

Ozone as a new control strategy for storage systems pest

Darija Lemic, Helena Virić Gašparić, Renata Bažok, Ivana Pajač Živković

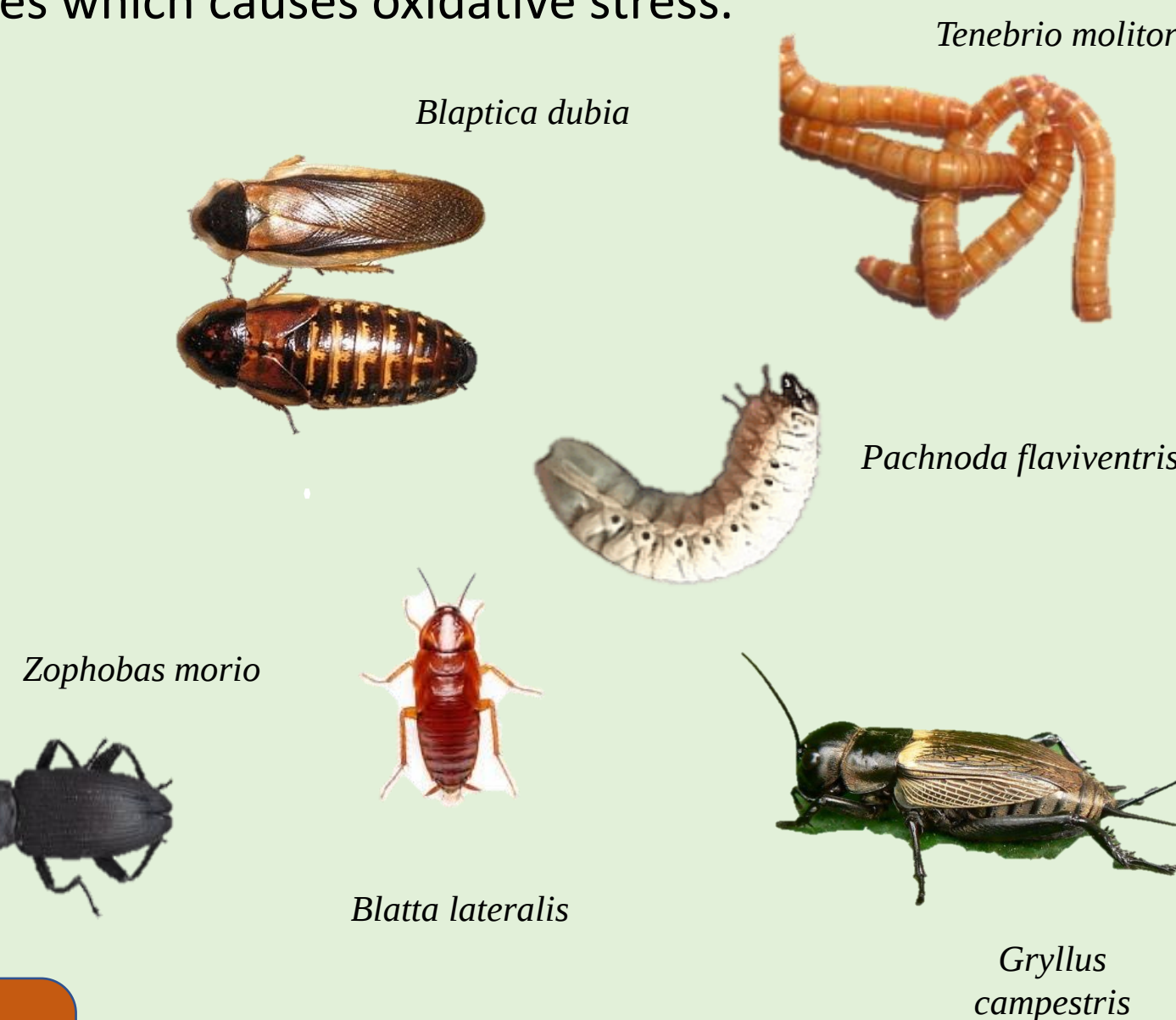
University of Zagreb, Faculty of Agriculture, Department for Agricultural Zoology, Svetosimunska 25, 10000 Zagreb; dlemic@agr.hr

