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A New, Cheap, Easy to Use, Foldable and Portable Autocidal Ovitrap for *Aedes* Control at Community Level

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Authors' contributions

This work was carried out by both authors. They designed the study and the protocole. GC wrote the first draft and did field trial in Bali. PC did literature research and field work in Angola, finalizing the writing. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Except for Yellow Fever there is still no operational vaccine, the Dengue vaccine (CYD-TDV, sold under the brand name Dengvaxia©) raised several issues and vaccination campaign were stopped. On the other hand there is still no specific treatment for the main arbovirus transmitted by *Aedes aegypti* and *Aedes albopictus* such as dengue, Chikungunya, Zika and recent outbreaks occurred all over the World. For WHO "vector control is the key strategy to control or prevent the transmission of dengue (and other arbovirus) but clearly there is a need for improved new vector control approaches. Only another one vaccine is available against arbovirus is against Japanese Encephalitis transmitted by *Culex tritaeniorhynchus*.

In line with this recommended approaches of new tools to be used at community level we successfully developed and implemented in Angola a "Very Simple Ovitrap Model" which actually "collected" eggs of *Aedes aegypti* warning for risk of arbovirus outbreaks, which, unfortunately, occurred few years later. These ovitraps were transformed as a tool for vector control in adding few drops of Bacillus thuringiensis (Bt) in the water and several hundred of tests showed that not a single larva of *Aedes aegypti* was ever found in these "Bt fitted simple ovitrap".

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To solve some operational issues (transport) we tested in Bali during 3 years several size and color of foldable container prepared as ovitraps and put in a garden among grass, banana trees etc, we thus collected eggs of *Aedes albopictus*, important vector of dengue and dengue hemorrhagic fever (DHF), a serious threat in Asia, and preliminary tests (unpub.) showed some resistance to insecticide increasing the need for control.
According to these trials, made in complete field conditions, we proposed a new foldable model of ovitrap as a vector control tool presented as a kit to be used at community level with a 3 steps action: open it/fill it/use it.

Keywords: Aedes aegypti; Aedes albopictus; new model foldable ovitrap for vector control; arbovirus; community participation.

1. INTRODUCTION

This last decade several outbreaks of yellow fever, Dengue (I, II, III, IV) occurred all over the World and except for Yellow fever and dengue no operational vaccines are currently available while now there is no specific drug treatment. The recently developed (2015) and promising "dengue vaccine" (CYD-TDV) raised several issues and vaccination campaigns were stopped. Therefore, for the time being, the control and prevention of such arbovirus outbreaks is mainly based on vectors control with several measures, from space spray to physical or chemical elimination of actual and potential breeding sites (Facts sheet WHO, May 7th 2010).

An important point is that these virus are transmitted by 2 main vectors *Aedes aegypti* and *Aedes albopictus*, therefore controlling one vector could avoid the transmission of several virus, emphazing the importance of vector control [1].

Aedes aegypti and *Ae. albopictus* breed principally in domestic containers, inside and outside houses and are therefore almost always close to population increasing the risk of human contamination. But at the same time easier to be controlled by community themselves if available methods of control are cheap and easy to be implemented.

Ae. albopictus is currently spreading all over the World and as underlined by WHO vector control is the key strategy to control or prevent transmission and new tools are urgently needed.

The Concept of our work is to use a classical "sampling tool" for vector control such as tse-tsé fly trap or the mosquito net trap which become the famous insecticide treated mosquito net [2,3], the main current tools for malaria control [4]. The idea is therefore to use ovitrap not only to collect eggs and *Aedes* and demonstrate the presence (or not) of the species but also to "transform" them to become autocidal and another tool for vector control.

2. OFFICIAL FACT SHEETS ON THE ARBOVIRUS DISEASES SITUATION

2.1 Yellow Fever

According to the WHO Fact Sheet May 7th 2019 "Forty-seven countries in Africa and Central and South America are either endemic for, or have regions that are endemic for, yellow fever. A modelling study based on African data sources estimated the burden of yellow fever during 2013 was 84 000–170 000 severe cases and 29 000–60 000 deaths". "There is currently no specific anti-viral drug for yellow fever" and "Vaccination is the most important means of preventing yellow fever". Vector control: "The risk of yellow fever transmission in urban areas can be reduced by eliminating potential mosquito breeding sites, including by applying larvicides to water storage containers and other places where standing water collects.

