

**Current Controversies: Vectors—Is the Transgenic Mosquito
As a Weapon Against Malaria Ever Going to Fly?
The Fourth MIM Pan-African Malaria Conference
Yaounde, Cameroon
November 17, 2005**

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference
Yaounde, Cameroon
Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?
November 17, 2005

[START RECORDING]

AYOADE ODUOLA: I am sure a lot of people are waiting to see what kind of contributors that there are. But I set the stage for this. What Jeffrey Site [misspelled?] just said is that we need a comprehensive approach to be successful with malaria. We have tried mikipolet [misspelled?] before and it didn't work. So now, we know that everything has to be there, prompt diagnosis, effective treatment, and effective vector control. Working together, this will help us reduce the mortality and morbidity before we have a vaccine.

But for vector control, there are several aspects and one of the many agents that are coming now because of genomics, molecular biology, is in transgenesis. With my colleague before we discoursed I said, "Well, this is not a controversy like the other controversies you have discussed. This has more implications." So the controversy and the discussion will be between everybody in this hall and those who are sitting here. We will pass out a questionnaire, which I would appreciate you completing, as the presentation goes on. The format for the presentation will be a little bit different. We've asked Dr. Bart Knols to set the stage in the 25 to 30 minute presentation and I will call on Professor Kitsos Louis to make comments on that presentation

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

for 5 to 10 minutes and then open it up to you for your suggestions and discussions. The reason for this is simple. We have stepped into an area that is unusual, that is an aspect that has never tried before, but what we've learned from some other issues, which will be discussed. We know some things that work and we know some things that don't work. But I don't believe that there such as a loom consists the only controversy that has been involved in this controversy. You have the decision makers if some thing comes out of if and you have the population. And this requires a lot of activities in [misspelled?]. So this is setting the stage for some of the discussions that we think will continue for the next few years. Dr. Bart Knols is going to present the first section. He works at the International Atomic Energy Agency. He is one of the leading experts in times of allergic control of vectors and especially, I know this of Africa. He is going to be talking more and he's been involved in SIT, the Sterile Insect Technique. So, he's going to bring that experience in terms of looking at prognosis and put forth these issues in the area. Professor Kitsos Louis some of those who are involved in vector and know malaria from Greece, he's been one of the leading people in times of pulling together, the database, the genomic issues that we have been working with and one of

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

Current Controversies: Vectors—Is the Transgenic Mosquito As a Weapon Against Malaria Ever Going to Fly?

November 17, 2005

the members of the executive committee that Sequence the Anopheles gambiae Genome. So he will be bringing that expertise to discuss. May I have the next slide, please.

What they will be talking about is based on events that took place 15 years ago. My predecessor at DTR was the [misspelled?] was among those who organized a meeting that was held in 1990. At the meeting they discussed looking at new ways and novel technologies that could be useful in controlling insect-borne diseases and using malaria vector as a template. They developed this road map. And this road map, not like a local road map, it's not flood [misspelled?]. It's been a very successful one.

And by starting that in 1995 identified some of the research issues and questions that needed to be addressed. Looking at population genetics, molecular basis, and how long it would take at each stage before we could reach a local potential refractory mosquito and what it would take to use this in public health setting for field trial. Most of the committee adheres today, very strictly, and at part will be presented with moot a long way in this and have achieved quite a lot. We are getting to a point where everybody needs to know as a question and see where is it going. What are the potential vibes? What are the issues? What are the challenges? This is what we are trying to understand now

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

from this discussion and I'm sure they will give you a fantastic thing. Please, we will make this short, so that we are not late for dinner, but we would like to get as much out as possible. Thank you for your patience. Dr. Bart Knols.

[Applause]

DR. BART KNOLS: Thank you very much Mr. Chairman. It's late, it's Thursday and if I were to sitting on your side, I would probably fall asleep halfway through this, so we have to bring some spice into it and that's why we have been handing out this small pieces of white paper to keep you awake and from time to time ask you a question, which you can answer on that little piece of paper. Then at the end of the session, you can at the door, give it to one of these ladies who is there collecting them. And your collective results will be announced in the MIMcom newsletter next week. If I could have the next slide?

As was said, I'm spending my time not working on weapons of mass destruction; I'm spending my time working on diseases of mass destruction at the International Atomic Energy Agency. If we start looking at the issues relating to genetic control, which I'm working on, then there are quite a few things that ought to be said before we start a dialogue. Right? We don't have a weapon yet, as I just mentioned. A transgenic mosquito, as a control strategy, is not yet there.

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

But if it could truly be developed as a good strategy, then it could be very lethal. And we should admit it. Some tools just take very long to develop. We've been working on vaccines for decades, so should we give this technology the same benefits of the doubt and give it decades for it to come to full fruition. We should admit that some strategies that make it, they become implemented and others simply don't. But in the process of working on them, I think we can learn a hell of a lot that we can actually apply not just in genetic control but in other control strategy too. There's a lot all that can be learned and not a waste.

Let's look at Kuran's [misspelled?] control and I would tend to say that if the hammer is the only tool that you have, you tend to view every problem as a nail. We've got nets and those's been doing a great job out there but let's not sit back and rest and think that everything will be fine once we have scaled up. There is more to be done.

Next.

So malaria control in as much as we are here gathering with 1500 people there is still a hell of a lot to be done and we're still not good enough at it. And therefore, I should say that any tool or any strategy drive it with both hands, develop it, and try it and if it's good it ought to be used.

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

Current Controversies: Vectors—Is the Transgenic Mosquito As a Weapon Against Malaria Ever Going to Fly?

