

Odonatological expeditions to the Tyva Republic (Tuva) 2000-2002

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Introduction

The Tyva Republic, within the Russian Federation, has acquired its present name in 1991. It was formerly known as the Tuvian Autonomous Region within the USSR. Its common names in the past centuries were Uryankhaiskii Krai or Soyotskii Krai. In modern Russian, it is known under the name *Tuva* (not *Tyva*), which will be used further in the text. This country, for example, embraces the sources of the great Siberian river Yenisei and its capital, the town of Kyzyl, represents the geographical centre of Asia. To date, this vast and clear cut territory was hitherto almost unexplored in odonatological respect. In particular, it was not visited by the outstanding Siberian odonatologist B. F. Belyshev. Scarce materials from the recent Tuvian territory were mentioned by Valle (1942), who considered it to be Mongolian.

In the only paper concerning the dragonflies of Tuva in particular (two localities in its very south) 14 species were reported (Zaika & Kosterin 1990). The "transitional form between *Ophiogomphus serpentinus* and *O. reductus*" considered in that work, however, turned out to be the Chinese-Mongolian species *Ophiogomphus spinicornis* (Kosterin, 1999). Finally, one of us published two works on the general lentic fauna of the Ubsu-Nur Hollow in general (Zaika, 1996) and Lake Tere-Khol' in particular (Zaika, 1999), where 26 and 9 species were listed, respectively. The latter work was based on larval identification. Because this is difficult, this information should be taken with caution. The presence of species such as *Ischnura pumilio* and *Cordulia aenea* was not confirmed by records of adults and may be erroneous.

This paper presents the results of several expeditions to different regions of Tuva in 2000-2002, which were partially supported by the IDF. In 2000 one team comprising Oleg Kosterin (O.K.) and Natalya Priidak, visited the main intermontane hollows of East Tuva: the eastern part of the Ubsu-Nur Hollow (the environs of Lake Tere-Khol' and Erzin village), the Central Tuvinian Hollow (the environs of Kyzyl), and the Todzha Hollow (the environs of Toora-Khem village and Lake Azas). The second group, including V. Zaika (V.Z.) visited the south-western uplands of Tuva. Thus, we managed to undertake a preliminary survey of most of the main parts of the Republic, except for the Turan Hollow and the Kaa-Khem River basin. These pilot expeditions allowed to choose directions of more detailed specific investigations. Further odonatological studies in 2000 and 2001, mostly at Kyzyl and Lake Chagytai, were made by V. Z.

Tuva is rather unfavourable for dragonflies, as most of its territory is quite arid and poor in stagnant water while cold and fast running mountain rivers are not inhabited by dragonflies at all. Tuva is equally remote from both western and eastern centres of taxonomical diversity of Odonata. We, therefore, did not anticipate to find a very interesting fauna. Fortunately, these expectations turned out to be not true.

The Tyva Republic (Tuva), a short description

The Tyva Republic (Tuva) is situated between 49°45' and 53°43' N and 88°48' and 99°15' E. It comprises several large mountain chains dividing it into several tremendous intermontane hollows.

In the north it is bordered by the West Sayan Mts. (with the highest mountain rising to an altitude of 2858 m), in the north-east by the East Sayan Mts. (3044 m), in the west by the Shapshal'skii (3201 m) and Chikhacheva (3278 m) Ranges, the latter belonging to the SE Altai Mts. In the NW part of Tuva, an ancient volcanic Alash Plateau (3122 m) is adjacent to the West Sayan.

In the south the border goes through the northern part of the great Ubsu-Nur Intermontane Hollow (mostly situated in Mongolia). In the south there is the large Tannu-Ola Upland, a latitudinally oriented mountain system with altitudes of 2000-2500 m (2967 m) subdivided into the West and East Tannu-Ola Ranges. This is a relatively young upland, with an almost perfectly plain and levelled upper surface which started to rise only very recently, in the Quaternary. Its rise blocked the water discharge from W Mongolia into the Yenisei River (Suslov, 1954). In the south-west of Tuva, the Shapshal'skii and West Tannu-Ola Ranges are connected by a short nearly latitudinal range Tsagan-Shibetu (3577 m). The massif Mongun-Taiga in the SW of the Republic has the highest elevation of Tuva (3970 m) and is a powerful centre of a modern glaciation.

In the SE part of Tuva, the southern chain of uplands is prolonged with the Khorumnug-Taiga Range (2856 m) and the Sangilen Upland (3276 m), the latter already belongs to the Hangai mountain system. All these mountains of South Tuva form the northern border of the Ubsu-Nur Hollow (with the minimum altitude of 750 m at the level of Lake Ubsu-Nur [Uvs-Nor]) and the watershed between the Northern Ocean and Inner Asia. They also coincide with the border between the Euro-Siberian and Central Asian biogeographical subregions of the Palaearctic (Suslov, 1954). The most distinct border of the Ubsu-Nur Hollow is represented by the Tannu-Ola Upland brinking to the Hollow by a straight sheer slope bearing at its foot an 1-10 km wide buttress of pediments formed by products of weathering. The Hollow is an area of active accumulation of soft Tertiary and Quarternary sediments (Suslov, 1954). Thus, neither Lake Ubsu-Nur nor its tributary the Tes Khem River have terraces, while small rivers descending from the mountains soon disappear in the debris forming peculiar dry deltas, the so-called *sairs*.

To the north of the Tannu-Ola there are two large hollows. In the west, the Khemchik River catchment area basin forms the Khemchik Hollow with the minimum altitude of 650 m above sea level. In the east, there is the Central Tuvian Hollow with the minimum altitude of 527 m above sea level. These two hollows are divided by a rather low (1914 m) nearly meridional range Adar-Dash. In the western part of the Central Tuvian Hollow there are numerous isolated mountains and hilly massifs on which the Gobi-type landscapes predominate. The small Uyukskii mountain range (2492 m) is a spur of the West Sayan and separates the small Turanian Hollow (minimum altitude of 660 m) from the Central Tuvian Hollow. In the north, the Turanian Hollow is enclosed by the Kurtushibinskii Range belonging to the West Sayan system, the nearly meridionally oriented Taskyl Range (2615 m) and the Akademik Obruchev Upland (2895 m). The ranges of the West and East Sayans, the tremendous and scarcely populated Todzha Hollow (800 m) are situated in the north-east of Tuva. The mountains of the eastern Tuva (the Obruchev Upland, Khorumnig-Taiga range, Sangilen Upland), sometimes referred to as the East Tuvian Upland, are ancient whereas the elevations of West Sayan and Tannu-Ola Upland are much younger. Hence, the geographic isolation of the Todzha Hollow is of an old age (Suslov, 1954), that may be reflected in the history of its biota.

The main rivers of Tuva are the Bii-Khem, or Bol'shoi [Greater] Yenisei in the Todzha Hollow catchment basin, and the Kaa-Khem, or Malyi [Lesser] Yenisei, the catchment basin of which is bordered by the Academician Obruchev Upland from the north and the Khorumnug-Taiga and Sangilen Mountains in the south. These two great rivers join at the city of Kyzyl to form the Ulug-Khem River, or Yenisei, which flows to the west, turns north, cuts through the West Sayan and leaves Tuva. At present the Ulug-Khem is barred by the

Sayano-Shushenskoe Water Reserve. Close to its break through the West Sayan, it receives the Khemchik River from the Khemchik Hollow in the southwest. The main river of the Ubsu-Nur Hollow is the Tes-Khem that descends from the western spurs of the Hangai Upland and flows to the east along the mountains bordering the hollow from the north. Numerous smaller rivers descend from the mountains of Tuva. Those descending from the Tannu-Ola to the Ubsu-Nur Hollow and some rivers of the Central Tuvonian Hollow disappear in the bottom debris soon after leaving the mountains.

The largest lakes of Tuva are: the Ubsu-Nur (Mongolian: Uvs-Nor), with only a small NE section of its bank belonging to Tuva (and Russia), the Tere-Khol' (which in some recent maps for some reason is spelled 'Tore-Khol') in the south-east, also in the Ubsu-Nur Hollow, another Tere-Khol' in the east, situated in the Kaa-Khem River basin, and numerous lakes of Todzha of glacial origin (see below). In the Central Tuvonian Hollow there are the lakes Cheder and Khadyn both having a high mineral content and the freshwater lake Chagytai.

Tuva has an extreme continental climate characterised by a low average annual temperature (-4°C) and its large circadian and annual amplitudes, the latter being from $+40^{\circ}\text{C}$ in summer to -54°C in winter. The Central Tuvonian and, especially, the Khemchik Hollows reside in the rain shadow of Altai and the West Sayan causing annual precipitation as low as 200-220 mm (Shkatarzhik, 1993). A mostly dry and hot desert climate (190 mm annual precipitation) is found in the Ubsu-Nur Hollow bordered from the north by the Tannu-Ola Mts. The winters in Tuva are prolonged (160-170 days) and are so dry that the snow cover in steppe hollows is thin and not permanent. In the mountains the winter is milder and snow deeper. In the steppes, the spring starts in April and has an explosive character: the difference in the average temperatures of March and April reaches almost 22°C with daily temperature fluctuations of $15-20^{\circ}\text{C}$. The trees produce leaves mostly in late May. The summer is hot, although frosts are possible throughout the season. The maximum precipitation occurs in summer, mostly in the form of showers. Autumn starts in late September, when the daily amplitude of temperatures may reach 30°C , the average temperature becomes negative from mid-October (All climatic data were from Suslov (1954) unless otherwise stated).

Sharp contrasts of relief, climate, soils, vegetation and animal population within such a restricted space cause a complicated pattern of diverse geographical landscapes. In Tuva, the Siberian nature comes into contact with the Inner Asian one, that is, the forest and highland belts with the steppe zone. The bottom of the Ubsu-Nur and, partly, the Central Tuvonian Hollows are occupied by dry and desertified steppes. These steppes include a specific *Nanophyton*-steppe, which some botanists consider a true stony desert. The even drier parts comprise areas of free barkhan sands.

In the mountains, the altitudinal zonation is well expressed, the forest belt occupying most of the area except in the south-western mountains where the steppe passes directly into highland tundras. In the forest belt the Siberian larch (*Larix sibirica*) predominates. Closer to the tree line, the Siberian stone pine (*Pinus sibirica*) is admixed into larch forests. The highlands are occupied with different kinds of mountain tundras with dominance of dwarf birch (*Betula rotundifolia*), *Kobresia*, moss and lichen, and a stony one, as well as the so-called highland steppes. In the rivulet and brook headwaters, there are patches of alpine meadows. At lower altitudes of Tuva, the so-called expositional forest-steppe is well-expressed, where northern slopes are covered with forest while southern slopes have steppe vegetation. Impressive contrasts in vegetation can be observed in very small differences of the relief and slope orientation. On the banks of the steppe rivers, there are stripes of riparian forests of *Populus laurifolia*, *Betula microphylla* and willows (*Salix* spp.), sometimes with larch. For a detailed characteristics of vegetation of Tuva see Maskaev et al. (1985).

The natural conditions of the relatively little known Todzha Intermontane Hollow contrast to the rest of Tuva. This large and very scarcely populated area covers approximately 250 km by 70-100 km (Molokova & Kartashev, 1999). Its base elevates from 850 m above sea level in the west to 2000 m in the east. It is bordered by the above mentioned mountain systems with altitudes of 2300-2900 m. There are also less elevated latitudinal mountain ranges generating the watersheds of the main rivers of the Hollow, namely Khamsyra, Azas and Bii-Khem. The latter is the main source of the great Siberian river Yenisei. Most of the hollow is a hilly plain of glacial origin. About 18 000 years ago most of the central and eastern parts of the hollow were occupied by a vast (30000 km²) glacier of which numerous glacial lakes remained to date. The largest lakes are the Many-Khol' and the Kadysh with an area of about 2500 ha each and the Azas, or Todzha of 5470 ha. The climate of the hollow is strongly continental and moderately humid. The average annual temperature is 5.5°C, the average period without frosts occurring is 52 days. Summer frosts are frequent and the average precipitation is 343 mm per year, 60% of which fall in summer.

The highlands have a less continental climate and the precipitation increases to 600-800 mm (Molokova & Kartashev, 1999). Such conditions favour the light taiga ecosystems which are indeed well developed there. The vegetation is classified as the Todzha Stone Pine-Larch District of the East-Sayanian Mountain Taiga Province (Maskaev et al., 1985). Altitudinal zones are represented by fragmentary steppes and forest-steppes (at altitudes of 850-900 m), a well-expressed subtaiga belt of the grassy birch (*Betula pendula*) and larch (*Larix sibirica*) forests (900-1100 m), the mountain taiga larch (1100-1300 m), stone pine (*Pinus sibirica*) (1200-1700 m) and common pine (*Pinus silvestris*) (1000-1700 m)

forests, the subalpine stone pine and larch forests and parklands (1700-1900 m), and the highlands (above 1900 m). In the latter, dwarf birch (*Betula rotundifolia*) tundras are found at (1900-2100 m), with fragments of open stone pine and fir stands, subalpine and alpine communities scarcely expressed at 1900-2200 m, *Dryas*/lichen (above 2000 m) or stony/detritous (above 2200 m) tundras. On the southern slopes, steppe ecosystems penetrate into the subtaiga and mountain taiga belts and can be found up to 1300 m. In the river valleys, patches of spruce (*Picea obovata*) taiga are abundant.

Illustrating Internet resources

A lot of the images of Tuvian landscapes (including many dragonfly habitats) made by O. K. during the expedition of 2000 are available in Internet at:

<http://pisum.bionet.nsc.ru/kosterin/landscap/tuva/tuva.htm>

or (a mirror site) at:

<http://genome6.cpmc.columbia.edu/kosterin/landscap/tuva/tuva.htm>

Some images of odonates taken during the expeditions are placed at:

<http://pisum.bionet.nsc.ru/kosterin/odonata/odonata.htm>

<http://genome6.cpmc.columbia.edu/kosterin/odonata/odonata.htm>

References to the file names of specific images (to find on either landscape page or odonata page, as relevant) are given in brackets <***> at the links given below. These sites are constantly updated by O. K., so the information available will often exceed that given here.

Expedition routes and notes

The first author's expedition in 2000

We arrived in Tuva on July 8 by a kind of taxi, which made 430 km from Abakan to Kyzyl in 5 hours, having crossed the mountain system of West Sayan. The subsequently crossed Oiskii, Aradanskii and Ergaki Ranges were covered with dark-needle taiga. The latter was crowned by a chain of several incredible pointed pinnacles, much unlike anything we saw before, save for the images of impermeable mountains in cartoon films. Then we crossed the Kurtushibinskii range of smooth outlines which represents a section of the main axis of Sayan and divides the Krasnoyarskii Krai Province and the Tyva Republic. Much different from many administrative borders it was indeed a border in a geographical sense. Immediately after the pass the Siberian taiga disappeared and we entered a true Inner Asia: the tremendous Turanian Intermontane Hollow opened in front of us. It was almost forestless and covered by steppe of a variety of warm hue. The steppe did not hide intricate details of relief, first of all outcrops of slanting layers of hard rock forming asymmetrical ridges (quests). It was truly one of those panopticons of geomorphology which are so frequent in Inner Asia.