Both vector surveillance and control are components of the prevention and control of vector-borne diseases, especially for transmission control in epidemic situations. For yellow fever, vector surveillance targeting *Aedes aegypti* and other *Aedes* species will help inform where there is a risk of an urban outbreak.

Understanding the distribution of these mosquitoes within a country can allow a country to prioritize areas to strengthen their human disease surveillance and testing, and to consider vector control activities". We can underline this sentence dealing with the knowledge of distribution of vectors to identify at risk areas or

spreading of the vectors and ovitraps are important tools in this issue.

The Global Eliminate yellow fever epidemics (EYE) long term strategy (2017-2026) has been developed by a coalition of partners (GAVI, UNICEF and WHO) to face yellow fever's changing epidemiology, resurgence of mosquitoes and increased risk of urban outbreaks and international spread.

2.2 Dengue and severe dengue (dengue hemorrhagic fever DHF)

For WHO "the incidence of dengue has increased 30 fold over the last 50 years. Up to 50-100 million infections are now estimated to occur annually in over 100 endemic countries, putting half of the world's population at risk. There is no specific treatment for dengue/severe dengue" and this virus is "a leading cause of death in children » [5].

Despite a risk of infection existing in 129 countries [6] 70% of the actual burden is in Asia [5].

WHO underlined that, for the time being "the world relies heavily on vector control and conventional methods have limited impact" "Dengue prevention and control depends on effective vector control measures. Sustained community involvement can improve vector control efforts substantially".

Recently (September 7th, 2020) WHO reported that "a three-year trial in Indonesia has produced encouraging results that show a significant reduction in the number of dengue cases. It involved the release *Wolbachia*-infected *Aedes aegypti* mosquitoes in and around the dengue-endemic city of Yogyakarta". *Wolbachia* is known for its impact in the relation mosquito-virus [7].

For WHO (loc.cit.) all new tools that demonstrate public health value against dengue and similar viruses will be a welcome addition to the vector control arsenal.

According to some clinical issues of the dengue vaccine (see Annex 1) is limited to "only persons with evidence of a past dengue infection would be vaccinated".

The Dengvaxia vaccination program run for schoolchildren in Philippines was suspended in November 2017 and the Department of Health banned the vaccine's use in the country.

Therefore dengue control relies still on vector control and some points deserve special attention: conventional methods have limited impact; all new tools will be welcome and operational researches are needed, sustained community involvement is crucial. These points fuel our reflexion to deal with these issues.

2.3 Chikungunya (CHIKV) Virus

This virus is transmitted by *Aedes aegypti* and *Aedes albopictus*, both species can also transmit other mosquito-borne viruses, including dengue and Zika fever viruses; their control will thus have an important impact on the transmission of several diseases at the same time [8].

According to WHO Fact sheet (September 15th 2020) "Since 2004, Chikungunya has spread rapidly and been identified in over 60 countries throughout Asia, Africa, Europe and the Americas". "Over 2 million cases have been reported since 2005". 2010 saw the virus continue to cause illness in South East Asia; major outbreak in 2015 affected several countries of the Region of Americas", "due to the challenges in accurate diagnosis for chikungunya, there is no real estimate for the number of people affected by the disease globally on an annual basis".

For Gao et al., [9] "In recent years, this disease has become a global public health problem. However, there is no licensed vaccine available for CHIKV. Accumulating research data have provided novel approaches and new directions for the development of CHIKV vaccines".

For Reyes-Sandoval [10] "despite this re-emerging disease has been documented in more than 100 countries in Europe, Oceania, Africa, Asia, the Caribbean, South and North America, no licensed vaccine is yet available to prevent CHIKF. Nevertheless, various developments have entered phase I and II trials and are now viable options to fight this incapacitating disease". His "review focuses on the development of CHIKV vaccines that have reached the stage of clinical trials since the late 1960s up until 2018".

Still according to the same WHO Fact Sheet (loc.cit.) "the proximity of mosquito vector breeding sites to human habitation is a significant risk factor for chikungunya as well as for other diseases that *Aedes* mosquito species transmit.

