

## English translation of:

**E. I. Malikova<sup>1</sup>. 1995. Strekozy (Odonata, Insecta) Dal'nego Vostoka Rossii. [Dragonflies (Odonata, Insecta) of the Far East of Russia]. (Autoreferate of the dissertation for aspiration of the scientific degree of candidate of biological sciences). Institute of Systematics and Ecology of Animals, Novosibirsk, 24 p. (in Russian)**

**Translation by O. E. Kosterin<sup>2</sup>, 2009**

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## Translator's comment

By this we open a series of translations of autoreferates of some dissertations recently defended in Russia on odonatology. Some explanation is needed as to rather an archaic Russian system of scientific degrees. Two scientific degrees (Russ. 'uchenaya stepen') exist in Russia: Candidate of Sciences and Doctor of Sciences. The 'Candidate of Sciences' corresponds to Ph. D. It may be defended either after three-year long special 'aspirantura' (post-graduate studentship) or after some years of research work in some scientific institutions, and only by those who previously have defended a diploma work finishing an university or institute, which in Russia is considered as getting the higher education (the bachelor-magister system is only recently being adopted in Russia). The 'Doctor of Sciences' corresponds to D. Sci or Dr habil (where these degrees exist) and should be rather a prominent scientific work crowning many years of research. (Note that in Russia a parallel system of the 'scientific ranks' (Russ. 'uchenoe zvanie') of Docent and Professor exists with respect to education). To get a scientific degree, a person should prepare and defend a dissertation, which is a large (in the case of 'doctor of sciences' a fairly huge) typed manuscript volume where the literature review and own results of the pretendent are delivered in detail. It exists in 2-4 copies only. After defense, a copy of Dissertation is preserved in the Dissertation Council where the defence took place. Another copy is sent to the



special department of the Lenin State Scientific-Technical Public Library in Moscow. However, as a rule, a dissertation is read by few persons only, including the scientific supervisor (for 'candidate dissertations'), two or three (for the two degrees, respectively) 'official opponents' and those persons who write the compulsory evaluation of a 'leading organisation'. At the same time, a month before the defence, the dissertant must issue, in about 100 copies, the so-called 'autoreferate', a concise (15-30 pages) digest of the dissertation prepared according to certain rules (and certain traditions), and send it to a compulsory set of main scientific libraries in Russia (as earlier in the USSR) and to a number of Russian specialists of the candidate's choice. There is a compulsory line 'on the rights of a manuscript' on the autoreferate's title page, which earlier, in the USSR, intended to declare that it is not an official and open publication but is a manuscript for internal use which was not allowed to cite in papers. This was motivated by some notions of security of scientific secrets of the state and officially sending of the autoreferates abroad was (or still is) prohibited. Presently this declaration remains just a formality and autoreferates are cited as any scientific publications, which they in fact are. However, autoreferates are not peer-reviewed before publication and may not always be of a top scientific quality. A set of odonatological autoreferates selected for translation and publication in IDF-report will exemplify you this specific Russian scientific genre in its natural variety. The series opens with a rather old autoreferate by Dr. Elena I. Malikova, Blagoveshchensk State Pedagogical University, a well-known Russian odonatologist. This is not an up-to-date synopsis of the Russian Far Eastern fauna but just a translation of that for 1995. It should be noted that for the 13 years that passed since its publication in 1995, it got somewhat outdated because of further investigations including those by the author herself. The translation was checked by the author, Dr. Elena Malikova, who added some notes between arrows (▷...◁); I also dared to makes notes.

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## I. GENERAL CHARACTERISTICS OF THE WORK

**Actuality of the subject.** Dragonflies (Odonata) are one of the most ancient insect orders and are characterised by a high morphological specialisation, owing to which many authors [Shvanvich, 1949, Rodendorf, 1980] attribute them to a special infraclass, a sister clade to all other winged insects. In spite of their old phylogenetic age, dragonflies are presently one of the flourishing insect groups evidenced by their wide range, species diversity and abundance in aquatic and semiaquatic habitats, practically in all climatic zones. Thanks to their great abundance, active predation and alternating of the aquatic and terrestrial



phases in their life cycle, dragonflies contribute considerably into turnover of substances in biogeocoenoses.

In spite of an almost 150-year old history of investigation of the odonatofauna of the Russian Far East, this territory is hitherto insufficiently and very unevenly explored in odonatological respect. Only fragmentary data exist for the Chukotka Peninsula and northern Magadan Province, scarce are data from northern Khabarovskiy Krai Province, the composition of the fauna of the Far Eastern islands is insufficiently revealed. Until the current study, the fauna of the Middle Priamurye [Amurland], one of the most important and peculiar regions of the Far East, remained practically unknown. Only the Primorskiy Kray Province fauna was studied relatively completely with quite a number of works being devoted to it (Bartenev, 1911, 1912, 1914, 1956; Belyshev, 1956, 1964, 1965, 1966 et al.). However, also in this area some gaps exist in the knowledge of species composition.

**Aim and goals of the investigation.** The aim of our work was to study the fauna of dragonflies of the Far East of Russia, to reveal its main zoogeographical and ecological peculiarities. With this aim, the following goals were prospected:

1. To reveal species composition of dragonflies of the Far East, with respect to modern data on their systematics.
2. To reveal geographical distribution of dragonflies on the territory of the Far East and to analyse the character of their ranges.
3. To propose zoogeographical regions of the Far East on the ground of distribution of dragonflies.
4. To study the main features of the ecology of dragonflies (phenology of imagines, habitat distribution of larvae).

**Scientific novelty.** In the present work, a detailed taxonomical review is given of the dragonflies of the Far East of Russia, which includes 97 species belonging to 41 genera of 9 families. Of these, 16 species are reported for the first time for the region. In the work, 8 new synonyms were substantiated, and 3 subspecies taxa were raised to species level. Unknown larvae of 4 species were described: *Cercion v-nigrum*, *Erythromma humerale*, *Leucorrhinia intermedia*, *Sympetrum imitans*. Data on ecology and bionomy of 79 species dragonfly species are presented, including such rare species as *Anisogomphus maacki*, *Macromia amphigena fraenata*, *Sympetrum croceolum*, *S. uniforme* and others. For most species, data on geographical distribution are specified and updated to sufficient extent. The data obtained allowed me to propose a system of zoogeographical regions of the Far East based on dragonfly distribution.

**Theoretical and practical value.** Species composition and peculiarities of geographical distribution of dragonflies on the territory of the Far East of Russia are



revealed. These data may be used for compiling a State Cadastre of the animal world of Russia, and also be applied in biomonitoring and other ecological studies. The data received on ecology of rare species of dragonflies may be used for working out measures for their protection. Determination keys are compiled for imagines and larvae of the dragonflies of the Far East.

**Approbation of the work and publications.** The main data of the work were presented orally on interlaboratory seminar on ecology and systematics of animals at ISEA SB RAS [Institute of Systematics and Ecology of Animals of Siberian Branch of Russian Academy of Sciences] on 20.1.1995. Three works have been published on the subject of the work.

**Structure and volume of the work.** The work contains an introduction, 5 chapters, conclusions, reference list and appendix. The main part of the work contains 154 pages of the text, 7 tables and 11 figures, the total volume of the paper is 233 pages. The reference list includes 175 works, including 88 in foreign languages.

