Arctoa (1999) **8**: *59-68*

TWO NEW MOSS TAXA FROM THE BUREYA RIVER, RUSSIAN FAR EAST

ДВА НОВЫХ ТАКСОНА МХОВ ИЗ БАССЕЙНА БУРЕИ, ДАЛЬНИЙ ВОСТОК

M. S. IGNATOV[1], E. A. IGNATOVA[2], Z. IWATSUKI[3], B. C. TAN[4]

М. С. ИГНАТОВ[1], Е. А. ИГНАТОВА[2], Д. ИВАТЗУКИ[3], Б. Ч. ТАН[4]

Abstract

The studies of extensive collections from the Upper Bureya River reveal two mosses which are describing. *Zygodon sibiricus* is close to *Z. rupestris*, but differ in presence of single peristome. It is widespread throughout the South Siberia and Russian Far East. *Actinothuidium hookeri* ssp. *boreale* differs from *A. hokeri* ssp. *hookeri* (widespread in Himalayas and Southern China) in longer leaves and the presence of central strand. This subspecies occurs in Russian Far East, North-East China (Heilongjang), Korea and Central China (Kansu and Quinhai).

Резюме

Изучение коллекций мхов, собранных в верхнем течении р. Бурея, выявило два не описанных ранее таксона мхов. *Zygodon sibiricus* близок *Z. rupestris*, но отличается наличием простого перистома. Этот вид широко распространен на юге Сибири и Дальнего Востока. *Actinothuidium hookeri* ssp. *boreale* встречается на Дальнем Востоке России в Хабаровском крае, а также в северо-восточном Китае (Хейлуньцзян), Корее и Центральном Китае (Ганьсу и Цинхай). Он отличается от *A. hokeri* ssp. *hookeri* (широко распространен в Гималаях и южном Китае) более длинными листьями и наличием в стебле центрального пучка.

The upper course of Bureya River is an interesting place in phytogeographical respect, being a northern limit of many temperate species. After a preliminary study (Ignatov & al., 1990) ca. 200 species were found here, and one of them, *Cryphaea amurensis* Ignatov, was described as a new for science (Ignatov & Cherdantseva, 1995). So, in 1997 three of us (Ignatov, Iwatsuki and Tan), undertook another field trip to this area and collected many interesting mosses, the account if which will be published separately. Two of them were found to be undescribed and they are discussed below.

Zygodon sibiricus sp. nova

A species proxima *Z. rupestris* capsulis peristomaticis differt.

Holotype: Khabarovsk Territory, Verkhnebureinskij Distr., Bureinskij State Reserve, Levaya Bureya River near Kuraigagna Creek mouth. 51°58'N — 134°53'E, 840 m alt. 21 August 1997 *Ignatov,* 97-1256 (MHA).

Plants small, yellow-green to brownish, growing as low tufts on tree trunks. Stem 3-10(15) mm long, 1-2 times dichotomously branching. Leaves in five spiral rows, erect when dry, reflexed when wet, 0.9-1.3(-1.45) x 0.25-0.35(-4.7) mm, distinctly keeled, elongate, acute, apex blunt to apiculate, margin entire, plane or recurved at places; costa to 0.8-0.95 of leaf length, 30-45 mm at base. Laminal cells highly multipapillose, irregularly hexagonal, 8-12 mm, basal cells rectangular, smooth; in apiculate leaves few uppermost cells also smooth. Dioicous. Sporophytes in most of collections. Seta 5-8 mm long. Capsule to 2 mm long, straight and erect, somewhat furrowed when dry. Stomata superficial, round-pored. Peristome single, with no traces of inner peristome. Outer peristome teeth 16. Spores mostly 15-18 mm, brown-

[1] – Main Botanical Garden of Russian Academy of Sciences, Botanicheskaya 4, Moscow 127276 Russia – Россия 127276 Москва, Ботаническая 4, Главный ботанический сад РАН

[2] – Department of Geobotany, Biological Faculty, Moscow State University, Moscow 119899 Russia – Россия 119899, Москва, Московский университет, Биологический факультет, каф. геоботаники

[3] – Hattori Botanical Lab., Okazaki Branch, 10-3 Mutsuna-shin-machi, Aichi-ken 444 Japan

[4] – School of Bioogica. Sciences, Faculty of Science, The National University of Singapore, Singapore 119260