At present, the main method to control or prevent the transmission of chikungunya virus is to combat the mosquito vectors. Prevention and control relies heavily on reducing the number of natural and artificial water-filled container habitats that support breeding of the mosquitoes. This requires mobilization of affected and at-risk communities".

2.4 Zika

According to WHO Fact Sheet of July 20th 2018 Zika virus is also transmitted by *Aedes*, the same as vector of dengue, chikungunya and yellow fever and the control of the vector induces the control of several arbovirus on the same time. On the other hand it has to be noticed that Zika virus is also transmitted from mother to foetus during pregnancy (inducing congenital malformations, preterm birth and miscarriage), through sexual contact, blood transfusion and organ transplantation.

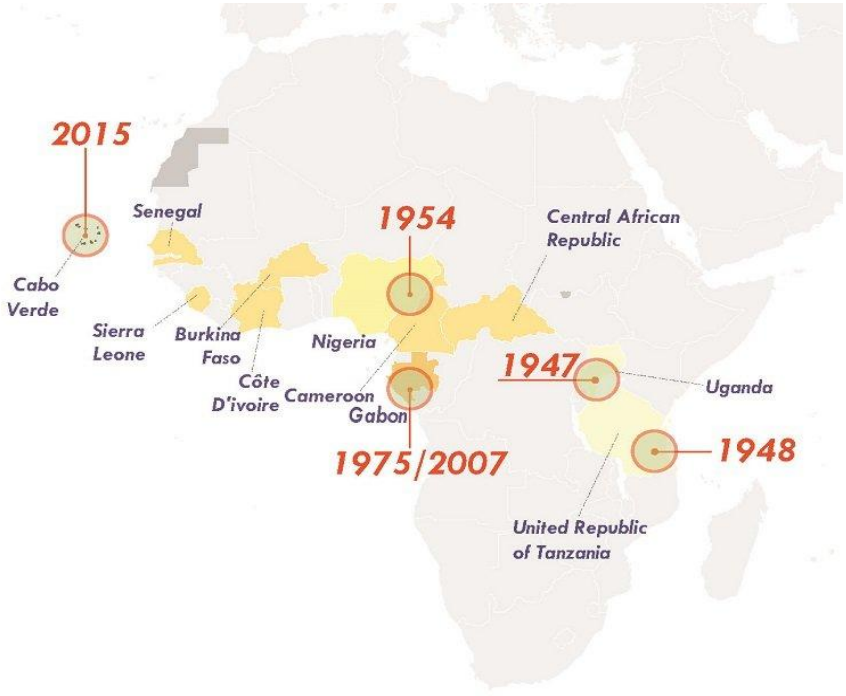
As reported by WHO "In October 2015, Brazil reported an association between Zika virus infection and microcephaly. Outbreaks and evidence of transmission soon appeared throughout the Americas, Africa and other regions of the world [11,12,13,14,15,16,17,18].

To date a total of 86 countries and territories have reported evidence of mosquito-transmitted Zika infection. No vaccine yet available for the prevention…development of a Zika vaccine remains an active area of research".

As of July 2019, a total of 87 countries and territories have had evidence of autochthonous mosquito-borne transmission of Zika virus (ZIKV) [19].

Prevention is based upon personal protection against mosquito bite but also by vector control such as larval control, actually "*Aedes* mosquitoes breed in small collections of water around homes, schools, and work sites. It is important to eliminate these mosquito breeding sites, including: covering water storage containers, removing standing water in flower pots, and cleaning up trash and used tires. Community initiatives are essential to support local government and public health programs to reduce mosquito breeding sites. Health authorities may also advise use of larvicides and insecticides to reduce mosquito populations and disease spread." [19].

Zika virus was reported from Africa (Map 1), SE Asia (Map 2), the Americas (Map 3) (WHO, February 7th 2016, "The history of zika virus").



Map 1. Zika virus in Africa

Map 2. Zika virus in SE Asia

Map 3. Zika virus in the Americas

In Indonesia, a retrospective population-based serosurvey found approximately 9% of children had evidence of prior ZIKV infection by the age of 5 years [20].

Case example of several arbovirus outbreaks in the same country: Angola.

In addition to malaria, Angola suffered recently of several vector-borne diseases such as yellow fever, dengue [21,22] and Zika [23] and some case of Chikungunya.

