

AN OVITRAP AND METHOD OF CONTROLLING VECTOR BORNE DISEASE

[0001] This invention relates to an ovitrap, and a method for controlling vector borne diseases, particularly those carried by mosquitoes.

- 5 [0002] More particularly it relates to the use of light to control the movement of mosquito larvae, away from the stimuli.

BACKGROUND

[0003] Mosquito borne diseases cause the most number of human fatalities yearly throughout the world, and have killed more humans than all the world wars put together.

- 10 With over 2700 species of mosquitoes known globally, mosquitoes have adapted and evolved to fill many tropical and sub-tropical niches around the world. With the onset of global warming this global distribution is increasing everyday as mosquitoes find new niches to adapt and invade. They are vectors of diseases, which mean they carry diseases from one animal to another without being affected by the disease themselves. This vector
15 disease transmission in mosquitoes is usually carried out by the female mosquitoes, as they possess the necessary mouth parts to pierce the epidermis of animals to draw out a blood meal. It is from this blood meal that female mosquitoes derive the essential amino acids for egg production and hence reproduction.

- [0004] Two most notorious species of mosquito are the *Aedes aegypti* and the *Aedes albopictus* mosquitoes. Native to Africa and Asia respectively, their distribution globally has
20 been significantly increased due to the movement of people and goods and through the impact of climate change. In many tropical countries, these 2 species of mosquitoes share the same environmental niche and in turn cause twice the disease transmission.

- [0005] They are both known vectors of Dengue Fever and Dengue Haemorrhagic Fever,
25 which account for >90 million clinically reported infections of Dengue per year in over 100 countries. Of these 90 million cases yearly, >500,000 manifest to the more virulent form of Dengue known as Dengue Haemorrhagic Fever which has a higher chance of human mortality than just Dengue alone. Every year Dengue causes >25,000 deaths.

- [0006] However, with modern research and diagnostics, new emerging diseases
30 transmitted by these mosquitoes have been identified. These include Chikungunya, Mayaro, Usutu and Zika. In 2015-2017, Zika, has been reported in 70 different countries with over 1 million cases in the Americas alone.

[0007] Female *Aedes spp.* mosquitoes preferred times for seeking a blood meal are at dawn and dusk, but biting can occur all through the day if conditions are favourable

(temperature/humidity dependent). The mosquito becomes infective approximately seven days after it has bitten a person carrying these viruses. This is the extrinsic incubation period, during which time the virus replicates in the mosquito and reaches the salivary glands. The average lifespan of an *Aedes spp.* mosquito in Nature is two weeks. Female mosquitoes will lay eggs about three times in her lifetime, and about 100 eggs are produced each time. If she is infective, she can also transfer the virus to her eggs, this is known as Transovarian transmission, and is a common precursor to the start of many outbreaks. The eggs can lie dormant in dry conditions for up to about nine months, after which they can hatch if exposed to favourable conditions, i.e. water and food.

10 [0008] The most common methods used to control these mosquitoes are by Adulticiding and Larviciding.

[0009] Adulticiding is the administering of an insecticide through aerial spraying, or fogging, which although moderately effective, will also affect beneficial insects such as pollinators (honey bees and butterflies) or affect other insects that are vital food sources for animals throughout the food chain. Adulticiding is mainly used as a last resort in the event of disease outbreaks.

[0010] Larviciding is the introduction of insecticides into the water bodies that mosquitoes lay eggs which hatch as larvae, which although moderately effective, will contaminate water sources for other animals and affect organism in the water impacting the aquatic food chain.

[0011] However, recently, developed larvicides and insecticides have achieved much greater specificity in eliminating the targeted species with little or no effect on non-targeted insects. These methods are unfortunately labour intensive and cost inhibitive in large scale programmes where mosquito control is needed the most

25 (<http://www.sove.org/SOVE%20folder/journal/December%202003/Nayar%20and%20Ali%2003-12.pdf>).

[0012] However, new methods are constantly being attempted to improve control strategies including the use of genetically modified mosquitoes and motorized CO₂ fans to attract and trap mosquitoes.

