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The review of Aneuraceae in the Russian Far East

Vadim A. Bakalin

Vadim A. Bakalin
e-mail: vabakalin@gmail.com

Botanical Garden-Institute FEB RAS, Vladivostok, Russia

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ABSTRACT

Aneuraceae are revised for the Russian Far East where its taxonomic diversity is the highest among Russian macroregions and concentrated in amphioceanic hemiboreal and temperate communities of the area. The distribution of 2 species of *Aneura* and 6 species of *Riccardia* is confirmed in the Far East and one more could be expected there. All known taxa are annotated with morphological description (based mostly or entirely on the material collected within the Russian Far East), ecology and distribution overviews and differentiation features. Oil bodies features are photographed based on materials from treated area.

Keywords: Aneuraceae, *Riccardia*, *Aneura*, Hepaticae, taxonomy, distribution, the Russian Far East, East Asia

РЕЗЮМЕ

Бакалин В.А. Обзор Aneuraceae на российском Дальнем Востоке. Семейство Aneuraceae ревизовано для российского Дальнего Востока, где оно достигает наивысшего таксономического разнообразия в сравнении с другими макрорегионами России. Наивысшие показатели видовой насыщенности приурочены к юго-восточной части Дальнего Востока. Распространение 2 видов *Aneura* и 6 *Riccardia* на российском Дальнем Востоке подтверждено, нахождение еще одного вида весьма вероятно. Каждый вид аннотирован морфологическим описанием (полностью или главным образом основанным на изучении дальневосточного материала), описанием экологических условий произрастания, распространения в пределах региона и отличительных черт морфологического строения. Особое внимание уделено признакам масляных телец, для которых приводятся фотографии, сделанные на основе материалов, собранных на Дальнем Востоке.

Ключевые слова: Aneuraceae, *Riccardia*, *Aneura*, печеночники, таксономия, распространение, российский Дальний Восток, Восточная Азия

Aneuraceae is relatively large family of simply thallose hepatics that include four genera: monotypic *Verdoornia* (with the only *V. succulenta* R.M. Schust.), *Aneura* (49 species, with one third of taxa with doubtful status), not rich in taxa *Lobatiriccardia* (9 species) and large and polymorphic *Riccardia*. The World checklist (Söderström et al. 2016) counts large number of species for the last genus, with ca. 40 % referred to '*incertae sedis*' that may actually belong to other genera. *Riccardia* shows the highest diversity in the former Gondwanaland with ca. 50 % of Australasian taxa are endemic (Frey & Stech 2009).

The checklist of Russian liverworts (Konstnatinova et al. 2009) counts 8 species of *Riccardia*, with *R. incurvata* Lindb. not known in the Russian Far East and *R. multifida* (L.) Gray treated very widely, as including also *R. descrescens*. *Aneura* is represented in Russia by three species (l.c.), including one (*Aneura mirabilis* (Malmb.) Wickett et Goffinet) still not known in the Far East. The East Asian countries adjacent southward to the Russian Far East are taxonomically richer there, including 5 species of *Aneura* and 21 that of *Riccardia* in Japan (Furuki 1991, Katagiri & Furuki 2012). Chinese checklist (Piippo 1991), where taxonomic diversity of the genus is likely poorly understood, lists 3 species of *Aneura* and 17 of *Riccardia*. Within Korean Peninsula 2 species of *Aneura* and 7 species of *Riccardia* are known (including very doubtful record of amphi-Atlantic *R. incurvata*) (Choi 2013).

There are two main 'difficulties' in the study of Aneuraceae: 1) limited number of morphological features (because of simply thalloid nature) and 2) high value of oil bodies characteristics (somewhat caused by the first point), oil bodies in Aneuraceae disappear very quickly and unavailable in herbarium material. While there are reliable studies on the family, involving large amount of the fresh material in Europe (especially western) and (in part) North America, the similarly comprehensive surveys are absent in the majority of other megaregions. Within Asia the only treatment essentially based on study of living material is that by Furuki (1991). Noticeable, among 21 species of *Riccardia* reviewed by Furuki in Japanese flora, 8 species were described as new-for-science, and this advance did not exhaust taxa that need to be described in the future (Furuki, pers. comm.).

Aneuraceae were never reviewed for the Russian Far East. The only available review of the genus is that by Schljakov (1976) for the North of USSR. The latter does not use the materials from the Russian Far East, although includes 3 of 6 *Riccardia* taxa now known from the Far East and 1 of 2 in *Aneura*. Another paper that provides the key to the *Riccardia* known in that time in the former USSR is that by Potemkin (1991). It stresses the great value of oil bodies characteristics in the study of Aneuraceae, but in practical results it only repeats the data on oil bodies taken from the literature, but not from the own study. Taking into account the urgent needs of the new treatment compilation for all groups of liverworts occurring in the Russian Far East, at least from the practical point of view (necessity for new guide book of hepatics in the land), the main goal of the present work is to provide the treatment of all Aneuraceae known in the Russian Far East now.

Material and Methods

The present account is mostly based on study of living plants that were collected around the Russian Far East and adjacent areas like Korean Peninsula and Japan. All collected materials were transferred alive for anatomical study to VBGI, where selected specimens were photographed and then compared with known taxa of the genus. The species concept is mostly followed to Furuki (1991). In total 211 specimens from various areas were studied.

The morphological diagnoses, as well as the figures of taxa are based on the studied specimens that are mostly from the Russian Far East, with some additions from East Asia and from other regions. The morphology descriptions indicate color for living plants (if otherwise it is not mentioned). Where the information on generative structures was unavailable from our material, it was taken from the literature and the corresponding reference was made. The epidermal and inner cells are measured in two projections: one from frontal view from dorsal side, with 'inner' meant the next and nearest layer inward and the second is from the cross section. All measurements are taken from the main axis. Formally the width of epidermal cells should be the same in both projections, but in the practice in the cross section it is obliged to operate the cell section made not in the widest place (countrary if used for measurements in frontal dorsal view).

The list of specimens examined for each taxon is placed at the end of the paper.

TAXONOMIC TREATMENT

Aneuraceae H. Klinggr

The family is characterized by plants of simply thalloid organization, without sharp differentiation into lateral laminae and midrib, without leaf-like structures along thallus margin, presence of well-developed massive calyptra and lacking involucres and perianth. Oil bodies in the most cases are completely destroying after initial drying. The representatives of the family tend to be occurring in wet to moist habitats in shady to open places. Two genera are known in the Russian Far East that may be keyed out by the following key*:

1. Main axis (2–)3–6 and more mm wide, very sparsely branched, margin commonly undulate and/or distinctly crispate, oil bodies colorless or nearly so, 10–25 and more per epidermal and inner cell .... *Aneura*

1. Main axis 0.2–1.5 (rarely wider) mm wide, regularly pinnately to tri-pinnately branched, thallus margin not undulate, sometimes crenulate, rarely crispate, oil bodies commonly 1–5(–8) per epidermal and inner cells, rarely more, grayish brownish, rarely (*R. latifrons*) absent or as small oil drops less than 2 μm in diameter .... *Riccardia*.

* here and below the keys use characteristics observed in taxa known in the Russian Far East.

Aneura Dumort., Commentat. Bot. (Dumortier): 115, 1822.

Plants prostrate, greenish to yellowish greenish, salad green and brownish green, sparsely branched, margin undulate and commonly crispate, unistratose wing along thallus margin 1–20 cells wide. Epidermal cells similar in size to inner cells or slightly smaller, oil bodies small, colorless to grayish, finely granulate, 10–30 per cell. Dioicous. Androecia terminal, with 4–10 and more pairs of antheridia. Calyptra 4–10 mm long. Spores 20–30 μm in diameter. Seta massive, 8–14 cells thick.

Two species are known in the Russian Far East: subcosmopolitan *Aneura pinguis* and East Asian *A. maxima*. They may be keyed as following:

1. Main axis with lateral somewhat translucent unistratose wings 5–15 cells wide, thallus margin undulate, translucent, not turned to ventral side [in our area South Kurils and Southeast Sakhalin] .... *A. maxima*

1. Main axis with lateral unistratose wings 1–3(4) cells wide, thallus margin crispate, not or loosely undulate, commonly turned to ventral side [throughout in our area] ...... *A. pinguis*

Aneura maxima (Schiffn.) Steph., Bull. Herb. Boissier 7 (10): 760 (270), 1899.

Description. Plants translucent, pale greenish, (4–)5–10(–12) mm wide and 30–100 mm long, loosely undulate and slightly crispate (lesser than in *A. pinguis*) along margin, thallus margin commonly turned to ventral side. Epidermal cells 70–100 × 28–50 μm, thin-walled, trigones vestigial; inner cells 125–175 × 37–58 μm, thin-walled, trigones wanting; unistratose wing (4–)5–15 cells wide (further 9–11 cell pairs are in bistratose portion). Oil bodies 15–30 per cell, finely granulate, colorless to grayish, spherical, 2–3 μm in diameter (slightly larger and fewer in number in inner cells). Cross section concave(dorsal)-convex, with very thin margin and merely well-developed 'midrib'; outer cells 25–63 μm, with vestigial to very small trigones; inner cells 37–100 μm, thin-walled, with wanting trigones, in 6–7 rows of cells. [Dioicous. Elaters 200–300(–350) × 8–10 μm; spores 20–30 μm in diameter (Furuki 1991)]. (Figures 1:1–4; 2)

Comment. The species somewhat resembles *A. pinguis* (especially its large modifications from wet and shady habitats), from which, however, differs in large unistratose wing along thallus margin (more than 5 cells wide), not so crispate thallus margin and somewhat translucent appearance. Other differentiation features are given under *A. pinguis*. Due to wide unistratose thallus margins the species acquire appearance of *Pellia*, if sterile, from which it differs in green (never with violet or purplish tint) pigmentation and drastically other generative structures (antheridia on lateral branches, vs. on the main axis, well developed calyptra vs. pseudoperianth, etc.).

