Why insects can develop from unfertilized egg cells

October 27 2017

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A scientist from the Lomonosov Moscow State University, Faculty of Biology, has, together with his Russian colleague, has explained the frequent occurrence of parthenogenesis development of insects from

unfertilized egg cells. Studying this phenomenon could contribute to controlling the species that cause damage to agriculture. The results were published in the *Journal of Zoological Systematics and Evolutionary Research*.

Winged insects of the superorder Holometabola pass four stages of development: egg, larva, pupa and adult insect. Some members of Holometabola experience parthenogenesis. The MSU researcher has described the modes of parthenogenetic development found in various groups of these insects.

Parthenogenesis occurs in three modes: arrhenotoky, thelytoky and deuterotoky. Arrhenotoky, in which only males appear from unfertilized egg cells, is observed in wasps, bees and bumblebees. Usually, the males in these species develop from unfertilized eggs and contain the single (haploid) chromosome set, while females appear diploid (with the double chromosome set) and from fertilized eggs.

Thelytoky, on the other hand, means that females appear from unfertilized eggs, while males are absent. This mode of parthenogenesis is characteristic of some weevils and bagworm moths, as opposed to social insects.

In Deuterotoky, both male and female organisms develop from unfertilized egg cells. Deuteroky is found, for example, in many gall wasps of the family Cynipidae.

"It has been shown that parthenogenesis is favorable for appearance and further existence of groups when the population density is low, as well as when the necessity arises for rapid reproduction of a particular genotype in favorable conditions. On the other hand, sometimes populations of insects who reproduce sexually reach very large population sizes, and that can also cause the development of parthenogenetic lineages," says

biologist Vladimir Gokhman, leading researcher of the MSU Botanical Garden.

The main cause of parthenogenesis is obvious: Insects have a problem with finding sexual partners when the population density is low, which is often the case in extreme habitats. On the other hand, parthenogenesis in high-density populations can be explained by the theory that when the population density is high, many evolutionary bans hampering parthenogenetic development are lifted, especially in phytophagous insects, which feed mostly on trees.

"Many serious pests of agriculture and forestry, as well as their natural enemies among insects, are parthenogenetic, and studying various types of parthenogenesis is therefore necessary to successfully control these pest species. Nowadays, world scientific literature is experiencing a rapid increase in studies dedicated to ecological, genetic and other aspects of parthenogenesis in insects. This information needs to be adequately and timely summarized and interpreted, but various surveys on this subject, as a rule, rapidly age," Gokhman says.

Phytophagous insects that reproduce by thelytoky are harmful to agriculture and forests, because a few females can quickly give rise to a fully functional pest population in the absence of males.

More information: Vladimir E. Gokhman et al, Parthenogenesis in Hexapoda: holometabolous insects, *Journal of Zoological Systematics and Evolutionary Research* (2017). DOI: 10.1111/jzs.12183

Provided by Lomonosov Moscow State University