30 [0013] In the research to understand the insect, its preferences, behaviour and population dynamics, scientists have developed simple tools to track *Aedes spp* populations. One of these devices, exploits the fact that these creatures require a water source for incubating eggs, and is known as an Ovitrap. Initially designed to monitor *Aedes spp* population in the field, scientist used Ovitrap devices to replicate mosquito breeding locations in a controlled manner, to attract the gravid female to these sites, where they or

their eggs and larvae could be counted and analysed for research. In doing this counting, adults and larvae were being removed at their locations and scientists realised that these devices were reducing the wild type *Aedes spp* populations significantly to the point that disease transmission had abated. These traps are known as Ovitrap, eggs sinks or gravid traps.

[0014] Publications, and their findings include the following:

[0015] Williams CR et al 2007 (<https://www.ncbi.nlm.nih.gov/pubmed/17427694>)

who reported Bifenthrin laced Ovitrap (known as Lethal Ovitrap) achieved 79.7% field mortality of adult *Aedes spp* ;

10 [0016] Perich MJ et al 2003 (<http://onlinelibrary.wiley.com/doi/10.1046/j.1365-2915.2003.00427.x/full>) who reported significant reduction in total positive containers and lower larvae per trap when using Ovitrap in residential areas in Brazil;

[0017] Zeichner et al 1999 (<http://onlinelibrary.wiley.com/doi/10.1046/j.1365-2915.1999.00192.x/full>) who reported how the use of insecticide laden traps was able to
15 achieve 100% control of female adults and larvae *Aedes spp*;

[0018] Barrera et al 2014 (<https://www.ncbi.nlm.nih.gov/pubmed/24605464>) who found that placements of 3-4 Ovitrap in 81% of the homes significantly reduced dengue incidence;

[0019] Barrera et al 2016
20 (https://www.researchgate.net/publication/311982210_Impact_of_Autocidal_Gravid_Ovitrapps_on_Chikungunya_Virus_Incidence_in_Aedes_aegypti_Diptera_Culicidae_in_Areas_With_and_Without_Traps) who found a 10x reduction in mosquitoes and Chikungunya transmission in areas with ovitrap deployment in Puerto Rico; and

[0020] BJ Johnson et al 2017 (<http://www.mdpi.com/2075-4450/8/1/5/htm>)

25 who proposed that mass deployment of Ovitrap would significantly impact invasive *Aedes albopictus* mosquitoes in the US.

[0021] Light, or rather light in the UV frequency, is used as an attractant in commercial light traps for many flying insects including mosquitoes. As disclosed in, for example:

30 (<http://www.ledsmagazine.com/ugc/2016/04/25/trapping-zika-virus-transmitting-mosquitoes-with-the-latest-led-technology-from-seoul-viosys-and-seti.html>);
(<https://membracid.wordpress.com/2008/09/09/do-those-mosquito-zappy-things-really-work/>); and

(<https://www.thoughtco.com/do-bug-zappers-kill-mosquitoes-1968054>).

[0022] Patent publications identified include:

[0023] WO2013/082700 discloses an apparatus and method for reducing populations of aquatically hatched insects. In contrast to the present invention the apparatus uses light to
5 attract gravid insects, as opposed to provide a negative phototaxis response in the larvae.

[0024] Arch. Environm. Contam. Toxicol 7, 339-347 (1978) discloses a biomonitoring procedure using negative phototaxis, and identifies the trait to have been first studied in the 1950's. The article however focuses on its use to sensitively monitor toxic levels of e.g. metals.

10 [0025] CN100411513 discloses a sluice rainwater trapping device with a funnel and a light channel to attract larva towards a light channel, which the larva are said to swim towards.

[0026] US 2010/0083562 discloses a container for capturing mosquito larvae which comprises a funnel arrangement which induces the larvae to an area where they find it
15 difficult to escape.

[0027] Applicant has exploited the fact that the larvae of mosquitoes *Aedes aegypti* and *Aedes albopictus* exhibit a negative phototaxis response, such that sudden intense light will initiate a 'turn-away' response or repellent response to the source of light, to improve the effectiveness of an ovitrap.

20 [0028] In particular, the behaviour exhibited enables them to:

- a. Use light to 'herd' mosquitoes;
- b. Trap and kill larvae without pesticides (if desired);
- c. Reduce emergence of adult mosquitoes from larval/pupae stage;
- d. Minimise human intervention (service traps infrequently); and
- 25 e. Provide greater flexibility of mosquito operations

[0029] An object of the invention is to provide an improved ovitrap and method for controlling mosquito populations and vector borne diseases with or without the use of pesticides.

