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Electric destroyer of anopheles' larvae for vector control in malaria

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Abstract: *The emergences of insecticide resistance in Anopheles and drug resistance in plasmodium have become a matter of great concern for malaria control in Africa South of Sahara. So many solutions have been applied except any electromagnetic challenge. Electromagnetic field can be fatal for all living being. In larval stage Anopheles are very vulnerable. We learn from Malapterurus electricus catfish the mastering of a tool that imitates the electric organ discharges (EOD) which the catfish uses to kill victims in fresh water. The given tool devastates Anopheles' larvae massively and spontaneously whatever their number. Hot water of more than 42 °C only can kill mosquitoes' larvae, but the electric field destroys them even at 26 °C for the temperature of the water in the tool.*

Keywords: *Malaria, electric organ discharge, Malapterurus electricus, vector control, electric destroyer*

I. Introduction

Malaria disease burden is a real disaster for Africa. There is nowhere in Africa where one can stay and be shielded from malaria havoc, Fig. 1- map 1. In Tunisia there has been no local transmission of malaria since 1979. Although the disease has been eradicated, its re-emergence is not to be considered impossible [1].

Malaria disease burden continues to be a major impediment to health and wealth in Sub-Saharan Africa. Every year that disease kills in Africa a lot of young children and pregnant women, [2], [3], [4], [5]. Because malaria is such a common disease and well known to the people it affects most, and because most of those who become sick with malaria do not visit health care facilities, assessing the size of the problem, and how it is changing over time, is an enormous challenge, [6], [7].

Roll Back Malaria program was launched as a catalyst for a renewed worldwide commitment to face up to a disease that has been ignored so long a time by the world. That strange sickness is putting a heavy brake on development, particularly in Africa. Malaria remains the single biggest cause of death of young children in Africa and one of the most important threats to the health of pregnant women and their newborns, [8].

World Health Organization, (WHO) defines malaria control as reducing the malaria disease burden to a level at which it is no longer a public health problem. The objectives of malaria vector control are two-fold: to protect people against infective malaria mosquito bites by reducing the vector longevity, the vector density and human vector contact; and to reduce the density of local

malaria transmission at community level, and hence the incidence and prevalence of infection and disease.

As a consequence of all there has been tremendous progress in increasing access to Insecticide Treated Nets, (ITNs) particularly in the Republic of Benin.

Antimalarial drug resistance becomes a major public health problem which hinders the control of malaria. Study of those who are treated for uncomplicated malaria demonstrated clinical failure for chloroquine and for Pyrimethamine-Sulfadoxine, (PS). Two issues raise serious doubts about the use of PS as a replacement for chloroquine. The former is detection of persistent asymptomatic parasitemia at day 7 in children treated with PS. The latter is widespread use of one PS component (sulfadoxine) to prevent opportunistic infection in Acquired Immunodeficiency Syndrome, (AIDS) patients or to treat infection, [9], [10], [11],[12].

The other side of the drama is the insecticide resistance in malaria. The emergence of resistance in *Anopheles* to common class of insecticides was reported from many countries in Africa. That resistance affects the major vectors of malaria: An. gambiae and Anopheles funestus s.l. In several parts of Africa the resistance of pyrethroid insecticides in An. gambiae is going to be investigated, [13]. The vector resistance to pyrethroid insecticides affects the malaria situation in some endemic areas of Africa by reducing the efficacy of ITNs as well as of Indoor Residual Spray, (IRS). If nets are not timely replaced, they eventually deliver a sub-lethal pyrethroid insecticide dose that selects for resistance, [14].

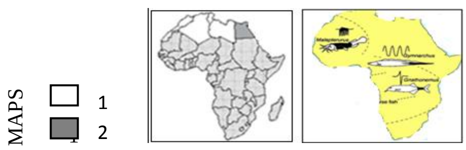

Figure 1. Malaria and electric catfish in Africa
Source: 1-: Recommandations canadiennes
2- Mao

Antimalarial policy despite its voluntarism and significant progress has not brought the last blow from which the health of people in humid tropical countries can be considered permanently spared of serious nuisance due to malaria disease burden. Thus, in spite of the great deal of effort deployed to control malaria disease burden, the target seems to remain as a whole.

However we have not to give up. It is quite possible to win malaria. We known that electric field can be fatal for every living being. The evidence is given by *Malapterurus electricus* catfish which naturally hunts in fresh water by the means of an electric pulsed wave. *Malapterurus electricus* counts in the strongly electric intermittent catfish in the world. It is a typical catfish of Africa, [15], Fig. 1-map 2.