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## **CONTENT OF THE WORK**

### **Chapter 1. HISTORY OF ODONATOLOGICAL STUDIES IN THE FAR EAST OF RUSSIA**

Studying the odonatofauna of the Far East of Russia started with the works by Hagen (1856, 1858) and Motschulsky (1859). Unfortunately, these early works



contained inaccuracies because of wrong labels or misidentifications. The first reliable data appeared in the papers by Selys Longchamps (1872, 1887), who reported 24 species for Amurland, 7 of which were newly described. Further development of odonatology in Russia was connected with the name of A. N. Bartenev (1912, 1914, 1915, 1930, 1956 etc.). In his studies devoted to the fauna and systematics of dragonflies, 47 species were reported for the Far East and 11 new species were described, although 9 of them turned out to be synonyms. Of other works, the most interesting are a paper by A. M. Djakonov [1926] with description of two new species from Primorskiy Kray, a study on the fauna of Kamchatka by I. Sjöstedt, (1927), and a number of Japanese studies of the fauna of the Kuril islands and Sakhalin (Matsumura, 1911; Oguma, 1913-1932; Kono et Tamanuki, 1928; Okumura, 1941, 1942; Asahina, 1949, 1958]. Altogether, till the middle of the 20th century 54 dragonfly species were reliably reported for the Far East (57% of the presently known fauna).

Since the 1950s, specifically planned studies on the fauna and biology of dragonflies of Siberia and also the Far East of Russia were conducted and organised by B. F. Belyshev. In his works, including the general monograph 'Dragonflies of Siberia', 85 species were reported for the Far East, although only 76 of them reliably. For 39 species, data on ecology in conditions of the Far East were adduced [Belyshev, 1956, 1965, 1966, 1971, 1973, 1974, 1976 etc.]. In the 1970-1980s, A. Y. Haritonov [1975, 1976, 1988 etc.] continued the study of the Far Eastern odonofauna. Especially a chapter of dragonflies which he prepared for the 'Guide for Insects of the Far East' (1986) is worth mentioning.

Besides the works by A. Y. Haritonov, a paper by V. V. Zaika issued in 1980 should be mentioned which was devoted to ecology and behaviour of dragonflies of the Kunashir island. Most recently, two faunistical works on dragonflies of Primorsky Krai were published by S. N. Gorb [1990, 1991].

Thus, a total of 80 species of dragonflies were reliably reported for the Far East of Russia to the moment of the beginning of our studies, that is 84% of the presently known fauna.

## Chapter 2. MATERIAL AND METHODS OF THE STUDY

In this study, material was collected by the author in 1989-1994. Collecting of imagines and larvae for revealing the species composition was carried out in some regions of Amur Province, Khabarovskiy and Primorskiy Krays: in the vicinities of the towns of Blagoveshchensk, Svobodnyy, the settlement of Belogorye, the villages of Grodekovo, Novinka, Ekaterinoslavka, Malaya Sazanka, Chernovka, Chigiri, the settlements of Kundur, Yadrino, Rovnyi, Fevral'sk of Amur Province; the towns of Ussuriysk and Slavyanka in Primorskiy Kray; and also in districts of the adjacent to our region Chita Province: Mogocho District (Pokrovka village) and Kalarskiy District (the settlements of Novaya Chara and Udokan). Imagines





and larvae were collected by standard methods with a hand-operated net. Exuviae were collected manually while visually examining the watershed line and vegetation at water bodies. Larvae were fixed in 70% ethanol. In total, 3178 specimens of imagines and 1416 specimens of larvae and exuviae of dragonflies were collected.

In addition, the collection of Zoological Museum of ISEA was widely used (more than 5000 specimens of imago). Besides, we treated and used in this very study the materials, collected in the Far East, from the collections of the Zoological Institute RAS (S.-Petersburg) and Zoological Museum of Moscow University, and also the collections of the Institute of Biology and Pedology (Vladivostok) and collections by students of the Blagoveshchensk, Komsomolsk and Ussuriisk State Pedagogical Institutes. In total, 8367 specimens of imago and 1449 specimens of larvae of dragonflies were studied.

Imagines and larvae of dragonflies were identified by keys in the monograph by B. F. Belyshev [1973b], imagines also by the 'Guide for Insects of the Far East of the USSR' [Haritonov, 1986]. In addition, we used a number of works on the fauna of East Asia [Needham, 1930; Chao, 1953-1955; Asahina, 1959a; 1959b; 1960; 1961a; 1961b; 1964; 1965a; 1965b; 1970; 1975; 1989c]. In taxonomically contradictory cases we turned to the original species descriptions [Selys, 1883; 1887; Martin, 1906; Bartenev, 1911; 1956; Needham, 1931; Doi, 1943; Asahina, 1948; 1956 etc.).

Stationary studies aimed at investigating the ecological peculiarities of dragonflies of the Far East were conducted in the vicinities of the city of Blagoveshchensk (May-October 1991 and May-September 1994), the settlement of Kundur of Arkhara District (June-August 1992) and the village of Malaya Sazanaka of Svobodnyy District of Amur Province (May-June 1993). Accounts of relative abundance of Anisoptera imagines were carried out once per 10 days on 500 m-long routes in different riparian biotopes. During this, all dragonflies were counted within the stripe of 3 m to the left and right from a counter except for those flying ahead the route. Most of dragonflies were identified to species, those from the genera *Aeshna*, *Somatochlora*, *Leucorrhinia* and a part of species of *Sympetrum* – to genus. Accounts of abundance of Zygoptera was done by the sweep-net method: by 100 net hits in each biotope. The accounts were done once per 10 days, in period of species replacement – 1 time per 3-5 days. In total 60 accounts of Anisoptera and 70 accounts of Zygoptera were done. The abundance of dragonflies in areas not covered by our studies was characterised by a share of specimens of each species in collections, by a 3-score scale: less than 1% - a rare species; 1-3% - not abundant species; more than 3% - abundant species. Besides, literature data were used [Belyshev, 1966c; 1973b; Belyshev et al., 1978].



### Chapter 3. REVIEW OF SPECIES

During our expeditions in the Far East of Russia 60 dragonfly species were found, 31 more species were located in the collections of the Zoological Museum of ISEA, ZIN RAS and Zoological Museum of MSU. Six species are included from literature data, though 3 of them, *Aeshna palmata*, *Anax junius* and *Neurothemis fluctuans*, are considered as dubious.

Systematics is given in accordance with the lists of the world dragonfly fauna [Davies, Tobin, 1984; Tsuda, 1986], with one exception: we consider it correct to attribute the Calopterygidae family to a separate suborder Caloptera Zaleskij, 1932, in accordance with the list of the dragonfly fauna of the USSR [Belyshev et al., 1989] ▷ O.K.: This point of view presently is not upheld by the author. ◁

For each species, a list of literature sources is provided containing data on current records in the territory of the Far East. The range and distribution in the Far East, abundance and subspecific attribution are also characterised. For most species, notes on systematic position of the Far Eastern specimens are given. Basic features of ecology of each species such as the duration of life cycle, phenology of imago, habitat preference of larvae are stated. For each species, the material studied by the author and the collection localities are specified.

#### Suborder Caloptera.

Family Calopterygidae. In the southern Far East, 3 species are found. *Mnais pruinosa costalis* Selys is for the first time reported for Russia from the Kunashir Island. The species status of *Calopteryx japonica* Selys is proved, which was earlier considered as a subspecies of *Calopteryx virgo* L. – both species occur sympatrically in Middle Siberia.