November 17, 2005

So briefly I'm going to explain to you what this is all about because a lot of people are not working in their daily lives with genetic controlled mosquitoes. So, what is this all about? First, if you work on this strategy, you develop a genetically modified mosquito that stops or prohibits parasite development. The mosquito flying along will no longer spread disease. We've put something in it that will stop it from doing that. And secondly, you release these mosquitoes and you hope that these genes that will confer that refractoriness, that inability to develop the parasite will spread throughout that population. And then, you think, you hope that you will be able to reduce transmission and as a result of that, we will have a blast [misspelled?] at morbidity and mortality of malaria.

In other words, the whole concept is based on replacing the mosquito population that [misspelled?] malaria with a mosquito population that no longer can. So, what is a transgenic mosquito then? That is a mosquito that has gotten new characteristics. You turn it into a new phenotype. And that new phenotype is the result of your active manipulation of its DNA in the laboratory. And then, by introducing these traits into the germ line, into the cells that will turn into sperm or eggs later on, you will actually be capable of passing them on to one generation to the next. In short,

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

there are issues related to getting these transgenes in the chromosomes. In other words, you need to micro-inject, which is quite an elaborate procedure, you need to micro-inject the DNA into the chromosomes, in those cells, in the insect. It's microsurgery. And then, you need to promote the integration of these transgenes in the genome, in those chromosomes. And that is purely done by using transposable elements. Now transposable elements have this natural tendency of breaking up DNA, inserting them into, and then repairing the DNA. So we have a vehicle here, which we can use to insert those genes into the genome.

And then third, we need to know, once we have accomplished that task, in other words, we need to include also the marker gene. In this case, it's shown here on this slide, which has green eyes. This is a gene expressing green phosphorescence protein and so that we can indeed we were successful in integrating these transgenes into the genome. That's a wonderful story! The question is can you do this with mosquitoes and can you then actually make them refractory to malaria. And indeed, this has been accomplished. Using the piggyback transposable element it has been possible to achieve stable genomial transformation of an anopheles and then using the SM1 peptides there was an expression of recumbent protein inside these mosquitoes that

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

convert, that deliver a resistance to parasite development in that mosquito leading to an 80 percent reduction in a transmission capability of that population in the lab. That is good and great news! Next.

A second example which was just published this month is the fact that a group of professorial [misspelled?] and empirical [misspelled?] has been able to develop a transgenic sex exchange [misspelled?], which is basically the expression of green phosphorescence protein in the gonads of males only which can be used to clearly separate the males and the females because you cannot release the females in the wild because they will transmit disease. So we have a transgenetic sex [misspelled?]. Next.

So, to conclude at this stage, we have been able to transform mosquitoes, we can engineer these mosquitoes in certain ways, we can make them do certain things. We have succeeded in creating a mosquito that is refractory to plasmodium development and we are searching for new effective molecules. We are trying to target the factor at more than one stage, sorry, the parasite at more than one stage during its development inside the mosquito. And I can almost guarantee you that same system is going to be developed for the prime African malaria factor and the most important plasmodium that we are dealing with, falciparum. Next.

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

However, if you develop a transgenic mosquito, you load this insect with genes with transgenes and the expression of those transgenes, the allocation of resource of that mosquito, to as an expression are costly. There is a fitness cost with associated with being a transgenetic mosquito. And here, even though you cannot see all the details, it shows that if you start with a 50-50 percent distribution of your transgenics in a cage and wild [misspelled?] that within a very short period of time, in about five generations, you get a full collapse of the homozyics and heterozyamics [misspelled?] transgenics and the [misspelled?] insects almost fully take over. Bad news. Next one.

However, there have also been experiments where this was not the case, where the proportion of stephensi [misspelled?] versus transgenics remain almost constant over a number of generations. Now the interesting thing is, that if you actually expose to these mosquitoes to parasites, if you infect them using membranes and suddenly the transgenes start doing their work, that you actually deliver a fitness advantage to these mosquitoes because the wild typed ones are suffering from the infection with plasmodium and in that case, there was actually an increase of the proportion of transgenics in those trials. So that was good news. Next.

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

Now, let me ask you then, the first statement. So, here's the time when you take your piece of paper, if you have it, I hope you all have it and here is your statement number one.

Statement one is: The successful transformation of anopheles and the development of refractory strains serve as a proof of principle that transgenic mosquitoes may one day fly to control malaria. Your views are welcomed.

Will we, on the basis of what we have, be able to push it through all the way to the end?

All right. I trust that you got that one. Next. The second question that I'm going to ask you is on the basis of what we've got now, transgenic mosquitoes, refractory toward malaria are you confident that this can actually be repeated with anopheles gambiae, which we know is more difficult to transform and whether we can actually develop a transgene that will deliver a victorious to falciparum? Can we do it also for the most important system in the world?

Okay, we move on. Genetic control, now this has got nothing to do with malaria but I just want to show you what genetic control can actually do. This is the new world's Curran [misspelled?] fly, it is a pest of cattle, where the fly lays the eggs on the skin and so, in the 1950s it was found that if you radiate males and you produced them in very

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

large numbers and you released them in the field. They can then induce sterility in that population and make it crash. And you can eradicate the population; the population was eradicated on the Isle of Kurassou in the late 50s. And then the technology was transferred to some in Florida and then from there something incredible happened! The entire United States, Mexico and the rest of Central American was freed from this—of this pest for a period of 40 years of sustained efforts. This is genetic control in the real world. Forty years of hard work has cleared the entire continent, the North of Americas, of a major pest. It is now amounting to benefits that in the order of \$4 billion per animal. Next.