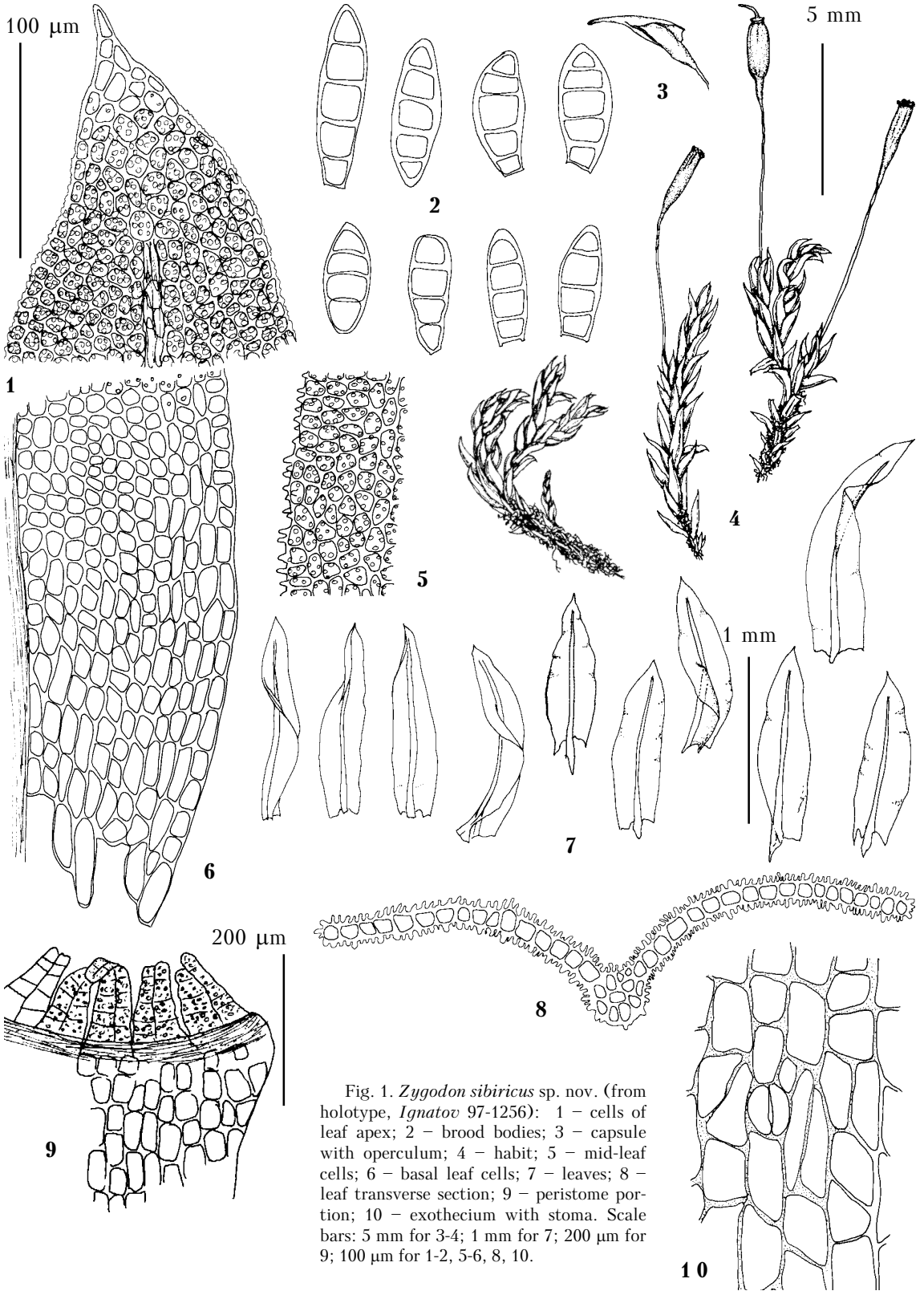


Fig. 1. *Zygodon sibiricus* sp. nov. (from holotype, *Ignatov* 97-1256): 1 – cells of leaf apex; 2 – brood bodies; 3 – capsule with operculum; 4 – habit; 5 – mid-leaf cells; 6 – basal leaf cells; 7 – leaves; 8 – leaf transverse section; 9 – peristome portion; 10 – exothecium with stoma. Scale bars: 5 mm for 3-4; 1 mm for 7; 200 μm for 9; 100 μm for 1-2, 5-6, 8, 10.

ish-green, low papillose in proximal surface and with fusing papillae in distal surface; ca. 10-20% spores smaller, (8-)11-13 mm, light-brownish, totally lacking green color, translucent, less papillose. Brood bodies abundant, axillary and on proximal part of upper surface of costa, brownish, with (3-)4-5(-6) uniseriate cells, elliptic, 20-30 x 50-84 mm.

Up to now a species of *Zygodon* widely distributed in South Siberia and Russian Far East was not completely described and correctly evaluated. Using European conception of *Zygodon*, Bardunov (1969) referred his Siberian collections to *Z. conoideus*, because he found that it has peristomate capsules.

Ignatov & Lewinsky-Haapasaari (1994) found that brood bodies in sterile collections from Altai are different from *Z. conoideus*, and also found that in the single available Bardunov's collection called "*Z. conoideus* c. fr." all capsules belong to *Orthotrichum* which is in admixture in that collection. Therefore Ignatov & Lewinsky-Haapasaari decided, that Siberian material is not really known with sporophytes and gametophytically indistinguishable from *Z. rupestris* Lor. and must be referred to this species.

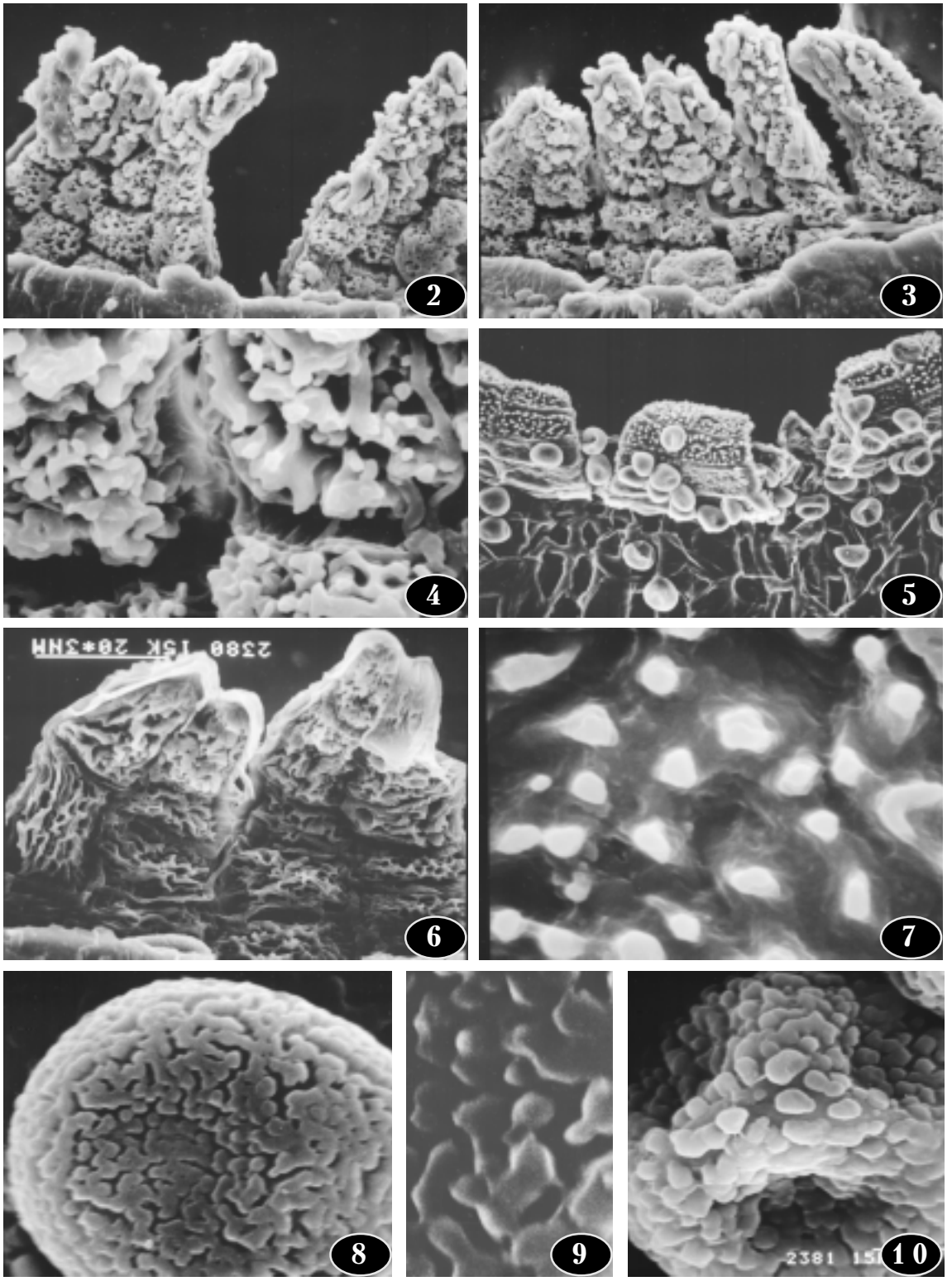
During the expedition to Bureya we have found *Zygodon* with capsules in many places. Most capsules have peristome though the latter is very rarely well-preserved, because capsules were partly premature, partly too old. Probably spores are maturing late in the autumn. Fortunately we were able to study perfectly preserved peristomes from several capsules. The peristome is single, with teeth relatively short and blunt. The inner surface is papillose (except 1-3 lowermost plates), the outer surface below has high branched papillae fusing with each other and forming reticulum; above papillae are simple but they are often covered by the additional material, or properistome, which looks as irregular blocks above papillae (Figs. 1-10).

