Hornet *Vespa Velutina* Selective Capture by Air Entrainment

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I. INTRODUCTION

In a previous report, [1], the possibility for selective capture of *Vespa velutina* by the use of an air cannon was discussed. In this second report, we address the alternative possibility for selective capture of *Vespa velutina* by tackling the problem on the opposite side, i.e., by inducing aerodynamic entrainment -region of low pressure, and then sucking out the insect.

The idea is pictorially depicted in Fig. 1 which is almost self-explanatory: **(1)** an insect is traveling down to a bait , **(2)** after crossing a motion sensor a prompt-signal is triggered which open a vacuum valve which connect a chamber with the vacuum cartridge, and as a result aerodynamic entrainment occurs and the insect is pulled into the chamber which opening has a one-way valve. If the opening has the same diameter than the effective diameter of the bee, then bees or insects of similar size can pass through the cavity, however, the bigger Vespa velutina - which has a diameter almost 3 times higher than the bee, is, of course, unable to do this. **(3)** vacuum valve is close and the bee is inside the chamber, **(4)** the bee, however, can go out because a second one-way valve open freely in that direction.
Bearing the above simplified scheme, the key point is to know how many captures can be performed for a given vacuum cartridge before is necessary replace the cartridge.

To begin with, for the air entrainment to have an important effect on the bee, the energy density induced by the pressure difference must be comparable to the kinetic energy density of the bee, and after simple reckoning one obtains

$$p_o - p \approx \frac{\rho v_b^2}{2} \tag{1}$$

where p_o is the atmospheric pressure; p is the vacuum pressure (pressure inside the cartridge); ρ is the air density; and v_b is the velocity with which the bee is approaching and for conservative calculations it can be assumed as the maximum speed attainable by the bee ~ 5 m/s. Therefore the pressure inside the cartridge is given by

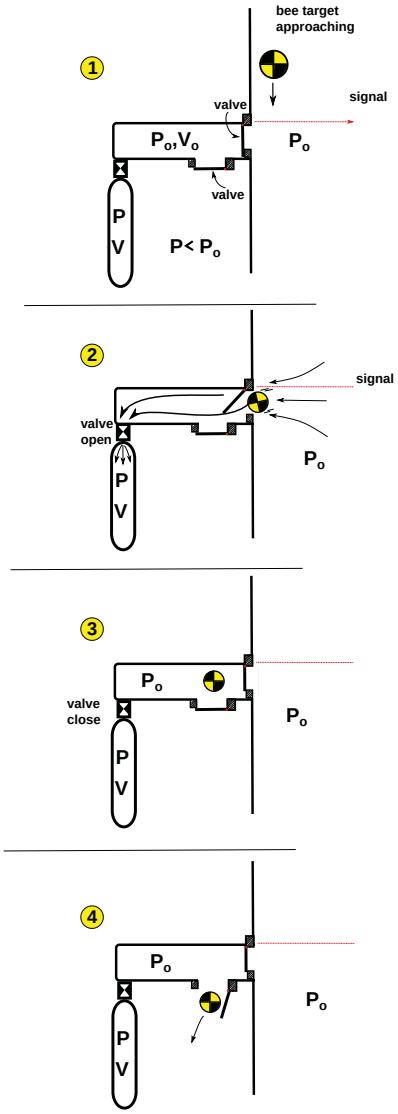

FIG. 1: Trapping by aerodynamic entrainment.

$$p \leq p_o - \frac{\rho v_b^2}{2} \tag{2}$$

Now, every time the vacuum valve is open and then concocting the chamber with the vacuum cartridge (sequence number (2) in Fig. 1), an amount of air sucked

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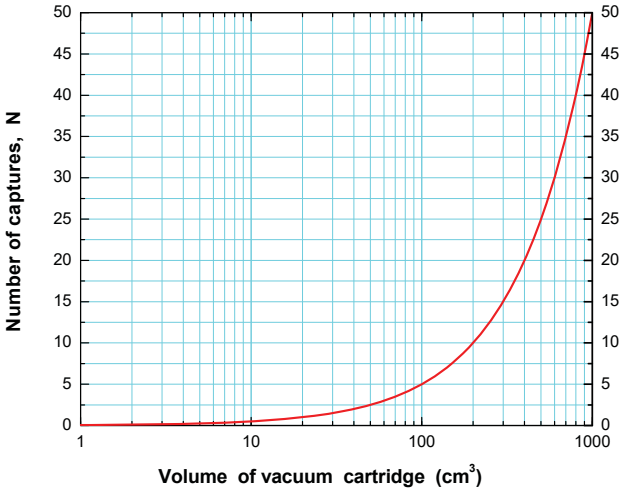

FIG. 2: Number of captures as a function of the volume of the vacuum cartridge

and introduced into the cartridge and therefore the cartridge is gaining pressure. Thus, the number of times the cartridge can be used (which is to say the number of captures) is up to the pressure inside the cartridge is higher than the pressure given by the relationship Eq.(2). This can be calculated as follows:

First, the volume of air sucked by the cartridge every time the vacuum valve is open must be at least in the order of the volume of the bee, say, V_b. Thus, if the initial pressure of the cartridge is $p \approx 0$ and the volume of the cartridge is V, the the pressure inside the cartridge after n-times the valve is open or which the same after n-captures, is given by

$$p = \left[\frac{p_o V_b}{V}\right] n \tag{3}$$

for $n \geq 0$. Therefore, the total number of captures N is given when the pressure is just $p_o - \frac{\rho v_b^2}{2}$ and yields

$$N \approx \left[1 - \frac{\rho v_b^2}{2p_o}\right] \frac{V}{V_b} \tag{4}$$

Fig. 2 shows the number of captures as a function of the volume of the vacuum cartridge. It is easy to see that the number of total captures is very small in comparison with the number of captures by using an air cannon, [1]. For example, a pressurized air cartridge would be able to produce around ≈ 350 captures for a cartridge 300 cm^3 volume and pressurized at 12 atms, [1], however, if air entrainment is used as discussed in this report, for a vacuum cartridge with the same volume the number of captures drop to 15 captures or thereabouts.

Acknowledgements

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II. REFERENCES

[1] Arias F.J; De Las Heras S. 2019. A method for selective hornet Vespa Velutina baited traps using a compressed air cannon. Report. Date. 2019-05-28.