

FIRST RECORDS OF EUROPEAN MANTID *MANTIS RELIGIOSA* (LINNAEUS, 1758) (INSECTA: DICTYOPTERA, MANTIDAE) IN LATVIA

Mihails Pupiņš, Mārtiņš Kalniņš, Aija Pupiņa, Ieva Jaundaldere

Pupiņš M., Kalniņš M., Pupiņa A., Jaundaldere I. 2012. First records of European Mantid *Mantis religiosa* (Linnaeus, 1758) (Insecta: Dictyoptera, Mantidae) in Latvia. *Acta Biol. Univ. Daugavp.*, 12 (2): 175–184.

New distributional records are presented for European or Praying Mantid *Mantis religiosa* (Linnaeus, 1758). In article described cases of *M. religiosa* registration in Latvia. Several communications, received from respondents in 2010, about the presence of Mantodea representatives in Latvia, appeared to be veracious. One record from 2008 detected. Possible ways of appearance of found *M. religiosa* in Latvia and possible consequences of *M. religiosa* appearance in Latvia was discussed in article.

Key words: Dictyoptera, Mantidae, *Mantis religiosa*, distribution, Latvia.

Mihails Pupiņš, Aija Pupiņa, Daugavpils University, Vienības iela 13, Daugavpils, LV-5401, Latvia; Latgales Zoo, Vienības iela 27, Daugavpils, LV-5401, Latvia; e-mail: eco@apollo.lv; bombinalatvia@inbox.lv

Mārtiņš Kalniņš, The Entomological Society of Latvia, Kronvalda bulv. 4, Rīga, LV-1586, Latvia; e-mail: martins.kalnins@biology.lv

Ieva Jaundaldere, Lapu iela 10, Lielvārde, LV-5070, Latvia; e-mail: segan@inbox.lv

INTRODUCTION

European or Praying Mantid *Mantis religiosa* (Linnaeus, 1758) (Mantodea, Mantidae) is a comparatively big, up to 50-75 mm, insect. A probable natural area of this species includes the following countries: Albania, Arabian peninsula, Armenia, Austria, Azerbaijan, Balearic Islands, Bulgaria, Belgium, Bosnia and Herzegovina, Canary Islands, China, Corsica, Crete, Croatia, Czech Republic, Cyclades Islands, Cyprus, Dodecanese Islands, Egypt, France, Georgia, Germany, Greece, Hungary, Iran, Iraq, Israel, Italy, Japan, Jordan, Lebanon, Macedonia, Madeira,

Malta, Moldova, Namibia, North Aegean Islands, Papua New Guinea, Poland, Portugal, Romania, Russia (Central, South), Sardinia, Saudi Arabia, Sicily, Slovakia, Slovenia, Spain, Sri Lanka, Sudan, Syria, Switzerland, Tunisia, Turkey, Ukraine and Yugoslavia (Milne, Milne 1980, Bfildi, Kisbenedek 1997, Abu-Dannoun, Katbeh-Bader 2007, Nagy, Kisfali 2007, Prokop, Vaclav 2008, Janšta et al. 2008, Heller 2008, BayScience Foundation 2009). The northern border of its distribution in Europe crosses France (up to 50°N), Belgium, Germany, Switzerland, northern Italy (southern Tyrol), Austria, Czech Republic, Slovakia, southern Poland, Ukraine, and Russia

(up to 54°N).

M. religiosa is present in Neotropical and Oriental region, but doubtful in Australian region (Heller 2008). However, according to other literary sources, *M. religiosa* was introduced to America (Bolivia, Jamaica, USA and Canada) and Australia (Vidlicka 2001, cited in: Janšta et al. 2008). Its anthropogenic introduction to America in 1890 led to a wide distribution of *M. religiosa* in the United States, Canada, Costa Rica (Cannings 2007, Liana 2007, Bay Science Foundation 2009), that characterizes it as a flexible species with abilities to invade rapidly on new territories out of the natural area. At the same time, apart from the anthropogenic one, there are other ways of distribution of flying and flightless insects (Černyšev 1996). Research on *M. religiosa* distribution possibilities in Europe to the north from the natural area arises interest both from the ecological point of view and in connection with a total climate changes in Europe, so, it is believed that the widening of *M. religiosa* area to the north in Germany is connected with the warming of climate (Liana 2007, UNEP, CMS, DEFRA 2009).