In one Bardunov' collection from Baikal area we found later nicely preserved capsules with similar peristome, only little different in lacking heavy blocks in upper parts of teeth. However complete absence of inner peristome and similar ornamentation on both inner and outer surfaces (Figs. 11-12), as well as gametophytic similarity, make us sure that these plants belong to the same species. Therefore it can be assumed, that *Z. sibiricus* is widespread in the South Siberia and Russian Far East. Unfortunately, without capsules this species is virtually indistinguishable from *Z. rupestris*. This cause the problem of the western border of *Z. sibiricus* and eastern border of *Z. rupestris*. Other South Siberian material is likely belong to one species. The westernmost locality in South Siberia is in Altai Mts., and further westward sterile collections of *Zygodon* were made in central part of the Western Siberia (Lapshina & Muldiyarov, 1998) and Subarctic and Middle Urals (Dyachenko, 1997). At present we have no way to refer them to *Z. sibiricus* or *Z. rupestris*.

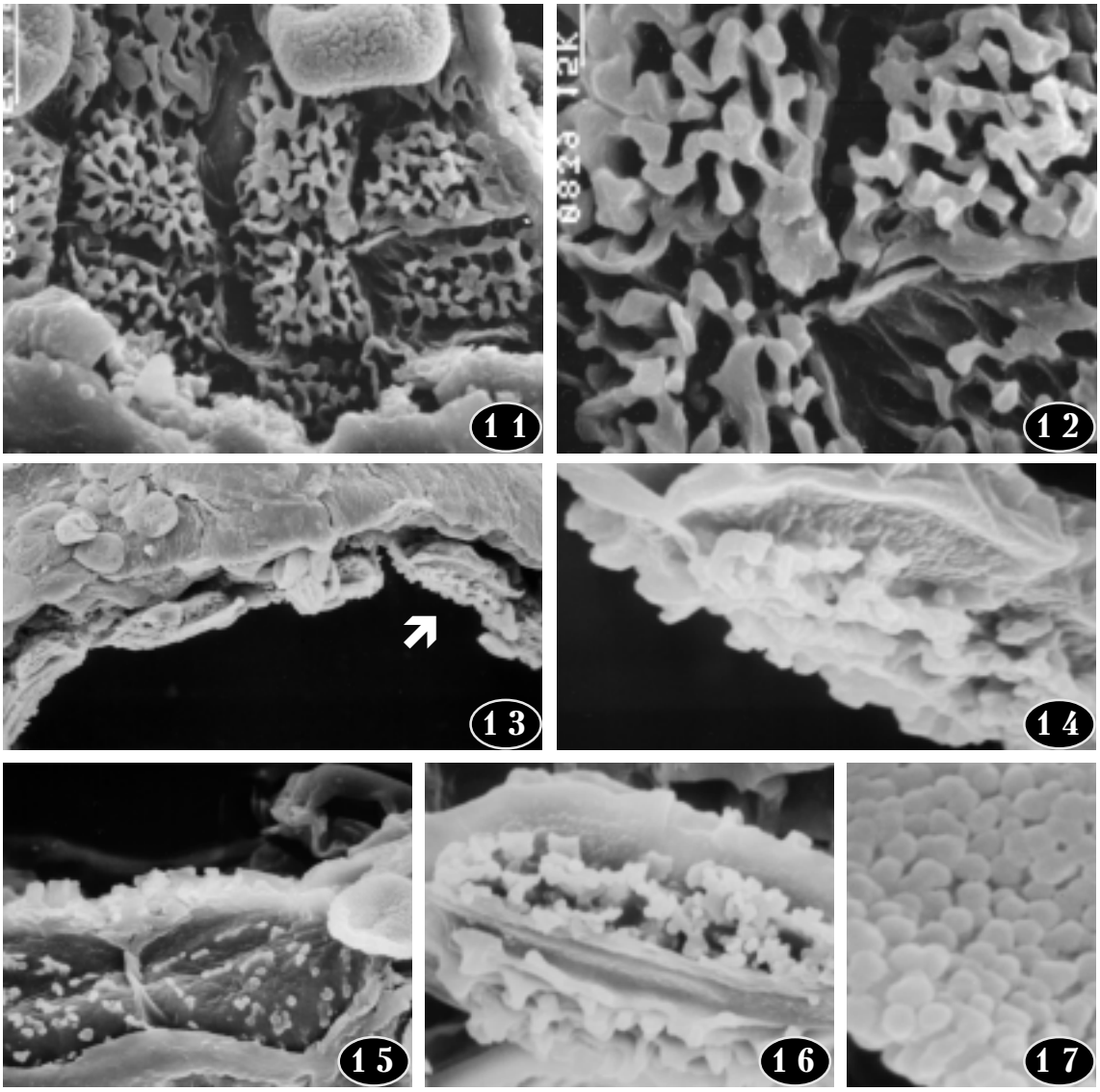
The latter species was described from Sweden, the lectotype (H-SOL!) is sterile (see also Karttunen, 1984). In European literature data on peristome of *Z. rupestris* are very scarce, because sporophytes are rarely produced, and also because until recently *Z. rupestris* was considered as a synonym or intraspecific taxa of *Z. viridissimus*, a species without peristome. Malta (1926) reported the absence of peristome for *Z. viridissimus* and thus (though not stated clearly) for all its varieties, including var. *vulgaris* Malta (= *Z. rupestris*). Duell (1985) mentioned nothing about peristome. Lewinsky-Haapasaari (1998, p. 376) describes its peristome as "absent or present as a low membrane only". Smith (1978) calls peristome of this species (under *Z. baumgartneri* Malta), as "absent or rudimentary". We were able to study only two collections from Europe with operculate capsules (collections with old opened capsules are not reliable, since peristome is broken very easily): 1) Schweiz, Val Crossa, 3.IV.1909 leg. Fuerbringer (H); 2.) Rom., Villa Doria Pamfila 3&6 April 1868, leg. Kiaer (H). In both no traces of peristome were seen. One collection from North America [USA, Washington, Ireland 8935, H, sub *Z. viridissimus*], also has no traces of peristome (all capsules open, but well preserved).

