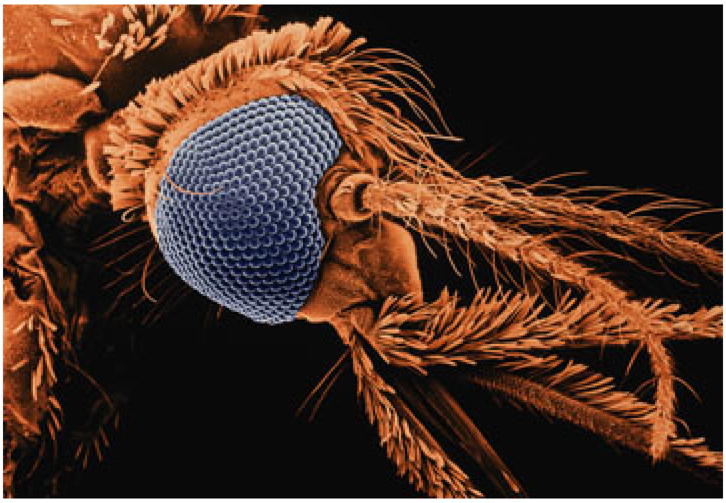
Malaria

Exterminate! Exterminate!

Oct 18th 2007 | SEATTLE
From The Economist print edition

New malaria vaccines—and a pep talk from the man who is paying for some of them—are raising the idea that malaria might be eliminated once and for all



“WE'VE made vaccines from pus and poop, we make them now using eggs—so why not make them in live mosquitoes?” So says Stefan Kappe, a researcher at the Seattle Biomedical Research Institute. To prove the point, his team is breeding millions of Anopheles mosquitoes (pictured above) and infecting them with malaria-causing parasites.

Not any old parasites, either. Those he uses have had some of their genes knocked out to stop them breeding in humans. Their destiny, like that of the “attenuated” viral strains grown in eggs, is to form part of a vaccine.

Once the parasites have had time to breed in the mosquitoes, the insects are killed and dissected under a microscope. The gold inside them is their salivary glands, the parts richest in parasites. These are extracted, processed and turned into what Dr Kappe hopes will become a successful vaccine. By injecting this vaccine of pared-down parasites into uninfected individuals, he intends to provoke an immune response to malaria that will be strong enough to kill a real infection before it gets going.

Provoking such a response is, of course, the idea behind any vaccine, and there are various ways of doing it. Dr Kappe's looks promising in the laboratory, but has yet to undergo clinical trials. Another method, however, has been on trial for several years by Pedro Alonso of the Barcelona Centre for International Health Research. This week saw the publication in the Lancet of the latest results from those trials. They look very promising indeed.

Surface and depth

The vaccine created by Dr Alonso and his colleagues has been tested on infants aged under five months in a region of Mozambique where the disease is endemic. It did not provide complete protection, but the infection rate observed over the course of the subsequent six months was 65% lower than in members of a control group, who were given a hepatitis B vaccination instead. And it was also safe—an important consideration, since infants are both the people most vulnerable to malaria and those in whom it is easiest to provoke adverse reactions.

Unlike Dr Kappe's vaccine, this one does not rely on injecting whole, attenuated parasites. Instead, some of the proteins that adorn the parasite's surface have been made in bulk. The vaccine is thus, in effect, all surface. Since the immune system can see only the surface of even a whole parasite, that is the only part it can learn to recognise, so a vaccine consisting of parasite surface and nothing else should be good at stimulating an immune response—and it is.

Dr Alonso's paper, then, is a bit of good news in an area—global health—that is more usually associated with misery. It is not, however, the only optimistic note as far as malaria is concerned. A newish and very effective drug called artemesinin is now being deployed, and the campaign to distribute insecticide-laced bed nets through large parts of Africa is also showing signs of success. A few people are therefore daring to whisper a word that has not been heard much in malaria circles since the 1960s: eradication.

On October 17th, the day Dr Alonso's paper was published, someone dared do more than whisper the word. Bill Gates almost shouted it at a conference on the disease which was organised in Seattle by his foundation. The Gates Foundation helped to finance the trials in Mozambique and Mr Gates used their success to give a rousing speech to the gathered experts, challenging them to raise their sights. Rather than continue with today's strategy of merely controlling malaria, he argued that it is time for the world to aspire to exterminate it altogether.

This is not a new idea. The last attempt to eradicate malaria began in 1955 (coincidentally, the year Mr Gates was born) and relied on a new wonder chemical called DDT to kill the mosquitoes. For a time, it was successful, but then evolution struck back, as natural selection favoured the spread of insecticide-resistant genes. Shortly afterwards, politics struck back, too, as the environmental movement successfully demonised DDT because of the damage it does to many other animals.

