Original Research Article
Journal der Pharmazie Forschung (**Formerly-Recent Advances in Pharmaceutical Science Research**)
Vol-2 | No-1 | 2013

Eco-engineering: Malaria elimination without insecticide or drugs

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Abstract

According to the WHO estimates, around 300-500 million cases of malaria occur worldwide every year and one million people die of this disease. These WHO figures are alarming in spite of the most diligent efforts and are enough to reach us to a conclusion that the measures taken are still not enough. Fight against malaria has been two pronged, on the one hand we need to developed effective anti malarial drugs and on the other we must try to eliminate the vector and co-host Anopheles. Even places where we have been able to eliminate the disease successfully are at a high risk of re-introduction of the disease because of the presence of the vector, thus an important goal is to eliminate the vector, which has the potential to catch the infection from a carrier visiting from a malaria endemic area. Further issues of concern are the side effects of the anti malarial drugs and the insecticides that we spray into the atmosphere. We cannot create and persist with a vacuum in the ecosystem by killing a species. To ensure a safe removal, we found a replacement of the anopheles with Megalopta. In this article we are discussing the reasons for and the technique required to safely replace Anopheles from the ecosystem. This replacement technique ensures non-viable eggs leading to an automatic elimination of anopheles. Extra food availability ensures development of another species as a replacement, and all this without using any insecticides hence absolutely safe for the ecosystem. This technique named 'ECO-ENGINEERING' can be used to eliminate all vector borne diseases.

Key words: Positive science, eco-engineering, malaria elimination, species replacement technique, fighting malaria effectively, drugs free elimination of malaria

1.0 Introduction

Malaria has terrorized man for centuries before we could find any meaningful treatment for it. In spite of the intensive research, and investment of billions of dollars all over the world to fight against this dreaded disease, it still remains to be a serious challenge and cause for millions of deaths. It remains to be one of the major causes of death in tropical countries [1]. The World Health Organization estimates that yearly 300-500 million cases of malaria occur and more than 1 million people die of malaria. The basis of our scientific research against most of the micro organisms has been the study of its life cycle and killing it during the same at some convenient point. In our drive to fight against malaria, we have discovered many anti-malarial drugs which kill the causative pathogen, the plasmodium, within the human body during various stages of development and hence bring relief from the symptoms. Besides the major problem of side effects, this method is faced with serious issues of drug resistance [2] and requires continuous innovation. Another method that has been adopted to fight malaria is the elimination of the co-host and vector the anopheles mosquito, but this also has not proved to be easy. In trying to kill the entire species, spraying of insecticides into the atmosphere also kills billions of other insects which are beneficial to us, on top of it insecticide resistance [3, 4] has prevented from achieving any meaningful goal. Despite decades of international efforts we are still not in a position to completely control this minute creature having immense potential to create havoc worldwide [4].

To achieve this goal there is a need to understand that every species has been assigned a role in the ecosystem in which it survives, it has a positive role that helps the ecosystem to run smoothly, in case of Anopheles it is pollination of the nocturnal flowers. This species has harmful traits and thus needs to be replaced with one that can perform the positive part effectively and is safe for the ecosystem. This calls upon to develop a new science that we call 'ECO-ENGINEERING', which is the study of techniques that will be able to eliminate or move a species from one place to another so as to make the ecosystem safe for all the members. In this article we have discussed this technique with respect to Anopheles and Malaria and demonstrated how with the help of it we shall be able to eliminate anopheles from our eco-system and malaria from the scene of healthcare without using insecticides, anti malarial drugs or vaccines, and without disturbing or damaging any other organism or hampering any of the functions of the ecosystem. With this technique we shall be able to control and eliminate malaria along with many other vector transmitted diseases. With minor variations the technique can be used in all parts of the world.

Anophelese are found worldwide except Antarctica. Malaria is transmitted by different Anopheles species, depending on the region and the environment [5]. Drug and insecticide resistance has hampered efforts of elimination of the disease [5]. Anophelines that can transmit malaria are found not only in malaria-endemic areas, but also in areas where malaria has been eliminated. The latter areas are thus constantly at risk of re-introduction of the disease [6]. Hence elimination of the vector is most important.