Yellow Fever (YF): for Ahmed and Memish [24] "the current YF outbreak in Angola began in December 2015 in the capital Luanda and by October 2016 there had been > 4300 suspected cases, with 376 deaths (case fatality rate = 8.8%). A total of 884 were laboratory confirmed but it is likely that case numbers may be seriously underestimated. YF has subsequently quickly spread to neighbouring Congo and further afield to Kenya and also China, this being of grave concern as this was a first introduction of YF to Asia. YF has recently hit Brazil, with 555 suspected cases and 107 deaths reported by the end of January 2017. Extremely rapid unplanned urban migration in Africa by non-immune rural populations to already densely populated cities, where high densities of mosquitoes co-exist with city dwellers in makeshift flimsy accommodation, poses a ready recipe for an epidemic of massive proportion.

Dengue: for Sharp et al. [22] "during the 2013 epidemic, the Angola Ministry of Health was notified of a total of 1,214 dengue case-patients, nearly all (98%) of whom resided in the capital, Luanda" and they considered that their "findings suggest that the 2013 dengue epidemic was larger than indicated by passive surveillance data". Biological analyses showed "that the Angola outbreak was most likely caused by an endemic virus strain that had been circulating in West Africa for many years. (15) demonstrating regional endemicity of dengue and actual risks of outbreak if *Aedes* control measures are not regularly taken. This regional presence of dengue virus in the region is threatening.

In Angola "An outbreak of dengue-like disease was observed in Luanda, Angola, at the end of 1970 and beginning of 1971. Chikungunya virus was isolated from the blood of a patient with typical symptoms of dengue and from a pool of Aedes aegypti mosquitos. A survey for antibodies to arboviruses in the sera of persons living in Luanda showed that the Chikungunya virus was indeed responsible for the outbreak. The fact that this outbreak immediately preceded and continued concurrently with a yellow fever epidemic in Luanda shows that two arboviruses from different antigenic groups may circulate simultaneously in the same ecological area" [25].

In his thesis (http://hdl.handle.net/10362/57140) "dengue e chikungunya: arboviroses emergentes en Angola" to the Instituto de Higiene e Medicine Tropical, Marques (2017) used molecular biology techniques on blood samples collected in 2012 and 2015 and reported one "concomitant positivy for Dengue (AgNS1+) and Chikungunya in the first survey then 28 cases of concomitant positivity for malaria and Chikungunya and 4 cases for malaria and Dengue.

3. RESULTS

3.1 Trial in Lobito, Angola

3.1.1 First conception and trial of the "Very Simple Ovitrap"

Looking for the presence of *Aedes aegypti* in parts of Lobito we prepared what was called "Very Simplified Ovitrap" based on a simple domestic black plastic bucket (picture) with 3 l of water of a close river, we added some grass collected around the bucket and some piece of polystyrene (picture).

These traps are situated in areas which seemed suitable for *Aedes* (dark, quiet places) and leave with poster to ask people "do not disturb".

We had 2 actions:

- immediately collect the pieces of polystyrene and transfer them in the laboratory, to get larva and adults and make their specific determination;
- wait few days with regular check every day until larva are observed in the bucket (picture) to see if they are viable in these conditions and developed as usual, then transfer the ovitrap in the laboratory, empty them getting larva (picture) maintained in rearing to have adults to do their specific determination and some classic insecticide tests (unpub.).

Adult determination showed the presence of *Aedes aegypti* on several places of the town where entomological surveys were already made looking for *Anopheles* and malaria risks [26].

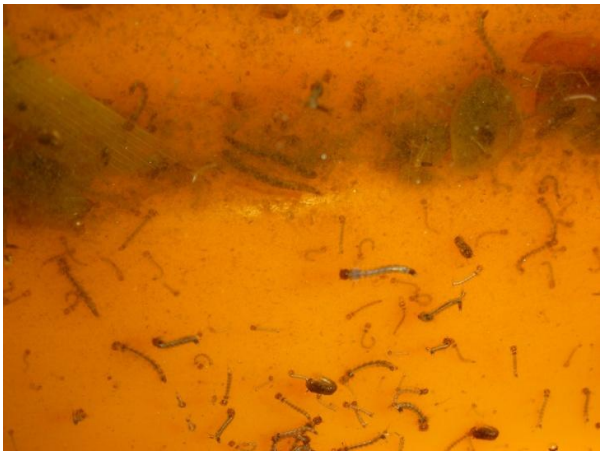
Pic. 1. Preparation of the "Very Simplified Ovitrap" (picture PC)

Pic. 2. Example of the very simplified ovitrap (picture PC)

Pic. 3. In few days several eggs are visible of the polystyrene blocs

Pic. 4. Eggs are visible of the polystyrene blocs.

