Tatiana V. Dikareva[1]*, Vadim Yu. Rumiantsev[2]
[1] Faculty of Geography, Lomonosov Moscow State University, Moscow, Russia; Leninskie gory, 1, 1199911, Tel. + 7 9060823239
* **Corresponding author:** e-mail: tvdikareva@yandex.ru
[2] Faculty of Geography, Lomonosov Moscow State University, Moscow, Russia; Leninskie gory, 1, 1199911, Tel. + 7 9060823239, vyurum@biogeo.ru

DISTRIBUTION OF ALLERGENIC PLANTS IN RUSSIA

ABSTRACT. We analyzed, for the first time ever, the geographical distribution of the main allergenic plants in Russia. All materials were organized as database and attached to the map in GIS Mapinfo. For each region of Russian Federation, two indices were calculated: the total number of allergenic plants in the region and the "allergenic index". A series of maps was compiled: the number of spring-flowering species, the number of summer-flowering species, the total number of species flowering during the whole year, the overall allergen danger during spring and summer seasons, respectively, and the overall allergen danger during the whole year.

In terms of the number of allergenic species and by the "allergenic index," the most dangerous regions appeared to be the Ryazan and Voronezh Oblasts, while the less dangerous – the Chukotka Autonomous Okrug, and the Magadan Oblast. The maps may serve as a reference source for allergologists and allergy sufferers.

KEY WORDS: allergenic plants, pollinosis, allergenic index, cross allergy, maps of distribution.

INTRODUCTION

By the end of the XXth century allergy became one of the most widespread diseases in the industrial countries. One of the causes of allergy is plant pollen. Plant pollen allergy – *pollinosis* – is the disease of each fourth inhabitant of our planet.

More than 700 species of allergenic plants are known. Allergenic plants produce the largest amount of pollen early morning; that is why this time is the most dangerous for allergy sufferers. Maximum concentration of pollen in the air occurs during the warm sunny weather, while rain and dryness slow down the pollen ripening and allergy sufferers feel better in such weather.

Pollinosis symptoms appear when pollen concentration in the air reaches the threshold values. It is accepted that the dangerous limit is 10–20 pollen granules per 1 cubic meter of air.

There are more than 700 species of allergenic plants. In medical literature allergenic plants are divided into three groups – trees, cereal grass, and weeds. They bloom during different periods and pollinosis exacerbations occur during two periods – spring-summer (from the beginning of April through the middle of June – trees) and summer (June-July – cereal grasses and from the end of June through the end of August – weeds). Usually the allergy sufferers react to the blooming of not one but several plants; that is why the seasonal exacerbations last approximately one month.

Pollen allergy takes the form of allergenic rhinitis and conjunctivitis and causes the symptoms of runny nose with clear discharge from nose, cough, and tickling feeling in the throat, as well as watering eyes, itch, and redness of eyes. Allergy may take the form of bronchospasm and bronchial asthma attack.

In Russian medical literature much attention is paid to various aspects of pollen impact on human organism. One can find the calendars of allergic plants flowering [www.kestine.ru], but the geographic distribution of those plants has not been analyzed. Foreign allergologists have been addressing this issue in detail beginning from the end of the XXth century [May, Smith, 2008; Rondónet al. 2011]. There is the website in the USA [www.pollenlibrary.com], which shows daily flowering and danger for all 300 allergic species in all states and large settlements.

The work presented herein is the first attempt of geographical analysis of the main allergenic plants distribution in Russia.

MATERIALS AND METHODS

We selected for analysis 119 allergenic species. Even this operation was difficult because there is no generally recognized list of such plants in Russia. In the workbook for allergologists [Allergologiya i immunologiya…, 2009; Poriadok okazaniya…, 2010], the most dangerous species and groups of species (often families) are named. We followed this workbook, internet resources [www.allergology.ru, www.pollenlibrary.com], and some additional literature sources [Esch et al, 2001].