The road through the Hollow was excellent and perfectly straight, so that the car once achieved a speed of 145 km/hr, that was more than we would calmly accept, being unfamiliar to such speeds in the rest of our country. Unfortunately, though quite well accessible, the Turanian Hollow remains almost *terra incognita* in an odonatological sense, for visitors often used to slip through it towards more famous places, and we were no exception. Having crossed several hilly ridges and the Turan and Uyk Rivers we approached a quite gentle Uyukskii Range that here and there was grown with larch forests, we rose to the pass and entered the Central Tuvinian Intermontane Hollow. From there, we moved towards the Ulug Khem or Great Yenisei River and the city of Kyzyl upon it. The Central Tuvinian hollow looked more wild and severe than the Turanian one. In the north it was bordered by forestless spurs of the Uyukskii Range and in the east by the Academician Obruchev Range. These mountains were covered with a drier and more lifeless steppe and were speckled with rock outcrops (<abovekyzyl>). The foothills were occupied by the above described desert/steppe with domination of *Nanophyton grubovii*. The dark-green cushions of this plant grew up to half a metre in diameter, between them there were conspicuous brushes of *Ephedra monosperma* and *E. daburica*, bright orange-red due to clusters of numerous juicy and very sweet berries. A mighty and swift river of Ulug-Khem flew narrowly rimmed with willows and poplar (*Populus laurifolia*), the right bank being high and rocky. During our expedition, the bridge was being repaired and so people and automobiles were carried by a large ferry. This process provided a great number of amusing and spectacular scenes crying for their photographer or cinema reporter.

The land lying southerly of the river was flat and perfectly lifeless. On July 9 we were acquainted with the town and its surroundings. The town itself turned out to be rather small and was very pleasant: sunny, spacious and somehow serene, with a lovely central square. The square was remarkable for its large white building of the Theatre of Opera and Drama that had a Chinese-style roof. As one of us referred to it as “a House of Culture”, a Soviet phrase denoting a kind of a governmental Common Hall in a town or at a factory, our Russian taxi driver exploded with indignation. From any place, spectacular views opened towards the magnificent surrounding mountains. All this did not look like Russia no more. The local people were very friendly, quite curious and of extremely colourful nature. Among the pedestrians passing by we met, for example, young Lamaist monks with short hair, wearing modern fashionable sandals and sun glasses but wrapped in their traditional purple togas. Near the obelisk marking the geographical centre of Asia, on a high quay at the junction of the Bii-Khem (Large Yenisei) and Kaa-Khem (Small Yenisei) Rivers, a large new Datsan (a lamaist temple) was towering, also in white and in Chinese style. The Orthodox church which we saw later was situated in a remote estate and was about two times smaller. In Novosibirsk a rumour is commonly heard that

Tuva is a very insecure place, for if a Tuvinian has drunken just a bit his only desire becomes to knife a foreigner. All the atmosphere in town provided evidence against that. However, we were told that the city lacks security immediately after sunset. Later, we repeatedly had to appear on streets in darkness, but although our experience was quite scarce it was not in favour of this notions either, for all Tuvinians we met retained amity and talkativeness. Noteworthy though, all of them claimed that the population of West Tuva is the dangerous and non-predictable one. As some of our friends visited West Tuva repeatedly, I suppose these rumours to be legends of the same kind, based on few cases many-fold reflected in folk's tale.

In odonatological respect, the city park of Kyzyl was most interesting. It was situated on the left bank of the Kaa-Khem River just upstream of its junction with the Bii-Khem. The park represents quite a large area of the floodland covered with sparse stand of poplars and a system of branching oxbows, wide and deep, mainly mesotrophic. The water was warm at the surface and cold at the ground because it was fed by springs. As to odonates, all attention was drawn to an immense number of *Enallagma cyathigerum risi*, mostly males, in the sedges of banks, flying over the water surface and perching on any emerging stem. Among them we found *Erythromma najas*, but much less abundant. There were males of *Aeshna juncea* over the water surface and we managed to catch a female of *Somatochlora graeseri* completely lacking the typical basal amber on wings.

On July 10 we departed to Erzin, that appeared not an easy task. Regular coach commuting had been ceased, allegedly because of a shortage of passengers. All public traffic was now left in the hands of private drivers. To get to Erzin, one has to go to the market square of Kyzal and to start inquiries. Very soon quite a few of cars bound to Erzin will be found, but each driver (all being Erzin dwellers arrived to the capital for their own needs) waits until all seats would be occupied, and the dynamics of passenger accumulation is very unpredictable. At last, we started moving to south-west of Kyzyl through a boring lifeless steppe of the Hollow bottom, towards a remote hazy blue wall of the East Tannu Ola Mts. on the horizon, with a perfectly smooth and even top line. After a while we entered a well-known vast pine forest called Balgazynskii Bor. Recently it had burned to a great extent so that weird dead pine trees stood very densely over large areas. When we passed by the Bor and the Balgazyn village wide damp meadows rich in flowers appeared. At Shuurmak village, earlier inhabited by Russian *starovery* (Old Believers) but nowadays mostly by Tuvinians, we at last approached Tannu-Ola, the slopes of which were covered with larch forests, so indispensable in Siberian mountains. Its foothills were occupied by the characteristic larch parkland: open stands of large handsome individual larches growing on a meadow steppe. From a deserted pass at the junction of the ranges of East Tannu-Ola and Khorumnug-Taiga, where ten years ago the first author met a frontier zone post and a herd of white camels,

we started to descend into the great Ubsu-Nur Hollow. As viewed from the pass it was not so impressive as the Turanian one, but having descended to its bottom we found it beyond doubt the most fantastically looked intermontane hollow we've ever seen. The bottom was covered with a sun burned steppe with miserable grass cover leaving the clayish ground bare. The southern Tannu-Ola spurs were characterised by sharp jagged shape of relic rocks and smooth pediments. The latters were speckled by dark bushes of *Caragana*. In the very Hollow here and there steep and rocky relic mountains rose that looked like ships or dragon backs. Swift mountain rivers descending from Tannu-Ola, such as the Samagaltai, flew for some distance through the hollow rimmed with dark green larches, small-leaved birches (*Betula microphylla*) and poplars. Further in the Hollow, these rivers disappeared in shingle dry deltas, called *sair*. The road turned to the east and went along the powerful Tes-Khem River, flowing from the Khangai Mts. to Lake Ubsu-Nur. Sometimes, the river cut through mountain spurs and the valley was very spectacular.

Passing Bert-Dag village, a centre of the Tuvinian camel breeding (which came to decline now), we approached Erzin on a road full of sand. This was a small and very unc cosy village practically without green, with very wide empty streets which little differed from the burnt out surrounding steppe. In the north very scenic mountains rose, stepped and jagged, being spurs of the Khorumnug-Taiga Range and Sangilen Mts, among which a pinkish lime-stone massif Ulug-Khayyakaan-Dag was most prominent (image <khayyakaan>) (not to be confused with the larger Khayyakaan Mt. in the Central Tuvinian Hollow). The village was situated on the Erzin River bank. Like many rivers falling from the mountains to the south this was a crystal-clear and ice-cold mountain torrent with few fords which rushed by several arms among shingle banks flanked with small-leaved birches, giant poplars and sparse larches, with thickets of willows and spiny *Caragana spinosa*. Among and along these thickets there were meadows, mostly trampled and short cut by cattle, where butterflies fluttered, hoopoes flew from tree to tree, and, generally speaking, life was seething. We were hospitably accepted by the staff of the Ubsu-Nurskaya Kotlovina State Nature Reserve and were accommodated in a guest room of its office building. Erzin was populated exclusively by Tuvinians. It seems that we saw the only Russian guy, fair-haired and blue-eyed. He worked as a gate-keeper in the Reserve court and amazed us because he hardly spoke Russian. Of course, he appeared to be a orphan adopted and raised in a Tuvinian family.

During the rest of the day we had an excursion upstream the valley. The steppe (according to our botanists, this year especially luxuriant) was practically lifeless, with the exception of sparse and hardly above the ochre-coloured ground rising withered plants of *Artemisia frigida*, *Potentilla acaulis* and some grasses. The only insects seen were very worn males of the butterfly *Hipparchia autonoe*. From time to time they were shooting into the air almost from our feet, most

frequently in places where the steppe evenness was disturbed by some hollow. About 2 km upstream of Erzin, sheer granite monumental rocks towered, some weathered to characteristic roundish shapes (<erzin2>, <erzin5>). There, we found a lonely female of *Sympetrum vulgatum* sitting on a branch of *Caragana spinosa*. From the rocky crest we were at gaze of numerous bakhans of the sandy desert Tsugeer-Els, preciously sharpened by beams of the setting sun beneath the south-eastern horizon, over the Tes-Khem River. In front of the rocks, at the junctions of the Erzin and Moren, another village, Bulun-Bazhy was situated in the valley. A section of the floodland between the villages was skillfully irrigated by an *aryk* (irrigation ditch) drawn aside from the river. However, until the time of our visit no crop seems to have been sowed there for years.

On July 11 we followed the Erzin River downstream along its floodland (<erzin>, <erzinriver>). Amongst trees and bushes, patrolling males of *Aeshna crenata* were seen. At stagnant pools there were also males of *Aeshna juncea* flying mostly above the water. Two *Ae. serrata* females were collected. In the sedges and above the water surface of the small pools *Lestes sponsa* and *Coenagrion hylas* (<hylas>) were abundant and a few *Coenagrion ecornutum* were also found. Then we crossed three kilometres of lifeless dry steppe and approached the Tes-Khem floodland. Close to it the vegetation became more green, above the grass large and fresh plants of *Artemisia dracuncululus* towered, clung with many large and beautiful long-horned beetles *Dorcadion carinatum* and some Curculionidae, amazingly diverse in ornaments and colouration. Beside these remarkable beetles large and thick motley brachypterid grasshoppers *Zichia baranovi* occurred of either green or sandy colour.

As different from the Erzin River, the right bank floodland of Tes-Khem reaches several kilometres in width and is an incredible labyrinth of river arms, oxbows and lakes, patches of poplar, birch and larch forest, tussock sedge bogs and enormous willow thickets. All these brakes contained a huge amount of dry brushwood which seemed to suffer no fire for many years, that was quite unexpected inside a steppe area. There were also patches of flowering meadows (on one of which we disturbed a goatsucker fledgling) and more dry steppe with sparse and very spiny bushes of *Caragana spinosa* up to 3 m in height. Needless to say, this was a dragonfly paradise, *Aeshna crenata*, and less abundant *Ae. juncea* were the most conspicuous. Everywhere, but more frequently at sedge bogs, teneral *Sympetrum danae* et *flaveolum* occurred as well as fewer mature *Leucorrhinia dubia orientalis*. Quite often we chased off yellowish-green *Ophiogomphus spinicornis* which perched on dry branches (<spinicornis>). This species was expected since ten years ago O. K. and V. Z. found it at the same river but west to this site (Zaika & Kosterin, 1990). Corduliidae were extremely rare and we managed to get only one individual, which turned to be a female *Somatochlora graeseri*, quite alike that collected at Kyzyl, without amber

on wings. Zygopterans were rather few: mostly *Lestes sponsa*, one female *L. dryas*, at some pool we found *Coenagrion lanceolatum*. Not so easily did we find our way to the very river of Tes-Khem. At this point the river had made quite a long way over the Hollow bottom. The water was, although clean and quite warm, fast and about waist-deep. Standing in there, the sand was soon washed away from underneath your feet. The banks were covered with dense willow thickets along which aeshnids patrolled and *O. spinicornis* perched, one *Lestes* being also noticed.

On July 12 we made a brief excursion to the Erzin River floodland, where we updated our list with a teneral male of *Coenagrion lunulatum*. We had an opportunity to participate in a short escapade to the mountains of the Khorumnug-Taiga Range, in a popular Russian jeep of the UAZ type which is simple but very passable. Having passed the steppe pediments, speckled with *Caragana* bushes, we immersed ourselves into an even and somewhat boring larch taiga. Our vehicle seemed to permanently climb impossible slopes until we reached a hut where the botanist Dr. Dmitrii Nikolaevich Shaulo, who helped us so much later during our trip, had been dwelt with his Tuvonian satellites for a while. The hut was beautifully situated among the taiga with its rich meadows, blossoming pink *Geranium* and their grazing horses. The botanical team was taken back for Erzin. As could be expected, no dragonflies were found in these taiga mountains. There was a weak shower in the mountains while in the hollow a thunderstorm blew with a dust squall instead of rain.

On July 13, O. K. repeated a sortie into the Tes-Khem floodland which was darkened by a loss of the dictaphone during an attempt to photograph another nightjar fledgling and by a failure to reach the very river. Instead, he found a long and winding oxbow with amazingly ice-cold water, obviously fed by ground springs, from which a couple of ruddy shelducks (*Tadorna ferruginea*) got into the air with cries. Several males of *Somatochlora graeseri* patrolled above the water surface. However, the oxbow was so long that 10-15 minutes passed by until a dragonfly returned to the same place on their patrol flight. So, it was not easy to get one of those. On gaps within the willow thickets at the banks *Leucorrhinia dubia orientalis* occurred somewhat more frequently than elsewhere in the floodland. This may indicate that its larvae developed in the oxbow. The cold water of the oxbow may have retarded the emergence of these spring dragonflies such that we were able to encounter them so late.

O.K. managed to come to a large lake with boggy sedge banks, not less than a kilometre in diameter, from which a couple of demoiselle cranes (*Anthropoides virgo*) took off. Dwellers of large lakes as *Enallagma cyathigerum risi*, *Erythromma najas* were found quite abundant and also few teneral *Sympetma paedisca* and *Coenagrion ecornutum*.

There he obtained also the last individuals of the omnipresent but early emerging *Libellula quadrimaculata*. On a clearing in the willow thickets, with high bushes of *Caragana spinosa*, O. K. found a ranging male of *Aeshna affinis*, the only individual of this species observed during the whole expedition.

We departed from Erzin towards the famous Lake Tere-Khol in the evening, under a terrifying thunderstorm (<erzinstorm>) with a cloud-burst, that are so characteristic for the summer Tuva. The vehicle was driven by the Director of the Reserve, Andriyan Dugarovich Doduk. In pink twilight, under picturesque heavens (<evening2>, <rain>, <sunset>) we descended into the Ubsu-Nur Hollow, passing by steppe and abandoned fields beside the stony dragons of relic rocks. The range of Tannu Ola in the north looked fantastic: an almost even wall of its foothills, cut through regularly by gorges. Everything was illuminated by decaying light and the mountain tops were hidden in dark heavy clouds.