In Japan until recently only sterile *Zygodon rupestris* was known. Just few years ago Higuchi found plants with capsules in mountains in the Northern Honshu (Higuchi & Shimizu, 1996). Japanese plants are similar to *Z. sibiricus* in gametophytic characters, complete absence of inner peristome, and in similarly papillose inner surface of outer peristome; however they differ in more reduced very short teeth (Figs. 13-16), and also in spore size: most spores are 10-14 mm, and few are larger, 20-24 mm (vs. spores mostly 16-17 mm), and papillae on spore surface are more even, round and not fused (cf. figs. 8-10 & 17). Material available at present do not allow to decide if Japanese plants still belong to our new species or merit a recognition as a separate species; additional collections are needed for this answer.

Other members of the section *Euzygodon* C.



Figs. 2-10. *Zygodon sibiricus* sp. nov. (2-5, 7 – from holotype, *Ignatov* 97-1256; 6, 8-10 – from Lan Creek, *Petelin* 23.VIII.1989). 2-3 & 6 – exostome from outside, 700x, 700x, 1000x ; 4 – outer surface of tooth, 2650x; 5 – exostome from inside, 350x; 7 – inner surface of tooth, 5220x; 8-9 – distal surface of spore, 5100x, 13600x; 10 – proximal surface of spore 4150x.



Figs. 11-17. 11-12: *Zygodon sibiricus* sp. nov. (from Baikal Lake, Bardunov & Makryj 21.VI.1977); 13-17: *Zygodon sp*. (Japan, Higuchi, 27715). 11-12 – outer surface of tooth, 1800x, 4400x; 13 – peristome, 520x; 14 – outer surface of tooth (arrowed on fig. 13) with papillae, 2820x; 15 – tooth from inside, 1450x; 16 – tooth from its top (outer surface above), 1950x; 17 – spore, 10800x.

Mьll. (= sect. *Zygodon*) are more remote (cf. Malta, 1926). Most of dioicous species of this group lack peristome or have only narrow lanceolate "Zilien". The well developed outer peristome is known in several South American species (*Z. ochraceus* C. Mьll., *Z. brevipes* C. Mьll., *Z. fasciculatus* Mitt., *Z. jaffuelii* Thйr., *Z. sordidus* C. Mьll. and *Z. pilosulus* C. Mьll., *Z. bartramioides* (Dusen) Malta), South African *Z. runcinatus* C. Mьll. and Mexican *Z. campylophyllum* C. Mьll. All these species differ from *Z. sibiricus* in double peristome, short, usually 3-celled brood bodies, and usually large size. European *Z. gracilis* Wils. differs from *Z. sibiricus* in large plants (2-6 cm high) and double peristome. Amphiatlantic *Z. conoideus* (Dicks.) Hook. et Tayl. differs from *Z. sibiricus* in double peristome, smooth inner surface of exostome teeth and very peculiar brood bodies, usually 5-9 cells long and with pellucid cell walls nicely illustrated with photographs by Malta.

Zygodon sibiricus has been found on trunks of *Populus*, rarer *Betula* and *Salix* and on rocks.

SPECIMENS STUDIED (with capsules): **Khabarovsk Territory:** Bureya River: Ignatov 97-420a; 97-1254, 97-1255, 97-1270 (MHA); Iwatsuki 60546, 60646a, 60108, 60697 (NICH). Amgun River: Ukrainskaya 95-13 (MW). **Irkutsk Prov.**: Bardunov & Makryj 21.VI.1977 (MHA ex IRK).

Actinothuidium hookeri subsp. ***boreale*** subsp. nov. Figs.18, *1-2 & 5-8* and 19, *1-10*

Plantae robustae, caulibus ad 11 cm longus, pinnato ramosis, fasciculo centrali ad normo distincto, folia ramosa longa acuminata, ca. 2.5:1.