MATERIAL AND METHODS

The present research is carried out in the process of studying of presence and distribution of exotic poikilothermic animals in nature of Latvia (Pupins 2007, Pupins, Pupina 2010), which has begun since 2004. The study consisted of the fundamental stages: 1) informative campaign among the population and interrogation of respondents, 2) identification of species and observation of found praying mantises and 3) field expeditions.

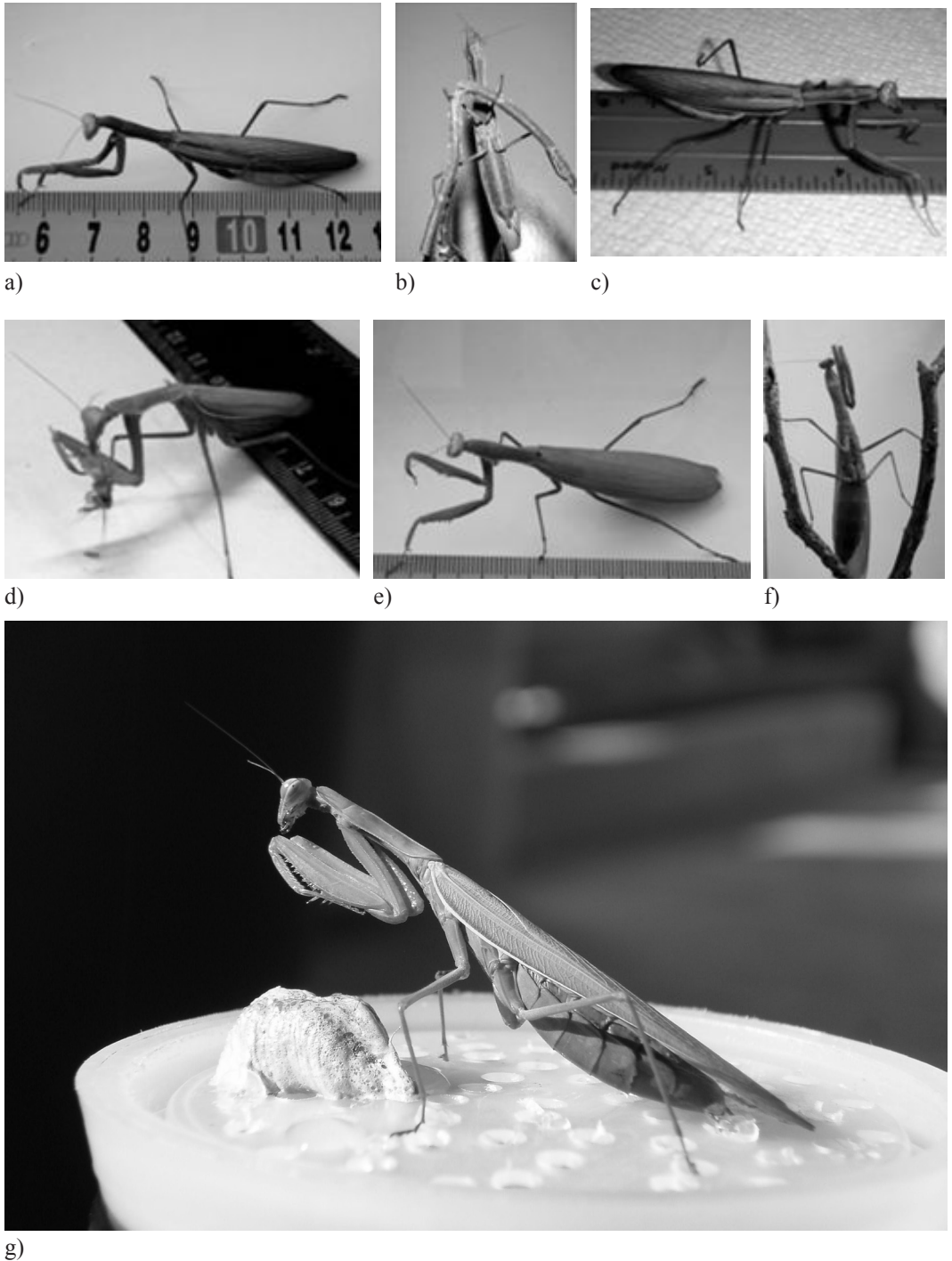
Informative campaign among the population and interrogation of respondents. In connection with the assumed small number of primarily introduced by man or independently moved exotic poikilothermic animals in nature of Latvia, the primary method of research appeared the interrogation of population. Interrogation was

accompanied by informative campaign with the use of newspapers, the Internet, radio and television among the inhabitants of Latvia, especially Latgale region (SE part of Latvia).