Can we do this with mosquitoes? And I don't think we're looking at something new. Genetic control of mosquitoes has actually been attempted in the past. Here you see a timeline and here you see for 1980s Kelax [misspelled?] and anopheles the time period where trials were being undertaken. You can clearly see that in the—during the Deed of Sierra, there wasn't that much interest, but following it, there was an increase. A haste in interest in doing genetic control including in developing countries again anopheles, in El Salvador, against anopheles in other sites in the world. I'll give you an example in due course. However, you can see that the in the early 80's interest for this thing weaned.

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

And that was mainly because there were problems associated with the releases of these genetically altered insects. They had impaired fitness. They were suffering from a disorder of mating. The ones that you were releasing were mating with the ones that you had also released, rather than going out and looking for wild females. And there was actual a reduced comparative ability of these insects. The guys that you released were not strong enough to compete with the guys in the field. So interest at that stage weaned.

My next questions to you, statement number three. Many genetic mosquito controlled trials have failed in the past. However, we know a lot more these days. We have a better understanding of the causes coupled with a vast increase in biological knowledge. Does that give us a better chance for success in the future? Now that we know more, will the chance for success be higher?

You can make a transgenic mosquito; I think I've convinced you of that. You can certainly do it in the lab. One of the outstanding critical issues are how are you going to drive those transgenes in a population of wild type insects? How are you going to do it in the field? And drive is a key issue there.

For drive there are several options like transposable elements, which I just mentioned to you. But there are also

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

Current Controversies: Vectors—Is the Transgenic Mosquito As a Weapon Against Malaria Ever Going to Fly?

November 17, 2005

other strategies that have been thought of like meiotic drive or the use of anti-symbiotic [misspelled?]? There are various ways in which people are trying to drive the genes into the wild. However, one question that will be released actually mortified the ambient [misspelled?] population over an unusually brief of time. If the strait of this transgenes take years before the population is replaced, well, you may then have to do something else because people are dying of malaria in the meantime. So, this should go reasonably fast, otherwise it's not going to be useful. And will the resulting modification actually be sufficiently extensive? So, if you have the baselines competent in terms of transmission of that population will you be able to reduce it sufficiently to see a public health gain as a result of it? Next.

Models from the group of Andy Spielman [misspelled?] in Harvard looking in to this issue they graphically here, I can show you, that in an area along the road they were releasing transgenic mosquitoes in all the great areas here of wild type insects and the models that after a year, you get these insects moving into and away from that road. In two years, you get clustering, but after 33 years of these transgenes being out there, you would only have covered about 50 percent of the population and unfortunately the other half

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

will transmit malaria just as well as they did before. So, there is a real issue to consider there. Next.

So, one could argue well I could just start releasing many more of my transgenic mosquitoes, then I can deal with the problem, but the critics will then tell you, well why not just sterilize your mosquitoes and do an SIT campaign because you are doing virtually the same thing. And then rather than by going for population replacement, you're going for population reduction, if not elimination. Next.

So, another issue there is that if you want to drive these transgenes and the drive mechanism into a population, that there is of course, a risk that the two will disassociate. That you will lose the affected gene from your drive mechanism and then since there will be an adaptive advantage to only the driver, you will end up with a population that has got your drive mechanism in it, but the transgene may be lost, which means you will have to look for another drive mechanism to start all over again. Next.

The third issue of course is that your refractor gene may undergo certain mutations, which no longer deliver the desirable outcome of refractoriness to falciparum. Next.

And of course, a critical issue is, "Wow! If we are promoting ITNs out there and a strain with IRS and we're doing everything on a massive scale as Jeffrey Sanks

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

[misspelled?] was just telling us, our transgenic mosquitoes are going to die. Right? Are we going to go into a phase where we tell people that well for the last five years, we've told you 300 nets! And now we go and say, "Take away the net," because we need our transgenics to survive. This is a key issue. How are we integrating this technology in an overall package of malarial vector control?

And then of course, if you replace your existing population with one that no longer transmits malaria and you're actually trying to boost drive, so you don't mind the large population. Well, that population is going to be capable of transmitting other passengers. *Anopheles gambiae* and major parts of rural Africa is a perfect vector of filariasis so you may do away with malaria but you've still got your filariasis problem.

And that's my next question for you. So, the potential public health gains in terms of malaria, they actually just defined the release of GM mosquitoes, even if the mosquito population remains competent for other diseases like filariasis, how about that one? So you do away with malaria, but there is still an issue with filariasis.

This is four?

[Talking amongst listeners]

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

**The Fourth Annual MIM Pan-African Malaria Conference
Yaounde, Cameroon
Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?
November 17, 2005**

Just leave question for question five. It's okay.
Next one. Diversity. There is an issue of course with populations of anopheles. Anopheles in West Africa is not the same as anopheles in East Africa. Plus we know that even in West Africa there are various chromosomal forms, there are molecular forms and in one way or the other to a larger or lower extent, there are reproductively isolated. So if you introduce your transgenes into a population, you're not necessarily going to cover that entire population, unless you have maybe an extremely potent drysis [misspelled?]. Next.

And then, of course in the major part of Africa, there is not just one vector, but there's two, gambiae arabiensis, well, put finesse on top, and then here in Cameroon, neli and mouchete, five. So are you going to bring them all into the lab, transform one after the other, and then release them and then hope that transgenes will flow? That's a key issue. Next.