This and the next night we spent in a hospitable yurta, the transportable round tent of the steppe nomads made of felt and with a hole in the centre of the roof. The owner was the Director's father, Dugar Damiraevich Doduk who maintains a traditional way of life and keeps herds of sheep, goats and cows and several horses. We were honoured to participate in the traditional, almost ritual Tuvian dish called 'khan', ram blood boiled in the gut of the ram and then roasted on the open fire. To go with it, there was a roasted liver wrapped into the fat of the ram and a very tasty drink 'tarak', a kind of very acid yogurt prepared from cow milk fermented with the aid of yeast. On July 14 we examined the dry steppe around the yurta (<cows>). There it was speckled with sparse bushes of *Caragana bungei* and looked as a diminished savannah, as far as we imagine one to look like (actually, Mr. Doduk, who visited the South African Republic, found it very much alike Tuva). On a trip to an aggregation of granite relic rock Yamalyg, we saw hundreds of ancient burials, although they could hardly be distinguished from the surrounding steppe. In the evening another thunderstorm front passed.

On July 15 we moved to Lake Tere-Khol at its narrowest part, just at the Mongolian border. From the NW bank the *Caragana*-steppe reached close to the water. The opposite Mongolian bank was quite high and formed by reddish sands, with very sparse vegetation, being a margin of quite a large sand desert Altan-Els. The lake has an astonishing clear and warm water, with a mineralization of only 0.4 g/l. This is because the water is filtered in from springs through the sands of the southern bank and then filtered away through sands elsewhere, so the water is permanently exchanging. The lake was beautiful: its calm surface reflected the deep blue of the sky with high clouds and the reddish-golden sands of the opposite bank, here and there with dark-green vegetation. The lake banks were sandy and quite firm, locally producing valuable beaches. There were some very shallow bays with a clayish bottom and almost

hot water. The banks were poor of vegetation: sparse sedges, somewhere on shallows there were small reed (*Phragmites australis*) thickets. In the deeper water submerged *Utricularia* occurred. Originally there was only species of fish in the lake called *osman* (*Oreoleuciscus pewzowi*). Later pike was introduced and now the lake is full of giant pikes which are unique in being enormously fat and so rather looking like some pike-swines. Of the dragonflies, there were plenty of the familiar *Enallagma cyathigerum risi* in the grass along banks. *Lestes sponsa*, *Coenagrion ecornutum* and *C. armatum* kept to the sparse emergent sedges, and in vegetation above the heated water of a shallow bay the only specimen of *Ischnura elegans*, a male, was collected. From the rather few aeshnids we managed to get two teneral females of *Aeshna serrata*. Males of *Orthetrum cancellatum* kept to sandy banks where they ranged to and fro over the shoreline or rested on the barren sand. We chased off a lot of teneral individuals of this species from the grass, so apparently its emergence was still in progress. Inside a small reed thicket of a shallow bay just at the Mongolian border we encountered an enormous amount of freshly emerged *Sympetrum vulgatum vulgatum*. With each step dozens of them with glittering wings got into the air and immediately sat back to the reed leaves and young panicles (<vulgatum> and <vulgatum2>). All 17 specimens collected were males although females appeared to be on photographs taken there. It is very likely that the flight period had just started and that males emerge earlier than females in this species. Perhaps it was provoked by a good weather after two days of thunderstorms. For one hour O. K. tried in vain to catch one of two extremely cautious bright-red *Sympetrum* males which kept to a very shallow bay with clayish banks without vegetation. They landed very seldom and were mostly on the wings, flying with short jumping movements. They could have been already matured *S. vulgatum*, *S. sanguineum*, or perhaps *S. fonscolombii*. The latter is still not known from the Asian Russia, but was found in Mongolia very close to this site (Belyshev & Doshidorzhi, 1958).

Closer to the evening we moved north-east to the massif of free barkhan sands called Tsugeer-Els meaning *Just Sand* in Mongolian. This patch of sand desert is bordered by a low relic mountain at the west side and forms a high buttress along several kilometres of the left bank of the Tes-Khem valley. This was truly a fantastic place with unique flora and fauna, as for instance Variegated Toad Agamas *Phrynocephalus versicolor* cryptic on the sand. The place had deserved much more than the two hours for its investigation that we had, but it had no relation to odonatology.

On July 16 O. K. again visited the Tes-Khem floodland attempting to find the dictaphone but failed, and no new odonate species were found. One day later we returned to Kyzyl in sunny weather. The crest of the Tannu-Ola Mountains range was again hidden with dark shaggy clouds. The rest of this and the entire next day were spent in Kyzyl in preparations for the departure to Todzha and

excursions to the barren mountains on the Ulug-Khem right bank. Of the things of general interest, a group of five (!) young and cheerful Russian girls wearing bikini, tourist boots and small rucksacks were encountered on a path winding amidst wild and lifeless spurs at the top of a mountain. This mountain was flagged with an enormous word 'Lenin' in large white stones that from time to time used to be replaced with the Tuvian name of the mountain, *Doge*, meaning sunlit. But it was always quickly restored back to Lenin. The careless appearance of these girls further undermined the myth of Tuva being a very perilous country.

On July 19 we sailed to Todzha, as there is still no road permeable in summer. It is accessible by air or water only. Three times a week a flat-bottomed water-jet vessel *Zarya* takes 200 passengers upstream the Bii-Khem river. Its draught comprises 20 cm only, so it is able to cross the Khutinskie Rapids at the point where the Bii-Khem breaks through the Taskyl Mountain Range. It takes 10 hours for *Zarya* to get from Kyzyl to Toora-Khem village (the 'capital' of Todzha Kozhuun). The way back on the next day takes 6 hours. The tickets are a problem and at each departure day a large crowd besieges the moorage office. Eventually all pretenders get on board, although many have to stand throughout the whole sailing. Using a rather Asian way, our chief Dmitrii Shaulo had addressed his friend Nikolai Ivanovich Putintsev, the Vice Chairman the State Ecological Committee of the Republic before the travel. With the aid of a paper showing quite impressive seals we were among the first passengers to buy tickets. During the sailing, O. K. and N. Priidak had an opportunity to take a masterclass by D. Shaulo who drank bear with this or that passenger talking about their life and soon making them his bossom friends, which are now scattered all over the Republic. Among the representatives, there was a tall, slightly drunken Tuvian, perhaps a metis with completely white hair and blue eyes. He wore a white flannel beach hat with a fringe, spoke some French and introduced himself to as a philosopher. This character indicated that Todzha was a place of some internal tourism.

During the first half of the journey sheer river-cut crags of the mountains showing slanting layers of grey, brown and bordeaux rocks were passed on either side of the river. Above the crags, the mountains were at first forestless but gradually their slopes become clad in larch taiga while the summits were hidden in raggy clouds. Finally, the mountains came so close that their tops could not be seen through the windows. The river became troubled and the vessel started to be shaken and tossed about by rollers, rising clouds of spray dropped into the opened window panes. These were the notorious Khutinskie Rapids. At the same time the sky turned gloomy and it started to rain, as if manifesting that we were entering Todzha. Upstream of a small moorage Seiba, where local people sold very tasty pies with *Russula* mushrooms, the mountains again withdrew from the river and become more gentle while the river became

calm. This was already Todzha, quite a different country. It was inclement and unfriendly: low gloomy skies, reflected in the grey but pearl-glistening waters of the Bii-Khem. The banks were grown with dense spruce and larch taiga, huge trees on the banks being here and there undermined by the river and bent over the water. Few precipitous slopes were rather low and covered with white-blooming *Aconogonon alpinum* herbs, or forests of the common pine. The rather large right tributary Systyg-Khem River had turbid yellow water which did not get mixed with the clear waters of the Bii Khem for a long time. We later learned that its turbidity resulted from gold-digging.

In the evening we arrived at Toora-Khem, or, to be more precise, at a neighbouring Saldam village where the moorage was situated. It was cold and wet, it rained from time to time. The vessel was met by the police which controlled the passports and ordered us to come to the local police station to be registered the next day. All the people arriving were monitored to prevent invasions by vodka and other undesirable goods to Todzha. Its scarce and subtle local population, with its traditional way of life, is vulnerable to many harmful influences of the outer world.

The population of Todzha is unlike the Tuvinians dwelling the steppe, and their harsh and loud dialect is hardly understood by the latter. For instance, the self-given name *Tozhu* is a local version of the word *Tyva*. Further north-east this word is replaced by *Tofa* of the Tofalars. In stature the Todzhians are more stout and have larger but less Asian appearances, their faces somewhat resembling those of native Americans. They breed reindeer which we, however, did not see as in summer their herds are on highland pastures. There are local peculiarities even in the criminal sphere, our hosts instructed us against theft rather than banditism.

We were left to the care of Nina Iosifovna Molokova, the Scientific Vice Director of the Azas Nature Reserve. We were accommodated in a capacious office house of the Reserve and were helped in various respects, including the arrangement of a three-days trip into the Reserve. In the twilight we made an excursion to the rivers of Toora-Khem and Bii-Khem. The first flows from Lake Azas and joining the great Bii-Khem at Toora-Khem village. Fog laid over the Toora-Khem and from a sheer crag of the opposite bank of the Bii-Khem the loud and sharp call of young red-footed falcons echoed. The valleys of both rivers were occupied by larch and spruce taiga with admixture of birch, which amazed us greatly with an incredible abundance and diversity of mushrooms, especially very popular edible ones. There were *Russula* (several species), *Leccinum scabrum* and *L. variicolor* (the latter species rare and seen by us for the first time), several species of *Xerocomus* and *Suillus* (we never imagined there are so many species in these genera), *Boletinus asiaticus* (nicely bright-purple, velvety but smarting in taste), precious *Lactarius resimus* and *L. deterrimus*, and even

Hericum coralloides (included into the Red Data Book of Russia). Nobody seemed to collect them. Our bank, the right of the Bii-Khem had a high terrace (<biikhem>). Its southern slope was covered by steppe but the set of plant species was much impoverished as compared with the mainland Tuva.

In the morning of July 20 a dense fog had risen and the first half of the day was sunny while in the evening a thunderstorm came. In the environs of Toora-Khem village, the Toora-Khem River (<toora>) was most interesting in odonatological respect. It was rather a shallow and fast but not troubled river. Males of *Somatochlora* ranged along the sedge bank. They appeared to be mostly represented by about equal shares of *S. graeseri* and *S. exuberata*. Unfortunately, that day we did not collect large series of representatives of *Somatochlora*. Later it turned out that among the specimens collected there were also a female of *S. metallica abocanica*, so found sympatrically with *S. exuberata*. Besides, we were surprised to catch an androchromic female of *Calopteryx splendens* s.l. Her wings were coloured up to very tips. We also captured a female of *Ophiogomphus obscurus*, a species pertained to the southern taiga subzone of Asia. Male *Erythromma najas* were observed flying low above the river surface or resting on floating leaves. Aeshnids were also present: the well recognisable rust-coloured *Aeshna grandis* and blue males of other species flying along the riparian willows. These males turned out to represent two close species: *Ae. crenata* and *Ae. serrata* which not often co-occur. In pools with dense sedges not far from the river right bank we found *Lestes sponsa* et *dryas*, *Coenagrion hylas*, probably the last surviving and very worn individuals of *Libellula quadrimaculata* and fresh teneral *Sympetrum danae* et *flaveolum*. Just downstream of the wooden bridge over the Toora-Khem, we saw several males of *Calopteryx* which spent their time with their ritual confrontations (<calopteryx>, <calopteryx2> and <calopteryx3>). Perhaps the bridge provided them with a good landmark for meeting each other. The males were quite worn. Two out of three captured had their wings also coloured up to the very tips, in the other just the very tips were hyaline.

On July 21 we parted to the Ilgi-Chul cordon at the border of the vast Azas Nature Reserve, at the NE corner of Lake Azas (see all images starting with <azas...>), again in an UAZ jeep. We joined two local men, Viktor, an inspector of the reserve (tall and very lean) and Sergei, a resigned police lieutenant colonel and now a bailiff (rather short and quite stout). Their aim was to check a report about poachers that were said to have appeared in the Reserve few days ago. The vehicle was specific in having a powerful acoustic system and tape recorder, which gradually gained in sound volume by itself as shaken on pits and bumps. There were two cassettes: one with old Soviet entertainment songs and one with original songs of the Afghanistan war veterans. We had to listen them permanently and pretty loud. After a wide and quite forestless agricultural plain, the land became rough and woody as we came nearer to Lake

Azas. The forest was mostly composed by birch, with a small admixture of larch, and most resembled our habitual landscapes around Novosibirsk. We passed the Azas tourist base situated nearby and met a cavalcade of horse-riding tourists.

Thanks to our hospitable companions we made a short visit to a charming Lake Nogaan-Khol' which the Russians call *Zelenen'koe* meaning something like "little greeny" (<zelenenkevening>). It was of intricate shape and indeed with a saturated blue-green water colour. It was situated amongst hills covered with dense larch taiga which spread to the very banks and hanged over them. The bottom was formed by a bright-white clay interspersed with broken mollusc shells. On the bank there was an ice-cold spring which is considered salubrious, a local spa, and on the hill above it a camp of Tuvinians in tents that came for healing. The Buddhist Society of Tuva constructed planked foot-ways, chutes for water and pavilions. At this time there were about ten families in the camp. Many people sat immovably in an incredibly cold water fallen from chutes, for up to an hour. They would need indeed an iron health for such a healing. It is said that the spirit of this source called *Arzhan* (as any such source throughout the Turkic world) is very jealous and after visiting it addressing to other salubrious sources is prohibited for a month. In spite of an extremely short time spent on the lake, we managed to collect a female of *E. najas* and a female of *E. cyathigerum*. A male of the latter species was got nearby on a bank of another very small and nice lake situated among larch taiga at the foot of a small hill. Our guides visited it in search for the Reserve grooms with their horses, for they needed horses for fulfilling their quest. Our guides called this officially nameless lake the Konyukhovskoe lake meaning "groom's", and said that "there is nothing inhabiting the lake but ducks and worms". But it appeared to have a much nicer thing: a male of *Enallagma cyathigerum cyathigerum* with black lateral stripes along the abdomen, the form which is known from NE Asia such as Yakutia, Kamchatka and the Okhot Sea coast and which has much confusion around its taxonomic status (see below). Indeed, the landscapes around us much resembled those of north-eastern rather than of the southern Siberia.

