

# A REVIEW OF THE GENUS *THYMALLUS* (PISCES: SALMONIFORMES, SALMONIDAE, THYMALLINAE) WITH TAXONOMIC NOTES

YURY V. DYLDIN<sup>1</sup>, LUBOMÍR HANEL<sup>2</sup>, VLADIMÍR I. ROMANOV<sup>3</sup>  
& JAN PLESNÍK<sup>4</sup>

<sup>1</sup>Tomsk State University, pr. Lenina 36, Tomsk, 634050, Russian Federation;  
e-mail: yurydyldin@gmail.com

<sup>2</sup>Department of Biology and Environmental Studies, Faculty of Education, Charles University, Prague, M.D.Rettigová 4, Praha 1, 116 39, Czech Republic;  
e-mail: lubomirhanel@seznam.cz

<sup>3</sup>Tomsk State University, pr. Lenina 36, Tomsk, 634050, Russian Federation;  
e-mail: icht.nrtsu@yandex.ru

<sup>4</sup>Nature Conservation Agency of the Czech Republic, Kaplanova 1931/1,  
148 00 Praha 11 – Chodov, Czech Republic, E-mail: jan.plesnik@nature.cz

**Recommended reference:** Dyldin, Yu. V., Hanel, L., Romanov, V.I. & Plesník, J.: A review of the genus *Thymallus* (Pisces: Salmoniformes, Salmonidae, Thymallinae) with taxonomic notes. Bull. Lampetra, ZO ČSOP Vlašim, 2017, 8: 103 – 126

**Abstract:** The current checklist of *Thymallus* species occurring in Eurasia and North America is presented with taxonomic notes in the paper. According to recent data the genus *Thymallus* includes totally 18 following taxa: *Thymallus aeliani*, *Th. arcticus*, *Th. baicalolenensis*, *Th. baicalensis*, *Th. brevicephalus*, *Th. brevipinnis*, *Th. brevirostris*, *Th. burejensis*, *Th. flavomaculatus*, *Th. grubii*, *Th. mertensii*, *Th. nigrescens*, *Th. nikolskyi*, *Th. pallasii*, *Th. signifer*, *Th. svetovidovi*, *Th.thymallus* and *Th. tugarinae*. All above mentioned species differ from each other not only in their bionomics, phenology (timing of spawning) and reproductive isolation, but also genetically and morphologically. The paper briefly describes opinions on the taxonomic status of the above mentioned species.

**Key words:** graylings of the world, *Thymallus* (Pisces), taxonomy, checklist

## Introduction

The genus *Thymallus* has an extensive range in Eurasia and North America. Graylings occur primarily in mountainous and foothill rivers and streams with clean and cold water, with a stony and pebble and, to a lesser extent, sandy bottom. Graylings are an important component in fish communities (ichthyocenoses) there; often the only species occurs in such waters (ZINOV'EV & BOGDANOV 2012; ANTONOV & KNIZHIN 2014a). Graylings produce different ecotypes depending on their occurrence in lakes, brooks, rivers or under

mixed habitat conditions. Graylings are typical rheophilous fishes able to active spread to such adjacent river ecosystems within a river system. Although graylings are freshwater species, some of them inhabit lower stretches within river basins of the Arctic Ocean (the Arctic grayling). In addition, the European grayling tolerates slightly brackish waters.

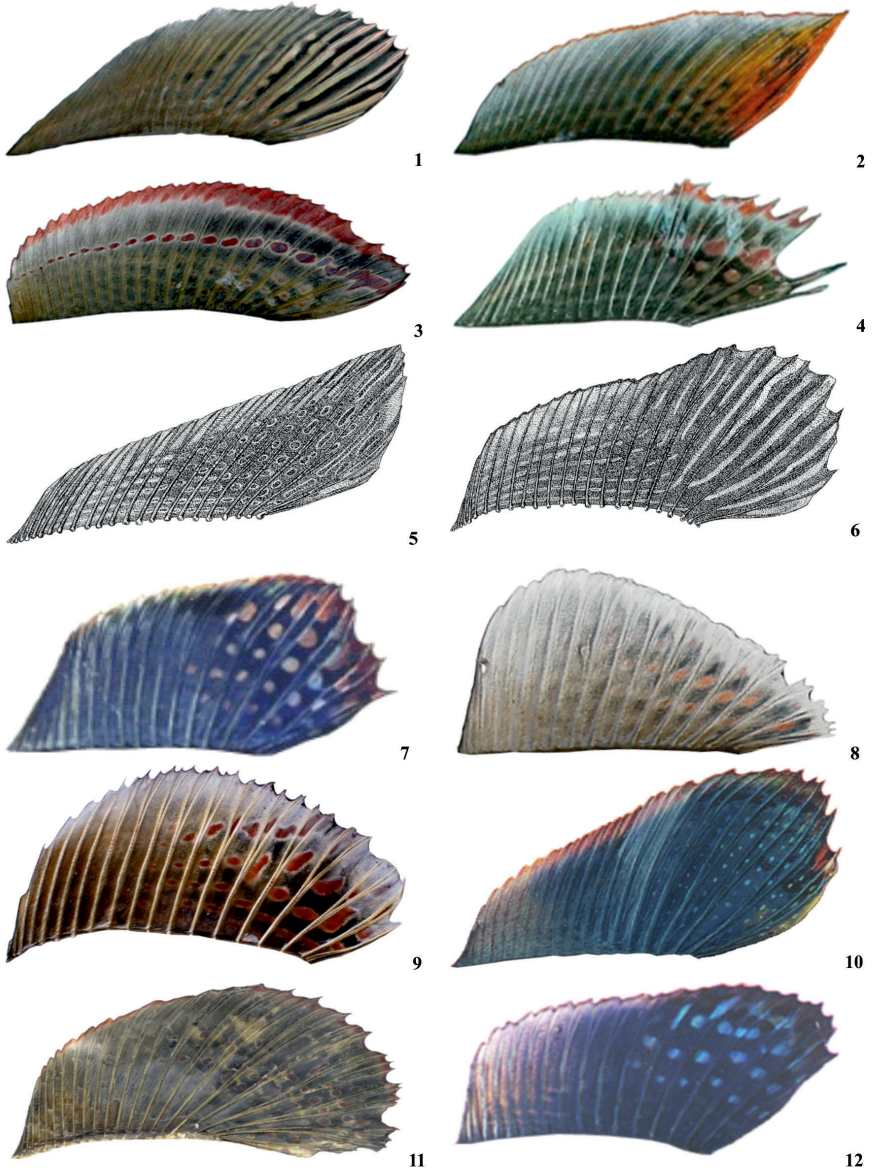
Graylings are among the most beautiful and most valuable freshwater fishes in the Northern Hemisphere. They are a significant food item in some regions, as well as the object of recreational/sport angling. The fishes require cool, well-oxygenated water, preferably with a swift current. Therefore, they are highly sensitive to changes in water quality and therefore may be considered as indicator species. With regard to special ecological requirements of the European grayling in Bohemia, already Frič (1872) designated the specific part of the stream as the so-called grayling zone, following the uppermost part of the stream (the brown trout zone). The grayling zone changes in its lower part into the so-called barbel zone. Graylings should be protected also as an important biological component (e.g. the European grayling is a protected species listed in the Appendix III to the Bern Convention) because it has become critically endangered in the Baltic Sea.

In the mixed samples from various European rivers, LINNAEUS (1758) described the grayling called *Salmo thymallus*. The species name *thymallus* originates from a faint smell of the herb thyme, which emanates from the fish's flesh. PALLAS (1776) described the Arctic grayling called *Salmo (Trutta) arcticus* in Russian waters east of the lower reaches of the Ob River. Valenciennes (CUVIER & VALENCIENNES 1848) described the new species *Thymallus mertensii* from the waters of the Eastern Kamchatka Peninsula and *Thymallus pallasii* from the Kolyma River. DYBOWSKI (1869, 1874) described several forms of *Thymallus grubii* Dybowski, 1869 and *Thymallus grubii* var. *baicalensis* Dybowski, 1874 from Siberian rivers, including also the Amur River basin and the Lake Baikal. Other authors identified many new forms of graylings in the next period (see text below).

The first data about graylings inhabiting Russia were published in Svetovidov's monography (1936). His study was based on mixed samples originating from the various sites within the whole species' Russian distribution range. Svetovidov hereby established the foundations for next detailed taxonomic studies on Russian graylings. According to Svetovidov's opinion (the author accepted the subspecies *Thymallus articus grubii*) the only species (subspecies) *Thymallus grubii* Dybowski, 1869 was suggested to live in the Amur River basin at the beginning of the 21st first century. In addition to the above taxon, four new species were later described from the Amur River basin, i.e. *Thymallus flavomaculatus* Knizhin, Antonov & Weiss, 2006, *Th. tugarinae* Knizhin, Antonov, Safronov & Weiss, 2007 и *Th. burejensis*, in some tributaries of the Amur River and *Th. baicalolenensis* Matveev, Samusenok, Pronin & Tel'pukhovskiy, 2005. The *Th. grubii* distribution is limited to typical habitats in the upper Amur (KNIZHIN 2009; SEMENCHENKO 2013; ANTONOV & KNIZHIN 2014a). All the mentioned species differ each other not only genetically but also by reproductive isolation (SEMENCHENKO 2013). Similar situation was found in Siberian graylings (Romanov, unpublished data).

Systematic status of the species within the genus *Thymallus* has been unclear yet, having been in some cases quite controversial. Graylings display high adaptivity in various habitats reflecting their wide range of genotype responses. Thus, the genus *Thymallus* can show the high level of polymorphism. Recent opinions on its taxonomy are based not only on current methods of identification including genetic research, but also on the dorsal fin

**Fig. 1.** Variability in the dorsal fin in some subarctic grayling species. Figs. 1 – 4 see ANTONOV & KNIZHIN (2014a, b), 1 – *Thymallus burejensis*; 2 – *Th. flavomaculatus*; 3 – *Th. tugarinae*; 4 – *Th. baicalolenensis*; according to our data 5 – *Th. mertensii*; 6 – *Th. pallasii*; 7 – *Th. baicalensis* (the Khantayskoye Lake); 8 – *Th. brevisrostris* (the Saksay River, Khovd River basin); 9 – *Thymallus* sp. (the Rashaant River, Khovd River basin); 10 – *Th. arcticus* (the Edynge River, the Khantayskoye Lake basin); 11. *Th. arcticus* (the Bulkur River, Lena River basin); 12 – *Th. brevipinnis* (the Khantayskoye Lake).



structure (i.e. on degree of branching of its branched rays or fin's coloration), cf. ROMANOV (2005) and KNIZHIN (2009).

In the past as well as at present, some researchers distinguished a few species and their subspecies with respect to the high intraspecific variability within the genus *Thymallus*. Former studies had been based primarily on morphometric characteristics (i.e., plastic and meristic parameters). Therefore, at first 3-5 species were identified within the genus of *Thymallus*, see SVETOVIDOV (1936), BERG (1948), RESHETNIKOV et al. (2003), etc.