30 BRIEF SUMMARY OF THE DISCLOSURE

[0030] In accordance with the present invention there is provided an ovitrap comprising a container, a cover, and a means for dividing the container into two regions, which in use

are filled with water, and which communicate via an opening such that a volume below the means defines a larvae trapping region, and a volume above the means defines an egg receiving region, characterised in that a light source is mounted above the container and is positioned to direct light downwards at a water surface, such that when the light is turned on to create a photo stimulus, the larvae respond by moving in a direction away from the light, from the volume above, into the volume below via the opening, a gating mechanism opening and closing the opening when the light is respectively turned on and off, such that the larvae are trapped in the volume below.

[0031] Preferably the means for dividing the contained is a funnel comprising a mouth and a stem with an opening said funnel being positioned inside the container.

[0032] Preferably the light source generates at least 5 lux.

[0033] Preferably the light has a colour temperature greater than 5000K.

[0034] More preferably the light source emits light which has a cool, white spectra, with two peaks, a first peak at about 450nm - 470nm, and a second peak at about 500nm - 700nm.

[0035] The light source identified proved particularly good at generating a negative phototaxis response, and contrasts to the use of wavelengths that are generally considered to act as attractants to mosquitos, the adult form of the larvae.

[0036] Preferably the gating mechanism comprises a plug member which is operatively moved between a closed position, where it is in a downward position, closing the opening in the stem, and an open position, where it is in a raised position, opening the opening in the stem.

[0037] In a preferred embodiment, the plug member, is carried on a rod.

[0038] Preferably the gating mechanism is operated by a solenoid.

[0039] The gating mechanism is operatively linked to the light source and the time and length the light is on, and gating mechanism open, is carefully controlled.

[0040] Gating can last for a time period which lasts anywhere from a few seconds to several minutes, with a preferred period of 30 seconds to a minute, or two, depending on the geographical location and target species.

[0041] The light and gate may be triggered to operate in synch', together, or there can be a short delay between the two. I.e. (i) gate open, followed by light on, and gate closed, followed by light off or (ii) light on, followed by gate open, and light off followed by gate closed.

[0042] Preferably the gating mechanism and light source are controlled by a clock and / or a light sensor.

[0043] The operation, and data control is preferably managed via a microprocessor and battery and can be controlled and accessed remotely.

- 5 [0044] Preferably the container comprises a mechanism for locating and retaining the funnel in position in the container and the funnel has a rim which facilitates location and retention.

[0045] Preferably the container comprises a mechanism for locating the cover and the cover has a lower portion which is shaped to facilitate location and retention.

- 10 [0046] In a preferred embodiment, the funnel precludes light from passing there through.

[0047] Preferably the cover comprises a lip with an internal surface with vertical protrusions, spaced equally apart. These vertical protrusions assist the female in positioning herself for optimal egg laying.

- 15 [0048] More preferably at least some of the internal surfaces of the cover and funnel are a roughened texture to assist female surface attachment for egg laying.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5198213/>

- [0049] In an optional embodiment, the funnel may be impregnated with various insecticides or insect growth regulators which leech slowly into the water to kill larvae and can contaminate ovi-positioning female mosquitoes. Alternatively, pesticides may be
20 added to the water in the ovitrap by licensed professional pest control operators.

- [0050] Preferably the light source comprises a plurality of LED lights which are mounted directly above the water surface and which direct the light down, at the water, and not outwardly, which is the method used to attract mosquitos. The light, and its intensity and frequency differ from mosquito attracting light sources which typically utilise ultra violet
25 (UV) or specific wavelengths in the visible spectrum to attract mosquitos. In contrast, the invention uses light to repel mosquito larva.

[0051] Preferably the light source is mounted on a cross member on the cover.

- [0052] Preferably the gating mechanism is positioned such that the solenoid is mounted on the cover, and is seated in a cover void together with electronics, and the rod is axially
30 aligned with the funnel stem such that the plug member can be moved, on operation, between open and closed positions.