Typus: Khabarovsk Territory, Verkhnebureinsy Distr., Bureinsky State Reserve, Levaya Bureya River near Lan Creek mouth, on rotten stump, 25 August 1997, *Ignatov* 97-1283 (MHA, NICH, SINU).

Plants forming loose mats or growing among other species of forest carpet. Stem to 11 cm long, creeping to ascendent, regularly and densely pinnate (ca. 15 branches per 1 cm of stem), rarely sympodially branching; central strand 3-8-celled, cortical cells in 2-4 layers. Branches to 25 mm long, slightly flexuose. Paraphyllia numerous, 1 to 7 cells wide at base, narrow ones – irregularly pinnate; wider – lanceolate, coarsely serrate. Stem leaves (1.9-)2.2-2.8(-3.0) x 1.0-1.7 mm, triangular, cordate, rather gradually long acuminate, deeply plicate, margin revolute at places in lower part, coarsely serrate above, serrulate below. Median laminal cells 25-40 x 8 mm, basal cells wider in several rows, in leaf corners short-rhombic cells (15-20 x 6-8 mm) forming extensive groups usually reaching 2/3 of basal part of leaf. Branch leaves of upper branches 1.6-2.2 x (0.59-)0.7-0.95 mm, with ovate basal part and lanceolate acumen, the latter equal to little longer than basal part; branch leaves of lower branches with shorter upper part. Probably dioicous, no gametangia seen.

Actinothuidium hookeri ssp. *boreale* differs from *A. hookeri* var. *hookeri* in characters summarized in Tabl. 1, as well as in habit: in the former branches are wider are overlapping each other in upper part of stem, whereas in the latter branches are narrower and rather distant one from another.

There are two problems which do not allow us to segregate the northern population as a separate species: (1) sympodial shoots and imperfectly developed plants are considerably smaller (branches to 10 mm only) and leaves of such expressions from both subspecies are more overlapping than those of well-developed expressions, and they are difficult to interpret; (2) two collections from the Xizang Province are somewhat intermediate: they have a relatively long branch leaves, but branches are narrow and central strand is absent; at present we include Tibetan plants to the type subspecies, though further investigations may reconsider their position (in the list of specimens these are marked with asterisk).

Actinothiudium boreale was found by us in Upper Bureya in four places. Two localities were known previously at about 100-200 km from the type locality. All collections were done in conifer or mixed forests with *Abies* and *Picea* in flood valleys, among *Pleurozium schreberi* and *Hylocomium splendens*.

SPECIMENS STUDIED:

Actinothuidium hookeri ssp. boreale

RUSSIA: **Khabarovsk Territory**: Lan Creek *Ignatov* 97-1283; Umalta-Makit Creek *Ignatov* 97-309; *Iwatsuki* 60755; Shakhtinskij *Ignatov* 97-308; Cheppos Creek *Iwatsuki* 60051; Tyrma River *Vassil'ev* IX.1931 (LE); Upper course of Amgun River, Alkit Creek 25.VII.1951 (LE).

CHINA. **Heilongjiang**: Rclohezi *Gao Chien* 1590 (IFSBH, dupl. in NICH); Mulin *Gao Chien* 13449 (IFSBH, dupl. in NICH); **Kansu**: China bor., Weichang, Tung-kiayng-tze X.1899 *Palibin* (H-BR, LE); Cheibsen-khit [8-9000 feet] 30.VIII.1901 V. F. Ladyzhenskiy 513 (LE); **Qinghai**: [on label Kansu, to

Tabl. 1. Comparison of characters of two subspecies of *Actinothuidium hookeri*

Characters \ subspecies	ssp. *boreale*	ssp. *hookeri*
Stem length (well-developed plants), cm	7-11	13-18
Branch width of branches ca. 25 mm long, mm	1.5-2.0	1.0-1.2
Branch width of branches ca. 15 mm long, mm	1.2-1.5	0.9-1.0
Length of stem leaf	1.9-3.0	1.7-2.2
Length of branch leaf	1.6-2.2	0.9-1.4(1.7)
l:w ratio of branch leaf	1.9-3.6/2.4	1.6-2.4(2.6)/2.0
central strand	weak, rarely absent	absent