Introduction

The main problem in food production is infestation of storage units with insect pests. Storage units (silos, containers) represent a perfect environment for insect development that includes protection from different atmospheric events, an infinite food source and living without disturbance (Pimentel, 1991). Having in mind the limitations in most of the methods for insect pest control in storage and transportation units and a high potential for resistance development towards insecticides (Zettler et al, 1989; Zettler and Cuperusi, 1990; Benhalima et al., 2004), development of modern methods is inevitable. **Ozone** usage as a method for insect pest management has shown a high potential (Leesch, 2003; Zhanggui et al, 2003; Isikber and Öztekin, 2009). Although the mechanism of ozone effect on insects is not clearly known, there are evidences of the respiratory system being the main target of its effect. Ozone is a gas with high reactivity and can make a remarkable damage on cell membranes which causes oxidative stress.

Materials & Methods

Tiens ozonator is used for ozonation. Power of the ozonator is 2.5 mg of ozone in a liter of water, meaning 0.001 ppm ozone per liter of air (Tiens, 2019).



Along with mortality, mobility and velocity were monitored

Species	Stage of development	Number of individuals treated during the research
<i>Sitophilus granarius</i>	Adult	480

Variants in the experiment (ozone exposure in minutes)	The total amount of ozone per variant (mg)	The applied concentration of ozone in air (ppm)
10 min	25 mg	0,0002
20 min	50 mg	0,0003
30 min	75 mg	0,0005
60 min	150 mg	0,001
90 min	225 mg	0,0015
120 min	300 mg	0,002
240 min	600 mg	0,004
360 min	900 mg	0,006
control	-	-

Species	Stage of development	Number of individuals
<i>Blatta lateralis</i>	Adult	280
<i>Blaptica dubia</i>	Adult	280
<i>Gryllus campestris</i>	Adult	280
<i>Pachnoda flaviventris</i>	Larvae	280
<i>Tenebrio molitor</i>	Larvae	280
<i>Zophobas morio</i>	Larvae	280

- The insect mortality and ozone efficiency was calculated based on the percentage of mortality.
- The efficacies of all variants were subjected to analysis of variance (ANOVA) to determine the difference in the effect of ozone on insects at different exposure times.
- ANOVA was performed on insect velocity and mobility data to determine the effect of ozone on the above parameters.

Monitored efficiency

Discussion and conclusions

- The larval stages are more resistant to ozone than the adult developmental stages of insects.
- In addition to mortality, ozonation has an effect on insect mobility and velocity (demonstrated in *Sitophilus granarius*). Increasing the duration of ozone exposure causes a decrease in insect mobility and velocity.
- For species where a low/no ozone effect was found, further studies with higher ozone levels and longer ozone duration are required.
- Ozone has a damaging effect on insects and could potentially be used for pest control, especially for pest control in storage systems.
- Since in this study the amount of ozone applied is related to the duration of ozonation, it is concluded that the efficiency of ozone treatment (mortality) increases with increasing ozone duration.