[0053] Preferably the cover comprises side walls, with openings, which project upwardly away from a lower portion, a cross member which supports the light source, and a top portion which contains a void.

[0054] The top portion extends outwardly beyond the walls of the container and has a sloped outer surface allowing water to run off its surface.

[0055] In use, the ovitrap is filled with water and may additionally comprise attractants, insect growth regulators, insecticides (including Larvicides) or biological control agents.

- 5 [0056] Applicant has separately determined that in order to maximise efficiency, and reduce times between servicing, it is desirable to ensure the ovitrap (see e.g. Fig 9) is continuously or intermittently topped up with water.

- [0057] In one embodiment this is achieved by means of a water feed tank, which can be an integral part of the ovitrap or a separate unit, which is provided with, e.g. a hose
10 connection and water control valve, although it will be appreciated that the control may be provided at the ovitrap, much as a float and ball valve of a toilet cistern works.

[0058] A water "auto-refill" of an ovitrap may be considered a separate and independent aspect of the invention.

- [0059] Preferred insect growth regulators which may be used include Periproxifen,
15 Methoprene and Diflubenzuron. Preferred biological control agents include *Beauveria bassiana* and *Bacillus thuringiensis var. israelensis*

- [0060] In accordance with a second aspect of the present invention there is provided a kit comprising an ovitrap together with one or more of a water tank, water conditioning agent, mosquito eggs or larvae, replacement lights or a DNA testing kit for identifying
20 mosquito species larvae and/or disease carrying mosquitoes in the field

- [0061] In accordance with a third aspect of the present invention there is provided a method of controlling mosquito populations comprising the use of light to create a photo stimulus, causing mosquito larvae to move from a location, where gravid mosquitoes have deposited their eggs, in a direction away from the light, to a location, where they are
25 trapped and killed.

[0062] Such a method may be used as a method of disease control, through the reduction in future progeny of disease carrying mosquitoes.

BRIEF DESCRIPTION OF THE DRAWINGS

- 30 [0063] Embodiments of the invention are further described hereinafter with reference to the accompanying drawings, in which:

[0064] FIG. 1 is a cross sectional view of an assembled ovitrap, showing the different parts of the trap;

- [0065] FIG. 2 is a cross sectional view of a funnel component;
- [0066] FIG. 3 is a cross sectional view of a container component;
- [0067] FIG. 4 is a cross sectional view of a cover component;
- [0068] FIG. 5 is a cross sectional view of a light array;
- 5 [0069] FIG. 6 is a cross sectional view of a gating mechanism;
- [0070] FIG. 7 is a cross sectional view of the ovitrap with the gating mechanism in an "open" – "lights on" position;
- [0071] FIG. 8 is a cross sectional view of the ovitrap with the closure component in an "closed" – "lights off" position;
- 10 [0072] FIGS. 9A, 9B and 9C illustrate the assembled ovitrap of the invention in use;
- [0073] FIG 9A shows recently hatched larvae in a water filled ovitrap – "lights off";
- [0074] FIG 9B shows larvae moving in response to the light stimulus – "lights on";
- [0075] FIG 9C shows larvae in a water filled trap – "lights off";
- [0076] FIG 10 shows a second embodiment of ovitrap with a solar cell;
- 15 [0077] FIG 11 is a block diagram showing the electronics for the ovitrap of Fig 10;
- [0078] FIG 12 is a diagram illustrating light with a colour temperature in the range 5000K-10000K;
- [0079] FIG 13 is a diagram illustrating a cool white spectrum, with two peaks, a first peak at about 450nm - 470nm and a second peak at about 500nm - 700nm contrasted to a
- 20 warm white light;
- [0080] FIG 14 is an ancillary water tank, for use with an ovitrap of the invention, with its lid removed;
- [0081] FIG 15 is an illustration of the water tank of Fig 14 connected to an ovitrap; and
- [0082] FIG 16 is a cross section view of the embodiment illustrated in Fig 15.

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DETAILED DESCRIPTION

- [0083] The Figs illustrate an ovitrap (10) according to a first aspect of the invention.
- [0084] In the Fig 1 embodiment illustrated, the ovitrap comprises five primary structural components, (illustrated separately in Figs 2-6) a container (12), a cover (14), a funnel
- 30 (16), a gating mechanism (18) and a light source (20).