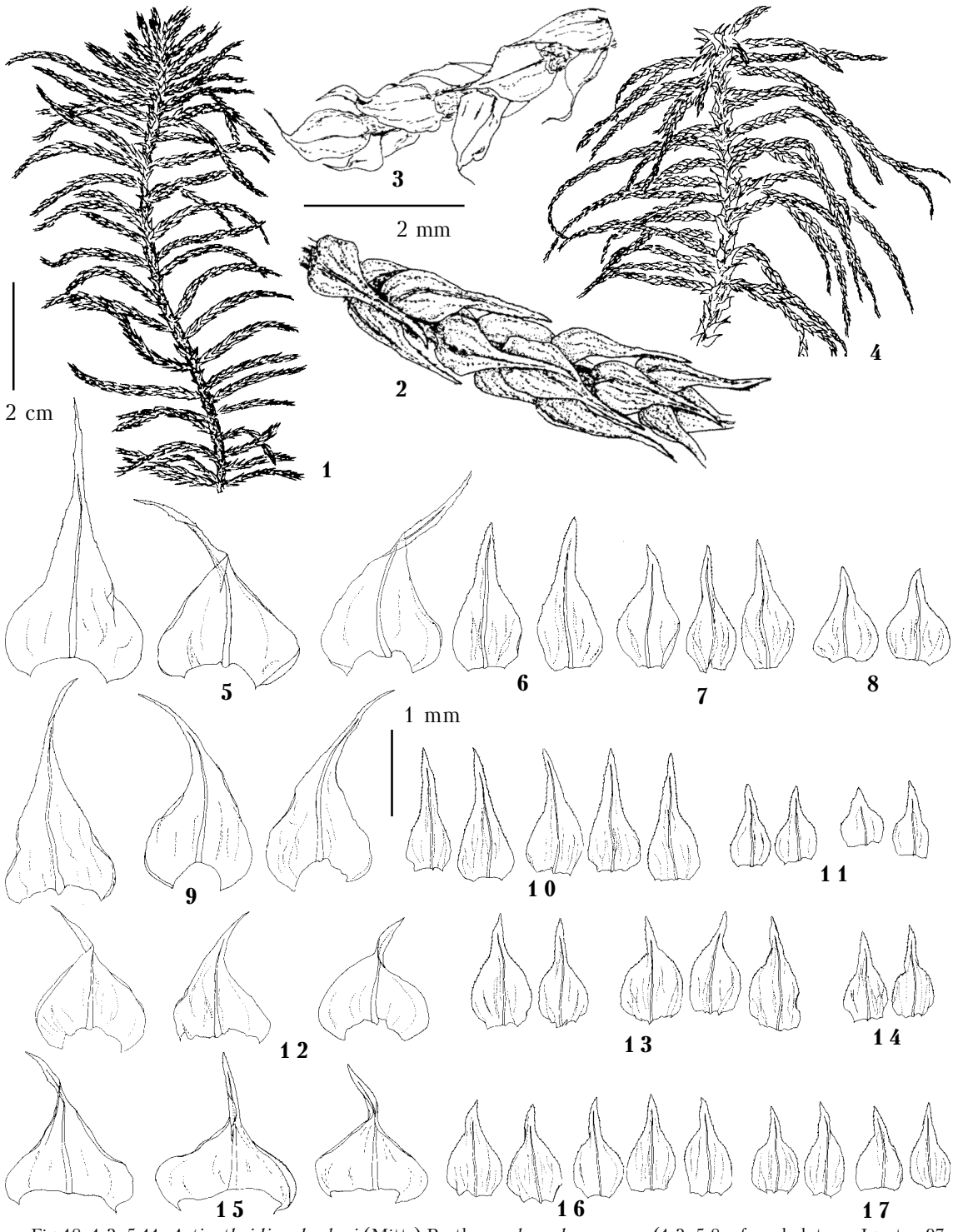


Fig.18. 1-2, 5-11: *Actinothuidium hookeri* (Mitt.) Broth. ssp. *boreale* ssp. nov. (1-2, 5-8 – from holotype, Ignatov 97-1283; 9-11 – from Przevalski 370); 4-3, 12-17: *A. hookeri* ssp. *hookeri* (3-4, 12-14 – from Sichuan, Exs. Mus. Vindobon. 2894; 15-17 – from Nepal, Kumaon, Hooker LE): 1,4 – habit; 2-3 – branch; 5, 9, 12, 15 – stem leaves; 6, 10, 13, 16 – branch leaves from upper branches; 7 – branch leaves from branch ca. 1 from stem top; 8, 11, 14, 17 – branch leaves from lower branches. Scale bars: 5 mm for 1, 4; 2 mm for 2-3; 1 mm for 5-16).