Diversity, the compatibility of your system, is it that you can develop a transgene against more than one genotype. Will it also work against the other? We know that the essay 1 peptide that works against the bergeii [misspelled?] doesn't work against falciparum. How do we deal with this? And then there's the issue with transmission intensity, where it has been shown again with modeling that

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

if you look at human parasite prevalence, that you have to have an extremely efficient system of transgene expression and parasite inhibition plus a very low level of original transmission in order to really go down from high prevalence to almost nil. Next.

So that means that we are going to be restrictant. Okay and that's question number six. The potential of genetically engineered mosquitoes may be restricted to limited parts of Africa where you just have one vector, where you've got low transmission and so on and so forth. Is it really worth it? What do you think? Should we develop a technology that may be applicable only in certain specific missions? Next one.

All right. Let's take a look at some social aspects of this. Let's take a look at stakeholders. You're all stakeholders here, but the people living out here in Yaounde are also stakeholders. Now we can classify stakeholders according to the way that they support or opposed a certain technology, product, whatever you call it. And they may be of low importance or they may be of high importance. And this is where we are. We're the Africans. And funding agencies want this, the TDR Molecular Epidemiology Task Force has been funding this for over a decade, NIH has been putting major amounts of funding into it and our scientists. But

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

there are scientists also that are working on bednets and they will say, "Oh, these transgenic mosquitoes, bed nets." And the other will say, "Oh, vaccines and drugs." We're all fighting for our own cup of tea. And there are just simply no GMO scientists. There are people who just don't want to hear anything about GM organisms. They're there. They may be here in the audience. It's not a shame. But it's okay. So, therefore we should see really where are the disease endemic countries in the whole picture? Where are these people from Yaounde, when it comes to this story? And where are the real antagonists? We know that Greenpeace is not very favorable to this kind of technology. We know that the media is not always friendly when we talk about this work. But, where are the disease endemic countries? Next.

They're in the center. In business terms it's called "They're the fence sitters." They can go in any direction in which they may be pulled by someone who makes a very strong argument. And we have, we have a very good example. When the Zambian population was starving of hunger, it was the government of Zambia that decided that they were going to refuse GM corn from the United States donated to feed these hungry people. And that was fact by Green organizations and the media and so on. It killed people. People were starving and they were not fed with the GM crop of corn. So with the

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

mosquitoes and GM insects the same thing may happen. We may be pulled in any direction. And I'm going to give you an example in a second. Next.

When a workshop was held in the Netherlands to discuss the ecological issues related to transgenic mosquitoes there was an extremely well balanced discussion amongst the scientists there. There was nobody for or against, pro or con. However, the press coverage was different. Journalists actually there saw major flaws. Journalists there said, "Well, that remains a big if!" So the media plays a crucial role in how this whole thing can move forward. So, there are people that say we as scientists, we as researchers let's first develop the technology and then we'll move on and then form the rest. So the next statement is science first, public opinion later. Let's worry about stakeholders later, let's do our science first. Next.

Other parts of the world, in particular Europe and the United States have legislation in place that's called code protocol, there's a Codex Alimentarius, there's a precautionary principle in Europe, there are many people talking about as to how we should progress with GM organisms. And in as much as African countries are currently engaging more and more in policy making in GM crops, there is not even

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

one page that can help us with GM insects and how to move it forward. It's not there. Next.

And then I'll give you the example of something that happened in India in the mid 70s. There was a genetic code trial [misspelled?] there funded by WHO, years of work and then something major happens. Two days before the actual release of these sterile insects was going to start, a journalist picked up the story and read about it. And he read that *aedes aegypti*, also called the Yellow Fever Mosquito. Now there is no yellow fever in Asia so, he thought, "Something's going to happen here in India." Because there was a rumor that the U.S. Army was doing experiments on an island in the Pacific where they were trying to develop *Aedes aegypti* and yellow fever as a biological weapon. So he thought, "We Indians are going to be used for testing this technology." This went up the chain and two days before the trial was actually going to start, Mrs. Gandhi closed down the whole show. Business over and done with and everybody could go home, after years of hard work and a lot of effort and being nearly there, to probably making public health benefit. So the press, politicians, everybody matters in this story.

My next statement will stake home attention undermine the ability to solve the ethical, legal and the social issues

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

related to the release of transgenic mosquitoes. Can we get everybody around the table to agree on moving forward with this technology?

There is a need, an urgent need for commitment planning. There is an urgent need to move to an equitable partnership, the first stable germide [misspelled?] transformation of anopheles was published in the year 2000. We are now at the year 2005 and there is not a single lab in subs here in Africa equally engaged in this research. That to me is a signal. It is a signal that we are not engaging everyone who should be involved at the same level. And there is an effort on the way now to engage scientists in these disease endemic countries further in this endeavor, but nobody is injecting yet. Nobody is transforming and I believe that this is essential that scientists in disease endemic countries start talking to their own people who rule the world of biotechnology and the policymaking in their country. I don't think that scientists in northern countries should be convincing the health authorities in southern countries as to how they should be fall with transgenic mosquitoes. It should be the scientists from these countries who should be taking the lead in this work. Next.

And to that regard, we had a workshop last year in Nairobi, which brought together a good representation of

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

Current Controversies: Vectors—Is the Transgenic Mosquito As a Weapon Against Malaria Ever Going to Fly?

November 17, 2005

people from the northern laboratories and disease endemic scientists to look together for a way in which we can bridge that gap between laboratory and field research. And plans were made. There's a book available. It's online; you can read the whole thing. And there are seven steps, which were made and agreed upon as to how we should move this thing forward. Next.