Standard morphometric methods for identifying of grayling taxa in Europe and North America have been used for many decades (SVETOVIDOV 1936; BERG 1948; RESHETNIKOV et al. 1998, 2003). In addition to them a lot of other traits, e.g. body and fins coloration (see Fig. 1), the dorsal fin structure (ROMANOV 2002), body size, scale size and finally reproductive isolation, huge geographical distance among „forms“, isolation of populations caused by the relief/landscape shape and geomorphology and genetic data have not been taken into account.

Therefore, later descriptions of new taxa within the genus of *Thymallus* have been based not only on morphometric characteristics. At present 18 grayling species have been already identified, taking into account comprehensive analyses of the former as well as the newest data published on their taxonomy, biology, ecology and genetics. The fishes are threatened by climate change, particularly due to increasing temperatures in their southern distribution ranges. Graylings suffer from dam constructions, river canalization, pollution by various contaminants, and eutrophication in many regions. Sufficiently detailed identification of differences among the individual species and native populations is important for maintaining and conserving their genetic and population diversity. Preservation of the specific genes in grayling native populations is necessary to be carried out before it is too late.

There have been a lot of substantial changes in grayling systematics during the past decades resulting from the newest method application (including genetic ones, investigation on the museum material and gathered data analyses). With regard to fragmented information available in databases and published in monographies, bulletins, papers and other peer reviewed and gray literature it is needed to present a complete current checklist within the genus *Thymallus* with taxonomic notes.

## Material and Methods

The genus *Thymallus* is classified within the order Salmoniformes, the family Salmonidae and subfamily Thymallinae (NELSON 2006; VAN DER LAAN et al. 2014; NELSON et al. 2016; ESCHMEYER & FONG 2017).

The authors critically analyzed in this contribution all known literature sources (books, articles, reports, theses), databases and type materials in museum collections; the authors' unpublished data were also used. Data given in the Catalog of Fishes (ESHMEYER et al. 2017) and FishBase (FROESE & PAULY 2017) were also employed. Typical habitats and synonyms are particularly in accordance with the primary reference sources, in the special cases data given by ESCHMEYER et al. (2017) and KOTTELAT (2006) were accepted.

Latin (scientific) and English name are given at all the mentioned species. When the English name has not known yet, the new name was established in accordance with the

principles of etymology (the English species names were derived from typical habitats or original descriptions and figures presented there). Bibliographic references are mentioned at original names, type localities and synonyms. The information on distribution and taxonomic notes are also given in most of the presented species.

## Results

### THE LIST SPECIES OF GRAYLINGS

**Class:** Actinopterygii Klein, 1885 – Ray-finned fishes

**Order:** Salmoniformes Bleeker, 1859 – Salmon

**Family:** Salmonidae Cuvier, 1816 – Salmon

**Subfamily:** Thymallinae Gill, 1884 – Grayling

**Remarks:** According to the recent molecular data, the Thymallinae subfamily is a sister group to Coregoninae (LI et al. 2010; CAMPBELL et al. 2013). Nevertheless, with respect to other data (YASUIKE et al. 2010; SHEDKO et al. 2013), the subfamily Thymallinae is rather close to Salmoninae.

**Genus:** *Thymallus* Linck, 1790 – Grayling

*Thymallus* Linck, 1790. P. 35 (type species: *Salmo thymallus* Linnaeus, 1758, appeared without species)

*Thymallus* Cuvier, 1829. P. 306 (type species: *Salmo thymallus* Linnaeus, 1758, by absolute tautonymy)

*Choregon* Minding, 1832. P. 119 (type species: *Salmo thymallus* Linnaeus, 1758, by monotypy)

*Phylogephyra* Boulenger, 1898. P. 330 (type species: *Phylogephyra altaica* Boulenger, 1898, by original designation)

#### 1. *Thymallus aeliani* (Valenciennes, 1848) – Aelian's or Adriatic grayling

*Thymallus aeliani* Valenciennes in Cuvier & Valenciennes, 1848. P. 447 (type locality: Lake Maggiore, Italy)

**Distribution:** the Lake Maggiore (du lac Majeur), Italy (Cuvier & Valenciennes 1848). Northern Adriatic basin, including Northern Italy and Western Slovenia (BIANCO 2013; BRAVNIČAR et al. 2015).

**Remarks:** species status for the taxon was confirmed by BIANCO (2013), but in the past it was listed in the synonymy with *Thymallus thymallus*. Haplotype of native representatives of the genus *Thymallus* occurring in the Adriatic Sea basin from Northern Italy to the Western Slovenia is very different from all other transalpine members of the genus. The variation had occurred probably 4 million years ago. Two species *Thymallus thymallus* and *Th. arcticus* can well illustrate the differences. There also is a very different pair of species *Th. thymallus* and *Th. aeliani*. *Th. thymallus* has red caudal fin, whereas blue caudal fin is typical for *Thymallus aeliani*. Both the species differ each other in maximum total length (*Th. thymallus* 60 cm, *Th. aeliani* 50 cm); for more details, see BIANCO (2013) and BRAVNIČAR et al. (2015).

## 2. *Thymallus arcticus* (Pallas, 1776) – Arctic grayling

*Salmo (Trutta) arcticus* Pallas, 1776. P. 706 (type locality: Sob River tributaries, lower Ob River, near Salekhard [Obdorsk], 66°31'48"N, 66°36'07"E)

**Distribution:** original description is based on individuals originating from the Sob River tributaries, the lower Ob River. According to data (e.g., BOGUTSKAYA & NASEKA 2004; KOTTELAT 2006; KNIZHIN 2009; ESCHMEYER et al. 2017) majority of the *Th. arcticus* subspecies are now accepted as the valid species. The present *Th. arcticus* geographic distribution is limited to the Arctic Ocean basin, lower stretches of some local rivers there respectively. According to our data, the current range of *Th. arcticus* is restricted to some tributaries of the Pechora River and to the Kara basin, the tributaries of the lower Ob and the Lower Yenisei (the Kureyka, the **Hantayka**); the **Pyasina, Taimyr and Hatay river basins** and extends to the eastern rivers in Yakutia, including the Lower Lena and the lower reaches of the Kolyma River (ROMANOV et al. 2016; ROMANOV 2017). **Formally with inclusion** of the forms described in North America, *Th. arcticus* is distributed from rivers of Pechora to the Chukchi Peninsula and on the North American coast in the basin of Chukchi and Beaufort seas to Alaska (the U.S.A.) and British Columbia (Canada) and (in isolation) in the upper Missouri basin in Montana, the U.S.A. (RESHETNIKOV et al. 2003; ROMANOV 2005; FROUFE et al. 2005; KNIZHIN et al. 2008b; KNIZHIN 2009).

**Remarks:** it must be noted that some of the following species were described in the North America waters:

*Coregonus signifer* Richardson, 1823. P. 711, pl. 26 – distribution along the Arctic Ocean coast with presence to the north up to 62° parallel of latitude and between the Welcome and Mackenzie rivers; the type locality Fort Simpson, British Columbia, Canada,

*Thymallus tricolor* Cope, 1865. P. 80 – the type locality Ausable River, Michigan, the U.S.A.,

*Thymallus montanus* Milner, 1874. P. 741 – the type locality Camp Baker, tributary of the Missouri River, Montana, the U.S.A., all in MILNER (1874).

At present, the North American graylings are synonymized with *Th. arcticus* (ESCHMEYER et al. 2017), but thus there has been a question - why the North American graylings are not classified within the taxa *Thymallus pallasii* Valenciennes, 1848 or *Thymallus mertensii* Valenciennes, 1848? Based on preliminary studies, the North American graylings are not classified in the synonymy with *Th. arcticus*. For clarification of the taxonomic status of the American graylings (*Thymallus montanus*, *Coregonus signifer* and *Thymallus tricolor*) further studies using new diagnostic methods are necessary. Thus, according to ROMANOV (2005), due to their morphological traits, the graylings of the Taimyr Peninsula are an aggregate closer to *Thymallus mertensii* from Kamchatka and *Thymallus signifer* from Alaska, instead of *Thymallus pallasii* Valenciennes, 1848 or *Thymallus arcticus*. With respect of Svetovidov's (1936) opinion the taxon *Th. signifer* is closer to *Th. arcticus pallasii*. This is partly in accordance with Svetovidov's suggestion (l.c.), that the species *T. arcticus* (including its four subspecies) was described by general diagnosis (unfortunately based on rather small sample) from the huge territory, particularly from the basins of Ob, Yenisei, Lena and Kolyma rivers (see ROMANOV 2005, 2007). The opinion was subsequently accepted in the Russian ichthyological literature (BERG 1948; RESHETNIKOV et al. 2003; etc.). Analysing numerous samples, some researchers suggest that the so-called "*T. arcticus*" is not homogeneous taxon throughout its whole distribution range (ROMANOV 2005, 2007; KNIZHIN et al. 2006c; etc).

Within the taxon of *Th. arcticus* were described more than 10 subspecies in the last century, the best known of them being *Thymallus arcticus arcticus* (Pallas, 1776) – the Siberian grayling, the Arctic Ocean basin (BERG 1948; RESHETNIKOV et al. 1998, 2003), *Th. a. pallasii* Valenciennes, 1848 – the East-Siberian grayling, the first description from the Kolyma River (BERG 1948; CHERESHNEV 1996; RESHETNIKOV et al. 1998, 2003, KNIZHIN et al. 2006e), *Th. a. mertensii* Valenciennes, 1848 – the Kamchatka grayling, the first description from the eastern Kamchatka coast (BERG 1948, as *T. a. grubei natio mertensii*; RESHETNIKOV et al. 1998, 2003; SHEIKO & FEDOROV 2000), *Th. a. baicalensis* (Dybowski, 1874) – the Baikal black grayling, the first description from the Lake Baikal and Selenga and Angara rivers (BERG 1948; RESHETNIKOV et al. 1998, 2003), *Th. a. brevipinnis* Svetovidov, 1931 – the Baikal white grayling, the Lake Baikal (BERG 1948, as *Th. a. baicalensis* infrasubspecies *brevipinnis*; RESHETNIKOV et al. 1998, 2003), *Th. a. brevicephalus* Mitrofanov, 1971 – the shorthead or Lake Markakol grayling, the latter being a taxon endemic to the Lake Markakol, Kazakhstan (e.g., MITROFANOV 1986, 1971; MITROFANOV et al. 2003), *Th. a. grubii* Dybowski, 1869 – the Amur grayling, the first description from the Onon and Ingoda rivers in the upper Amur River basin (BERG 1948; RESHETNIKOV et al. 1998, 2003), *Th. a. signifer* (Richardson, 1823) – the Alaska grayling, within Russian waters only distributed on the tip of the Chukchi Peninsula (CHERESHNEV 1996, 2008; RESHETNIKOV et al. 1998, 2003), *Th. a. nigrescens* Dorogostaisky, 1923 – the Hovsgol or Mongolian grayling, in the Lake Hovsgol and its tributaries, Mongolia (RESHETNIKOV et al. 1998, 2003; ROMANOV 2005), *Th. a. lacustris* Gundrizer, 1967 – the Lake grayling, in the Bol'shoy Yenisei drainage (GUNDRIZER 1967), *Th. a. dentatus* Gundrizer, 1979 – the Dentated Siberian grayling, in the Kara-Khol Lake in the Kham-Syra River system, the Bol'shoy Yenisei drainage, Tuva (GUNDRIZER 1979), and *Th. a. yaluensis* Mori, 1928 – the Yalu River grayling, the first description from the upper Yalu River, Korea (MORI 1928).

