

finds fall on 2015–2016, i.e. the tendency of the increase of distribution speed is observed.

It should be noted that the mantises living on natural and anthropogenically modified territories have phenotypic differences (body color): green, yellow and brown. It is known that green individuals are commonly found on vegetating plants, and brown ones – on sun-bleached plants. According to our observations within Minsk brown individuals more often occur in the most urbanized parts of the city, and green and yellow individuals occur in the conditions close to the natural environment.

17 species of insects mainly pests of various cultures are given on <http://www.ias.by> about alien species. Among them different species of aphids, being a fodder object of the praying mantid, are dominated. To study the nature of the trophic relations of this species an experiment is being conducted on the basis of the Minsk Gymnasium school № 43. During the experiment the offspring has been received and the range of the praying mantid fodder objects has been defined. So, the adults feed on flies (Diptera) and their larvae, and the praying mantid nymphs feed on fruit flies (Drosophilidae) and aphids (Aphidodea), thereby bringing benefit.

Thus, the praying mantid can be used as a biological method of struggle, including greenhouses.

**Shalkevich P.<sup>1</sup>, Kundas S.<sup>2</sup>, Moroz A.<sup>1</sup>**

*<sup>1</sup>International Sakharov Environmental Institute of Belarusian State University,  
Minsk, Republic of Belarus;*

*<sup>2</sup>Belarusian National Technical University, Minsk, Republic of Belarus*

## **COMPARISON OF MULTI-THREADING SIMULATION METHODS OF NON-ISOTHERMAL HEAT AND MOISTURE TRANSFER**

---

Using of parallel computing technologies of modeling the non-isothermal heat and moisture transfer in soil is very important for improving obtained simulation results. In previous works the authors developed computational algorithms and methods which allow most effective solution of the task using High Performance Computing technologies. However, due to the computer resource requirements of the task solution, it is worth checking whether it is possible to further improve its performance metrics. Is it possible to speed up the task solution, using different software technologies in the context of the developed computational algorithms?

To date there are five software technologies which can be used to speed up calculations in modeling the non-isothermal heat and moisture transfer of contaminants in soil:

- 1) Intel TBB;
- 2) Intel Cilk Plus;

- 3) OpenMP;
- 4) C++11 Threads (similar to Boost);
- 5) Using Pthreads directly.

Considering that the developed algorithms and methods of parallel computing of the task of modeling the non-isothermal heat and moisture transfer of contaminants in soil are implemented in the SPS (Simulation Processes in Soil) software package which is based on C++ there is no need to use Intel TBB and Intel Cilk Plus technologies. Using Pthreads directly we can probably get some better results, but implementation of this software technology will take much more time than the worth of the result. Thus, we should compare OpenMP and C++11 Threads implementation. OpenMP framework has been already implemented by the authors unlike C++11 Threads. It is also interesting to use C++11 Threads because it is included in the current C++ language standard ISO / IEC 14882: 2011.

To compare OpenMP and C++11 Threads frameworks an experiment was conducted. The simulation of non-isothermal heat and moisture transfer of contaminants in soil, at a distance of 10 meters from the source was made. The speed of calculations was measured with the use of *time* function (Table 1).

Table 1. – The results of calculation time comparison of compare OpenMP and C++11 Threads frameworks

OpenMP	C++11 Threads
real 0 m 7.438 s	real 0 m 8.588 s
user 0 m 3.828 s	user 0 m 4.616 s
sys 0 m 3.132 s	sys 0 m 4.176 s

In this article we had a closer look at possible frameworks for managing multi-threading of simulation of non-isothermal heat and moisture transfer of contaminants in soil efficiently. We have seen that there are actually a variety of options, but OpenMP shows the best efficiency.

### **Sheiko A.**

*Belarusian State University, Minsk, Republic of Belarus*

## **THE FIRST DATA ON SPECIES ANTHOPHILOUS INSECTS VISITING INFLORESCENCES OF ARUNCUS VULGARIS RAFIN. IN MINSK REGION (HYMENOPTERA, APOIDEA)**

The study of the relationship between anthophilous insects and plants which they pollinate is becoming increasingly important. The obtained data allow us to estimate the role of insects in seed reproduction of plants and may indicate the role of plants as sources of nectar and pollen for anthophilous insects.