Distribution. The eastern East to South-East Asian species widely distributed through Japan, slightly rarer in

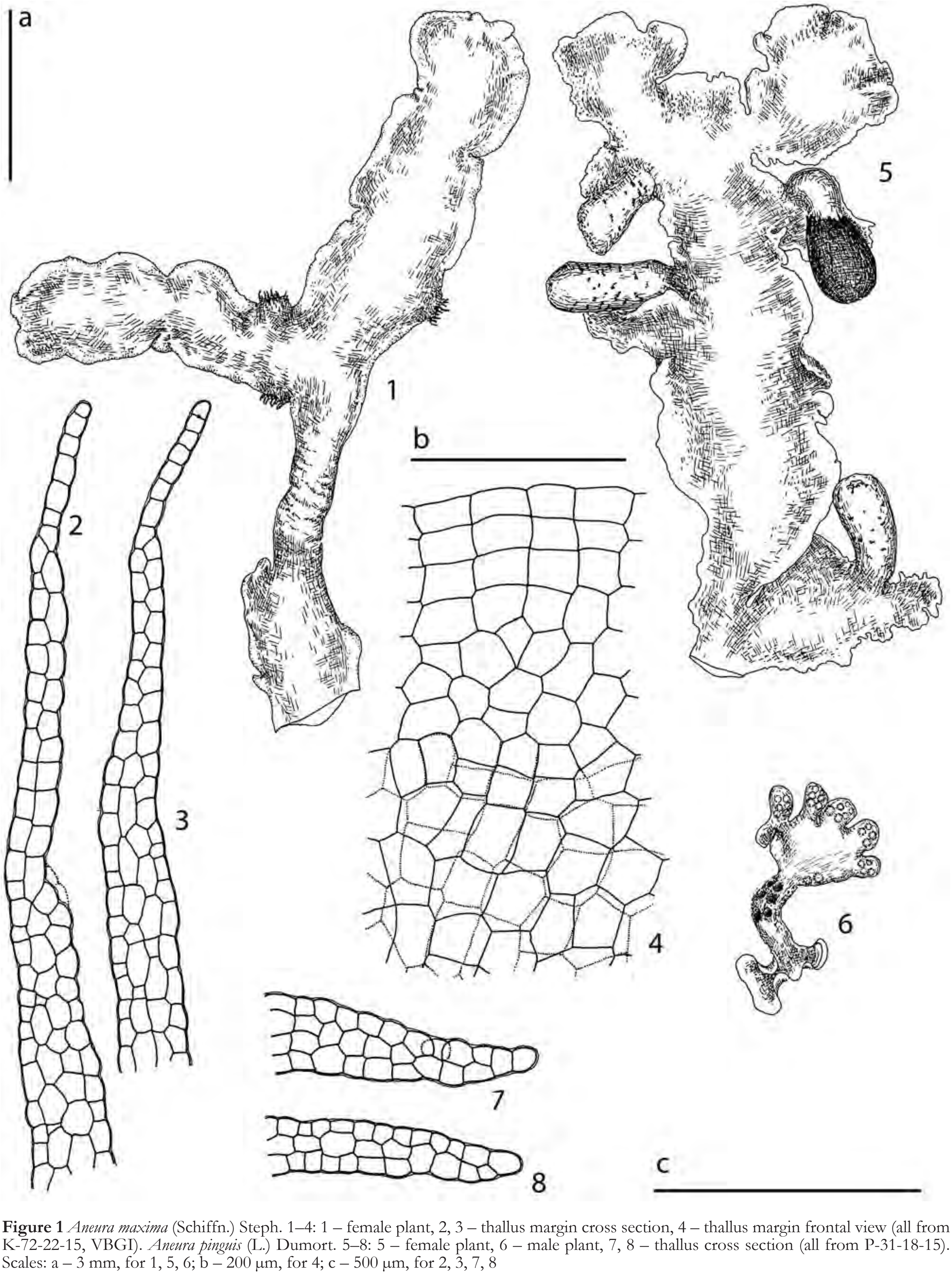

Figure 1 *Aneura maxima* (Schiffn.) Steph. 1–4: 1 – female plant, 2, 3 – thallus margin cross section, 4 – thallus margin frontal view (all from K-72-22-15, VBGI). *Aneura pinguis* (L.) Dumort. 5–8: 5 – female plant, 6 – male plant, 7, 8 – thallus cross section (all from P-31-18-15). Scales: a – 3 mm, for 1, 5, 6; b – 200 μm, for 4; c – 500 μm, for 2, 3, 7, 8

Korean Peninsula (due to drier climate), then continue area in east and south China and reaches Indonesia via Indochina. In the Russian Far East it is confined to South Kurils (where locally abundant in northern part of Iturup Island) and one locality in South-Eastern Sakhalin Island. All known localities lie below 60 m a.s.l., although in adjacent areas southward the species reaches higher elevations. Towards to tropical zone disappears in low elevations and oc-

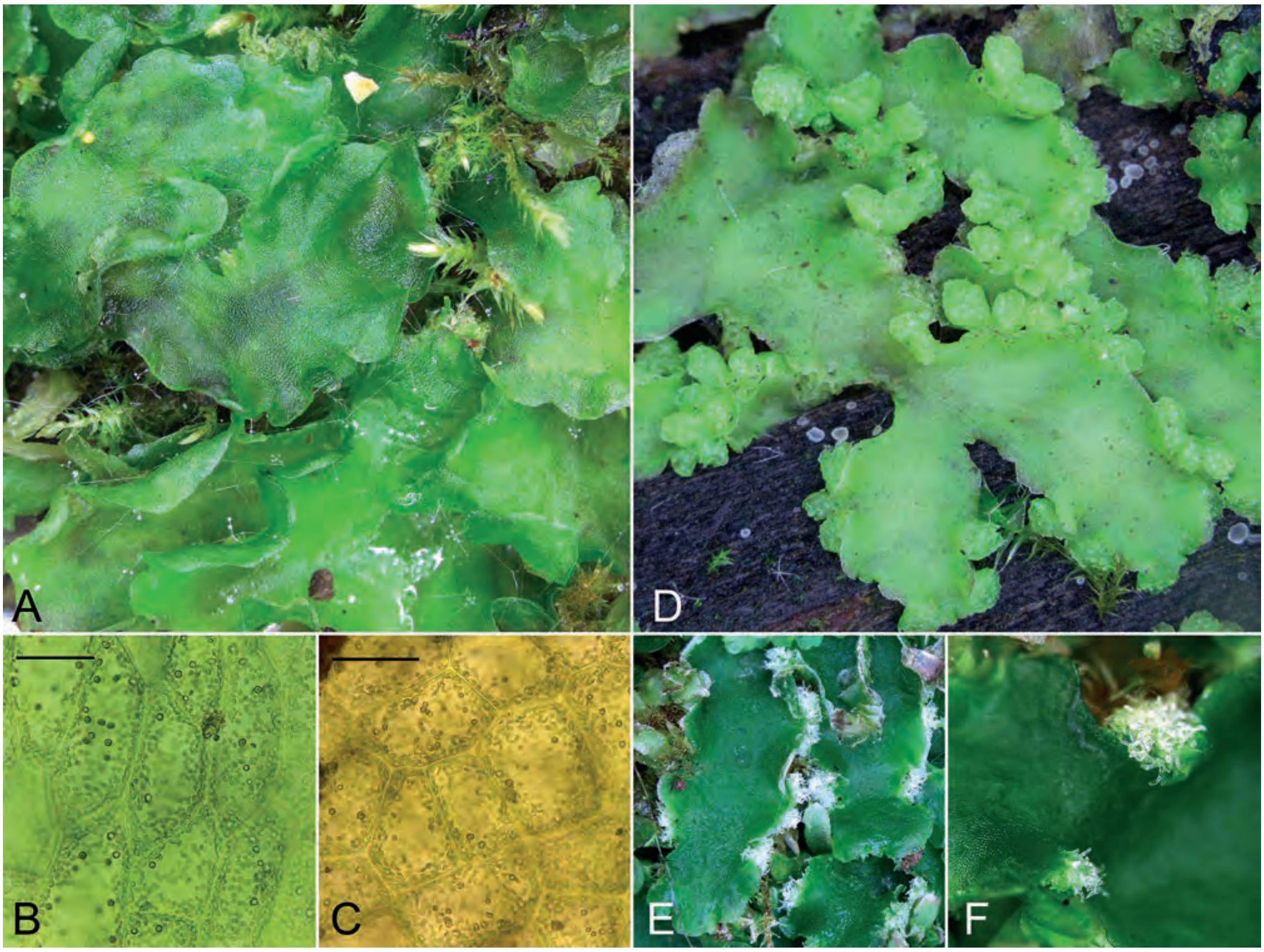

Figure 2 *Aneura maxima* (Schiffn.) Steph. A–C: A – plant habit, B, C – epidermal cells of the thallus (A – from K-80-1-15, B – from Kor-44-1-14, C – from S-47-1-16, all in VBGI). *Aneura pinguis* (L.) Dumort. D–F: D – male plant, E, F – female plant (D – from P-31-21-15, E, F – from P-40-6-15, all in VBGI). Scales: 50 μm for B, C

curs in oro-subtropical and oro-south-temperate communities, like above 3000 a.s.l. in Northern Vietnam. There are number of indications of *A. maxima* for Europe and North America, all of them are apparently belonged to another taxa that was stressed in Konstantinova et al. (2009).

