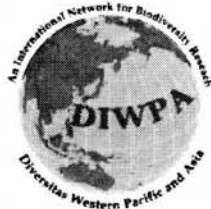


**Perspectives of the Biodiversity Research  
in the Western Pacific and Asia  
in the 21st Century**

**December 18-19, 2003  
Kyodai-kaikan, Kyoto**



Organized by DIWPA (DIVERSITAS in Western Pacific and Asia)

Co-organized by the Research Institute for Humanity and Nature, and by the 21 COE Biodiversity Program of Kyoto University

DIWPA Web Site: <http://diwpa.ecology.kyoto-u.ac.jp>

## Progress of the Forest DIWPA-IBOY Program in North-West Part of the Pan-Japan Sea Area

**Sergey Storozhenko<sup>1</sup>, Koji Nakamura<sup>2</sup>, Vasily Sidorenko<sup>1</sup>, Sergey Kholin<sup>1</sup>, German Lafer<sup>1</sup>, Shin-ichi Tanabe<sup>2</sup> and Kazuya Kimura<sup>2</sup>**

<sup>1</sup>Institute of Biology and Soil Science, Far Eastern Branch of the Russian Academy of Sciences, Vladivostok-22, 690022, Russia,

<sup>2</sup>Division of Biodiversity, Institute of Nature and Environmental Technology, Kanazawa University, Kanazawa, Ishikawa 920-1192, Japan

### Introduction

The problem of biodiversity of the World and its regions is widely discussed now. Insects are much more abundant than other living organisms together. Excellent arguments have been made for 5-15 million (Stork, 1997), 12.5 million (Hammond, 1992), but estimated number even may be up to 30 millions extant insect species (Erwin, 1982).

The International Network for DIVERSITAS in the Western Pacific and Asia (DIWPA) was established in 1993 with a series of biodiversity focussed goals including the inventory and monitoring of biodiversity and ecosystem function of biodiversity. DIWPA has led to much improved collaboration between biodiversity researches and has organised in 2001 the "International Biodiversity Observation Year" (IBOY). The forest IBOY program was focus on the biodiversity of the sites in the region from Russia to Australia.

The main aim of this paper is to discuss the first results of the IBOY activity in the core site at Ussuriiskii Reserve as well as in the satellite sites at Murav'eva-Amurskii Peninsula in the Russian part of the Pan-Japan Sea Area. A special attempt is made in comparison of the insect diversity of the studied plot with the biodiversity of the Primorskii krai and Russian Far East.

Present study was supported in part by grants of Far Eastern Branch of the Russian Academy of Sciences No. 03-3-„B-06-016 and No. 03-1-0-06-028 (S. Yu. Storozhenko, principal investigator). The insect-collecting equipment was provided to a number of DIWPA-IBOY Forest sites in the program "An Integrated Study on Biodiversity Conservation under Global Change and Bioinventory Managing System (DIVER)" undertaken for five years from 1997 to 2002 under the leadership of Dr. H. Kawanabe and the financial support by a Grant-in-Aid for Scientific Research (Creative Basic Research 09NP1501) from the Japanese Ministry of Education, Culture, Sports, Science and Technology. This study is also funded partly by the 21th Century COE Program of Kanazawa University "Environmen-

tal Monitoring and Prediction of Long- and Short-Term Dynamics of Pan-Japan Sea Area - Construction of Monitoring Network and Assessment of Human Effects."

### Insect diversity of the Russian Far East

Russian Far East occupies the square 3016 thousand sq. km. and extends from Wrangel Il. (71° N) southwards to Khasan Lake (42° N) and from Dezhnev Cape (170° W) westwards to Stanovoj Range (120° E). The forests occupy 39% of this square and dominate in Primorskii krai, Khabarovskii krai, Amurskaya oblast, and Sakhalin Il. The insect fauna of Russian Far East is represented by about 31500 estimated species from 629 recorded families of 31 orders (Storozhenko *et al.*, 2002). The largest orders are Hymenoptera (72 families, 9000 estimated species), Diptera (119 families, 8000 species), Coleoptera (114 families, 5500 species), Lepidoptera (81 families, 5000 species). The most insect orders are well represented in each region except Chukotka.