However, I do dare to take the other stand also. We are now going to involve the very limited number of people who are available to work to implement, to monitor insecticide resistance, to work with ITNs, to do larvae control, to do everything. Many countries have just had one or two medical epidemiologists. How are we going to go and ask these medical epidemiologists to engage in work that may never, never to fruit that come off the tree? So I could say should African scientists be spending their time on an approach that may never fly? We're nearly there. Next.

Oversight. Those of you who work in vaccines, they have heard of the African Malaria Vaccine Testing Network. When there was more and more interest building up to us developing vaccines and testing them in disease endemic countries. Suddenly it was recognized that there was a mechanism needed to coordinate those efforts. So that everyone was having their own partnerships and doing things

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

all over the place. And I'm a strong proponent that we start to coordinate genetic control trials all over Africa in exactly the same way. Who can do what, where, when and why. Otherwise and unfortunately this is happening, people from northern labs are going to all sorts of remote islands and all sorts of remote parts of the country. There are a lot of cosmetic partnerships that being established and people are claiming territory. I am working here and I am going to develop my genetic control with these people in this country. I think we need to be very, very careful as to how we move this forward, and in that regard I suggest that there is an oversight mechanism that ensures consistency in planning and implementation of the old endeavor, that as I mentioned that we create a sense of ownership of this technology by scientists and the people that matter, the authorities in these disease endemic countries. That we develop a negotiation platform, which currently is, absent, and may lead to a loss of coherence. And that we actually developed a window for us all to deal with negative stakeholders, antagonists, people who will try and condemn the whole thing. Thought I suggested in several forums that we need a group, a network, a coordinated network that steers this whole process. And I will suggest that the executive part of that is your ally with those people who are actually in the

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

disease endemic countries. Let them be involved in setting the research agenda. That will set the pace in how we are developing the technology. That ensures uptake of it and full evaluation. And in the center is going to be representation of people that are having an advisory function and they may be from all over the world. Somebody may have good expertise in dealing with research ethics or maybe working on GM crops and that expertise can come into this group on a rotationary basis to give advice as to how we should move the whole endeavor forward. Next.

So, statement number 10. Unless the genome mosquito is carefully monitored and steered by an international network, it will fail. If we let everyone go out on their own, do we run the risk that something will go seriously wrong? Or should we set up a mechanism where at least we can monitor what is going on.

It is a very controversial subject. I think that's very clear from my presentation. My last slide will be based and that's also my last statement, so don't fill in the last statement. The last statement is when just before you go out. So now Professor Louis will say a few words. He is going to comment, then the floor will be open and then at the end of everything that you've heard, I would appreciate if you would fill out statement number 11. And that little

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

**The Fourth Annual MIM Pan-African Malaria Conference
Yaounde, Cameroon
Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?
November 17, 2005**

piece of paper can be delivered at the door when you go out.

Thank you very much.

[Applause]

PROFESSOR KITSOS LOUIS: Wow! If there are two people in this conference who can sell refrigerators to the Eskimos, this is for Mr. Bart. So he covered everything, it's obvious, and this is the reason why I am not going to be showing you any slides which is good news for you because it's going to be much faster. I will try to cover just a few things that Bart did not cover and give you some personal ed [misspelled?] and I will make even one statement myself, but you don't have to vote.

So, the first thing I want to say is the title of this so-called controversy is wrong because the transgenic mosquito, it is not a question whether the transgenic mosquito will ever fly—it does fly. Swiss Air doesn't fly but the mosquito flies.

[Laughter] [Applause]

I have only had one of my genes Swiss. Okay? So I'm not responsible for Swiss having done so much, but anyway, there's a lot of different story. Now, why doesn't the transgenic mosquito fly? Because there hasn't been transgenic mosquitoes for five years and because transgenic mosquitoes have been extremely important for the

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

understanding of biology of mosquitoes. We know from the *Drosophila* that no programs would have been possible if we had not had transgenic *drosophila*, which was less than the early 1980s. We only achieved transgenesis in mosquito and *anopheles* was the first one. No, sorry. The first one was in 1990, but by now the major bad guys like *gambiae* and *sinensis* and [^]. *Culex pipiens*, a bad guy for a few people, but anyway. Out there you can transform and what will it bring us? It will bring us a lot of understanding of biology and here at this point, I make a plea for all vector biologists that we in spite of everything else, in spite of malaria being there, we have to push and understand better mosquito biology. I would have shown a slide if I had not retracted them of the *Anopheles* genus in 1990, which were just 3 black lines, and the *Anopheles* genus today, which is an ensemble and anywhere else in SBI. It is not enough, we have to understand much, much more than only the genome. There is a larvae a period of the life which is there, there's behavior, there's God knows what. And for these things to be understood we need transgenic mosquitoes. And we have to transgenic mosquitoes we also get vector affecter genes. Bart talked about one of them, but there's more. Tony James [inaudible] has used antibodies quite affectively, *foshalae* [misspelled?] based has been used quite effectively.

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

And we need to find more effective genes and this is possible to do with transgenic mosquitoes. It is also possible to find better promoters, we have promoters, but we need better promoters that work indeed when we want them, where we want them. And that work very nicely. And we need better vectors. Because, I mean Bart alluded to spreading the gene but how are we going to do it? We don't know yet. So, we need better vectors, better systems and for that we need transgenic mosquitoes.

And finally we need to improve our strategies and to we need to know more about relation biology and as strange as it sounds even for that, we will need transgenic mosquitoes. So transgenic mosquitoes are there, they are there to stay. They will not go down and talking about transgenic mosquitoes as a weapon is one thing, but talking about transgenic mosquitoes generally is a different one. Talking about transgenic mosquitoes as a weapon, I would make my statement at this point.