The informative campaign was conducted also among the visitors of Latgales Zoo. The discussions were centred on the importance of urgent communication to specialists when unusual animals were found in nature of Latvia. The amount of audience, interrogated with the help of Mass - Media, is unknown and can be equated with its print run or number of websites visitors, the number of interrogated visitors of Latgales Zoo is about 20 000 people a year.

The audience target groups were biologists and students of biology at Daugavpils University, teachers of biology, staff of nature-conservation organizations, fishermen, hunters, workers, whose activities take place in natural medium (woodcutters, drivers, forest rangers, etc.).

Initial communications from respondents about the unusual large insects, possibly, praying mantises, met by them, were obtained mainly via the telephone, as well as through an electronic mail and personally. After a successful verification (see below) of the first communication an additional informative campaign was carried out in local newspapers, with a purposeful call already to report about the praying mantises met in Latvia. The purposeful interrogation method was used also in the research on *M. religiosa* distribution in Poland (Liana 2007). Verification of reported data was carried out in a form of a specially organized 10-15 minutes long interview with a respondent when receiving a communication about an insect, probably, praying mantis, met in nature of Latvia. Respondent was asked questions about the insect appearance, the place and time of its observation, its behaviour, etc. Questions were repeated 2-3 times in the different formulations for raising the veracity of the report. In case of probable praying mantis observation, respondent was recommended to catch an insect and isolate it till the arrival of researchers, or, when it was impossible, to photograph it.



g)

Fig. 1. Finds in Latvia 4 *Mantis religiosa* females: founding #1 – a, b; founding #2 – c; founding #3 – e, f; founding #4 – d (photos A. Pupiņa, M. Pupiņš); founding #6 – g (photo I. Jaundalere).



Fig. 2. The habitat, surrounding the place of *Mantis religiosa* finding #3 in Daugavpils district, Nīcgales region (photo M.Pupiņš).

Identification of species and observation of found praying mantids. Identification of species of found praying mantises was carried out with the help of appropriate book (Milne, Milne 1980), gender was identified visually, if necessary, consultations with the specialists: Valerijs Vahrusevs (Latvia, Latgales Zoo), Mihail Berezin, Yekaterina Tyurina (Russia, Moscow Zoo) were carried out. The measurement of body length was carried out with the help of the sliding calliper along the maximal body length with an accuracy up to 1 mm. Visual estimation of outward anatomical damages of praying mantis was also carried out. Field expeditions. In the course of field expeditions coordinates were fixed and place of praying mantis finding was inspected, additional interviews with respondents and interrogations of other local residents were carried out, biotopes were documented with photos. For mapping of findings a map of Latvia in the Mercator projection was used, for measuring the distances between findings *Google Earth* service was used.

RESULTS

Several communications, received from respondents in 2010, about the presence of Mantodea representatives in Latvia, appeared to be veracious. One record from 2008 detected.

Finding #1. 13.08.2010 the authors received the first communication about the found Mantodea representative. The insect was found by a respondent in Daugavpils 13.08.2010., on the public building, the coordinates of finding are 55°52'21.07"N; 26°33'23.85"E. The subsequently received insect from the respondent was identified as *M. religiosa*. It was an adult female with the body length of 58 mm (Fig. 1: a, b), light brown in colour, without any damages of extremities, antennae or wings. The abdomen of insect was thin and empty. Its edges were almost linear in the dorsoventral projection.