The target of our paper is to present the results of a study which concerns the destruction of *Anopheles*' larvae in the way of *Malapterurus electricus* catfish. We have set up in this purpose the model and the equivalent electric scheme of that catfish, [16].This tool delivers electric waves in the way of the catfish and destroys spontaneously the larvae of *Anopheles* in the water. We can now hope the reduction of *Anopheles*' populations in the endemic areas for malaria.

II. Materials And Methods

The electric organ discharge of electric catfish is produced by some tissues equipped with electric charges that can create an electric field and potential, [17]. In practice we need a capacitor to create an electric field. To prove the feasibility of a destroying of anopheles' larvae by electric discharge, we deal first with a parallel-plates capacitor, Fig. 2-a. Its capacitance is given by Eq. 1:

$$C_1 = \frac{A\varepsilon_0}{d}. \qquad (1)$$

Where A is the surface of each plate, d is the distance between the plates and $\varepsilon_0 \approx 8.85.10^{-12}$ *Farad/m* stands for the permittivity constant for the vacuum. The efficacy of the so conceived tool is impressive. But the tool possesses some weakness concerning its short range and the eventual corrosion of the ion made frames of the capacitor. As the tool must stay in water and cover a long distance, we found the solution given by two cupper wires, Fig. 2-b. The capacitance of two cylindrical wires is given by Eq. 2:

$$C_2 = \frac{2\pi\varepsilon_0\ell}{\ln(\frac{d}{a}-1)}. \qquad (2)$$

Here, a stands for the radius of each cylinder, d for the distance between the axis of the cylinders and ℓ for the length of the wires. With a cooper wire the weapon will not corrode in fresh water and can be spread out any required distance. To test the weapon in Laboratory we made a wooden artificial river, Fig. 3. *Anopheles* larvae can live in sweet water as well as in brackish one. Thus we have tested the weapon in each quality of water respectively and have got similar results.

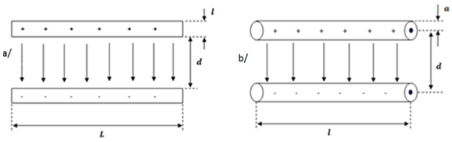

Figure 2. a- Capacitance of two parallel-plates capacitor
b- Capacitance of two cylindrical wires

Figure 3. The anopheles' larvae destroyer in a wooden lake

[18] and [19]. A simulation in Matlab of the potential difference of two points in space gives a twofold straightening alternation curve. That remark has enabled us to set the electric equivalent scheme of *Malapterurus Electricus* up as a Graetz bridge rectifier: that is the simulator of electric discharge of the catfish. We made a parallel-plates capacitor with iron plates of area S = 4677, 54 10^{-6} m^2 separated a distance d = 10, 05.10^{-3} m, Fig. 2-a. We put the capacitor in a non conducting waterproof material and drop in some water with *Anopheles'* larvae, and then we connect the capacitor to the power supply through the simulator of electric discharge. After a moment we notice that all the larvae are destroyed. The electric weapon we are setting up would be a real challenge if we could spread it out a long distance in fresh or brackish water. We have also succeeded in destroying larvae with the capacitance of two copper wires of 1, 5 mm section to reach the goal, Fig. 2-b and Fig. 3. For every test we measure the temperature of the water. We took *Anopheles*' larvae from *Sainte Cecile* in Cotonou a typical endemic area for malaria in the Republic of Benin.

III. Results and Discussion:

The parallel-plates capacitor is iron made and cannot perform for a long time in water as a result of corrosion. We found the capacitance of two copper wires as the providential solution, (see Fig.2-b). The copper will not corrode and the wire can cover any required distance. As we can see on Tab 1 and 2 larvae destruction power depends on the current nature and the value of the voltage applied to the simulator: with a pulsed voltage of 90. 70 V a magnitude we need the same duration (01 min 22 sec 49 ties) to destroy larvae as it is in the case of direct voltage but the power delivered in pulsed voltage mode is lower than the direct voltage one. In each case the power rises with the voltage value and the destructive duration decreases in the same time, (Tab 1 and 2, Fig. 4.). The heating temperature of the water also increases with the voltage, see Fig. 5. To save energy we must set up a weakly pulsed voltage electric weapon to imitate nature perfectly.
In fact we can realize now why every electric catfish gives out solely pulsed EOD, see Fig. 1-

map 2: nature works wonders and always saves energy. Hot water can kill anopheles larvae provided only that its temperature goes beyond 43° C. We have heated separately water and we measure its temperature and we drop in larvae. Our observations are recorded in Tab 3