Pic. 5. Collecting water from the bucket (PC)



Pic. 6. Example of sample with larva (and even some pupa) collected from a Very Simplified Ovitrap in Lobito

Then the bucket was filled again with water, grass and polystyrene for further sampling either at the same place to study the evolution of the population or in other places to determine the "at risk" areas.

A great lot of such trials showed that such "Very Simplified Ovitraps" were actually functional to attract gravid females without any chemical and to obtain eggs.

Using such locally made "very simplified ovitraps" then adult determination showed the actual presence of *Aedes aegypti* in several parts of Lobito town, in both upper and lower part (unpub. obs.) and the risk of outbreaks [22].

3.1.2 From a very simple ovitrap (VSOp) to a Vector control ovitrap VCOp

We prepared lots of 2 Very Simple Ovitraps, exactly the same, placed side by side: One was the VSOp (see above) and in the other one we introduced 1 ml of *Bacillus thuringiensis* (locally procured from the Cuban team of researchers) in the 3 l of water and the ovitrap became a new "Vector Control Ovitrap" (VCOp). A regular check was done looking for eggs and larva in both ovitrap.

2 trials were done: one in the Sonamet© Yard (Angolese company which supported the trial) and one in the Lobito town (in the house of Sonamet workers).

During 4 years trial done on the Sonamet Yard (Table 1a):

- we counted 838 eggs and 330 larva in ovitraps without *Bt* showing that our very simple ovitrap once again attracted gravid females and procured viable eggs and larva;
- we counted 844 eggs on polystyrene of ovitraps with *Bt* (i.e. almost same number of eggs as in bucket without *Bt* which confirmed that attractiveness of ovitrap were similar), but not a single larva showing the efficacy of such "*Bt* furnished ovitraps" which thus could be considered as an additional tools for *Aedes* control.

The same trial was done in Lobito town (Table 1b) and it appeared that:

- in ovitraps without *Bt* we collected 533 eggs and 99 larva;
- in closed ovitraps with *Bt* we collected 562 eggs (i.e. almost same number of eggs as in traps without *Bt*) but not a single larva of *Aedes* during the 4 years of the trial.

Adding few drops of *Bacillus thuringiensis* appeared of great efficacy and makes the ovitrap as a new simple and promising vector control tool.

3.1.3 First trial of the Foldable simple ovitrap "FSOp"

Considering the proved efficacy of our very simple ovitrap system but the size of the bucket which could limit the number transported to be installed in focal or at risk places we though how to get an easier model of container and we found the foldable one already commercially available for example for camping etc.

We tried some of them of different size and color, with water, grass and polystyrene blocks (picture) in unfold container; several trials showed that their attractiveness was maintained as we found eggs of *Aedes aegypti* on polystyrene. After their use the container can be fold, stock somewhere for further trials taking few places for their stockade showing their efficacy and operational advantages.

3.2 Trials in Bali

In Bali we tried a lot of such simple foldable ovitraps, of different size and color, installed among the vegetation, under banana trees and different other places of the large garden of a house in Batuan-Sukawati (pictures).

Table 1a. Sampling obtained with ovitrap with or without *Bacillus thuringiensis* in Yard area

Lobito Yard	Ovitrap with *Bt* eggs	(= VCOp) larva	Ovitrap without *Bt* eggs	(= VSOp) larva
Year 2014	130	0	121	72
Year 2015	234	0	244	86
Year 2016	248	0	228	38
Year 2017	232	0	245	134
total	844	**0**	838	330

Table 1b. Sampling obtained with simple ovitrap with or without *Bacillus thuringiensis* in the town

Lobito town	Ovitrap with *Bt* eggs	= VCOp larva	Ovitrap without *Bt* eggs	= VSOp larva	Nb sessions
Year 2014	4	0	2	0	2
Year 2015	87	0	85	0	15
Year 2016	289	0	277	51	42
Year 2017	182	0	169	48	17
total	562	**0**	533	99	76

Pic. 7. Exemple of a simple foldable ovitrap, with water, grass and 2 blocks of polystyrene tested in Angola

Pic. 8. Example of container fold

With 25 consecutive trials, during 2 consecutive years, for each model, we collected eggs and larva which were reared till adult stages, their determination confirmed the presence of *Aedes albopictus* in that area. Preliminary insecticide tests showed some resistance which is matter of concern (unpb.data).