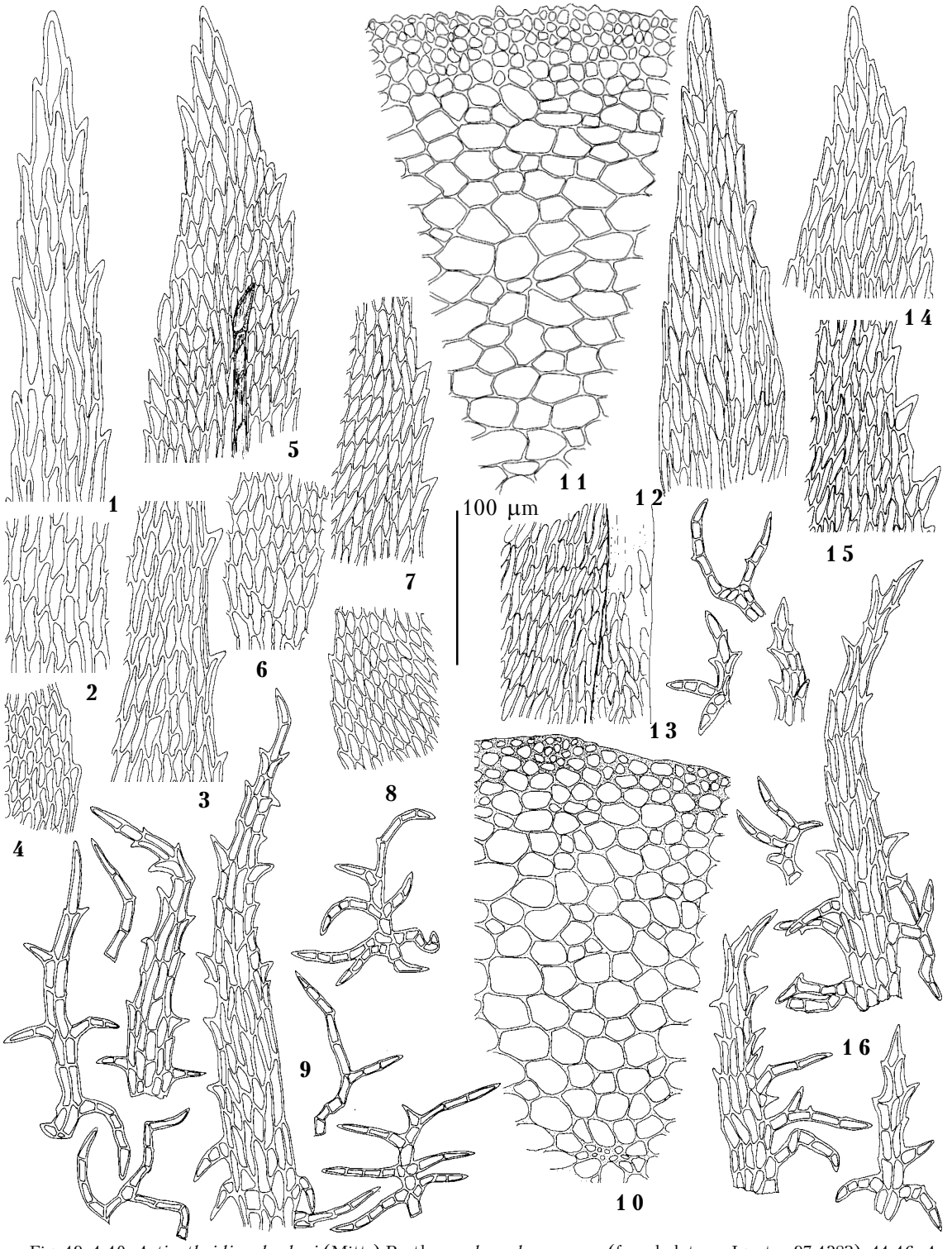


Fig. 19. 1-10: *Actinothuidium hookeri* (Mitt.) Broth. ssp. *boreale* ssp. nov. (from holotype, Ignatov 97-1283); 11-16: *A. hookeri* ssp. *hookeri* (from Nepal, Kumaon, Hooker LE): 1, 12 – upper laminal cells of stem leaf; 2-3, 13 – median laminal cells of stem leaf; 4 – lower laminal cells of stem leaf; 5, 14 – upper laminal cells of branch leaf; 6-7 – median laminal cells of branch leaf; 8 – lower laminal cells of stem leaf; 9, 16 – paraphyllia; 10-11 – stem transverse sections. Scale bar 100 μm for all.

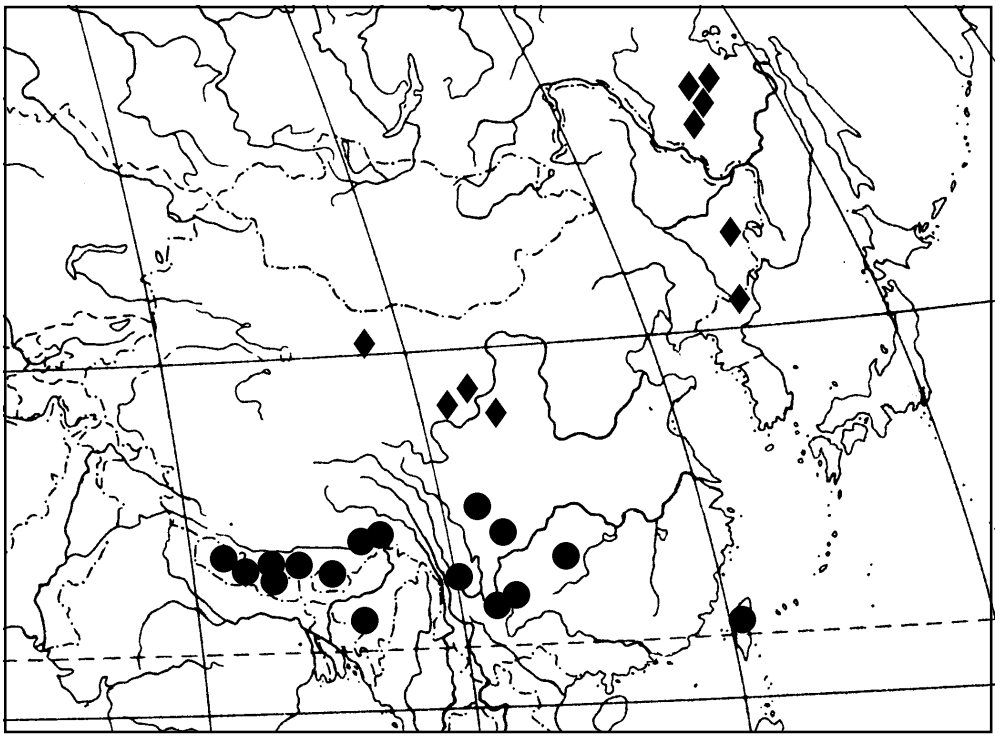


Fig. 20. Distribution of subspecies of *Actinothuidium hookeri* (Mitt.) Broth.: rombs – ssp. *boreale* ssp. nov.; circles – ssp. *hookeri*, basing on specimens studied, which we were able to locate.

which it formerly belong] Kwanmang-se pr. Sinning, in piceeto. 2500 m. Leg. 14-17.VII.1935. Fenzel 2202pp. (LE); Terra Tangutorum: Przevalski 370 (H-BR, LE).

Actinothuidium hookeri ssp. hookeri

CHINA: **Guizhou**: *B. Tan* 91-1197 (H, NICH); Mt. Fanjin *Gao Chien &* al. 32349 (IFSBH, dupl. in NICH); **Sichuan**: Mt. Omei *Gao Chien &* al. 40061 (IFSBH, dupl. in NICH); [*unclear*] 163 (IFSBH, dupl. in NICH); H. Smith 8.VIII.1922 [3600 m], 5.IX.1922 [4000 m] (H-BR); Krypt. exs. Mus. Nat. Hist. Vindobon. 2894 [3000-3550 m, leg. Handel-Mazzetti] (LE); Hepaticae sinicae exs., ed. P.C.Chen, 94 (ser. 11) var. szechuanicum Chen, materia originalis: China, Szechuan, Mt. Omei, Chingting, ca. 3000 m. in sylvis (Abies delavayi), in ericetis humidis, cim sphagno associatum. Leg et det. P. C. Chen, VIII 1942 (LE, NICH); **Xizang**: Takeda & Wang 860324-5a,b,c [3430 m] (NICH); Tibet: Kongpogyata Co. Le 2145 [3600 m] (NICH); Ya-dong Co. Zang Mu 278 (NICH); *North-Central Tibet: Samokhe River [3300 m], Dylis 964 (LE); *Linzhi [*unclear*] 7(10) (IFSBH, dupl. in NICH); **Yunnan**: Handel-Mazetti 8446, 9615, 6543, 7811, 3565, 2441, 1642, 2340, 1520, 1448, 1370, 1002 [2500-3800 m] (H-BR); Gebauer 21 (H-BR); Musci Selecti et Critici (ed. Verdorn) 102 [3000 m, Maire XI.1913 LE, NICH]; Liziang, Mt. Yulong [*unclear*] 3232 (IFSBH, dupl. in NICH).