At present according to the most recent data some of the above subspecies are classified as the valid species, i.e. *Th. pallasii*, *Th. mertensii*, *Th. baicalensis*, *Th. brevipinnis*, *Th. brevicephalus*, *Th. grubii*, *Th. nigrescens* and *Th. yaluensis*. Based on some other studies (KNIZHIN et al. 2008b; KNIZHIN & WEISS 2009; KNIZHIN 2009; ROMANOV 2017; ROMANOV et al. 2011; ROMANOV et al. 2017) the taxon of *Thymallus nikolskyi* Kaschenko, 1899, former synonymized with *T. arcticus*, is considered now as the separate valid species. The Yalu River and the Amur River drainage are disconnected each other and the isolation caused differences in morphological traits thus grayling populations from the Yalu River are classified as the subspecies *Th.a.yaluensis* (MA et al., 2016), or even as the separate species (ESCHMEYER et al., 2017). According to an earlier study (MA et al. 2008) the taxon was synonymized with the species *Th.grubii*.

There also are several forms described which are formally considered within the taxon of *Th. arcticus* and further research on them is needed:

*Thymallus arcticus arcticus* natio *alchutovi* Johansen, 1945, from the Teletskoye Lake, the Altai Mts., Russia; according to ICZN it is classified as an infrasubspecies (KOTTELAT 2006; GOLUBTSOV & MALKOV 2007; ESCHMEYER et al. 2017);

*Thymallus microstoma* Herzenstein, 1883, from the Chuya River in in the Koschagatsch region, the Altai Mts. (GOLUBTSOV & MALKOV 2007; ESCHMEYER et al. 2017). It is necessary to say that latter taxon is mentioned by Herzenstein (1883) in the list of fishes collected by G. N. Potanin's expedition. According to the ICZN it is nomen nudum, because the name without a description cannot be accepted, see GOLUBTSOV & MALKOV (2007);

*Thymallus nikolskyi* var. *ongudajensis* Kaschenko, 1899, from the Urusul River at Ongudai, tributary of the Katun' River, the Altai Mts. (BERG 1948; KOTTELAT 2006; GOLUBTSOV & MALKOV 2007; ESCHMEYER et al. 2017);

*Thymallus sellatus* Kaschenko, 1899, from the Tenga Lake, the Urusul River basin, the Altai Mts. (BERG 1948; KOTTELAT 2006; GOLUBTSOV & MALKOV 2007; KNIZHIN 2009; ESCHMEYER et al. 2017);

*Thymallus arcticus arcticus* natio *rufocaudatus* Kafanova, 1970, from a lake located in the Chulyshman River upper stretches, the Ob river upper section (GOLUBTSOV & MALKOV 2007; KNIZHIN 2009).

### 3. *Thymallus baicalensis* Dybowski, 1874 – Baikal black grayling

*Thymallus grubii* var. *baicalensis* Dybowski, 1874. P. 391, pl. 8, fig. 1 (type locality: the Lake Baikal, the Selenga and Angara rivers)

*Thymallus arcticus baicalensis* morpha *angarensis* Dorogostaisky, 1923. P. 77 (type locality: the Angara River, the Lake Baikal at the source of the Angara)

**Distribution:** according to KOTTELAT (2006) and KNIZHIN (2009) the range of *T. baicalensis* includes the Lake Baikal and its tributaries including the Yenisei and Angara rivers; it also was found in the southern part of the Taimyr Peninsula, see ROMANOV (2005, 2017), and in the Selenge River watershed in Northern Mongolia (TSOGTSAIKHAN et al. 2017). A revision of its present distribution range is necessary.

**Remarks:** BERG (1908) classified the taxon as *Thymallus arcticus* ssp. *baicalensis*. Svetovidov (1931) within the subspecies "*baicalensis*" distinguished special infrasubspecies "*brevipinnis*". But the subspecies consists of three different populations or species (TUGARINA 1981). PIVNIČKA & HENSEL (1978) confirmed that *Thymallus baicalensis* is the separate valid species. In the past as well as at present (BERG 1948; RESHETNIKOV et al. 1998, 2003; see KNIZHIN et al. 2006d; see KNIZHIN 2009; MATVEEV et al. 2009; etc.) it is usually accepted as the subspecies *T. arcticus baicalensis* with inclusion of the so-called "white" and "black" forms. According to other studies (TUGARINA 2001; BOGUTSKAYA & NASEKA 2004; KOTTELAT 2006; MATVEEV & SAMUSENOK 2009) evaluating morphological differences, ecology, habitats etc., it is accepted in two valid species, i.e. the black grayling *T. baicalensis* and the white grayling *Thymallus brevipinnis* Svetovidov, 1931.

The species (*Thymallus baicalensis*) had been imported into the former Czechoslovakia in 1959 as eggs hatched in the Vsetín and Česká Koruna hatcheries. The third part of import consisted of 2,500 juveniles of 6-12 cm in length, and was introduced into the Dobšiná riverine lake in Slovakia. The first specimen was caught in 1961, and mass spawning migrations reported from there in spring 1962. Up to 1975, the grayling occurred regularly there, with descending abundance of its population (partially fished out for artificial spawning). Since 1975, the species has totally disappeared (BARUŠ & OLIVA et al. 1995). The second introduction of the species to Europe (Poland) was mentioned by HOLČÍK (1991). Nevertheless, this grayling was not established itself in European waters.

### 4. *Thymallus baicalolenensis* Matveev, Samusenok, Pronin & Tel'pukhovskiy, 2005 – Barguzin River grayling or Baikal-Lena [Bajkalo-Lensky] grayling

*Thymallus arcticus baicalolenensis* Matveev, Samusenok, Pronin & Tel'pukhovskiy in Matveev et al., 2005. P. 71, pl. 1 (type locality: the Barguzin River, the Lake Baikal basin, Russia)



*Thymallus arcticus lenensis* Weiss, Knizhin, Kirillov & Froufe, 2006. P. 521 (type locality: the Lena River basin)

**Distribution:** in the upper reaches of the Barguzin River (it is the third largest tributary of the Lake Baikal), also in other rivers and lakes in the Baikal basin including the Lena River drainage (upper, middle and lower stretches) (MATVEEV et al. 2005; VOKIN et al. 2007; PROSEKIN 2007; MATVEEV & SAMUSENOK 2006, 2009; MATVEEV et al. 2009; ANTONOV 2012).

**Remarks:** according to various authors (KNIZHIN et al. 2006a, 2006d, 2008a; KNIZHIN 2009; ANTONOV & KNIZHIN 2011) it is accepted as *Thymallus* sp. (the Lena River grayling) or as *Thymallus* sp. (*lenensis*) (see SEMENCHENKO 2013), with the occurrence in the Lena River basin from upper reaches near to the river delta, the upper reaches of the North-Eastern tributaries of the Lake Baikal, and also in the Amur River basin and Uda River, etc.

This is not in accordance with the International Code of Zoological Nomenclature (ICZN), because the taxon was described based on ICZN standards, including holotype, which is maintained by the Zoological Museum of the Irkutsk State University (ZMISU) under the number V-No.19 (a male with a body length of 313 mm caught in the Barguzin River in 2005, collector A. N.Tel'pukhovskij). Other paratypes (No.V-16-18, 20-41) are also maintained within the ZMISU collection. With respect to the principle of priority the scientific name *Thymallus baicalolensis* is valid.

### 5. *Thymallus brevicephalus* Mitrofanov, 1971 – Shorthead or Lake Markakol grayling

*Thymallus arcticus brevicephalus* Mitrofanov, 1961. nom. nud.

*Thymallus arcticus brevicephalus* Mitrofanov, 1971. P. 109, pls. 1-3 (type locality: the Lake Markakol, Kazakstan)

**Distribution:** an endemic species in the Lake Markakol, Kazakhstan (MITROFANOV 1971; MITROFANOV et al., 1986; MITROFANOV et al. 2003; KNIZHIN 2009; MEN'SHIKOV 2011).

**Remarks:** originally described as the subspecies *Th. arcticus brevicephalus*, as the separate species *Th. brevicephalus* was accepted by KNIZHIN (2009). We also accept the taxon as the separate species, because, beside some morphological differences, in comparison with the rest of species within the genus *Thymallus*, also some ecological differences have been known (MITROFANOV 1971; MITROFANOV et al. 1986). Nevertheless, comparative data published by MITROFANOV (l.c.) were based on studying mixed samples. Type specimens are not at disposal. In the past, *Th. arcticus* was reported from the Lake Markakol (e.g., SVETOVIDOV 1936).

This taxon had been for the first time mentioned by MITROFANOV in the Conference proceedings (nom. nud.) in 1961, but in 1971 he just presented sufficient description in accordance with ICZN requirements (Art. 5. Art 11 respectively). The complete description of the subspecies is given here and therefore its scientific name could be since this time accepted. But type specimens are not at disposal. More morphological and genetic analyses to clarify its taxonomic status and degree of a relationship to other taxa within the genus *Thymallus* are needed, particularly among graylings living in the upper reaches of the Ob River basin.

**6. *Thymallus brevipinnis* Svetovidov, 1931** – Baikal white grayling

*Thymallus arcticus* var. *brevipinnis* Svetovidov, 1931. P. 85, pl. 2, fig. 3, 4 (type locality: Lake Baikal)

**Distribution:** middle and northern parts of the Lake Baikal, where it comes into the Barguzin and Selenga rivers near the Mongolian borders (SVETOVIDOV 1931, 1936; BERG 1948; TUGARINA 2001; MATVEEV & SAMUSENOK 2009; MATVEEV et al. 2009). **Baikal graylings** with characteristics of “white” and “black” forms were found in the Yenisei River (ZADELENOV & GULIMOV 2000), according to ROMANOV’S (2009a, 2017) opinion this grayling inhabits also the Khantayskoe Lake in the Taimir Peninsula.

**Remarks:** the taxon was presented as the infrasubspecies *Thymallus arcticus baicalensis* infrasubspecies *brevipinnis*, see SVETOVIDOV (1936) and BERG (1948), or as the subspecies *Thymallus arcticus brevipinnis*, see RESHETNIKOV et al. (1998, 2003). Some authors (TUGARINA 2001; BOGUTSKAYA & NASEKA 2004; KOTTELAT 2006; MATVEEV & SAMUSENOK 2009) have recently classified the taxon as the valid species *Th. brevipinnis*. It must be highlighted that according to KNIZHIN (2009) the „white“ form of the Baikal grayling (earlier specified as the subspecies of *T. arcticus brevipinnis*), must be accepted as the subspecies of the black Baikal grayling (i.e. *Thymallus baicalensis brevipinnis*), because the most recent studies do not confirm that the taxon *Th. b. brevipinnis* could be classified as the separate species.