July 22 was devoted to exploring the eastern end of Lake Azas with the aid of a small flat-bottomed oar boat. The lake had clear and quite warm water and firm banks, mostly blocked up with immense logs (<bird>). Most noticeable were *Somatochlora graeseri* and *S. metallica abocanica* (here no *S. exuberata* were found), *Aeshna juncea* and *A. grandis*, females of the latter ovipositing into logs. Scarce floating vegetation was of course occupied with *E. najas*. The bays along the eastern bank were entirely covered with *Persicaria amphiba*, *Nuphar pumila* and *Nymphaea tetragona*. One of these bays was in fact the estuary of the Azas River. We entered it and floated for some distance upstream the river. The banks of the estuary were covered with inundated sedge where scarce general

Sympetrum flaveolum and *S. danae* were present. Further upstream the river a dense taiga rose on both banks. On July 23 we directed our boat towards a small additional lake at the very Azas River mouth, separated from the main lake by a rather narrow tongue of land (images starting with <lake...>). The tongue's turf soil was covered by a boggy Siberian stone pine/larch taiga with an admixture of spruce, a short- shrub layer formed by bog whortleberry (*Vaccinium uliginosum*) and *Ledum palustre* (images <bog>, <bog2>, <bogvert>). There were open quaking mires with fruiting lesser cranberries (*Oxycoccus microcarpus*) and cloudberries (*Rubus chamaemorus*). That small lake appeared to be dragonfly paradise indeed. Males of *Somatochlora metallica abocanica* and *S. graeseri* were rushing above the water while beneath bowing sedges ovipositing females of *S. graeseri* cluttered with their wings here and there. Above the sedge and the bogs and along riparian coniferous trees, *Aeshna juncea*, *Ae. crenata* and few *Epitheca bimaculata* flew. It later turned out that we had also collected a female *Aeshna subarctica*. Teneral *Sympetrum flaveolum* and *S. danae* were not frequent, and we saw an old individual of *Libellula quadrimaculata*. There were no *Leucorrhinia*, although they could be expected here. Only two species of damselflies, that were not previously encountered were found: *Coenagrion hastulatum* and *C. johannsoni*. The former records favoured the notion that *C. hastulatum* seems to prefer the more boreal habitats than its counterpart *C. lanceolatum* which is common in more arid lands. These species almost exclude each other. So it was one more example of replacement of close taxa in Todzha as compared with the mainland Tuva, along with *Enallagma cyathigerum cyathigerum* and *E. c. risi*, *Ophiogomphus obscurus* and *O. spinicornis*. *C. johannsoni* was very abundant on the bank and penetrated into *Ledum* thickets in the open riparian taiga. *C. johannsoni* was seen mostly in tandem. It turned out that this small lake was the exclusive site for three odonate species, *Aeshna subarctica*, *Epitheca bimaculata*, *Coenagrion johannsoni*, of the whole expedition by the first author.

On July 24 we undertook a walk upstream the Azas River valley along open stepped slopes. On our way back we descended to a sombre oxbow laying in a dell overshadowed with mossy taiga (see images <swamp>, <swamp2>). It inundated a young larch coppice still staying dead in the water. It was extremely cold, as usual due to sources leaking from the bottom, and full of *Spirogyra* algae. From time to time we saw a *Somatochlora* sp., perhaps the only individual on the oxbow. In the grass in the bank there occurred teneral *L. sponsa* and the common *Sympetrum danae* and *S. flaveolum* while among trees *Ae. serrata* and *Ae. juncea* flew, as well as another lonely old *L. quadrimaculata*. In the evening we departed from Lake Azas and spent the night in the camp at Nogaan-Khol' Lake. On a glade of its bank we observed the crepuscular flight of *Aeshna grandis* and *juncea*. While this is a common habit of the former, we were surprised to observe the latter participating as well. We collected one female *Ae. juncea* which had remarkably darkened wings. To a greater surprise we took a dead

male *Ortherrum cancellatum* from a cobweb. When darkness fell we could hear the barking of roe-deer very close and its echo from the surrounding taiga. One could hardly believe that such a blood-freezing sound could be produced by such a rather small and gentle creature.

We spent July 25 and 26 in the environs of Toora-Khem village. At the bridge we collected a very worn male *Calopteryx* with its wings coloured to the tips. Passing along the banks we found several specimens of *Ophiogomphus obscurus* of both sexes. The bank was covered with damp spruce taiga with bog whortleberry in the ground layer. Further on, the slope of the valley slopes rose and in the forest we saw huge anthills and numerous *gruz̄di* (*Lactarius resimus*) - an extremely tasty mushroom when salted! - that nobody had looked for. The oxbows resembled the ones described above from the Azas River with inundated young larches and filamentous algae in a very cold water. We encountered two species of *Leucorrhinia*: *L. rubicunda intermedia* and *L. dubia orientalis*, many *Coenagrion hylas*, mostly in tandems (<hylas2>, <hylas3>), *C. hastulatum*, both *Lestes* species, *dryas* and *sponsa*, and *Ae. crenata*.

On July 28 we returned to Kyzyl on the Zarya vessel. When we complained about the dirty window, a young handsome Tuvinian man which occupied the seat next to the window unexpectedly produced a piece of gauze, wetted it with pure alcohol and tried to wash the window. He introduced himself as a masseur and a manual healer and then demonstrated us in detail the "active points" on the palm. During the whole trip, another Tuvinian, an aged gentlemen sitting behind us, played an accordion and sang various songs, especially a very sad Tuvinian one which was readily joined in by a team of children returning from a summer camp. In particular, he used to sing with the famous Tuvinian overtone "throat" singing, an unique way of sounding which I would hardly describe even in my native Russian language. He sang Tuvinian and Russian folk songs (e.g. the notorious 'Oi, moroz, moroz!') and even popular songs by Vladimir Vysotskii.

On July 29, back in the park of Kyzyl we noticed certain changes in the dragonfly fauna. *Enallagma* became notably more scarce while numerous *Sympetrum* appeared, many being teneral. Among those there were three not seen earlier: *S. sanguineum*, *S. depressiusculum* and *S. pedemontanum*. On the oxbow, numerous *S. vulgatum* emerged, *Aeshna juncea* and *Ae. grandis* flew, and males of *S. graeseri* appeared in a considerable number. *L. sponsa*, *C. lanceolatum* and teneral *Sympetma paedisca* were added to damselflies. We also updated our collection of characters with a very neatly clothed young deaf-and-dumb man. He wore a snow-white shirt and fine spectacles and resembled a Japanese rather than a Tuvinian. We communicated via a notebook, in which he eagerly wrote various questions using giant letters. If we were to try to reflect his 'speech' in a foreign language, they would read something like "Where situate street shop intim salon in Novosibirsk Academia Town ♀" (We really did not know!). He also communicated

that he was studying in Novosibirsk and claimed: “*I know here no dragonfly is! Place Kaa-Khem forest with many dragonfly bogs little pond*” (the dragonflies meanwhile flying just above his head) and tried to direct us to the Kaa-Khem settlement, an extension of Kyzyl. But we indeed were going to go to this settlement where the Ubsu-Nur Hollow Reserve office was situated at that time. So we followed his advice and visited the left bank Kaa-Khem floodland at this settlement in the evening. In that place the floodland was very wide, with some river arms but almost with no oxbows, and we found only *Lestes sponsa* and *S. flaveolum*.

On July 30 we made an excursion to the Ondum Mountain in 30 km upstream the Kaa-Khem River of Kyzyl (<ondum>, <ondum2> and those starting with <pediment...>). These south-western spurs of the Academician Obruchev Upland were crowned with jagged rosy lime-stone rocks carved with niches and small caves, the largest of which were seen even from Kyzyl. Especially symbolic was the combination of the mighty and wide, deep-blue and ice-cold river of Kaa-Kmen, bordered with a dark-green stripe or the riparian poplar wood, with pinkish-grey desert mountains of lunar or marthian appearance, rising right upon the river and bearing sheer rocks (<koktei>, <koktei2>). However, there we saw neither a dragonfly nor damselfly.

On July 31 we took a direct coach from the centre of Kyzyl to the market in Novosibirsk, which takes 24 hours without long stops and carries mostly minor drapery merchants, the so-called *chelnoki*, that in Russian means ‘shuttles’. We could trace behind the window in detail how the Central Asian nature changes with the Sayanian taiga, with the luxuriant Khakasian steppes, the Achinsk forest-steppe, the even a darker taiga of the Kuznetskoe Alatau Mts. and, at last, the forest-steppe of the great West Siberian Plain. As a farewell joke of nature, we happened to observe a male of the butterfly *Parnassius stubbendorffii* on a short stop in a dale between Sayanian ranges, which should have ceased its flight period in June.

The second author's expedition of 2000

In July and August 2000 a team of entomologists of various profiles agreed to call themselves the Third International Expedition (for its personnel see Acknowledgements). They (that is, us) made a field trip to West Tuva, an area very little explored in odonatological respect. This voyage was very fruitful for the recognition of perspectives and possibilities to work in these regions but brought rather few dragonfly material (four species only). We departed from Kyzyl on July 18 and made a first camp on the Khendergei River. On the next day we reached a pass (50°35,924 N 091°29,726 E), which we called among ourselves Vetroduinyi [wind blowing] Pass. This pass went through the Tsagan-Shibetu Range, at 350 km from Kyzyl. We first camped at the Arzaity River, later at the Kargy River and on July 24 we reached the huge and highly elevated Lake Khindiktig-Khol' which would be worth much attention.

However, the weather turned out to be extremely cold (the water in a bucket froze at night) and pretty windy, so we decided to depart soon. We managed to find only the commonest Siberian species *Sympetrum flaveolum*. Two days later we camped at the sources of the Kargy River and on the next day crossed the Tsagan-Shibetu Mts. There we collected another *Sympetrum flaveolum* and in the evening arrived to the Barlyk River. On July 29 we moved to its tributary Onaacha brook. There were a lot of *Aeshna juncea*, but the specimens collected were unfortunately lost. On July 31 we returned to the Khendergei River. On August 1 we moved to the Khemchik River where we made the only interesting odonatological finding. Near a bridge of the road to the Sut-Khem we found a male *Ophiogomphus spinicornis*. This finding supports our supposition that the «*Ophiogomphus reductus*» previously reported from that valley (Valle 1942) was in fact *O. spinicornis*. We stayed near the Ak-Sug River until August 5 when we returned to Kyzyl.

Observations and collections of dragonflies in Tuva in 2001 and 2002 were made solely by the second author (V. Z.)

2001

Dragonflies were monitored in Kyzyl, and its surroundings, mostly in the above mentioned City Park. The earliest damselflies, *Sympecma paedisca* after hibernation, were collected on April 23, and a good series for phenetical analysis of the pterothorax coloration was collected. The latest dragonfly, *Sympetrum danae*, was observed on the 6 October. In the periods of May 11-13, June 27 - July 3 and August 20 - Sept. 15, Lake Chagytai was investigated, mostly in hydrobiological respect. From June 7 to June 11, Lake Kara-Khool' was visited.

2002

In addition to observations in and around Kyzyl field trips were made to a number of Tuvinian lakes. Between 16th and 19th of May and 21st and 28th of June, Lake Chagytai was investigated. In particular, during the second trip the larvae of *Enallagma cyathigerum* risi (9 males and 16 females) were collected. On June 28 on the western bank a 9 mm long female larva was collected of *Coenagrion* sp. having pointed caudal lamellae and 7-segmented antennae. In pools at the southern bank, of which one contained Charophyta algae two larvae of *Aeshna juncea* (37 mm in length) were collected on June 18 and 24.

On a trip to the Todzha Hollow between July 20 and 31, a series of *Somatochlora metallica abocanica* (3 males and 1 female) and a male *Epitbeca bimaculata* was collected at Lake Azas. At last, *E. cyathigerum cyathigerum* was found on the main Lake Azas. A male with well developed lateral black stripes on segments 3-4 was collected within a reed thicket. On July 26, three males of *S. m. abocanica* and a couple of *Sympetrum danae* were collected. Larvae of *S. m. abocanica* and *Ae. juncea* were also found. On 28 July an excursion was made west of Krasnyi

Kamen' Cape to a small boggy bay of Lake Azas. Near a narrow gulf separated from the main lake by a barrier of 2-5 m width a series of *Sympetrum danae*, two males of *Aeshna juncea* and a male of *Ae. crenata* (with darkened wings) were captured and larvae of *Somatochlora metallica* and *S. danae* found. On July 29, Lake Nogaan-Khol' was revisited and 6 males of *E. cyathigerum cyathigerum* were collected. On July 20 the Toora-Khem River was inspected for the presence of *Calopteryx* and *Somatochlora exuberata* et *metallica* because they were collected there in 2000. Larvae of *Ophiogomphus obscurus* and one of *Leucorrhinia* sp. were collected. On July 31 at the small lake Adyr-Kezhig in an arable plain near Adyr-Kezhig village, we collected 4 males of *E. cyathigerum cyathigerum* (only one had well expressed stripes) and 1 female (no stripes), 1 female of *S. m. abocanica* and some *Aeshna. grandis* and *Ae. serrata*.

On August 5 some Coenagrionidae, *Sympetrum* and *Aeshna* were collected at Lake Chagytai. On August 20, three females of *Sympetrum vulgatum*, a male and female of *S. flaveolum*, some *Lestes* and Zygoptera larvae were collected at Lake Kara-Khool' (Bai-Taiga). On September 23, some larvae of *Aeshna* were collected at Lake Sut-Khol'. On the September 25 Lake Chagytai was revisited.

Collecting sites

In the following list, the main collecting sites are conventionally denoted by 1-2 words which are given in bold and explained. The ordinal numbers correspond to those on a map of Fig. 1. Administrative subordination of sites to "kozhuuns", the local official name of districts, is given. Coordinates and elevations are inferred from a map 1:1 Mio.

Central Tuvinian Hollow:

1. **Kyzyl**: The city park of Kyzyl, oxbows on the left bank of the Kaa-Khem River floodplain covered with open riparian poplar forest. 51°43'N 94°27'E, 650 m above sea level (a.s.l.)
2. **Donmas-Sug**: A rivulet flowing through Kyzyl under the upper terrace of the old Ulug-Khem bed. It is 2-4 m wide, has a velocity of up to 0.5 m/s, banks with grass or with willow thickets and there are some boglets in its floodlands. It is fed from springs and remains unfrozen in winter.
3. **Ulug-Saylyg**: The Ulug-Sailyg River headwaters (the Elegest River basin) near Khovu-Aksy village, a typical mountain torrent with spectacular waterfalls over large boulders in the taiga gorge. Tanda Kozhuun. 51°06'N 93°37'E, ca. 1000 m a.s.l.
4. **Chagytai**: A large (6.2 x 6 km) and deep (up to 10-15 m) freshwater Lake Chagytai. Tanda Kozhuun. 49°58' - 51°00'N 94°41'-94°45'E, 1004 m a.s.l.
5. **Mazhalyg**: The outflow of the Mazhalyg River from (4), with sedges, reed and rush swamps. 51°00'N 94°45'E, 1004 m a.s.l.

