis*. Murine typhus is associated with urban *Rattus* populations and its distribution is virtually worldwide. It persists wherever there are substantial urban rat populations and is widespread and probably under reported. Leptospirosis is certainly the most widespread zoonoses in the world. *R. norvegicus* is the most common urban reservoir; in Detroit, Michigan USA, 90% of the *R. norvegicus* populations was found to be carrying leptospires (Demers, 1983). Urban rodents are also the reservoirs of a serious helminthic infection, angiostrongyliasis caused by *Angiostrongylus cantonensis* in urban areas.

Pest control

Inhabitants of the cities of the developed world give a high priority to the control of pests in their homes and in their environment. Substantial quantities of insecticides are purchased by householders for control of household pests. The presence of cockroaches is likely to be a factor in causing serious allergies (Sapong *et al.*, 1996), particularly in the inner cities where cockroach densities often very high (Rosenstreich *et al.*, 1997). Nine of every ten households in the United States uses some types of pesticide in their house, garden, or yard. Households in the southeastern United States used the most pesticides (Savage *et al.*, 1981).

CONCLUSIONS

Arthropod pests and vectors and rodent pests and reservoirs of disease are of major importance in cities throughout the world. In the tropical disease endemic countries, densities of mosquitoes are often so high

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and the fear of disease so great that they lead to major expenditures by families that can ill-afford them. While in the cities of the developed world arthropod densities are far lower and disease transmission is less of a threat, annoyance from biting insects results in significant expenditures.

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