There are four levels of insect family diversity: around 200 families (Chukotka), around 300 (Magadanskaya oblast and Kamchatskaya oblast), around 450 (Amurskaya oblast, southern part of Khabarovskii krai, Sakhalin and Kuril Islands), and 600 families (Primorskii krai). Insects are best and well represented at the species level in Primorskii krai, mostly in its extremal southern part (about 22600 estimated species).

Three regions in Holarctic have almost the same number of species: Russian Far East (Storozhenko *et al.*, 2002), Japan (Hirashima, 1990) and Canada (Danks *et al.*, 1997). Russian Far East and Canada belong to temperate zone of Holarctic. Southern borders of these vast regions have the same latitude (42°N), which result in similarity of climatic and vegetation belts. These factors have strong influence for distribution and diversity of insects. Therefore total number of insect species in both regions is almost equal, and percentages of Lepidoptera (16% of total species) and Diptera (24-25%) are the same, but the beetles are more numerous in Canada. The number of recorded insect spe-

cies for Japan in spite of its rather small square is approximately the same as for Russian Far East and Canada. The reason of such similarity depends on more southern position of Japan (up to 23° N). Coleoptera represented in Japanese fauna much better (32% of total insect species) than in Canada (25%) or Russian Far East (17%), probably it results of the increasing of beetle percentage for subtropical faunas.

#### The core site in the Russian Far East

The core site in Russia has been established in Primorskiy krai near Ussuriyskiy Natural Reserve. A one hectare plot have been selected in the vicinity of Kamenushka village on the top of the hill (200m above sea level) on left side of Volkha River (43°36.63'N, 132°14.18'E) in mixed coniferous-broad-leaved forest. A plot was established according DIWPA-IBOY recommendations (Toda, Kitching, 1999).

The plant diversity of the mixed coniferous-broad-leaved forest at plot is characterised by follow (Storozhenko, 2003). There are 91 recorded species of vascular plants: trees, bushes and lianas are represented by 34 species, the herbs - by 57 species. The number of herb species at plot will be increased after studying of ephemeral spring herbs and sedges (*Carex*). The three layer at plot consist of 3 sub-layers: highest (at a height of 23-27m, with *Abies holophylla*, *Pinus koraiensis*, *Quercus mongolica*, *Tilia amurensis*, *Betula platyphylla* and other trees with mean diameter about 40-60cm), median (at a height of 16-20m, the same species plus *Acer mono* with mean diameter about 20-25cm), and lower (at a height of 8-12m, composing by *Acer pseudosieboldianum*, *Carpinus cordata* and young trees with mean diameter about 10-12cm). The shrub layer is mosaic and composing by 14 plant species. *Corylus mandshurica* is dominant here. The herb layer (about 60 species) at plot is not uniform. The forb and graminoids are dominant in the half of plot, in other half the cryptogams are most abundant.

#### Results of arthropod collecting in the core site

To collect arthropods in canopy and ground zones of plot the follow seven techniques and traps recommend by DIWPA-IBOY [9] are used: light traps, Malaise traps, window traps, pitfall traps, banana traps, litter sampling, and bark spraying. All types of traps were concurrently used periodically from 25 June to 12 September 2001. After collecting and fixation of the entomological materials all samples have been sorted to ordinal or families levels. A

part of arthropods is fixed in alcohol (mainly from window traps, pitfall traps, banana traps, bark spraying, and litter sampling), the specimens from light traps and Malaise traps are kept mainly in cotton layers in dry condition. All data are stored in database using Excel. The 33619 specimens of arthropods from 118 samples in plot have been collected totally. The most abundant orders are Diptera (17479 specimens) and Lepidoptera (8888 specimens). The orders Coleoptera (2128 specimens), Hymenoptera (1332 specimens), Collembola (746 specimens), Homoptera (686 specimens) and Acari (1077 specimens) are well represented too. Other insect orders and arthropod groups are represented by about 1300 specimens.