**7. *Thymallus brevirostris* Kessler, 1879** – Mongolian grayling

*Thymallus brevirostris* Kessler, 1879. P. 305 (type locality: tributary of the Daingol Lake; the Dsapchyn River)

*Phylogeophyra altaica* Boulenger, 1898. P. 330, fig. (type locality: south side of the Altai Mountains, China)

*Thymallus brevirostris kozovi* Dashdorj, Dulmaa & Tsendayush, 1968. P. 40 (type locality: the Khoton and Khorgon lakes, Mongolia)

*Thymallus brevirostris altaicus* Dashdorj, Dulmaa & Tsendayush, 1968. P. 45 (type locality: the Khoton and Khorgon lakes, Mongolia)

**Distribution:** western part of Mongolia, also China (the upper Irtysh River) and Russia in some lakes in the Kobdo River basin, Tuva (BERG 1948; GUNDRIZER & POPKOV 1984; RESHETNIKOV et al. 1998, 2003; FROUFE et al. 2005; KOTTELAT 2006; KNIZHIN et al. 2008b; KNIZHIN 2009).

**Remarks:** the species includes a series of little known forms, some of which are arbitrarily divided into “large” and “minor” groups, see Knizhin (2009), Slynko et al. (2010).

**8. *Thymallus burejensis* Antonov, 2004** – Bureya River grayling

*Thymallus burejensis* Antonov, 2004. P. 443, fig. 2 (type locality: the Levaya Bureya River, tributary of the Bureya River, the Middle Amur River, Russia)

**Distribution:** endemic species of the upper and middle stretches of the Bureya River basin, tributary of the Amur River middle section (ANTONOV 2004; BOGUTSKAYA et al. 2008; KNIZHIN 2009; ANTONOV & KNIZHIN 2011, 2014a, b).

**Remarks:** from all other members of the genus *Thymallus*, inhabiting the Amur River basin and adjacent areas, it differs not only morphologically, but also genetically and by the body length (ANTONOV & KNIZHIN 2014b). Formerly the species was called “big-scale” or

“large- scale” form of the Amur grayling *Thymallus grubii* Dybowski, 1869, see ANTONOV (1995, 2001), BOGUTSKAYA & NASEKA (2004), KNIZHIN et al. (2004) and KNIZHIN (2009).

### 9. *Thymallus flavomaculatus* Knizhin, Antonov & Weiss, 2006 – Yellow-spotted grayling

*Thymallus grubii flavomaculatus* Knizhin, Antonov & Weiss, 2006. P. 582, figs. 2, 3 (type locality: the Anyui River, tributary of the Lower Amur River basin, Russia)

**Distribution:** upper stretches of bigger tributaries of the Lower Amur River basin, in some tributaries of the Ussuri River, upper stretches of tributaries of the Japan and Okhotsk seas, including the Tatar Strait and Tumnin River basins (KNIZHIN et al. 2006b; BOGUTSKAYA et al. 2008; KNIZHIN 2009; ANTONOV & KNIZHIN 2011, 2014).

**Remarks:** in the past, the taxon was accepted as the yellow-spotted „form“, e.g., ANTONOV (2001), FROUFE et al. (2003) and KNIZHIN et al. (2004), or as *Thymallus* sp. 2 in SHEDKO (2001) and BOGUTSKAYA & NASEKA (2004), see also KNIZHIN et al. (2006b). According to BOGUTSKAYA et al. (2008), SHEDKO et al. (2013) it is classified as the separate species *T. flavomaculatus*. According to ANTONOV & KNIZHIN (2014a) it differs from *Th. grubii* in coloration and body length, but no difference was found by DNA testing, and therefore they classified the taxon at the subspecies level (i.e. *Th. g. flavomaculatus*).

### 10. *Thymallus grubii* Dybowski, 1869 – Amur grayling

*Thymallus grubii* Dybowski, 1869. P. 955, pl. 18, fig. 9 (type locality: the Onon and Ingoda rivers, the upper Amur River basin, Russia)

**Distribution:** the species was described by DYBOWSKI (1869) based on four specimens from the Onon and Ingoda rivers, in the upper Amur River basin. The current knowledge of the Amur grayling distribution range is limited to upper and middle parts of the Amur River basin to the Bureya River basin, including northeastern China and Mongolia (KNIZHIN et al. 2004; BOGUTSKAYA & NASEKA 2004; KOTTELAT 2006; KNIZHIN 2009; ANTONOV & KNIZHIN 2011). It is known from northern China in the Amur River basin, including the Sungari, Nenjiang, Yalu, Tumannaya (Tumen) and Huma rivers (SUN & MA 2011; MA et al. 2012).

**Remarks:** it is necessary to highlight that in the Huma River system (the right tributary of on the northern loop of the Amur River in the China’s province of Heilongjiang) was discovered, based on microsatellite analysis and morphological traits, in addition to *Th. grubii* and *Th. tugarinae* also the third “form”, previously designated as *Th. sp.* populations from the Huma River (see SUN & MA 2011). It should be mentioned that according to SAFRONOV et al. (2003) and the genetic data by MA et al. (2008) the *Thymallus articus yaluensis* Mori, 1928. P. 11 (type locality: the upper Yalu River at Kozan, Korea) was classified in the synonymy of *Th. grubii*. Nevertheless according to the new research by MA et al. (2016) it is supposed that *Th. yaluensis* is the valid species (see also ESCHMEYER et al. 2017).

Svetovidov (1936), after studying 12 individuals of graylings originating from different parts of the distribution range, classified the Amur grayling subspecies as *Th. a. grubei*. Later, some authors accepted his opinion (NIKOLSKII 1956; BERG, 1948; RESHETNIKOV et al. 1998, 2003; and others). However, by other studies (PIVNIČKA & HENSEL 1978), some authors suggest that *Th. grubii* is the separate valid species (TUGARINA & KHRAMTSOVA

1980, 1981; SAFRONOV et al. 2003; KNIZHIN et al. 2004; BOGUTSKAYA & NASEKA 2004; KOTTELAT 2006; KNIZHIN 2009): the suggestion has been confirmed by genetic studies (MA et al. 2008; SUN & MA 2011; SEMENCHENKO & ATOPKIN 2012; SEMENCHENKO 2013; etc.).

It must be mentioned that, except of *Thymallus grubii*, there currently have been the following taxa from different parts of the Amur River basin specified: *Thymallus burejensis*, *Thymallus flavomaculatus*, *Thymallus tugarinae*, including *Thymallus* sp. (the Lena River grayling) or as *Thymallus* sp. (*lenensis*) and *Th.* sp. (populations from the Huma River, China), see ANTONOV (2004), KNIZHIN et al. (2006b), KNIZHIN et al. (2007), KNIZHIN (2009), SUN & MA (2011), SEMENCHENKO (2013) and ANTONOV & KNIZHIN (2014a).

### 11. *Thymallus mertensii* Valenciennes, 1848 – Kamchatka grayling or Mertens' grayling.

*Thymallus mertensii* Valenciennes, 1848. P. 453 (type locality: Kamchatka)

**Distribution:** described by VALENCIENNES (1848) based on M. Mertens' drawing, without specifying the type locality (it was known at that time only from the Kamchatka). Eastern part of the Chukotka Peninsula, the Koryak Autonomous Area and the Kamchatka Peninsula (CHERESHNEV 1996; RESHETNIKOV et al. 1998, 2003; SHEIKO & FEDOROV 2000; TOKRANOV & SHEIKO 2006; BUGAEV 2007); rivers in the southern part of the Taimyr Peninsula (ROMANOV 2005). Applying morphological traits (formula of the dorsal fin, number of scales in the lateral line, drawing of dorsal fin, etc.) they were defined as *Th. a. mertensii* and *Th. a. signifer* (Richardson, 1823) from the Ob River lower reaches, as well as between the Ob (lower section) and Yenisei rivers (see ROMANOV 2004). For improving knowledge of the species' current distribution range further studies are needed.

**Remarks:** this taxon was specified as *Thymallus arcticus grubei natio mertensi* infrasubspecies, see SVETOVIDOV (1936) and BERG (1948). It is classified at present by some authors as the subspecies *Thymallus arcticus mertensii*, see CHERESHNEV (1996), RESHETNIKOV et al. (1998), SHEIKO & FEDOROV (2000), ROMANOV (2004, 2005), KNIZHIN (2009). Moreover, some authors (BOGUTSKAYA & NASEKA 2004; KOTTELAT 2006; TOKRANOV & SHEIKO 2006) accepted it as the valid species *Th. mertensii*.

### 12. *Thymallus nigrescens* Dorogostaisky, 1923 – Hovsgol or Black grayling

*Thymallus arcticus nigrescens* Dorogostaisky, 1923. P. 76 (type locality: the Lake Hovsgol [Hövsgöl], northern Mongolia).

**Distribution:** endemic species of the Lake Hovsgol and its tributaries, Mongolia (SVETOVIDOV 1936; BERG 1948; TUGARINA 2001, 2002; RESHETNIKOV et al. 1998, 2003; KOTTELAT 2006; TSOGSAIKHAN et al. 2017).

**Remarks:** some authors consider the taxon as a member of the species *Thymallus arcticus*, either in the circle of the subspecies *Th. arcticus nigrescens*, see GUNDRIZER (1967), RESHETNIKOV et al. (1998, 2003), TUGARINA (2001), ROMANOV (2005) or within *Th. baicalensis* as the subspecies *Th. baicalensis nigrescens*, see KNIZHIN (2009), KNIZHIN & WEISS (2009). Nevertheless, according to other opinions (SVETOVIDOV 1936; BERG 1948; KOTTELAT 2006; MATVEEV et al. 2009; AHRENSTORFF et al. 2012; TSOGSAIKHAN et al. 2017) it is classified as the separate species *Th. nigrescens*.

### 13. *Thymallus nikolskyi* Kaschenko, 1899 – Nikolsky's grayling or Upper Ob grayling

*Thymallus microstoma* Herzenstein, 1883. P. 244 (type locality: the Chuya River in the Koschagatsch region, the Altai Mts.) nom. nud.

*Thymallus nikolskyi* Kaschenko, 1899. P. 131 (type locality: the Tcharysh River, Katun River, Tom River of upper Kusnetzk, ther upper Ob River system)

? *Thymallus nikolskyi* var. *ongudajensis* Kaschenko, 1899. P. 134 (type locality: the Ursul River, a tributary to the Katun River)

? *Thymallus sellatus* Kaschenko, 1899. P. 135, pl. 2, fig. 6 (type locality: the Ursul River basin)

**Distribution:** it was originally described based on the specimens from seven localities in the upper Ob River system, including the Katun and Ursul rivers, the Tcharysh River at the Ust'-Kan and Lake Tel'men'e (KASCHENKO 1899). The Ob River upper stretches (KNIZHIN et al. 2008b; KNIZHIN 2009) and the Tom River basin (ROMANOV et al. 2011).

**Remarks:** the species was in the past synonymized with *Thymallus arcticus* (Pallas, 1776), see Svetovidov (1936), Berg (1948) and others. Taking into account additional studies it was shifted to the separate species *Th. nikolskyi*, e.g. ROMANOV (2009b), KNIZHIN (2009), KNIZHIN & WEISS (2009. P. 12), ROMANOV et al. (2011), ROMANOV et al. (2016, 2017); ROMANOV (2017). The validity of the latter species was also confirmed by genetic data, see SEMENCHENKO (2013).

