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Invited Review

The role of wildlife in the transmission of parasitic zoonoses in peri-urban and urban areas

Ute Mackenstedt [a,*], David Jenkins [b], Thomas Romig [a]

[a] Parasitology Unit, University of Hohenheim, Emil-Wolff-Straße 34, 70593 Stuttgart, Germany
[b] School of Animal and Veterinary Sciences, Charles Sturt University, Locked Bag 588, Wagga Wagga, NSW 2678, Australia

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ABSTRACT

During the last 100 years in many countries of the world, there have been dramatic changes in natural/rural landscapes due to urbanization. Since many wildlife species are unable to adapt to these alterations in their environment, urbanization is commonly responsible for a decline of biodiversity in areas of urban development. In contrast, some wild animal species are attracted to peri-urban and urban habitats due to the availability of an abundant food supply and the presence of structures in which to shelter. Urban foxes and/or raccoons are common sights in many peri-urban and urban areas of Europe where they can reach far higher population densities than in their natural habitats. The same is true for foxes and dingoes in some urban areas of Australia. Unfortunately, some of these highly adaptable species are also hosts for a number of parasites of public health and veterinary importance. Due to the complexity of many parasitic life cycles involving several host species, the interactions between wild animals, domestic animals and humans are not fully understood. The role of potential hosts for transmission of a zoonotic disease in urban or peri-urban areas cannot be extrapolated from data obtained in rural areas. Since more than 75% of human diseases are of zoonotic origin, it is important to understand the dynamics between wildlife, domestic animal species and humans in urbanized areas, and to conduct more focused research on transmission of zoonotic parasites including arthropod vectors under such conditions.

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* Corresponding author. Parasitology Unit, University of Hohenheim, Emil-Wolff-Straße 34, 70593 Stuttgart, Germany. Tel.: +49 (0)711 45922275; fax: +49 (0) 711 45922276.
E-mail address: mackenst@uni-hohenheim.de (U. Mackenstedt).

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1. Introduction

Human induced landscape changes are believed to be an important factor causing modifications in the transmission of some zoonotic parasites, leading to outbreaks of human diseases, both endemic and emerging (Patz et al., 2004). Urbanization is one of those landscape alterations with the deepest impact on human health and is characterized by permanent and drastic land conversions (Patz et al., 2000, 2004). Urban areas currently contain more than 50% of the human population worldwide and this trend is increasing (United Nations Department of Economics and Social Affairs, 2003). However, it is not easy to define urban areas because they may comprise large and rapidly expanding cities, smaller towns and villages as well as smaller more diffuse human settlements. Areas defined as urban vary in size, density of human habitation, amount of vehicular traffic, infrastructure, population densities and ecological parameters. Bradley and Altizer (2007) addressed the need to find quantifiable parameters to distinguish between the differ ent areas following the gradient from natural rural environment to core urban areas. Quantitative parameters such as population density or building density in urban, suburban and rural areas have been used (Shochat et al., 2006). Urbanization is generally accompanied by deforestation and habitat fragmentation linked with a progressive loss of biodiversity from rural areas to the central urban core, accompanied by a corresponding increase in human population density.