Increase in population of Pigeons in metro cities- In the process of development of the cities, we cut down the larger trees like Tamarind (*Tamarindus indica*), Neem (*Azadirachta Indica*) , Peepal (*Ficus Religiosa*) , Mango (*Mangifera Indica*) etc. and replaced them with faster growing species of smaller trees like Gulmohar (*Delonix Regia*) and Kaner (*Nerium Oleander*) etc. which offered ornamental advantages as well, thus getting a dual advantage of a quick replacement of the cut down trees and beautification of the city.These new trees did not offer enough nesting sites for the birds who live in flocks and need to build a nest on trees to lay their eggs, hence they had to move towards the outskirts of the city where larger trees were available, leaving the entire available food at the disposal of birds like Pigeons who can survive living on the window panes and ventilators. This helped the growth of Pigeons who replaced the other bird communities from the city. This understanding instigated us to develop a strategy to eliminate Anophelese.

Classification [8,9]					
Kingdom	:	Animalia	**Kingdom**	:	Animalia
Phyllum	:	Arthropoda	**Phyllum**	:	Arthropoda
Class	:	Insecta	**Class**	:	Insecta
Order	:	Hymenoptera	**Order**	:	Hymenoptera
Suborder	:	Apocrita	**Suborder**	:	Apocrita
Superfamily	:	Apoidea	**Superfamily**	:	Apoidea
Family	:	Halictidae	**Family**	:	Halictidae
Subfamily	:	Halictinae	**Subfamily**	:	Halictinae
Tribe	:	Augochlorina	**Tribe**	:	Augochlorina
Genus	:	**Megalopta**	**Genus**	:	**Megalopta**
Species	:	**Genalis**	**Species**	:	**Genalis**
Kingdom	:	Animalia	**Kingdom**	:	Animalia
Phyllum	:	Arthropoda	**Phyllum**	:	Arthropoda
Class	:	Insecta	**Class**	:	Insecta
Order	:	Hymenoptera	**Order**	:	Hymenoptera
Suborder	:	Apocrita	**Suborder**	:	Apocrita
Superfamily	:	Apoidea	**Superfamily**	:	Apoidea
Family	:	Halictidae	**Family**	:	Halictidae
Subfamily	:	Halictinae	**Subfamily**	:	Halictinae
Tribe	:	Augochlorina	**Tribe**	:	Augochlorina
Genus	:	**Megalopta**	**Genus**	:	**Megalopta**
Species	:	**Ecudoria**	**Species**	:	**Ecudoria**

Table- 1

2.0 Materials and methods

An in depth study of male and female Anopheles mosquitoes with reference to the life cycle and other features was carried out. An in depth study of the eco-system, the life cycle and behavior of organisms of phylum Arthropoda, class insecta to find a replacement. Several genera and species were studied for the purpose. Only a few species appear to be fully nocturnal. They include several Asian species of genus Xylocopa(Timberlake), and several species of the new world genus Megalopta[7]. Hence, we zeroed in to ***Megalopta genalis*** and ***Megalopta ecuadoria*** on basis of characteristic features given below, matching or contradicting with Anopheles as required for a harmless replacement into the ecosystem.

The characteristic features for both the species are studied i.e. the one that needs to be replaced and that which is selected as a replacement. Every species has been assigned a positive role in the ecosystem. The replacement species should be able to perform this role equally effectively, at least for some time, without the harmful effects of the species that needs to be replaced and ensure blockage of the generation of the harmful species, thus creating a temporary vacuum.

