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## SPREADING THE WORD: THE ECOLOGY OF URBAN BIRDS OUTSIDE THE UNITED STATES, CANADA, AND WESTERN EUROPE

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URBANIZATION IS ONE of the major forces driving land-use change across the globe. Over half of the world's population now resides within urban areas (United Nations Population Fund 2007), and thus urbanization's large footprint represents a threat to biodiversity (Vitousek et al. 1997, Czech et al. 2000). Ecologists have responded to this growing environmental concern by conducting research to assess the effects of urbanization on wildlife communities (McKinney 2008). For example, the National Science Foundation is supporting long-term ecological research in urban areas. Much of such research has focused on birds in an attempt to better understand how avian populations and communities respond to urbanization (see Marzluff et al. 2001, Chace and Walsh 2006, and references therein). However, ecological generalizations regarding this topic are disproportionately represented by research from temperate-upland urban areas carried out in the United States, Canada, and western Europe (hereafter US/CA/WE; Marzluff et al. 2001, Chace and Walsh 2006). By contrast, most of the largest cities in the world are located outside of these three regions, and given that the majority of future population growth is not expected to occur in US/CA/WE (Montgomery 2008), there is a mismatch between the literature on urban birds and the regions with the most rapid current and future urban growth.

Three major reviews have summarized ornithological research on urban birds in recent decades (Marzluff et al. 2001, Chace and Walsh 2006, Evans et al. 2009), but these included very few citations of research conducted in urban areas outside the US/CA/WE (i.e., 10 from Australia, 2 from Mexico, and 1 each from Japan, Brazil, Panama, Trinidad and Tobago, Indonesia, and Malaysia; Fonaroff 1974; Jones 1981; Iñigo 1986; Ruzsczyk et al. 1987; Catterall et al. 1989, 1991, 1998; Green et al. 1989; Indrawan and Wirakusumah 1995; Kentish et al. 1995; Wood 1996; Sewell and

Catterall 1998; Petit et al. 1999; Sodhi et al. 1999; Hashimoto et al. 2005; Parsons et al. 2006; Arizmendi et al. 2007; Hodgson et al. 2007). The paucity of referenced research from urban areas outside the US/CA/WE by these reviews has left a message of a seeming scarcity of studies on how birds use urban habitats and how they respond to urbanization in other regions of the world (e.g., MacGregor-Fors 2008, Perepelizin and Faggi 2009, Villegas and Garitano-Zavala 2010). We believe that this is misleading and that, in fact, much relevant research resides latent in the current literature.

In an attempt to substantiate our position, we conducted a thorough review to locate studies of urban birds that were published between 1940 and 2008 and conducted in areas outside the US/CA/WE, between ~35°N and ~35°S, the region that broadly encompasses all tropical and subtropical areas of the world (Hornak 2002). We used the key words "urban" and "bird" to search the Web of Knowledge database (including Web of Science, Current Contents Connect, Biological Abstracts, and Zoological Record databases). We excluded publications that consisted of species lists or that limited their discussion to the threats that urbanization poses for biodiversity. This search yielded 129 studies conducted in 21 countries (Table 1).

We detected a rapid increase in the number of urban ornithology studies conducted outside the US/CA/WE in the past few decades, especially after 2003. These publications are mainly from Australia, Brazil, Argentina, and China but include at least one published study from each of 17 other countries (Table 1). Analyses of community structure were most common, followed by single-species population research and behavioral studies (e.g., foraging ecology, parental behavior). Surprisingly, few studies focused explicitly on conservation issues (Table 1). The reported results

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TABLE 1. Publications on urban ornithology in human settlements outside the United States, Canada, and western Europe, 1940–2008.

Country	Total number of publications	Community ecology <sup>a</sup>	Population ecology <sup>b</sup>	Behavior <sup>c</sup>	Conservation biology <sup>d</sup>
Australia	36	19	11	6	—
Brazil	17	9	1	6	1
Argentina	15	10	1	4	—
China	14	10	—	4	—
Mexico	9	6	3	—	—
Other <sup>e</sup>	8	6	—	—	2
Israel	6	2	2	1	1
Japan	6	4	1	—	1
India	4	3	—	1	—
Singapore	4	1	2	1	—
South Africa	4	2	2	—	—
Chile	2	1	—	1	—
Puerto Rico	2	2	—	—	—
Venezuela	2	1	—	1	—

<sup>a</sup>Community diversity and composition (taxonomic and functional) and spatial distribution.