Table 1
Power delivered by the pulsed wave generator

Magnitude, V	Time of destruction, mn:ss:tt	Courant, mA	Puissance, W
90.70	01:22 : 49	1.9	0.172
107.67	00 :50 :01	2.5	0.270
116.15	00 :43 :10	2.9	0.337
130.30	00 :31:01	3.1	0.404
144.44	00 :21 :96	3.6	0.520
155.75	00 :19 :23	3.9	0.607
167.06	00 :13 :75	4.2	0.702
178.38	00 :12 :12	4.5	0.803
186.86	00 :11 :22	4.7	0.878
198.18	00 :09 :22	5.2	1.030
206.66	00 :08 :11	5.3	1.096
212.32	00 :06 :80	5.8	1.231

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Table 2 Electric current field

Power delivered by the direct Direct voltage, V	Time of destruction, min: sec: tie	Courant, mA	Power, W
90.70	01:22:49	3.1	0.281
107.67	00:50:01	5.9	0.635
116.15	00:43:10	6.5	0.755
130.30	00:31:01	6.8	0.886
144.44	00:21:96	7.4	1.069
155.75	00:19:23	8.8	1.371
167.06	00:13:75	10	1.671
178.38	00:12:12	10.6	1.891
186.86	00:11:22	11.5	2.149
198.18	00:09:22	13.1	2.596
206.66	00:08:11	14.1	2.914
212.32	00:06:80	13.8	2.930

Table 3
Larvae killing with hot water

Température of water °C	Larvae are:	Alive = O Numbed = 1 Dead = 2
45.0	2	
43.2	1	
41.5	0	
40.0	0	
39.2	0	
38.5	0	
36.6	0	

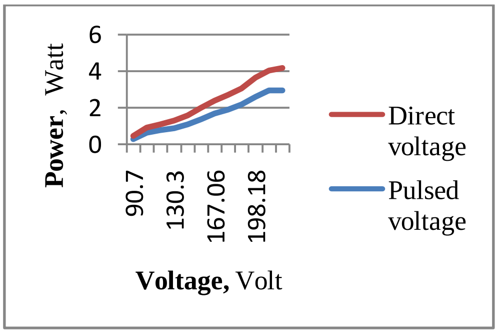
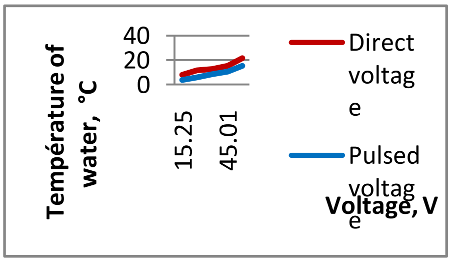


Figure 4. Power delivered by each type of electric field

The weapon destroys larvae even at 28, 6° C (with 90, 70 V and 15 sec 25 tie in duration) whereas hot water of more than 43° C only kills larvae: hence the electric weapon is the only one responsible for the *Anopheles*' larvae destruction.



5. Figure Temperature behaviour of the water

IV. Conclusion

Our paper is about to achieve its aim. The objectives of malaria vector control are well known: protection of people against infective malaria mosquito bites by reducing the vector longevity, the vector density and the human vector contact; and the reduction of the density of local malaria transmission at community level…

Our work focuses directly on a major point of malaria vector control' objectives that concerns vector density reduction. It would be more effective to control *Anopheles*' larvae than mosquito that got wings to fly. Larvae are more concentrated in fresh or brackish water than *Anopheles* is in the air. Mosquitoes' larvae are generally vulnerable in electric field but *Anopheles*' larvae are the most. The reason is as follows: when culex's larvae (for example) come up the water' surface to catch oxygen, they keep themselves diagonally in the water whereas *Anopheles*' larvae lie in a plate at the water surface to catch oxygen and simultaneously a potential difference if there is any. The true vector of malaria disease burden is *Anopheles*' larvae. On top of indoor strategy of control by ITNs and IRS we have to fight against *Anopheles*' larvae which are the primary vector of malaria. The tool of such a new strategy of vector control is the electrostatic weapon that we have set up in our Laboratory. The weapon devastates spontaneously all larvae located inside its sensibility in fresh or brackish water.

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