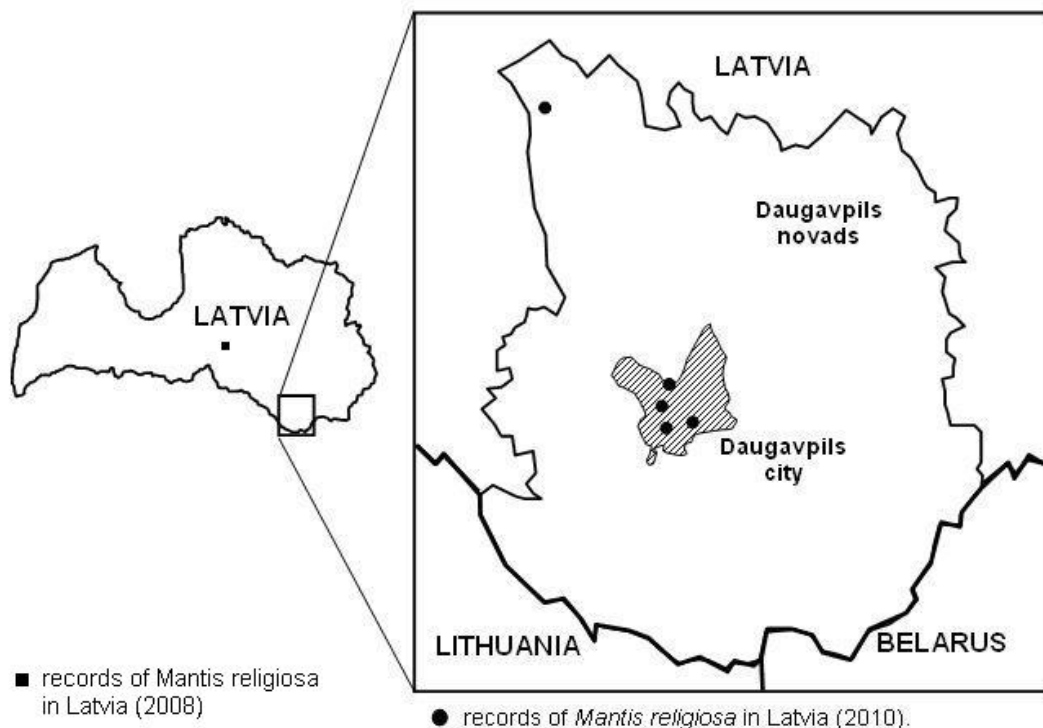


Fig. 3. Location of 6 findings of *Mantis religiosa* in Latvia in 2008 and 2010.

Finding #2. 14.08.2010 the authors received the second communication about the found Mantodea representative on 08.08.2010 about 17.00 in the Daugavpils city centre. Coordinates of the finding are 55°52'2.53"N; 26°31'19.11"E. The insect was found by a respondent in the yard of public building on the asphalt. The received after a certain time insect from the respondent was identified as *M. religiosa*. It was also a light brown female, with the partially amputated antennae, with the body length of 63 mm. (Fig. 1: c).

Finding #3. 16.08.2010 the authors received the third communication about the found Mantodea representative from Daugavpils region, Latgale. The subsequently received insect from the respondent was identified as *M. religiosa*. It was an adult female with the body length of 62 mm (Fig. 1: e, f), light green in colour, without any damages of extremities, antennae or wings. The insect's abdomen was bulging and filled. Its edges were markedly arched in the dorsoventral

projection. *M. religiosa* was found on 16.08.2010 in the sparsely populated locality, at a distance of 1.7 km from the nearest populated area Nīcgale, coordinates of the finding: 56°8'41.68"N; 26°20'40.71"E. The insect was found outside, on the window of petrol station, in the shadow approximately at 13.00, in sunny weather, the air temperature +30.4°C. *M. religiosa* was active; it attempted to hide from a person that had found it, flying approximately 4 meters to the flowerbed.

Finding #4. 21.09.2010 the authors received the fourth *M. religiosa*. A respondent found it on the same day on the outskirts of Daugavpils, coordinates of the finding: 55°54'15.63"N; 26°31'45.01"E. It was an adult female green in colour with the body length of 57 mm, thin, with damaged wings (approximately 1mm of wings was torn off), it was found on the lawn during cleaning (Fig. 1: d).

Finding #5. 22.09.2010 the authors received the fifth communication about the found

Mantodea representative. The insect was found by respondent in the end of August on the outskirts of Daugavpils on the flowerbed and was left in nature; the authors did not manage to receive it. Coordinates of the finding are 55°53'4.61"N; 26°30'59.18"E, insect's description by the respondent make it possible to assume that it was also *M. religiosa*, green in colour, it was impossible to ascertain its gender and size.

Finding #6. 21.08.2008. one of the authors (I. Jaundaldere) found Mantodea representative on wall of the building in Lielvārde city. Coordinates of the finding are 56°43'00.95"N; 24°48'43.85"E). It was an adult female green in colour with the body length 70 mm (Fig. 3: g), without any damages of extremities, antennae or wings. The later specimen was identified as *M. religiosa* (det. M. Kalniņš).