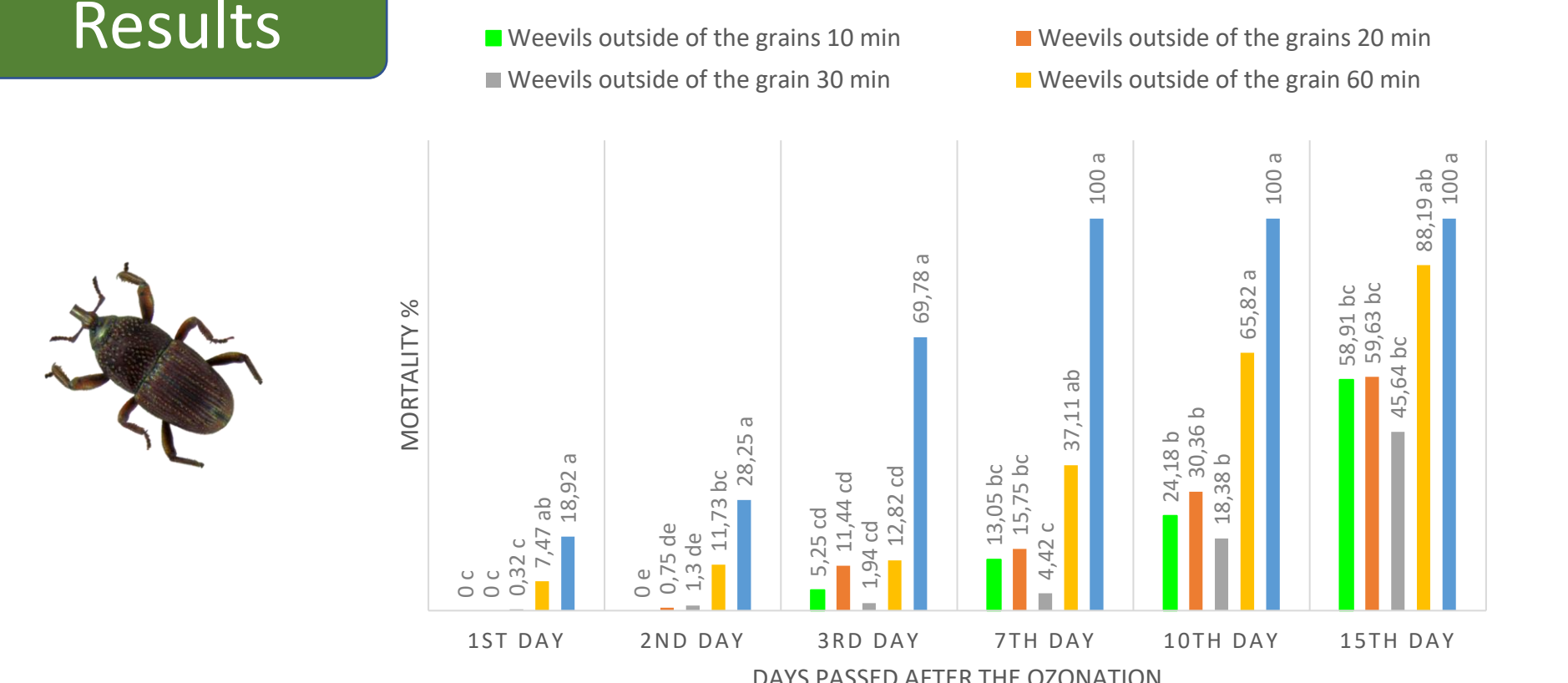
Research aims

The main aim of the paper is to define the efficiency of ozone as a fumigant in suppression of different insect species

