INSECTS IN THE URBAN ENVIRONMENT: PEST PRESSURES VERSUS CONSERVATION CONCERN

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Abstract—Spatial scale, from global and regional, through landscape down to habitat and microhabitat is a critical concept for both understanding pest- and threatened-insect biology. At the finer scale, there are some distinct influences and impacts on insect populations, some of these (e.g. open water butts, unburied organic matter) encourage population surges of a few species to become pests. Others (e.g. electric lights, fast-moving traffic) are a blanket mortality factor for many species. However, not all aspects of urbanization are harmful to biodiversity, especially where there is ecological landscaping. Furthermore, there is no evidence that urban pest control alone has a major adverse impact on biodiversity. Landscape degradation and habitat destruction has far greater effect. With appropriate IPM, coupled with ecological landscaping, much, but not all, biodiversity will be protected, global climate change aside.

INTRODUCTION

Urbanization is the replacement of nature by culture (Rolston, 1994). In particular, it is the replacement by high-density culture. Landscapes have been transformed from pristine, to agricultural and sub-urban, and finally to urban landscapes. Many habitats have been lost and a few new ones gained. This has happened all within a few decades, and is pan-global (Davis, 1978).

These impacts hinge on spatial scales from global and regional (e.g. mosquito population changes in response to global warming (Martin and Lefebvre, 1995)), through landscape (e.g. electric lights, fast-moving traffic, replacement of mangroves by docks, etc.) down to highly local (e.g. water butt communities, unburied organic matter, wood stored in a warehouse, etc.). Yet the highly local is related to the regional and global e.g. discarded vehicle tyres encourage the spread of mosquitos (Craig, 1993) and transported goods from harbour to harbour carry biota with specific habitat requirements (Fig. 1).

It is the loss of wild nature and the increase in urbanization that have aroused conservation mindedness. Yet urbanization, for human health's sake and protection of material goods and properties, has demanded increased hygiene and improved pest control against some of the organisms that have benefitted from urbanization. Herein lies the conflicts of interest. Polarized thinking has put pest control and conservation in separate camps, leaving the entomological fraternity with the distinct dilemma: to control or to conserve? (Samways 1994). Beliefs and folk wisdom, rather than the cool head of science, have fuelled the control/conserve dichotomy. Time is now ripe to appraise which aspects of urban pest control are in conflict with the conservation of biodiversity, and to make recommendations to resolve this conflict. This paper aims at such an appraisal, without crusade.

Impacts of urbanization

We need to be clear about the impacts of urbanization *per se* as opposed to the impacts of urban pest control. The difference is a crucial one for biodiversity.

Urbanization generally impoverishes biodiversity (Davis, 1978; 1979). With urbanization, populations of some widespread species develop lacunae at the urban nodes (Samways, 1989). Local endemic species may be completely eliminated, as with the Antioch katydid *Neduba extincta* from expanding San Francisco (Rentz, 1993).

For some species, urbanization either directly (e.g. *P. americana* in houses) or indirectly (e.g. the woolly bear beetles, *Dermestes* spp., attacking dry organic goods stored in buildings) may increase its area of occupancy and its extent of occurrence i.e. local and global ranges increase.

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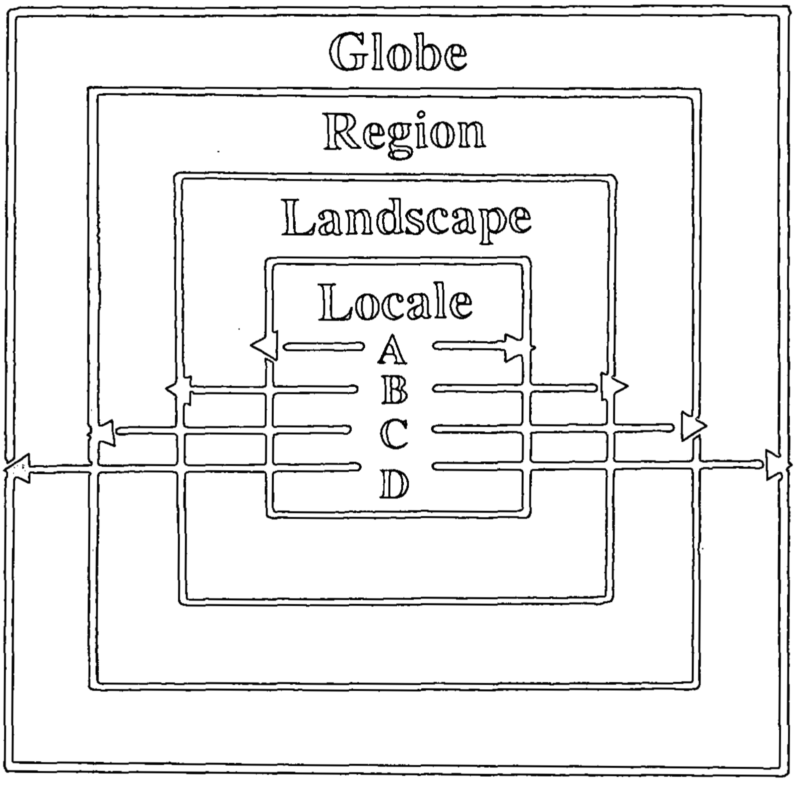