#### Suborder Zygoptera.

Family Lestidae. Data on 6 species are presented, of which *Lestes japonicus* Selys is for the first time reported for Russia from southern Primorye; for the first time for the Far East – *Sympecma fusca* VdL., by collections from the Kunashir Island ▷ E.M.: The latter finding was later cancelled, for this appeared to be a mislabeling. ◁

Family Coenagrionidae. 21 species occur in the region. *Cercion calamorum* Ris, *C. hieroglyphicum* Brauer, *C. plagiosum* Needham were for the first time reported for the Russian fauna. Larvae of *Cercion v-nigrum* Needham and *Erythromma humerale* Selys were described. Based on differences of the imaginal and larval morphology, the species status of *E. humerale*, earlier considered a subspecies of *E. najas*, is proved ▷ O.K.: Arguments are insufficient for there are just few quantitative differences, I disagree with the specific status of *E. humerale*. ◁ It was stated that *Agrion brevicauda* Bart., 1956 is a synonym to *Cercion v-nigrum*, *Agrion*



*striatum* – to *C. plagiosum*, *Enallagma nigrolineatum* Bel. et Harit., 1975 – to *E. antiquum* (Bart.). ▷ O.K.: Under the names *Agrion antiquum* and *Enallagma nigrolineatum* melanised specimens of *Enallagma cyathigerum cyathigerum* Charp, were described. Belyshev and Haritonov did so since they accepted *E. risi* as a 'typical' *cyathigerum* ◁.

Family Platycnemididae. In the southern Far East 3 species occur, of them *Platycnemis pennipes* (Pall.) is found in the region for the first time ▷ E.M.: and is still the only one ◁. The identity of *Denticnemis bicolor* Bart., 1956 to the species *Copera tokoyensis* Asahina, 1948 is revealed.

#### Suborder Anisoptera.

Family Aeshnidae. Data on 11 species are presented, of which *Aeshna palmata* Hagen and *Anax junius* Drury are known in the Far East only by dubious reports. *Aeschnophlebia zygotera* Bel. is shown to be a synonym of *A. longistigma* Selys.

Family Gomphidae. There are 15 species recorded in the region. For the first time recorded are *Asiagomphus melanopsoides* (Doi) and *Trigomphus citimus* (Needh.) from southern Primorye, and also *Gomphidia confluens* Selys and *Gomphus epophthalmus* Selys from Amur Province (record of the latter by B. F. Belyshev for Primorskiy Kray was erroneous) ▷ E.M. Presently it is considered as *Shaogomphus postocularis epophthalmus* ◁. The species *Davidius annulatus* Djak. and *Gomphus flavipes* Ch. are, according to modern revisions, attributed to the genus *Stylurus*. The taxonomical status of *Trigomphus anormolobatus* Bart. is unclear: according to our opinion it is not a synonym of *T. nigripes* Selys, as B. F. Belyshev considered, but is close to the Japanese *T. melampus* Selys.

Family Cordulegasteridae is represented by the only species *Anotogaster sieboldii* Selys, inhabiting Sakhalin and the southern Kuril islands.

Family Corduliidae. 12 species occur in the Far East. *Somatochlora alpestris* (Selys) is for the first time recorded in the region. *S. japonica* Mats. is a junior synonym of *S. exuberata* Bart. ▷ E.M.: Further investigations on the exact publication date of *S. exuberata* have shown that it is *S. japonica* which is the elder synonym and hence the valid name, see Malikova, E. I. 2006. Synonymy of *Somatochlora japonica* Matsumura, 1911 and *S. exuberata* Bartenev, 1911, with the priority of the former // XVII Int. Symp. of Odonatology, 31 July - 4 August 2006. Abstracts of Papers. Hong Kong Wetland Park, Hong Kong, China, 2006. P. 33. ◁. A species status of *S. exuberata*, earlier considered as a subspecies of *S. metallica* Mats., is stated. An aberrant form of *S. exuberata* Bart. is described with a wide amber spots at the hind wing bases – *S. exuberata* ab. *graeserioides* ab. nova. The larva of *Macromia* sp., described by A. N. Popova [1953] from South Primorye, is attributed to *M. manchurica* Asahina. ▷ E.M.: Later a female imago was also obtained from Primorye, see Malikova, E. I. & R. Seidenbusch. 2001. Description of a female *Macromia manchurica* Asahina, 1964 (Macromiidae). Tombo 43: 21-22 ◁. *Macromia sibirica* Djak. and *M. bartenevi* Bel. are junior synonyms of *M. amphigena fraenata* Martin.





Family Libellulidae. 25 species are recorded in the region. It is stated that *Leucorrhinia ussuriensis* Bart. is a synonym of *L. orientalis* Selys. The larvae of *Leucorrhinia intermedia* Bart. and *Sympetrum imitans* are described. Based on differences in morphology of imagines and larvae the species status of *S. imitans* is substantiated, which was earlier considered as a subspecies of *S. vulgatum* ▷ E.M.: Later it was reconsidered because of great variances in larval morphology. ◁. Consequently, the subspecies *S. vulgatum fuscopterum* Bel. should be considered as *S. imitans fuscopterum* Bel., comb nov. The record by A. N. Bartenev of *Neurothemis fluctuans* Fabt. (= *palliata* Ramb.) for Vladivostok appears to be unreliable.

Hence, according to the modern data, 97 species of dragonfly inhabit the Far East of Russia (101 species and subspecies) referring to 41 genus and 9 families. This is almost 64% of the fauna of Russia [Belyshev et al., 1989]. For the first time for the region 16 species were recorded, 10 of which – for the first time for the fauna of Russia.

▷ E.M.: Since 1995, several more species were recorded in the region: *Aeshna serrata* Hagen in Kamchatka (see Dumont, H.J., A.Yu. Haritonov, O.E. Kosterin, E.I. Malikova & O.N. Popova, 2005. A review of the Odonata of Kamchatka Peninsula. *Odonatologica* 34: 131-153), *Macromia daimoji* Okumura in Primorskiy and Khabarovskiy Krays, *Stylurus occultus* Selys in Khabarovskiy Kray (see Malikova E. I., O. E. Kosterin, V. V. Dubatolov. 2007. A dragonfly (Odonata) collection from the Bolshekhekhtsirskii State Nature Reserve (Khabarovskii Krai, Russia). II. Seasons 2006 and 2007. In: *Zhivotnyi mir Dal'nego Vostoka* [Animal World of the Far East], A. N. Streltsov ed., Issue 6, p. 5-9), *Orthetrum cancellatum* (Linnaeus, 1758) (Malikova, unpubl.). The old record of *Aeshna viridis* Ev. by Bartenev, 1912 (1 ♀., Ussuri-Geb., Radde) is very dubious, as well as the author's record based on two early instar larvae. Taxonomical status of some species was revised. ◁

## Chapter 4. ZOOGEOGRAPHICAL ANALYSIS OF THE DRAGONFLY FAUNA OF THE FAR EAST OF RUSSIA

### 4.1 CHOROLOGICAL ANALYSIS

▷ E.M.: Here and on some calculated figures the results became somewhat out-dated and should be slightly corrected. ◁

One of the first classification of dragonfly ranges was proposed by A. N. Bartenev [1930]. His system was close to the modern systems by K. B. Gorodkov [1984] and M. G. Sergeev [1986] in subsequently considering latitudinal and longitudinal components of ranges. However, although A. N. Bartenev noted that the ranges of Palaearctic dragonflies are extended in east-western rather than north-south direction, he did not connected them with vegetation zones. Bartenev subdivided the Palaearctic into three stripes (subareas) only: northern, middle and southern. B. F. Belyshev also stressed the peculiarity that the geographic-



al distribution of dragonflies is not connected to vegetation zones. His opinion was based on the fact that dragonflies do not directly depend on the vegetation character and are in principle not connected to zonal landscapes since they are non-specialised predators and in the larval state live in fresh water bodies, that is in intrazonal landscapes [Belyshev, 1970; 1974; Belyshev, Haritonov, 1981].

However, distribution of dragonflies, as well as other ectothermic animals, depends first of all on the temperature regime [Haritonov, 1994] which, along with humidity, is the main climatic factor determining distribution of certain vegetation types. So, ranges of most dragonfly species coincide with the limits of one or several adjacent natural zones. Hence, methods of chorological analysis worked out for other insect groups are in our opinion quite applicable for dragonflies.