TAIWAN: Noguchi 6935, 6955 (NICH).

KOREA: Samziyon, 3554, anonym (LE)]

SIKKIM: E. Long 7617 [3610 m] 7868 [3654 m] (H-BR); Hooker 1104 (LE); Togashi 29.V.1960 [3900 m] (NICH)

BHUTAN: Herb Griffith 733 (H-BR, LE); Rogers XI.1900 (H-BR); Kanai 20.V.1967 [3700-4500 m] (H, NICH); 24.V.1967 [3500-3800 m] (NICH); [3200 m] 26.V.1967 (H, NICH); Hara & al. 26.V.1967 [3200-3400 m] (NICH); Tanaka 15.V.1967 [3200-3700 m] (NICH); 18.V.1967 [3850-4100 m] (H, NICH); Bartholomew 149b [3330 m] (NICH).

NEPAL: Kanai & al. 852281 [3400 m] (H, NICH); Hara & al., 2.XI.1963 [1700 m] (H); 28.X.1963 [2600-3000 m] (H); Z. Iwatsuki 19.VI.1972 (H); Inoue – Bryophyta Selecta Exs. 476 (Kanai 21.VIII.1977 LE, NICH); Inoue – Bryophyta Selecta Exs. 276 (Iwatsuki 19.VI.1972, 3000 m [on label misprinted as 300 m] H, NICH); Hara & al. 28.X.1963 [2600-3000 m] (NICH); Hara & al. 29.X.1963 [2400-2800 m] (NICH); Hara & al. 2.XI.1963 [1700 m] (NICH); Hara & al. 17.VII.1969 [3950 m] (NICH); Kanai & al. 16.XI.1963 [2500-3000 m] (NICH);

Kanai & al. 15.XI.1963 [1500-2500 m] (NICH); Iwatsuki 363 [2300-2600 m] (NICH); Kanai 670989 [3250 m] (NICH); Kanai 670994-4 [3400 m] (NICH); Zimmermann 255 [2940 m] (NICH).

HIMALAYA: Hampe 1.IV.1889 (H-BR).

INDIA orientalis: com. Hampe, ex herb. Broth. (LE); Kanai & al. 7.VI.1960 [2600-3550 m] (NICH); Iwatsuki & al. 8821, 8884, 9550, 9890, 9916, 10825 [10000 feet] (NICH); B596a [11900-11600 feet] (NICH).

BURMA: col. Dickason/ det. E. Bartram 8531 (H, NICH).

ACKNOWLEDGEMENTS

We are much obliged to the National Geographic Society for support of expedition to Upper Bureya area (grant 5821-96), to A. Dumikayn, the Director of Bureya State Reserve for help during field trip, to curators of H, IFSBH, LE, TSN, NICH for loan of specimens, to M. Higuchi and A. J. E. Smith for valuable comments, and to the Hattori Botanical Laboratory for support of work of Ignatov & Ignatova in NICH.

LITERATURE CITED

[BARDUNOV, L.V.] БАРДУНОВ, Л.В 1969. Определитель листостебельных мхов Центральной Сибири. – [Handbook of mosses of Central Siberia] *Л., Наука [Leningrad, Nauka], 319.*

DЬLL, R. 1985. Zygodon in Europe and Macaronesia, with special regard to Central Europe. – *Abstracta Bot.* (*Budapest*) **9**, Suppl. 2: *45-54.*

[DYACHENKO, A. P.] ДЬЯЧЕНКО, А. П. 1997. Флора листостебельных мхов Урала. Часть 1. – [The moss flora of Urals. Pt. 1] *Екатеринбург, изд-во Уральск. ун-та* [*Ekaterenburg, Izd-vo Uralsk. Univ.*], *264.*

HIGUCHI, M. & H. SIMUZU 1996. Sporophytes of Zygodon viridissimus (Dicks.) Brid. var. rupestris Lindb. ex Hartm. – *Proc. Bryol. Soc. Japan* **6**(10): *199-201.*

IGNATOV, M. S. & V. YA. CHERDANTSEVA 1995. The families Cryphaeaceae, Leucodontaceae and Leptodontaceae (Musci) in Russia. – *Arctoa* **4**: *65-104.*

[IGNATOV, M. S., E. A. IGNATOVA, D. A. PETELIN & B. F. KHASANOV] ИГНАТОВ, М. С., Е. А. ИГНАТОВА, Д. А. ПЕТЕЛИН, Б. Ф. ХАСАНОВ 1990. Материалы к бриофлоре Буреинского заповедника (Хабаровский край). – [Contribution to the bryoflora of Bureya Reserve {Khabarovskij Territory)] *Бюлл. МОИП, отд. биол. [Byull. Mosk. Obshch. Ispyt. Prirody. Otd. Biol.]* **95**(6): *86-96.*

IGNATOV, M. S. & J. LEWINSKY-HAAPASAARI 1994. Bryophytes of Altai Mountains. II. The genera Amphidium Schimp., Orthotrichum Hedw. and Zygodon Hook. & Tayl. (Orthotrichaceae, Musci) – *Arctoa* **3**: *29-57.*

LAPSHINA, E. D. & E. YA. MULDIYAROV 1998. The bryophyte flora of the Middle Western Siberia. – *Arctoa* **7**: *25-32.*

KARTTUNEN, K. 1984. Zygodon gracilis, Z. rupestris and Z. dentatus, comb. nov. (Musci, Orthotrichaceae), history and nomenclature. – *Ann. Bot. Fennici* **21**: *343-348.*

LEWINSKY-HAAPASAARI, J. 1998. Orthotrichales. – *In: Nyholm, E. Illustrated flora of Nordic mosses. Fasc. 4. Copenhagen & Lund, Nord. Bryol. Soc.: 373-405.*

MALTA, N. 1926. Die Gattung Zygodon Hook. et Tayl. Eine monographische Studie. – *Latvijas Universitates Botaniska Darza* (*Riga*) **1**: *1-185.*

SMITH, A. J. E. 1978. The moss flora of Britain and Ireland. – *Cambridge, Cambridge Univ. Press., 706.*