- A. Light traps. The standard Pennsylvania trap with 8W daylight fluorescent tube and 12v battery is used. We operate 2 traps, one at ground level and one in the canopy. The 20 samples are made at randomly determined points (10 at ground level and 10 at canopy). The 19598 specimens of insects and other arthropod have been collected totally. The orders Lepidoptera, Coleoptera and Hymenoptera are represented in canopy zone slightly better than in ground. On the contrary the number of specimens of Diptera, Homoptera and Heteroptera in the ground zone are about twice greater than in canopy.
- B. Malaise traps. We use two standard Malaise traps. The 25 samples (13 at ground level and 12 at canopy) are made. The 10039 arthropod specimens have been collected. All large orders (Diptera, Hymenoptera, Lepidoptera, Coleoptera, Homoptera) are represented in ground zone considerably (2-10 times) better than in canopy.
- C. Window traps. We operate two window traps. The 501 specimens of insects and other arthropod have been collected from 18 samples (9 at ground level and 9 at canopy). The orders Diptera, Hymenoptera and Collembola are represented in ground zone 2-3 times better than in canopy. On the contrary the number of specimens of Homoptera and Coleoptera in canopy zone are about twice greater than in ground.
- D. Pitfall traps. We use 60mm plastic tubes with detergent as a killing agent. Five traps are arranged in a cross with 0.5 meter between each trap as a trapping "unit". Totally 1842 specimens of insects and other arthropods were collected from 17 "units". The Collembola, Diptera, Hymenoptera and Coleoptera are most abundant.
- E. Banana traps. Twenty-four samples have been made using banana traps (6 samples at ground, 6 - at 1.3m, 6 - at 2.5m and 6 - at 6m above ground level). Drosophilidae (Diptera) is dominant here (144 specimens).

F. Litter sampling. We collect 2 samples from random points in the plot. Each comprises about a litre of moist leaf scraped up from around the selected point. The Acari, Diptera, and Collembolla are most abundant here.

G. Bark spraying. The bark spraying was made on square unit (1x0.5m) of 5 tree species: oak (*Quercus mongolica*), birch (*Betula platyphylla*), ashwood (*Fraxinus mandshurica*), fir (*Abies holophylla*), pine (*Pinus koraiensis*), and in hollow of old oak tree. The arthropod fauna of the bark surface of trees quite different from fauna of hollow, mainly by increasing of the Dipteran family Phoridae, and order Orthoptera in hollow. The number of specimens of different orders on bark surface is similar for all tree species, except Collembolla and Acari, which are more numerous on the *Fraxinus mandshurica* bark.

#### **Preliminary analysis of insect diversity of the core site**

For a few groups of insects, such as orders Coleoptera, Orthoptera, Ephemeroptera, Trichoptera, and families Drosophilidae (Diptera) and Formicidae (Hymenoptera) all collected in the core site specimens were determinate up to species (Storozhenko *et al.*, 2003; Tiunova, Storozhenko, 2003; Arefina, Storozhenko, 2003; Kholin, Kupianskaya, 2003). It give possibility to compare the biodiversity in plot (0.01 sq. km) with diversity of local (Ussuriiskii Reserve, 405 sq. km) and regional (Primorskii krai, 169900 sq. km) faunas (Storozhenko, 2003).

The fauna of Primorskii krai consists of 117 families of Diptera, but only 39 families (33.3%) are mentioned from the plot. There are three large groups of the families in the plot: most abundant families (more than 100 collected specimens), common families (10-100 specimens totally), and rare families (less than 10 specimens). Beside must abundant Diptera the families Muscidae, Tabanidae and Sciaroid flies are dominant in Malaise traps, Ceratopigonidae, Tipulidae and Sciaroid flies very common in light traps, and Drosophilidae were collected mainly in banana and light traps. Seventeen families of Diptera are common, the majority of them well represent in Malaise and light traps. The Sphaeroceridae and Antomiidae were collected mainly in pitfall traps. Empididae are dominant in window traps. Eleven families of Diptera are rare and represented by 1-5 specimens in all types of traps totally.

