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〈Note〉

Development of a Catch Basin Sump Insert to Reduce Mosquitoes

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Abstract - A catch basin sump is one major habitat for mosquito larvae, especially in urban areas. This study developed a device for mosquito control, specifically for the catch basin sump. It consists of a housing, is a little smaller than the catch basin sump, numerous floating materials, which the key component for mosquito control, and mesh nets. The small balls or pyramid-shaped floating materials inhibit mosquito enclosures and spawning by significantly decreasing the surface area of the water, which is essential for the mosquito life cycle. These floating materials were designed to keep the water flowing. The mesh nets were installed to prevent the outflow of floating materials. The efficiency of the floating materials was tested with 3 conditions (1, 2, 3 layers of floating materials) and a control group. The emergence of mosquito adults decreased by 20% in one-layer, and 70-80% in second and third layers. Therefore, this device is expected to certainly contribute to mosquito population control in the catch basin sump.

Keywords : catch basin sump, control, device, larval control, mosquito

INTRODUCTION

For more than 100 years mosquitoes have been known to develop in water collected in catch basins during storms (Stockwell *et al*. 2006; Allen and Shellito 2008; Harbison *et al*. 2010; Metzger *et al*. 2011, 2012). *Culex pipiens* and *Cx. restuans* are important in the transmission of West Nile Virus (WNV) in urban areas of the northeastern USA (Andreadis *et al*. 2001; Tedesco *et al*. 2010). They develop until the attainment of adulthood in relatively large numbers in catch basins (Anderson *et al*. 2006). Moreover, specific mosquito species (Genus *Aedes*) are known to occur inside catch basins (Andreadis *et al*. 2001; Andreadis and Wolfe 2010).

In order to control mosquito occurrence in catch basins, chemical control methods are mainly implemented using *Bacillus thuringiensis israelensis* (Bti), *Bacillus sphaericus* (Bs), or Spinosad, which is a mixture of two neurotoxins produced during fermentation by *Saccharopolyspora spinosa* (Andreadis *et al*. 2001). Although the efficiency of chemical control is regularly examined (Stockwell *et al*. 2006; Anderson *et al*. 2011), the effect of applying theese control measures continuously has not been tested in detail. This requires repeated regular control, but a regular examination is not a fundamental solution to mosquito incidence. Therefore, the present study developed an effective mosquito control device based on the habits of the mosquito larvae and adult mosquitoes. We tested the device inside catch basin sump, which prevents (pupa emergence/emergence of adult/eclosion) and the spawning of adult mosquitoes, aiming to essentially eradicate mosquito occurrence in catch basin sump.

DEVELOPMENT OF DEVICE AND COMPONENTS

This device reduces the open water surface of the catch basin sump using deposits in order to ultimately inhibit the