An average body length of the caught in 2010 praying mantids is $L = 60.0 \pm 2.9$ mm. Registered in the research in 2008 and 2010 *M. religiosa* findings distributed around the territory of Latvia as follows (Fig. 3). The findings were located at a different distance from each other (Table 1); an average distance between the findings in 2010 was 14.3 ± 14.8 km. Average distance between findings in 2008 and 2010 is ~ 130 km.

DISCUSSION

Possible ways of appearance of found *M. religiosa* in Latvia. Is it possible that registered in the research *M. religiosa* females got to nature of Latvia from a terrarium of some collector of invertebrates? Yes, of course, it is possible despite the fact that *M. religiosa* are not recommended for researches due to the complicacy of their keeping in zooculture (Yager 1999). On the basis of the carried out research and personal experience of authors in keeping *M. religiosa* in zooculture the probability of such possibility is extremely small, since: 1) the authors interrogated known animal-lovers (n=8) in the region, none of them kept *M. religiosa*; 2) there were registered quite many *M. religiosa* in the research (five

imagoes). If they were grown in captivity, then their owner must have kept and reared them in separate terrariums (EuroRep Ltd. 1999) due to *M. religiosa* expressed cannibalism (Milne, Milne 1980); 3) all found females were impregnated, meanwhile, it is known that sexual cannibalism is characteristic for *M. religiosa* females (Roeder 1935, Vahed 1998, Prokop, Vaclav 2008). They eat up males in 31 % of cases of pairing in nature (Lawrence 1992) and almost always eat up males during pairing in zooculture (experience of the authors). In other words an assumed animal-lover must have kept and reared males and females separately before pairing that requires a great number of specially equipped terrariums (Yager 1999, EuroRep Of Ltd. 1999) and developed fodder base. As the authors' experience in contacting with regional animal-lovers shows, it is usually difficult for them to set up, equip and support such a great number of terrariums; 4) raising of *M. religiosa* larvae to imago requires a sufficiently great number of fodder insects of different stages of development, the majority of regional animal-lovers does not have zoocultures of fodder insects (Pupins, Pupina non-publ.data); 5) *M. religiosa* were found at the significant distance (maximal distance between the findings more than 33 km) from each other, which makes their flight from one terrarium unlikely; 6) the time of imago registration in Latvia and laying of oothecae coincide with the time of *M. religiosa* reproduction in other parts of the area, whereas, during *M. religiosa* keeping in zooculture, change of generations occurs irrespective of the season and is heavily displaced relative to natural phenology (Liana 2007, Pupins, Pupina non-publ. data, data of the present research, see above); 7) during 2010 in the proposals about sale of exotic animals, published on the Latvian advertising portals (for example, www.ss.lv), the proposals of *M. religiosa* were not registered, though, at the same time, another species of praying mantises (*Creoboter* sp., pers.com. D. Telnov) was proposed. All this makes an anthropogenic introduction from the terrarium of registered *M. religiosa* unlikely: flight or discharge into nature allows assuming that obtained in the research females in the same summer arrived from a natural area.

Might the registered *M. religiosa* imagoes get to Latvia another anthropogenic way, for example, to be delivered by chance with some other goods? Walther et al. asserts that “Mediterranean insects such as the praying mantis *M. religiosa* and the bush cricket *Meconema meridionale* (Orthoptera, Meconematidae) are expanding their native range in southern Germany, but they are also found further north, far away from their natural range; these populations are considered to be the result of accidental transport by humans” (Walther et al. 2009). Indeed, since 2004 the authors received data about the presence of representatives of allochthonous species of poikilothermal animals (Pupins 2007, Pupins, Pupina 2010), including invertebrates: exotic spider, scorpion in Latvia (Pupins, Pupina non-published of data). At the same time, findings of invertebrates were single, they all took place in the urban environment, in grocery stores, which makes it possible to assume the anthropogenic reasons for the appearance of the species in Latvia: for example, random delivery with tropical fruits. *M. religiosa* registration in Latvia in 2010 differs from previous findings of exotic invertebrates in that all the *M. religiosa* findings are made: 1) in a comparatively short period (from August 8 to September 21); 2) on a sufficiently large territory (the maximal distance between the places of findings is more than 33 km); 3) in localities, urbanized to a different degree (city center, city outskirts, sparsely populated rural territory); 4) more than one adult individual (minimum 4 adult females) were found. This makes it possible to assume a non-anthropogenic way of *M. religiosa* appearance in Latvia.