Eggs were noticed on polystyrene of each foldable ovitrap tested whatever the size and the color, the key point is the shadow place.

It is clear that such simple, cheap, locally made "ovitrap trap for vector control" could be promoted and used at large scale at family and community level according to their feasibility and operational advantages as ecologically sound with no risk of pollution.

They could be used for operational researches such as evaluation of risks of arbovirus outbreaks or for evaluation of vector control activities such as space sprays.

Pic. 9. Container unfold

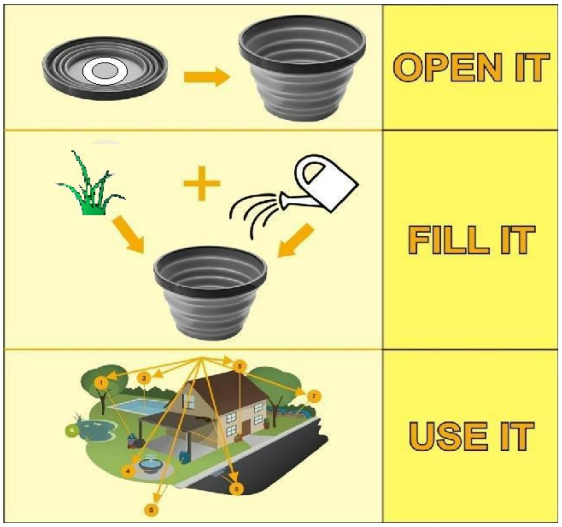
One of the blue one

Pic. 10. Examples of small and large size and color Foldable Ovitraps in place in a garden in Bali, under banana tree or vegetation etc, pink one, green one, blue one foldable container

4. THE NEWCONCEPT OF A FOLDABLE KILLING OVITRAP (FKO) FOR *AEDES* CONTROL AT COMMUNITY LEVEL

From these positive experiences against *Aedes aegypti* in Africa and *Aedes albopictus* in Asia and the knowledge of the biology of these vectors we develop a new concept of a foldable, light, *easy to use, ready to use*, and cheap model of ovitrap as a kit (see schema joined) which can easily be transported in great number everywhere to increase the coverage for both trapping and killing *Aedes* mosquitoes at community level.

They could be easily implemented inside as well as outside houses having no hazards risk at human and animals level, socially adapted as “locally” prepared for water and plants and with a long lasting killing action such as were prepared the well known Long Lasting Insecticide Treated Mosquito Nets (LLIN) Olyset© or Perma©Net and others [2,3].



Pic. 11. The "how-to-use" shows how easy it is to implement in 3 steps the Foldable Killing Ovitrap: Open it – Fill it – Use it

The Killing Ovitrap kit includes:

- 1 folded black silicone bucket
- 1 ring of IGR or *B.t*. impregnated substratum (already inside and in place in the bucket) which could be refilled as a ball point pen

1 "how to use" document

Using local water (rain or river) and local plants (as attractive) and no chemical risk as it is fitted with the recommended *Bacillus thuringiensis* (*B.t.*) it is "*environmentally-friendly*" (as we know that *B.t.* was already largely used in river for the Onchocerciasis Control Programme "OCP" in West Africa and currently in space spray against *Aedes caspius* in France) and there is no "*excess waste material*" as refill is made by local products (water, plants).