1.1. Wild animals in urban/peri-urban areas

According to McKinney (2006), urbanization is one of the leading causes of species extinction. The decline in species richness is explained by the inability of many native species to cope with the environmental alterations associated with urbanization, eventually leading to extinction in the urban core. However, the impact of urbanization on biodiversity depends on the ecological structure of the urban and peri-urban areas: replacement of natural ecosystems by densely populated uniform settlements in resource-poor countries has a clearly different effect than the spread of suburban landscapes into agricultural land in the industrialized world. Urban and peri-urban environments can be very attractive for adaptable wild animals. The biodiversity of plants and animals in these areas frequently exceeds the biodiversity in more natural environments due to the close proximity and variation of different habitat types (e.g. gardens and forest remnants). Additionally, the supply of food resources (waste food, pet food or garden produce) of urban and periurban areas in industrialized countries is far higher than in natural or rural environments. Urban and periurban areas are therefore very attractive for adaptable species, which may reach far higher population densities than in more natural or rural landscapes (Despommier et al., 2006; Bradley and Altizer, 2007). These species are typically food generalists. Shochat et al. (2006) discriminate between 1. synanthropic generalist species, able to tolerate a wide range of urban conditions; 2. urban adapters, able to adapt to urban habitats but also utilizing natural resources; and 3. urban exploiters which are dependent on urban resources. Species range and density of wild animals in urban areas are determined by the type of urban habitats. According to McKinney (2002, 2006), anthropogenic disturbances of various nature (noise, traffic, presence of humans and pet animals) vary in intensity between different urban, peri-urban or rural environments, which will select for the adaptability of individual species to these conditions. Observations in rapidly expanding urban areas have revealed that some wild animals not only cope well with urbanization but are actually attracted to urban environments. Therefore, urbanization is a very dynamic process and changes in the composition of wildlife communities in urban and peri-urban areas are also very important for zoonotic vector-borne infections, because many of these highly adaptable species are important reservoir hosts for vector-transmitted pathogens. Therefore, changes in the abundance of certain wild animals will affect vector populations as well. Recently, abundant tick populations have been detected in peri-urban and urban areas worldwide, increasing the risk of zoonotic infections of humans and domestic animals. An increasing number of studies have been initiated to understand the complex processes involved in these developments (Daszak et al., 2000; Randolph, 2001; McKinney, 2002; Miller and Hobbs, 2002; Bradley, 2004; Patz et al., 2004; Polley, 2005; Despommier et al., 2006; Shochat et al., 2006; Bradley and Altizer, 2007; LoGiudice et al., 2008; Lambin et al., 2010; Reisen, 2010; Kellner et al., 2012; Pfäffle et al., 2013; Thompson, 2013; Rizzoli et al., 2014).

1.2. Zoonotic parasites and urban/peri-urban areas

As a result of established wildlife populations in and around human settlements, zoonotic diseases (including such that are caused by parasites) can be transmitted in the immediate environment of humans. The range of pathogens transmitted not only depends on the species and abundance of individual host species, but, especially with parasites, on the host communities as a whole. Considering the complexity of parasitic life cycles (especially zoonotic vector-transmitted infections) which often include several different hosts, it is obvious that urbanization may be beneficial for the transmission of some parasites, but not for others to the point that the parasite's life cycle is inhibited completely. Therefore, the importance, transmission and prevalence of a parasite in a given host cannot be simply extrapolated from the natural (or rural) to the urban situation. Factors influencing the transmission of zoonotic parasites in urban areas are not well understood. As an example, rich food resources may increase the birth and litter survival rates of urban-adapted species, thus intensifying the parasite transmission due to the abundance of highly susceptible juvenile hosts. On the other hand, decreased hunting pressure may change the age pyramid in favour of older animals, which causes the opposite effect (Prange et al., 2003). Pet animals may be involved in the transmission cycles of these parasites in urban areas, and the presence and frequency of pets may have a significant effect on disease pressure to humans. In urban and peri-urban areas, the frequency of contact between wildlife and humans changes from sporadic encounters to permanently sharing the environment, thus greatly increasing the chance of parasite transmission to humans (Daszak et al., 2000; Polley, 2005). More than 75% of human diseases are of zoonotic origin and are related to wildlife and domestic animals (Taylor et al., 2001). Therefore, more information is required to better understand the dynamics between wildlife species, humans and domestic animals in urbanized areas (Blair, 1996; DeStefano and DeGraaf, 2003; Chace and Walsh, 2004; Faeth et al., 2005; Wilcox and Ellis, 2006).

In the following chapters, we address the state (most often, the lack) of knowledge on various helminths and ticks whose zoonotic potential in urban and peri-urban environments has been recognized. We review examples from contrasting types of urbanized areas in central Europe and Australia, respectively.

2. *Echinococcus multilocularis*

2.1. Background on transmission factors

Alveolar echinococcosis (AE), caused by the larval stage of the cestode *Echinococcus multilocularis*, is a zoonotic disease of increasing importance in the northern hemisphere (Davidson et al., 2012). Incidence and prevalence of human AE vary widely across the expansive range of *E. multilocularis* for reasons, which are only