Given this history, cynicism about the idea of eradication is understandable. Steven Phillips, chief medical officer of Exxon Mobil, a firm whose African operations are inevitably affected by malaria, argues that eradication is technically impossible and favours emphasis on “bread and butter” disease control. But Regina Rabinovich and Tachi Yamada, the scientists responsible for running the Gates Foundation's anti-malaria effort, argue that eradication was never seriously attempted in Africa in the past. They think that today's money, technologies and political will are strong enough to make eradication a realistic aspiration.

Dr Phillips is right, in the sense that even the finest vaccine cannot do much good if it does not reach villages in endemic areas. However, things change — even in Africa. A report released this week by Unicef, the United Nations Children's Fund, suggests several countries, including Ghana, Tanzania, Benin and Gambia, are making progress in spreading artemesinin and bed nets.

Eradication would not be cheap. A back-of-the-envelope estimate suggests it would cost about $9 billion a year for two or three decades to make and distribute the necessary vaccines, drugs and equipment. But that compares with $3 billion a year indefinitely, merely to contain the problem — not to mention the economic damage done by the disease. Big ideas have to await the right time to be realised. But for malaria that time may be now.

Evolution

Live fast, love hard, die young

Oct 18th 2007
From The Economist print edition

Chasing females can take years off life

IN THE cause of equal rights, feminists have had much to complain about. But one striking piece of inequality has been conveniently overlooked: lifespan. In this area, women have the upper hand. All round the world, they live longer than men. Why they should do so is not immediately obvious. But the same is true in many other species. From lions to antelope and from sea lions to deer, males, for some reason, simply can't go the distance.

One theory is that males must compete for female attention. That means evolution is busy selecting for antlers, aggression and alloy wheels in males, at the expense of longevity. Females are not subject to such pressures. If this theory is correct, the effect will be especially noticeable in those species where males compete for the attention of lots of females. Conversely, it will be reduced or absent where they do not.

To test that idea, Tim Clutton-Brock of Cambridge University and Kavita Isvaran of the Indian Institute of Science in Bengalooru decided to compare monogamous and polygynous species (in the latter, a male monopolises a number of females). They wanted to find out whether polygynous males had lower survival rates and aged faster than those of monogamous species. To do so, they collected the relevant data for 35 species of long-lived birds and mammals.

As they report this week in the Proceedings of the Royal Society, the pattern was much as they expected. In 16 of the 19 polygynous species in their sample, males of all ages were much more likely to die during any given period than were females. Furthermore, the older they got, the bigger the mortality gap became. In other words, they aged faster. Males from monogamous species did not show these patterns.

The point about polygyny, according to Dr Clutton-Brock, is that if one male has exclusive access to, say, ten females, another nine males will be waiting to topple the harem master as soon as he shows the first sign of weakness. The intense competitive pressure means that individuals who succeed put all their efforts into one or two breeding seasons.

That obviously takes its toll directly. But a more subtle effect may also be at work. Most students of ageing agree that an animal's maximum lifespan is set by how long it can reasonably expect to escape predation, disease, accident and damaging aggression by others of its kind. If it will be killed quickly anyway, there is not much reason for evolution to divert scarce resources into keeping the machine in tip-top condition. Those resources should, instead, be devoted to reproduction. And the more threatening the outside world is, the shorter the maximum lifespan should be.

There is no reason why that logic should not work between the sexes as well as between species. And this is what Dr Clutton-Brock and Dr Isvaran seem to have found. The test is to identify a species that has made its environment so safe that most of its members die of old age, and see if the difference continues to exist. Fortunately, there is such a species: man.

Dr Clutton-Brock reckons that the sex difference in both human rates of ageing and in the usual age of death is an indicator that polygyny was the rule in humanity's evolutionary past—as it still is, in some places. That may not please some feminists, but it could be the price women have paid for outliving their menfolk.

Quantum cryptography

Heisenberg's certainty principle

Oct 18th 2007
From The Economist print edition

The Swiss are using quantum theory to make their election more secure

HANGING chads. Ballot stuffing. Gerrymandering. Such dirty tricks enfeeble democracy. But the security of the votes cast in Geneva during Switzerland's general election on October 21st is guaranteed. The authorities will use quantum cryptography—a way to transmit information that detects eavesdroppers and errors almost immediately—to ensure not only that votes are kept secret but also that they are all counted.

In quantum cryptography, as in most long-distance data transmission, the information is carried by photons, the particles which compose light and other sorts of electromagnetic radiation. These particular photons, however, are manipulated in a special way. The simplest example is when the sender (whom cryptographers usually call Alice) dispatches a stream of them to the receiver (who is known as Bob). These photons will have one of two modes. In the first, a photon is polarised either vertically or horizontally. In the second, it is polarised diagonally—plus or minus 45°. In the first mode, a photon polarised vertically represents a “0” and one polarised horizontally represents a “1”. Similarly, in the second mode polarisation at +45° represents “0” and at -45°, “1”.

