



# Syntaxonomic notes on the order *Ledo palustris*–*Laricetalia* (Siberian boreal cryo-mesophilous larch forests): validation and description

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## ABSTRACT

Validation and description of new syntaxa of the boreal light coniferous forests of North Asia in the Braun-Blanquet system was carried out in accordance with the latest 4th edition of the International Code of Phytosociological Nomenclature. These are the alliance *Ledo palustris*–*Laricion cajanderi* Ermakov **all. nov.** and the order *Ledo palustris*–*Laricetalia cajanderi* Ermakov **ord. nov.** For all these syntaxa, the diagnostic species, peculiarities of ecology and phytocenotic structure, as well as geographical area are indicated. Prodrum of the validated order *Ledo palustris*–*Laricetalia cajanderi* is represented.

**Keywords:** syntaxonomy, light-coniferous forests, validation, syntaxa, Braun-Blanquet, Siberia

## РЕЗЮМЕ

Ермаков Н.Б. Синтаксономические заметки о порядке *Ledo palustris*–*Laricetalia* (сибирские бореальные криомезофильные лиственничные леса): валидизация и описание синтаксонов. Выполнена валидизация и дана характеристика синтаксонов бореальных светлохвойных лесов Северной Азии в системе Браун-Бланке: союза *Ledo palustris*–*Laricion cajanderi* Ермаков **all. nov.** и порядка *Ledo palustris*–*Laricetalia cajanderi* Ермаков **ord. nov.** в соответствии с последним 4-м изданием Международного кодекса фитоценологической номенклатуры. Для всех единиц указаны диагностические признаки, особенности экологии и фитоценотической структуры, а также распространение. Приведен современный Продромус единиц валидизированного порядка *Ledo*–*Laricetalia cajanderi*.

**Ключевые слова:** синтаксономия, светлохвойные леса, валидизация, синтаксоны, Браун-Бланке, Сибирь

At present, the classification of the boreal forests of Northern Asia (the class *Vaccinio–Piceetea* Br.-Bl. in Br.-Bl. et al. 1939 in the Braun-Blanquet system) is based on a rather well-developed higher units system representing all zonal and geographical vegetation types. However, for various reasons, not all names of these syntaxa have been validly published in accordance with the International Code of Phytosociological Nomenclature (ICPN) (Theurillat et al. 2021) and not all descriptions of syntaxa were completed. In particular, some syntaxa of light-coniferous boreal forests from Siberia – the alliance *Ledo palustris*–*Laricion cajanderi* Ermakov in Ermakov et Alsynbayev 2004 and the order *Ledo palustris*–*Laricetalia cajanderi* Ermakov in Ermakov et Alsynbayev 2004 were published invalidly in Ermakov et al. (2002) and in Ermakov & Alsynbayev (2004). This paper aims to validate syntaxa of the Siberian light-coniferous forests in accordance with the ICPN (Theurillat et al. 2021) and provides ecological, phytocenotic and geographical characteristics.

The materials from publications where the previously described order name '*Ledo palustris*–*Laricetalia cajanderi*' and subordinated units were used for the nomenclatural analysis. Checking the correctness of the syntaxa names and their validation was carried out in accordance with the 4th edition of the International Code of Phytosociological Nomenclature (ICPN) (Theurillat et al. 2021). I followed Czerepanov (1995) and Ignatov et al. (2006) in vascular plants and bryophytes taxonomy.

Ass. *Ledo palustris*–*Laricetum cajanderi* Ermakov, Cherosov et Gogoleva 2002

This is the central association of the alliance *Ledo palustris*–*Laricion cajanderi* and its nomenclature type (holotypus). It was typified with one relevé chosen as “nomenclature type” (without *ex pressis verbis* ‘holotypus’) in Ermakov et al. (2002). However, this association name was validly published since before 1 January 2021, when the original diagnosis contained only one single validly published element, the Latin word “*typus*” was not mandatory to designate the type [Art. 5a, ICPN].

