

Why are mosquitoes so attracted to humans?

Richard Béliveau

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Two fascinating studies have just identified certain factors that explain why human blood acts as a real magnet for mosquitoes.

In colder countries like Canada, mosquitoes are mainly nuisances associated with the arrival of summer, unpleasant no doubt, but without too many major impacts on health.

However, this is not the case on a global scale: it is often forgotten, but mosquitoes are the deadliest animals for humans, with more than one million deaths annually which are directly caused by pathogens transmitted by mosquito bites (malaria, in particular).

GEOGRAPHIC EXPANSION

However, the protection against these diseases provided by colder climates is likely to change considerably over the next decades: indeed, according to the Intergovernmental Panel on Climate Change, the increased risk of transmission of infectious diseases by vectors such as mosquitoes and ticks is one of the concrete consequences of climate change.

Warming will allow the geographical expansion of several of these vectors, in particular mosquitoes of the *Aedes* genus, responsible for the transmission of several dangerous arboviruses (dengue, chikungunya, yellow fever, Zika), mosquitoes of the *Culex* genus (Nile virus), and also certain ticks, vectors of the bacteria responsible for Lyme disease.

The significant increase in Lyme disease cases in Canada in recent years shows that these impacts of global warming are already beginning to be felt, and experts predict that climate change could also favor the emergence of transmitted diseases by mosquito vectors of arboviruses (of the genus *Aedes*).

It is likely that this type of mosquito will be present in 197 countries by 2080, including Canada, which could cause the appearance of serious infectious diseases that were until now exclusively present in warmer countries. (1)

MOSQUITO MAGNETS

Eliminating the threat posed by mosquitoes relies in large part on finding an answer to a very simple, but so far unresolved question: why are humans particularly popular prey for mosquitoes?

Two articles recently published in the very prestigious journal *Cell* provide important answers to this question.

In the first study, the researchers focused on identifying molecules produced by the skin that are detected by the olfactory system of female mosquitoes and allow them to preferentially navigate to human blood. (2)

It has long been known that some people are much more attractive to mosquitoes than others, so the researchers compared the volatiles secreted



by these two groups of people. This approach allowed them to discover that the attraction of mosquitoes to humans was largely determined by the levels of carboxylic acids present in the skin, in particular pentadecanoic, heptadecanoic and nonadecanoic acids.

This therefore opens ways to the development of next-generation mosquito repellents, capable of interfering with the detection of these substances and preventing the transmission of viruses carried by these mosquitoes.

ALTERATION OF THE SKIN MICROBIOME

In the other study, researchers observed that viruses carried by mosquitoes could also influence the attraction of mosquitoes to humans. (3)

Using mice as a model, researchers showed that the flavivirus vector mosquito showed a preference for animals that were already infected with a flavivirus (dengue or Zika). Further analysis revealed that this attraction was due to the presence of a volatile molecule called acetophenone. A similar mechanism seems to be present in humans, as this substance is secreted in large quantities in dengue patients.

A very interesting aspect of the study is to show that this production of acetophenone is caused by an increase in certain bacteria in the skin made possible by the suppression of antibacterial defenses by the virus. In other words, during their evolution, flaviviruses have developed a strategy to increase the attraction of mosquitoes towards the humans they infect and thus promote their large-scale dissemination.

However, the researchers also observed that the antibacterial defenses of subjects infected with flaviviruses can be reactivated by administering a derivative of vitamin A, which reduces the attraction of mosquitoes and interrupts the transmission cycle of the virus.

This could therefore constitute another way of reducing the degree of attraction of mosquitoes and limiting their potential for viral transmission. A very complex war, that of mosquitoes against humans...

- (1) Kraemer MUG et al. Past and future spread of the arbovirus vectors *Aedes aegypti* and *Aedes albopictus*. *Nat. Microbiol.* 2019; 4: 854-863.
- (2) De Obaldia ME et al. Differential mosquito attraction to humans is associated with skin-derived carboxylic acid levels. *Cell* 2022; 185: 4099-4116.e13.
- (3) Zhang H et al. A volatile from the skin microbiota of flavivirus-infected hosts promotes mosquito attractiveness. *Cell* 2022; 185: 2510-2522.e16.