Ecology. Contrary to *Aneura pinguis*, the species has narrower ecological niche and in area treated is limited by moist cliffs of neutral reaction in open sites. It grows in areas surrounded by hemiboreal communities (southward of treated area it may grow near stream in even subtropical vegetation belt) on open cliffs near sea coast, along streams with steep banks and wet cliffs near waterfalls. More rarely the species may be observed in peaty bank of lakes. The species is sensitive to constant moisturizing and high air moisture and limited in distribution to insular part of the Far East. Southward, in Korean Peninsula and Japan, the species becomes more common and plastic in ecology than in our area and may occupy moist roadsides.

Aneura pinguis (L.) Dumort., Syll. Jungerm. Europ.: 86, 1831

Description. Plants yellowish greenish to bright green and salad green, (2–)3–6(–10) mm wide, 20–100 mm long, irregularly and very sparsely branched, thallus margin crispate, not or loosely undulate, commonly more or less rigid. Epidermal cells 62–84 × 30–50 μm, thin-walled, 5–6-gonal, trigones wanting; inner cells 70–150 × 35–75 μm, thin-walled, trigones wanting to vestigial; unistratose wing 1–3(–4) cells wide. Oil bodies 10–20 per epidermal and inner cells, finely granulate, spherical, 3–5 μm in diameter (slightly larger and fewer in number in inner cells), grayish. Cross section concave(dorsal)-convex, outer cells 37–75 μm, thin-walled, trigones wanting; inner cells 37–84 μm, in 6 rows of cells, thin-walled, trigones wanting Dioicous. Spores 22–28 μm in diameter, brown, papillose; elaters 1-spiral, ca. 70–90 × 8 μm, with (10)20–30 μm homogenous ends. (Figures 1:5–8; 2: D–F; 3)

Comment. This malleable species may be mistaken with East Asian *A. maxima*. On one hand, large epixylous mesophytic phases of *A. pinguis* commonly occurs in the southern flank of the Far East and characterized by discolored thallus margin, especially in older part of shoots. These phases are characterized by fleshy thalli, with margin turned to ventral side and thallus margin (despite being discolored), not unistratose for a long distance from the edge. Besides, *A. maxima* is never growing in mesophyte conditions. On the other hand, some thalli from hygrophytic conditions become noticeable thin, translucent and develop undulate (not crispate) thallus margin also give aspect of

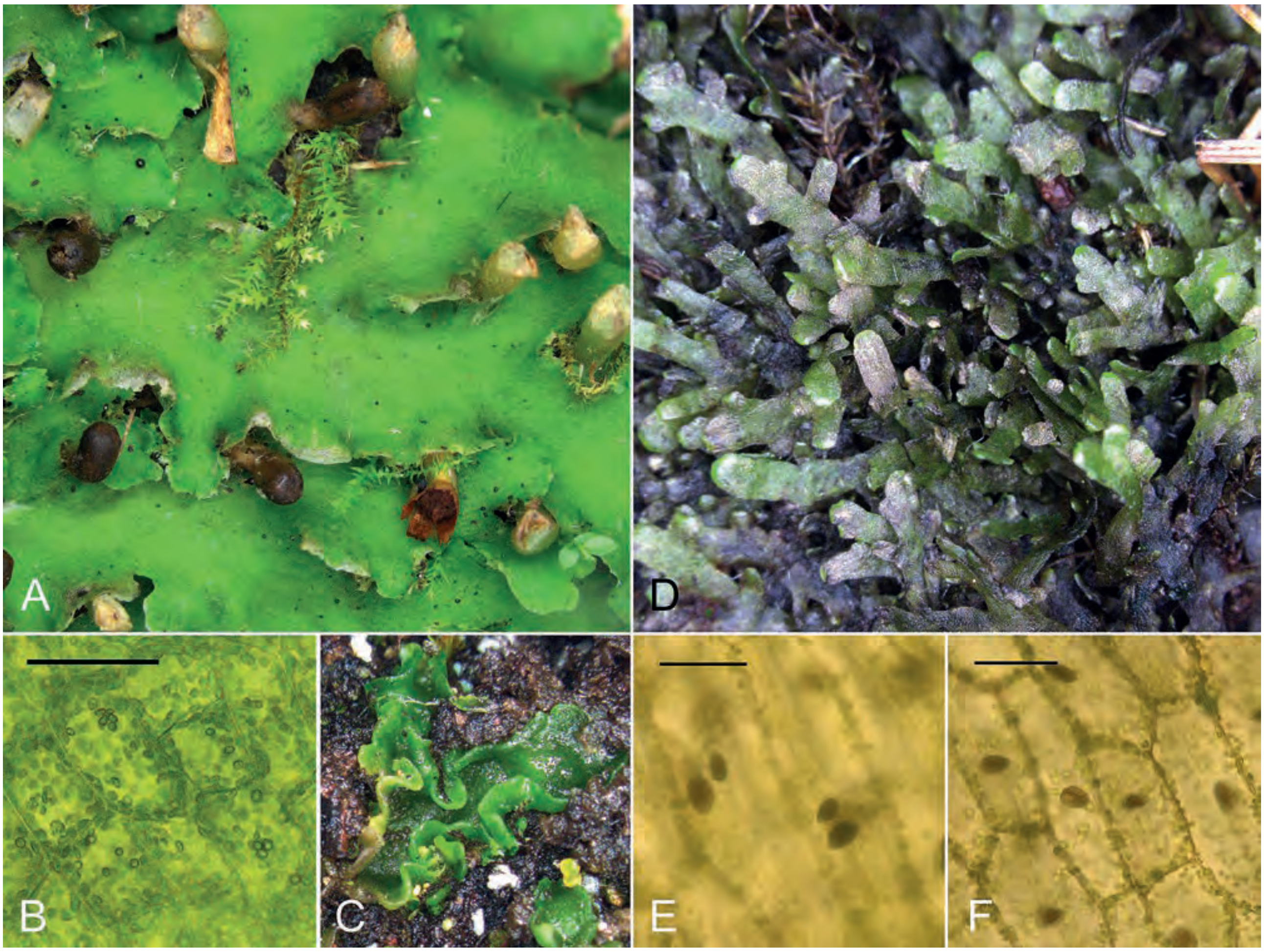

Figure 3 *Aneura pinguis* (L.) Dumort. A–C: A – plant habit, B – epidermal cells of the thallus, C – sterile plant (A – from P-31-18-15, B, C – from Mag-29-25-14, all in VBGI). *Riccardia aeruginosa* Furuki D–F: D – plant habit, E – inner cells of the thallus, F – outer cells of the thallus (from K-70-1-15, VBGI). Scales: 50 μm for B

A. maxima. However, the unistratose wing is very narrow in those phases and never reaches 5 or more cells broad. The molecular work is needed to understand the real taxonomic diversity in the complex.

Distribution. Subcosmopolitan species, as Schuster (1992: 558) wrote "ranging from High Arctic (82°32'N in Ellesmere I.) to the tropics through enormous series of habitats". Although absent in Antarctica and some records from Antipodes need to be verified (e.g. from Brazil, cf. Gradstein & Da Costa 2003). The conspecific nature of the populations across the known area of *Aneura pinguis* s.l. was questioned by Preussing et al. (2010). *Aneura pinguis* is absent in the areas with desert climates. Known throughout the Russian Far East and relatively large 'gaps' in its distribution (the dot map in Bakalin 2010, remains reliable) could be explained by the only poor state of knowledge of liverwort flora. *Aneura pinguis* is widely distributed through the adjacent lands. Unlike to other members of the family the high plasticity of the species permit it grow in various types of habitats and it is observed in the Russian Far East ranging from multidominant cool-temperate forests in lower elevations to the highest points of mountain ranges with cryo-desert climate. The water availability is the only limiting factor that prevents its distribution in dry prairie-like communities of Khanka lowland and oak forest with *Lespedeza* in the south as well as dry alpine highlands (dry stony fields and crashed stones) through the mountainous areas of the Far East. The highest point where the species was observed lies at the 2010 m a.s.l. in the North Sikhote-Alin; relatively wet East Kamchatka provide habitats suitable for the species to the elevations near 1500 m a.s.l.; in drier Magadan Province the species is observed to 1200 m a.s.l.; Primorye Territory with commonly dry mountain summits prevent it distribution there and the highest observed elevation is slightly above 1200 m a.s.l.

Ecology. *Aneura pinguis* is a species of complex nature (Preussing et al. 2010). Whether it results in supposed exceeding plasticity in ecology is not clear. By now, two different ecological phenotypes of the species are known in the Russian Far East. In northern half of the area and in upper elevations of the southern flanks of the territory the species is known as neutrophilic to acidophilic hygrophyte and occupies moist to wet fine soils and cliffs in forestless zone or belt above the timberline, widely spreading to boreal coniferous communities and regularly occurs in raised oligotrophic mires (rarely in eutrophic swamps). Throughout the area, the northern populations of the species prefer open places with constant water availability. In those conditions the species is commonly associated with arctic-alpine liverworts like *Anthelia juratzkana* (Limpr.) Trevis. and *Marsupella boeckii* (Austin) Lindb. ex Kaal., or with *Gymnocolea inflata* (Huds.) Dumort., *Scapania paludicola* Loeske et Müll. Frib., etc. in mires. On the other hand, in southern part of the Russian Far East, the species starts to occurs in low elevation belt where could be characterized as acidophilic mesophyte and regularly occurs in decaying wood in shady places in hemiboreal mixed and broadleaved communities. The associates of the species are strikingly different from those in the North and commonly represent by temperate East Asian taxa like *Pedinophyllum truncatum* (Steph.) Inoue, *Xenochila integrifolia* (Mitt.) Inoue or taxa of broader distribution like *Fuscocephaloziopsis lunulifolia* (Dumort.) Váňa et L. Söderstr., *Nowellia curvifolia* (Dicks.) Mitt., etc. The slight differences of two modifications in general appearance (like more pale and yellowish coloration, more thin and then commonly discolored thallus margin of southern populations) seems to be connected by uninterrupted grade of changes to the northern phases of the taxon, although molecular investigations are needed to solve this enigma.