The concept of this innovative *Foldable Killing Ovitrap* is simple: a half-liter *foldable* black plastic container (such as those used for backpack travelers) but size of 1 or more liter can be developed with the same foldable system. It is half filled with rainwater (or river water) with some local leaves to constitute a *natural attractive trap* for gravid *Aedes aegypti* or *Ae. albopictus* gravid females, which come to lay eggs on the edge of water. At the same time females could touch this place with *Bt* (or PPF) and then disseminate the product to other breeding sites, natural (tree holes etc) or man-made increasing the action at a larger scale

The key element of the new "Foldable Killing Ovitrap" is a size and shape adapted round piece of extruded polystyrene (or other substrat) which is previously placed inside the "cup" and is already impregnated with either *B.t.* or an Insect Growth Regulator "IGR" (such as pyriproxyfen, PPF) (as recommended by CDC), previously prepared for that purpose and with a long lasting diffusion such as Long lasting impregnated mosquito nets LLIN "Olyset"® where permethrin is inside the polyethylene fiber with a slow diffusion of the product and which can be easily changed almost every month/5 weeks (see Annex 2).

In such Foldable Killing Ovitrap, young larvae emerging from eggs laid by the gravid females will thus be immediately in contact with the *Bt* or IGR and will die, actually reducing the density of *Aedes* population of places receiving the trap without any chemical contamination of environment, without insecticide selective pressure, without any trouble in human population who will appreciate this kind of traps so easy to be implemented and rapidly perceiving the reduction of painful bite of annoying day biting *Aedes* mosquitoes.

Actually the Foldable Killing Ovitrap can easily be scaling up due to its remarkable feasibility, low weight, foldable, transportable, cheap, no plug needed, no special attractant or CO_2 needed and long lasting efficient, ready to use and therefore so easy to use at familial and communities level.

According to the worsening situation of arbovirus outbreaks new tools are needed to increase their efficacy with actual communities participation thanks to easy to use-ready to use such kits of long lasting and foldable killing ovitraps.

Example of a large size foldable ovitrap

DETAILS: 10L capacity water tank | Diameter: 35 cm | Height: 35 cm (unfolded) / 5.5 cm (folded) | Materials: TPR rubber and plastic PP | Weight: 570 g.

5. DISCUSSION

Outbreaks of arbovirus, yellow fever (in spite of vaccine), dengue (with the issues of Dengvaxia), Chikungunya, Zika (with its impact on pregnancy and microcephaly) clearly emphasized the need for vector control with new tools as recommended by WHO. An interesting entomological point is the fact that same vectors, say Aedes aegypti or Aedes albopictus, can transmit several virus, therefore controlling the mosquitoes means controlling 2 or more virus at the same time.

Pic. 12. Some commercial ovitraps foldable « domestic » container

Pic. 13. Commercially available tablets

Pic. 14. Example of an autocidal gravid ovitrap

Another interesting entomological information is given by the biology of larva, as reported by Service [1] "*Aedes albopictus*, vector of dengue in South-east Asia (and other places), resembles *Ae. aegypti* in breeding principally in domestic containers" i.e. close to human habitation, increasing the contact human beings/mosquitoes and thus the risk of transmission, but also improving the possibilities of control by community themselves if available methods of control are not only efficient but also cheap, easy to implement, scalable without environmental impact while obviously space spraying of insecticide could be deleterious and done only by specialists.

A great lot of model of ovitraps were developed from the simple "bamboo pots" [27,28]; to the recent sophisticated one (Annex 2) which are efficient but should be expensive or need special attractant (pheromone) or source of CO_2 or olfactory clues or electric plug which could not be available or present everywhere, for example in suburbs areas.

"During the first three years of the US *Aedes aegypti* Eradication Programme which began in 1964, ovitraps were developed for detecting the presence of *Aedes aegypti*." [29]. Classical black jar ovitrap were extensively used in America and elsewhere, "each trap consists of a glass jar painted glossy black on the outside, 3 in in diameter at the top, about 5 in high with tapered sides and having a capacity of about 1 pint. Water to a depth of about 1 in is added to the jar and a ¾ in wide, 5-in long hardboard having a smooth and rough surface is attached vertically with a paper clip to the inside of the jar" [29].

An interesting behaviour of the gravid females is that they deposited a few eggs in each breeding site and therefore they could take some "products" on their legs and thus could disseminate eventual "chemical" introduced in ovitraps and "contaminate" other breeding sites, natural or artificial.