[0085] The funnel (16) comprising a wide mouth (22) and a narrow stem (24) with an opening (26) at the bottom of the stem, which funnel is seated in the container (12), which in use is filled with water, such that its' stem (24) is positioned such that its' opening (26) is located towards the base (28) of the container (12). The funnel (16) has a rim (30) with
5 locating apertures (not shown) allowing the funnel to be retained by lugs (32), on stops (34) which project inwardly from the inner wall (36) of the container (12).

[0086] Cover (14) (See Fig 4) comprises a lower portion (38) which is shaped and sized to sit on the rim (30) of the funnel (16) snugly within the upper confines (40) of the container (12). The cover comprises side walls (42), with openings (44), which project
10 upwardly away from the lower portion (38), a cross member (46) which supports the light source (20), and a top portion (48) which contains a void (50) and is shaped to house the gating mechanism (18), and electronics (52) as broadly illustrated in Figs 6 and 11. The top portion is also shaped to allow water to run off its outer surface (54) and has a portion (56) which extends peripherally beyond the container (12) boundaries. This provides an
15 attractive environment for the gravid female mosquitoes and helps limit evaporation of water from the trap.

[0087] Mounted in the void (50) within the top portion (48) is the gating mechanism (18) which comprises a shaped plug member (58) which engages the funnel (16) where it narrows to the stem (24). The plug member sits at the end of a rod (60) which can be
20 moved up and down from its normal closed position (62) (Fig 8), where it is in a downward position closing the opening (26) in the stem (24), to an open position (64) (Fig 7), where it is in a raised upward position, opening the opening (26) in the stem (24). The rod is operated by the action of a solenoid (66) which is controlled by a solenoid driver (68) operated by a microprocessor (70) powered by a battery (72) or other power source. The
25 solenoid driver (68) is synchronised with a light (LED) driver (74) so that the mechanism is "open" when the lights (20) are turned on and "closed" when the lights (20) are turned off.

[0088] The turning on and off is controlled by a clock (76) and / or light sensor (78). The ovitrap also has a temperature sensor (80) and humidity sensor (82) for data gathering facilitating effective "remote" management.

30 [0089] In the Fig 10 embodiment the trap is provided with a solar panel (84) which links with a charger (86) to the battery (72) and a power convertor (88) although the trap can also be mains operated via a mains adaptor (90) if desired.

[0090] Turning to Fig 9a-c the following describes the devices method of operation. An ovitrap is first assembled, filled with water, preferably distilled or conditioned water (aged).
35 To this may be added organic attractants (including mosquito eggs), insect growth

regulators, pheromones or the like and the gating mechanism checked to ensure it will operate as desired.

[0091] Fig 9a shows an ovitrap after eggs have hatched. Before this however, a gravid mosquito will have been attracted to the trap, which is filled with water (shaded) and which may contain additional attractants to just below the container surface (92). Gravid mosquitoes enter the ovitrap via openings (44), land on the surface (39) of the lower cover (38) and deposit their eggs on the meniscus of a volume of water (darker hatching) above (Va), and above the funnel (16) which volume defines an egg (101) receiving region. In this state the lights (20), which are directed downwardly towards the water surface (92), are turned off, and the plug (58) of the mechanism (18) closes the funnel opening (26) separating, and preventing communication between, the volume of water above (Va) and a volume of water below (Vb) (lighter hatching).

[0092] In order to kill the larvae (102), they are "herded" from the volume above to the volume below, where they are trapped. To facilitate this movement and trapping the light (20) and gating mechanism (18) operate such that the gating mechanism is opened when the lights (20) are turned on (Fig 9b). In response to the light stimulus, preferably a light stimulus which emits an intense light, the larvae of, particularly, *Aedes aegypti* or *Aedes albopictus*, swim away from the light, through the opening (26) into the volume below (Vb). The light need only be triggered for a short period, programmed anywhere up to 300 seconds, which is a sufficient duration for the larvae to move from Va to Vb, whereupon the light is switched off and the plug closed (as Fig 9c). The trapped larvae (102) swim upwards, are trapped in the volume below (Vb), and eventually die from oxygen starvation (suffocation). Their brief presence however, stimulates other gravid females to deposit eggs, and the process of turning the lights and gating mechanism on and off ensures substantially that all future larvae are trapped and suffocated, thus providing effective mosquito and disease control.