In Primorskii krai the number of the species of family Drosophilidae (Diptera) and order Orthoptera are almost

the same (114 and 102 species respectively). But the fauna of plot is quite different in both groups. Drosophilidae are well represent in studied forest ecosystem (58% of local fauna of Ussuriiskii Reserve, and 39% of regional fauna of Primorskii krai), while Orthoptera occupied mainly open areas and are pure represent in plot (8% and 4% respectively).

Eleven species of ants (Hymenoptera: Formicidae) were collected in plot, which consist 18 % of the fauna of Primorskii krai, and 39 % of Ussuriiskii Reserve respectively (Kholin, Kupianskaya, 2003).

The fauna of Coleoptera of Primorskii krai is represented by 3800 species from 104 families. Only 212 species from 51 families were collected by all types of traps in plot, which consist 49% of families and 5.6% species of the fauna of Primorskii krai (Storozhenko *et al.*, 2003). The most diverse families in plot are Staphylinidae (38 species from 22 genera), Carabidae (28 species from 16 genera) and Nitidulidae (17 species from 10 genera), each other family is represent by 1-8 species.

The fauna of caddisflies (Trichoptera) of Primorskii krai is represented by 254 species from 92 genera and 25 families. The fauna of Ussuriiskii Reserve consists of 78 species from 43 genera and 20 families. Only 22 species from 16 genera and 11 families were collected in plot at Kamenushka by light traps in the canopy and ground zones, which consist 44 % of families, 17.4 % genera and 8.7 % species of the fauna of Primorskii krai, and 55 %, 37.2 % and 28.2 % of Ussuriiskii Reserve respectively. The number of specimens of Trichoptera in the canopy and ground zones in plot is almost the same, but number of species is quite differing: 20 species occurred in ground zone, and only 11 ones in canopy zone (Arefina, Storozhenko, 2003).

The fauna of mayflies (Ephemeroptera) of Primorskii krai is represented by 91 species from 11 families. Only 4 species from 3 families were collected by Light traps in the canopy and ground zones in plot at Kamenushka, which consist 27.3% of families and 4.4% species of the fauna of Primorskii krai (Tiunova, Storozhenko, 2003).

In orders Coleoptera, Orthoptera, Ephemeroptera, Trichoptera, as well as families Drosophilidae and Formicidae all collected in plot specimens belong to known species. New species will be found beside insects poorly

studied in Russian Far East. For example, two new genera and 33 new species of gall midges (Diptera, Cecidomyiidae) have been described based on material collected in plot (Fedotova, 2002, 2003; Fedotova, Sidorenko, 2003).

**Satellite sites at vicinities of Vladivostok**

After meeting in Kanazawa in March 2003 the Japanese and Russian entomologist outline a plan to study the insect diversity of forest ecosystems in respect to human activity and pollution in the Pan-Japan Sea Area using DIWPA-IBOY data. A newly started project, the 21st-Century COE program aims to elucidate the effects of human-generated environmental changes on biodiversity and ecosystem functions in the Pan-Japan Sea Area and thus, can be regarded as being the next stage of DIWPA-IBOY that has worked with such basic information as the actual status and spatial and temporal trends of biodiversity in natural ecosystems within Western Pacific and Asian region (Tanabe *et al.*, 2003).

Seven satellite sites was selected in Russia at vicinities of Vladivostok (Murav'eva-Amurskii Peninsula) in 2003:

1. Secondary broad-leaved forest (Nagornii Park) inside Vladivostok;
2. Oak forest at lower slopes of mountain near the highway;
3. Oak forest at the top of the mountain;

4. Primary mixed coniferous-broad-leaved forest at the middle slopes of mountain;
5. Primary mixed coniferous-broad-leaved forest at the lower slopes of mountain;
6. Secondary broad-leaved forest in valley of Bogataya River;
7. Grassland nears the pond in valley of Bogataya River.

The sampling was made using pitfall traps only on 14 June, 1 August, 4 September and 15 October 2003. Totally 7427 specimens of arthropods were collected. All specimens have been sorted to ordinal or families levels according DIWPA-IBOY recommendations. Almost all arthropods are fixed in alcohol, but the beetles (Coleoptera) are pinned, labelled and kept in dry condition. The data obtained by pitfall traps in 2003 (sites No 1-7) and in 2001 (core site, No 8) are given in **Table 1**.