For the classification of dragonfly ranges we used the method by M. G. Sergeev [1986] and considered subsequently the latitudinal and longitudinal components of ranges. The names of range groups are given in accordance with the terminology by M. G. Sergeev with certain additions. We reveal 5 latitudinal groups of ranges: boreal (with forest and forest-steppe subgroups), polyzonal, subboreal, subtropical and cosmopolitan, and 9 longitude groups: circumareal (with circumboreal and circumtropical subgroups), transpalaeartic, east palaeartic, west palaeartic, Siberian-Pacific, Daurian-Pacific, Pacific, Americano-Siberian and that of endemics of the pacific islands.

Of latitudinal groups, the greatest species diversity is found in subboreal (southern forest) species, comprising the basis (39.2%) of the odonatofauna of the Far East. It is this group to which the autochthonous elements of the Amurian-Japanese fauna belong to. The next most diverse is the group of boreal species (31.9%). Widely distributed (holarctic and transpalaeartic) species, and the species of the Siberian (Angarian) fauna complex belong to this group. The group of subtropical species (13.4%) is composed of migrants from South-East Asia. In the Far East of Russia, they meet the northern limit of their ranges and most of them are rare species there. Polyzoal species (13.4%) are a group of widely ranging species of uncertain origin. Only one species, *Pantala flavescens*, belongs to the cosmopolitan group. Among the longitudinal groups the most abundant is the Pacific one (41 species, 42.3%), the species of which occurs in Russia only in the Far East. The second largest is the transpalaeartic group (22 species, 22.6%). The Far Eastern odonatofauna includes 8 circumboreal and 1 circumtropical species. Quite large is the group of Siberian-Pacific species (10 species, 10.3%) ranging westwards to the Irtysh basin. Four species are found in both east palaeartic and Daurian-Pacific groups. The west palaeartic group is represented by just one Euro-Siberian species, *Platycnemis pennipes*, found by us on the Amur-Zeya Plateau. Four species are endemic to the Pacific islands, one of which, *E[nallagma] belyshevi* is an endemic of the South Kurile islands (It-



urup and Kunashir). ▷ O.K.: *Enallagma belyshevi* Bel. et Har. is in fact just a colour morph of *E. circulatum* Selys ◁. Two species belong to the American-Siberian group, the distribution of which in the Far East needs confirmation.

In summary, the odonate fauna of the Far East may be subdivided into two approximately equal species complexes. The first of them are widely ranging Holarctic and Palaearctic species. Practically only these species form the fauna of the northern Far East (for Kamchatka 2 southern species were reported, *Sympetrum frequens* and *Pantala flavescens*, and 2 American ones, *Aeshna palmata* and *Anax junius*, but we consider these reports as dubious). In the southern Far East their role decreases: they comprise 45.4% of the reliably known fauna. In Amurland and the Primorskiy Kray the species of the second, East-Asian complex predominate, comprising in sum 52.6% of the reliably known fauna.

#### 4.2 ZOOGEOGRAPHICAL SUBDIVISION OF THE FAR EAST BASED ON DISTRIBUTION OF DRAGONFLIES.

The Far East of Russia, or, more precisely, the southern Far East is of interest in zoogeographical respect as it is a transition zone between the typical Holarctic (Boreal) and Sino-Indical (Oriental) faunas, and so for a long time have attracted the attention of zoogeographers. A classical and most detailed scheme of zoogeographical regions of the Far East is by A. I. Kurentzov [1963; 1965; 1974] who used mostly data on distribution of lepidopterans.

Hitherto no detailed scheme of odonatological regions of the Far East existed owing to shortage of faunistic materials from many regions important in zoogeographical respect, foremost the Middle and Upper Amurland. According to the scheme of zoogeographic regions of the world adapted for the distribution of dragonflies [Belyshev, Haritonov, 1981], a part of the territory of the Far East (Primorskiy Kray and Middle Amurland) belonged to the East Asian subregion of the Subholarctic region of the Boreal kingdom, the rest of the territory was included into the Siberian subregion of the Holarctic region. ▷ O.K.: Curiously, in Belyshev's rather extravagant zoogeographical system, until now non-critically adopted by many Russian odonatologists, the meaning of the terms 'holarctic' and 'boreal' is reversed as to the commonly accepted: Belyshev subdivided the entire world into two zoogeographical kingdoms, Boreal and Meridional, the Boreal referring roughly to the Northern Hemisphere and the Meridional to the equatorial regions and Southern Hemisphere, while his term 'Holarctic' referred to the northern forest zone and Arctic, that is more or less corresponds to the common sense of the word 'boreal'. ◁

In modern biogeography two main approaches to define range patterns are used. The first is to compare ranges of species, genera and (less frequently) other systematic groups that allows one to specify geographic particularities of taxa, to reveal centres of diversity and, based on this, to isolate regions where species with certain types of ranges predominate. The second approach is com-



paring lists of species composition of *a-priori* isolated regions. This approach demands, first, quite complete knowledge on the fauna of a region studied and, second, correct *a-priori* isolation of regions [Starobogatov, 1970; Kucheruk, 1979].

In order to identify odonatogeographic regions we applied the method of revealing of boundaries by evaluation of significance of bundles of range borders (sinperats), described in detail in the works by I. V. Stebaev and M. G. Sergeev [Stebaev, Sergeev, 1979; Stebaev, 1980; Sergeev, 1980, 1986], which allows one to reach a synthesis of the two main approaches to biogeographical regioning. According to this method, sinperats are connected by physico-geographical boundaries, usually to borders of climatic zones (for zonal boundaries) or orographical barriers (for meridional boundaries). The significance of zoogeographical boundaries was evaluated by their power (the number of species not crossing the boundary) or effectiveness calculated as percentage of the species not crossing the boundary in the total number of species found on both sides of the boundary.

As a result, the present knowledge on the odonatofauna of the Far East and territorial distribution of its components allowed us to identify 14 regions (districts) that differ in species composition (Figure 1, Table 1; see appendices 1 and 2 in this IDF-Report). The borders were drawn with reference to the physico-geographical regioning of the Far East [Sochava, 1962]).

A considerable similarity of the faunas within the districts of the Kolyman, Kamchatian and Okhotian Districts (Jaccard coefficient value being 66-84%) was noted suggesting the districts can be united into one Province. We attribute these districts to the Taiga Province of Siberian Subregion of the Holarctic Region of the Boreal Kingdom, according to the scheme of zoogeographical regioning of the world based on distribution of dragonflies [Belyshev, Haritonov, 1981]. The fauna of Chukotian District strongly differs from that of the neighbouring Kolyman District (similarity coefficient value being 44.4%) and should be attributed to Forest-tundra Province of Siberian Subregion, according to the system by B. F. Belyshev and A. Y. Haritonov.

Large similarity coefficients are also observed between the taiga districts of Amurland and Primorskiy Kray – Upper Amurian, Bureyan-Lesser-Khinganian and Sikhote-Alinian ones (68-82%). The similarity between each other of nemoral and mixed-forest districts is somewhat lower: Middle-Amurian, Amurian-Lower-Ussurian, South Primorian and Khasan-North-Korean (52-80.5%). The similarity coefficients between taiga and nemoral districts fluctuated from 38% (between Tugurian-Lower-Amurian and South Primorian Districts) to 70% (between Sikhote-Alinian and Amurian-Lower-Ussurian Districts). On average, the values of the similarity coefficient of the eight above mentioned districts are



between 50-60% that allows one to unite them into one province. We call it Amurian Province and attribute it to the East-Asian Subregion of the Subholarctic Region of Boreal Kingdom. Upper-Amurian, Bureyan-Lesser-Khinganian, Tugurian-Lower-Amurian and Sikhote-Alinian Districts may be isolated as Taigous Subprovince, while Middle-Amurian, Amurian-Lower-Ussurian, South-Primorian and Khasanian-North-Korean Districts into Nemoral Subprovince of Amurian Province.