<sup>b</sup>Reproductive biology; effects of urbanization on size and distribution of bird populations and/or relative abundances.

<sup>c</sup>Feeding biology, reproductive biology, and/or behavior.

<sup>d</sup>Urban hazards, identification of urban habitats for bird conservation, and birds as bioindicators.

<sup>e</sup>Includes Colombia, Costa Rica, French Guiana, Malaysia, Pakistan, Panama, The Philippines, and Trinidad and Tobago.

were both similar to and different from patterns that have been described in studies from the US/CA/WE. For instance, similar to what has been reported for urban birds in US/CA/WE, many of the studies in other areas of the world showed that bird species richness decreases, total bird abundance and/or density increase, the number of exotic species increases, the number of food guilds decreases, and nest predation increases with urbanization (e.g., Wood 1996; Sewell and Catterall 1998; Wang et al. 2004, 2008; Piper and Catterall 2006; Ghose and Santra 2008; Palmer et al. 2008). Also, several habitat and landscape features shown to influence urban-dwelling birds in the US/CA/WE have likewise been demonstrated to affect urban bird communities in other parts of the world. These include negative effects of habitat fragmentation and isolation on bird diversity (Chen et al. 2006, Ghose and Santra 2008); positive effects of habitat heterogeneity on native bird diversity (Shwartz et al. 2008); positive effects of urban park, woodland, and vegetation remnant size on bird species richness (Li et al. 2008); positive effects of tree and shrub density and cover on bird species richness and abundance (Ge et al. 2005, Lu et al. 2007, MacGregor-Fors 2008); and positive effects of anthropogenic food input on both native and exotic bird abundance (Ryan et al. 1991, Lim et al. 2003, Whittington et al. 2006).

On the other hand, a number of studies outside the US/CA/WE have detected noteworthy results that include the predominance of nectarivorous (Australia), frugivorous (Singapore), and insectivorous species (Brazil and Mexico) in urban bird communities (Jones 1983, Argel-de-Oliveira 1995, Villanueva Villanueva and da Silva 1995, Lim and Sodhi 2004, Hodgson et al. 2007, Young et al. 2007, MacGregor-Fors 2008); reduced total abundance in urbanized areas compared with forest habitats from the same region (Posa and Sodhi 2006); and resilience of species related to open areas to effects of urbanization (Stiles 1990). Additionally, some

studies have explored interesting research tools related to the prediction of avian diversity, the presence of particular bird species within urban areas (Bino et al. 2008, Isaac et al. 2008), and the modeling of habitat requirements for target species (Hashimoto et al. 2005).

As we have hopefully shown in this brief commentary, the major reviews of the urban ornithology literature published by Marzluff et al. (2001), Chace and Walsh (2006), and Evans et al. (2009) do not adequately reflect the amount of information available from outside the US/CA/WE. We recognize that delays can be expected between publication and citation in the primary literature, and that may be why those authors missed some of the papers that we found. Moreover, language was a possible barrier to communication, although most of the studies that we located included English abstracts, and translation “freeware” is now available (e.g., Google Translate).

Ecology, like any science, seeks generality, and the identification of similar patterns in disparate environments suggests fundamental principles. Our cursory review suggests both shared patterns and differences in the results of urban ornithology studies conducted in the US/CA/WE and those conducted elsewhere. A full understanding of how birds respond to urbanization can be gained only when studies from all corners of the Earth are merged with the currently available information on urban ornithology from the US/CA/WE.

Although some cities in developing countries are concentrating efforts to enhance the ecological quality of urban areas through habitat management, protection, and restoration, people often consider highly developed cities to be ecological “wastelands” (Isaac et al. 2008). But in fact, urban areas may act as reservoirs for several wildlife groups, sheltering diverse and complex bird communities in small human settlements as well as in large cities (Garaffa et al.

2009, Ortega-Álvarez and MacGregor-Fors 2009). We strongly believe that urban ornithology is at a promising stage throughout the world, and cities outside the US/CA/WE have much to contribute to this burgeoning field. With further effort, urban ornithology can positively influence urban management and planning policies to enhance habitat quality for urban-dwelling wildlife and the environmental conditions citizens face on a daily basis.

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