

Similarity in Bioelectromagnetic Fields Emitted by Hairs of the Mosquito Larva (*Culex quinquefasciatus*) and Humans

Abraham A. Embi

13442 SW 102 Lane, Miami, Florida 33186, USA

Background: Previously, bio-electromagnetism in living plant tissue was detected for the first time by means of sensitive magnetic magnetometer. Subsequently, this finding was confirmed when bioelectromagnetic fields (BMFs) of plant tissue were also detected by a novel optical microscopy approach. Additionally, BMFs were also documented in the human hair. Introduced is the cross-species BMFs similarity of body parts (hairs) between Humans and Insects.

Materials and Methods: A solution was prepared utilizing Prussian Blue Stain (PBS) and nanosized iron particles 2000 nanometers in diameter (2K). The PBS included two parts of Potassium Ferricyanide (Fe_3), one part of HCl 2.5% and one part of the 2K iron particles. This formula will be referred as (PBS Fe_3 2K) throughout the manuscript. Adult mosquitoes and larvae were placed on separate glass slides and covered by two drops of PBS Fe_3 2K and allowed to evaporate. Images recorded. The same method was used by placing *ex vivo* plucked human hairs. Images also recorded. Equipment used: After evaporation, images were viewed and recorded in the normal mode (no filters) x10 and x40 magnifications. Equipment used was a video-microscope (Celestron LCD Digital Microscope II model #44341, Torrance, California, USA). All pictures downloaded and labeled by using a MacBook Apple computer and Apple Inc. iPhoto 8.1.2, Application.

Results: In this manuscript similarity in BMFs emitted by hairs of the Mosquito Larva (*Culex quinquefasciatus*) and Humans were documented. Upon evaporation, crystals were detected randomly adhering to some areas of the mosquito's antenna, wing tips, distal legs and proboscis and the larva's siphon and hairs, thus proving the presence of bioelectromagnetic forces. Similar results were seen on the human hairs samples.

Discussion: It should be noted that the attraction of a magnetic substance to a body part must be based upon electromagnetic interaction. Different parts could exhibit different magnetic profiles depending on factors such as, circadian rhythmicity, and polarity to attract substances susceptible to said interaction. This principle applies to insects and Humans. The basis is always piezoelectricity or electromagnetic induction. This effect was discovered in 1880 by the brothers Pierre and Paul-Jacques Curie.

Mosquito | Bioelectrobiomagnetism | *Culex quinque-fasciatus* |
Mosquito Larva | Human Hair | Hair follicle.

Introduction

The purpose of this manuscript is to compare the Bioelectromagnetic forces (BMFs) emitted by the *Cx. Quinquefasciatus* mosquito larva's hair with the human counterpart. Bioelectromagnetism, is the study of the interaction between electromagnetic fields and biological entities.

The bioelectromagnetic discipline was first documented in plants by using a sensitive atomic magnetometer) detecting BMFs in living tissue [2].

A recently published technique [3] using a glass slide, in conjunction with a video-microscope and a specially mixed Prussian Blue Stain solution (PBS) with iron nanoparticles, confirmed Corsini's findings by enabling documentation of BMFs found in living plants and animal tissue [4]. This approach has been further validated in papers listed in the literature, such as BMFs presence in *ex vivo* human hair follicles [5] and BMFs penetration through 1 mm glass barrier [6]. This research hereby is now extending the detection of BMFs to insects with evidence found in selective anatomical parts of the *Cx. quinquefasciatus* mosquitoes and larvae. The functions of these newly described BMFs found in the hairs of the mosquito and humans are presently unknown.

Materials and Methods

Prussian blue was the first modern synthetic pigment and is not soluble in water [7] (Gail E et al. 2011). For this research Prussian Blue was made with aliquots of a 2.5% solution of two parts Potassium Ferricyanide ($\text{K}_4 \text{Fe}_3 \text{CN}_6$), one part 2.5% solution HCl and one part of nano-sized (2000 nm mean diameter) iron particles. The combined solution will be referred to as (PBS Fe_3 2K) throughout the text, where PBS=Prussian Blue Stain, Fe_3 =indicating Potassium Ferricyanide and 2K=iron particles 2000 nanometers (nm) in diameter. Adult mosquitoes and larvae were obtained from commercial breeders in Central Florida and out of state. The breeders certified that larvae and mosquitoes were of the *Cx quinquefasciatus* species and confirmed by microscopic examinations. The human hair samples were self harvested via twizzers by the author.