We selected the most widespread species or the species that produce the largest amount of pollen – the most dangerous for allergy sufferers during flowering period. We included into this list only those decorative plants that overstep the limits of artificial plantings (for example, ash-leaved maple). For each species, the degree of allergenic danger was estimated on a three-grade scale: dangerous (3), medium (2) and weak (1). This estimation was based on the materials of the above-mentioned websites and on the available data of pollen production of selected species. The selected species were divided into two groups: spring-flowering (April-May – beginning of June) and summer-flowering (middle of June – beginning of September). The number of analyzed species according to the danger category and period of flowering is given in Table 1.

Table 1. Number of analyzed allergenic species by categories of danger and terms of flowering

Flowering period	Categories of allergenic danger			Total
	weak (1)	medium (2)	dangerous (3)	
Spring	4	24	18	**46**
Summer	6	33	34	**73**
Total	**10**	**57**	**52**	**119**

For the spring period, we selected only 4 weakly dangerous species. Those are: the dominant species in the communities (common beech and oriental beech) and the widespread species (common juniper). The bald cypress is an example of rare species but is frequently mentioned as allergenic in practically all foreign literature. For the summer period, we selected 6 weakly dangerous species widespread in the European territory of Russia (ETR) (see Table 1).

Data on the allergenic species ranges were obtained from the plants guide-books [Gubanov, et al., 1995; Sosudistie rasteniya Sovetskogo Dal'nego Vostoka, 1996; Flora Sibiri, 1987–2003] and from the database Agroatlas [www.agroatlas.ru]. The distribution of selected species was then associated with the subjects of the Russian Federation (RF). It is not well accepted in biogeographical mapping of taxonomic entities. But such approach is well understood by a large section of the population including allergologists and allergy sufferers.

The material was organized as database and the association with the subjects of the RF was mapped with the help of GIS Mapinfo. The database was created using the methodology developed by the authors for the database of the Russian terrestrial vertebrates [Rumiantsev, Danilenko, 1998]

For each region of the RF two indices were calculated: the total number of allergenic plants in the region and "allergenic index" – the sum of allergenic danger grades in the scale. For estimation we used the software applications Visual FoxPro and Statistika.

A series of maps were designed: the number of spring-flowering species (Fig. 1), the number of summer-flowering species (Fig. 2), the total number of species flowering during the whole year (Fig. 3), the overall allergenic danger during spring (Fig. 4) and summer (Fig. 5) seasons, respectively, and the overall allergenic danger during the whole year (Fig. 6).

RESULTS AND DISCUSSION

The results obtained through analysis of the compiled maps are presented below.

The maximum number of allergenic species that flower during spring (Fig. 1) is found in the central regions of the ETR. The number decreases towards north, south, and east and is the lowest in the Chukotka Autonomous Okrug and the Magadan Oblast. This can be explained by the fact that during spring flower, the allergenic deciduous trees and some coniferous trees are distributed in the southern part of the forest zone.

The maximum number of allergenic species that flower during summer (Fig. 2) is in the southern regions. Those are broadleaved forests, forest-steppe, steppe, and the forests of Ciscaucasia. The species are: cereal grasses, wormwoods, and "weeds" – goose-foot, pigweed, nettle, plantain etc., and for the trees – tillet. The number of such species is maximal in the zone of broadleaved forests.

The total number of allergenic species for the whole period of flowering (Fig. 3) is maximal in the central regions of the ETR, the Kaliningrad Oblast, the Karsnodar Kray, and Crimea. This can be explained by the fact that allergy is studied and registered mostly in the territory of the ETR and only local species are considered. The second reason is that the variety of allergenic species reflects the total species diversity in communities, which is the greatest in the broadleaved forest and forest-steppe zone. Allergenic species include weeds as well, which are the product of anthropogenic impact on vegetation, thus,