Adult *M. religiosa* individuals fly actively (Triblehorn, Yager 2001). At the same time, distance from the findings in Latvia to the places of the natural inhabiting of species is sufficiently large and previously *M. religiosa* were not registered in Latvia. An external factor, which facilitated *M. religiosa* appearance in Latvia, might be strong winds - storms, which came from the south and the southeast to the territory of Latvia in August 2010. Settling of flying insects by wind to significant distances is also known

(Černyšev 1996). It is also worth mentioning that *M. religiosa* is an aerochorous species and uses wind by settling of larvae (Milne, Milne 1980). These facts allow assuming that adult *M. religiosa* findings in Latvia in 2010 might have an anemogenic origin and flying insects were carried by storms from a historical area of distribution. In this case, finding of *M. religiosa* in Latvia confirms a manifesting role of strong winds in settling of southern flying insects northwards in Europe geographically (significant distance), quantitatively (big insects, group of individuals are moving) and qualitatively (slightly traumatized adult representatives of a new species of fauna, impregnated and ready for reproduction are moving). At first glance, this assumption can be contradicted by the fact that almost all found in the research praying mantises did not have any external damages, which, it would seem, might appear during a distant flight together with storm. The absence of significant external injuries of found *M. religiosa* individuals can be explained both by sufficient highly developed in the course of evolution anatomical-physiological and behavioural adaptability of these aerochorous insects to moving by air, including to settling with the help of strong winds, and by the fact that the greatest destructive impacts of wind experience flying objects, which have a huge difference in speed with the surrounding air, but moved by a strong wind comparatively small and light *M. religiosa* can have lower speed with respect to the mass of surrounding air. Moreover, the assumption about the fact that *M. religiosa* use strong winds for settling is indirectly confirmed by the fact that activity of males is increased and they fly greater distances, before storms, when the temperature was very high (Liana 2007).

Possible consequences of *M. religiosa* appearance in Latvia. *M. religiosa* is sufficiently flexible and adaptable to inhabiting new territories species (Milne, Milne 1980), fed with diverse preys: diurnal insects, including caterpillars, flies, butterflies, bees and some moths (Milne, Milne 1980), including *Lacerta agilis* (Reptilia: Squamata: Sauria) (Jehle et al. 1996), it dwells at various heights (0 to 1840 meters) above sea level (BayScience Foundation 2009). Since

M. religiosa spend winter in an egg-stage that are situated in open-located ootheca above the snow level (Milne, Milne 1980, Pupins, Pupina pers.obs.), the basic limiting factor for species existence in Latvia can be comparatively low winter air temperatures. Moreover, relatively short and cool Latvian summer cannot give enough time to larvae to develop to reproduction stage, since *M. religiosa* lay eggs late in summer (Milne, Milne 1980, Liana 2007). Therefore, got into Latvia in 2010 adult *M. religiosa* cannot, possibly, reproduce themselves successfully under the conditions of a comparatively cold Latvian climate. At the same time, it should be noted that *M. religiosa* were found in the south eastern part of Latvia, in Latgale, in the zone with average minimal temperatures in January -6° - -7°C and with average air temperatures in July $+17^{\circ}\text{C}$ that is the highest for Latvia; with the duration of a frostless season 150-160 days (Turlajs 2007). An average temperature on the north Ukraine, where passes the historical northern boundary of *M. religiosa* area, comprises in January from -7°C to -8°C , an average temperature in July from $+18^{\circ}\text{C}$ to $+19^{\circ}\text{C}$ (Nacional'nyj turističeskij ofis), which is close to analogous temperatures in Latgale (Turlajs 2007). In Belarus, where in recent years inhabitants also observed and specialists commented on appearance of *M. religiosa* (Anonymous 2008, Filipkova 2010, Grešišena, Olejnik 2010), in July an average temperature is from $+17^{\circ}\text{C}$ on the north to $+18.5^{\circ}\text{C}$ on the south; an average temperature in January varies from -4.5°C on the southwest to -8°C on the northeast (Oficial'nyj sajt respubliki Belarus). Likewise, during the estimation of the perspectives for *M. religiosa* registration in Latvia, it is necessary to consider general climate warming in a region.