The Single Slide Preparation (SSP)

A single slide preparation (SSP) consists of a single 25x75x1mm clean glass slide, where the biological sample is covered with drops PBS Fe_3 2K. Live mosquitoes *Cx. quinquefasciatus* larvae (n=10) and adult mosquitoes (n=10) were studied. All samples were placed approximately on the center of a 25x75x1mm glass slide. Two drops of the PBS Fe_3 2k (paramagnetic solution) completely covered the specimens. After total evaporation (approximately 2 hours) the SSPs were then viewed in the normal mode (no filters) at X10 and/or 40X magnification with a video microscope (Celestron. LCD Digital Microscope II model #44341 Torrance California USA).

Still microphotographs and video recordings were downloaded and labeled as seen in Figure 1 by using an Apple Inc. iPhoto 8.1.2, App.

Conflict of Interest: No conflicts declared.

Corresponding Author: Abraham A. Embi.

Phone 305-387-6102. Email: embi21@att.net

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Figure 1. *Cx. quinquefasciatus* larva. Post evaporation micro-photograph image of distal Siphon in SSP PBS Fe_3 2K solution. There is selective accumulation of the paramagnetic ferricyanide crystals attracted by the distal end of the Siphon. It is hypothesized that this is an example of the Siphon bioelectromagnetism attracting the paramagnetic Ferricyanide crystal previously mixed with iron particles. A=Distal end of Siphon B=Potassium Ferricyanide paramagnetic crystals X10 magnification.

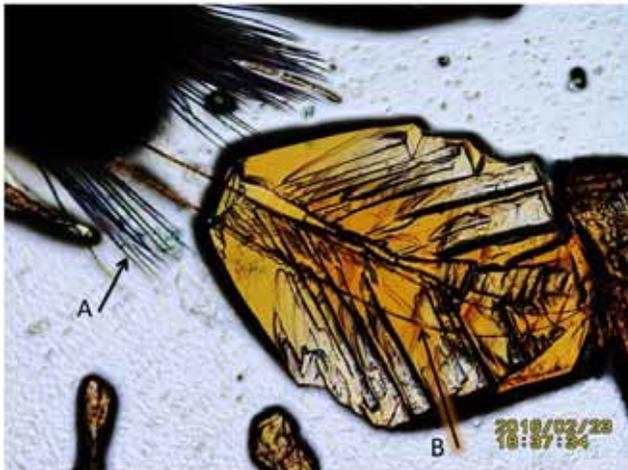


Figure 2. *Cx. quinquefasciatus* larva. Showing protruding long subsiphonal hairs from its terminal segment. The long caudal hairs are seen conspicuously engulfed inside a PBS Fe_3 2k (Potassium Ferricyanide) crystal. It is hypothesized that this is an example of the long hairs bioelectromagnetism attracting the paramagnetic Ferricyanide crystal previously mixed with iron particles. A=Dorsal brush B=One of two Caudal hairs. X10 magnification.

Cx. quinquefasciatus samples selection criteria

Methodology: Mosquitoes, adult and larvae samples were randomly picked from a sample of approximately 100 specimens. Only living larvae were selected by observing viability (ie: rapid motion response to tweezers). Instar stage was not a consideration for sample selection. All samples were processed using the same technique. As an additional comment, larvae that moved towards the edge of the wet field (drops) placed on slides were not taken in consideration, since bioelectromagnetic information (crystal accretion) is lost at that point.

Supplementary Experiments

- 1) A small wedge of rubberized magnetic material 2x3x0.5mm substituted the mosquito in a SSP PBS Fe_3 2K and
- 2) While videotaping a living-wiggling larva immersed in a paramagnetic solution, a set of dislodged paired abdominal hair tuft was observed magnetically being attracted by the main body.