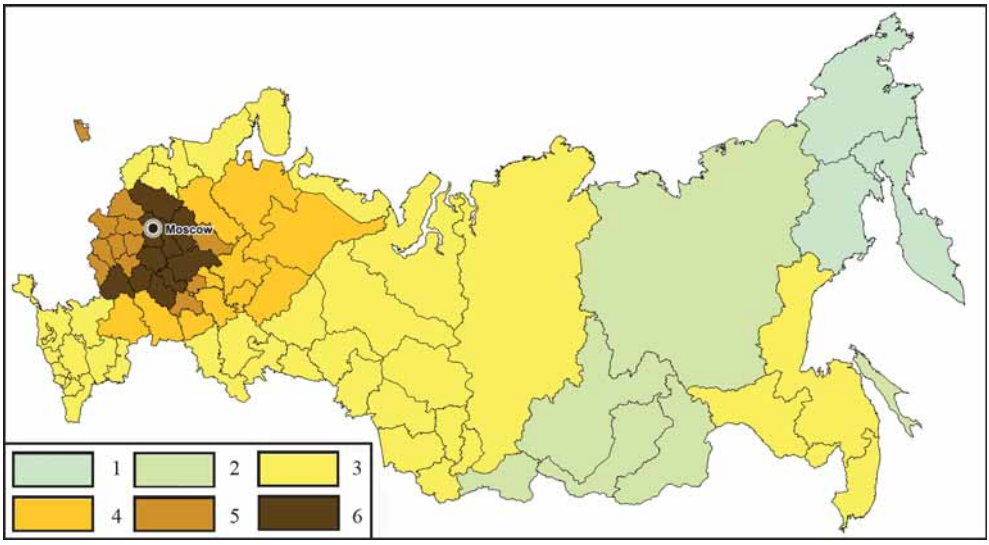


Fig. 1. Number of allergenic plant species flowering during spring:
1 – *10 and less (3)*, **2** – *11–15 (6)*, **3** – *16–20 (39)*, **4** – *21–25 (11)*, **5** – *26–30 (12)*, **6** – *31 and more (11).*
(In brackets – number of administrative units within the range).

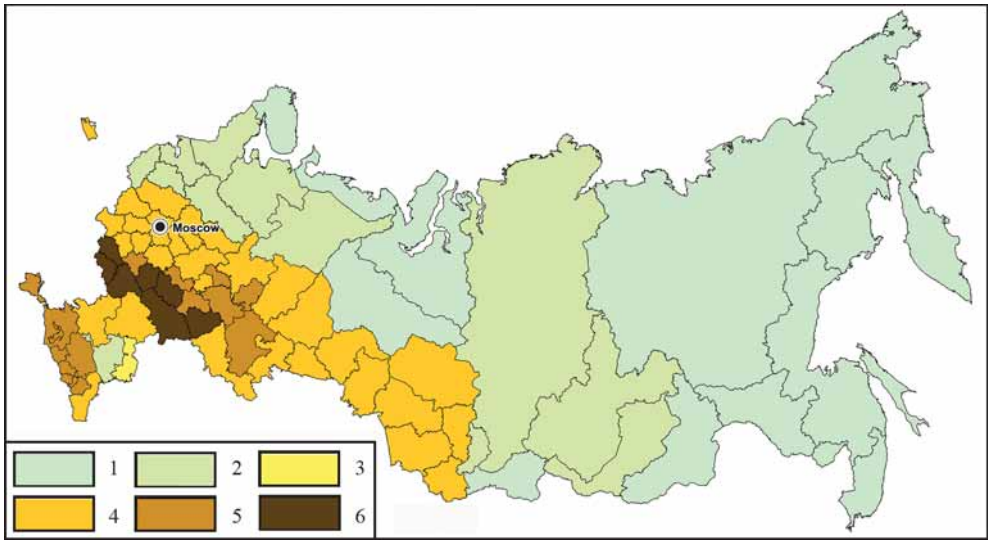


Fig. 2. Number of allergenic plant species flowering during summer:
1 – *34 and less (15),* **2** – *35–39 (12),* **3** – *40–44 (1),* **4** – *45–49 (31),* **5** – *50–54 (16),* **6** – *55 and more (7).*
(In brackets – number of administrative units within the range).

the impact is maximal in the well-developed regions of the ETR.