Probable anemogenic appearance of *M. religiosa* in Latvia at the end of summer 2010 makes it possible to assume that, if storms transferred to a significant distance these comparatively large insects (an average length of found *M. religiosa* in Latvia is 60 mm), it is possible to assume appearance of other new south species of flying

insects in Latvia during this period that dwell in natural areas together with *M. religiosa* (BayScience Foundation 2009), and also from interstitial territories, above which passed the storm.

During the estimation of the consequences of *M. religiosa* appearance in Latvia it is necessary to focus attention on the probability of appearance of parasites in Latvia, for which Praying Mantids are hosts (Schmidt-Rhaesa, Ehrmann 2001), some of them can prove to be new for Latvian entomological fauna.

ACKNOWLEDGEMENTS

The authors thanks Valērijs Vahruševs (Latgales Zoo, Latvia), Mihail Berezin, Yekaterina Tyurina (Moscow Zoo, Russia) for the consultations; Māris Lielkalns (Riga National Zoo, Latvia) for help in collecting materials; all respondents for communications about findings of *Mantis religiosa*. Also we thank anonymous reviewers for criticism and remarks.

REFERENCES

- Abu-Dannoun O., Katbeh-Bader A. 2007. Mantodea of Jordan. *Zootaxa*, 1617: 43 – 56.
- Anonymous 2008. Sensaciâ: bogomoly i tarantuly poselilis' v Belarusi. [Sensation: Mantids occurred in Belarus]. Interfax.by. Informacionno-spravočnyj portal Belarusi. <http://www.interfax.by/mosaic/1049838> (Accessed August 23, 2010). (In Russian).
- BayScience Foundation 2009. *Mantis religiosa* (Religious Mantis). *ZipcodeZoo*. Available on: http://zipcodezoo.com/Animals/M/Mantis_religiosa/Default.asp (Accessed November 11, 2010).
- Bfildi A., Kisbenedek T. 1997. Orthopteran assemblages as indicators of grassland naturalness in Hungary. *Agriculture, Ecosystems and Environment*, 66: 121 – 129.

- Cannings R.A. 2007. Recent range expansion of the Praying Mantis, *Mantis religiosa* Linnaeus (Mantodea: Mantidae), in British Columbia. *Journal of the Entomological Society of British Columbia*, 104: 73 – 80.
- Černyšev V.B. 1996. Èkologiâ nasekomyh. Učebnik [Ecology of Insects. Learning book]. Izdatelstvo MGU: 1 – 304. (In Russian.)
- EuroRep Ltd. 1999. Keeping a Pet Mantis. An Introductory Information Leaflet: 1 – 2.
- Filipkova I. 2010. Bezobidnyj hišnik. [Non-dangerous predator]. *Respublika. Gazeta Soveta Ministrov Respubliki Belarus*. Available on: <http://respublika.info/5068/nature/article41674/> (Accessed August 23, 2010). (In Russian).
- Grešišena T., Olejnik E. 2010. Pauki-krestoviki lezut v doma! [Cross-spiders go to buildings!]. *Blik TV*. <http://inforotor.ru/visit/5985672?url=http://www.blik.ua/content/view/33917/> (Accessed August 23, 2010). (In Russian).
- Heller K.-G. 2008. *Mantis religiosa*. Fauna Europaea version 2.3, <http://www.faunaeur.org>
- Janšta P., Vrabec V., Stránský J., Mikát M., Mocek B. 2008. The occurrence of the praying mantis (*Mantis religiosa*) (Mantodea: Mantidae) in central Bohemia and its distribution in the Czech Republic. *Klapalekiana*, 44: 21 – 25.
- Jehle R., Franz F., Kapfer M., Schramm H., Tunner H.G. 1996. Lizards as prey of arthropods: Praying Mantis *Mantis religiosa* (Linnaeus, 1758) feeds on juvenile Sand Lizard *Lacerta agilis* Linnaeus, 1758 (Squamata: Sauria: Lacertidae). *Herpetozoa*, 9 (3/4): 157 – 159.
- Lawrence S. E. 1992. Sexual cannibalism in the praying mantid, *Mantis religiosa*: a field study. *Animal Behaviour*, 43 (4): 569 – 583.
- Liana A. 2007. Distribution of *Mantis religiosa* (L.) and its changes in Poland. *Fragmenta Faunistica*, 50 (2): 91 – 125.
- Linnaeus C. 1758. Systema naturae per regna tria naturæ, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima, reformata. 1 – 824.
- Milne L, Milne M. 1980. The Audubon Society field guide to North American insects and spiders. Alfred A. Knopf, Inc., New York, NY.
- Nacional'nyj turističeskij ofis: Pogoda v Ukraine. [Wheather in Ukraina]. Gosudarstvennâ služba turizma i kurortov Ministerstva kul'tury i turizma Ukrainy. <http://ukrtourism.com.ua/ru/ukraine/wether/> (Accessed November 9, 2010). (In Russian).
- Nagy A., Kisfali M. 2007. Effects of mowing intensity on Orthoptera assemblages of meadows in southwest Hungary. *Analele Universitatii din Oradea, Fascicula: Protectia Mediului*, 12: 100 – 105.
- Oficial'nyj sajt respubliki Belarus: Klimat i pogoda v Belarusi [The official site of Republic of Belarus. Climate and weather in Belarus]. <http://www.belarus.by/ru/about-belarus/climate-and-weather> (Accessed November 9, 2010). (In Russian).
- Olejnik O. 2010. Stolicu atakuût bogomoly [The Mantids attack the capital]. *Blik TV*. <http://www.blik.ua/content/view/33261/45/> [23.08.2010]. (In Russian).
- Prokop P., Vaclav R. 2008. Seasonal aspects of sexual cannibalism in the praying mantis (*Mantis religiosa*). *Journal of Ethology*, 26 (2): 213 – 218.
- Pupins M. 2007. First report on recording of the invasive species *Trachemys scripta elegans* a potential competitor of *Emys orbicularis* in Latvia. *Acta Universitatis Latviensis*,