The ground beetles (Coleoptera: Carabidae) was selected as a primary model group. The specimens of the ground beetles from all sites have been determinate to species. In comparison with data obtained in 2001 for core site at Kamenushka by pitfall traps only, the diversity of Carabidae in satellite sites looks as follow: 1) Nagornii park (74 specimens, 18 species), 2) oak forest near the highway (68 specimens, 9 species), 3) oak forest at the top of the mountain (22 specimens, 4 species), 4) mixed coniferous-broad-leaved forest at the middle slopes (100 specimens, 10 species), 5)

**Table 1.** Number of specimens of arthropod orders collected by pitfall traps in 2001 and 2003 in Russia

Taxa	Sites (see text)								Total
	1	2	3	4	5	6	7	8	
Collembola	454	427	438	617	431	226	117	522	3232
Hymenoptera	44	469	214	234	376	95	44	292	1768
Coleoptera	140	129	86	137	103	236	147	231	1209
Diptera	83	71	97	44	50	43	76	493	957
Araneae	92	172	146	101	175	49	94	75	904
Acari	29	50	77	24	55	13	88	132	468
Myriapoda	25	16	48	32	51	13	1	37	223
Homoptera	22	32	14	14	5	11	99	17	214
Orthoptera	0	42	21	0	1	0	13	17	94
Isopoda	25	24	12	12	6		2	0	81
Lepidoptera	9	6	9	9	5	4	2	3	47
Heteroptera	0	1	1	2	0	8	8	0	20
Thysanoptera	0	1	8	1	0	0	1	1	12
Dermaptera	0	2	0	0	0	1	0	7	10
Pseudoscorpions	3	0	1	1	1	0	0	0	6
Syphonaptera	0	2	0	0	1	1	0	0	4
Psocoptera	0	0	0	3	0	0	0	0	3
Neuroptera	0	0	0	1	0	0	0	0	1

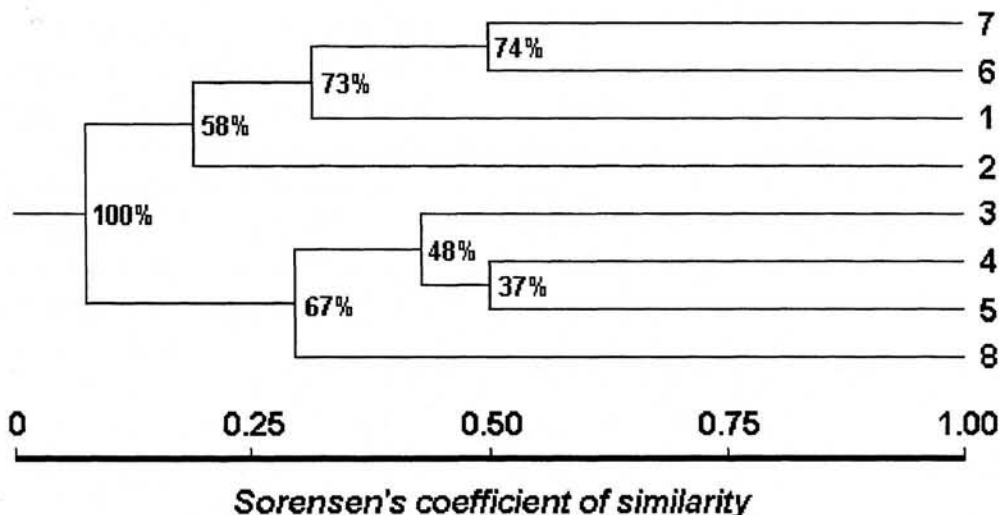
mixed coniferous-broad-leaved forest at the lower slopes (75 specimens, 10 species), 6) broad-leaved forest in valley (189 specimens, 19 species), 7) grassland nears the pond (112 specimens, 21 species), 8) mixed coniferous-broad-leaved forest at Kamenushka (105 specimens, 9 species). Totally 59 species from 19 genera were collected in all sites.