The concentration of allergenic species in the central regions of the ETR can be associated with one more factor. The allergy morbidity rate is higher in those regions where the indices of air, water, and food pollution are higher. The high level of pollution stimulates the so called "cross" allergenic response [Romaniuk, 2010], which makes human organism more sensitive to pollen. Thus,

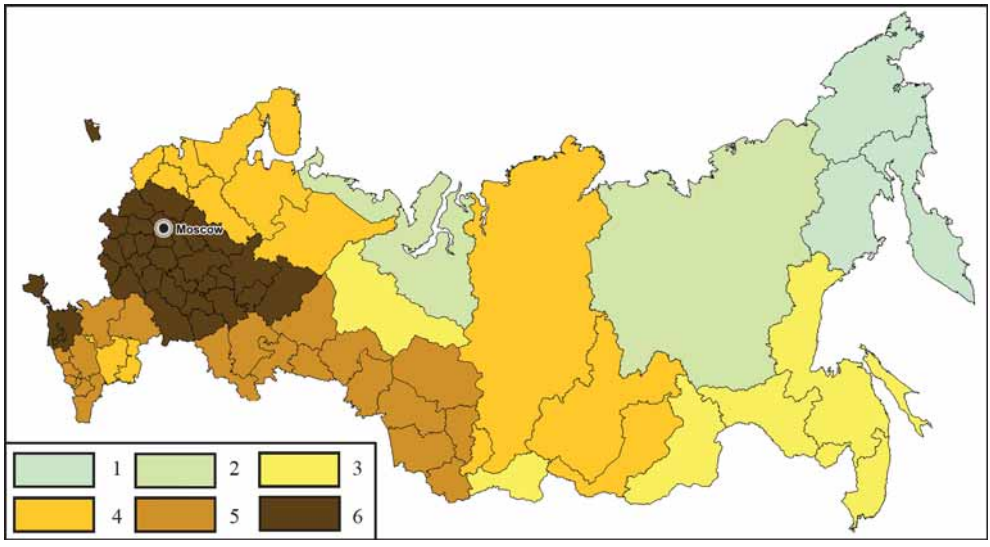


Fig. 3. Number of allergenic plant species flowering during the whole vegetation period:
1 – *30 and less (3),* **2** – *31–40 (3),* **3** – *41–50 (8),* **4** – *51–60 (14),* **5** – *61–70 (21),* **6** – *71 and more (33).*
(In brackets – number of administrative units within the range).

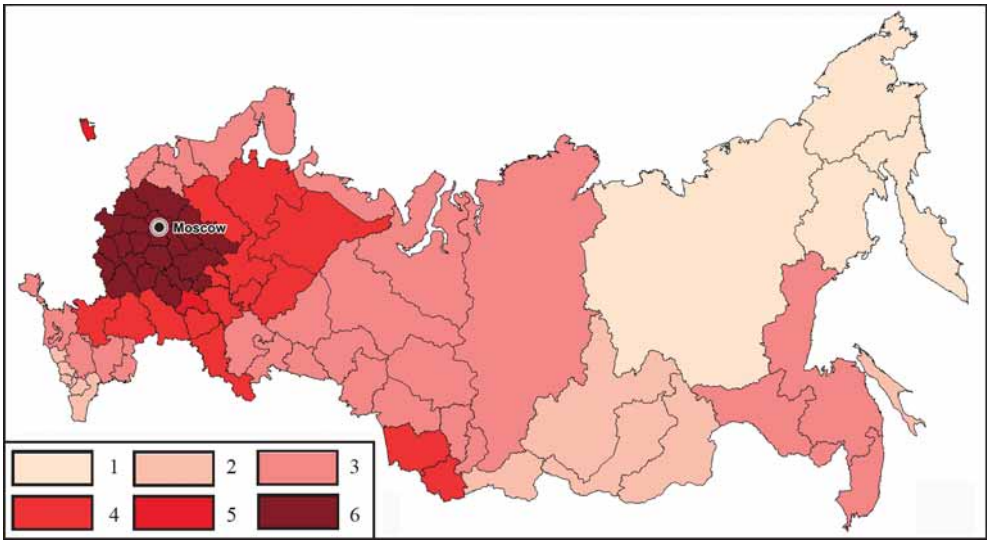


Fig. 4. Summarized "allergenic index" in spring:

1 – *30 and less (4)*, **2** – *31–40 (11)*, **3** – *41–50 (29)*, **4** – *51–60 (15)*, **5** – *61–70 (2)*, **6** – *71 and more (21).*
(In brackets – number of administrative units within the range).

the allergenic species are concentrated in industrially developed and, because of this reason, polluted regions of Russia.