### 14. *Thymallus pallasii* Valenciennes, 1848 – Pallas' grayling or East-Siberian grayling

*Thymallus pallasii* Valenciennes, 1848. P. 448 (type locality: Kolyma, Russia)

**Distribution:** described by VALENCIENNES (1848) without specifying the type locality (only Russia is mentioned; description was based on material collected by Pallas from the Kolyma River, see BERG 1948). The distribution range usually include: rivers on the Arctic coast in Eastern Siberia from the Khatanga River to the Chukotka Peninsula including the Ola River in the Magadan region (See of Okhotsk basin), (see BERG 1948; CHERESHNEV 1996, 2008; RESHETNIKOV et al. 2003; ANTONOV & KNIZHIN 2014b).

**Remarks:** its distribution range needs to be more specified. According to ROMANOV (2005), the type locality of *Th. pallasii* is the Kolyma River basin; in other parts of distribution range, for example in southern part of the Taimyr Peninsula and in the lower reaches of the Lena River, other taxa occur, e.g. *Th. arcticus mertensii* or *Th. a. signifer*. The taxon is in the Russian literature usually considered as the subspecies *Thymallus arcticus pallasii*, e.g. see SVETOVIDOV (1936), BERG (1948), RESHETNIKOV et al. (2003), ROMANOV (2005), KNIZHIN (2009), ANTONOV & KNIZHIN (2014b). According to others authors, it is the separate valid species *T. pallasii*, see BOGUTSKAYA & NASEKA (2004), KOTTELAT (2006), SHEDKO et al. (2013).

### 15. *Thymallus signifer* (Richardson, 1823) – Alaska grayling

*Coregonus signifer* Richardson, 1823. P. 711, pl. 26 (type locality: rivers north of the Great Slave Lake, Canada), see Eschmeyer et al. (2017), according to Milner (1874) Fort Simpson, British Columbia, Canada.

*Coregonus thymalloides* Richardson, 1823. P. 714 (type locality: rivers north of the Great Slave Lake, Canada), [young] see Milner (1874)

?*Thymallus tricolor* Cope, 1865. P. 80 (type locality: Michigan, U.S.A.)

**Distribution:** the species' distribution range needs further specification, particularly in Russia, from where CHERESHNEV (1996, 2008) reported its occurrence only in some rivers from the eastern part of the Chukchi Peninsula. MILNER (1874) described its occurrence in North America on the Arctic Ocean coast, being distributed to the north up to 62° parallels and between the Welcome and Mackenzie rivers.

**Remarks:** it must be noted that CHERESHNEV (1996, 2008) suggested that *Th. arcticus palasii*, *Th. a. mertensii* and *Th. a. signifer* differ from each other by the large complex of morphological, biological and ecological features. Probably the subspecies *Th. a. pallasii* and *Th. a. mertensii* in Alaska are the separate species (*T. signifer*). This taxon was in Russian literature usually accepted as a subspecies of *Th. arcticus*, see CHERESHNEV (1996, 2008), RESHETNIKOV et al. (2003), ROMANOV (2005), KNIZHIN (2009). According to others authors (MECKLENBURG et al. 2002, ESCHMEYER et al. 2017) it was synonymized with *T. arcticus*. KOTTELAT (2006) listed the taxon as the separate species *T. signifer*.

#### 16. ?*Thymallus svetovidovi* Knizhin & Weiss, 2009 – Svetovidov's grayling or Upper Yenisei grayling

*Thymallus svetovidovi* Knizhin & Weiss 2009. P. 6, fig. 2 (type locality: Sharga Gol River, Mongolia)

?*Thymallus arcticus lacustris* Gundrizer, 1967 (type locality: lake in the Bol'shoj Yenisei drainage)

*Thymallus arcticus arcticus* natio *rufocaudatus* Kafanova, 1970 (type locality: lake located in the upper Chulyshman River, upper reaches of the Ob River)

?*Thymallus arcticus dentatus* Gundrizer, 1979. P. 15 (type locality: area of Lakes Kara-Khol in the Kham-Syra River system, the Bol'shoj Yenisei drainage, Tuva, Russia)

**Distribution:** in the upper stretches of all rivers within the Yenisei River basin (GUNDRIZER 1967, as *Thymallus arcticus lacustris*; KNIZHIN & WEISS 2009; KNIZHIN 2009, 2011). Russian area: e.g. the Abakan River upper stretches in Khakassia, as well as the sources of the Bol'shoj Yenisei and Belin rivers in Tuva (KNIZHIN & WEISS 2009; KNIZHIN 2009, 2011). KOTTELAT (2006: 26) this species accepted as *Thymallus* sp. 1, (see KNIZHIN & WEISS 2009).

**Remarks:** taxonomic status of this newly described species has not been not clear yet. Thus, according to authors' unpublished data with the special respect to morphology, the species is very similar to the subspecies *Thymallus arcticus lacustris* Gundrizer, 1967. With respect to the principle of priority of the scientific name according to the ICZN the study by GUNZINGER (1967) can be accepted. Therefore *Thymallus svetovidovi* Knizhin & Weiss, 2009 should be considered as a junior synonym of *Th. lacustris* Gunrizer, 1967. However, it is also suggested (ROMANOV 2009b) that specimens of *Th. svetovidovi* in Southern Siberia from the Yenisei River upper stretches are very close to *Th. nikolskyi*. Therefore, *Th. svetovidovi* could be accepted as a junior synonym for *Th. nikolskyi*. For final clarification of this taxonomic and nomenclatoric question further detailed research is needed.

#### 17. *Thymallus thymallus* (Linnaeus, 1758) – European grayling

*Salmo thymallus* Linnaeus, 1758. P. 311 (type locality: rivers of Europe)

**Distribution:** the European grayling is widely distributed across Europe from the Pyrenees to the Ural Mountains (KOTTELAT & FREYHOF 2007; KNIZHIN 2009). Northern boundary of its distribution in Russian waters is limited by rivers in the Ural Mountains, flowing to the northern and southern directions. The so called „Arctic“ or Siberian grayling (ZINOV'EV & BOGDANOV 2012) occurs in rivers flowing on eastern slopes of the above mountains (according to authors' opinion, the latter is the species complex). The European grayling occurs in two core areas (KOSKINEN et al. 2002); the majority of populations is being found in southern Europe and a lesser part is distributed throughout the western area, including England and Denmark. It is also known from mountain rivers in the former Yugoslavia (Slovenia and Serbia), where the southern zone of its European distribution is located, see SUŠNIK et al. (2001) and JANKOVIĆ (2010).

**Remarks:** OLIVA & NAIKSATAM (1974) had studied plastic and meristic traits in the grayling from various European sites, intraspecific variability was found to be relatively low. KOSKINEN et al. (2000) studied genetic lineages and postglacial colonization of the grayling (*Thymallus thymallus*) in Europe. JURCZYK & BRUZAN (2003) analyzed genetical parameters of graylings from Poland, MARIĆ et al. (2011) published results on genetic diversity in Serbian grayling populations. A sharp decline in many populations (genetic bottleneck effects) in the species in Europe was analyzed by SWAIDIPONG et al. (2010). HAUGEN & VØLLESTAD (2001) summarized data on life history in the grayling from the last century. Despite the existence of various genetic studies on many European grayling populations, only one widespread valid species (*Thymallus thymallus*) is for the present identified in European waters (except for the Italian endemic species *Thymallus aeliani*). Reports on genetic variability suggest that at least the Adriatic and Loire populations are distinct lineages, but diagnostic morphological data have not been yet available. Because of extensive stocking throughout the northern Adriatic basin it might be too late to study the original morphology, genetics, and distribution (FREYHOF 2014). The relationship between total length (L) and weight (W) of the largest angled *Thymallus thymallus* individuals (n = 139, 41–57 cm, 0.7–2.4 kg) in the former Czechoslovakia was published by HANEL (1989). The above relationship was as follows:  $\log W = -2.7986 + 1.6997 \log L$ . HORKÁ et al. (2015) reported that hatchery-reared graylings displayed greater total migration distance over the study period (total migration) than did wild fish, which was caused mainly by their dispersal in the downstream direction.

### 18. *Thymallus tugarinae* Knizhin, Antonov, Safronov & Weiss, 2007 – Lower Amur grayling or Tugarina's grayling

*Thymallus tugarinae* Knizhin, Antonov, Safronov & Weiss, 2007. P. 141, figs. 2–3 (type locality: the Anyui River, the Amur River basin)

**Distribution:** currently, the species' distribution range includes northern Sakhalin Island, the Amur River estuary, Lower Amur River stretches and also partly in the central and upper Amur River basin, including the Tatar Strait, Primorsky Krai and Uda and Tugur rivers belonging to the continental part of the Sea of Okhotsk (SAFRONOV et al. 2001, as *Th. grubii*; SAFRONOV et al. 2003, as *Th. grubii*; KNIZHIN et al. 2007; SAFRONOV 2009; MIKHEEV 2010; ANTONOV & KNIZHIN 2011, 2014a; ANTONOV 2012; SEMENCHENKO 2013; DYLDIN & ORLOV 2016). The Lower Amur grayling was confirmed by genetic data, namely by microsatellite analysis (MA et al. 2009, SUN & MA 2011) in the Huma River and some rivers in the Amur River basin in northern China.

**Remarks:** till description of the species *Th. tugarinae* from local populations inhabiting Sakhalin waters and the Amur River basin were classified as *Th. arcticus*, *Th. arcticus grubii* or *Th. grubii*, see DYLDIN & ORLOV (2016). According to the present knowledge, the species *Th. grubii* is not a member of the Sakhalin ichthyofauna, because its current occurrence is limited only to the type locality (see text on *Th. grubii*).