Faunal similarities between sites were evaluated by using Sorensen's coefficient of similarity:  $S = 2a/(2a+b+c)$ , where  $a$  is the number of species common to both sites and  $b$  and  $c$  are the number of species occurring on each of the site (see Legendre, Legendre, 1983). The similarity matrix resulting from pair-wise calculations was then subjected to single and complete linkage clustering as well as unweighted arithmetic average clustering (UPGMA; NTSYS program,

version 1.70, Net Technology Systems, Ecully, France). The results obtained by these approaches being all very similar, we constructed dendrogram using UPGMA. The accuracy of each cluster was estimated by bootstrap analysis using statistical program FreeTree (Pavlicek *et al.*, 1999). A dendrogram was deduced from 1000 bootstrap samples.

The results of analysis of Carabid fauna in all sites are shown in Fig. 1. There are two main branches in dendrogram: one of them consists of grassland and different types of secondary forest (sites No 1, 2, 6, 7), and another united primary forest ecosystems (sites No 3, 4, 5, 8). The diversity of Carabidae varied in first group from 9 to 21 species, in second group from 4 to 10 species for each site.

Fig. 1 Similarity of 59 Species of Carabidae Collected by Pitfall traps Among 8 Sites in Russia Bootstraps Probabilities (expressed in percentage) are Indicated at the Node of Each Cluster



**Conclusions**

The insect fauna of Russian Far East is represented by about 31500 species. Insects are best and well represented at the family and species levels in Primorskii krai, mostly in its southern part.

A one hectare plot has been established in the forest near Ussuriiskii Natural Reserve in Primorskii krai in 2001 as a core site. The 33619 specimens of arthropods from 118 samples have been collected totally in plot using 7 trapping methods. Beside 31 recorded from Primorskii krai insect orders only 19 were found in the plot. The most abundant orders are Diptera (52% of specimens) and Lepidoptera (26%). In plot the number of families of the large orders, such as Coleoptera, Diptera and Trichoptera, amounts to 30-40% of the total number of families in Primorskii krai.

The number of species in plot varied from 4-9% (Coleoptera, Orthoptera, Ephemeroptera, Trichoptera) to 18% (Hymenoptera: Formicidae) or 39% (Diptera: Drosophilidae) of the fauna of Primorskii krai, therefore the estimated number of insect species of the plot in core site at Kamenushka is calculated at about 1100-2250.

Seven satellite sites was studied at vicinities of Vladivostok in 2003. Totally 7427 specimens of arthropods were collected by pitfall traps. All specimens of family Carabidae (Coleoptera) were determinate to species. The preliminary analysis of the ground beetles fauna show, that biodiversity of the primary, non-destroyed forest ecosystem is less than the diversity of the secondary forest, the forest under strong human press, or grasslands.

## Acknowledgements

Authors express cordial thanks to the Russian participants of IBOY Drs A.S. Lelej, Yu. A. Tshistjakov, M. G. Ponomarenko, E. A. Beljaev, V. N. Kuznetsov, A. N. Kupianskaya (Institute of Biology and Soil Science, Vladivostok), Dr S. A. Belokobylskij (Zoological Institute, St. Petersburg), and Dr Z. A. Fedotova (Samara Agriculture Academy) for collecting, sorting and identifying of insects, as well as for botanists Dr T. A. Komarova, E. V. Timoshenkova (Institute of Biology and Soil Science, Vladivostok), Drs V. I. Budzan, V. N. Usov and students of the Far Eastern Agriculture Academy (Ussuriisk) for help in preparing of the plots and description of vegetation.