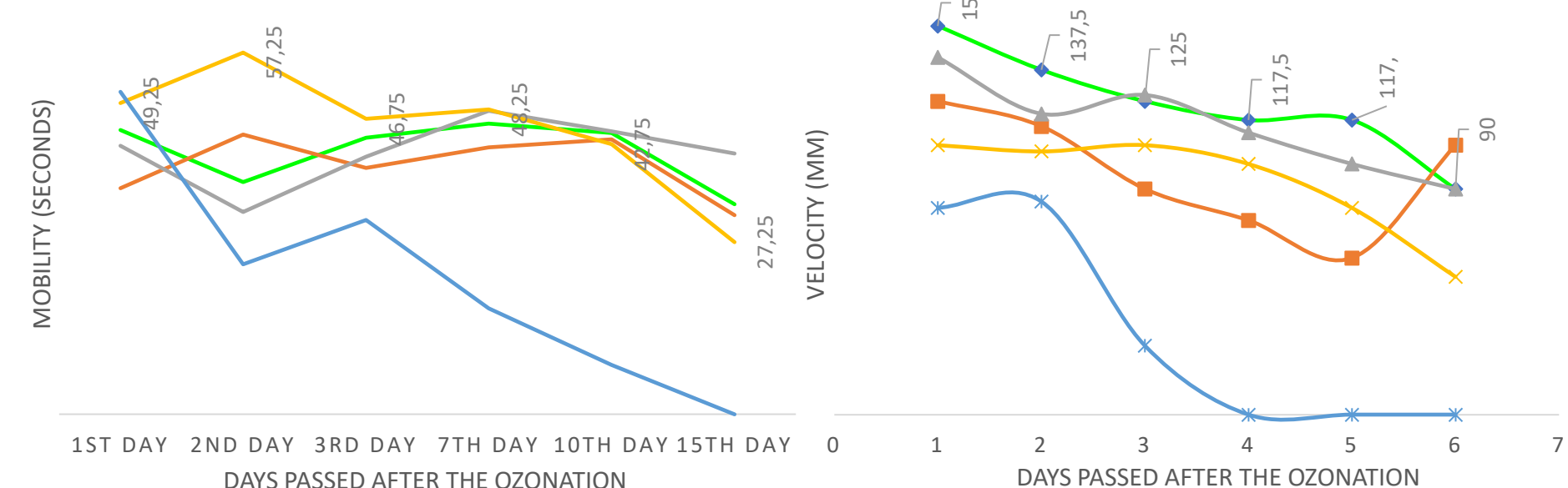
Specific aims of the paper are:

- Definition of time exposure to ozone needed to cause a satisfying mortality rate in insects (> 95%).
- Definition of ozone effect on insect mobility and velocity.
- Definition of correlation in mortality and time passed after the ozone treatment.