Riccardia Gray, Nat. Arr. Brit. Pl. 1: 679, 1821

Description. Plants prostrate, bright to brownish green, rarely (*R. chamedryfolia* among regional taxa only) salad-green, brownish greenish to olive and brown in the herbarium. Freely and mostly regularly palmately or pinnately to tri-pinnately branched. Thallus margin commonly plane and straight, not crispate (exception: *R. chamedryfolia*), nor undulate, unistratose wing along margin 0–4(–5) cells wide. Oil bodies grayish to brownish, commonly larger in inner cells, present or absent in epidermal cells, 1–5(–10) per cell, rarely absent or reduced to numerous and small (1–2 μm in diameter) oil drops (*R. latifrons*). Dioicous to monoicous and heteroicous. Androecia terminal to intercalary. Spores 12–18 μm in diameter. Seta 4(–7) cells in diameter.

Seven species were reported for the Russian Far East (Konstantinova et al. 2009); the record of *Riccardia subalpina* Furuki is questionable. It was recorded by Bakalin et al. (2009), but in the course of the present revision the vouchers were not found. Taking into account the general distribution of the taxon (subalpine and alpine areas in Japanese Hokkaido and Honshu) the occurrence of the species in the South Kurils looks possible. Therefore, due to the absence of confirmed data on the occurrence of that species in the Russian Far East, I include the species to the key and discussion, but not provide the description. It is worth to be mentioned that the reliable identification is only possible if living plants are in the study (especially when plants from the southern portions of the Far East are in the hand). The presence of generative organs is also very valuable. In the case of sterile and previously dried material the identifications in many cases remain doubtful.

The key to *Riccardia* in the Russian Far East.

1. Unistratose wing 2–4 cells wide along thallus margin, margin crenulate, oil bodies nearly absent in epidermal cells (present not more than in 10–15% of cells), monoicous (paroicous, synoicous and autoicous) plants .... *R. decrescens*

1. Unistratose wing 0–1(–2) cells wide, margin mostly straight to crispate, not crenulate, oil bodies absent or present in epidermal cells, dioicous or monoicous plants **2**

2. Plants small sized, main axis shorter 10 mm long **3**

2. Plants moderate to large, well developed plants longer than 15 mm **6**

3. Plants autoicous, relatively few and larger oil bodies absent in outer and inner cells of the thallus, sometimes numerous and small oil drops are present [boreal, oroboreal, subarctic and arctic communities] .... *R. latifrons*

3. Plants dioicous to heteroicous, 1–10 relatively large oil bodies present in all or some outer and inner cells [mostly temperate and hemiboreal communities] **4**

4. Inner cells only slightly larger than epidermal cells (0.6–0.8 of inner in width), oil bodies relatively small, 0–10 per cell, mostly spherical less than 5–6 μm in diameter ... *R. vitrea*

4. Inner cells distinctly larger than epidermal cells (0.3–0.5–0.8 of inner in width), oil bodies more than 5 μm in diameter or more 5 μm wide, 1–5 per epidermal or inner cell **5**

5. Thallus in the cross section with distinct and moderate in size concave trigones, oil bodies by 1 in some epidermal and inner cells .... *R. subalpina*

5. Thallus in the cross section with vestigial trigones, oil bodies by 1–5 in some or nearly all epidermal and inner cells .... *R. palmata*

6. Plants monoicous (autoicous, paroicous and synoicous), oil bodies by 1–5 per epidermal cell .... *R. chamedryfolia*

6. Plants dioicous, oil bodies by 1(–2) per epidermal cell .... *R. aeruginosa*

Riccardia aeruginosa Furuki, J. Hattori Bot. Lab. 70: 345, 1991

Description. Plants greenish brownish to brownish greenish and rusty brownish, main axis 0.3–1.0 mm wide and 8–20 mm long, regularly pinnately to bipinnately branched. Epidermal cells 42–170 × 20–65 μm, with thin or obscurely thickened walls and wanting or vestigial to very small concave trigones; inner cells 150–225 × 50–80 μm, thin-walled, with very small to vestigial trigones; margin entire, unistratose wing absent or 1 cell wide. [Oil bodies brown, fusiform to elliptical and spherical, in epidermal and wing each cells by 1(–2), 8–15 × 5–15 μm, in inner cells 10–20 × 8–15 μm, 2(–3) in each cell. Cross section biconvex to plane(dorsal)-convex and concave-convex; outer cells 17–62 μm in diameter, thin-walled, with vestigial trigones; inner cells 25–75 μm, thin-walled, in 3–4 rows of cells, trigones absent to small, concave. Dioicous. [Male plants commonly smaller. Elaters 150–300 × 10–15 μm. Spores 14–16 μm in diameter. Furuki 1991)]. (Figure 3: D–F).

Comment. The majority of the records of this species for the Russian Far East (Bakalin 2010) are mistaken with *R. chamedryfolia*. Two species differ in the inflorescence (dioicous versus autoicous). Other features, like epidermal cell size stressed by Furuki (1991) and thallus margin features (crispate to straight versus straight) are largely overlapping. Another problem may be the delimitation of the species from *R. decrescens*, from which (aside sexuality) the species differs in poorly developed or absent unistratose wing along thallus margin and entire thallus margin versus commonly distinctly crenulate in *R. decrescens*.

Distribution. Imperfectly known, probably oceanic to hyperoceanic East Asian, currently known in Japan, including main chain (from Kyushu to southernmost Ryukyu), Bonin and Volcano Island (Furuki 1991). The nominal absence of the taxon in Hokkaido and Honshu may challenge its occurrence in South Kurils (from where it is recorded in Russia). However, I did not find the robust differences between Russian specimens and the species distributed in Japan (also basing on study of the type in HIRO), although the possibility of cryptic speciation was not investigated. Both localities in the Russian Far East (Iturup and Kunashir Islands) are from coastal area, at the elevations below 25 m a.s.l. The reports of the species from Commanders, North Kurils and Sakhalin in Bakalin (2010) are based on misidentifications for *Riccardia chamedryfolia* and *R. decrescens*.

Ecology. This species was described from Japan, where occupies wet soil and rocks in southern flank of the country that implies subtropical forests in middle to low elevation belts. The ecology of the species in the Russian Far East (basing on two specimens) is noticeable different from Japanese ones. *Riccardia aeruginosa* known in our area from South Kurils, where the species occurs in oligotrophic and mesotrophic mires, associated with *Sphagnum*, *Cephalozia bicuspidata* (L.) Dumort. and *Kurzia makinoana* (Steph.) Grolle – the habitats where two more species of the genus (*R. chamedryfolia* and *R. multifida*) could be easily observed.

Riccardia chamedryfolia (With.) Grolle, Trans. Brit. Bryol. Soc. 5 (4): 772, 1969.

Description. Plants pale greenish to yellowish greenish, more or less regularly bipinnately branched, main axis 0.7–1.5 mm wide and 10–20 mm long, margin more or less crispate to (rarely) entire. Epidermal cells 5–6-gonal, 50–125 × 25–75 μm, thin-walled, trigones wanting, inner cells 100–225 × 35–75 μm, thin-walled, trigones wanting; unistratose wing 0–2 cells wide. Oil bodies brownish, granulate, in epidermal cells by 1–2, shortly ellipsoidal to shortly fusiform, in inner cells by 1–2(–4) per cell, shortly fusiform to long fusiform. Cross section plane(dorsal)-convex to concave-convex, epidermal cells 25–55 μm; inner cells 37–100 μm, thin-walled, trigones wanting to vestigial, in 3–5 rows of cells. Autoicous. [Elaters 150–300 × 10–15 μm; spores 15–18 μm in diameter (Furuki 1991)]. (Figures 4: 1–5; 5: A–C)

Comment. The species area overlaps with that of *R. descescens* in East Asia, both taxa are locally abundant and sometimes growing intermixed. However, even in the field two species are distinctly differs due to well developed unistratose wing in *R. descrescens* (absent or poor in *R. chamedryfolia*) and straight thallus margin (crenulate in microscopic level) in *R. multifida* versus commonly somewhat crispate in *R. chamaedryfolia*.

Poorly developed plants have main axis 0.3–0.6 mm wide and 6–10 mm long. However, even in those modifications the cell size remains relatively large with epidermal cells 70–113 × 32–48 μm and inner 125–175 × 37–55 μm. These phases were observed in two different places: the north extremity of the area (Magadan Province: Mag-22-30-14) and in unusually (for the species) dry habitat in the south (Yuzhno-Sakhalinsk, on decaying wood along stream, 04.IX.2005 leg. Bakalin).

The one of the basic features of the species is pinnate branching, however in one case (K-50-15-06) plants are palmately branched, and then resembles large *Riccardia palmata*, from which, however easily differs in large size, crispate thallus margin and autoicous inflorescence, along with occurrence in wet moss patches (not in decaying wood as it is characteristic for *R. palmata*).

