How not to grow mosquitoes in African towns

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Mosquitoes bring discomfort and devastating illness to millions of people in the humid tropics. However, not all areas of standing water are their breeding sites. This article explains which mosquitoes are a problem in each area and what are the specific breeding sites for each mosquito.

Mosquitoes and the diseases they carry are a major global problem. Malaria, the most important mosquito-borne disease, is carried by a variety of *Anopheles* mosquitoes. Every year it causes more than a million deaths and 300 million cases. More than 2 billion people in 103 countries are exposed. Dengue, an epidemic viral disease carried by *Aedes* mosquitoes, is a growing urban health problem in Asia and Latin America. Filariasis is a chronic worm infection that causes the disfiguring and disabling disease elephantiasis. It is transmitted by a variety of mosquito species. One of these – *Culex quinquefasciatus* – is the most abundant human-biting mosquito in tropical towns and cities throughout the world. In many urban areas, residents are bitten by hundreds of these mosquitoes every night. This is a major problem in itself, and causes residents of tropical cities, especially those living in poor housing, to spend hard-earned cash on repellent coils and sprays. The result is a billion dollar industry, including sales of about 29 billion repellent coils every year.[1]

In urban areas, these problems are essentially man made, in the sense that mosquito breeding sites, like other physical features of the urban environment, are almost all created by people. In most cases, they are created as an inadvertent side effect of some perfectly innocent human-activity – for example curing concrete, or growing vegetables. And in most cases, the people responsible for these activities – including urban planners, architects and engineers – are unaware that their work has this unfortunate by-product.

Most people – including most professionals with responsibility for urban environments – have only a vague and unspecific idea of where mosquitoes come from. They believe that mosquitoes come from all kinds of standing water, dirty water, and water in small domestic containers. In fact, most species of mosquito have a rather narrow range of suitable breeding sites. Even within this suitable range, some sites are much more productive than others. The most productive 20 per cent of breeding sites produce more than 80 per cent of the adult mosquito population. So if you want to control mosquitoes – or just to avoid contributing to the problem – you do not have to get rid of all standing water. Rather, you have to focus attention on the specific types of waterbody that are suitable for the local mosquitoes, and especially on the most productive categories.

What, then, are the places that are important as breeding sites? How are they recognized and described? Unfortunately, mosquitoes vary from region to region (see Box) as do the potential breeding sites that are common in urban areas. So it is not possible to offer a guide that is both usefully specific, and that is also applicable in tropical cities of all regions.

This part of Zanzibar town was not a breeding site for malaria vectors when abandoned and covered in reeds, but it became an important breeding site when rice cultivation began

Urban mosquitoes: which disease, where?

In any given urban environment, the engineer should be concerned about two or at most three disease-carrying mosquitoes. The regional breakdown of these mosquitoes and the problems they cause is as follows:

Tropical Africa:
Anopheles gambiae
- malaria

Culex quinquefasciatus
- nuisance
- filariasis in the east

Aedes aegypti
- yellow fever risk in some places

Indian subcontinent:
Anopheles stephensi
- malaria

Culex quinquefasciatus
- nuisance
- filariasis

Aedes aegypti
- dengue

South-east Asia:
Aedes aegypti and *Aedes albopictus*
- dengue

Culex spp.
- nuisance
- filariasis

Latin America:
Aedes aegypti
- dengue
- yellow fever risk in some places

Culex spp.
- nuisance
- filariasis in some places

Table 1
Summary of important and unimportant urban breeding sites of *Culex quinquefasciatus* in Africa

Always or often important	Rarely or never important
Flooded pit latrines	Dry pit latrines
Septic tanks and soakage pits	Unpolluted puddles, pools and ponds
Stagnant polluted water in blocked drains – including gulley traps	Small rainwater containers, cans, coconut shells
Sullage ponding	Flowing open water in streams
Flooded basements	Potholes in roads that are regularly disturbed by vehicles

Dengue, for example, is an important urban problem in Latin America and in South and South-east Asia, but not in Africa. Urban malaria is a major problem in much of South Asia and Africa, but only exceptionally in other continents.

African mosquitoes

In this article we will consider the example of Africa. *Culex quinquefasciatus* is the most abundant nuisance mosquito occurring in almost all African towns, and in East Africa it is the main urban vector of filariasis (see Table 1). It is well adapted to urban conditions, largely because the polluted water in which it prefers to breed is also abundant in urban areas. It is often found below ground level: in soakage pits, septic tanks, flooded basements, pit latrines and blocked drains polluted with domestic refuse.