Results

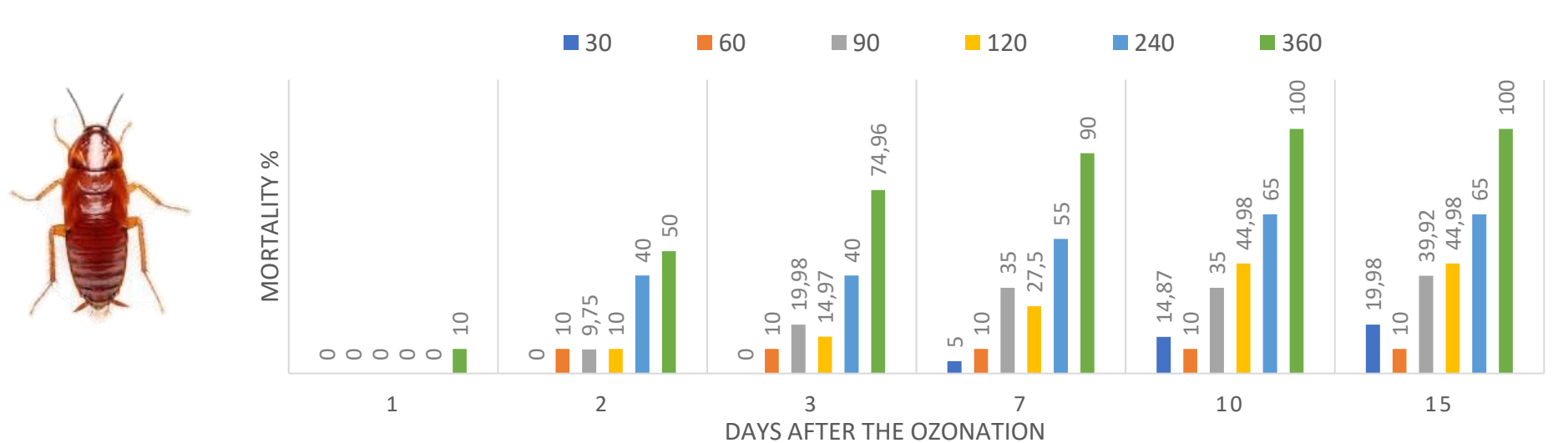


Graph 1. Mortality of weevils

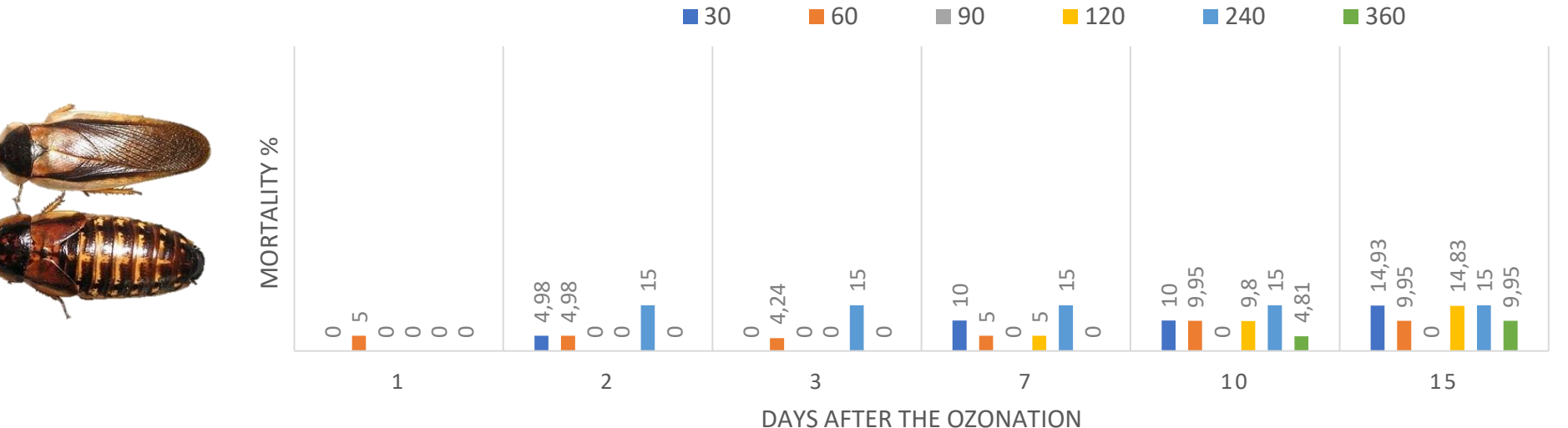


Graph 2. Mobility of weevils