The highest overall allergy danger during spring (Fig. 4) is detected in the central regions of the ETR and the Kaliningrad Oblast; it decreases to the south and east. It is higher (but not much) in the Far East (the Primorsky Kray, the Khabarovsk Kray, the Amur Oblast, and the Jewish Autonomous Oblast). This fact can be explained by the high allergy danger

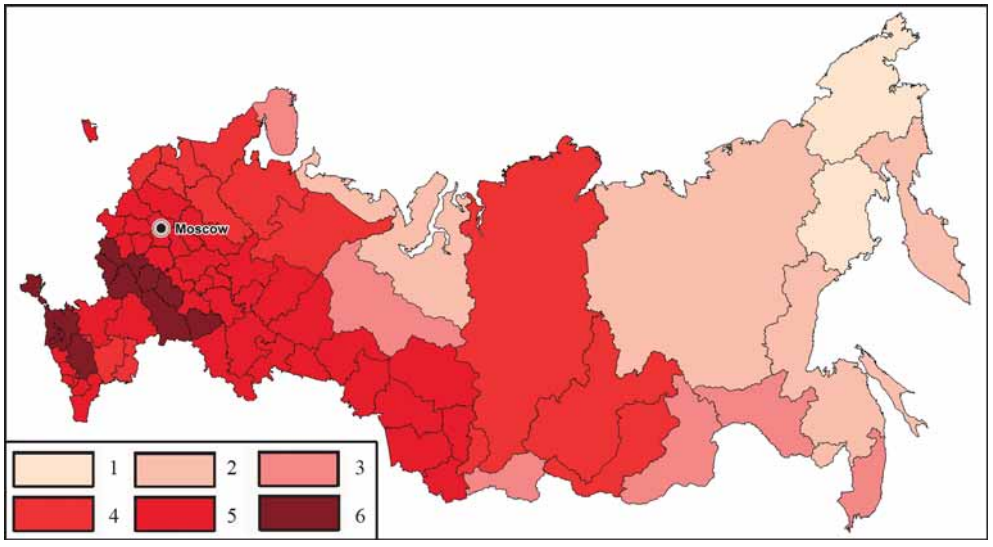


Fig. 5. Summarized "allergenic index" in summer:

1 – *40 and less (2)*, **2** – *41–60 (7)*, **3** – *61–80 (6)*, **4** – *81–100 (13)*, **5** – *101–120 (42)*, **6** – *121 and more (12).*
(In brackets – number of administrative units within the range).

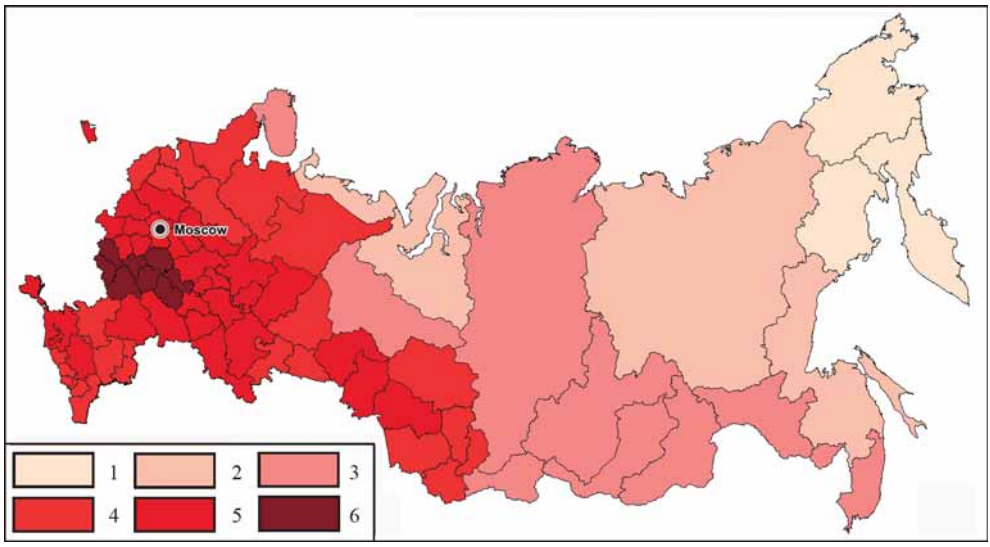


Fig. 6. Summarized "allergenic index" in the whole vegetation period:

1 – *70 and less (3),* **2** – *71–100 (5),* **3** – *101–130 (10),* **4** – *131–160 (24),* **5** – *161–190 (32),* **6** – *191 and more (8).*
(In brackets – number of administrative units within the range).

resulting from the predominance of willows and oaks in the broadleaved forests of the Far East. The allergy danger is minimal in the Sakha Republic, the Chukotka Autonomous Okrug, the Magadan Oblast, and the Kamchatka Kray, as well as in the Ciscaucasian republics during this period.

Forest-steppe and steppe regions of the ETR are the most dangerous for allergy sufferers during summer (Fig. 5): the Kursk, the Voronezh, the Saratov, the Samara, the Lipetsk, and the Penza Oblasts, as well as the Stavropol Kray and the Krasnodar Kray, Crimea, and the Republic of Adygeya. It can be explained by high allergenic danger of most cereal and wormwood species, abundant in the Russian steppes [Dikareva, 2004]. A relatively high danger is typical of broadleaved, smalleaved, and mixed forests, mostly because of the cereal species flowering. The minimum danger is typical of the northern and the Far East regions (the Sakha Republic, the Chukotka, the Nenets, and the Yamalo-Nenets Autonomous Okrugs, the Magadan and the Sakhalin Oblasts, the Kamchatka and the Khabarovsk Krays during this period).

For the whole period of flowering (Fig. 6), the most dangerous regions are the Kursk, the Belgorod, the Voronezh, the Ryazan, the Lipetsk, the Tambov, and the Penza Oblasts and the Republic of Mordovia. As it was mentioned above, these regions have developed industry and high level of environment pollution.

As a whole, according to the number of allergenic species and the "allergenic index," the most dangerous are the Ryazan and the Voronezh Oblasts, while the least dangerous are the Chukotka Autonomous Okrug and the Magadan Oblast.

CONCLUSION

Thus, the analysis revealed the principal laws of allergenic plants distribution in Russia.

The most dangerous for allergy sufferers region of Russia during spring and summer are the Ryazan and the Voronezh Oblasts, respectively. The least dangerous during spring and summer are the Chukotka Autonomous Okrug and the Magadan

Oblast, respectively; both regions were the least dangerous if the entire period was considered.

Further research on connection between pollinosis and environment pollution in the region is necessary. We also plan to compare our results with data on the pollinosis morbidity rate.

The compiled maps could serve as reference material for allergologists and allergy sufferers. These maps and the database could be used in development of an interactive information system.

ACKNOWLEDGEMENTS

The research was supported by the Russian Geographical Society and the Russian Fund for Basic Research (№ 13-05-41165) "Integral assessment and mapping of the natural factors impact on the public health in Russia" ■

REFERENCES

1. Agroecologicheskiy atlas Rossii i sopredel'nykh stran. [Agroecological atlas of Russia and adjacent countries]. Available from: www.agroatlas.ru (in Russian).

2. Allergologiya i immunologiya: nacional'noye rukovodstvo. (2009). [Allergology and Immunology: national guidebook]. – Editors R.M. Haitova, N.I. Iliena – M.: GEOTAR-Media. (in Russian).

3. Allergologiya. [Allergology]. Available from: www.allergology.ru (in Russian).

4. Calendar' pyleniya. [Calendar of pollen production]. Available from: www.kestine.ru (in Russian).

5. Dikareva T.V. (2004). Okhrana biotsenoticheskogo i botanicheskogo raznoobraziya stepey Evrazii na territorii Rossii [Protection of biocoenotic and botanical diversity of Eurasian steppes on the Russian territory]. Aridnie ecosistemi [Arid ecosystems]. V. 10. № 22–23, pp. 69–80. (in Russian).

6. Esch Robert E. et al. (2001). Common allergenic pollens, Fungi, Animals and Arthropods. Clinical Reviews in Allergy and Immunology. V. 21, pp. 261–292.