Malaria, however, is by far the most important mosquito-related problem in urban Africa (see Table 2). This is not because African malaria vectors are specially adapted to urban conditions, but because they are extraordinarily efficient as vectors, and can maintain transmission at very low densities. The principal African vector, *Anopheles gambiae s.l.*, typically breeds in small, shallow, sunlit and usually temporary bodies of unpolluted surface water, such as muddy rain puddles and hoof prints. Like most tropical mosquitoes, this species requires at least seven days to complete its development, so water bodies that persist for less than a week are not important. On the other hand, *An. gambiae* is a colonizer species, which means that it is among the first insects to arrive in a fresh-formed puddle, and succeeds best in the first few weeks before populations of predatory insects and small fish have had time to build up. This in turn means that puddles in freshly disturbed soil are especially productive, and that larger permanent pools, ponds and streams are important only if they have shallow margins.

Such water bodies are common and widespread in rural areas during the rainy season, but in urban areas, collections of rainwater that persist for more than a week tend to be either enclosed in concrete or polluted with organic debris. Both of these processes are hostile to malaria vectors, which therefore tend to be restricted to those parts of town where relatively rural

Table 2
Summary of important and unimportant urban breeding sites of *An. gambiae* in Africa

Always or often important	Rarely or never important
Wet crops, e.g. rice, cultivation ridges	Dry crops: maize, banana, papaya
Muddy footprints	Small containers: tins, coconut shells, tyres, rubbish
Temporary muddy sunlit puddles	Overhead water tanks
Unlined slowing-flowing stormwater drains with shallow muddy and/or grassy margins	Drains that are swiftly-flowing or concrete-lined, or covered or heavily polluted
Shallow borrow pits	Septic tanks, pit latrines
Puddles and small pools formed at the margins of streams and ponds, especially where disturbed or diverted by construction or cultivation	Deep open water in large ponds, flowing open water in streams
Swamps and marshes converted to rice or other wet crops	Ponds and swamps thickly overgrown by reeds, papyrus, etc., or covered by floating vegetation
Undisturbed tyre tracks in muddy roads	Potholes that are in paved roads or regularly disturbed by vehicles

In Africa, small containers like this tyre are breeding sites for the yellow fever mosquito *Aedes aegypti*, but are completely unimportant as a source of malaria vectors

conditions persist. (*An. gambiae* does not mind mud and silt, but if the water is not 'clean' enough to be drunk by a thirsty dog or cow, then it is probably also unsuitable for malaria vector breeding.) These areas are normally easy to identify: they are often associated with undeveloped patches of open ground, and with flood-prone areas. Above all they are associated with urban cultivation of particular crops, especially rice, yam, sweet potato, and other market garden crops grown in cultivation ridges.

Only some crops tend to produce malaria vector mosquitoes in this way. Maize, for example, is not associated with mosquito breeding at all, since it is not normally grown in cultivation ridges or in waterlogged soil.[2] Cassava and banana are also relatively innocent crops, except where cassava is grown in flooded cultivation ridges.

Misleading messages

Very few people are aware of the importance of these places, and especially of the dangers of urban cultivation of wet crops. This is perhaps not surprising, given that educational literature is frequently misleading. For example, health education messages on community-based malaria control often indicate the need to clean up small containers such as discarded bottles, cans and old tyres. In fact, small containers are completely irrelevant for malaria control. They are breeding sites for the yellow fever mosquito, *Aedes aegypti*, but in Africa this species is not a priority for control except in a few parts of West Africa where yellow fever is present. This species can also breed in the axils of banana plants: thus bananas are a mosquito hazard in yellow fever areas, but not in most of Africa.

Health education messages also incorrectly stress the need to cut grass and bush around houses. This is a remarkably widespread and persistent myth. In fact, vegetation around houses is irrelevant, as either a breeding site or a resting site for mosquitoes. Some people think that such simple hygiene techniques were once known to scientists as an effective method of malaria control, and that they have been unjustly forgotten and neglected since the development of 'modern' synthetic insecticides.

This is not the case. For example, just before the Second World War (when DDT was invented), a panel of the world's most experienced malariologists conducted a review of 'naturalistic' methods of malaria control, and concluded:

> As for destruction of shelters, we know of no instance where a small radius of clearing about houses or inhabited centres has done any good, but many instances where it has done great harm. Nevertheless, the cutting of underbrush and trees around dwellings is an obligatory anti-malaria measure in many tropical settlements.[3]

This was subsequently confirmed in 1946 by Ribbands,[4] who demonstrated experimentally that bush clearing had no impact on the biting densities of local mosquitoes.

In most tropical cities, the goal of getting rid of all mosquito-breeding sites remains an unattainable dream. Nevertheless, most urban residents, and urban environmental professionals, are willing to make some effort to avoid contributing to the problem and making it worse. For their efforts to be successful, however, they need a much more precise and specific awareness of where mosquitoes come from.

With this knowledge, engineers and other urban development workers can develop local solutions for at least some of the troublesome sites – as Pete Kolsky has shown in the town of Surat, India.[5]

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