Bob's receiver can be set to only one mode at a time, so if Alice sends him a vertically polarised photon and his equipment is in the first mode, then he will record a “0”. If his equipment is in the second mode, he will have an equal chance of recording a “0” or a “1”. After a short time, Alice tells Bob that the photon she sent should have been measured in mode one; she does not tell him what value it should have been. Bob now knows whether he made a correct measurement. If he did, he keeps the result and tells Alice that they have a match. If not, he junks it and tells Alice to do likewise—a process that takes a few millionths of a second.

It is at this point that Eve may show up. Eve is the name that cryptographers give to an eavesdropper. Should Eve intercept the transmission, the laws of quantum mechanics mean that she cannot read it without altering the photon in some way. By recording each photon, she actually destroys what she is measuring. She must therefore generate some new photons and send these to Bob, in the hope that he doesn't twig what is going on. But her equipment, too, must be set to one mode or the other, and she cannot be certain that the polarity of the photon she sends to Bob is correct.

This means that if Eve is involved, when Alice and Bob come to compare their data there will be many more mistakes than would otherwise be expected. Eve's presence will thus quickly be revealed and appropriate countermeasures can be taken. And the system works not only when there is an intelligent eavesdropper on the line, but also when data become corrupted accidentally.

For a truly secure system, the message will be encrypted in a way that requires a mathematical key to unlock it. In fact, both key and message can be transmitted this way: if the key is sent first, any interception will be detected and the key discarded. Only when the key has been safely transmitted need the message itself be sent.

This being Switzerland, it is unlikely that anyone will try a bit of electronic ballot-stuffing in this particular election, so it is the anti-accidental-corruption feature that is of most interest to Geneva's returning officers. And in truth, this is as much a piece of advertising as a real application. The firm behind the efforts, ID Quantique, is Swiss. The other two companies developing quantum cryptography for commercial use, MagiQ and BBN Technologies, are American. Employing quantum cryptography to transmit the vote from polling stations to central counting house is thus a bit of a publicity stunt.

Still, this will be the first time the technology has been deployed for real, so whether the system succeeds or fails will be of great importance to ID Quantique. Like the other two firms, it has its eyes on banks, insurance companies and other businesses that have to move a lot of sensitive data around. Whether the government of Florida will be interested is a different question.

Evolution

The origin of speakies

Oct 18th 2007
From The Economist print edition

More evidence that Neanderthals could talk to each other

IF YOU found yourself in a cocktail bar with a Neanderthal man, what would he say? A good conversation is one of the great joys of being human, but it is not clear just how far back in the hominid lineage the ability to use language stretches. The question of when grunts and yelps turned into words and phrases is a tricky one. One way of trying to answer it is to look in the fossil record for evidence about what modern humanity's closest relatives could do.

Svante Pääbo, of the Max Planck Institute for Evolutionary Anthropology in Leipzig, and his colleagues have done just that. Dr Pääbo is an expert in extracting and interpreting the DNA of fossils. As he reports in the latest issue of Current Biology, he and his team have worked their magic on a gene called FOXP2 found in Neanderthal remains from northern Spain.

The reason for picking this particular gene is that it is the only one known so far to have a direct connection with speech. In 1990, a family with an inherited speech disorder known as verbal dyspraxia drew the attention of genetics researchers. Those researchers identified a mutation in FOXP2 as the cause of the dyspraxia.

Since then FOXP2 has been the subject of intensive study. It has been linked to the production of birdsong and the ultrasonic musings of mice. It is a conservative type, not changing much from species to species. But it has undergone two changes since humans split from chimpanzees 6m years ago, and some researchers believe these changes played a crucial role in the development of speech and language.

If these changes are common to modern humans and Neanderthals, they must predate the separation of the line leading to Homo sapiens from the one leading to Homo neanderthalensis. Dr Pääbo's research suggests precisely that: the FOXP2 genes from modern humans and Neanderthals are essentially the same. To the extent that the gene enables language, it enables (or enabled) it in both species.

There has been much speculation about Neanderthals' ability to speak. They were endowed with a hyoid bone, which anchors the tongue and allows a wide variety of movements of the larynx. Neanderthal skulls also show evidence of a large hypoglossal canal. This is the route taken by the nerves that supply the tongue. As such, it is a requisite for the exquisitely complex movements of speech. Moreover, the inner-ear structure of Homo heidelbergensis, an ancestor of Neanderthals, shows that this species was highly sensitive to the frequencies of sound that are associated with speech.

That Neanderthals also shared with moderns the single known genetic component of speech is another clue that they possessed the necessary apparatus for having a good natter. But suggestive as that is, the question remains open. FOXP2 is almost certainly not “the language gene”. Without doubt, it is involved in the control and regulation of the motions of speech, but whether it plays a role in the cognitive processes that must precede talking remains unclear—jokes about engaging brain before putting mouth in gear notwithstanding.

The idea that the forebears of modern humans could talk would scupper the notion that language was the force that created modern human culture—otherwise, why would they not have built civilisations? But it would make that chat with a Neanderthal much more interesting.