Another problem provides the plants from very shady and wet habitats, where the plants sometimes become thinner than commonly and develop 2–3-celled unistratose wing. These plants may be misidentified as *R. decrescens*, from which, however, in differs in yellowish green pigmentation in the herbarium (versus commonly brown), crispate thallus margin (versus basically entire, but crenulate due to marginal cells protrudences) and, especially, in distribution of oil bodies in all (or nearly so) epidermal and inner cells (versus oil bodies are in not more than 20 % of epidermal cells).

Distribution. Virtually boreo-cool-temperate subcircumpolar, commonly montane, with gaps in the central part of North America (Schuster 1992) and East Siberia, questioned for continental Yakutia (Konstantinova et al. 2009). Easily spreading southward to temperate zone by mountain ranges in the both western and eastern North America, as well as in alpine Europe, Caucasus and amphi-Pacific East Asia. Rare or questionable in Arctic, from where the most of records are based on previously dried material where the identifications may be "not fully reliable" (Schuster 1992: 648). However, concerning of the latter it should be noted that, at least in Russian Arctic there are not so large species that tentatively could substitute *R. chamedryfolia* and result in misidentification (*R. latifrons* ssp. *arcica* mentioned below is, although as wide as *R. chamedryfolia*, but never could be as long as well developed *R. chamedrifolia*). In adjacent to the Russian Far East areas it seems to be absent in East Siberia, Yakutia, although present in South Siberia in the areas still moistened by wet air masses going from Atlantic (especially near Baikal Lake). Southward common though Japan, where most of records are from low elevation, although with some stations above 1200 m a.s.l. (Aichi Pref., Furuki, 1991). Sparsely distributed in Korean Peninsula, although locally abundant in the mountains of the central part of the peninsula. Within China recorded from Eastern and southern parts of the country (westward to Sichuan and Yunnan, Piippo 1991). In the Russian Far East distributed in strictly amphi-Pacific areas, absent in Amur lowland in the south-western Russian Far East and in Khabarovsk Territory (where, however, likely may be found). The confirmed distribution starts from 64°29'N in Chukotka Autonomous district, where species occurs near hot springs (Sireniki Settl.) – an area for many taxa of relict or otherwise unusual distribution (Yurtzev 1974). Southwardly known in Commanders and areas adjacent to the coast in East and West Kamchatka. Surprisingly known in several localities of Kolyma Upland with substantively continental climate with very low amount of summer precipitation (near to 200 mm per year, with about half at summer time), although realized locally in low intensity of rains results in durable 'water spray' condition when amount of precipitation remains very low, but kept everything completely moist. As expected, it is distributed in Kurils (although only in Southern part of the island chain!) and Sakhalin, where locally abun-

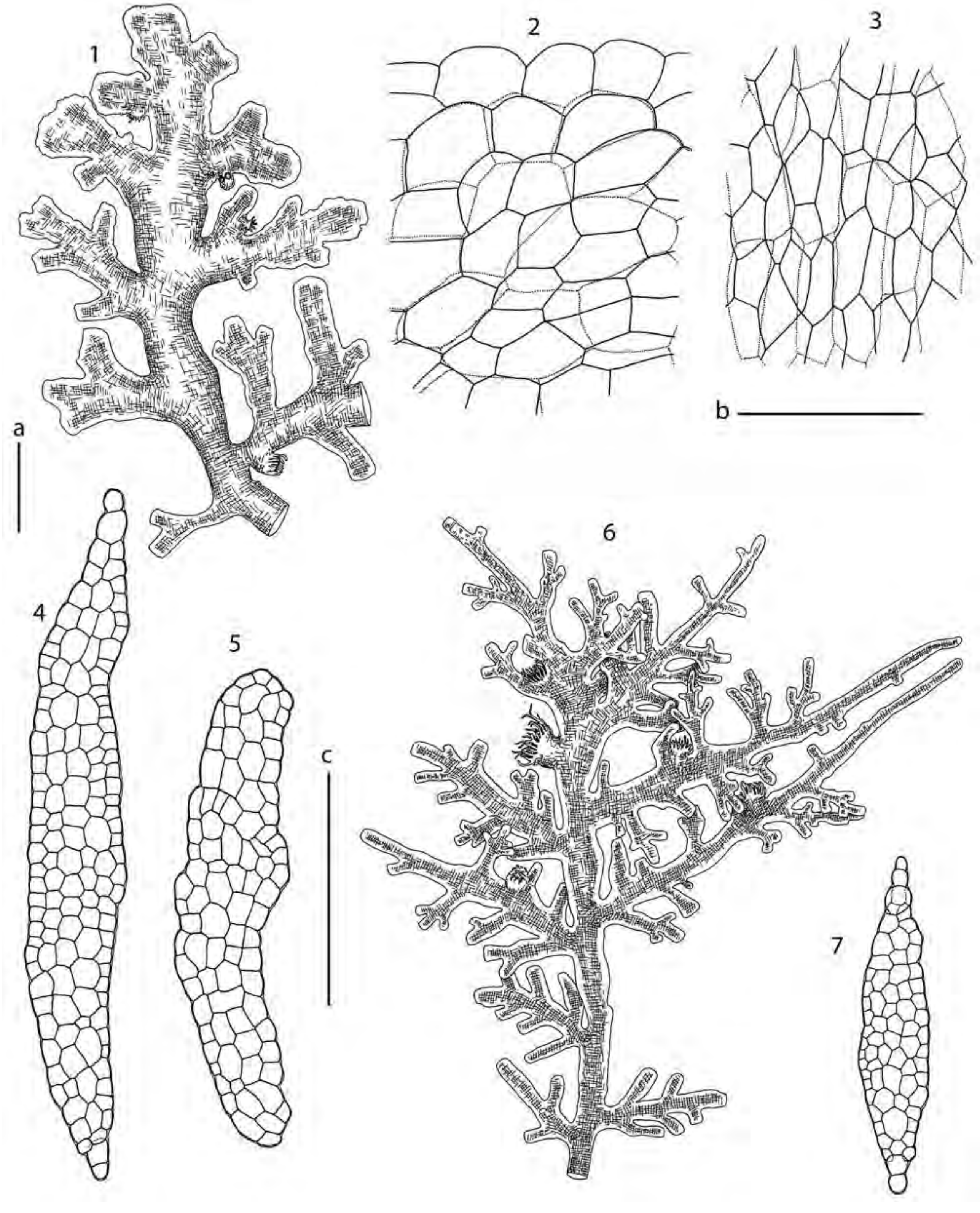

Figure 4 *Riccardia chamedryfolia* (With.) Grolle 1–5: 1 – plant habit, 2 – thallus margin, frontal view, 3 – thallus middle part, frontal view, 4, 5 – thallus cross section (all from K-72-17-15, VBGI). *Riccardia decrescens* (Steph.) S. Hatt. 6, 7: 6 – plant habit, 7 – thallus cross section (all from K-125-7-04, VBGI). Scales: a – 2 mm, for 1, 6, b - 200 μm, for 2, 3, c – 500 μm, for 4, 5, 7

dant. Once was found in Primorye Territory, where identification is, however, based on study of previously dried material. Most of localities are from low elevations below 300–400 m a.s.l. ranging from North to the South despite complete difference in vegetation communities across latitudinal range. Magadan Province localities are quite surprising: whereas the southernmost and the 'warmest' Magadan locality lies near sea coast at the elevation about 150 m a.s.l. the northern localities from Kolyma Upland (61–63°N) lies mostly between 800 and 1100 m a.s.l. The only reason ex-