- Biology*, 723: 37 – 46.
- Pupins M., Pupina A. 2010. Amerikas sugas *Pygocentrus sp.* (Actinopterygii: Characiformes: Characidae: Serrasalminae) sastapšanas gadījums Latvijā, Daugavpilī. [Registration case of an American species *Pygocentrus sp.* (Actinopterygii: Characiformes: Characidae: Serrasalminae) in Latvia]. *Klimata mainība un ūdeņi*. Rīga. Latvijas Universitāte. 77 – 82 (In Latvian).
- Roeder K.D. 1935. An experimental analysis of the sexual behavior of the Praying Mantis (*Mantis Religiosa L.*). – *The Biological Bulletin*, LXIX, 2: 203 – 220.
- Schmidt-Rhaesa A., Ehrmann R. 2001. Horsehair Worms (Nematomorpha) as Parasites of Praying Mantids with a Discussion of their Life Cycle. *Zoologische Anzeigung*, 240: 167 – 179.
- Tribblehorn J.D., Yager D.D. 2001. Broad versus narrow auditory tuning and corresponding bat-evasive flight behaviour in praying mantids. *Journal of Zoology, London*, 254: 27 – 40.
- Turlajs J. (ed.) 2007. Latvijas ģeogrāfijas atlants. Karšu izdevniecība Jāņa sēta: 1 – 40 (In Latvian).
- UNEP, CMS, DEFRA 2009. Migratory Species and Climate Change. Impacts of a Changing Environment on Wild Animals. UNEP, CMS Secretariat: 1 – 68.
- Vahed K. 1998. The function of nuptial feeding in insects: a review of empirical studies. *Biological Review*, 73: 43 – 78.
- Walther G.-P., Roques A., Hulme P.E., Sykes M.T., Petr Pysek P., Kuhn I., Zobel M., Bacher S., Botta-Dukat Z., Bugmann H., Czucz B., Dauber J., Hickler T., Jarosik V., Kenis M., Klotz S., Minchin D., Moora M., Nentwig W., Ott J., Panov V.E., Reineking B., Robinet Ch., Semchenko V., Solarz W., Thuiller W., Vila M., Vohland K., Settele J. 2009, Alien species in a warmer world: risks and opportunities. – *Trends in Ecology and Evolution*, 24 (12): 686 – 93.
- Wareham D.C. 2005. Elsevier's Dictionary of Herpetological and Related Terminology. Elsevier B.V.: 1 – 240.
- Yager D.D. 1999. Comparative aspects of Rearing and Breeding Mantids. In: Prete F.R. et al. (eds): *The Praying Mantids*. John Hopkins Univ. Press: 311 – 317.

Received: 01.09.2012.

Accepted: 01.11.2012.