## References

- AHRENSTORFF, T.D., JENSEN, O.P., WEIDEL, B.C., MENDSAUKHAN, B. & HRABIK, T.R. (2012): Abundance, spatial distribution, and diet of endangered Hovsgol grayling (*Thymallus nigrescens*). *Environmental Biology of Fishes* 94: 465–476.
- ANTONOV, A.L. (1995): On graylings (the genus *Thymallus*) from the Bureya River (the Amur basin). *Voprosy Ikhtiologii* 35: 831–834. [In Russian].
- ANTONOV, A.L. (2001): Materials on new salmonids from the Amur tributaries. Vladimir Ya. Levanidov's Biennial Memorial Meetings, Vladivostok, Dalnauka, 1: 264–268. [In Russian].
- ANTONOV, A.L. (2004): A new species of grayling *Thymallus burejensis* sp. nova (Thymallidae) from the Amur basin. *Voprosy Ikhtiologii* 44: 441–451. [In Russian].
- ANTONOV, A.L. (2012): Diversity of fishes and structure of ichthyocenoses in mountain catchment areas of the Amur Basin. *Journal of Ichthyology* 52 (2): 149–159.
- ANTONOV, A.L. & KNIZHIN, I.B. (2011): Distribution, ecology and range formation of grayling (Thymallidae) in the Amur drainage. *Vestnik DVO RAN* 2011, 1: 41–48. [In Russian].
- ANTONOV, A.L. & KNIZHIN, I.B. (2014a): A riddle of Amur grayling. *Priroda* 1: 31–37. [In Russian].
- ANTONOV, A.L. & KNIZHIN, I.B. (2014b): Graylings (Thymallidae) of the Amur River basin: history of research and modern concepts of diversity. *Amurian Zoological Journal* 6 (3): 298–307. [In Russian].
- BARUŠ, V. & OLIVA, O. et al. (1995): Lampreys (Petromyzontes) and fishes (Osteichthyes). Academia, Praha, 624 pp. [In Czech].
- BERG, L.S. (1908): Vorläufige Bemerkungen über die europäisch-asiatischen Salmoninen, insbesondere über die Gattung *Thymallus*. *Ezhagodnik. Zoologicheskogo Muzeya Akademii Nauk SSSR*, 12: 500–514.
- BERG, L.S. (1948): Freshwater fishes of Soviet Union and adjacent countries. Vol. 1. Guide to the fauna of the U.S.S.R. No. 27. Moscow–Leningrad: Izdatel'stvo Akademii Nauk SSSR, 466 pp. [In Russian].
- BIANCO, P.G. (2013): An update in the status and exotic freshwater fishes of Italy. *Journal of Applied Ichthyology*, doi: 10.1111/jai.12291
- BOGUTSKAYA, N.G. & NASEKA, A.M. (2004): Catalogue of agnathans and fishes of fresh and brackish waters of Russia with comments on nomenclature and taxonomy. Moscow: Scientific Press “KMK”, 389 pp. [In Russian].
- BOGUTSKAYA N.G., NASEKA A.M., SHEDKO S.V., VASIL'eva E.D. & CHERESHNEV I.A. (2008): The fishes of the Amur River: updated check-list and zoogeography. *Ichthyological Exploration of Freshwaters* 19: 301–366.
- BOULENGER, G.A. (1898): On a new genus of salmonoid fishes from the Altai mountains. *Annals and Magazine of Natural History (Series 7)*, 1(4), art. 54: 329–331.



- BRAVNIČAR J., PALANDAČIĆ A., SUSNIK BAJEC S. & SNOJ A. (2015): Genetic introgression insights in Adriatic grayling (*Thymallus thymallus aeliani*) obtained from museum specimens. In: 2nd International Workshop on Conservation Biology. 17–19 June 2015. UP FAMNIT, Koper, Slovenia.
- BUGAEV, V.F. (2007): Fish of the Kamchatka River watershed (abundance, utilization, issues). Petropavlovsk–Kamchatsky: Izdatel'stvo "Kamchatpress", 192 pp. [In Russian].
- CAMPBELL, M.A., LÓPEZ, J.A., SADO, T. & MIYA, M. (2013): Pike and salmon as sister taxa: detailed intraclade resolution and divergence time estimation of Esociformes + Salmoniformes based on whole mitochondrial genome sequences. *Gene* 530, 1: 57–65.
- CHERESHNEV, I.A. (1996): Biological diversity of freshwater fish fauna in Russian North–East. Vladivostok: Dal'nauka, 198 pp. [In Russian].
- CHERESHNEV, I.A. (2008): Freshwater fishes of Chukotka. Magadan: NESC FEB RAS, 324 pp. [In Russian].
- COPE, E.D. (1865): Partial catalogue of the cold–blooded Vertebrata of Michigan. Part II. Proceedings of the Academy of Natural Sciences of Philadelphia, 17: 78–88.
- CUVIER, G. & VALENCIENNES, A. (1848): Histoire naturelle des poissons. Tome vingt et unième. Suite du livre vingt et unième et des Clupéoïdes. Livre vingt–deuxième. De la famille des Salmonoïdes. v. 21: i–xiv + 1 p. + 1–536, Pls. 607–633. [In French].
- DASHDORJ, A., DULMAA, A. & TSENDAYUSH, YA. (1968): A new form of grayling *Thymallus brevisrostris kozovi* subsp. n. from the Khovd River basin. Proceedings of the Mongolian Academy of Science, Environmental Science 4: 38–45. [In Mongolian].
- DOROGOSTAIKY, V. (1923): On the taxonomy of graylings from the Baikal Basin. Trudy Irkutskogo Obshchestva Estestvoispytatelei 1: 75–80. [In Russian].
- DYBOWSKI, B.N. (1869): Vorläufige Mittheilungen über die Fischfauna des Ononflusses und des Ingoda in Transbaikalien. Verhandlungen der K.–K. zoologisch–botanischen Gesellschaft in Wien 19: 945–958.
- DYBOWSKI, B. N. (1874): Die Fische des Baical–Wassersystemes. Verhandlungen der K.–K. zoologisch–botanischen Gesellschaft in Wien, 24(3–4): 383–394.
- DYLDIN, YU.V. & ORLOV, A.M. (2016): Ichthyofauna of fresh and brackish waters of Sakhalin Island: an annotated list with taxonomic comments. 2. Cyprinidae–Salmonidae families. *Journal of Ichthyology* 56 (5): 656–693.
- ESCHMEYER, W.N. & FONG, J.D. (2017): Species by family / subfamily. <http://researcharchive.calacademy.org/research/ichthyology/catalog/SpeciesByFamily.asp>. Electronic version accessed 16 February 2017.
- Eschmeyer, W.N., Fricke R. & van der Laan R. (eds) (2017): Catalog of fishes: genera, species, references. <http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>. Electronic version accessed 1 March 2017.
- FREYHOF, J. (2011): *Thymallus thymallus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <[www.iucnredlist.org](http://www.iucnredlist.org)>. Downloaded on 11 January 2014.
- FRITSCH (FRIČ), A. (1872): Vertebrates of Bohemia. The review of all observed mammals, birds, amphibians and fishes. [= Die Wirbeltiere Böhmens. Ein Verzeichnis aller bisher in Böhmen beobachteten Säugethiere, Vögel, Amphibien und Fische]. *Archiv für die Naturwissenschaften und Landesdurchforschung von Böhmen*, 2(2): 1–152. [In German].

- FROUFE E., KNIZHIN I., KOSKINEN M.T., PRIMMER C.R. & WEISS S. (2003): Identification of reproductively isolated lineages of Amur grayling (*Thymallus grubii* Dybowski 1869): concordance between phenotypic and genetic variation. *Molecular Ecology* 12: 2345–2355.
- FROUFE E., KNIZHIN I. & WEISS S. (2005): Phylogenetic analysis of the genus *Thymallus* (grayling) based on mtDNA control region and ATPase 6 genes, with inferences on control region constraints and broad-scale Eurasian phylogeography. *Molecular Phylogenetics and Evolution* 34: 106–117.
- GOLUBTSOV, A.S. & MALKOV, N.P. (2007): Essay on the fish fauna of the Altai Republic: systematic diversity, distribution and conservation. Moscow: Scientific Press “KMK”, 164 pp. [In Russian].
- GUNDRIZER, A.N. (1967): About a new subspecies of Siberian grayling from the basin of the Big Yenisei [=O novom podvide sibirskogo khariusa iz basseyna Bol'shego Yeniseya]. *Uchenyye zapiski Tomskogo Ordena Trudovogo Krasnogo Znamenii Gosudarstvennogo Universiteta im. V.V. Kuybysheva* 53: 79–94. [In Russian].
- GUNDRIZER, A.N. (1979): Dentated Siberian grayling – *Thymallus arcticus dentatus* subsp. Nova [=Zubastyy sibirskiy kharius – *Thymallus arcticus dentatus* Subsp. Nova]. In: New data on the fauna and flora of Siberia [=Novye dannye o faune i flore Sibiri]. Tomsk: Publishing house of Tomsk University, pp. 15–22. [In Russian].
- GUNDRIZER, A.N. & POPKOV, V.K. (1984): Specific features of ecology of Mongolian grayling *Thymallus brevirostris* Kessler (Thymallidae) in Lakes of Tuva ASSR. *Voprosy Ikhtiologii* 24: 69–76. [In Russian].
- HANEL, L. (1989): The relationship between body length and weight in very large fishes of Czechoslovakian waters [= Die Beziehung zwischen Körperlänge und –gewicht bei besonders grossen Fischen aus tschechoslowakischen Gewässern]. *Fischökologie* 1(1): 23–27 [In German with English summary].
- HAUGEN, T.O. & VØLLESTAD L.A. (2001): A century of life–history evolution in grayling. *Genetica* 112–113(1): 475–491.
- HERZENSTEIN, S.M. (1883): List of fishes collected in north–western Mongolia in the course of the expeditions of 1876, 1877, 1879 and 1880 // G.N. Potanin. *Essays on north–western Mongolia. Results of travels undertaken in 1879–1880 on orders of the Imperial Russian Geographical Society. Sanct Peterburg. Essays north–western Mongolia*, 3: 244.
- Holčík, J. (1991): Fish introductions in Europe with particular reference to its central and eastern part. *Canadian Journal of Fisheries and Aquatic Sciences*, 48 (suppl. 1): 13–23.
- Horká, P., Horký, P., Randák, T., Turek, J., Rylková, K. & Slavík, O. 2015: Radio–telemetry shows differences in the behaviour of wild and hatchery–reared European grayling *Thymallus thymallus* in response to environmental variables. *Journal of Fish Biology* 86, 2: 544–557.
- ICZN (2012): The International Code of Zoological Nomenclature, Fourth Edition. [Http://iczn.org/iczn/index.jsp](http://iczn.org/iczn/index.jsp)
- JANKOVIĆ, D. (2010): Serbia – part of the south zone of the range of distribution of the European grayling (*Thymallus thymallus* L.). *Archives of Biological Science Belgrade* 62: 115–121.
- JOHANSEN [=IOGANZEN] B.G. (1945): New forms of fishes of Western Siberia [=Novye formy ryb iz Zapadnoy Sibiri]. Notes on the fauna and flora of Siberia [=Zametki