**Diagnostic species** are *Anacamnum palustre*, *Carex globularis*, *C. ijimii*, *C. pallida*, *Larix cajanderi*, *Ledum palustre*, *Polytrichum commune*, *Sphagnum girgensohnii*, *S. warnstorffii*, *Tomentypnum nitens* and *Vaccinium uliginosum*. The *Ledo palustris*–*Laricetum cajanderi* occurs in the Central Yakutian Plain (Eastern Siberia) and includes mesophilous larch forests of cool, often water-logged soils. They are confined to wide depressions on watersheds and higher river terraces, with permafrost at a depth of 10–30 cm. The characteristic feature of the sites is uneven micro-relief related to local thermokarst phenomena. *Larix cajanderi* is the single dominant of the tree layer, showing lower cover values of 25–55 %. The low shrub layer has a cover 5–10 %, being formed by *Duschekia fruticosa*, *Rosa acicularis*, *Salix myrtilloides*, and the dwarf shrubs *Vaccinium uliginosum* and *Ledum palustre*. The herb layer has a cover 30–50 % and low species-richness – 9–17 species per 100 m<sup>2</sup>. Uneven micro-relief supports some dry-resistant plants occupying tops of small knolls. The moss layer is well developed (cover values 70–90 %) and represented by mosses such as *Anacamnum palustre*, *A. turgidum*, *A. acuminatum*, *Polytrichum juniperinum*, *Sphagnum girgensohnii*, *S. warnstorffii*,

*S. fuscum* and *Tomenthypnum nitens*. Lichens, *Cladonia stellaris*, *C. rangiferina*, *C. arbuscula*, *Cetraria islandica*, *Peltigera aphthosa* and *P. canina*, occur predominantly at the tops of small knolls.

Ass. ***Carici iljinii–Laricetum sibiricae*** Ermakov in Ermakov et Alsynbayev 2004

The association name was typified with one relevé chosen as “nomenclature type” (without *exspresso* ‘holotypus’) in Ermakov et Alsynbayev (2004). However, this association name was validly published because original diagnosis contained only one single published element [Art. 5a, ICPN]. **Diagnostic species** of this association are *Pinus sibirica*, *Calamagrostis obtusata*, *Poa sibirica*, *Carex iljinii*, *Luzula alpino-pilosa*. These larch-pine (*Larix sibirica*, *Pinus sibirica*) boreal coniferous forests are widespread in the southern part of the Western Sayan Mts (Southern Siberia) with ultra-continental climate where they form an upper part of the forest belt at altitudes of 1600–1900 m.

***Ledo palustris–Laricion cajanderi*** Ermakov **all. nov.**

This alliance name was originally represented in the paper by Ermakov et al. (2002) as provisional syntaxon. Later, Ermakov in Ermakov & Alsynbayev (2004) described it as a new higher unit. The association *Ledo palustris–Laricion cajanderi* Ermakov et al. 2002 was chosen as “nomenclature type” (without *exspresso* ‘holotypus’) of this alliance. However, in the text of this paper, another validly published association *Carici iljinii–Laricetum sibiricae* Ermakov in Ermakov et Alsynbayev 2004 was assigned (as a result of a technical error) to this alliance as well. Neither of these two units was pointed as “holotypus”, so the name *Ledo palustris–Laricion sibiricae* Ermakov in Ermakov et Alsynbayev 2004 **nom. inval.** [Art. 5a, ICPN] was published invalidly. Therefore, now I validate the description of the alliance *Ledo palustris–Laricion cajanderi* Ermakov **all. nov.** (*hoc loco*) by re-assigning the association *Ledo palustris–Laricion cajanderi* Ermakov, Cherosov et Gogoleva 2002 (Ermakov, Gogoleva, Cherosov 2002, p. 440) as the **Typus (holotypus)** *hoc loco* of this alliance. Diagnostic species of the *Ledo palustris–Laricion cajanderi* are *Arctagrostis latifolia*, *Aulacomnium acuminatum*, *Calamagrostis lapponica*, *Duschekia fruticosa*, *Equisetum pratense*, *Pedicularis labradorica*, *Polytrichum jensenii* and *Salix myrtilloides*. It includes larch forests widespread in the watersheds of the Central Yakutian plain where they occupy shallow depressions with cold shallow soils on permafrost.

All. ***Pino sibiricae–Laricion sibiricae*** Ermakov in Ermakov et Alsynbayev 2004

The alliance name *Pino sibiricae–Laricion sibiricae* Ermakov in Ermakov et Alsynbayev 2004 was validly published in Ermakov & Alsynbayev (2004) because it was typified with one validly published association *Carici iljinii–Laricetum sibiricae* Ermakov in Ermakov et Alsynbayev 2004. The diagnostic species of the alliance are *Larix sibirica*, *Pinus sibirica*, *Calamagrostis obtusata* and *Cerastium pauciflorum*. This alliance includes larch (*Larix sibirica*) and pine (*Pinus sibirica*) mixed forests widespread in the continental and ultra-continental regions of Western Siberia, Southern Siberia and Northern Mongolia where they occur on humid long-frozen soils.