The fauna of South-Kurilian District has a very low similarity coefficient (14-30%) with all districts except with Sakhalin (39.5%). We attribute these districts to Japanese Province of East-Asian Subprovince of Subholarctic Region, although in future, with more data accumulated, only the southern part of Sakhalin will probably be attributed to this Province. In this case the northern Sakhalin will be isolated into a separate district, probably belonging to Amurian Subprovince.

The so acquired odonatogeographic scheme of the Far East is most close to that proposed by Ya. I. Starobogatov [1970] which is based on distribution of freshwater molluscs. It may be assumed that expanding of dragonflies as amphibiotic insects connected with fresh water bodies took place via ways to some extent similar with the ways of expanding of freshwater molluscs.

## Chapter 5. SOME PECULIARITIES OF ECOLOGY OF DRAGONFLIES IN THE FAR EAST OF RUSSIA

### 5.1. SEASONAL DYNAMICS OF FLIGHT

The seasonal dynamics of flight is one of the adaptations of dragonflies to seasonal change of their environment and one of the most important ecological characteristics. The phenology of dragonflies is subject to geographical changes followed in latitudinal, longitudinal and altitudinal directions [Haritonov, Borisov, 1989]. Until recently, only scarce and very non-systematic data exist on phenology of dragonflies in the Far East of Russia. As a result of our field studies and also summation of label data we noticed the following:

The flight period of dragonflies in Amur Province is similar or coincides in all districts. The most noticeable differences in southern regions of Primorskiy Kray and northern regions of Amur Province are observed in time of cessation of flight of autumn species: in southern Primorye dragonflies are active throughout all September and often October, while in northern Amur Province flight of dragonflies is as a rule finished in middle September. Differences in the emergence of spring species in southern Primorskiy Kray and in northern Amur Province do not exceed 5-7 days.

The flight period in the northern Far East (our data mostly concern Kamchatian and Kolymian Districts) strongly differs from those of the same species in south-





ern Far East. So, below the adult phenology is considered separately for the northern and southern Far East.

Judging on materials available, dragonfly phenology in Sakhalin and the Kurilian islands differs from that both in the continent and the Japanese islands (Hokkaido in particular). A trend of shortening and shifting to later dates may be noted for the majority of species, that seems to be due to severe climatic conditions. The data are insufficient for a detailed analysis.

The dragonfly flight season in southern Far East lasts somewhat more than 5 months (May-October); mass flights proceed about four months (late May – middle September). By the flight period in the southern Far East, 7 phenological groups are identified: spring-autumn (3 species) – May-June and August-September; spring-summer (7 species) – mid-May to mid-July; early summer (11 species) – first half of June to the end of July; summer (29 species) – all summer months; late summer (10 species) – mid-July to the end of September, at favourable conditions to the end of October; autumn (10 species) – mid-August to the end of September. During the season, two maxima of species diversity of dragonflies are observed: in middle (between July 1 and 20) and late (between August 10 and 30) summer.

In the northern Far East (in Taiga Province) the flight season lasts for less than 4 months (June – the first third of September). By the flight period only three phenological groups were found: early summer (6 species) – mid-June to early August; summer (13 species) – early July to the end of August; late-summer (5 species), mid-July to the end of August – beginning of September. Only one maximum of species diversity is observed in mid-summer, between July 10 and August 1.

## 5.2. DISTRIBUTION OF LARVAL HABITATS

There are diverse and often contradictory data concerning association of different dragonfly species to certain types of water bodies. This situation may be explained by a number of reasons. First of all, most dragonfly species, as A. N. Bartenev [1930] already noted, are quite eurytopic. While species exist which are strictly confined to flowing water, almost all limnophylic species may inhabit both stagnant and semi-flowing waters. Besides, selection of a larval habitat is one of the mechanisms of adaptation to environment and is subject to regular geographical variation.

The most constant habitat characteristic is a complex of mutually connected factors: water flow speed, nature of the ground and presence of submerged vegetation, according to which two main dragonfly biotope may be isolated: 1) inhabitants of stagnant or slow flowing water living in vegetation thickets and 2)



inhabitants of ooze, sandy or stony bottom of rivers, brooks and lakes not connected with water vegetation.

The ground inhabitants in the Far Eastern fauna are representatives of the Gomphidae family, and of the genera *Somatochlora*, *Macromia*, *Epophthalmia*, *Libellula*, *Orthetrum*, *Pantala*. All other species inhabit thickets of water vegetation using it as a shelter and, consequently, are absent from water bodies or their parts which lack vegetation. By their larval habitat, dragonfly species are subdivided into 4 groups: inhabitant of exclusively stagnant water bodies (limnophiles), predominantly of stagnant waters, predominantly of flowing waters and of flowing waters (rheophiles). Forty-four dragonfly species (47.4% of total number of species for which data exist) inhabit stagnant waters, predominantly limnophiles are 22 species (23.6%), only in flowing water 17 species (18.3%), mostly in flowing water – 9 species (9.7%).

## CONCLUSIONS

1. As a result of the investigations conducted it was revealed that the territory of the Far East of Russia is inhabited by 97 dragonfly species (101 species and subspecies) referring to 41 genera and 9 families. This comprises 64% of the fauna of Russia. Among them, 16 species were reported by us for the first time for the region, 10 of which – for the first time for the fauna of Russia. Probably our knowledge on the species composition of dragonflies of the Far East is almost exhaustive since, for instance, from the neighbouring but more southerly situated territory of Korea 90 dragonfly species were at present registered.

2. The highest species diversity and high abundance of populations are found in the families Libellulidae and Coenagrionidae resulting in a high faunal similarity to the Siberia. At the same time, noteworthy is a relative richness of species composition of the small family Gomphidae, most ancient among Anisoptera ▷ O.K.: most probably this is not true ◁ and distributed mostly in tropics. This feature make the Far Eastern fauna resembling the Oriental one.

3. By the results of chorological analysis, two species complexes approximately equal in number may be isolated in the dragonfly fauna of the Far East. The first are wide-range Holarctic and Palaearctic species. It is practically only these species which form the fauna of the northern Far East. In the southern Far East their role decreases: they comprise in sum 44.7% of the reliably known fauna. In Amurland and Primorskiy Kray species of the second, East Asian complex, predominate: subboreal and subtropical species comprising in sum 54.2% of the reliably known species.

4. Dragonflies are unevenly distributed in the territory of the studied region. The most species diversity is found in the nemoral areas of Primorskiy Kray (72 spe-



cies) and Middle Amurland (49 species). The fauna of subtaiga and taiga areas of Upper and Lower Amurland is substantially impoverished and includes 33 and 31 dragonfly species, respectively. From Magadan Province, 18 species are known at present, 22 species in Kamchatka, 29 dragonfly species inhabit Sakhalin, 24 – the Kurile islands, the fauna of which is enriched by the species endemic for the Pacific.

5. As a result of the analysis of ranges and geographical distribution of dragonflies a scheme of zoogeographical regions is proposed for the Far East of Russia. The territory studied belongs to the Holarctic and Subholarctic areas of Boreal Faunistic Kingdom. Within the Holarctic Area we identified 4 districts belonging to Forest-Tundra and Taiga Provinces. To Subholarctic Region we attributed the entire Amur basin upstream to the confluence of Shilka and Argun' in the west and also Sakhalin and the South Kurile islands. Here we identified 10 districts belonging to Amurian and Japanese Provinces.