## References

- Arefina T. I., Storozhenko S. Yu. 2003. "International Biodiversity Observation Year (IBOY): the caddisflies (Insecta: Trichoptera) of the forest ecosystems of the Primorye Region." *Far Eastern Entomologist*, N 129. pp 7-8.
- Danks H. V., Downes J. A., Larson D. J., Scudder G. G. E. 1997. "Insects of the Yukon: Characteristics and History." *Insects of the Yukon Biological Survey of Canada (Terrestrial Arthropods)*. H. V. Danks, J. A. Downes (eds). Ottawa, pp. 963-1013.
- Erwin T. 1982. "Tropical forests: their richness in Coleoptera and other arthropod species" *Coleopterists Bulletin*, Vol. 36, pp. 74-75.
- Fedotova Z. A. 2002. "New species of Gall Midges (Diptera, Cecidomyiidae) from the Russian Far East." *Far Eastern Entomologist*, N 118, pp. 1-35.
- Fedotova Z. A. 2003. "New genera and species of Gall Midges (Diptera, Cecidomyiidae) from the Russian Far East." *Far Eastern Entomologist*, N 125, pp. 1-30.
- Fedotova Z. A., Sidorenko V. S. 2003. "New species of Gall Midges of the tribe Stomatosematini (Diptera, Cecidomyiidae) from the Russian Far East" *Far Eastern Entomologist*, N 128, pp. 1-11.
- Hammond P. 1992. "Species inventory." *Global biodiversity. Status of the earth's living resources*. B. Groombridge (ed). London pp 17-39.
- Hirashima Y. (supervisor) 1990. *A Check List of Japanese Insects*. Entomological Laboratory, Faculty of Agriculture, Kyushu University and Japan Wild Life Research Center (eds) Fukuoka 1767 pp (In Japanese)
- Kholin S. K., Kupianskaya A. N. 2003. "International Biodiversity Observation Year (IBOY): the ants (Hymenoptera: Formicidae) of the forest ecosystems of the Primorye Region." *A. I. Kurentsov Annual Memorial Meetings, Vladivostok*, Vol. 14, pp 50-55 (In Russian)
- Legendre L., Legendre, P. 1983. *Numerical Ecology. Developments in Environmental Modeling* Vol. 3, 419 pp, Elsevier Sci. Publ. Co., Amsterdam, Oxford, & New York
- Pavlicek A., Hrda S., Flegr J. 1999. "FreeTree - Freeware program for construction of phylogenetic trees on the basis of distance data and bootstrap/jackknife analysis of the tree robustness. Application in the RAPD analysis of the genus *Frenkelia*" *Folia Biologica* Vol. 45, pp 97-99.
- Stork N. E. 1997. "Measuring global biodiversity and its decline" *Biodiversity II: understanding and protecting our biological resources* M Reaka-Kudla, D. E. Wilson, E. O. Wilson (eds). Washington D. C. pp 41-68
- Storozhenko S. Yu. 2003. "IBOY activity in Russia and insect diversity of the Russian Far East." *Proceedings of International Symposium of the Kanazawa University 21st-Century COE Program* Vol. I, pp 434-437
- Storozhenko S. Yu., Lelej A.S., Kurzenko N. V., Tshistjakov Yu. A., Sidorenko V. S. 2002. "Insect biodiversity of the Russian Far East" *Far Eastern Entomologist*, N 109, pp 1-28.
- Storozhenko S. Yu., Sidorenko V. S., Lafer G. Sh., Kholin S. K. 2003. "The International Biodiversity Observation Year (IBOY): insects of the forest ecosystems of the Primorye region." *A. I. Kurentsov Annual Memorial Meetings, Vladivostok*, Vol. 13, pp 31-52. (In Russian)
- Tanabe S., Nakamura K., Toda M. J. 2003. "Beyond the DIWPA-IBOY: monitoring network and strategies to assess human impacts on biodiversity in the Pan-Japan Sea Area" *Proceedings of International Symposium of the Kanazawa University 21st-Century COE Program* Vol. I, pp 438-442.
- Tiunova T. M., Storozhenko S. Yu. 2003. "International Biodiversity Observation Year (IBOY): the mayflies (Insecta: Ephemeroptera) of the forest ecosystems of the Primorye Region" *Far Eastern Entomologist*, N 124 p 16
- Toda M., Kitching R. L. (Eds). 1999. "IBOY-DIWPA: Biodiversity assessment program in the Western Pacific and Asian region" *Forest ecosystems: the assessment of plant and animal biodiversity in forest ecosystems* Vol. 2, pp 1-71.