However there is a homonym of this alliance – the *Pino sibiricae–Laricion sibiricae* Guinochet ex Dostalek et al. 1988 **nom. dub.** [Art. 37; ICPN] published invalidly in Dostalek et al. (1988). Guinochet (1982) characterizing boreal coniferous forests from southern Siberia published the association *Rhododendro–Pinetum sibiricae* Guinochet 1982 which was represented by two relevés (Guinochet 1982, table 1). The name of this association was not validly published because neither of the two relevés was chosen as a nomenclature type [Art. 5; ICPN]. However, there is another important reason why the name of this association should be rejected. The species

composition of relevés in table 1 in Guinochet (1982) is so incomplete that it makes it impossible to use them in syntaxonomic analysis. Guinochet (1982) indicated that the cover of the moss layer in relevé 1 in table 1 is 100 % however no species of bryophytes or lichens were given. In fact, in this floristically poor forest community (only 12 species of vascular plants are indicated), there is no information on the species composition of the main (according to the cover value) moss-lichen layer. As a result, the floristic composition of this community of coniferous forests was characterized so incompletely that it made it impossible to correctly interpret it syntaxonomically at the level of association, alliance, order, and even class. Therefore, the name of the association *Rhododendro–Pinetum sibiricae* Guinochet 1982 **nom. inval.** was also invalidly published in accordance with Art. 37 of the ICPN. This conclusion is very important because later Dostalek et al. (1988) made an unsuccessful attempt to validate the association *Rhododendro–Pinetum sibiricae* Guinochet ex Dostalek et al. 1988 **nom. dub.** [Art. 37; ICPN] choosing the floristically extremely incomplete relevé 1 from table 1 of Guinochet (1982) as the lectotype. In the same publication, Dostalek et al. (1988) made an unsuccessful attempt to describe the new alliance *Pino sibiricae–Laricion sibiricae* Guinochet ex Dostalek et al. 1988 **nom. inval.** [Art. 5a, Art. 17; ICPN] because they chose the invalidly described association *Rhododendro–Pinetum sibiricae* Guinochet ex Dostalek et al. 1988 **nom. dub.** as its nomenclature type.

***Ledo palustris–Laricetalia cajanderi*** Ermakov **ord. nov.**

The order *Ledo palustris–Laricetalia cajanderi* Ermakov in Ermakov et Alsynbayev 2004 **nom. inval.** [Art. 5a, Art. 17; ICPN] was invalidly published in Ermakov & Alsynbayev (2004) because the invalidly published (in the same paper) alliance *Ledo palustris–Laricion cajanderi* Ermakov in Ermakov et Alsynbayev 2004 **nom. inval.** [Art. 5a; ICPN] was selected as the ‘Nomenclature type’ of the order. Therefore, now I validate the *Ledo palustris–Laricetalia cajanderi* Ermakov **ord. nov.** (*hoc loco*). The alliance *Ledo palustris–Laricion cajanderi* Ermakov **all. nov.** (validated in this paper) is chosen as the **Typus (holotypus)** *hoc loco* of this order.

Diagnostic species of the order *Ledo palustris–Laricetalia cajanderi* are *Aulacomnium palustre*, *A. turgidum*, *Carex globularis*, *C. iljinii*, *C. pallida*, *Empetrum nigrum*, *Ledum palustre*, *Polytrichum commune*, *Sphagnum girgensohnii*, *S. warnstorffii*, *S. fuscum*, *Tomentypnum nitens* and *Vaccinium uliginosum*. The *Ledo–Laricetalia cajanderi* forests occur in the ultra-continental bioclimatic sector of Northern Asia where they are related to north- and middle-boreal subzones and to the higher part of the forest belt in the mountains of Southern Siberia and Mongolia. Everywhere they are confirmed to permafrost or to the sites with wet, long-frozen soils.