Fig. 1. The nestedness of spatial scale of the effects of urbanization on some insect populations. A) Only 'Local' e.g. establishment of the Onychophoran *Opisthopatus cinctipes* refuse tip in KwaZulu-Natal in a garden, South Africa. B) 'Locale' to 'Landscape' e.g. establishment of the dragonfly *Crocothemis erythraea* across several suitable ponds in a town. C) 'Locale' to 'Region' e.g. establishment of *C. erythraea* in ponds and gravel pits (Ott, 1995) in urban areas from southern Germany to Cape Town. D) 'Locale' to 'Globe' e.g. establishment of the cockroach *Periplaneta americana* in kitchen cupboards across the world.

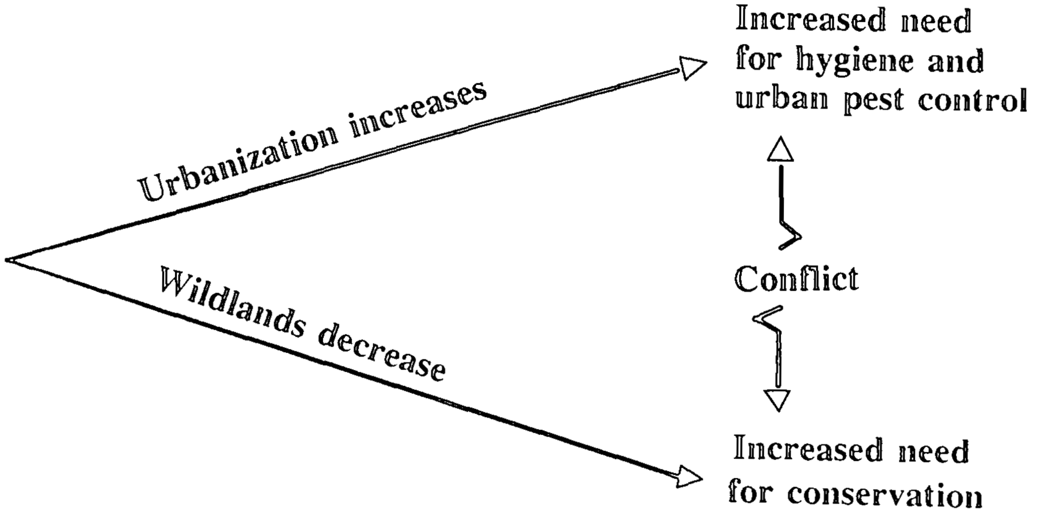

Fig. 2. As urbanization increases, so the landscape is increasingly transformed. With high human density, and concern for maintaining good human health and protection of material goods, there is also an increased need for good hygiene and effective urban pest control. But this landscape transformation impoverishes biodiversity and there is a dichotomy between conserving remaining biodiversity and controlling the few noxious species that have benefitted from the landscape change. But is there conflict between *control* and conservation? Not necessarily.

Impacts of urban pest control

It is interesting to know the extent to which urban environments encourage biodiversity. Water butts, ponds, thatch, lofts and garages can be immensely rich in fauna. Sometimes, these biotopes support otherwise extremely rare and localized species. The magnificent whip-scorpion, *Damon variegatus*, is generally only encountered behind boards etc. in private garages in South Africa.