6. The dragonfly flight season in the southern Far East lasts somewhat more than 5 months (May-October); mass flying proceeds for about four months (late May – middle September). In the northern Far East the flight season lasts for less than 4 months (June – the first third of September). Most odonate species in the Far East hibernate at the larval or egg phase, 1 species, *Sympecma paedisca*, hibernates in the imaginal phase. Two species from the *Ischnura* genus in the southern Far East probably develop in a bivoltine mode and produce two generations per year, a spring and autumn one.

7. The seasonal dynamics of the species diversity of dragonflies was analysed in the southern and northern Far East. In the north, the flight of dragonflies is short and almost simultaneous in all species: only three seasonal groups may be isolated. During the season, only one maximum of species diversity occurs in mid-summer, between July 10 and August 1. In the southern Far East the flight period of dragonflies is longer, the seasonal groups are distinctly differentiated. Seven seasonal groups are isolated. During the season, two maxima of species diversity are observed: in middle (between July 1 and 20) and late (between August 10 and 30) summer.

8. Grouping of dragonflies of the Far East is attempted in accordance with the habitat distribution of larvae. Forty-four dragonfly species were classified as inhabitants of exclusively stagnant water bodies (limnophiles), to those of predominantly stagnant waters – 22 species, to those of predominantly flowing waters – 9 species and to those of exclusively flowing water (rheophiles) – 17 species (18.3%). The amount of rheophilic species increases from north to south: they are absent in the fauna of the northern Far East, in the taiga districts of Amurland their proportion is from 3 to 8%, in nemoral and mixed-forest districts of the southern Far East – from 16 to 18%. The proportion of strictly limnophilic



species decreases from north to south, from 100% in Chukotkian and Kolymian Districts to 40-48% in Middle-Amurian and South-Primorian ones, both due to changes in species composition and to switch of some species to inhabiting not only stagnant but also to the semi-current water bodies. ▷ O.K.: Here is some contradiction, for 'limnophiles' were above determined as strict inhabitants of stagnant waters. ◁

9. Quantitative accounts of dragonflies in combination with literature data allowed us to evaluate the abundance of dragonflies in southern Far East. 42 species may be considered as abundant, 29 species as not abundant, 23 species are known by scarce specimens. 15 dragonfly species need in protection, of which 5 (*Asiagomphus melanopsoides*, *Gomphus schmidtii* ▷ E.M.: Presently considered as *Schaogomphus schmidtii*. ◁, *Trigomphus citimus*, *Aeschnophlebia kolthoffi* ▷ E.M.: A junior synonym of *A. longistigma*; should be excluded from the list. ◁, *Macromia manchurica*) are narrow range species and are under a threat of extinction.

#### LIST OF PUBLICATIONS ON THE SUBJECT OF THE WORK

1. Malikova, E.I. [Dragonflies (Insecta, Odonata) of the environs of the city of Blagoveshchensk. In Russian]. In: Dugintsov, V.A. (ed.) "Problemy ekologii verkhnego Priamurya", Blagoveshchensk State Pedagogical Institute, Blagoveshchensk, 1993, pp. 91-101. (in Russian)

2. Malikova E.I. [*Gomphidia confluens* Selys (Odonata, Insecta) – a new species and genus of dragonflies in the Russian fauna. In Russian]. In: Chub, A.V. (ed.) "Problemy ekologii verkhnego Priamurya. II", Blagoveshchensk State Pedagogical Institute, Blagoveshchensk, 1995, pp. 115-118. (in Russian)

3. Malikova E.I. [A list of dragonflies (Insecta, Odonata) from Amur Province in the collection of the Zoological Institute of RAN (St Petersburg). In Russian]. In: Chub, A.V. (ed.) "Problemy ekologii verkhnego Priamurya. II", Blagoveshchensk State Pedagogical Institute, Blagoveshchensk, 1995, pp. 119-126. (in Russian) In press ▷ O.K.: This was at the moment of publication of this autoreferate, below the references to later issued papers are given. ◁

Malikova, E.I., 1997a. The fauna of dragonflies (Insecta, Odonata) of Amur region. In: Kolesnikova, L.G. (ed.) "Problemy ekologii verkhnego Priamurja. III", Blagoveshchensk State Pedagogical University, Blagoveshchensk, pp. 109-116. [In Russian; English title and abstract]. (in Russian)

Haritonov, A.Yu. & E.I. Malikova, 1998. Odonata of the Russian Far East: a summary. *Odonatologica* 27: 375-381. ▷ O.K.: This unfortunate paper was issued in 1998 but it had been submitted in 1992 and appeared too much out-dated even for 1995, the date of publication of this autoreferate. Moreover, it contained a number of sad errors in the table. ◁



## Appendix 1

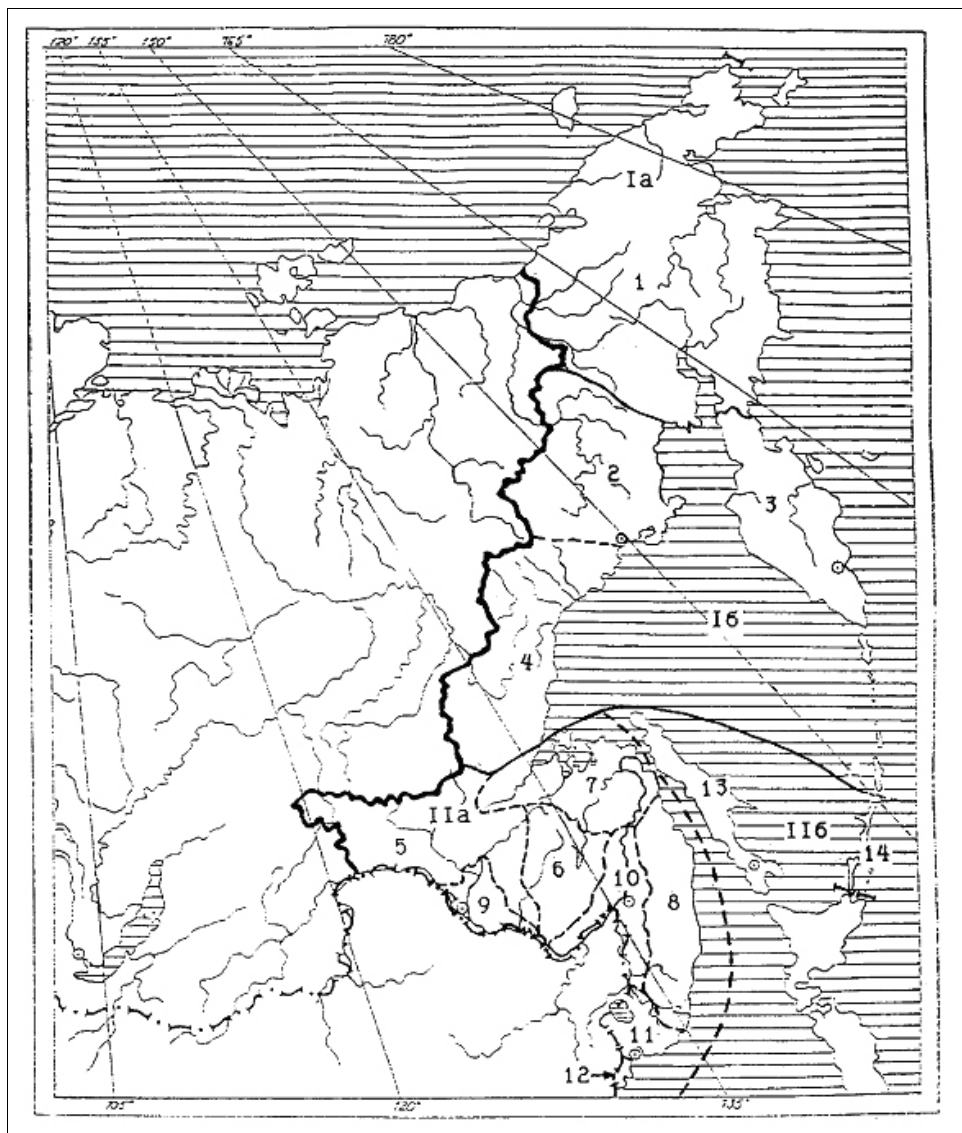


Figure 1. A scheme of zoogeographical regioning of the Far East of Russia based on distribution of dragonflies.