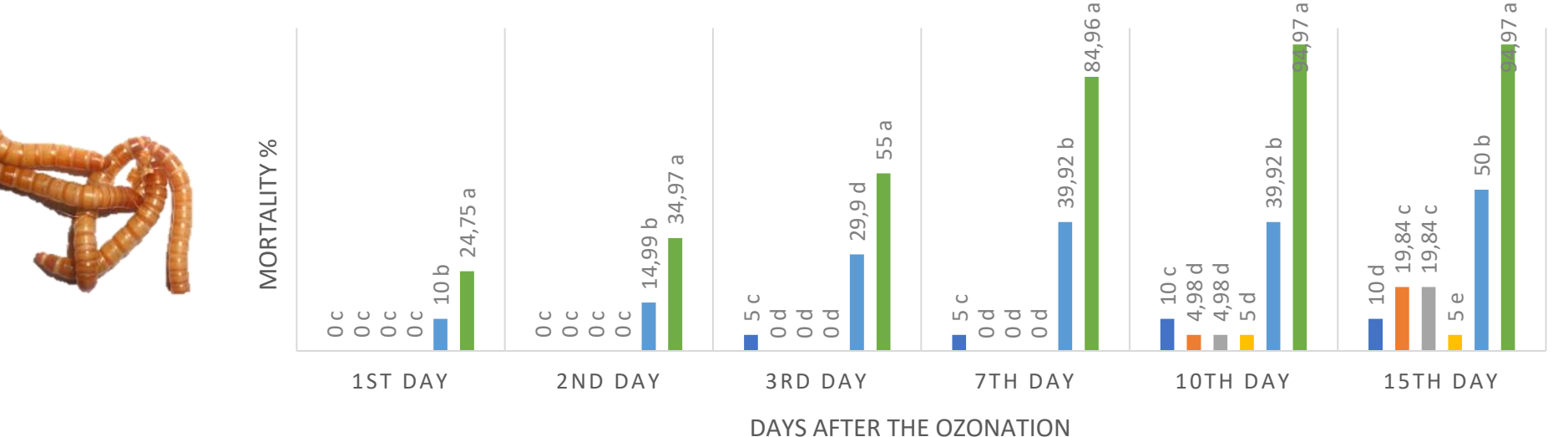
Graph 3. Velocity of weevils



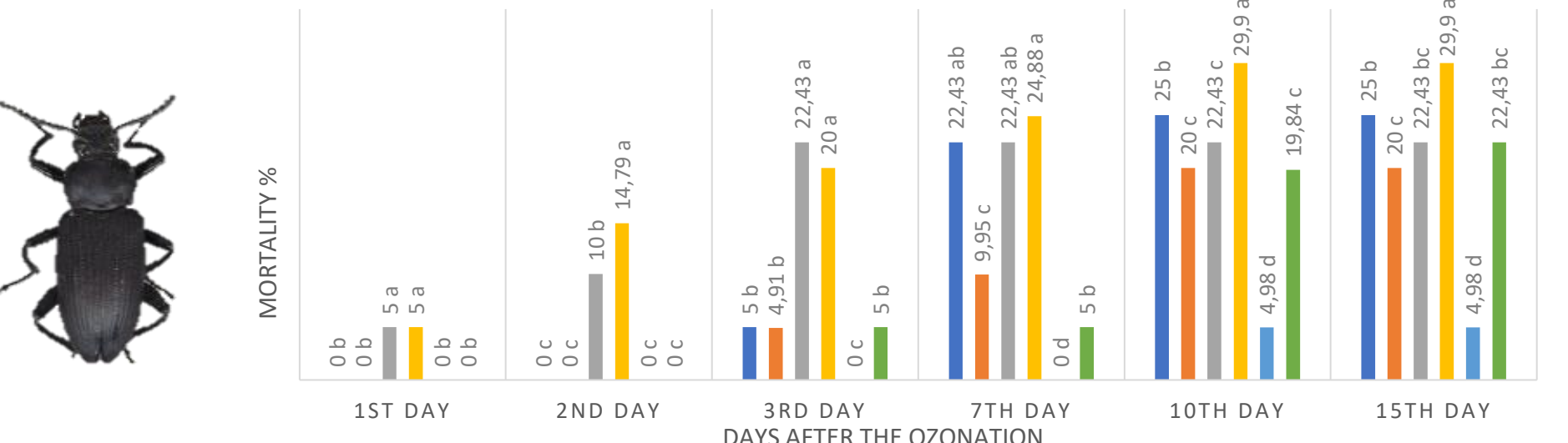
Graph 4. Mortality of the *Blatta lateralis* during the research