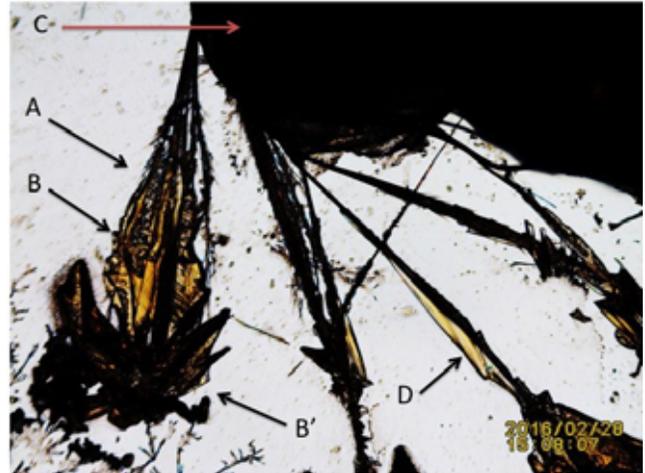


Figure 3. *Cx. quinquefasciatus* larva. Post evaporation micro-photograph image of a thoracic single hairs and hair tuft attracting Potassium Ferricyanide crystals. This SSP Fe_3 2K preparation demonstrates the presence of bioelectromagnetic fields in the larva hair tuft. A=Hair tuft B=Paramagnetic ferricyanide crystals attracted to tuft. Please notice a larger deposition of crystal at the distal end of tuft structure (B') C=Arrow points at larva's thorax D=Example of single hair biomagnetism (attracting paramagnetic crystals). (For additional details, please refer to supplementary video (from 0.02 to 0.13 seconds)

<https://www.youtube.com/watch?v=IroOdNMSmVs>

Results

Larvae

A visual inspection of the larvae mounted in a SSP Fe_3 2k solution and allowed to evaporate showed conspicuous and consistent paramagnetic crystals accretion to the distal syphon, and hair (Figs 1,2,3).

Adult Mosquitoes

Cx. quinquefasciatus adult mosquitoes were mounted in SSPs of the paramagnetic PBS Fe_3 2K solution. The mosquitoes studied showed variability of paramagnetic crystals accretion to body parts. BMFs were seen at the antenna, leg tips and joints, end of wings and proboscis. This is clearly shown in (Figs 4,5).

Supplementary Experiment

To replicate the biomagnetic property of the PBS Fe_3 2K solution. with inanimate samples

- 1) The mosquito sample was substituted by a small rubberized magnetic wedge on the SSP and also covered by drops of paramagnetic PBS Fe_3 2k. The image obtained showed paramagnetic crystals attracted to a magnetic source (Fig 6).

Rare occurrence finding supporting the larva's hair magnetic property.

- 2) Apparently, the larva undergoes rapid movements after disposing of waste material through the anal portion. In this specific video an abdominal hair tuff was dislodged. This structure (hair tuff) was videotaped being attracted by the larva's body. Is theorized that this rare attraction event confirms the presence of bioelectromagnetism.

(For additional details, please refer to supplementary video (from 0.02 to 0.13 seconds)

<https://www.youtube.com/watch?v=IroOdNMSmVs>



Figure 4. Showing *Cx. quinquefasciatus* male mosquitoes mounted in SSP Fe₃ (Paramagnetic Ferricyanide), showing: A=Distal proboscis attracting crystals B=Typical male hairy antenna C= Legs also attracting crystals and D=Another specimen showing wing attracting crystals.

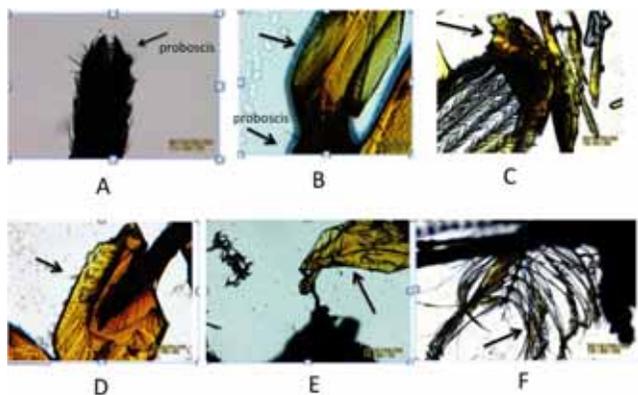


Figure 5. *Cx. quinquefasciatus* panel. Displaying adult mosquito parts post exposure to PBSFe₃2k. Pictures from B to F show biomagnetism expressed by attracting crystals (arrows) of the paramagnetic Ferricyanide solution as follows. A=Control proboscis B=Proboscis with crystals C=Wing attracting crystals D=Mosquito tarsus (leg tip) with crystals E=Female mosquito antenna and F=Male mosquito antenna. E & F both displaying crystallization indicative of biomagnetism.