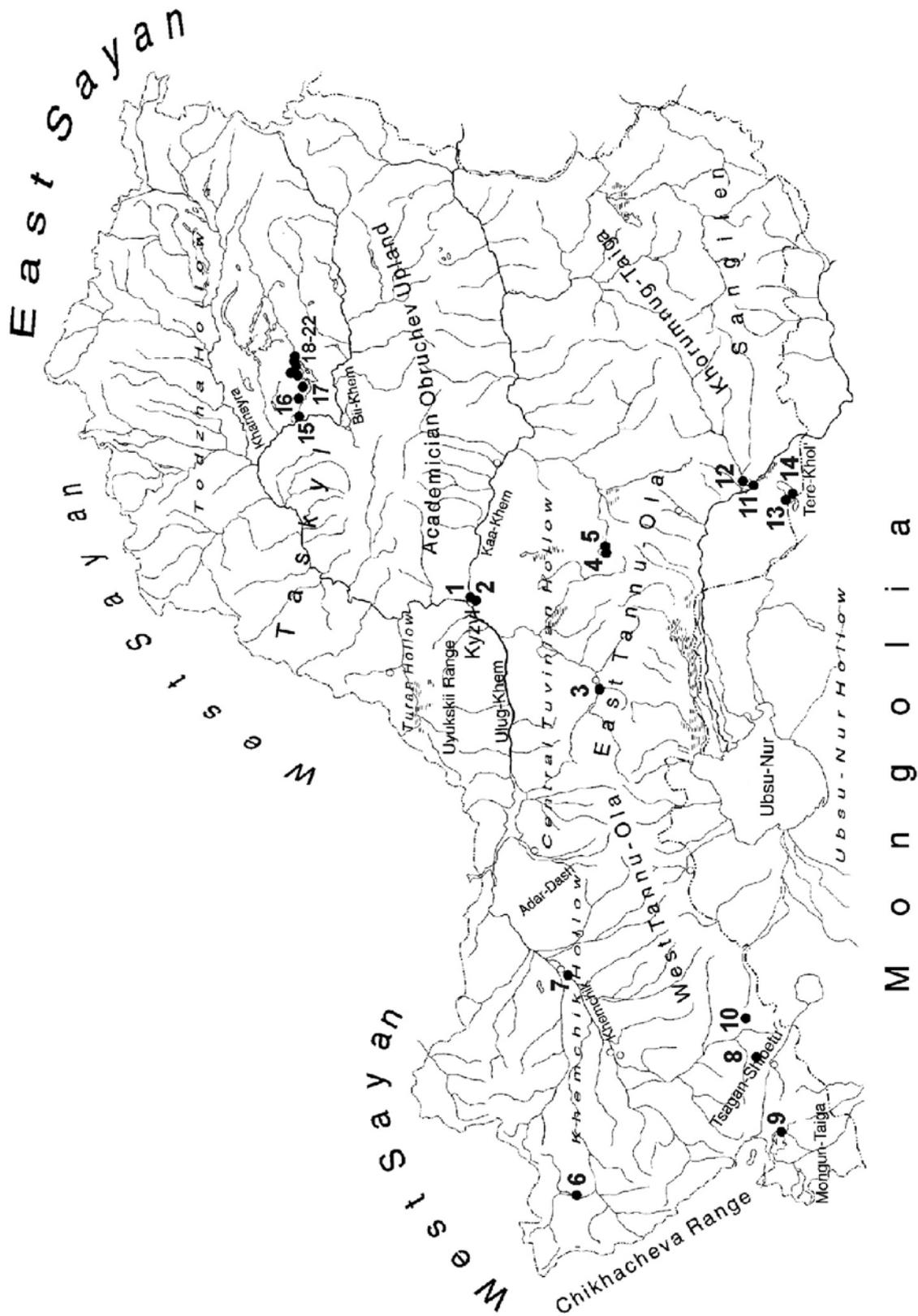


Figure 1: Map of Tuva.

Khemchik Hollow:

6. Kara-Khool': Lake Kara-Khool' or Bai-Taiga on the Alashskoe Upland. Bai-Taiga Kozhuun. 89°29'N, 51°30'E, ca. 1500 m a.s.l.

7. Khemchik: The Khemchik River (here 50 m wide) at the bridge of the road to Sut-Khol'. Sut-Khol' Kozhuun. 51°22'N, 91°15'E, 723 m a.s.l.

Mongun-Taiga area:

8. Tsagan-Shibetu: The Tsagan-Shibetu mt. range, a road to Mугur-Aksy village. Mongun-Taiga Kozhuun. ca 50°25' N 90°30' E, 2000 m a.s.l.

9. Khindikikh-Khol': The eastern bank of Lake Khindikikh Khol'. Mongun-Taiga Kozhuun. 50°21'N, 89°56'E, 2305 m a.s.l.

10. Onaacha: The Barlyk River valley at the Onaacha brook mouth, the Kargy River basin. 50°30'N, 90°44'E, 1715 m a.s.l.

Ubsu-Nur Hollow:

11. Tes-Khem: the Tes-Khem River right bank floodland 5 km SW of Erzin village. Erzin Kozhuun 50°15'N 95°06'E, 1150 m a.s.l.

12. Erzin: The Erzin River floodland and surroundings of Erzin village. Erzin Kozhuun. 50°15' N 95°10' E, 1150 m a.s.l.

13. Tere-Khol': NW bank of a large freshwater Lake Tere-Khol' (on some maps "Tore-Khol") lying among half-free and free sands, 50°03'N 95°00'E, 1150 m a.s.l.

14. Sharlan: a bay of Lake Tere-Khol called Sharlan [Tuv. 'aspen'], surrounded by sands. This is the point from where the lake is fed by powerful ground sources.

Todzha Hollow, Todzha Kozhuun

15. Toora-Khem: In and around Toora-Khem village and the banks of the Toora-Khem River, 52°28' N 96°08' E, about 900-1100 m a.s.l.

16. Adyr-Kezhig: a small lake about 100 m in diameter, with reeds and sedge, 4 km E of Adyr-Kezhig village. 52°26'N 96°18'E, about 950 m a.s.l.

17. Nogaan-Khol': Lake Nogaan-Khol' 52°25' N 96°28' E, about 950 m a.s.l.

18. Konyukhovskoe: a small eutrophic anonymous lakes near the northern bank of the large Azas Lake, called Konyukhovskoe by personnel of the Azas Nature Reserve, surrounded by hills covered with larch taiga.

19. Krasnyi Kamen': surroundings of the Krasnyi Kamen' cape on Lake Azas northern bank. 52°46'N 96°33'E, about 950 m a.s.l.

20. Azas: Todzha District, N and E banks of Lake Azas at brook Ilgi-chul, 52°46' N 96°38' E, about 950 m a.s.l.

21. Azas oxbow: near (20), a swampy oxbow of the Azas River at its mouth, surrounded by larch taiga. 52°45'N 96°36'E, about 950 m a.s.l.

22. Azas small lake: A small lake close to (20) and (21), surrounded by a bog *Ledum* / bog whortleberry / peat-moss Siberian stone pine / larch taiga, with a quaking bog along its banks. 52°44'N 96°38'E, about 950 m a.s.l.

Annotated list of species

All material from 2001 and 2002 was collected by V. Zaika. For the material from 2000 the collector is indicated at the end of the stretch of records by each collector as V. Z. (V. Zaika) or O. K. (O. Kosterin), or other respective collectors. Note that the number of specimens collected does not reflect the relative abundance of species.

1. *Calopteryx splendens* (Harris, 1782)

(15) Toora-Khem: 20/VII - 1 ♀, 21/VII - 3 ♂, 26/VII - 1 ♂ (O. K.)

The specimens collected (almost all of those seen) turned out to be quite problematic from a taxonomical point of view. In three males the dark violet-blue colouration extended to the wing tips. The inner margin of the colour patch was uneven and had a proximal projection along the vein R4 for about halfway between the wingbase and nodus, 3-4 cells distally of the IR3 release. From this point, the coloration border is slanting backwards and ends at the hind margin at the level of 3/4 of the distance between the wingbase and nodus. In the space between the costa and R2 the coloration withdraws to a point at about 3 mm proximally of the nodus. In the fourth male the coloration ends at about 1.5 mm before the wingtips. The inner margin of the wing patch is also uneven and extends proximally in projections between the main veins. It starts at about 2/3 of the distance from the wingbase to the nodus and its border meets the hind margin somewhat proximally of the nodus level. The area between the costa and R2 is clear up to the nodus. The wing coloration of this male is typical to the Siberian *Calopteryx splendens* but rather extended when compared to West European specimens.

The only female collected was androchromic, her wings were coloured intensely smoky-brown and the veins have a noticeable blue iridescence, much less strong than in males. The inner margin of the coloured patch was diffuse, at its border the colour appeared along all veins and left the cells transparent in the middle. The margin of the patch coincided with that of the first three males. Along the costal margin the colour was weakened up to the node, at which small transparent windows were situated. The pseudostigma was large, about 1.5 mm long on the fore wing and 1 mm long on the hind wing. It was crossed by 7 veins on the fore wing and by 4 and 6 veins on the hind wing.

The body pattern in general was typical for representatives of *Calopteryx splendens* from various, even distant, regions. Our specimens lacked the green tint of the metallic iridescence on wings and body but had a violet tint instead, that may just reflect their age.

In 1993, a population of *Calopteryx splendens* was found by V. Z. just 30 km NE of Toora-Khem (15), on the Dus-Khem River. There, the males had the wings and body normally coloured, with the wingtips clear for 1.5-3 mm and the body blueish-green.

The collected female had no wing coloration. Both samples are too small but prevailing of the wing characters in the only two populations known for Todzha, and so closely situated ones, is intriguing. The extended wing colouration and presence of androchromic females of the population at site (15) corresponds to the East European subspecies *Calopteryx splendens ancilla* Selys, 1853. However, in Siberia there are extremely few records of androchromic females: one from Novosibirsk Province and two from SW Altai (now within Kazakhstan). The latter two were described as *Calopteryx johanseni* Belyshev, 1955 but are identical to the form *faivreii* Lacroix, 1915. With regard to males, only two have been known from Siberia whose wings were coloured to the tips. Both were from the Gornaya Shoria elevation. Therefore, all hitherto known Siberian populations should be attributed to the nominotypical subspecies, although the Toora-Khem population looks quite exceptional.

2. *Lestes sponsa* (Hansemann, 1823)

- (1) Kyzyl: 25/VI 2000 - 1♂ (V. Z.), 29/VII 2000 - 5♂ 2♀ (O. K.), 5/VIII 2000 - 2♂
- (4) Chagytai: S bank, a bogged pool, 25/VI 2000 - 1♂ (V. Z.)
- (11) Tes-Khem: 11/VII 2000 - 3♂, 13/VII 2000 - 1♂ 4♀, 16/VII 2000 - 1♂ 1♀
- (12) Erzin: 12/VII 2000 - 1♂ (O. K.)
- (13) Tere-Khol': N bank, 23/VIII 2000 - 2♂ (V. Z.)
- (15) Toora-Khem: 20/VII 2000 - 1♂ 2♀, 26/VII 2000 - 8♂ 2♀
- (18) Konyukhovskoe: 21/VII 2000 - 1♂
- (21) Azas oxbow: 24/VII 2000 - 5♂ (one teneral) (O. K.)

Everywhere a common species that prefers shallow boggy banks with abundant thickets of sedge, rush or young reed.

3. *Lestes dryas* Kirby, 1890

- (11) Tes-Khem: 13/VII 2000 - 1♂, 16/VII 2000 - 1♂
- (15) Toora-Khem: 20/VII 2000 - 3♀, 26/VII 2000 - 1♂ (O. K.).

Occurs together with the previous species but much less frequently.

4. *Sympetma paedisca* (Brauer, 1877)

- (1) Kyzyl: 23/IV 2001 - 11♂ 5♀; 8/V 2000 - 6♂ 1♀, 9/V 2001 - 27♂ 3♀; 12/V 2000 - 1♂, 19/V 2001 - 1♀ (V. Z.); 29/VII 2000 - 2♀ (teneral) (O. K.), 4/VIII 2000 - 2♀, 5/VIII 2000 - 1♀
- (4) Chagytai: 27/VI 2000 - 1♂ (V. Z.)
- (11) Tes-Khem: 13/VII 2000 - 1♀ (teneral), 16/VII 2000 - 1♀ (teneral) (O. K.).

A widespread but not abundant species. The specimens from (11) and (4) have a continuous bronze stripe on the prothorax. Among the specimens collected at (1) in May 2000, one male has no gaps, one male has one gap on right side, five males and two females have a gap on both sides. Among those collected there in July and August, one male and three females have continuous stripes while two teneral females have two gaps. Other representatives of the same cohort were collected after hibernation in spring 2001: 34 males and 6 females

have no gaps, 1 male and 2 females have gaps on either side, 3 males are asymmetrical, 2 having a gap on the right side and 1 on the left. In total, the ratios of individuals without gaps to those with gaps is 47:14 (if a specimen had a gap on one side only, it was counted by adding 0.5 to both classes). In contrast, in specimens of the 1999 cohort the ratio was reversed (1.5 : 7.5). In this small sample it appears that the thoracic stripe fragmentation can fluctuate across generations, perhaps depending on the conditions of larval development. Since some taxonomical subdivision has been proposed based on this character (though later rejected by Jödicke 1997) special studies would be desirable to make this clear and large series should be accumulated. One can note that the specimens from the very south of Tuva, from Ubsu-Nur Hollow, have a continuous thorax stripe, although throughout the species range the opposite trend of an increasing fragmentation to the southern direction is usually observed.

5. *Coenagrion johannsoni* (Wallengren, 1894)

(22) Azas small lake: 24/VII 2000 - 14♂ 1♀ (O. K.)

This species, generally confined to the forest zone, was found only in Todzha. It was numerous at quaking bog margins and penetrated into thickets of ledum and bog whortleberry. Tandems were frequently observed.

6. *Coenagrion hylas* (Trybom, 1889)

(12) Erzin: 12/VII 2000 - 2♂ (1♀ visually)

(15) Toora-Khem: 20/VII 2000 - 1♂; 26/VII 2000 - 1♂ 1♀ (O. K.)

Found in Todzha and Ubsu-Nur Hollows, in both cases at very small oxbows swamps, sometimes ice-cold, at river banks surrounded by spruce/larch taiga in Todzha (15) or poplar riparian wood in the Ubsu-Nur Hollow at (12). It was quite abundant.

7. *Coenagrion armatum* (Charpentier, 1840)

(4) Chagytai: A bog at SE bank, 28/VI 2000 - 5♂

(near 5) a bog at the Mazhalyk River, 27/VI 2000 - 1♂ (V. Z.)

(13) Tere-Khol': 15/VII 2000 - 3♂ (O. K.)

A fairly widespread species in Siberia but relatively early flying. At (13) it kept to sparse sedge emerging from the water, at (4) to riparian grass. In both cases it was not too abundant.

8. *Coenagrion lunulatum* (Charpentier, 1840)

(12) Erzin: 12/VII 2000 - 1♂ (teneral) (O. K.)

Of this generally very common species in Siberia, in three seasons we surprisingly found only one teneral male.

9. *Coenagrion hastulatum* (Charpentier, 1825)

(15) Toora-Khem: 26/VII 2000 - 4♂

(22) Azas small lake: 23/VII 2000 - 4♂ (O. K.)

In one male the lateral black strokes on tergite II are fused with the mushroom-shaped spot. All males had two black dots on tergite IX. Found only in Todzha.

10. *Coenagrion lanceolatum* (Selys, 1872)

(1) Kyzyl: 9/VII 2000 - 1♀, 29/VII 2000 - 2♂ (O. K.)

(5) Mazhalyg: 23/VI 2000 - 1♂ (V. Z.)

(11) Tes-Khem: 11/VII 2000 - 1♂ 1♀, 13/VII 2000 - 1♂ 1♀, 16/VII 2000 - 1♂ (O. K.)