- po faune i flore Sibiri]. Tomsk, 6: 1–16. [In Russian]. It was released in print 1946 year, by GOLUBTSOV & MALKOV (2007).
- JURCZYK, Ł. & BRUZAN, P. (2003): Analysis of MTDNA sequences of European grayling, *Thymallus thymallus*, from Southwestern Poland. Archives of Polish Fisheries 11: 301–306.
- KAFANOVA, V.V. (1970): Red-tailed grayling from the lake Lower Kulagash–Bazhi [=Krasnokhvostyy kharius iz ozera Nizhneye Kulagash–Bazhi]. Proceedings of the Research Institute of Biology and Biophysics at the Tomsk State University [=Trudy nauchno–issledovatel’skogo instituta biologii i biofiziki pri Tomskom gosudarstvennom universitete] 1: 80–89. [In Russian].
- KASCHENKO, N.F. (1899): Results of Zoological Expedition to Altai in 1898. Vertebrates. Tomsk: Tomsk University, pp. 131–155 pp. [In Russian].
- KESSLER, K.F. (1879): Beiträge zur Ichthyologie von Central–Asien. Bulletin de l’Académie Impériale des Sciences de St. Pétersbourg 25: 282–310.
- KNIZHIN, I.B. (2009): The graylings (*Thymallus* Cuvier, 1829) of the Holarctic (systematics, phylogeography, features of ecology). Ph.D. Thesis. Moscow: Institute of Ecology and Evolution named after A.N. Severtsova, 52 pp. [In Russian].
- KNIZHIN, I.B. (2011): Diversity and taxonomic identification of graylings (*Thymallus*) in the Yenisei River Basin. Journal of Siberian Federal University, Biology 3: 293–300. [In Russian].
- KNIZHIN, I.B., WEISS, S.J., ANTONOV, A.L. & FROUFE, E. (2004): Morphological and genetic diversity of Amur graylings (*Thymallus*, Thymallidae). Voprosy Ikhtiologii 44: 59–76. [In Russian].
- KNIZHIN, I.B., WEISS, S.J., BOGDANOV, B.E., SAMARINA, S.S. & FROUFE, E. (2006a): Finding a new form of the grayling *Thymallus arcticus* (Thymallidae) in the basin of Lake Baikal. Voprosy Ikhtiologii 46: 38–47. [In Russian].
- KNIZHIN, I.B., ANTONOV, A.L. & WEISS, S.J. (2006b): A new subspecies of the Amur grayling *Thymallus grubii flavomaculatus* ssp. nova (Thymallidae). Voprosy Ikhtiologii 46: 581–589. [In Russian].
- KNIZHIN, I.B., BOGDANOV, B.E. & VASIL’EVA, E.A. (2006c): Biological and morphological characteristic of the Arctic grayling *Thymallus arcticus* (Thymallidae) from Alpine Lakes of the basin of the upper reaches of the Angara River. Voprosy Ikhtiologii, 46: 747–759. [In Russian].
- KNIZHIN, I.B., WEISS, S.J. & SUŠNIK, S. (2006d): Graylings of Baikal Lake basin (*Thymallus*, Thymallidae): diversity of forms and their taxonomic status. Voprosy Ikhtiologii 46: 442–459. [In Russian].
- KNIZHIN, I.B., KIRILLOV, A.F. & WEISS, S.J. (2006e): On the diversity and taxonomic status of graylings (*Thymallus* Thymallidae) from Lena River. Voprosy Ikhtiologii 43: 182–194. [In Russian].
- KNIZHIN, I.B., ANTONOV, A.L., SAFRONOV, S.N. & WEISS, S.J. (2007): New species of grayling *Thymallus tugarinae* sp. nova (Thymallidae) from the Amur River Basin. Voprosy Ikhtiologii 47: 139–156. [In Russian].
- KNIZHIN, I.B., WEISS, S.J., BOGDANOV, B.E. & KOPUN, T. (2008a): New data on the distribution of the Upper Lena form of grayling (Thymallidae) in the basin of Lake Baikal and its taxonomic status. Voprosy Ikhtiologii 48: 166–172. [In Russian].
- KNIZHIN, I.B., WEISS, S.J., BOGDANOV, B.E., KOPUN, T. & MUZALEVSKAYA, O.V. (2008b):

- Graylings (Thymallidae) of water bodies in western Mongolia: morphological and genetic diversity. *Voprosy Ikhtologii* 48: 745–766. [In Russian].
- KNIZHIN, I.B. & WEISS, S.J. (2009): A new species of grayling *Thymallus svetovidovi* sp. nova (Thymallidae) from the Yenisei basin and its position in the genus *Thymallus*. *Journal of Ichthyology* 49: 1–9.
- KOSKINEN, M.T., NILSSON, J., VESELOV, A.J., POTUTKIN, A.G., RANTA, E. & PRIMMER, C.R. (2002): Microsatellite data resolve phylogeographic patterns in European grayling, *Thymallus thymallus*, Salmonidae. *Heredity* 88: 391–401.
- KOSKINEN, M.T., RANTA, E. & PIIRONEN, J. et al. (2000): Genetic lineages and postglacial colonization of grayling (*Thymallus thymallus*, Salmonidae) in Europe, as revealed by mitochondrial DNA analyses. *Molecular Ecology* 9: 1609–1624.
- KOTTELAT, M. (2006): Fishes of Mongolia. A check-list of the fishes known to occur in Mongolia with comments on systematics and nomenclature. The World Bank. Washington, DC. i–xi + 103 pp.
- KOTTELAT, M. & FREYHOF, J. (2007): Handbook of European freshwater fishes. Kottelat, Cornol, Switzerland and Freyhof, Berlin, Germany. Publications Kottelat. xiii+ 646 pp.
- LINNAEUS, C. (1758): *Systema Naturae*, Ed. X. (*Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Tomus I. Editio decima, reformata.) Holmiae. v. 1: i–ii + 1–824.
- LI, J., XIA, R. & MCDOWALL, R.M. et al. 2010. Phylogenetic position of the enigmatic *Lepidogalaxias salamandroides* with comment on the orders of lower euteleostean fishes. *Molecular Phylogenetics and Evolution* 57 (2): 932–936.
- MA, B., HUO T.–B. & JIANG, Z.–F. (2008): *Thymallus arcticus yaluensis* is a synonym of *T. grubii* by mitochondrial control region sequences analysis. *Acta Zootaxonomica Sinica* 33: 414–419. [In Chinese, with English summary].
- MA, B., LUI, T., ZHANG, Y. & CHEN, J. (2012): Phylogeography and population genetic structure of Amur grayling *Thymallus grubii* in the Amur basin. *Asian–Australasian journal of animal sciences*, 25: 935–944.
- MA, B., JIANG, Z.–F. & HUO, T. (2009): Analysis of genetic variation and geographic divergence of *Thymallus tugarinae* by microsatelli. *Journal of Fishery Sciences of China* 16, (5): doi 10.3321/j.issn:1005–8737.2009.05.005.
- MA, B., JIANG, H. & SUN, P. et al. (2016): Phylogeny and dating of divergences within the genus *Thymallus* (Salmonidae: Thymallinae) using complete mitochondrial genomes. *Mitochondrial DNA: The Journal of DNA Mapping, Sequencing, and Analysis* 27(5): 3602–3611.
- MARIĆ S., RAZPET A., NIKOLIĆ V. & SIMONOVIĆ P. (2011): Genetic differentiation of European grayling (*Thymallus thymallus*) populations in Serbia, based on mitochondrial and nuclear DNA analyses. *Genetics Selection Evolution* 43(2): doi:10.1186/1297–9686–43–2.
- MATVEEV, A.N., SAMUSENOK, V.P. & TEL'PUKHOVSKY et al. (2005): New subspecies of Syberian grayling *Thymallus arcticus baicalolenensis* subsp. nov. (SALMONIFORMES, THYMALLIDAE). *Vestnik Buryatskogo Universiteta, Seriya 2, Biologiya* 7: 69–82. [In Russian].
- MATVEEV, A.N. & SAMUSENOK, V.P. (2006): Biodiversity and fish community structure in reservoirs of the Baikal rift zone. *Bulletin of the East Siberian Scientific Center SB RAMS*. 2006, 2: 84–91. [In Russian].

- MATVEEV, A.N. & SAMUSENOK, V.P. (2009): Fishes (Pisces) in the basin of Lake Baikal. In: Timoshkin O.A. (Ed.), Index of animal species inhabiting Lake Baikal and its catchment area: In 2 volumes. Vol. II: Basins and Channels in the south of East Siberia and North Mongolia. Book 1. pp. 212–232. [In Russian].
- MATVEEV, A.N., SAMUSENOK, V.P. & VOKIN, A.I. (2009): Fishes (Pisces) of mountain reservoirs of the Lake Baikal basin and the upper reaches of the Lena. In: Pleshanov, A.S. (Ed.), Biota of reservoirs of the Baikal rift zone. Publishing house of Irkutsk State University, pp. 166–192. [In Russian].
- MECKLENBURG, C.W., MECKLENBURG, T.A. & THORSTEINSON, L.K. (2002): Fishes of Alaska. American Fisheries Society, Bethesda, Maryland. i–xxxvii + 1037 pp.
- MEN'SHILOV, M.I. (2011): Fishes of the Ob River Basin. Perm: Publishing House of Perm State University, 216 pp. [In Russian].
- MIKHEEV, P.B. (2010): Seismosensory system of the Lower Amur grayling *Thymallus tugarinae* (Thymallidae) from the Anyui River. Voprosy Ikhtiologii, 50: 777–781. [In Russian].
- MILNER, J.W. (1874): Notes on the grayling of North America. United States Commission of Fish and Fisheries. Report of the Commissioner for 1872 and 1873: 729–742.
- MITROFANOV, V.P. (1961): Fishes of the Lake Markakol. In: Proceedings of the conference on fisheries of the Republics of Central Asia and Kazakhstan. Frunze. [=Trudy konferentsii po rybnomu khozyaystvu respublik Sredney Azii i Kazakhstana.], pp. 51–61. [In Russian].
- MITROFANOV, V.P. (1971): Grayling of the Lake Markakul. Biological Sciences. Alma-Ata, 1: 104–112. [In Russian].
- MITROFANOV, V.P., DUKRAVETS, G.M. & PESERIDI, N.E. et al. (1986): Fishes of the Kazakhstan. V. 1. Minnow, Sturgeon, Herring, Salmon, Pike. Alma-Ata: Nauka, 272 pp. [In Russian].
- MITROFANOV, I.B., BAIMBETOV, A.A. & MOORE, J.M. (2003): Dictionary of Kazakhstan fish names in four languages. NPO «Tethys», Almaty, Kazakhstan, 56 pp.
- MORI, T. (1928): On the fresh water fishes from the Yalu River, Korea, with descriptions of new species. Journal of the Chosen Natural History Society 6: 54–70.
- NELSON, J.S. (2006): Fishes of the world. John Wiley & Sons, Inc, 601 pp.
- NELSON J.S., GRANDE T.C. & WILSON M.V.H. (2016): Fishes of the world. Fifth edition. John Wiley & Sons, Inc., Hoboken, New Jersey, xlii + 752 pp.
- Nikolskii, G.V. (1956): Fishes of the Amur basin. Moscow: Izdatel'stvo AN SSSR, 551 pp. [In Russian].
- OLIVA, O. & NAIKSATAM, A.S. (1974): On the systematics of the European grayling, *Thymallus thymallus* (Linnaeus, 1758) (Osteichthyes: Thymallidae). Věstník Československé společnosti zoologické [=Acta Societatis Zoologicae Bohemoslovenicae] 38: 187–214.
- PALLAS, P.S. (1776): Reise durch verschiedene Provinzen des Russischen Reichs. Dritter Theil. Vom Jahr 1772 und 1773. Kayserlichen Academie der Wissenschaften, St. Petersburg, 454 pp.
- PIVNIČKA K. & HENSEL K. (1978): Morphological variation in the genus *Thymallus* Cuvier, 1829 and recognition of the genus of the species and subspecies. Acta Universitatis Carolinae Biologica 1975–1976: 37–67.
- PROSEKIN, K.A. (2007): Ecological and biological features of graylings in the reservoirs and streams of upper Barguzin River (Pribaikalye). Ph.D. Thesis. Ulan-Ude, 23 pp. [In Russian].