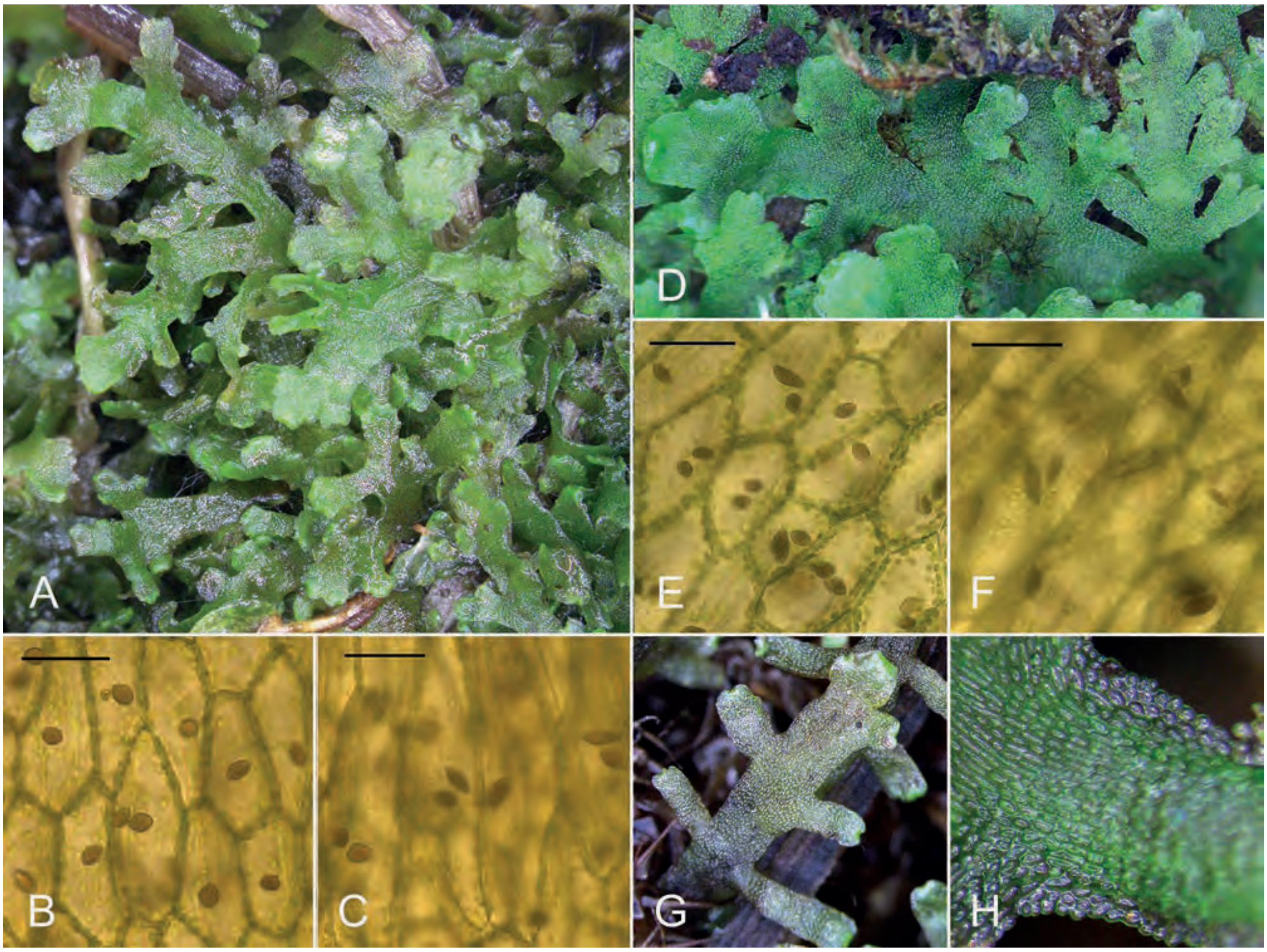

Figure 5 *Riccardia chamedryfolia* (With.) Grolle A–C: A, D – plant habit, B, E – epidermal cells of the thallus, C, F – inner cells of the thallus (A–C from K-72-17-15, D–F – from S-48-28-16, all in VBGI). *Riccardia aeruginosa* Furuki G – plant habit (from K-70-1-15, VBGI). *Riccardia decrescens* (Steph.) S. Hatt. H – thallus fragment (from Be-237-11-15, VBGI). Scales: 50 μm for B, C, E, F

plaining this distribution I see the phenomenon of wet air mass interception that additionally wets higher elevations of Kolyma Upland (and make, therefore, possible *R. chamegryfolia* survival there).

Ecology. Acidophilic to neutrophilic hygrophyte. Within the Russian Far East this species is known from true oligotrophic and mesotrophic mires and various wetlands like moist sedge meadows and wet tundras. It commonly grows over and among moss patches (mainly *Sphagnum*, *Aulacomnium*, *Tomenthypnum*), sometimes being intermingled with other hepatics like *Riccardia multifida*, *Aneura pinguis*, *Scapania paludicola*, *Harpanthus flotovianus* (Nees) Nees. In the areas with high air moisture and as exception the species may be found on decaying wood, where once with *Geocalyx graveolens* (Schrad.) Nees and *Metzgeria lindbergii* Schiffn. (!) (in this connection it worth to be mentioned the decaying wood is characteristic habitat type of the species in the Northern Japan, cf. Furuki 1991), over humificated stream and lake banks and even (in southernmost Kurils) in clayish roadsides. In general it is the species of intra-zonal communities like mires and meadows, although in the north it spreads to zonal tundras, whereas in the South – to the hemiboreal communities (especially those of Saso-Fagetalia crenatae Suz-Tok.). *Riccardia chamedryfolia* prefers open sites, although in the southern part of the Russian Far East it may occur in shady sites. The latter is the evident tendency, and in Japan the species is easily to observe (if even not dominantly) in such shady conditions.

Riccardia decrescens (Steph.) S. Hatt., Bull. Tokyo Sci. Mus. 11: 165. 1944. (≡ *Riccardia multifida* subsp. *decrescens* (Steph.) Furuki)

Description. Plants pale greenish to yellowish greenish and pale brownish, mostly among hydro- to hygrophilous mosses in loose patches, main axis 0.5–1.0 mm wide and 10–20 mm long, freely regularly to irregularly pinnately to bipinnately branched. Epidermal cells 30–125 × 20–38 μm, thin-walled, trigones wanting to vestigial; inner cells 120–300 × 37–63 μm, thin-walled, trigones wanting; margin crenulate, unistratose wing 2–3 cells wide, cells along margin 30–75 μm. Oil bodies in epidermal cells very scattered to virtually absent, by 1 per cell, in wing cell scattered (in ca. 30–40 % of cells), by 1, in inner cells 1–3 per cell, brownish, granulate, ellipsoidal to shortly fusiform. Cross section biconvex to plane(dorsal)-convex; outer cells 20–50 μm, thin-walled, with vestigial trigones; inner cells 35–95 μm, thin-walled, with small concave trigones, in 3–6 rows of cells. Synoicous, paroicous and autoicous, rarely dioicous(?).

Spores finely papillose, brown, 15–17 μm in diameter; elaters unispiral, 400–700 × 12–13 μm, with long homogenous ends to 225 μm long. (Figures 4: 6, 7; 6; 7; 8: 1, 2)

Comment. *R. decrescens* shows wide variation of inflorescence distribution, including autoicous, paroicous and synoicous. The dioicous inflorescence although was noted by Mizutani & Hattori (1957), was not supported by Furuki (1991). However, in one specimen from South Kurils (Kunashir, K-63-21-06) the only unfertilized archegonia and no traces of antheridia were found and the specimen may be regarded as the evidence of dioicous inflorescence of *R. decrescens*.

This species (unlike other taxa of the genus) is sometimes growing together with *R. chamedryfolia*, from which, however, it can be easily differentiated by well-developed unistratose crenulate wings, with thallus margin not crispate, narrower epidermal cells and narrower main axis, versus absent to unstable unistratose wing that if present is not crenulate, but with thallus margin commonly somewhat crispate. Some differences are also noted in size of epidermal cells.

The distinct feature of the species is the ability to acquire brown pigmentation in herbarium specimen, that sometimes is poorly developed (especially if drying conditions were favorable), but in the most cases it is well pronounced especially in the phases with relatively small epidermal cells (mod. densiretis), like K-63-6-06. Due to this feature most of the populations of *R. decrescens* can be distinguished from *R. chamaedryfolia* prior the plants would be soaked in the water in the identification process. On the other hand, this feature is somewhat similar to *R. aeruginosa* that commonly acquires brown pigmentation in herbarium too.

I observed sporophytes only twice in this species, both times the elaters were somewhat longer than provided by Furuki (250–500 μm long, cf. Furuki 1991), although the diapasons are largely overlapping.

Distribution. Imperfectly known, probably completely substitutes *R. multifida* in eastern fringes of Asia. Regarded by Furuki (1991, under ssp. *decrescens* (Steph.) Furuki) as endemic taxon of Japan, although later was found as relatively common in Korea (Choi 2013). The records of *R. multifida* from East China (Piippo 1991, etc.) should also belong to *R. decrescens*. Within Japan and Korea it is observed in various altitudes, regardless of latitude, e.g. in Miyazaki Pref. of southernmost Kyushu observed at 80 m a.s.l., whereas in middle Honshu known at 2500 m a.s.l. (Furuki 1991). Our Japanese collections are from slightly above 800 m a.s.l. in Shikoku. Within the Russian Far East the species is sparsely distributed (although locally abundant) through subarctic, boreal and hemiboreal zones under oceanic and suboceanic climates, distinctly avoids cool-temperate climate in the Far East (that everywhere in the latter is more dry than hemiboreal). Most of the localities lie below 100 m a.s.l., in stations near sea or oceanic coasts. A few locations are from slightly above 500 m a.s.l. in East Kamchatka in very wet subarctic mountainous vegetation under oceanic climate. Other relatively 'high' localities are from eastern slope of Badzhal Mountains (southern half of Khabarovsk Territory) that heavily locally wetted by 'intercepted' monsoon wet air masses going from Pacific Ocean.

Ecology. Acido- to neutrophilic hygrophyte. *Riccardia decrescens* is predominantly a species of swampy landscapes and lighted wetlands like wet *Carex* and *Juncus* meadows. It grows in micro-depressions between moss patches (contrary to *R. chamedryfolia* that commonly growing over patches) and on their sides. In swamps the species may be associated with *Calypogeia neogaea* (R.M. Schust.) Bakalin, *Cordaea flotoviana* Nees, *Harpanthus flotovianus* (Nees) Nees, *Riccardia chamedryfolia*, etc. The species may be locally abundant over peaty banks of sluggishly flowing streams. Throughout the northern part of area treated it prefers open sites. In southern part of the Far East it may grow in wet roadsides and steep slopes in insular part of the area, especially that near sea coast (under constant influence of wet air masses) in Saso-Fagetalia crenatae. The peculiar habitat of the species is the thermal pools and stream surroundings (registered temperature of flushing water is +22°C) in Chukotka Peninsula (the northernmost locality for the taxon), where *Riccardia decrescens* is associated with *Pellia neesiana* (Gottsche) Limpr., *Saccobasis polita* (Nees) H. Buch and *Solenostoma subellipticum* (Lindb. ex Heeg) R.M. Schust.

Riccardia latifrons (Lindb.) Lindb., Acta Soc. Sci. Fenn. 10: 513, 1875.