Found in the Ubsu-Nur and Central Tuvonian Hollows. Belyshev (1973) considered this species to range westwards up to the Yenisei. Recently M.V.Dronzikova reported it for the town of Guryevsk in the Kemerovo Province (Dronzikova, 1999) and for a small lake in Artybash near Lake Teletskoe (personal communication). Malikova (1995) has shown that the related species *Coenagrion bastulatum* ranges eastwards to the Pacific. In South Siberia being rare east of the Yenisei. In South Siberia, these two related species tend to replace each other at opposite sides of the Yenisei, *C. lanceolatum* being rare west of it while *C. bastulatum* rare east of it. In the North, *C. bastulatum* is more frequent, including in NE Asia, e.g. in Yakutia (Belyshev, 1973). Records of *C. bastulatum* at (22) and (15) are situated east of (1) and (12) (where *C. lanceolatum* was common). That is, in the taiga-rich Todzha we only found the “more western” species *C. bastulatum*, which in general extends east mostly within the taiga zone, while in more south-western arid hollows a “more eastern” species *C. lanceolatum* is common.

Quite abundant on small and very small pools in river floodland.

11. *Coenagrion ecornutum* (Selys, 1872)

(11) Tes-Khem: 13/VII 2000 - 1♂, 16/VII 2000 - 1♂

(12) Erzin: 11/VII 2000 - 1♂

(13) Tere-Khol': S bank, 15/VII 2000 - 1♀ (O. K.)

Moderately common at medium-sized to very small stagnant water bodies in river floodlands but less frequent than the previous species. Not found in Todzha.

12. *Erythromma najas* (Hansemann, 1832)

(1) Kyzyl: 9/VII 2000 - 1♂ (O. K.), 10/VII 2000 - 3♂ 1♀, 4/VIII 2000 - 1♀ (V. Z.)

(11) Tes-Khem: 13/VII 2000 - 3♂, 16/VII 2000 - 1♂

(15) Toora-Khem: 20/VII 2000 - 4♂ 1♀

(17) Nogaan-Khol': 21/VII 2000 - 1♂

(20) Azas: 20/VII 2000 - 1♂ 2♀ (O. K.)

Male specimens from (1) and (11) had light stripes on the fore part of the pterothorax for about half of its length. In 5 out of 6 males from Todzha they were absent. The inner sides of the femora and tibia have yellow stripes, interrupted at some distance in the femora distal part, the gaps being on average greater in specimens from Todzha. In one male from (11) the stripes are wide and almost continuous. Thus, the specimens from Central Tuvinian and Ubsu-Nur Hollows demonstrate characters of the eastern taxon *humeralis* Selys, 1887 (= *baicalensis* Belyshev, 1964) described from the Baikal area and thought to range in East Siberia and the Far East. In Todzha the characters of the nominotypical *najas* predominated. Belyshev (1973) claimed that his “subspecies *baicalensis* [sic]”, a junior synonym of *humeralis* described from the same area (Malikova, 1995), is smaller with an abdomen shorter than 26 mm while in *najas* s. str. it is longer than 26 mm. Our males from Todzha have the abdomen 26.5-27 mm long (measured without cerci). In the male series from (1) seven have the abdomen 27 mm long, one 26 mm long and one 25 mm long. The males from the Ubsu-Nur Hollow have it 25 mm long. Hence, the individuals from the Ubsu-Bur Hollow fully fit the diagnostic characters of *humeralis*. Most of the specimens from the Central Tuvinian Hollow were as large as *najas* s. str. but all have the humeral stripes. The Todzhian specimens correspond to the nominotypical (but one with humeral stripes). However, all these characters are variable within populations (note the male with stripes from Todzha) and are insufficient for rising *humeralis* to bona species, as it used to be done (e. g. Malikova, 1995). A subspecific rank fits more to this taxon. It is noteworthy that Todzha (NE of Tuva) is inhabited by specimens in which the “western” characters predominate while more southern and western arid hollows support more “easterly-looking” populations.

This damselfly inhabits rather large lakes and slow current rivers but keeps strictly to the floating vegetation, as it does in Europe (Schiel, 1998). This should be the reason why it seemingly does not inhabit Lake Tere-Khol' (13).

13a. *Enallagma cyathigerum cyathigerum* Charpentier, 1840

(16) Adyr Kezhig 31/VII 2002 - 4♂ 1♀ (V. Z.)

(17) Nogaan-Khol': 21/VII - 1♀; 29/VII 2002 - 6♂

(18) Konyukhovskoe: 21/VII 2000 - 1♂ (O. K.)

(19) Krasnyi Kamen': 22/VII 2002 - 1♂ (V. Z.)

Found only in Todzha. Of the males collected at (17), two had distinct black lateral stripes along the abdominal segments II-V and black strokes on sides of segments I and VIII-IX, three had weakly expressed narrow stripes on segments III-IV, strokes on segment II and their remnants on segments VII-IX, one had a narrow short stripe on segment III only and one had no stripes at all. A female had only some strokes of vestigial stripes. The male obtained at (18) had the stripes very well expressed. The male from (19) had stripes on

segments III-IV and strokes on segments I-II and VIII-IX. One male from (16) obtained in 2002 also had these, one had less expressed stripes and smaller strokes while two other males and the female had no stripes. The stripes and strokes are expressions of the same trend of lateral melanization of the abdomen, varying in expression. While on segments III-IV long stripes appear, the black spots at their hind margins acquire acute forward projections on sides on the following segments. On segments II and IX there appear lateral strokes. This additional melanization in most cases is imperfect: the stripes and strokes often have indistinct margins and are brownish rather than black. Only if stripes are long and wide they become as distinct as the regular markings, to resemble the pattern of *Coenagrion hylas*.

The structure of the male appendages superiores were characteristic of those of the nominotypical subspecies: a yellow lobe directed backwards, in lateral view protruding as a 'nose'. This character, in combination with the varying degree of the melanization are common in populations of NE Asia, i.e. the northern Irkutsk Province, Yakutia, the continental Okhotsk Sea coast and, locally, in Kamchatka. This melanized form has acquired a number of Latin names, that will be overviewed elsewhere, but this form hardly deserve recognition as a separate subspecies. It is not impossible that the varying degree of melanization is imposed by severe environmental conditions in those regions, where larval development may be prolonged for two and even three years (Haritonov, 1990). The existence of the melanized *E. cyathigerum cyathigerum* in Todzha adds to the impression of a close proximity of the Todzha landscapes to East Siberian ones.

These damselflies were found in rather small forest lakes, did not occur on the Azas River and were very scarce at (22). In southern Yakutia, they also inhabit rather small boggy pools and oxbows surrounded by forest in the Aldan River floodland (Kosterin, in press). *Enallagma cyathigerum risi* Schmidt, 1961 prefers large lakes with open banks and slow current rivers in different regions of Siberia.

13b. *Enallagma cyathigerum* Charpentier, 1840 ssp. *risi* Schmidt, 1961

(1) Kyzyl: 9/VII 2000 - 19 m (O. K.), 19/VII 2000 - 1 ♀, 4/VIII 2000 - 1 ♂ (V. Z.), 14/VIII 2000 - 1 ♂ 1 ♀; 25/VI 2001 - 37 ♂ 25 ♀; 22/VII 2000 - 2 ♂ 1 ♀ (V. Z.)

Dus-Khol': 21/VII 2000 - 1 ♂ 2 ♀ (collector unknown)

(4) Chagygtai: 21/VI 2000 - 3 ♂, 22/VI 2000 - 11 ♂ 9 ♀, 22/VI 2002 - 1 ♀ emerging

(5) Mazhalyg, a bog, 23/VI 2000 - 2 ♂ 1 ♀, 24/VI 2000 - 2 ♀, S bank, 25/VI 2000 - 1 ♀, 27/VI 2000 - 6 ♂, 28/VI 2000 - 5 ♂ 9 ♀, 3/VII 2000 - 3 ♀ (V. Z.)

(11) Tes-Khem: 13/VII 2000 - 3 ♂, 16/VII - 5 ♂

(13) Tere-Khol': 15/VII 2000 - 31/VII, 2 ind (O. K.)

All specimens from the Central Tuvinian and Ubsu-Nur Hollows have the upper appendages typical for the taxon *risi* Schmidt, 1961 (Seidenbusch, 1997; Kosterin, 1999). This taxon ranges in arid and semiarid regions of Asia from the lower Volga basin to the Sungari River basin (Kosterin, 1999). It used to be considered a separate species but the existence of areas where specimens show all the range of variation from the typical *risi* to *cyathigerum* s. str. in the structure of their cerci are in favour of a subspecies status. Such intermediate specimens are known from woody and rather humid mountain systems protruding into semiarid plains occupied by *risi*, namely, Middle Ural, Altai, the mountainous regions of Irkutsk Province (Kosterin, 1999), of Amur Province and southern Khabarovskii Krai Province (E. I. Malikova, pers. comm.). The analysis of nuclear rRNA genes by Samraoui et al. (2002) also suggests conspecificity of *risi* and *cyathigerum*.

Thus, in Tuva we find one of the shortest distance (150 km) between typical representatives of the morphotypes *cyathigerum* and *risi*. This corresponds well to the contrasts in natural conditions of Todzha and the Central Tuvinian Hollow and the ancient mountain isolation of the former from the latter. Whether populations of this species exist on the Academician Obruchev Upland dividing the intermontane hollows and, if so, whether they demonstrate intermediate characters is to be revealed in the future.

This taxon inhabits rather large lakes with clear water surface and open banks. Lake Tere-Khol' (13) represents its most favourable habitat type. In the Tes-Khem floodland (11) it was found at a rather large lake, near (1) it was extremely abundant at large oxbows of the Kaa-Khem left bank within the city park.

14. *Ischnura elegans* (Van der Linden, 1820)

(13) Tere-Khol': 15/VII 2000 - 1♂ (O. K.)

A trans-Eurasian species becoming quite rare in the eastern part of Eurasia (Malikova, 1995). At (13) it was found on a shallow bay among emergent vegetation.

15. *Aeshna juncea* (Linnaeus, 1758)

(1) Kyzyl: 9/VII - 1♂ (O. K.), 22/VI 2001 - 1♀; 10/VII 2000 - 1♂ 1♀ (V. Z.), 29/VII 2000 - 3♂ (O. K.); 4/VIII 2002 - 1 m; 19/VIII 2001 - 1♀;

Mezhegei: 3/IX 2000 1♂ visually

(10) Onaacha: 29/VII 2000 - 10 ind. (they are lost) (V. Z.)

(11) Tes-Khem: 11/VII 2000 - 3♂ 1♀, 13/VII 2000 - 1♀, 16/VII 2000 - 1♀

(17) Nogaan-Khol': 24/VII 2000 (in twilight) - 1♀ (O. K.)

(19) Krasnyi Kamen': 22/VII 2002 - 1 larva; 28/VII 2002 (small bay) - 2♂ (V. Z.)

(20) Azas: 22/VII 2000 - 2♂

(21) Azas oxbow: 24/VII 2000 - 1♂

(22) Azas small lake: 23/VII 2000 - 2♀ (O. K.)

Whereas one male (21) and 3 females (17 and 22) from Todzha and 1 male from the Ubsu-Nur Hollow (11) had no light spots on the head back side, 4 males and 3 females from (1), 2 male and 2 female from (11) and 4 males from Todzha (19 and 20) had those spots. The female captured at (17) had brown darkenings on its wings.

A common eurybiotic species. On large lakes it is, as a rule, inferior in number to *Aeshna crenata* (Belyshev, 1973). However, in the floodland of the wide right bank of the Tes-Khem River with a variety of water bodies (11) both species occurred in abundance. At Lake Nogaan-Khol' (17) a female of this species was surprisingly observed participating in crepuscular flight together with *Aeshna grandis*.

16. *Aeshna subarctica* Walker, 1908

(22) Azas small lake: 23/VII 2000 - 1 ♀ (O. K.)

The species ranges in forest and tundra zone of the Holarctic. One female was collected in the taiga-clad Todzha (22).

17. *Aeshna crenata* Hagen, 1856

(11) Tes-Khem: 11/VII 2000 - 4♂ 1 ♀

(15) Toora-Khem: 20/VII 2000 - 1♂, 26/VII 2000- 1♂

(22) Azas small lake: 23/VII 2000 - 2♂ 1 ♀ (O. K.)

(19) Krasnyi Kamen' (a small bay): 28/VII 2002 - 1♂ (dark-winged)

The females collected showed strong brown darkenings of the wings. Slight darkenings were noticed on the wings of males from Todzha. The species is abundant in a woody floodland at (11) and common in Todzha.

18. *Aeshna serrata* Hagen, 1856

(1) Kyzyl: 7/IX 2000 - 1 ♀ (V. Z.)

(12) Erzin: 11/VII 2000 - 2 ♀

(13) Tere-Khol': 15/VII 2000 - 2 ♀ (one teneral)

(15) Toora-Khem: 20/VII - 1♂ (O. K.)

(16) Adyr Kezhig: 31/VII 2002 - 1♂ 1 ♀ (V. Z.)

(21) Azas oxbow: 24/VII 2000 - 1♂ (O. K.)

This species prefers open Asian landscapes, especially those in the steppe (Belyshev, 1973) while *A. crenata* tends to inhabit forest lakes. However, these two related species do not exclude each other and co-occur together. We expected this species to be more abundant in the Ubsu-Nur Hollow. However, it was *A. crenata* which prevailed at (12), maybe because the floodland stagnant and semicurrent oxbows there were surrounded by woody vegetation. At the same time, we found *A. serrata* in the woody Todzha. At Lake Tere-Khol' (13) with open steppen banks we found only *A. serrata*, as expected.

19. *Aeshna grandis* (Linnaeus, 1758)

(1) Kyzyl: 10/VII 2000 - 1 ♀; 29/VII 2000 - 1 ♂ (O. K.)

Mezhegei: 3/IX 2000 1 ♀ visually, ovipositing (V. Z.)

(15) Toora-Khem: 20/VII 2000 - 1 specimen (visually) (O. K.)

(16) Adyr Kezhig: 31/VII 2002 - 2 ♀ (V. Z.)

(20) Azas: 22/VII 2000 - 1 ♂ 1 ♀ (teneral)

(22) Azas small lake: 23/VII 2000 - 2 ♀ (O. K.)

Very common in Todzha and at (1), not found in the Ubsu-Nur Hollow. Females oviposited into floating logs.

20. *Aeshna affinis* Van der Linden, 1825

(11) Tes-Khem: 13/VII 2000 - 1 ♂ (O. K.)

The only specimen, a male, was encountered ranging between high bushes of *Caragana spinosa* on a wide dry glade in the floodland at (11). For the first time this species was reported for Ubsu-Nur Hollow and Tuva by Zaika & Kosterin (1992). It occurred in a dry delta of the Shivilig-Khem.

21. *Ophiogomphus spinicornis* Selys, 1878

(7) Khemchik: 1/VIII 2000 - 1 ♂ (V. Z.)

(11) Tes-Khem: 11/VII 2000 - 5 ♂

(12) Erzin: 16/VII 2000 - visually (O. K.)