Behaviour of Anopheles	**Behaviour of Megalopta**
Feeding habits: Crepuscular or nocturnal, male and female both feed on nectar but the female requires a blood meal to ensure viable eggs [10,11]	**Feeding habits:** Crepuscular or nocturnal, male and female both feed on nectar, no need of a blood meal [13].
Eggs: Lays eggs on water.	**Eggs:** Lays eggs in the nest made in dead wood.
Responsibilities within the ecosystem Pollination of the nocturnal flowers.	**Responsibilities within the ecosystem** Pollination of the nocturnal flowers.
Flight: Anopheles mosquito can fly for up to four hours continuously at 1 to 2 kilometres per hour (0.6–1 mph travelling up to 12 kilometres (7.5 miles) in a night(11).	**Flight:** Do not fly very far away from the nest. M. genalis are apparently flying at the very limits of their visual ability [14].
Temperature range for survival of larvae: The larvae survived best between temperatures 16-34 degree Celsius [12]	**Temperatures in regions of abundance:** 22-32 degrees C.
Most active in months: Active almost for the entire year but most active during April to October.	**Active in the months:** Most of the 11860 bees caught were Megalopta, these species were present throughout the year, as were Rhinetula and ptiloglossa [15,16].
Abundantly found: Not relevant as it has to be eliminated.	**Abundantly found in [16]: Megaloptagenalis** is abundantly found in Panama and northern Columbia. **MegaloptaEcudoria** is abundantly found in Panama, Columbia, Ecuador, and Brazil.

Table-2: Characteristic features

The beneficial features and the harmful features of both the species should be carefully studied and analyzed before making the final decision of the replacement.

To achieve the goal of replacement we have to make life difficult for the harmful species in a way that it should flee from the area and the new species should successfully takeover its positive role in the ecosystem at least for some time. In case of Anopheles its dual requirement of a blood meal and copulation for laying viable eggs was found to be the weak point, our aim thus is to prevent viable eggs by blocking one of these. To achieve this purpose we shall, prevent copulation by driving the male anopheles away from the garden with a flood of Megalopta. Megalopta can survive in similar conditions and the food and feeding time of both Megalopta and anopheles is the same. Hence outnumbering the anopheles the Megalopta will take over all the food sources (flowers). Anopheles has an outstanding flying capacity and can fly up to 12 kms in one night. It will use this capability to locate easier food sites and fly away covering up to 50 kms in four nights. We can be assured that Megalopta will not fly away from the site because it has a very limited flying capability, it does not fly very far away from the nest it flies at the very limits of its visual ability. The survival temperature for Megalopta ranges from 22^0-34^0 hence when the temperature falls below this range in winters the Megalopta may either adapt to the lower temperatures or may perish leaving a vacuum in the ecosystem with extra food available. In the absence of viable eggs of anopheles this will give an opportunity to some other species to take over the food sources.

3.0 Results and discussion

The bees should be placed in overwhelming quantities in the areas with human population. Huge numbers of bees need to be imported along with the nest from their native land (Brazil and Equador) where they are found in abundance and several nests placed at pre-decided points marked at a distance of approximately 500m from each other, so that they exceed the population of Anopheles in the area, ways have to be found to import or culture the bees to be released. The feeding time of the bee and Anopheles is the same hence as soon as the bees are released they will emerge from the nests and occupy the nearby flowers depriving the opportunity for the male Anopheles. The overwhelming numbers of the bees shall ensure that the Anopheles does not get an opportunity to occupy a flower when one bee leaves.

The male Anopheles has the capacity to fly long distances in one night and hence while moving from one flower to another flower it will venture into search for new sites of easy availability of nectar. Such site it shall find only out of the city in areas away from the human population. This way we shall be able to drive the male Anopheles away into human population free areas. Female Anopheles, in the absence of the copulation will not be able to lay eggs. Driven by the dual impact, firstly the scarcity and competition for nectar, and secondly for copulation the females will follow the males or perish. Even if in the new human free lands they are able to copulate they will not be able to lay viable eggs in the absence of a blood

meal and hence the species will be eliminated. On the other hand if it survives with animal blood, it will become plasmodium free and still will not be allowed to return to the human populated areas because of increased competition for nectar due to the presence of the replacement species.
On the other hand if the Megalopta survives the flood of the bee will automatically be controlled within one generation, by the intra-specific competition for food which it will face after the departure of Anopheles due to limited availability of food (flowers). Compared to the costs we have already invested for malaria elimination with limited success, the costs involved in this project shall be trivial and the success sure and lasting. Brazil is a home for both Megalopta and Malaria because Megalopta builds its nest in dead wood, a 4% decrease in forest was associated with 50% increase in malaria in Western Brazil [17]. The reason is that Megalopta constructs its nest in dead wood and with deforestation the population of Megalopta reduces resulting in an increase in population of Anopheles and malaria.

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