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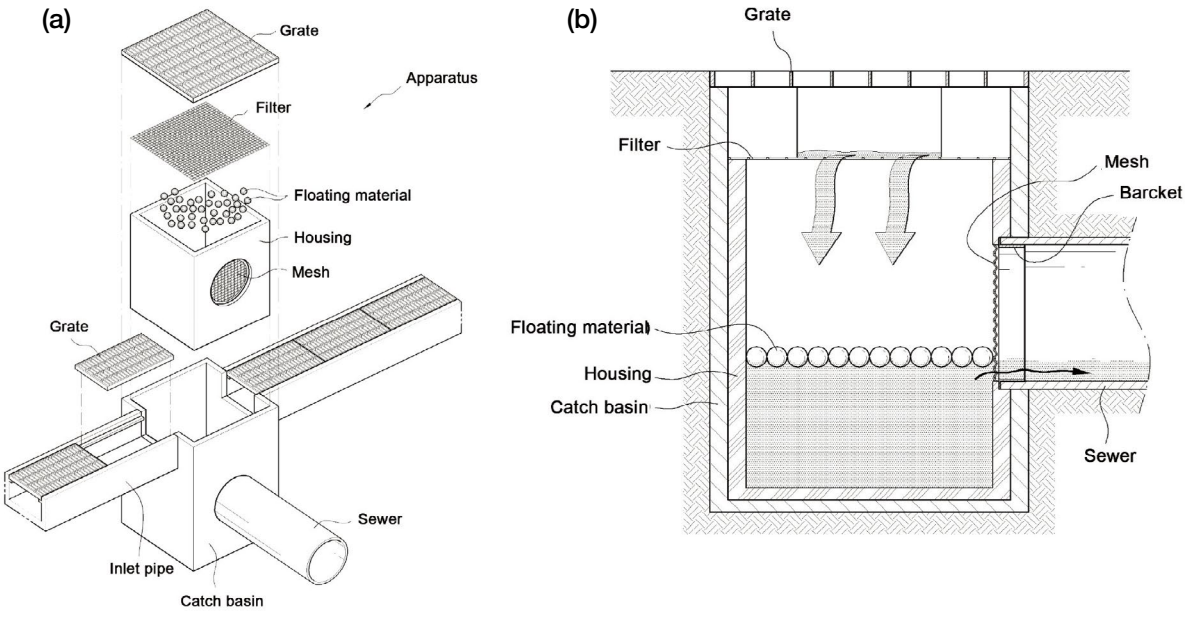

Fig. 1. Mosquito control device (a) overview, (b) sectional view.

eclosion of adult and spawning. It consists of a housing that harbors floating materials for the inhibition of mosquito occurrence, and mesh nets for preventing the loss of floating materials.

A cubic housing was produced, which was slightly smaller than the existing catch basin sump, and was inserted inside it for installation. The concrete size of the housing cube was designed to be flexibly adjusted according to the form and size of the target catch basin. The height of the housing is designed to be lower than the upper inlet pipe through which the water flows in, in order to ensure smooth drainage. There was an area connected to the sewer, which was of the same size as that of the connected sewer. High-density polyethylene (HDPE) was used for the housing material considering its durability, sludge management, and easy cleaning (Fig. 1).

Floating material (e.g., Styrofoam) is the key factor determining the success of this device. This material should reduce the area of open water surface to an extent that does not interfere with the flow of catch basin and sewer. Therefore, a large quantity of floating material smaller than fluid (water) was put in in order to form a layer of floating material. Minimizing pores interferes with the incubation of mosquito larvae. The size of the floating material produced was 10 mm in diameter in order to ensure smooth sedimentation

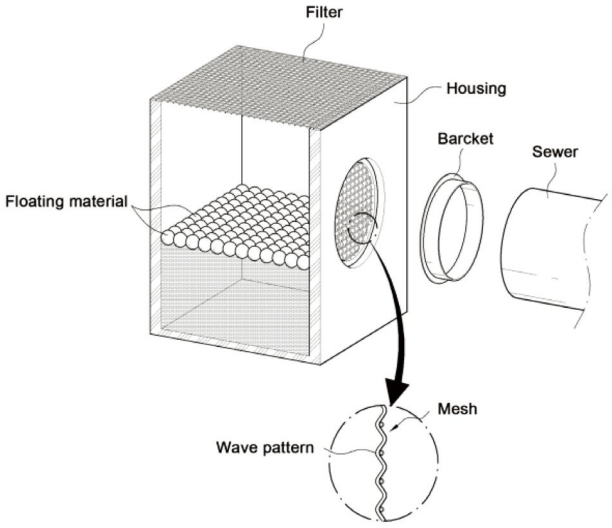

Fig. 2. Detailed diagram of the mosquito control device.

of fluid and foreign substances. The material was either globose or pyramid in shape. As for the pyramid-shaped material, a pendulum was attached to the vertex inside, and its bottom face was designed to cover the fluid surface. When necessary, the size of the floating material could be varied to minimize the pores in the floating body, and the horizontality of the arrangement was maintained using the mesh wrapping the floating materials.