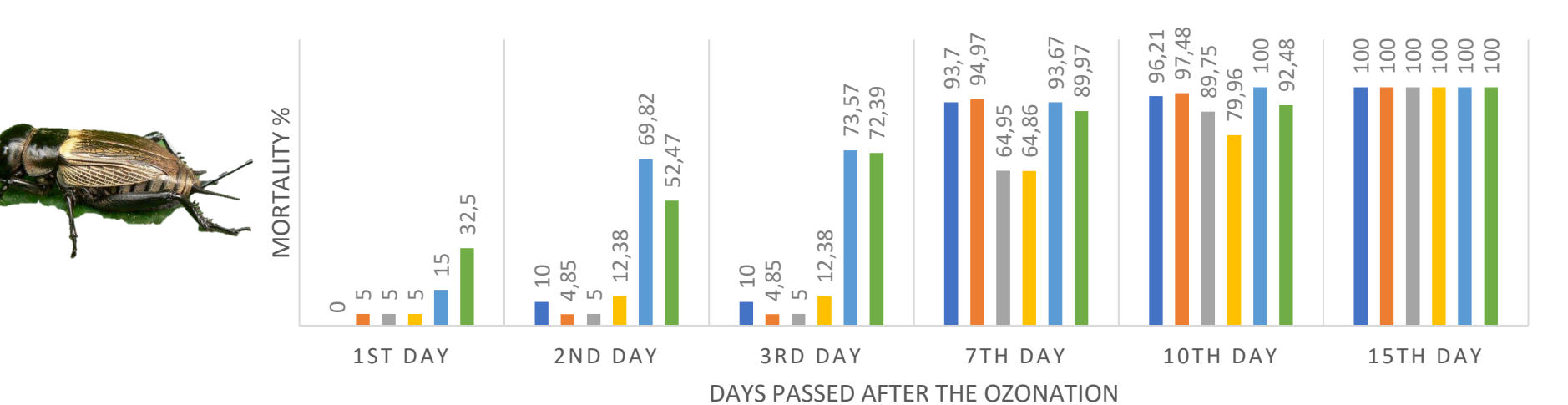
Graph 5. Mortality of the *Blaptica dubia* during the research



Graph 6. Mortality of the *Tenebrio molitor* during the research



Graph 7. Mortality of the *Zophobas morio*



Graph 8. Mortality of the *Gryllus campestris*

The effects of ozone and mortality of *Pachnoda sinuata flaviventris* larvae were not determined on any variant throughout the study period. Even during the last reading date, larvae were viable.

References:

- BENHALIMA, H., CHAUDHRY, M. Q., MILLS, K. A., PRICE, N. R. (2004). Phosphine resistance in stored-product insects collected from various grain storage facilities in Morocco. Journal of Stored Products Research, 40: 241-249.
- ISIKBER, A. A., ÖZTEKIN, S. (2009). Comparison of two stored-product insects, Ephestia kuehniella Zeller and Tribolium confusum du Val to gaseous ozone. Journal of Stored Products Research, 45: 159-164.
- LEESCH, J. G. (2003). The mortality of stored-product insects following exposure to gaseous ozone at high concentrations. U: Advances in stored product protection. Proceedings of the 8th international working conference on stored-product protection, (P. F. Credland, D. M. Armitage, C. H. Bell, P. M. Cogan, E. Highley, E. ur.). CAB International. Oxon, UK. 827-831.
- PIMENTEL, D. (1991). World resources and food losses to pests. U. Ecology and Management of Food Industry Pests. FDA Technical Bulletin 4, (J. R. Gorham ur.). Association of Official Analytical Chemists. Arlington, VA. pp. 5-11.
- ZETTLER, J. L., CUPERUSI, G. W. (1990). Pesticide resistance in *Tribolium castaneum* (Coleoptera: Tenebrionidae) and *Rhyzopertha dominica* (Coleoptera: Bostrichidae) in wheat. Journal of Economic Entomology, 83: 1677-1681.
- ZETTLER, J. L., HALLIDAY, W. R., ARTHUR, F. H. (1989). Phosphine resistance in insects infesting stored peanuts in the southeastern United States. Journal of Economic Entomology, 82: 1508-1511.
- ZHANGGUI, Q., XIA, W., GANG, D., XIAOPING, Y., XUECHAO, H., DEKE, X., XINGWEN, L. (2003). Investigation of the use of ozone fumigation to control several species of stored grain insects. U: Advances in Stored Product Protection. Proceedings of the 8th International Working Conference on Stored-product Protection (P. F. Credland, D. M. Armitage, C. H. Bell, P. M. Cogan, E. Highley ur.). CAB International. Oxon, UK. pp. 846-851.