[0093] Lights may be triggered daily, every few days or weekly depending on the requirement.

[0094] As the trap allows larvae to survive for some period within the trap, but not emerge as an adult, it has the added effect of making the trap more effective over time since larvae that survive in the trap release pheromones that are detected by gravid females looking for suitable locations for egg laying. The more larvae present in the trap, the more likely nearby flying gravid females will detect it and lay eggs, as it shows that the water source is viable for its offspring.

[0095] The intense light preferably generates at least 5 lux, more preferably at least 100 lux, and more preferably still at least 200 lux. Most preferred is a light that generates between 270 and 310 lux, typically about 290 lux.

5 **[0096]** Most preferred is a lighting which emits light with a colour temperature of greater than 5000K, more preferably still, a colour temperature in the range 5000K-10000K as illustrated in Fig 12.

[0097] Preferably the light has a cool white spectrum, with two peaks, a first peak at about 450nm - 470nm and a second peak at about 500nm - 700nm as illustrated in Fig 13.

[0098] The preferred lighting comprises a LED light source.

10 **[0099]** The funnel (16) or container (12) may be impregnated with an Insect Growth Regulator (IGR), e.g. periproxifen or methoprene and/or pheromones or other attractants that will leech out into the water body at a controlled rate over time. The leeching of such additives will be internal to the trap.

15 **[00100]** Fig 14 illustrates a water tank (200), with it's lid removed. It comprises a receptacle (202) with a plurality of height adjustable legs (204). The receptacle has a cage structure (206) for retaining a conditioning agent, such as hay, an outlet (208) and baffles (210) in the surrounding vicinity to reduce debris accumulating about the outlet.

20 **[00101]** As is more clearly seen in Figs 15 the water tank (200) is fitted with a lid (212), and a hose (214) feeds the ovitrap (10). In detail, and as shown in cross section, Fig 16, the receptacle (202) may be filled or connected to a water supply via an inlet (216) which, as illustrated, comprises a multi diameter hose attachment. The supply may be a mains supply or e.g. a separate feed, such as a water butt. A hose (214) takes a volume of water (Vc) from the water tank to the ovitrap (10), and flow is controlled by a valve mechanism (218), comprising e.g. a valve body (220), float arm (222) and float (224). The hose may
25 comprise multiple sections (214a; 214b) connected about a connector (226) provided on the ovitrap.

CLAIMS

1. An ovitrap (10) comprising a container (12), a cover (14), and a means (16) for dividing the container (12) into two regions (101; 102), which in use are filled with water,
5 and which communicate via an opening (26) such that a volume (Vb) below the means (16) defines a larvae (102) trapping region, and a volume (Va) above the means (16) defines an egg (101) receiving region, characterised in that a light source (20) has a cool, white spectra, with two peaks, a first peak at 450nm - 470nm, and a second peak at 500nm - 700nm and is mounted above the container (12) and is positioned to direct light
10 downwards at a water surface (92), such that when the light is turned on to create a photo stimulus, the larvae (102) respond by moving in a direction away from the light, from the volume above (Va) into the volume below (Vb) via the opening (26), a gating mechanism (18) operatively linked to the light source (20) which opens and closes the opening (26) when the light is respectively turned on and off, such that the larvae are trapped in the
15 volume below.
2. An ovitrap as claimed in claim 1 wherein the means (16) for dividing the container is a funnel (16) comprising a mouth (22) and a stem (24) with an opening (26), said funnel being positioned inside the container (12).
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3. An ovitrap as claimed in claim 1 or 2 wherein the light source (20) generates at least 5 lux.
4. An ovitrap as claimed in any of the preceding claims wherein the light has a colour
25 temperature greater than 5000K.
5. An ovitrap as claimed in any of the preceding claims wherein the gating mechanism (18) comprises a plug member (58) which is operatively moved between a closed position (62), where it is in a downward position closing opening (26), and an open position (64),
30 where it is in a raised position, opening the opening (26).
6. An ovitrap as claimed in claim 5 where the plug member (58) is carried on a rod (60).