Common in the Ubsu-Nur Hollow, in riparian woods and bush thickets at (11) and (12). The “transitional form between *Ophiogomphus serpentinus* and *O. reductus*” earlier reported by us (Zaika & Kosterin, 1992) from the Tes-Khem and Shivilig-Khem River valleys appeared in fact to be the Chinese-Mongolian species *Ophiogomphus spinicornis* (Kosterin, 1999). Hence, no specimens are known to show transitional characters between any of the four North Asian species of *Ophiogomphus* (*O. cecilia* (Geoffroi in Fourcroy, 1785) (= *O. serpentinus* (Charpentier, 1825), *O. obscurus* Bartenev, 1909, *O. reductus* Calvert, 1898 and *O. spinicornis* Selys, 1878). Therefore, the species status of the four species, well substantiated by Asahina (1979) and Haritonov & Borisov (1990) but doubted by Belyshev (1973) and us (Zaika & Kosterin, 1992) presently remains unchallenged. Most probably, it was also *O. spinicornis* which was reported by Valle (1942) as *Ophiogomphus reductus* Calvert, 1898 for the Khemchik, for these two species have somewhat similar anal appendages. The male of *O. spinicornis* collected by V. Z. at site (7) gives a strong evidence for this supposition. In addition to Tuva, in the Russian territory this species is known from the Baikal southern bank (Kosterin, 1999) and for the steppes of Transbaikalia: the Onon River at Nizhnii Tsasuchei (Kosterin, 1999) and Kyra village (unpublished).

22. *Ophiogomphus obscurus* Bartenev, 1909

(15) Toora-Khem: 20/VII - 1 ♂; 26/VII - 4 ♂ 1 ♀ (O. K.); 31/VII 2002 - 2 larvae 30 mm long (V. Z.)

In Todzha, *O. obscurus* is found in typical taiga habitats. Most probably it breeds in the Toora-Khem River (15), on the banks of which adults fly. Some individuals occur also on the Bii-Khem banks but they are hardly expected to develop in such a fast and powerful river.

In the Central Tuvianian Hollow (implied without the Khemchik River basin), no representative of Gomphidae was recorded so far. Therefore, this steppe hollow separates the steppe species *O. spinicornis* and the taiga-inhabiting *O. obscurus* although by a yet unknown way.

23. *Somatochlora metallica* (Van der Linden, 1825) ssp. *abocanica* Belyshev, 1955.

(15) Toora-Khem: 20/VII - 1 ♀ (O. K.)

(16) Adyr-Kezhig: 31/VII 2002 - 1 ♀

(19) Krasnyi Kamen': 20/VII 2002 - 1 larva (18 mm long); 22/VII 2002 - 2♂ 2♀, 27/VII 2002 - 1♂ 1 larva (17 mm long) (V. Z.)

(20) Azas: 22/VII - 2♂

(22) Azas small lake: 23/VII - 1♂ 2♀ (O. K.)

In the female from (15) the yellow stripe connecting the yellow spots on the frons is interrupted in the middle, in that from (16) it is continuous, in one female from (22) it is continuous and very wide, in the other female from the same site the stripe has two gaps, in the two females from (19) it has one narrow gap. In three males the stripe is continuous, in three others interrupted. However, in all cases, it is always an obvious stripe stretched out from the yellow spots to connect them. There is a wide yellow stripe on the fore femora, going along their abaxial side to 2/3-3/4 of their length in all specimens except for the female from (16), in which only trochanters are yellow. The hairs covering the upper part of the head are of light colour (in the female from (15) they are yellow), the pterostigma is very dark-brown to black. The wing membrane has a light yellowish-brown coloration varying in intensity. It is most intense in one female from (21) and (16), and, especially and mostly in the distal wing part of a female from (15). In one female from (22), traces of amber are noticeable along the costa, in one female collected at (19) there is amber in two cells between the costa and subcosta on the fore wing, in the other one also on the hind wing, in the female from (15) a weak amber along the costa of both wings is added to their strong brown darkening. The body coloration is bright, blueish metallic green in males or yellowish- metallic green in females. In males, the rear half of the projection bearing the accessory genitals is yellow, on sides of segment II proximally of it there is a slanting yellow elongate-oval stroke. The epiproct is three fourth as long as the cerci, or slightly more. The abdomen length (measured with appendages) is 36-37 mm in males, 38-40 mm in females, the hind wing length is 35-37 mm.

All specimens collected at (22) were *S. metallica* and correspond to Belyshev's characteristics (see Belyshev, 1973) of the subspecies *abocanica*, except for the dark wings: dark pterostigma, light hairs in the upper part of the head, wings with scarce amber but darkened. In our specimens the darkening was weak, but this character is environment- and age-dependent and is, therefore, hardly suitable for taxonomic use. The female from (15) also perfectly fit to ssp. *abocanica*, that from (16) lacked the yellow on the fore femora, but had all other characters well expressed: a wide yellow stripe on the frons, bright body coloration, light hairs on the head and strongly darkened wings. At the same time all five males from (15) (see below) are true *Somatochlora exuberata* Bartenev, 1910.

Therefore, we encountered a sympatry between *metallica* and *exuberata* at the Toora-Khem River. No specimen is intermediate between them. Hence, their species status is now corroborated by their sympatry. Both entities have large ranges, western and eastern, with constant diagnostic characters, and they meet in Todzha retaining all their diagnostic characters. These two separate ranges make it fairly unlikely (but in principle possible) that we deal with two highly pleiotropic alleles of the same locus. The syndrome of diagnostic characters of both taxa is most likely controlled by a number of loci. The absence of intermediate specimens or those with a free combination of characters in the zone of contact demonstrated a lack or negligible amount of gene flow between the entities. In essence, this proves them to be separate biological species. The fact that *S. metallica* was the only found on Lake Azas (20) while *S. exuberata* predominated on the river flowing out of it most probably indicates ecological differences between these species as well. Note that both species were found only in Todzha Hollow.

These dragonflies were quite abundant along the banks of Lake Azas and at the small lake at the Azas River mouth. The males flew low above the water, manoeuvring among branches of logs in the first case and following the quaking bog margin in the latter.

24. *Somatochlora exuberata* Bartenev, 1910, bona species.

(15) Toora-Khem: 20/VII - 5♂ (O. K.)

The dragonflies demonstrate all the diagnostic characters of the taxon: absence of even traces of a yellow stripe between the yellow spots on the frons, absence of yellow on fore femora, black hairs in the upper part of the head, black pterostigma, and a very dark body. The wings are hyaline, in one male with a hardly noticeable darkening of a yellow-brownish tint. The thorax was dark-bronze-green and rather dull, the abdomen glossy-black, almost without bronze glitter. The projection bearing male accessory genitals is entirely black, proximal of it is a large whitish triangular spot on either side of segment II. These colouration characters of segment II, according to material available to us, are stable within *S. metallica* and *S. exuberata* all over their ranges and

distinguish them as different species. The epiproct length is $2/3$ of that of cerci, or even shorter. The length of abdomen (with the appendages) is 39-40 mm that of the hind wing 35-37 mm. Thus, we fail to find size differences between *S. metallica* and *S. exuberata* while morphological and colour differences are quite reliable.

The dragonflies flew along the sedge banks of a slow river of Toora-Khem (15). On the Bii-Khem River they were not found.

25. *Somatochlora graeseri* Selys, 1887

(1) Kyzyl: 9/VII 2000 - 1♂, 29/VII 2000 - 4♂ (O. K.), 4/VIII 2000 - 1♂ (V. Z.)

(11) Tes-Khem: 11/VII 2000 - 1♀, 13/VII 2000 - 1♂

(15) Toora-Khem: 20/VII 2000 - 1♂, 26/VII 2000 - 1♂

(20) Azas: 22/VII 2000 - 1♂

(22) Azas small lake: 23/VII 2000 - 6♂ 6♀ (O. K.)

The female obtained at (11) completely lacks the basal amber, which is so characteristic for females in this species. One of the two females collected at (1) had only traces of it while the other had the amber quite normally expressed. In the Todzha Hollow, all females had well-expressed basal amber, except in one of them where it was very pale but yet extends to the triangles. Belyshev (1973) wrote that the degree of amber development varies in wide limits, up to its complete disappearance as an aberration. It is not impossible that in arid intermontane hollows of Tuva this became a norm. Checking this supposition is a matter of further investigations. In males from (1) the wings are noticeably darkened.

In the Tes-Khem floodland (11) the species was scarce. The female was collected beside willow bushes, males were observed slowly flying above the surface of the large oxbow with ice-cold water. There seemed to be 3-4 males on the entire oxbow, and it was a very low density so that they almost did not encounter each other, and a male passed by a fixed point of the bank once in 5-10 minutes. At the oxbows of (1) the species was much more abundant and in Todzha numerous both at banks of a slow flowing river (15), a large lake (20) and, especially, on the small swampy lake at the Azas River mouth (22).

26. *Epitheca bimaculata* (Charpentier, 1825)

(19) Krasnyi Kamen': 22/VII 2002 - 1♂ (V. Z.)

(22) Azas small lake: 23/VI 2000 - 2♂ (O. K.)

So far found only in Todzha. In three males collected, the hind wing lengths were 38, 38 and 39 mm. The basal amber was absent, the dark basal spots reached the middle of the triangles in the two males collected in 2000 but and did not reach the triangles in the male collected in 2002. According to Belyshev's diagnostic characters (Belyshev, 1973), the two former specimens com-

bine those of ssp. *altaica* Belyshev, 1951 (the basal spots reaching the triangles) and *sibirica* (Selys, 1887) (the amber absent), the latter specimen corresponds to *sibirica*. However, subspecies isolation within *Epitheca bimaculata* is not well substantiated (Kosterin, 1999).

At (22) males flew above the boggy banks and along edges of a peat-moss larch/Siberian stone pine taiga.

27. *Libellula quadrimaculata* Linnaeus, 1758

(4) Chagytai: N bank, 23/VI 2000 - 1♂, S bank, 25/VI 2000 - 1♂, W bank, 27/VI 2000 - 3♀, 28/VI 2000 - 1♂ (V. Z.) a bog

(11) Tes-Khem: 13/VI 2000 - 1♀, 20/VII 2000 - 1♀

(15) Toora-Khem: 20/VII 2000 - 1♀

(21) Azas oxbow: 24/VII 2000 - 1♂

(22) Azas small lake: 23/VII 2000 - 1 visually (O. K.)

A common species occurring on any stagnant water bodies, including the smallest ones. By the time of our observations, its flight season had been mostly ceased.

28. *Orthetrum cancellatum* (Linnaeus, 1758)

(13) Tere-Khol': 15/VII 2000 - 3♂ 2♀ (1♂ and 1♀ teneral)

(17) Nogaan-Khol': 25/VII 2000 - 1♂ (in a cobweb) (O. K.)

As anywhere in West Siberia, the males are pruinose with blue not only throughout the abdomen but also over the thorax. The species inhabits large lakes with firm open banks. Lake Tere-Khol' provides such favourable conditions and is inhabited in great abundance. On July 15, 2002 the emergence still proceeded. Males perched on sand or any barren ground near the water and periodically range along the very shoreline for dozens of metres. The finding of a dead male in cobweb on the bank of Lake Nogaan-Khol' (17) in Todzha, residing in a dense larch taiga near to the very bank, was quite unexpected.

29. *Leucorrhinia dubia* (Van der Linden, 1825)

(11) Tes-Khem: 11/VII 2000 - 2♂; 13/VII 2000 - 3♂ 2♀; 16/VII 2000 - 1♂

(15) Toora-Khem: 26/VII 2000 - 2♂ 2♀ (O. K.)

In the specimens collected, the pterostigma was brownish-black. In males, the yellow spots on segments IV-V were missing, on segment VI the spot is either missing or hardly noticeable, the labrum is white. In females, the labrum was in general black; in three females from (11) it had two small lateral light spots at base, in the fourth, in addition, a narrow light central spot at base and two small light marks at the four margin. In one female from Todzha these light spots were absent, in another there were only traces of the latero-basal spots.

In females, the upper dark basal spot on the hind wing was missing. It turns out that the labrum colouration is intermediate between that of *L. dubia dubia* and *L. dubia orientalis* Selys, 1887, but closer to that of *dubia* in specimens from Todzha. These observations may support the notion of a subspecific status of the taxon *orientalis*.

The species of *Leucorrhinia* are characterized by a relatively early flight period. Nevertheless, in mid-July at (11) these dragonflies occurred quite frequently at the bush vegetation and the water, most frequently at the ice-cold oxbow. In Todzha this species was found in a similar habitat: in an oxbow of the Toora-Khem River (15) fed by ice-cold sources. Those specimens collected were already rather old.

30. *Leucorrhinia rubicunda* (Linnaeus, 1758).

- (1) Kyzyl: 25/V 2001 - 1♂; 25/V 2002 - 1♂
- (4) Chagytyai, east bank: 26/VI 2002 - 3♂, 28/VI 2000 - 3♂ (Bosenkov leg.)
- (5) Mazhalyg: 27/VI 2000 - 1♂, 27/VI 2002 - 1♀ (V. Z.)
- (15) Toora-Khem: 26/VII 2000 - 2♂ 3♀ (O. K.)

Old individuals of this species were found in Todzha in late July, together with the previous species. Perhaps it was the low water temperature which cause them to be still present there. Most probably, the species in fact occurs in a much greater variety of habitats but the dragonflies had ceased flying to the time of our expedition.

At Lake Chagytyai (4) the species was common on small bays among bushes, mostly at the outflow of the Mazhalyg brook (5). The dragonfly especially often perched on dry branches.

31. *Sympetrum sanguineum* (Müller, 1764)

- (1) Kyzyl: 29/VII - 2♂ (O. K.)

Only two males were collected. One had a bright-red coloration, the other, probably young, was orange-yellow. The fore femora had yellow stripes.

32. *Sympetrum depressiusculum* (Selys, 1841)

- (1) Kyzyl: 28/VII 2000 - 2♂ 2♀ (V. Z.), 29/VII 2000 - 1♂ 1♀ (O. K.), 4/VIII 2000 - 2♂ 1♀ (V. Z.)

All the specimens had a yellow stripe on the fore femora.

33. *Sympetrum flaveolum* (Linnaeus, 1758)

- (4) Chagytyai: Mazhalyk, a bog, 17/VI 2000 - 1♀ (f. *typica* heterochrom)
- (6) Kara-Khool': 20/VIII 2001 - 1♂ 1♀
- (8) Tsagan-Shibetu: 27/VII 2000 - 1♀ (ab. *latreillei* Selys)
- (9) Khindikikh Khol': 24/VII 2000 - 1♂ (ab. *heteroptera* Bart.) (V. Z.)
- (11) Tes-Khem: 11/VII 2000 - 1♂ 3♀ (f. *nodalis* Bart.- 2, f. *typica* heterochrom - 1), 13/VII 2000 - 2♂ 2♀

(15) Toora-Khem: 20/VII 2000 - 5 ♀ (teneral), 26/VII 2000 - 2♂ 1 ♀ (ab. *latreillei* Selys)

(20) Azas: 22/VII 2000 - 1♂ teneral

(22) Azas small lake: 23/VII 2000 - 1♂ (teneral); 24/VII 2000 - 1♂ (O. K.)