Another important point is that the urban environment grades into the suburban one (and finally to the rural and wild environments). Insect species richness increases along this gradient away from the city centre (Davis, 1978; 1979) (Fig. 3). This is largely due to an increasing proportion of land occupied by gardens, parks etc. the farther away from the city centre. The important thing is that the pervasive general effects of urbanization (e.g. acid rain, car pollutants, industrial pollutants, etc.) coupled with decreasing land availability (Davis, 1979; Hafernik, 1992) and decreasingly small and isolated habitat patches (Kindvall and Ahlen, 1992) far outweigh the effects of urban pest control as an impoverishing impact on local biota.

It is this increase of a few species that are then the target for suppression, if not local elimination. This pest control is however, relatively localized, taking place only in certain buildings and some green spaces at any one time. Often the methodologies (e.g. fumigation of a library) are highly confined, unlike many of those of agriculture. Inevitably, the impact on overall biodiversity is low. However, the open-air use of pesticides in an urban setting is not without secondary problems. Zgomba *et al.* (1986), for example, have clearly shown the adverse impact of mosquito larvicides on mayfly and dragonfly larvae.

There are three considerations however, making it difficult to generalize about adverse impacts of urban chemical pest control. Firstly, some compounds have environmentally undesirable, effects. Methyl bromide, for example, according to the United Nations Environment Programme accounts for between 5 and 10 per cent of ozone depletion (Spinney, 1995). Secondly, resistance to compounds such as phosphine, as well as organic pesticides, is becoming an increasing problem in

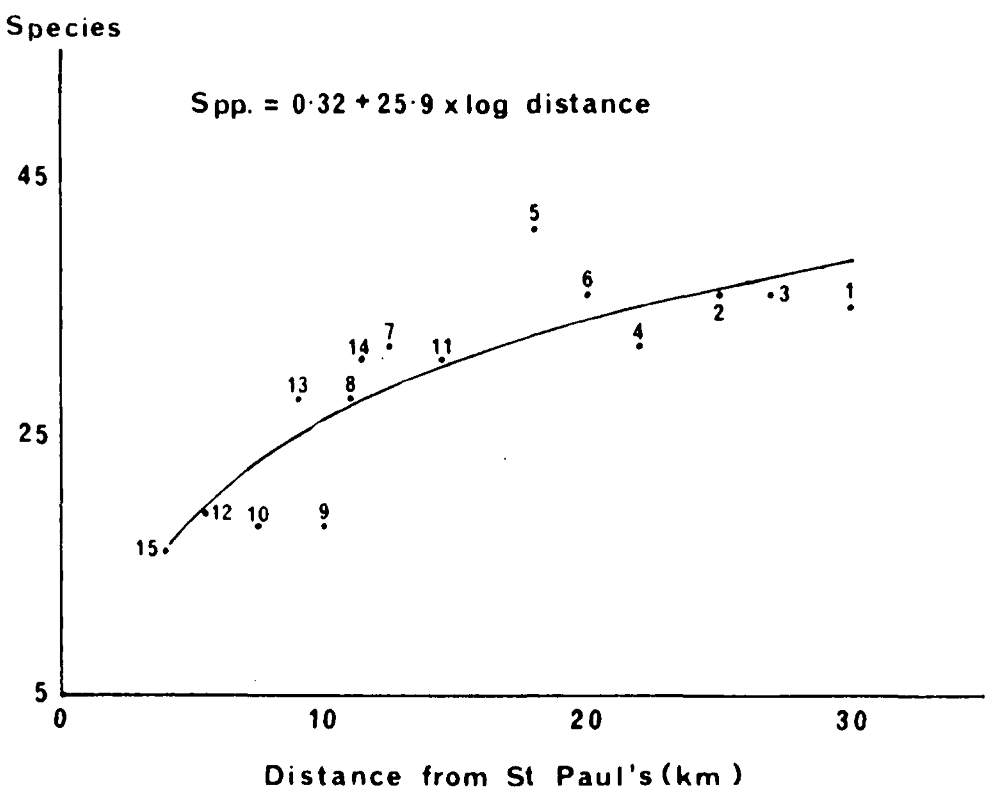

Fig. 3. Relationship between total arthropod species, identified from 15 London gardens, and distance from the city centre (from Davis, 1979).

the confines of silos, buildings, and glasshouses. Thirdly, it is not always easy, at least in dwellings, to separate the effects of good hygiene from good pest control. Indeed, pest control is often needed only when hygiene is wanting. Fourthly, warm climates present more formidable pest control challenges than temperate ones, partly because there are more opportunistic species in the tropics, and also because buildings are leakier to the outside environment (Fig. 4). It then follows from the last two points that there is a relatively rich fauna in tropical buildings, in stark contrast to the situation in temperate lands (Fig. 4).