Discussion

The development of a novel and simplified method for imaging the BMFs in plant and animal tissue has allowed for the detection of BMFs in insects, namely the *Cx. quinquefasciatus* species and human hairs. By definition, paramagnetic materials exhibit a positive magnetic susceptibility [9]. Paramagnetic crystals, such as those of Potassium Ferricyanide are attracted by an opposite magnetic field. In the experiments presented, the paramagnetic Potassium Ferricyanide in solution covered the mosquitoes and larvae samples was placed on a glass slide (SSP). Upon evaporation paramagnetic crystals were observed adhering to

external anatomical areas of the biological samples. In the adult mosquito, the individual variability observed as to the crystal accretion sites, could be attributed to some different body parts expressing different magnetic profiles.

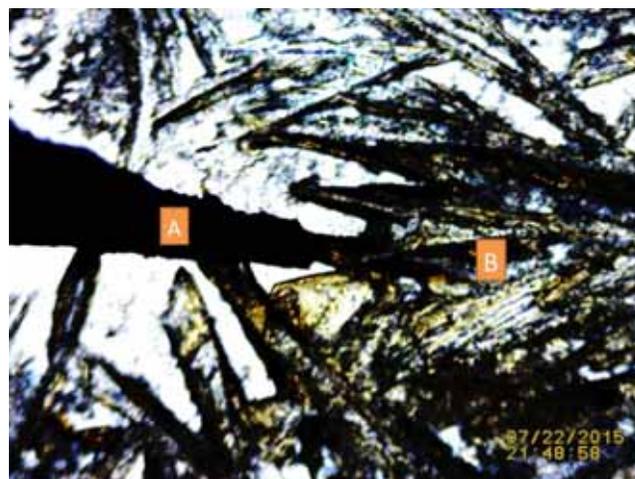


Figure 6. Supplementary experiment showing magnet fragment in SSP PBS Fe₃ 2K (after evaporation). Paramagnetic crystals attracted towards magnetic source. A=Tip of magnetized rubber fragment B=Ferricyanide crystals attracted by magnetic field. (Reprinted from Embi AA. Demonstration of Human Hair Follicle Biomagnetic Penetration Through Glass Barriers. International Journal of Materials Chemistry and Physics Vol. 2, No. 2, 2016, pp. 71-740. Figure 2).



Figure 7. *Ex vivo* freshly plucked human scalp hair immersed in SSP PBS Fe₃ 2K. After evaporation the paramagnetic crystals are shown adhering to A=Hair Shaft F=Hair Follicle B=Ferricyanide crystals attracted by the bioelectromagnetic field of the hair shaft. Please compare with Figures 2 and 3 of the mosquito larva's hairs.

Bioelectromagnetism found in Human and Insect hairs

Mosquitos undergo metamorphosis and during the larval aquatic stage and adult, hairs are present. A hair grouping (more than one with a single follicle) is classified as a Tuff. Only in the larva is that all images showed hairs (individuals and tuffs) consistently exhibiting magnetic susceptibility (Figs 2 and 3). In the human body hairs harvested also show magnetic susceptibility (Fig 7). This finding supports a cross species similarity of bioelectro-

magnetism present in the hair shaft of humans [9] and mosquitoes (*Cx. quinquefasciatus*). The images support that selective body parts (such as hairs) always attract iron laden paramagnetic crystals, thus exhibiting bioelectromagnetism. The intensity of attraction in some individuals could depend on factors such as, circadian rhythmicity and polarity to attract a substance susceptible to such interaction. It is theorized that the placement of living specimens in a hostile environment could cause a “disruption of the circadian cycle which is strongly associated with metabolic imbalance” [10]. Increase in metabolism (read energy) has been shown to have a marked effect in cells at a molecular level. “This process involves the electron transfer chain and therefore, as inferred from Faraday’s Law, electron movement will induce electromagnetic fields (EMFs). Biological entities emit photoelectrons that can be tracked and visualized by small paramagnetic nano-sized iron particles” [11]. The basis is always piezoelectricity (motion converted to electromagnetism) or electromagnetic induction (production of voltage due to dynamic interaction) as described in 1880 by the brothers Pierre and Paul-Jacques Curie [12].

Summary

Using a novel and simplified method for imaging, the bioelectromagnetic energy in plant and animal; *Cx. quinquefasciatus* mosquitoes and larvae were studied. Bioelectromagnetism was detected randomly in various anatomical locations in both stages of development (Larva and Adult). An exemption needs to be made with hairs; all images showed that hairs from humans and mosquito (in the larval stage) expressed magnetic susceptibility.

The physiological function of the BMFs found in the mosquito and humans are unknown at present. Further research is warranted

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