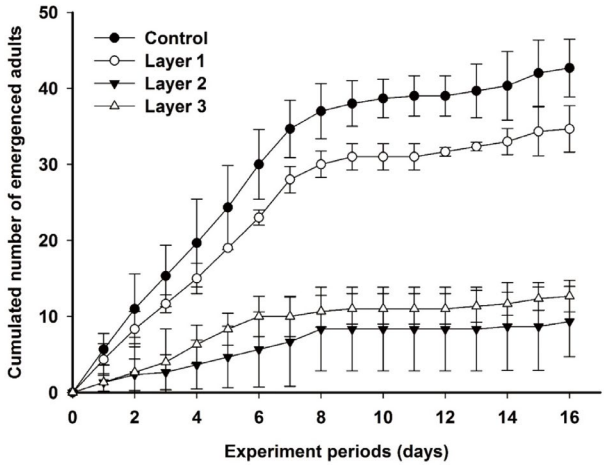

Fig. 3. Cumulative number of *Aedes ablopictus* emerging.

Two areas requiring mesh net in this device: 1) the connection between the sewer and housing to prevent the loss of the floating matter through the sewer, and 2) the top of the housing to prevent the floating material from flowing out due to rising water level caused by precipitation. The top of the mesh was designed as a simple sheet. The mesh size was determined to be as large as possible to an extent that did not allow the floating mater to flow out, in order to facilitate the filtration of water and other foreign substances. The mesh was made with iron to ensure its durability and strength. For the sewer, wavy mesh was produced to prevent the floating material from accumulating on the mesh and impeding the water flow. A filter net can be placed on the top of the housing to filter sludge if needed (Fig. 2).

LABORATORY TEST

In order to test the effectiveness of our device in mosquito control, an indoor experiment was conducted using the key components. 50 individual larvae of *Aedes albopictus* (25 individuals each of the third and fourth instar) were put inside a square plastic container [28 cm × 17 cm × 18 cm (L × W × H), water level: 8 cm] to observe adult emergence. The experiment was conducted under different conditions: without floating materials (control) and with floating materials in one, two, or three layers. The number of emerged adults and the duration of eclosion were compared with three replicates for each conditions. Out of the two types of floting material, only spherical styrofoam balls (10 mm in diameter) were used for this test. The number of emerged adults was calculated 24-hour after starting the experiment. The experiment continued until there was no living larva left after eclosion or death. The experiment data were analyzed by ANOVA using the SPSS statistic program.

It took 16 days for all larvae to either eclose or die. An average of 42.7 adults emerged in the control group. In the device with floating materials in one, two, and layers, an average of 34.7, 9.33, and 12.7 emerged, respectively (Fig. 3). Even a single layer of floating materials showed approximately 20% of eclosion prevention as compared with that of the control ($p < 0.05$). When there were two or more layers of floating material, the prevention effect increased to 70−80%. The average number of emerged adults was smaller in the two-layered than in the three-layered condition; however, there was no statistically significant difference ($p > 0.05$).

CONCLUSIONS

This device is expected to effectively reduce mosquitoes if used in natural setting. Mosquito control in a natural environment may have many variables, but this device test results show that 20% of eclosion prevention can actually have a 120 times effect on the next generation of mosquito control. The mosquitoes (*Aedes albopictus*) used in the experiment lay an average of eight eggs, and about 150 eggs a time. Genarally, mosqiuto lay more than 13 times on average, the mosquito control effect on this device may be higher. Additionally, adding layers of floating material provides up to 80% mosquito control, which is more effective than using chemical control.

With mosquito control, if pollutant adsorbent material is coated over the surface of the floating material, it will further reduce additional pollutants flowing into rivers in the vicinity through sewer pipes, because the adsorbent will adsorb non-point source pollutants flowing in from the roads (oil and tyre dust) in the event of rain. Therefore, managing the catch basin sump with our device will significantly help in controlling mosquitoes continuously in a more environment friendly manner.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

We received mosquitoe species from the Korea Centers for Disease Control and Prevention (KCDC) for experiments.

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