## CONCLUSIONS

The order *Ledo–Laricetalia cajanderi* is one of the key higher units of boreal forests because it represents zonal light-coniferous boreal forests widespread in the north- and middle-boreal subzones of Northern Asia and adjacent areas of North-Eastern Europe. At present, it includes four alliances, 22 associations and 4 subassociations. The Prodromus of this order is as follows:

Ord. ***Ledo palustris–Laricetalia cajanderi*** Ermakov **ord. nov.** (syn.: *Ledo palustris–Laricetalia cajanderi* Ermakov in Ermakov et Alsynbayev 2004 **nom. inval.** [Art. 5a, Art. 17; ICPN])

All. ***Ledo palustris–Laricion cajanderi*** Ermakov **all. nov.** (syn.: *Ledo–Laricion cajanderi* Ermakov in Ermakov et Alsynbayev 2004 **nom. inval.**) [Art. 5a, Art. 17; ICPN])

- Ass. *Ledo palustris–Laricetum cajanderi* Ermakov, Cherosov et Gogoleva 2002
- Ass. *Moebingio lateriflorae–Laricetum gmelinii* Anenkhonov in Anenkhonov et Chytry 1998
- Ass. *Aconito ranunculoidis–Laricetum cajanderi* Ermakov in Krestov, Ermakov, Osipov et Nakamura 2009
- Ass. *Salici krylovii–Laricetum cajanderi* Krestov in Krestov, Ermakov, Osipov et Nakamura 2009
- Ass. *Chamaedaphno calyculatae–Laricetum cajanderi* Krestov in Krestov, Ermakov, Osipov et Nakamura 2009
- Ass. *Carici pallidi–Laricetum gmelinii* Krivobokov 2012 prov.  
 Subass. *C. p.–L. g. typicum* Krivobokov 2012 prov.  
 Subass. *C. p.–L. g. festucetosum ovinae* Krivobokov 2012 prov.
- All. *Pino sibiricae–Laricion sibiricae* Ermakov in Ermakov et Alsynbayev 2004
- Ass. *Linnaeo borealis–Pinetum sibiricae* Ermakov et Polyakova 2022
- Ass. *Carici iljinii–Laricetum sibiricae* Ermakov in Ermakov et Alsynbayev 2004
- Ass. *Carici iljinii–Pinetum sibiricae* Ermakov 2014
- Ass. *Bergenio–Pinetum sibiricae* Zhitlukhina et Alimbekova 1987
- Ass. *Bergenio crassifoliae–Laricetum sibiricae* Makunina 2011
- Ass. *Calamagrostio obtusatae–Laricetum sibiricae* Chytry, Anenkhonov, Danihelka, Unal et Valachovic in Anenkhonov et Chytry 1998
- Ass. *Melampyro pratense–Laricetum sibiricae* Ermakov et Makhatkov 2011
- Ass. *Ledo palustris–Pinetum sibiricae* Ermakov et Makhatkov 2011
- Ass. *Vaccinio uliginosi–Laricetum sibiricae* Makunina 2020
- All. *Cladonio stellaris–Laricion gmelinii* Anenkhonov et Chytry 1998
- Ass. *Vaccinio uliginosi–Laricetum gmelinii* Anenkhonov in Anenkhonov et Chytry 1998
- Ass. *Maianthemo bifolii–Pinetum sibiricae* Danihelka, Anenkhonov, Chytry et Pesout in Anenkhonov et Chytry 1998
- Ass. *Rhododendro parvifolii–Laricetum cajanderi* Ermakov, Nikolin, Troeva et Cherosov 2010
- Ass. *Flavocetrario nivalis–Laricetum cajanderi* Ermakov, Nikolin, Troeva et Cherosov 2010
- All. *Rhododendro aurei–Laricion cajanderi* Krestov et Ermakov in Krestov, Ermakov, Osipov et Nakamura 2009
- Ass. *Geranio albiflori–Laricetum gmelinii* Ermakov in Krestov, Ermakov, Osipov et Nakamura 2009
- Ass. *Sanguisorbo stipulatae–Laricetum cajanderi* Krestov et Osipov in Krestov, Ermakov, Osipov et Nakamura 2009
- Ass. *Rhododendro aurei–Piceetum jezoensis* Krestov et Nakamura 2002  
 Subass. *Rh.a.–Pj. typicum* Krestov, Ermakov, Osipov et Nakamura 2009  
 Subass. *Rh.a.–Pj. calamagrostetosum lapponicae* Krestov, Ermakov, Osipov et Nakamura 2009
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