I. Holarctic Region, Siberian Subregion,

Ia: Forest-Tundra Province, 1 – Chukotian District

Ib: Taigous Province, districts: 2 – Kolyman, 3 – Kamchatian, 4 – Okhotian.

II. Subholarctic Region, East-Asian Subregion.

IIa: Amurian Province, districts: 5 – Upper-Amurian, 6 – Bureya-Lesser-Khingani-an, 7 – Tugurian-Lower-Amurian, 8 – Sikhote-Alinian, 9 – Middle-Amurian, 10 – Amurian-Lower-Ussurian, 11 – South-Primorian, 12 – Khasanian-North-Korean.

IIb: Japanese Province, districts: 13 – Sakhalinian, 14 – South-Kurilian.





## Appendix 2

**Table 1. Distribution of dragonflies over the territory of the Far East of Russia,**  
**Designations: A – abundant, NA – not abundant, + - a rare species known by solitary findings; ! – the species is known by**  
**dubious records; ? – expected; \* - the first record for the Russian fauna, \*\* - the first record for the Far East of Russia.**  
**Columns (zoogeographical districts): 1 – Chukotian, 2 – Kolymian, 3 – Kamchatian, 4 – Okhotian, 5 – Upper-Amurian, 6 –**  
**Bureya-Lesser-Khingian, 7 – Tugurian-Lower-Amurian, 8 – Sikhote-Alinian, 9 – Middle-Amurian, 10 – Amurian-**  
**Lower-Ussurian, 11 – South-Primorian, 12 – Khasanian-North-Korean, 13 – Sakhalinian, 14 – South-Kurilian.**

▷ O.K.: for the last 13 years new distributional records were made which are not marked in the table. ◁

| No. | Species[ and subspecie]   | Holarctic Region       |                  |   |    | Subholarctic Region  |   |   |    |    |    |    |    |    |    |
|-----|---|------------------------|------------------|---|----|----------------------|---|---|----|----|----|----|----|----|----|
|     |   | Siberian Subregion     |                  |   |    | East-Asian Subregion |   |   |    |    |    |    |    |    |    |
|     |   | Forest-Tundra Province | Taigous Province |   |    | Amurian Province     |   |   |    |    |    |    |    |    |    |
|     |   | 1                      | 2                | 3 | 4  | 5                    | 6 | 7 | 8  | 9  | 10 | 11 | 12 | 13 | 14 |
| 1   | <i>Calopteryx atrata</i> Selys ▷ E.M.: presently <i>Atrocalopteryx atrata</i> ◁ |                        |                  |   |    |                      |   |   |    |    | NA | NA | NA |    |    |
| 2   | <i>C. japonica japonica</i> Selys   |                        |                  |   |    |                      |   |   | NA | NA | NA | A  | A  |    |    |
| 3   | <i>Mnais pruinosa costalis</i> Selys *  |                        |                  |   |    |                      |   |   |    |    |    |    |    |    | NA |
| 4   | <i>Lestes dryas</i> Kriby   | A                      | A                | A | A  | A                    | A | A | A  | A  | A  | A  | A  | A  | A  |
| 5   | <i>L. japonicus</i> Selys *   |                        |                  |   |    |                      |   |   |    |    |    |    | +  | +  |    |
| 6   | <i>L. sponsa</i> Hansemann  |                        |                  |   | NA | A                    | A | A | A  | A  | A  | A  | A  | A  | A  |
| 7   | <i>L. temporalis</i> Selys  |                        |                  |   |    |                      |   |   |    |    |    |    | +  | +  |    |
| 8   | <i>Sympecma fusca</i> Vander Linden ** ▷ E.M.: mislabeling ◁                    |                        |                  |   |    |                      |   |   |    |    |    |    |    |    | +  |
| 9   | <i>S. paedisca braueri</i> Bianchi ▷ E.M.= <i>S. paedisca</i> Brauer ◁          |                        |                  |   |    | A                    | A | A | A  | A  | A  | A  | A  |    |    |
| 10  | <i>Mortonagrion selenion</i> Ris  |                        |                  |   |    |                      |   |   |    |    |    |    |    | +  |    |
| 11  | <i>Cercion calamorum</i> Ris *  |                        |                  |   |    |                      |   |   |    |    |    |    |    | +  |    |
| 12  | <i>C. hieroglyphicum</i> Brauer *   |                        |                  |   |    |                      |   |   |    |    |    |    |    | +  |    |
| 13  | <i>C. plagiosum</i> Needham *   |                        |                  |   |    |                      |   |   |    |    |    |    | +  | ?  |    |
| 14  | <i>C. v-nigrum</i> Needham  |                        |                  |   |    |                      |   |   |    | NA | NA | NA | NA |    |    |
| 15  | <i>C. armatum</i> Charpentier   |                        |                  | A | NA | ?                    | + | ? |    |    | +  |    |    |    |    |