7. Flora Sibiri. [Siberian Flora]. (1987–2003).Vv. 1–14. Novosibirsk: Nauka. (in Russian).

8. Gubanov I.A., Kiseleva K.V., Novikov V.S., Tihomirov V.N. (1995). Opredelitel' sosudistykh rasteniy tsentralnykh regionov Evropeyskoy territorii Rossii [Guide-book of vascular plants of the central regions of European Russia. – 2-nd edition, supplemented and revised]. – M.: Argus. (in Russian)

9. May, J.R.; Smith, P.H. (2008)."Allergic Rhinitis". In DiPiro, J.T.; Talbert, R.L.; Yee, G.C.; Matzke, G.; Wells, B.; Posey, L.M. Pharmacotherapy: A Pathophysiologic Approach (7th ed.). New York: McGraw-Hill. pp. 1565–1575.

10. PollenLibrary. Available from: www.pollenlibrary.com

11. Poriadok okazaniya meditsinskoy pomoshchi bol'nym s allergicheskimi zabolevaniyami i boleznyami assotsiirovannymi s immunodefitsitami. Prilozheniye k prikazu Ministerstva

zdravookhraneniya i social'nogo razvitiya Rossiyskoy Federatsii ot 4 fevralya 2010 goda. (2010). [Medical care procedure of allergy sufferers and patients with immunodeficiency. Enclosure to the order of the Public Health and social development Ministry of Russian Federation from February 4]. № 60н2. (in Russian).

12. Romaniuk L.I. (2010). Pollinoz i perekrestnaya pishchevaya allergiya. Problemi diagnostiki, lecheniya i profilaktiki. [Pollinosis and cross food allergy. Problems of diagnostics, cure and prevention] // Zdorovia Ukraina. № 1, pp. 46–48. (in Russian).

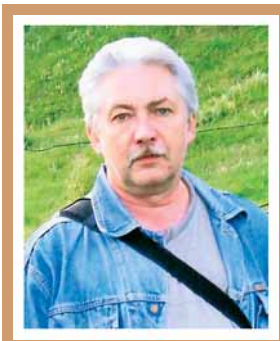
13. Rondón C., Blanca-López N., Aranda A., Herrera R., Rodriguez-Bada J.L., Canto G., Mayorga C., Torres M.J., Campo P., Blanca M. (2011). Local allergic rhinitis: allergen tolerance and immunologic changes after preseasonal immunotherapy with grass pollen. The Journal of Allergy and Clinical Immunology. 127 (4): 1069–1071.

14. Rumiantsev V.Yu., Danilenko A.K. (1998). Informatsionnaya Sistema "Naseleniye nazemnykh pozvonochnykh Rossii" [Data system "The population of terrestrial vertebrates of Russia"]. Problemi ecoinformatiki. Materialy tretiego mezhdunarodnogo simpoziuma. [Problems of ecological informatics. Materials of the third international symposium]. Moscow, pp. 126–129. (in Russian).

15. Sosudistye rasteniya Sovetskogo Dal'nego Vostoka. (1996). [Vascular plants of the Soviet Far East]. Vv. 1–8. – Editor S.S. Kharkevich. – Sankt-Petersburg: Nauka, (in Russian).

Received 10.10.2015 Accepted 06.11.2015

Tatiana V. Dikareva has a Ph. D. degree in Geography. She is Senior Researcher at the Department of Biogeography, Faculty of Geography, Lomonosov Moscow State University. Her main research interests include biodiversity, management and conservation of water protection vegetation, successions of vegetation, and changes in floristic composition. Her current main scientific activities are in the field of dynamics of vegetation under the impact of climate change and impact of changes in vegetation on public health. She is the author and a co-author of more than 70 scientific publications.



Vadim Yu. Rumiantsev has a Ph. D. degree in Geography. He is Senior Researcher at the Department of Biogeography, Faculty of Geography, Lomonosov Moscow State University. His main research interests include mammalian environmental geography, biogeographic mapping, and the use of GIS technology in biogeography. His current main scientific activities are in the field of theoretical, methodological, and practical aspects of geoinformation mapping of the distribution of terrestrial vertebrates. He is the author and a co-author of more than 230 scientific publications, including more than 90 thematic map-sheets in complex national and regional atlases.