Description. Plants brownish greenish to yellowish brownish, irregularly and unclearly palmate or irregularly pinnate or bipinnate, the main axis 0.25–0.6 mm wide and 2–5(–6) mm long. Epidermal cells 5–7-gonal, 37–90 × 17–58 μm, thin-walled or walls slightly thickened, trigones vestigial to nearly absent; inner cells 75–125 × 30–63 μm, thin-walled, trigones vestigial; unistratose wing absent or 1(–2) cells wide, margin entire to loosely crispate or, rarely, crenulate. Oil bodies virtually absent in both inner and outer cells, or present as numerous droplets 1–2 μm in diameter. Cross section concave(dorsal)-convex to plane-convex, outer cells 25–50 μm, commonly elongated (dorsiventrally compressed) along margin; inner cells 32–50 μm, in 2–3 rows of cells. Autoicous. Androecia with 2–3(–4) pairs of antheridia. Spores papillose, brown, 12–13 μm in diameter; elaters unispiral, ca. 220 × 12 μm, with merely long (25–35 μm) homogenous ends. Gemmae bicellular, 25–35 × 20–25 μm, subquadrate to mostly ellipsoidal. (Figures 8: 3, 4; 9: A).

Comment. Schuster (1987, 1992) introduces ssp. *arctica* R.M. Schust. et Damsh. for the northernmost populations of the species that differs from ssp. *latifrons* in the number of disputable features like "main axis exhibiting persistent dominance", "secondary branches remain abbreviated", lunate versus biconvex cross section, frequency of gemmae production (supposedly common in ssp. *latifrons*) and wider thalli. On the one hand ssp. *arctica* resembles *R. latifrons* due to the absence of large oil bodies in both epidermal and inner cells, and, on the other hand inseparable in dry conditions from *R. chamedryfolia* due to the larger size. Although this question requires further studies, it should be noted that some of features are not reliable and main axis commonly remains dominated both in some southern localities in the Russian Far East and in northern that in the case of narrow main axis makes senseless this distinguishing fea-

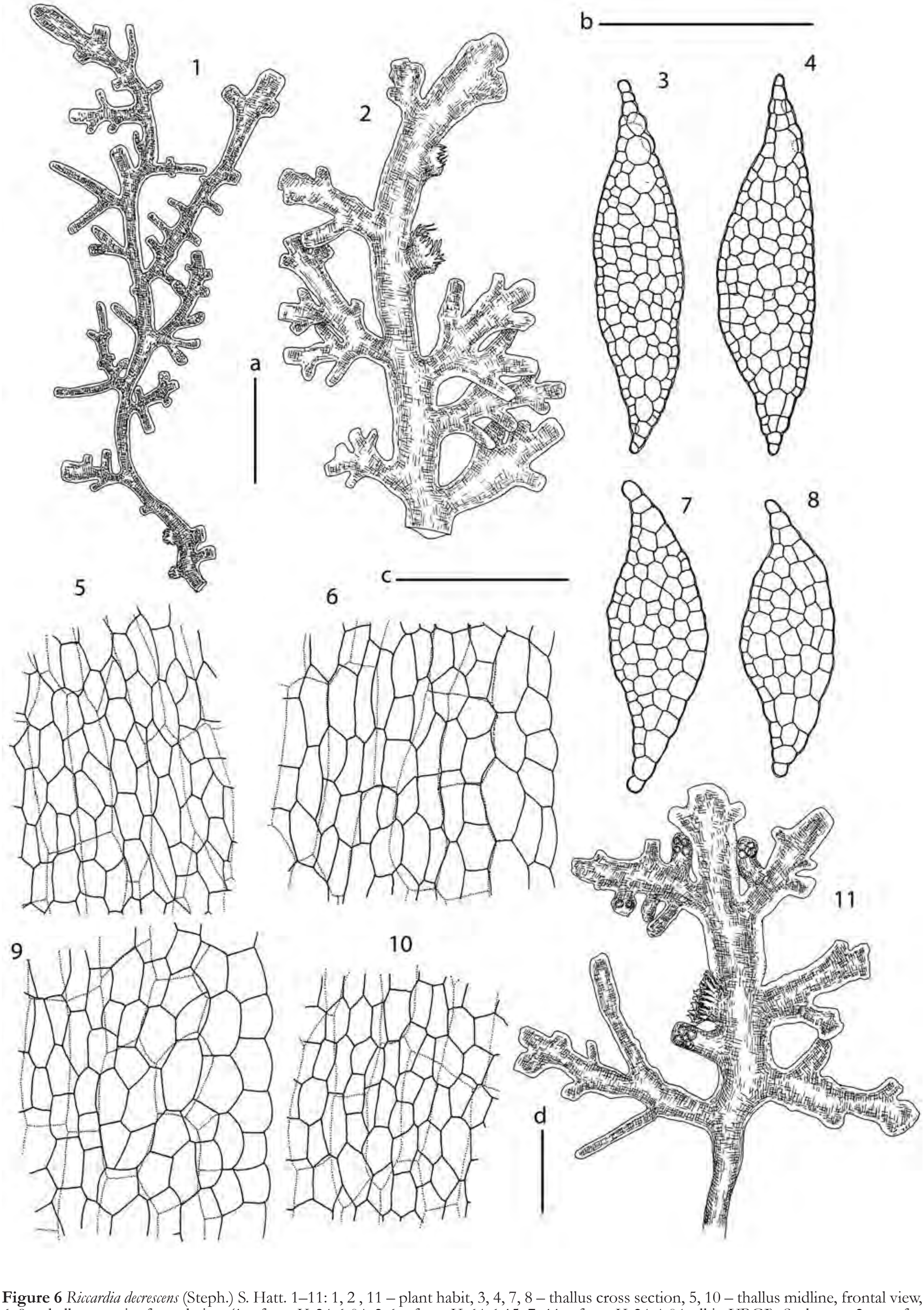

Figure 6 *Riccardia decrescens* (Steph.) S. Hatt. 1–11: 1, 2 , 11 – plant habit, 3, 4, 7, 8 – thallus cross section, 5, 10 – thallus midline, frontal view, 6, 9 – thallus margin, frontal view (1 – from K-24-6-04, 2-6 – from K-64-6-15, 7–11 – from K-24-4-04, all in VBGI). Scales: a – 2 mm, for 1, 2; b – 500 µm, for 3, 4, 7, 8; c – 200 µm, for 5, 6, 9, 10; d – 1 mm, for 11

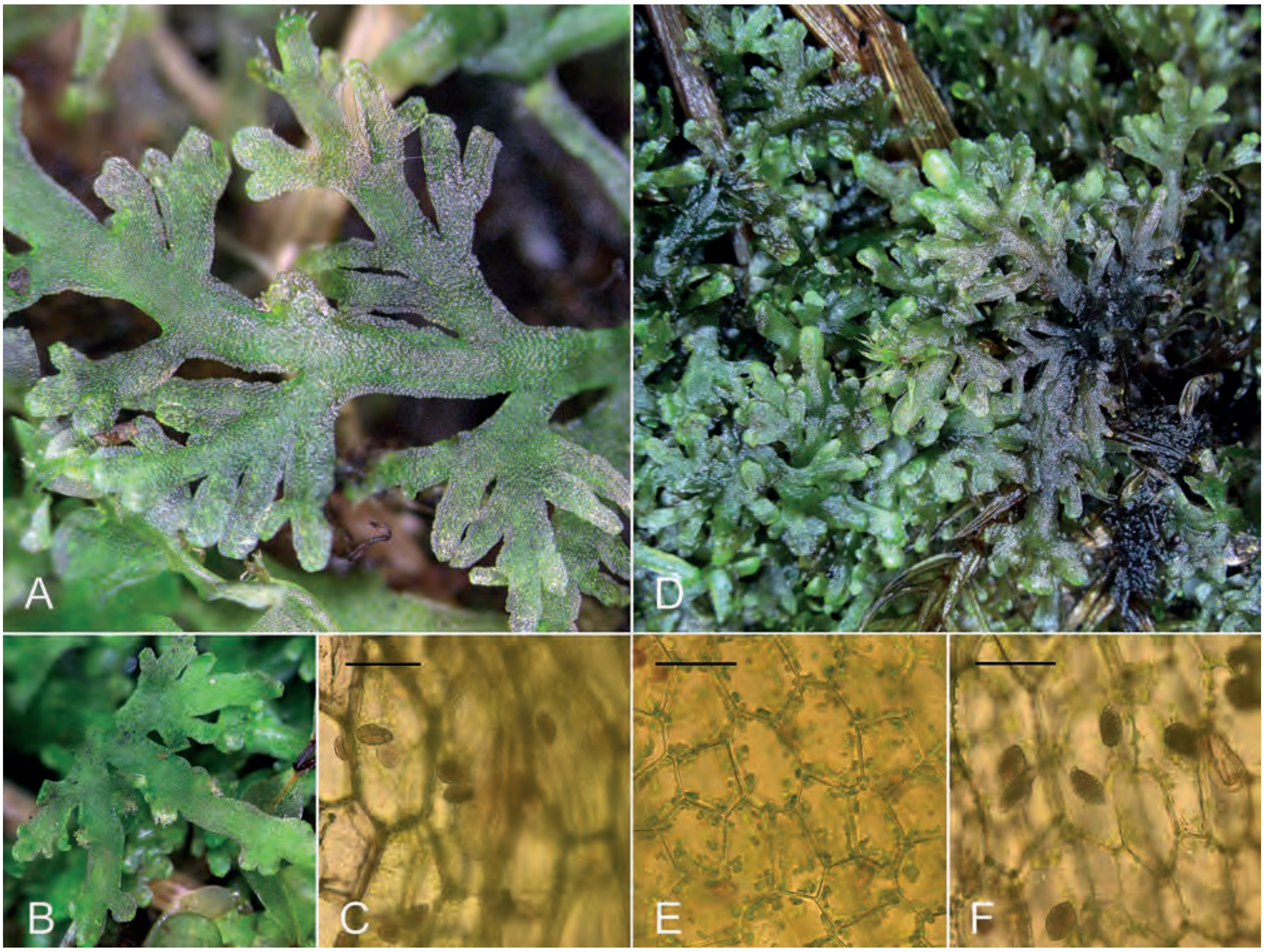

Figure 7 *Riccardia decrescens* (Steph.) S. Hatt.: A, B. D – plant habit, E – outer cells, C, F – inner cells (A – from Be-237-11-15, B, C – from K-64-6-15, D-F – from K-70-20-15, all in VBGI). Scales: 50 μm for C, E, F

ture. The noted (Schuster 1992) frequent gemmae production for ssp. *latifrons* (in contrast to absence of gemmae in ssp. *arctica*) is not reliable in the Russian Far East, since there is only one gemmiparous specimens of the taxon known in the Russian Far East due to data at hand, other specimens are gemmae free.