And my statement is the following: There's never, ever, ever, ever been control of a vector born disease in the world—with a exception of yellow fever—without controlling the insects that transmit it. So, it's a fact. Without controlling the insects, you don't get control of any insect-borne disease. And this is the reason why, I urge people to

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

continue work on transgenic mosquitoes as a weapon. When will it be possible to use it as a weapon? Where's the [inaudible] that we could use of understand the beginning that we could start the field trials in about five years. Yes, that's possible. My feelings are that it may five, 10, 20 years until we reach the state where we can use transgenic mosquito to fly malaria. It may be even more than that. But we will eventually. Will that be the solution? I just can't say that again. It is a fact in my mind at least in my mind that at least it's a fact that transgenesis as a weapon is in no competition whatsoever to bed nets, insecticides or anything else. And at this point I will tell you something that I told Bart this afternoon. That some of these statements where you had to vote and since this is a controversy I am allowed to do it. He will have the last word anyway. Some of these statements in my mind remind me of this famous question, which goes, "Will you beat your wife again?" There is no way that you can answer this question without looking like an idiot. If you say, "No" it means that you have beaten her already. If you say, "Yes" it means that you will beat her. [Laughter] So be very, very careful with some of those statements. You have voted already [applause], which is fine, okay.

[Applause]

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference
Yaounde, Cameroon
Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?
November 17, 2005

So, I repeat I don't see any competition between transgenesis and any other way to control malaria through the control of the insects. I only see one competition, which is possible, and again I urge funding agencies and scientists to be careful about that. The only competition for funds and the only competition will be basically biological research. We should not put all of our efforts into only understanding how to make a good weapon. I say again, we need to understand the biology of mosquitoes much, much better than we have or that we do already.

So, my last statement words are go for it. Thank you.

[Applause]

Sorry, this was supposed to be the background to my slide because Andrea Crisanti was going to speak and I'm not Andrea Crisanti, thank God. [Laughter] I would only spew of her own, so that you could see who Andrea Crisanti is, okay. Thank you.

AYOADE ODUOLA: Thank you. Well, the controversy is over, so now I call on the audience to add to their own controversy, their suggestions, questions, and comments.

Wow! There's no controversy.

MALE SPEAKER: Thanks so much. But I was so excited about this session aspects of this [inaudible]. If you make

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

Current Controversies: Vectors—Is the Transgenic Mosquito As a Weapon Against Malaria Ever Going to Fly?

November 17, 2005

for example, you do a sex agent from females to males, like in the particular case of sense we know that the female and [misspelled?] mosquito, then when will be the generation of the male ones? And then you knock off the possibility of transmitting malaria. But my interest is in if you have a threshold component of that, can we expect some kind of disconnection between a particular mosquito which in this area a female and now [inaudible] into a male and interactions with other mosquitoes. Because I think there could be some sessions, rush on that.

[Laughter]

PROFESSOR KITSOS LOUIS: There was never any talk of changing the sex of mosquitoes. I'm careful about that again. [Laughter] There is talk in sex in meaning getting rid of the female mosquitoes that are going to be released. So that only males are released. So the females stay there. They can bite you, they can do anything they want to and we hope they will not transmit malaria. It's only a matter of releasing male mosquitoes, which are prepared. I mean, he talked about the screwworm I mean, it was prepared in a factory, and you know you just release males for obvious reasons. One of which he mentioned but there's more, okay. So, there's no—we don't do anything to the poor mosquitoes, so the society, I mean.

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?

November 17, 2005

[Laughter]

MALE SPEAKER: I saw a blank there. What are the results, sense we are in the area, I think this would be good [inaudible] control over armies. That's what I would like to say.

PROFESSOR KITSOS LOUIS: His comments are so to recruitment into the U.S. Army. I already say fighting malaria in Africa and they need new recruits in Africa to fight malaria. So, as you go out, there is an enlistment for [inaudible]. And you can sign up.

MALE SPEAKER: I think there is a need to push for studying the biology of the mosquito. For example, you can find a lot of [inaudible] Belize working now on [inaudible]. They can for example, differentia some of these *Anopheles gambiae* using molecular tools but you can find very few people who can use microscopic differentiation between *Anopheles gambiae* and *Anopheles* [inaudible], for example. Thank you for this talk.

DR. BART KNOLS: Well, just very quickly on that. I think that the need for basic vector biology tools to study the vector biology is not going to change. I think that whole of that should stay and we should make sure that the curriculum that people are being through keeps all of this on the agenda. I think what we're discussing here is the

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

addition of new additional expertise in order to make this whole thing move forward.

MALE SPEAKER: Thank you for your excellent presentation but I am missing one part of the survey and that's the parasite. I think the parasite has also a huge capability to attach itself to a changing environment. So, I'm completely missing that part of the story. And my second question and this is not, I don't know this field very good, but it's just a guts feeling. If you know that the mosquitoes can multiply and exchange genes and adapt to an environment, they always say the morale is if we had a big disaster, the insects will survive for this. I'm wondering why in all this thousands of years in existence, that they've nature didn't find a way to have a fitter mosquito, than the one that's transmitting malaria. So, this is just a gut feeling, how are you so confident that with transgenic things you can do better with nature in 3,000 years, which in a couple of days you have a millions, thousands of insects in a couple of weeks going from one property, so. Actually, those are two questions.