7. An ovitrap as claimed in claim 5 or 6 wherein the gating mechanism (18) is operated by a solenoid (66).
- 5 8. An ovitrap as claimed in claim 1 wherein the gating mechanism (18) and light source (20) are controlled by a clock (76) and / or a light sensor (78).
9. An ovitrap as claimed in any of the proceeding claims further comprising a microprocessor (70) and battery (72).
- 10 10. An ovitrap as claimed in claim 2 wherein the container (12) comprises a mechanism (32; 34) for locating and retaining the funnel (16) in position in the container (12) and the funnel (16) has a rim (30) which facilitates location and retention.
- 15 11. An ovitrap as claimed in any of the preceding claims wherein the container (12) comprises a mechanism (34; 40) for locating the cover (14), and the cover (14) has a lower portion (38) which is shaped to facilitate location and retention.
- 20 12. An ovitrap as claimed claim 6 wherein the funnel (16) and plug member (58) preclude light from passing there through.
13. An ovitrap as claimed in claim 2 wherein the funnel has a reflective inner surface (94) and a roughened upper surface (96) about the rim (30).
- 25 14. An ovitrap as claimed in any of the preceding claims wherein the wherein the surface (39) of the cover (14) is to assist a female mosquito to position herself for optimal egg laying.
- 30 15. An ovitrap as claimed in any of the preceding claims wherein the light source (20) comprises a plurality of LED lights and is mounted directly above the water surface (92).

16. An ovitrap as claimed in claim 15 wherein the light source is mounted on a cross member (46) on the cover (14).
17. An ovitrap as claimed in claim 7 wherein the gating mechanism (18) is positioned
5 such that the solenoid (66) is mounted on the cover (14), and is seated in a cover void (50) together with electronics (52), and the rod is axially aligned with the funnel stem (24) such that the plug member (58) can be moved, on operation, between open and closed positions.
18. An ovitrap as claimed in claim 17 wherein the cover (14) comprises side walls (42),
10 with openings (44), which project upwardly away from a lower portion (38), a cross member (46) which supports the light source (20), and a top portion (48) which contains the void (50).
19. An ovitrap as claimed in claim 18 wherein the top portion (48) extends outwardly
15 (56) beyond the walls of the container (12).
20. An ovitrap as claimed in claim 18 or 19 wherein the top portion (48) has a sloped
20 outer surface (54).
21. An ovitrap as claimed in any of the preceding claims which is connected to a water
tank (200) with a mechanism (218) ensuring an appropriate water level in the ovitrap is
maintained.
22. An ovitrap as claimed in claim 21 wherein the water tank (200) comprises a
25 receptacle (202) with an outlet (208), lid (212), and hose (214), and further comprises one or more of adjustable legs (204), a water conditioning cage (206), and a water inlet valve (216).
23. An ovitrap as claimed in any of the proceeding claims which in use is filled with
30 water and may comprise one or more of a female mosquito attractant, insect growth regulator, insecticide or other biological control.

24. An ovitrap as claimed in claim 23 wherein the insect growth regulator is. Periproxifen, Methoprene or Diflubenzuron.
25. An ovitrap as claimed in claim 23 wherein biological control is *Beauveria bassiana*,
5 or *Bacillus thuringiensis var. israelensis*.
26. An ovitrap as claimed in claim 23 wherein the attractant is a water conditioning agent or mosquito eggs.
- 10 27. A kit comprising an ovitrap as claimed in any of the preceding claims together with a water tank, water conditioning agent, mosquito eggs or larvae, replacement lights or a DNA testing kit for identifying mosquito species larvae and/or disease carrying mosquitoes in the field.
- 15 28. A method of controlling mosquito populations using the ovitrap as claimed in claim 1, wherein said method comprises the use of light (20) which has a cool, white spectra, with two peaks, a first peak at 450 nm - 470 nm, and a second peak at 500 nm - 700 nm to create a photo stimulus, causing mosquito larvae (102) to move from a location (Va), where gravid
20 mosquitoes have deposited their eggs, in a direction away from the light, to a location (Vb), where they are trapped and killed.
29. The method as claimed in claim 28 wherein the light source (20) generates at least 5 lux.
- 25 30. The method as claimed in claim 28 wherein the light source (20) has a colour temperature greater than 5000K.
31. The method of disease control comprising the method of any of claims 28 to 30.