- RESHETNIKOV, YU.S. et al. (1998): Annotated check–list of cyclostomata and fishes of the continental waters of Russia. Nauka Publishers, Moscow, 220 pp. [In Russian].
- RESHETNIKOV, YU.S. et al. (2003): Atlas of Russian freshwater fishes. Second edition. In two volumes. Nauka Publishers, Moscow,. vol. 1: 1–379 pp., vol. 2: 1–253 pp. [In Russian].
- RICHARDSON, J. (1823): Notice of the fishes. No. 6. Pp. 705–728, pls. 25–26 in: J. Franklin, Narrative of a journey to the shores of the Polar Sea, in the years 1819, 20, 21 and 22 [...] with an appendix on various subjects relating to science and natural history. Murray, London.
- ROMANOV, V.I. (2002): Morphofenetic features of some subspecies of Siberian grayling in areas of their sympathy. Evolutionary biology. T.2. Materials of the II International Conference «The Problem of Species and speciation» Tomsk, 24–26 October. 2001. Tomsk: Publishing TSU, pp, 268–288; 402, 403. [In Russian].
- ROMANOV, V.I. (2004): Some specific features of variation of morphological characters in the western Arctic grayling *Thymallus arcticus* (Pallas). In: Proceedings of III International Conference on “Problems of species and species formation”. Tomsk. Vestnik Tomsk State University, 10 (Suppl.), pp. 107–111.[In russian].
- ROMANOV, V.I. (2005): Fauna, systematics and biology of fishes in the conditions of lakes and rivers hydrosystems of the southern Taimyr. Ph.D. Thesis. Tomsk. 44 pp. [In Russian].
- ROMANOV, V. I. (2007): About the status of the west Siberian subspecies of the Siberian grayling (*Thymallus arcticus arcticus*): an analysis of some meristic characters. In: Studies on ichthyology and allied disciplines in inland water bodies at the beginning of the 21st century (on the 80th anniversary of Professor L. A. Kudersky). Sbornik nauchnykh trudov GosNIORKh. – V. 337. Moscow–St. Petersburg: Scientific Press «KMK», pp. 436–452. [In Russian].
- ROMANOV, V. I. (2009a): Features of the distribution and structure of grayling fish (Thymallidae) of the basins of the Yenisei River and Lake Baikal. Problems and prospects for the use of aquatic biological resources of Siberia in the XXI century. Materials of the All–Russian Conference. Krasnoyarsk, pp. 52–58. [In Russian].
- ROMANOV, V. I. (2009b): On the question of taxonomic status of graylings from the upper Ob’ River and upper Yenisei River (Thymallidae). In: Babina S. G. (Ed.), Materials of the regional scientific conference devoted to the 20 anniversary of reserve on September, 16–18th 2009. Kemerovo: Publishing House “Asia”, pp. 85–91. [In Russian].
- ROMANOV, V. I. (2017): On the taxonomic composition of the graylings (Thymallidae) from the Ob and Yenisei River basins. International Journal of Environmental Studies, 74 (5): 845–853.
- ROMANOV V. I., INTERESOVA E.A., DYLDIN YU. V., BABKINA I.B., KARMANOVA O.G. & VOROBIEV D.S. (2017): An annotated list and current state of ichthyofauna of the Middle Ob River basin. International Journal of Environmental Studies, 74 (5): 818–830.
- ROMANOV, V. I., LAVRENTIEV, S. YU.& DYLDIN, YU. V. (2016): On the morphology of the Siberian grayling (*Thymallus arcticus* (Pallas)) dwelling in the Kazim River basin (Lower Ob River). Surgut State University Bulletin 3 (13): 37–42. [In Russian].
- ROMANOV, V. I., PETLINA, A.P., KARMANOVA, O.G. & BABKINA, I.B. (2011): Current state of ichthyofauna in Tom River basin. Tomsk State Pedagogical University Bulletin 8:

102–108.

- SAFRONOV, S.N. (2009): Species diversity, knowledge and monitoring of rare and endangered Salmoniformes fish of Sakhalin Island. Journal “News of Irkutsk State University”. Series «Biology, Ecology» 2009, 2: 51–54. [In Russian].
- SAFRONOV, S.N., JUL'KOV, A.I., NIKITIN, V.D. & LEJINSKII, S.N. (2003): Taxonomic position of grayling (genus *Thymallus*) from Sakhalin waters and right-bank the Lower Amur tributaries. Vladimir Ya. Levanidov's Biennial Memorial Meetings, Vladivostok, Dalnauka, 2: 355–367. [In Russian].
- SAFRONOV, S.N., ZHUL'KOV, A.I. & NIKITIN, V.D. (2001): Distribution and Biology of Amur grayling (*Thymallus grubii* Dybowski, 1869) in Sakhalin. Vladimir Ya. Levanidov's Biennial Memorial Meetings, Vladivostok, Dalnauka, 1: 269–276. [In Russian].
- SEMENCHENKO, A.A. (2013): Phylogeny and mechanisms of formation of areas graylings of the Amur River basin (genus *Thymallus*, Salmonidae). Ph.D. Thesis. Vladivostok, 22 pp. [In Russian].
- SEMENCHENKO A.A. & ATOPKIN D.M. (2012): A comparative analysis of the far Eastern grayling species *Thymallus tugarinae* and *Thymallus grubii flavomaculatus* based on the data from mitochondrial DNA cytochrome b gene sequencing. Biologiya Morya 38(7): 520–528. [In Russian].
- SHEDKO, S.V. (2001): The list of cyclostomes and fresh water fishes of the Primor'e coast. Vladimir Ya. Levanidov's Biennial Memorial Meetings, Vladivostok, Dalnauka, 1: 229–249. [In Russian].
- SHEDKO, S.V., MIROSHNICHENKO, I.L. & NEMKOVA G.A. (2013): Phylogeny of salmonids (Salmoniformes: Salmonidae) and its molecular dating: analysis of mtDNA data. Genetika 49: 718–734. [In Russian].
- SHEIKO, B.A. & FEDOROV, V.V. (2000): Chapter 1. Class Cephalaspidomorphi – Lampreys. Class Chondrichthyes – Cartilaginous fishes. Class Holocephali – Chimaeras. Class Osteichthyes – Bony fishes. In: Moiseev R.S. & Tokranov A.M. (Eds.), Catalog of vertebrates of Kamchatka and adjacent waters. Petropavlovsk–Kamchatsky: Kamchatsky Pechatny Dvor, pp. 7–69. [In Russian].
- SLYNKO, YU.V., MENDSAYKHAN, B. & KAS'ANOV, A.N. (2010): On intraspecies forms of the Mongolian grayling (*Thymallus brevirostris* Kessl.) from Hoton Nur Lake (western Mongolia). Voprosy Ikhtiologii 50: 32–41. [In Russian].
- SUN, J.–X. & MA, B. (2011): Genetic differentiation and taxonomic status of three species in grayling *Thymallus* in Huma River by microsatellite analysis. Chinese Journal of Fisheries, 24(1): doi: 10.3969/j.issn.1005–3832.2011.01.004
- SUŠNIK, S., SNOJ, A. & DOVČ, P. (2001): Evolutionary distinctness of grayling (*Thymallus thymallus*) inhabiting the Adriatic river system, as based on mtDNA variation. Biological Journal of the Linnean Society 74: 375–385.
- SVETOVIDOV, A.N. (1931): Material on systematics and biology of graylings of Lake Baikal. Travaux de la Station Limnologique du Lac Baikal [= Trudy Baikal'skoi limnologicheskoi stantsii], 1: 19–199, pls. 1–4. [In Russian].
- SVETOVIDOV, A.N. (1936): European–Asiatic graylings (genus *Thymallus* Cuvier). Trudy of the Institute of Zoology Akad. Nauk SSSR, 3: 183–301. [In Russian].
- SWATDIPONG A., PRIMMER C.R. & VASEMÄGI A. (2010): Historical and recent genetic bottlenecks in European grayling, *Thymallus thymallus*. Conservation Genetics 11: 279–292.
- TOKRANOV, A.M. & SHEIKO, B.A. (2006): Fishes. In: Tokranov, A.M. (Ed.), Red data

- book of Kamchatka. Vol. 1. Animals. Petropavlovsk–Kamchatsky: Publishing house «Kamchatsky Pechatny Dvor», pp. 33–89. [In Russian].
- TSOGTSAIKHAN, P., MENDSAIKHAN, B. & JARGALMAA, G. et al. (2017): Age and growth comparisons of Hovsgol grayling (*Thymallus nigrescens* Dorogostaisky, 1923), Baikal grayling (*T. baicalensis* Dybowski, 1874), and lenok (*Brachymystax lenok* Pallas, 1773) in lentic and lotic habitats of Northern Mongolia. *Journal of Applied Ichthyology* 33(1): 108–115.
- TUGARINA, P.YA. (1981): Grayling of the Lake Baikal. [=Hariusy Bajkala]. Novosibirsk: Izdatel'stvo «Nauka», 281 pp. [In Russian].
- TUGARINA, P.YA. (2001): Graylings fishes (Thymallidae) of largest lakes of the Central Asia [=Hariusovye ryby (Thymallidae) krupnejshih ozer Central'noj Azii]. *Trudy kafedry zoologii pozvonochnyh. Irkutsk State University*, 1: 114–127. [In Russian].
- TUGARINA, P.YA. (2002): Ecology fish Lake Hovsgol and their fishery potential. Irkutsk: Publishing Irkutsk University, 209 pp. [In Russian].
- TUGARINA, P.YA. & KHRAMTSOVA, V.S. (1980): Morphophysiological characteristic of the Amur grayling *Thymallus grubei* Dyb. *Voprosy Ikhtiologii* 20: 590–605. [In Russian].
- TUGARINA, P.YA. & KHRAMTSOVA, V.S. (1981): On the Ecology of the Amur Grayling *Thymallus grubei* Dyb. *Voprosy Ikhtiologii* 21: 209–222. [In Russian].
- VAN DER LAAN, R., ESCHMEYER, W.N. & FRICKE, R. (2014): Family–group names of Recent fishes. *Zootaxa Monograph* 3882, 1: 1–230.
- VOKIN, A.I., SEDYKH, T.N. & SATDAROVA, L.R. (2007): Peculiarities of biology of Baikal–Lena grayling *Thymallus arcticus baicalolenensis* (Salmoniformes, Thymallidae) from mountain water bodies in upper reaches of Mama River (Vitim–Lena basin). *Bulletin of the East Siberian Scientific Center SB RAMS*. 2007, 2(54): supplement, 20–25. [In Russian].
- WEISS, S.J., KNIZHIN, I.B., KIRILLOV, A. & FROUFE, E. (2006): Phenotypic and genetic differentiation of two major phylogeographical lineages of Arctic grayling *Thymallus arcticus* in the Lena River, and surrounding Arctic drainages. *Biological Journal of the Linnean Society* 88: 511–525.
- YASUIKE, M., JANTZEN, S. & COOPER, G.A. et al. (2010): Grayling (Thymallinae) phylogeny within salmonids: complete mitochondrial DNA sequences of *Thymallus arcticus* and *Thymallus thymallus*. *Journal of Fish Biology* 76 (2): 395–400.
- ZINOV'EV, E.A. & BOGDANOV, V.D. 2012: On the distribution of the European and Siberian graylings in the Urals. *Agrarian Herald of the Urals* [=Agrarnyy vestnik Urala], 4(96): 42–44. [In Russian.]
- ZADELENOV, V.A. & GULIMOV, A.V. (2000): On the sympatric populations of grayling in the middle reaches of the Yenisei River. In: *The problem of species and speciation. Abstracts of the report I International Conference*. Tomsk: TSU Publishing, pp. 57–58. [In Russian].