DR. BART KNOLS: As far as the first question is concerned, is a fully legitimate question that there is a very easy answer that *Aegis aegypti* does not transfer human plasmodium but transmits other plasmodium and the plasmodium

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

has not adapted to [inaudible] again. So, that's my answer to that, okay. I think the same answer can be given for the second question, more or less. I can't really think of any other thing to say, okay. It is very difficult and it would bring big story, a big debate and us too far to start now on which vector transmits which parasite, for what reason and how they evolved? We're talking about the evolution of vector parasite and the host. And the host is not only the human; the host goes from crocodiles or whatever to humans. And so, I would like to discuss this question at ease, at a point where it's a little bit earlier. But the first one, I think already the answer is being that in any situation just give an answer that [inaudible] would not necessarily adopt something.

MALE SPEAKER: I listened to the first speaker. All alone you have, you can think about. A lot of headache you will get if this is a child, listening to him. Getting him to tell you the modified aspect of biological warfare, molecular biology and all that involved. All those, well looking at the mosquito in terms of malaria, what things is an attempt to simplify the whole story. We see the child with [inaudible] and must get him from the environment. Thank you.

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

Current Controversies: Vectors—Is the Transgenic Mosquito As a Weapon Against Malaria Ever Going to Fly?

November 17, 2005

DR. BART KNOLS: I think you made a very valid point. And there are major parts of the world where this has actually been accomplished. And here I may recall the presence of *Anopheles gambiae* in Brazil in the 1930s over an area of 54,000 square kilometers where it was eradicated simply by doing larvae control. However, I think if we are open about the current situation of the world, then it's going to be unlikely that these same strategies can just be implemented like they were implemented before. And therefore, that control strategies do play a role but at perhaps replace the strategies in the long-term will also.

MALE SPEAKER: I'm leaning toward it and agree with the situation that we need to study the biology of our target organism a lot more but it must be the devil's advocate. And I looked at how we do our research in the *Anopheles* download database. I said we have a genome and we have transgenics, but we don't know they eat apart from when they fly in the house, we don't know what they're eating. We don't really know what larvae eat, we don't know what adults eat when they're having children. When there is more known about the ecology about polar bears, lions, butterflies and a host of agricultural classes, than there is about organism that kills a billion plus people per year. So, a lot of those questions can be answered with jam jar technology, very low technology,

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

Current Controversies: Vectors—Is the Transgenic Mosquito As a Weapon Against Malaria Ever Going to Fly?

November 17, 2005

plastic pans, and simple field methodology. And I think there's an opportunity there for the African Institute to participate and partners. We don't necessarily need to be able to inject eggs or to get into transgenesis. But I would ask both participants if they would favor a re-balancing of research priorities so at least we get to know the enemy a little bit more.

FEMALE SPEAKER: [inaudible] and it was just revealed to make some questions to us and to people to answer, by just putting up your hands in this room. But how many people are working with disease resistance in this room? And insecticide resistance, who is working on insecticide resistance here? Ten, 20, all right. Well, I think many people left anyway. So how many people can identify the [inaudible] mosquitos' species in the field? Okay. Better. And how many people here in this place, are able to transform mosquito? The person sitting here, did you do this yourself? I am knowing only three people in the world who can do that, in the whole world, three persons who can do that. Repeatedly, easily and we are speaking about really [inaudible] and I think was positive about this discussion that the county preferred for public relationship, we can promote this [inaudible] but this is our sort of responsibility to prepare a positive outcast of these events

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

Current Controversies: Vectors—Is the Transgenic Mosquito As a Weapon Against Malaria Ever Going to Fly?

November 17, 2005

and to relive and specify that this is important for this sending the biogene and of course, it requires the [inaudible] direction related to the biology and the whole bit and it's not at all, compromised or alternative to study in the field. On the contrary again, as you have mentioned to me too, how many studies have propelled? Actually a lot of biogenes that is in the field to show that transgenic mosquitoes will never fly again, so that's good.

PROFESSOR KITSOS LOUIS: Good, have fun. There are lots to credit those who go to dinner.

MALE SPEAKER: Thank you. I'm not an epidemiologist, but my question was to the second speaker. I thought Bob read the [inaudible] point by mentioning that these mosquitoes are already weak and if we are going to release them are we going to ask the people to stop using the bed nets so that they are able to survive? And the second speaker came out and says actually there's no competition at all with the genome mosquitoes. Would you like to elaborate on this and shed more light on this?

PROFESSOR KITSOS LOUIS: Yes, my sample is very clear. First of all we are not going to be releasing mosquitoes that are not fit. Mosquitoes are not fit today and by this afternoon I might could say so. But I've said that we are going to be releasing I hope we will be able to

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

release in 5, 10 or 20 years and I hope that by then we will have solved the problem of fitness. So, having said that, I do not say why the insecticide impregnated bed nets should be a problem. If the goal is to replace a population, the fact that a few mosquitoes die, perhaps make your through the bed nets, may perhaps make your life easier. So these are all questions that have to be seen. That has to be addressed over the next 5, not 20 years, so that we know what to deal with. But this is not the reason, there are some arguments that some people who say that it may be necessary. There's no reason to stop the research and say, "Okay, I believe that one person who said so is not here, so that's why we're not going to do it." Okay? This is most simple. I think we have to continue. There's absolutely no reason why not to at this moment. I could completely aside; I'm talking about scientific reason. I'm not talking about bioethical problems at all. I'm not at risk there.

FEMALE SPEAKER: I just want to endorse absolutely the idea of the basic research and using genetically engineered mosquitoes as research tools and also studying the ecology of mosquitoes. But I have a question about using them as malaria control tools. What do you see as the potential risks? Either ecologically or epidemiological from

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

these tools? And why do we never hear about these in these halls?