According to the CDC document "Surveillance and Control of *Aedes aegypti* and *Aedes albopictus* in the United States" "Ovitraps have several advantages, including being inexpensive, easily deployed, and not invasive. A small number of ovitraps is usually enough to determine vector presence; less than 100 ovitraps can reliably estimate abundance in a large urban neighborhood [30]. Typically, one ovitrap is placed per city block. Lastly, ovitrap data is easy to analyze; it is usually expressed as

the percentage of positive ovitraps (ovitraps with eggs). The mean number of eggs per ovitrap can be used to estimate adult mosquito abundance". It is reported in the same document that "some ovitraps are specifically designed not to produce mosquitoes [31,32,33,34] and called "autocidal ovitrap".

The concept of using ovitrap principle for control was applied to develop Autocidal Gravid Ovitrap (AGO) to attract and capture gravid specimen of *Aedes aegypti* [34].

AGO traps consist of three primary components of 9 elements (see description in Mackay et al., [34]) but the size of the pail (19 l) must be noticed.

Such AGO traps were tested in some localities 20 kms apart from Porto Rico and it was concluded that "AGO traps seem to be effective tools to suppress outbreaks of *Ae. aegypti* in the study areas".

Moreover its entomological efficacy it must be noticed the potential operational issues due to the size of the pail and all the equipment of the trap which could limit its large scale use at community level.

Such autocidal gravid ovitrap was recently modifying adding fan and lures [35] or "incorporating BG lure or BG lure + octenol" [36] to increase their efficacy.

6. CONCLUSION

We adopt the concept of autocidal ovitrap for *Aedes* control but we conceived and proposed a very simple, very cheap ovitrap for an "easy to use" at community level and which must be presented as a *kit* already prepared in a foldable container to save place and with a tablet of *Bacillus thuringiensis* or an insect growth regulator such as pyriproxyfen and ready for use: open it/fill it/use it.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Annex 1

Some information about the Dengue vaccine

(Long story which is not the purpose of our article).

For WHO:

The first dengue vaccine, Dengvaxia® (CYD-TDV) developed by Sanofi Pasteur was licensed in December 2015 and has now been approved by regulatory authorities in ~20 countries. In November 2017, the results of an additional analysis to retrospectively determine serostatus at the time of vaccination were released. The analysis showed that the subset of trial participants who were inferred to be seronegative at time of first vaccination had a higher risk of more severe dengue and hospitalizations from dengue compared to unvaccinated participants. As such, use of the vaccine is targeted for persons living in endemic areas, ranging from 9-45 years of age, who have had at least 1 documented dengue virus infection previously.

WHO position on the CYD-TDV vaccine

As described in the WHO position paper on the Dengvaxia vaccine (September 2018) the live attenuated dengue vaccine CYD-TDV has been shown in clinical trials to be efficacious and safe in persons who have had a previous dengue virus infection (seropositive individuals). However, it carries an increased risk of severe dengue in those who experience their first natural dengue infection after vaccination (those who were seronegative at the time of vaccination). For countries considering vaccination as part of their dengue control programme, pre-vaccination screening is the recommended strategy. With this strategy, only persons with evidence of a past dengue infection would be vaccinated (based on an antibody test, or on a documented laboratory confirmed dengue infection in the past). Decisions about implementing a pre-vaccination screening strategy will require careful assessment at the country level, including consideration of the sensitivity and specificity of available tests and of local priorities, dengue epidemiology, country-specific dengue hospitalization rates, and affordability of both CYD-TDV and screening tests.

Vaccination should be considered as part of an integrated dengue prevention and control strategy. There is an ongoing need to adhere to other disease preventive measures such as well-executed and sustained vector control. Individuals, whether vaccinated or not, should seek prompt medical care if dengue-like symptoms occur.

According to CDC “A vaccine to prevent dengue (Dengvaxia®) is licensed and available in some countries for people ages 9-45 years old. The World Health Organization recommends that the vaccine only be given to persons with confirmed prior dengue virus infection.

The vaccine manufacturer, Sanofi Pasteur, announced in 2017 that people who receive the vaccine and have not been previously infected with a dengue virus may be at risk of developing severe dengue if they get dengue after being vaccinated.

Annex 2

Some commercial ovitraps*

(no advertising, comparable advertising are forbidden, these informations are showed just as "indication" of some commercially available ovitraps and are not endorsed by authors)

Peer-review history:
The peer review history for this paper can be accessed here:
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