Weighing the evidence

Apart from the potentially serious repercussions on biodiversity from using pesticides on medically important aquatic insects (e.g. Zgomba *et al.*, 1986), and the more widespread impacts of methyl bromide and ozone-unfriendly aerosol propellants, there is little evidence that chemical urban *pest control* has been harmful. This may be due however, to lack of research. In Brazil for example, highly persistent compounds such as endrin and other organochlorines have been widely used to control leaf-cutting ants (*Atta* spp.), and, similarly, various persistent compounds have been widely used against ants and termites throughout the tropics (Hill, 1975). Such useage must inevitably have contributed to the global nett impact of pesticides on biodiversity, possibly even as far afield as the ocean floor.

It is also not clear whether biological control agents have had any adverse impact on urban biodiversity, as it has in rural and wild settings (Howarth, 1991; Samways, 1988). On the contrary, the very few cases of *bona fide* biological control using insects (e.g. against glasshouse pests (Hussey and Scopes, 1985), against mosquitoes in water butts (Sebastian *et al.*, 1990) have been highly specific and localized. This contrasts with the impact (not necessarily deliberate) where cats have been shown to have a major impact on indigenous fauna in an English village (Churcher and Lawton, 1987).

Recommendations

The next step beyond objective appraisal is to make management recommendations towards conservation of as much biodiversity as possible.

(A) Global and widespread impacts
- Use only ozone-friendly propellants in pesticide aerosols
- Withdrawal of ozone-harming compounds e.g. methyl bromide

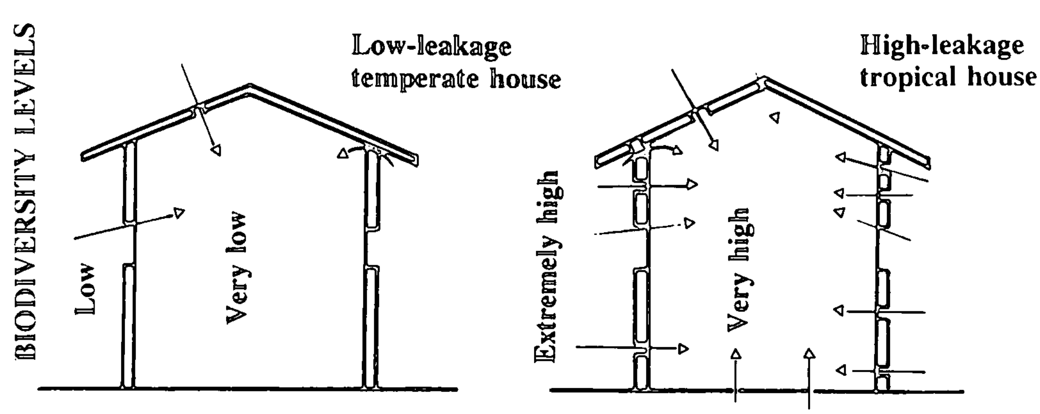

Fig. 4. Concept of the leakiness of dwellings relative to biodiversity outside and inside the house in temperate and tropical areas. Temperate lands, especially in the northern hemisphere, are relatively poor in biodiversity compared with the tropics. Houses in temperate lands are also relatively better sealed, especially for heat conservation. This means that biodiversity within dwellings in temperate lands is very low, and very low compared with outside. In strong contrast, dwellings in the tropics are rich in biodiversity, not only because the outside is more speciose, but also because much of this biota is also able to enter the house.

- Avoid overuse of compounds that are resulting in chemical resistance (e.g. phosphine)
- Avoid the use of polyphagous predators, especially vertebrates, in biocontrol programmes

(B) Local impacts
- Use spot treatments of pesticides and only where and when necessary (N.B. This requires more research on economic thresholds)(Not only does this reduce contamination but it also preserves the life of valuable compounds)
- Use non-persistent pesticides
- Increase hygiene to reduce the need for pesticides
- Use host-specific natural enemies (e.g. as in glasshouses)

CONCLUSIONS

Urbanization has had a major impoverishing effect on all levels of biodiversity the world over. Yet a few species have benefitted and have increased in abundance, at times to become pests. Consequent urban pest control, both chemical and biological, has had very little further impoverishing effect and its direct impact has been minimal. In short, it is the initial process of urbanization that is in conflict with biodiversity conservation, not the act of urban pest control.

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