Dr. Bart Knols: There are, there are risk associated with even after a successful and initial release. I think I mentioned here, that you in the long run an effective molecule that is no longer doing what it's supposed to be doing. In other words, we're talking about resistance. Could resistance crop up? There are people that advocate that rather one defective molecules will lead two if not three and target the parasite at more than one stage during its' development in the vector. So, combination [inaudible] if you wish. Depending on one molecule, if initially you are successful and the whole system collapses and you have a population that has not been exposed to the patient for a reasonable or long period of time, you may end up with major problems. Another issue that has not been addressed here because it needs more discussion, I believe, is the problem of transgenic mosquitoes potentially being able after submitting other passengers, which they do now. And in Laughlin and in Atlanta we have discussed whether transgenic mosquitoes may be capable of spreading HIV and this sounds ridiculous but we have to convince the community and the people who have to make decisions that they can't. So this needs to be addressed.

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

Current Controversies: Vectors—Is the Transgenic Mosquito As a Weapon Against Malaria Ever Going to Fly?

November 17, 2005

The third issue, which didn't come up here is the transfer problems as they relate to horizontal gene transfer. In other words, the transgenes that we put into a mosquito end up in another organism. So, it is not that we are ignoring these issues. They have been summed up here in terms like capability, complexity and those terms. We acknowledge them.

PROFESSOR KITSOS LOUIS: My comment is this there is natural mutation going on all the time, whose results we cannot control. It could be positive or negative for mankind. So this here of producing a mosquito that may transmit this or that should actually not really come up because whether you produce that or not, nature may produce one for you. And so, if we can in this vast world of natural mutation add one that we actually can control the results and it is positive for human beings, I really don't see a controversy at all. Because it is like the stream is flowing and you add one more trouble [inaudible] in your [inaudible]. If you didn't add the stream would still be flowing, the stream of mutation. So this is really the comment that I wanted to make that nobody should really be worried about this. It's just adding one little mutation in the whole world of mutations that is going on. But this thing we have to control it so we know what the results will be, whether

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

Current Controversies: Vectors—Is the Transgenic Mosquito As a Weapon Against Malaria Ever Going to Fly?

November 17, 2005

the rest of the mutations going on all the time. We have no control of it and cannot show what the outcome will be, good or bad for humanity. So, with this I advocate for new recruits into the malaria army, the malaria war army. Thank you.

MALE SPEAKER: I just wanted to go back to the adaptation of the parasites so I don't think you can really compare the adaptation to a new species with the adaptation to genetic variation we did in centuries so, if you even have a work factory that is more fit than the wild card considering the other variability of parasites in the field. How do you know there won't be a subpopulation that affects the refractory?

MALE SPEAKER: So I was saying that when you answered a while ago to the question about the adaptation of the parasites that they don't cross species, but there's different crossing the species than crossing variation within the same species. How do you know there won't be a subpopulation given all the diversity of parasites that can affect the refractory mosquitoes?

PROFESSOR KITSOS LOUIS: Simply, we don't.

DR. BART KNOLS: What can I say? I mean, shall we not do anything just because we don't.

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

Current Controversies: Vectors—Is the Transgenic Mosquito As a Weapon Against Malaria Ever Going to Fly?

November 17, 2005

MALE SPEAKER: The thing is that once involved by changing one gene any parasite of malaria will affect that.

PROFESSOR KITSOS LOUIS: One gene may be crucial for God knows what, okay? I mean, I can't answer that and nobody can. I mean, we just don't know. But we don't think there will be any affect on mankind.

MALE SPEAKER: I think the point of series, [inaudible] hospital lies among the waste, ability to fly. And I want your opinion, if there is any means by which we can infect some any old genetic changes by affecting the biogenesis of the [inaudible] that fixed place inside the mosquito. That is going to affect the formation of the harpers or the wing formations, where that to happen, this organism would not have the capacity to get onto man to bite and stop this blood or transmitted parasite. And we're not sure that this happens. I'm of the opinion that the parasite will continue to use its' antennae to transmit this. I would like to see [inaudible] it will transmit to a patient. And to the hospital itself will gradually phase out. That is my opinion.

AYOADE ODUOLA: Thank you.

PROFESSOR KITSOS LOUIS: There's a very good friend of mind who isn't here, wasn't here the last time. And I'm sure he would have liked to be here. This is Mario

¹ kaisernetwork.org makes every effort to ensure the accuracy of written transcripts, but due to the nature of transcribing recorded material and the deadlines involved, they may contain errors or incomplete content. We apologize for any inaccuracies.

The Fourth Annual MIM Pan-African Malaria Conference

Yaounde, Cameroon

**Current Controversies: Vectors—Is the Transgenic Mosquito As a
Weapon Against Malaria Ever Going to Fly?**

November 17, 2005

[inaudible]. Mario had this idea a few years ago to engineer mosquitoes that will stop it in blood and will go back to his forefathers and stop eating flowers and sugars and be happy again. It goes along those lines, okay? And I'm glad to see that Mario's idea, although a little bit differentiated just catches up. Yes, it would be a great idea, but let's see how we can do it. I mean I don't know how. Fabio, do you know?

AYOADE ODUOLA: I think at this point, I would like to bring this to a close. I'd like to take the time to thank Wood, Bart and Kitsos for their contribution, excellent presentation and if you'd join me to give them thanks.

[Applause]

I would like to thank all of you for your contribution and participation, especially for the patience for waiting. Thank you and have a good evening.

Oh, please drop the papers.

[END RECORDING]