This species is famous for its variation of orange colouration of wings. By these characters, most of our specimens belong to *forma typica*, other forms and aberrations, determined by the key by Belyshev (1973) are given above. This species tends to breed in temporarily inundated tussock meadows and bogs. It was not surprising that these dragonflies were not scarce at (11) where large tussock bogs were common.

34. *Sympetrum danae* (Sulzer, 1776)

(1) Kyzyl: 4/VIII 2000 - 2♂ 1 ♀

(11) Tes-Khem: 11/VII 2000 - 2♀, 13/VII 2000 - 1♂ 1 ♀

(13) Tere-Khol': 15/VII 2000 - 1♂ 1 ♀

(15) Toora-Khem: 20/VII 2000 - 1♂ 1 ♀ (both teneral), 26/VII 2000 - 1♂ 1 ♀ (O. K.)

(19) Krasnyi Kamen': 26/VI 2002 (a small bay) - 1 larva (15 mm long); 27/VII 2002 - 1♂ 1 ♀, 28/VII 2002 (a riparian bog) - 5♂ 6 ♀ (V. Z.)

(20) Azas: 22/VII 2000 - 2♂

(21) Azas oxbow: 24/VII 2000 - 2♂ 1 ♀ teneral

(22) Azas small lake: 23/VII 2000 - 1♂ 1 ♀ (teneral) (O. K.)

This rather late flying species mostly breeds in inundated sedge, either in small boglets or at the banks of large lakes and rivers.

35. *Sympetrum pedemontanum* (Müller in Allioni, 1766).

(1) Kyzyl: 26/VII 2000 - 1♂ (A. Bosenko), 29/VII 2000 - 1♂ (O. K.), 4/VIII 2000 - 1♂ (V. Z.); 16/IX 2001 - 1♂

In most specimens the wing band starts at equal distance between the node and pterostigma and ends at the middle of the pterostigma, its maximum width is 5 mm. The species has a late flight period.

36. *Sympetrum vulgatum* (Linnaeus, 1758)

(1) Kyzyl: 29/VII 2000 - 2♂ (teneral), 31/VII 2000 - visually just emerged individuals (O. K.), 4/VIII 2000 - 2♂ 1 ♀

(6) Kara-Khool': 20/VIII - 3 ♀ (V.Z.)

(near 12) Erzin Kozhuun, Bulun-Bazhi village, ca. 1200m a.s.l., barren rocks with bushes. 10/VII 2000 - 1 ♀

(13) Tere-Khol' 15/VII 2000 - 17♂ (teneral) (O. K.)

The specimens collected in any part of Tuva had the characters of the nominal subspecies and do not demonstrate deviations towards the Transbaikalian and Far Eastern subspecies *S. vulgatum imitans* Selys, 1886.

This relatively common species was not found in the floodlands of the rivers Erzin and Tes-Khem (11 and 12). It is most probably not present there or appears later in the season. The only mature female was collected at bushes of *Caragana spinosa* on the granite rocks on the Erzin River left bank at Bulun-Bazhy. Most probably it got there dispersing from some remote breeding place. While visiting Lake 'Tere-Khol' (13) we observed a mass emergence of *Sympetrum vulgatum* in small reed thickets on heated shallows at the SW bank. At the very end of July we observed a massive emergence in the oxbows of the Kaa Khem at (1).

Discussion

Altogether, in 2000-2002 we collected 36 dragonfly species in the Tyva Republic. We did not observe or collect six species earlier recorded for this territory, namely *Aeshna mixta* Latreille, 1805 (Zaika & Kosterin, 1992; Zaika, 1996, 1999), *Sympetrum tibiale* (Ris, 1897) (Zaika, 1996, 1999), *Lestes macrostigma* Evermann, 1836 (Zaika, unpubl. observation), *Aeshna caerulea* Ström, 1783, *Anax parthenope* Selys, 1839, and *Somatochlora alpestris* (Selys, 1840) (unpubl. records of specimens in the collection of the Institute of Systematics and Ecology of Animals of Siberian Division of the Russian Academy of Sciences, Novosibirsk). The entire checklist of Tuva, therefore, presently contains 42 species but is most probably still incomplete. For example, in the highlands we should expect species mostly restricted to taiga as *Somatochlora arctica* (Zetterstedt, 1840) and *S. sablbergi* Trybom, 1899, known from adjacent regions. We may also expect the eastern *Coenagrion glaciale* (Selys, 1872).

The large diversity of rivers in Tuva yielded a surprisingly low number of Gomphidae. In the rivers of the Todzha Hollow and in the more western forested piedmonts of the West Sayan the presence of such rheophilic species cannot be excluded as *Calopteryx japonica* Selys, 1853, *Stylurus flavipes* (Charpentier, 1825), *Shaogomphus postocularis* (Selys, 1869), *Nibonogomphus ruptus* (Selys, 1859), and *Macromia amphigena* Selys, 1871. These species occur in the Altai and Krasnoyarskii Krai Province, north of West Sayan, some of which are represented by Siberian subspecies. In the boggy and forested Todzha we should expect to meet *Cordulia aenea* (Linnaeus, 1758) which prefers such landscapes. Southern species of *Sympetrum* may also be found in the future, such as *S. striolatum* (Charpentier, 1840) which was collected by V. Z. at the southern bank of Lake Ubsu-Nur Hollow on August 17, 1995, just at the southern border of Tyva Republic. *S. fonscolombii* (Selys, 1840) was reported from about the same place by Belyshev & Dozhidorzhi (1958). Furthermore, *Sympetrum meridionale* (Selys, 1841), *Calopteryx virgo* (Linnaeus, 1758) and *Coenagrion puella* (Linnaeus, 1758) are known from Mongolia (for a review see Kosterin, 1999) and may also be expected. The fact that they all were not recorded during our expeditions indicates that they are at least rare in Tuva.

For the species that we have recorded, the odonate fauna of the Todzha Hollow was by far the most interesting. First of all, only here we found some species that are confined to forest habitats: *Ophiogomphus obscurus*, *Coenagrion johannsoni*, *Somatochlora metallica* and *S. exuberata*. Second, we found the two latter species, which previously have been thought to be geographic vicariants, to occur in sympatry that provides a sound argument for their species status. Third, the fauna of the Todzha Hollow, situated in the north-east of Tuva, appeared to be more similar to the Western Siberian odonate fauna than to that of the southern steppes. For example, *Calopteryx splendens* was represented only in the Todzha Hollow. Likewise, we found *Coenagrion hastulatum* there, while in the Central Tuvian Hollow *C. lanceolatum* prevails. Fourth, Todzha is the easternmost known locality of western species *Somatochlora metallica* s. str. and *Erythromma najas najas* while in the rest of Tuva the half-way streaks are present, as in ssp. *humerales*.

Perspectives of further studies

There is no doubt that our findings only represent a sketch and the first step of odonate studies of such a vast and complicated territory as the Tyva Republic. At present we recommend that further faunistic studies should be primarily concentrated on the calm rivers and diverse lakes in the Todzha and the West Tuvian Hollows. In the Central Tuvian Hollow it should be specifically searched for representatives of the genus *Ophiogomphus*. The Turanian Hollow and the southern principal slope of West Sayan, the Kaa-Khem River valley and the Sangilen Upland are yet completely unknown in odonatological respect.

Our findings allow and encourage a specific research plan devoted to identify the species status of certain taxa. In the Todzha Hollow, more populations of *Calopteryx* should be sought for and large series should be collected. These should include alcohol preservation for a later analysis of neutral DNA variation that can be used to elucidate phylogenetic divergence and hence taxonomic status. The same applies to *Somatochlora metallica abocanica* and *S. exuberata*. The Todzha Hollow presents a fine opportunity to investigate ecological differences such as flight period, habitat preference and behaviour that accompany (or have caused) the genetic divergence of these two species.

Another interesting attempt would be investigating the patterns of variation of *Enallagma cyathigerum* along the 150 km-long transect starting in the Kaa-Khem River basin and crossing the Academician Obruchev Upland. Based on what is observed in other regions, we predict to find all transitions from *E.c risi* to *E. c. cyathigerum*. However, it is most probably that the upland does not offer habitats suitable for this species and may therefore provide a complete ecological barrier to fully isolate the subspecies at such a short distance. It should be noted that the very hard accessibility of the Upland makes this venture very difficult.

Finally, a comparison of the larval morphology of *Leucorrhinia dubia* s. l. may contribute to elucidate the status of the taxon *orientalis*, for which in Tuva a transitional zone between the nominotypical subspecies and *orientalis* can be expected. The Tuvinian females appeared intermediate between *orientalis* and *dubia* s. str.. As the main difference between the taxa is considered to concern the spine armament (Belyshev, 1973), we may encounter intermediate larval morphology.

Collections and their fate

In 2000-2002 we collected 610 specimens of adult dragonflies and damselflies. Thirty-nine males of *Enallagma cyathigerum risi* were sent to Dr. Robby Stoks (Belgium), and a couple of *Enallagma cyathigerum antiquum* was sent to Dr. Henri Dumont (Belgium) for the analysis of mitochondrial DNA. Parts of the collection will be transferred to Siberian Zoological Museum at the Institute of Systematics and Ecology of Animals of the Siberian Division of the Russian Academy of Sciences at Novosibirsk and to the collection of Tyvinian Institute of Complex Exploitation of Natural Resources. All other material is hereby offered for investigation to any interested researcher. Inquiries for dry specimens collected in 2000 should be addressed to O. K., for other specimens to V. Z. (they are mostly preserved in alcohol).

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References

- Asahina, S. 1979:** Notes on Chinese Odonata. XI. On two North Chinese Gomphids, with special reference to Palearctic *Ophiogomphus* species. - Tombo 22: 2-11.
- Belyshev, B. F. 1973:** Dragonflies (Odanata) of Siberia. Vol. 1, Parts 1, 2. - Nauka, Siberian Division - Novosibirsk - 620 p.] (In Russian)
- Belyshev, B. F., Doshidorzhi, A. K. 1958:** On odonata fauna of Mongolia. - Zoologicheskii Zhurnal 37: 34-40 (In Russian)
- Haritonov, A. Yu. 1990:** Boreal'naya odonatofauna i ekologicheskie faktory rasprostraneniya strekoz [The Boreal odonatofauna and the ecological factors of distributions of dragonflies]. Dissertation for the scientific degree of doctor of biological sciences [D. Sci. Thesis]. - Novosibirsk - 531 p. (a manuscript in Russian).
- Haritonov, A. Yu., Borisov S. N. 1990:** Eurasian species of the genus *Ophiogomphus* (Odonata, Gomphidae). - In G. S. Zolotarevko, (ed.): Redkie gel'minty, kleshchi i nasekomye (Novye i maloizvestnye vidy fauny Sibiri) [Rare Helminths, Mites and Insects. (New and Little-Known Species of the Fauna of Siberia)] 21: 43-51.] (in Russian).

- Jödicke, R. 1997:** Die Binsenjungfern und Winterlibellen Europas. Lestidae. Westarp Wissenschaften, Magdeburg, 227 pp.
- Kosterin, O.E. 1999:** Dragonflies (Odonata) of the Dauriskii State Nature Reserve and its surroundings. - In: Dubatolov V. V. et al., eds. Nasekomye Daurii i sopredel'nykh territorii. Sbornik nauchnykh trudov. [Insects of Dauria and Adjacent Territories] 2: 5-40, (in Russian) Novosibirsk.
- Malikova, E. I. 1995:** Strekozy (Odonata, Insecta) Dal'nego Vostoka Rossii [Dragonflies (Odonata, Insecta) of the Far East of Russia]. Unpubl. Dissertation for the scientific degree of candidate of biological sciences [Ph.D. Thesis]. - Novosibirsk - 233 p. (in Russian)
- Maskaev, Yu. M., Namzalov, B. B., Sedel'nikov, V. P. 1985:** Geobotanicheskoe raionirovanie [Geobotanical Regioning]. - In: I. I. Koropachinskii (ed.) Rastitel'nyi pokrov i estestvennye kormovye ugodya Tuvinskoi ASSR [Vegetation and Natural Forage Resources of the Tuva ASSR] - Nauka, Siberian Division - Novosibirsk - 1985 - P. 210-247 (in Russian)
- Molokova, N. I. & Kartashev, N. D. 1999:** Zapovednik "Azas" [the Azas Nature Reserve]. - In: Zapovedniki Sibiri [Nature Reserves of Siberia. Spanenberg, ed.] - Logata, p. 128-126 (in Russian)
- Samraoui, B., Weekers, P. H. H., Dumont, H. L. 2002:** The *Enallagma* of the western and central Palaearctic (Zygoptera: Coenagrionidae). - Odonatologica 31: 345-434.
- Schiel, F.-J. 1998:** Zur Habitatbindung des Grossen Granatauges (*Erythromma najas* Hansemann, 1823) (Odonata: Zygoptera) am südlicher Oberrhein. - Naturschutz am südlichen Oberrhein 2: 129-138.
- Seidenbusch, R. 1997:** Morphological imaginal comparison in the *Enallagma deserti* - complex: *Enallagma deserti* Selys, 1871, *Enallagma boreale* Selys, 1875, *Enallagma circulatum* Selys, 1883, *Enallagma belyshevi* Haritonov, 1975, *Enallagma risi* Schmidt, 1961 - Sulzbach-Rosenberger Libellenrundbrief 6: 10-15.
- Shkatarzhik, K. A. 1993:** Geografiya Respubliki Tuva [Geography of Tuva Republic] - Tuvinian Book Press - Kyzyl, 128 p. (in Russian).
- Suslov, S. P. 1954:** Fizicheskaya geografiya SSSR. Aziatskaya chast' [Physical Geography of the USSR. Asian Part]. - State Teaching-Pedagogical Publishing House of the Ministry of Education of the RSFSR - Moscow, 711 p. (in Russian).
- Valle, K. J. 1942:** Odonaten aus dem westlichen Zentralasien. - Ann. Entomol. fenn. 8: 114-126.
- Zaika, V. V. 1996:** Amfibiontnye nasekomye (Insecta) Ubsu-Nurskoi kotloviny [Amphibiotic insects (Insecta) of the Ubsu-Nur Hollow] - In: Global'nyi monitoring i Ubsu-Nurskaya kotlovina [Global Monitoring and the Ubsu-Nur Hollow]. Proceedings of IV International Symposium on the results of International Program of Biosphaeral Monitoring "The Ubsu-Nur Hollow Experiment" - Intellect - Moscow - p. 62-66. (in Russian).
- Zaika, V. V. 1999:** Gidrobionty ozera Tore-Khol' (tsentralnaya chast' Ubsu-Nurskoi kotloviny, Tuva) [Hydrobionts of Lake Tore-Khol' (central part of the Ubsu-Nur Hollow, Tuva)]. - Abstracts of IV International Scientific Conference "Natural Conditions, History and Culture of West Mongolia and Adjacent Regions", Tomsk, April 20-24 1999, Tomsk, p. 46-47. (in Russian).
- Zaika, V. V., Kosterin, O. E. 1992:** Some interesting findings of dragonflies (Odonata) in South Tuva. - Acta Hydroentomologica Latvica 2: 81-84.