|    |  |    |    |    |    |    |    |    |    |    |    |    |    |    |   |   |
|----|--|----|----|----|----|----|----|----|----|----|----|----|----|----|---|---|
| 16 | <i>C. concinnum bartenevi</i> Belyshev ▷ O.K.: presently the species valid name is <i>C. johanssoni</i> Wallengren ◁ | NA | NA | A  | A  | A  | A  | A  | A  | A  | A  |    |    |    |   |   |
| 17 | <i>C. c. convalescens</i> Bartenev ▷ O.K.: both subspecies probably unnecessary ◁                                    |    |    |    |    |    |    |    |    |    |    | A  | A  | NA |   |   |
| 18 | <i>C. ecornutum</i> Selys  |    |    |    |    | A  | A  | A  | A  | A  | A  | A  | A  | A  |   |   |
| 19 | <i>C. glaciale orientale</i> Belyshev  |    | NA | ?  | A  | A  | A  | A  | A  | A  | A  | A  | A  |    |   |   |
| 20 | <i>C. hastulatum</i> Charpentier **  |    |    |    |    | NA | NA |    |    |    |    | +  | ?  |    |   |   |
| 21 | <i>C. hylas ussuriensis</i> Belyshev ▷ O.K.: a hardly necessary subspecies ◁   | NA | NA | NA | A  | A  | A  | NA | NA |    |    | NA | A  | A  | A |   |
| 22 | <i>C. lanceolatum</i> Selys  |    | NA | NA | NA | A  | A  | A  | A  | A  | A  | A  | A  | A  |   |   |
| 23 | <i>C. lunulatum</i> Charpentier  | ?  | A  | A  | A  | NA |    |    |    |    |    |    |    |    | + |   |
| 24 | <i>Erythromma humerale</i> Selys ▷ O.K.: most probably a subspecies of <i>E. najas</i> Vdl. ◁                        |    |    |    |    | A  | A  | A  | A  | A  | A  | A  | A  |    |   |   |
| 25 | <i>Nehalennia speciosa</i> Charpentier **  |    |    |    |    |    |    |    | NA | NA | NA | NA | NA |    |   |   |
| 26 | <i>Enallagma antiquum</i> Bartenev ▷ O.K.: a synonym of <i>E. c. cyathigerum</i> Charp. ◁                            | ?  | ?  | A  | A  |    |    | NA | ?  | NA | ?  | ?  | ?  |    |   |   |
| 27 | <i>E. belyshevi</i> Haritonov ▷ O.K.: A synonym of the next species. ◁   |    |    |    |    |    |    |    |    |    |    |    |    |    | A |   |
| 28 | <i>E. circulatum</i> Selys   |    |    |    |    |    |    |    |    |    |    |    |    |    | + | A |
| 29 | <i>E. cyathigerum</i> Charpentier  |    |    | !  | !  | ?  | ?  | ?  |    |    |    | +  | !  |    |   |   |
| 30 | <i>Ischnura asiatica</i> Brauer  |    |    |    |    |    |    |    |    | NA | NA | NA | NA |    |   |   |
| 31 | <i>I. elegans</i> Vanderlinden **  |    |    |    |    |    |    |    |    | NA |    |    | ?  |    |   |   |
| 32 | <i>Platycnemis pennipes</i> Pallas **  |    |    |    |    |    |    |    |    | +  |    |    |    |    |   |   |
| 33 | <i>P. phyllopoda</i> Djakonov  |    |    |    |    |    |    |    |    |    |    | NA | NA |    |   |   |
| 34 | <i>Copera tokoyensis</i> Asahina *   |    |    |    |    |    |    |    |    |    |    | +  | ?  |    |   |   |
| 35 | <i>Aeshna caerulea</i> Stroem  |    | +  | NA | NA | NA | ?  | NA | NA |    |    |    |    |    |   |   |
| 36 | <i>A. crenata</i> Hagen  |    | NA | NA | A  | A  | A  | A  | A  | A  | A  | A  | A  | A  | A |   |
| 37 | <i>A. juncea angustistyla</i> Oguma ▷ O.K.: subspecies perhaps unnecessary ◁   | A  | A  | A  | A  | A  | A  | A  | A  | A  | A  | A  | A  | A  | A |   |
| 38 | <i>A. mixta</i> Latreille  |    |    |    |    |    |    |    |    |    |    | NA | A  |    |   |   |
| 39 | <i>A. subarctica</i> Walker  | ?  | NA | NA | NA | ?  | ?  | NA |    |    |    |    |    |    |   |   |
| 40 | <i>A. palmata</i> Hagen  |    |    | !  |    |    |    |    |    |    |    |    |    |    |   |   |
| 41 | <i>A. viridis</i> Eversmann ▷ O.K.: most probably an error ◁   |    |    |    |    |    |    |    |    | +  |    | +  |    |    |   |   |
| 42 | <i>Anax junius</i> Drury   |    |    | !  |    |    |    |    |    |    |    |    |    |    |   |   |
| 43 | <i>A. parthenope julius</i> Brauer   |    |    |    |    |    |    |    |    |    | NA | A  | A  |    |   |   |
| 44 | <i>Aeschnoflebia kolthoffi</i> Sjöstedt ▷ E.M.: A synonym of the next  |    |    |    |    |    |    |    |    |    |    | +  | +  |    |   |   |



|         |  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|---------|--|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 77      | <i>Lyriothemis pachygastra</i> Selys   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 78      | <i>Orthetrum albistylum speciosum</i> Uhler  |    |    |    |    |    |    |    |    | +  |    | NA | NA |    |    |
| 79      | <i>O. melania</i> Selys  |    |    |    |    |    |    |    |    |    |    |    |    |    | NA |
| 80      | <i>Deielia phaon</i> Selys   |    |    |    |    |    |    |    |    |    |    | +  | +  |    |    |
| 81      | <i>Neurothemis fluctuans</i> Fabricius   |    |    |    |    |    |    |    |    |    |    | !  |    |    |    |
| 82      | <i>Sympetrum baccha matutinum</i> Ris  |    |    |    |    |    |    |    |    |    |    | NA | NA |    |    |
| 83      | <i>S. cordulegaster</i> Selys  |    |    |    |    |    |    | NA | ?  | NA | NA | NA | A  | A  |    |
| 84      | <i>S. croceolum fuscoatrum</i> Belyshev  |    |    |    |    |    |    | ?  | ?  | ?  | NA | NA | NA | NA |    |
| 85      | <i>S. danae</i> Sulzer   | NA | NA | A  | A  | A  | A  | A  | A  | A  | A  | A  | A  | A  | A  |
| 86      | <i>S. depressiusculum</i> Selys  |    |    |    |    |    | NA | A  | ?  | A  | A  | A  | A  | A  |    |
| 87      | <i>S. eroticum eroticum</i> Selys  |    |    |    |    |    | NA | A  | NA | A  | A  | A  | A  | A  |    |
| 88      | <i>S. flaveolum flaveolum</i> Linnaeus   | NA | A  | A  | A  | A  | A  | A  | A  | A  | A  | A  | A  | A  | A  |
| 89      | <i>S. frequens</i> Selys ▷ E.M.: = <i>S. depressiusculum frequens</i> ◁                          |    |    |    | !  |    |    |    |    |    |    |    | A  | A  | +  |
| 90      | <i>S. imitans imitans</i> Selys ▷ E.M.: = <i>S. vulgatum imitans</i> Sel. ◁                      |    |    |    |    | +  | A  | NA | NA | NA | NA | NA | A  |    | NA |
| 91      | <i>S. imitans fuscopterum</i> Belyshev ▷ E.M.: Most probably = <i>S. vulgatum imitans</i> Sel. ◁ |    |    |    |    |    |    |    |    |    |    |    |    | A  |    |
| 92      | <i>S. infuscatum</i> Selys   |    |    |    |    |    |    |    |    |    |    |    | A  | A  | A  |
| 93      | <i>S. kunckeli</i> Selys   |    |    |    |    |    |    |    |    |    | NA |    |    | NA |    |
| 94      | <i>S. parvulum</i> Bartenef  |    |    |    |    |    |    |    |    |    | NA |    | NA | NA |    |
| 95      | <i>S. pedemontanum elatum</i> Selys  |    |    |    |    |    |    |    |    |    |    |    |    |    | NA |
| 96      | <i>S. p. kurentzovi</i> Belyshev ▷ O.K.: = <i>S. p. pedemontanum</i> ◁                           |    |    |    |    |    | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 97      | <i>S. risi</i> Bartenef  |    |    |    |    |    |    | ?  | ?  |    | +  |    | NA | NA |    |
| 98      | <i>S. striolatum imitoides</i> Bartenev  |    |    |    |    |    |    |    |    |    |    |    | A  | A  | A  |
| 99      | <i>S. s. kurile</i> Belyshev   |    |    |    |    |    |    |    |    |    |    |    |    |    | A  |
| 100     | <i>S. uniforme</i> Selys   |    |    |    |    |    |    | ?  | NA | NA | NA | NA | NA |    |    |
| 101     | <i>Pantala flavescens</i> Fabricius  |    |    |    | !  |    | +  | ?  | +  | +  | A  | NA | A  | A  | NA |
| Totally |  | 9  | 18 | 22 | 24 | 33 | 30 | 32 | 36 | 49 | 46 | 67 | 63 | 29 | 24 |

▷ O.K.: Since 1995, four more species were added:

|  |                                       |  |  |  |  |    |  |  |  |  |    |    |   |  |  |
|--|---------------------------------------|--|--|--|--|----|--|--|--|--|----|----|---|--|--|
|  | <i>Aeshna serrata</i> Hagen           |  |  |  |  | NA |  |  |  |  |    |    |   |  |  |
|  | <i>Stylurus occultus</i> Selys        |  |  |  |  |    |  |  |  |  |    | NA |   |  |  |
|  | <i>Macromia daimoji</i> Okumura       |  |  |  |  |    |  |  |  |  |    | +  | + |  |  |
|  | <i>Orthetrum cancellatum</i> Linnaeus |  |  |  |  |    |  |  |  |  | NA |    |   |  |  |

◁