The southernmost form of the species (var. *miyakeana* (Schiffn.) Furuki) that could be hardly expected in the Russian Far East differs from var. *latifrons* in slightly smaller epidermal cells (25–60 × 25–40 μm, cf. Furuki 1991) and dioicous inflorescence.

Distribution. 'Holarctic' in Schuster (1992) or subboreal-montane in Damsholt (2002). Despite large and at the first look almost Holarctic range I think the species may be characterized as boreal-Hemiarctic with evident tendency to spread southward by the corresponding communities, rarely occurring in cool-temperate zone, where, if present, occupies unusual habitats that resembles those in Hemiarctic and boreal zones or having intrazonal nature. Despite Schuster (1992) noted strong penetration southward of boreal zone the associates he listed are essentially boreal or hemiarctic (*Calypogeia sphagnicola* (Arnell et J. Perss.) Warnst. et Loeske *Fuscocephaloziopsis loitlesbergeri* (Schiffn.) Váňa et L. Söderstr., *F. lunulifolia*, *Nowellia curvifolia* (Dicks.) Mitt., *Schistochilopsis incisa* (Schrad.) Konstant., etc.). Moreover, the accompanying taxa are essentially the same with that of the northern form ('ssp. *arctica*') that penetrates to the Arctic zone both in New and Old World. In the areas adjacent to the Russian Far East the species is throughout, although sparsely distributed in East and South Siberia, then as rarity in Korean Peninsula (only higher elevations), throughout northern to middle Japan, where ranging from near sea level to 800 m a.s.l. in Hokkaido and on nearly the same altitudes in northern Honshu, although southward, in Fukushima, Nagano, Yamanashi and Yamagata Prefectures becomes restricted to higher elevations (1450–2070 m a.s.l., Furuki 1991). Starting from the middle Japan and to its southernmost tips it is replaced in lowlands by *R. latifrons* var. *miyakeana* – the taxon of unclear status and obviously imperfectly known distribution. In China (Piippo 1991) recorded from Heilongjiang and Jilin (where likely could be distributed) and, after gap, from Guangdong and Taiwan (from where records are doubtful in my opinion, or should belong to var. *miyakeana*). The Russian Far East records starts from Magadan Province, where elevation ranges from very near to sea level in coastal areas to (with the 'gap' between) 1000–1100 m a.s.l. in mountainous areas of Kolyma Upland. This unexpected occurrence may be explained by the

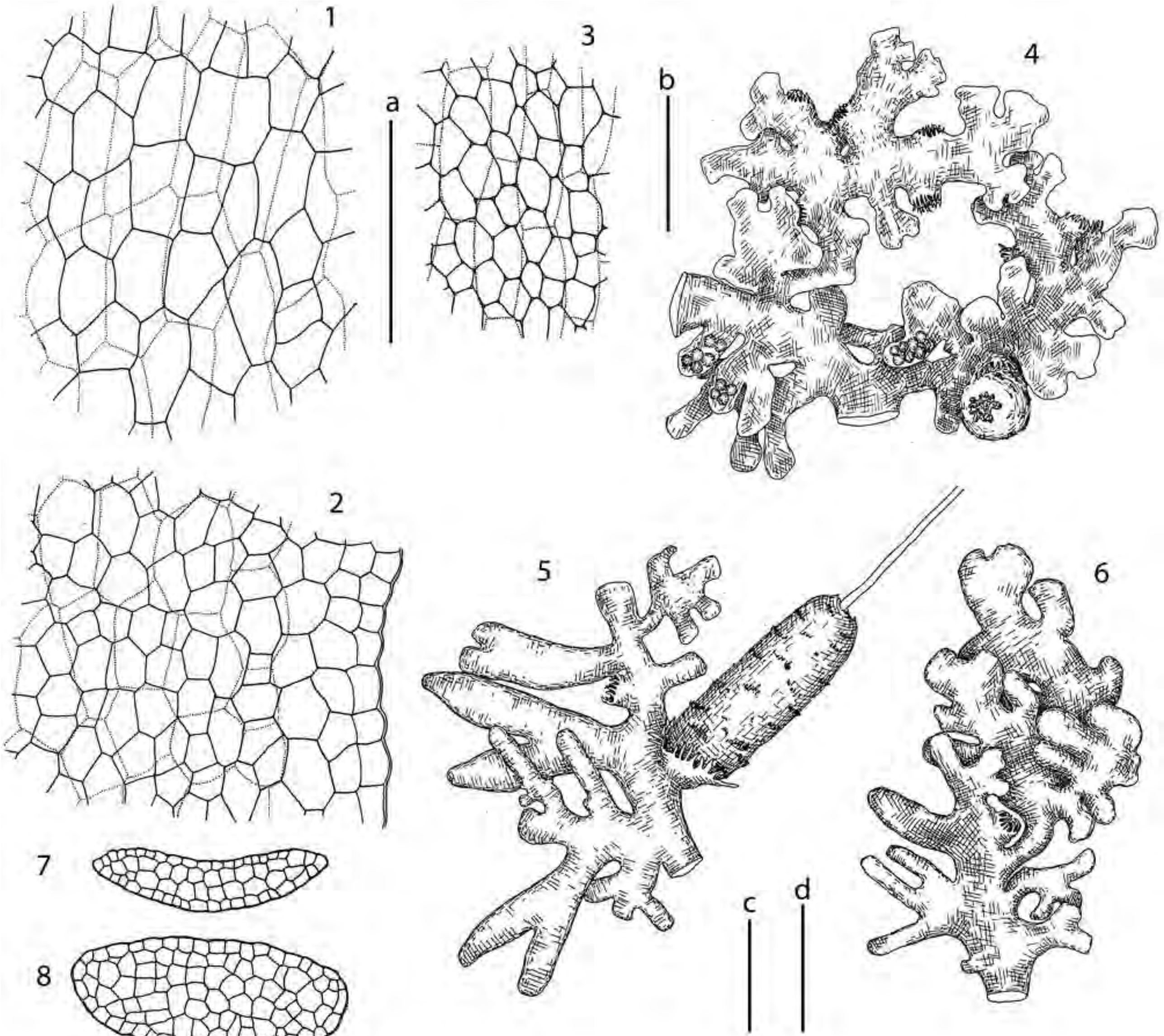

Figure 8 *Riccardia decrescens* (Steph.) S. Hatt.1, 2: 1 - thallus midline, frontal view, 2 – thallus margin, frontal view (all from K-125-7-04, VBGI). *Riccardia latifrons* (Lindb.) Lindb. 3, 4: 3 – thallus midline, frontal view, 4 – plant habit (all from S-57-3-09, VBGI). *Riccardia palmata* (Hedw.) Carruth. 5–8: 5, 6 – plant habit, 7, 8 – thallus cross section (all from P-17-18-12). Scales: a – 200 μm, for 1–3; b – 1 mm, for 4; c – 200 μm, for 7, 8; d – 1 mm, for 5, 6.

same factors as noted for Kolyma localities of *R. chamedryfolia*. Within Kamchatka the confirmed records are from low elevation near Petropavlovsk-Kamchatski City that is in the south-eastern flank of the peninsula and from high elevation (1300 m a.s.l.) in Anaun dormant volcano in Central Kamchatka, where the habitat may be additionally wetted by intercepted wet air masses going from the Pacific. In Khabarovsk Territory it is known from low elevations both in northern and southern extremities of the land (Okhotsk, De Castri), whereas in localities distanced from the sea in the middle part of the territory observed at the elevations ranged from 600 to 850 m a.s.l. Relatively common in Sakhalin Province, being reported from South Kurils and eastern Sakhalin Island, where elevation ranges from the near to sea level to almost 1000 a.s.l. In Primorye Territory relatively rare and known from limited number of localities in Sikhote-Alin at the elevations from 240 to 420 m a.s.l.

Ecology. Acidophilic hygrophyte. The species, both in the terms of morphology and somewhat in distribution and ecology, is similar to *Riccardia palmata*, however, *R. latifrons* is characterized by more northern distribution, tendency to occupy open sites and wetter habitats. It occurs from tundra to hemiboreal zones, being rare in the latter. Southward in Japan the type variety of the taxon occurs in oroboreal and subalpine communities. Starting from tundras and even alpine heathlands, where growing in wet depressions and over mossy patches, along humificated stream banks and wet cliffs covered with fine soil, the species going southward by stream banks, rarely occurring in decaying wood. Southward, in Japan, the decaying wood becomes more common habitat type for the species than stream banks and rocks. In peaty banks of lakes and streams it forms pure patches or associated with *Kurzia makinoana*, *Scapania irrigua* (Nees) Nees, *Cephalozia bicuspidata*. In mires, wet tundras and moist

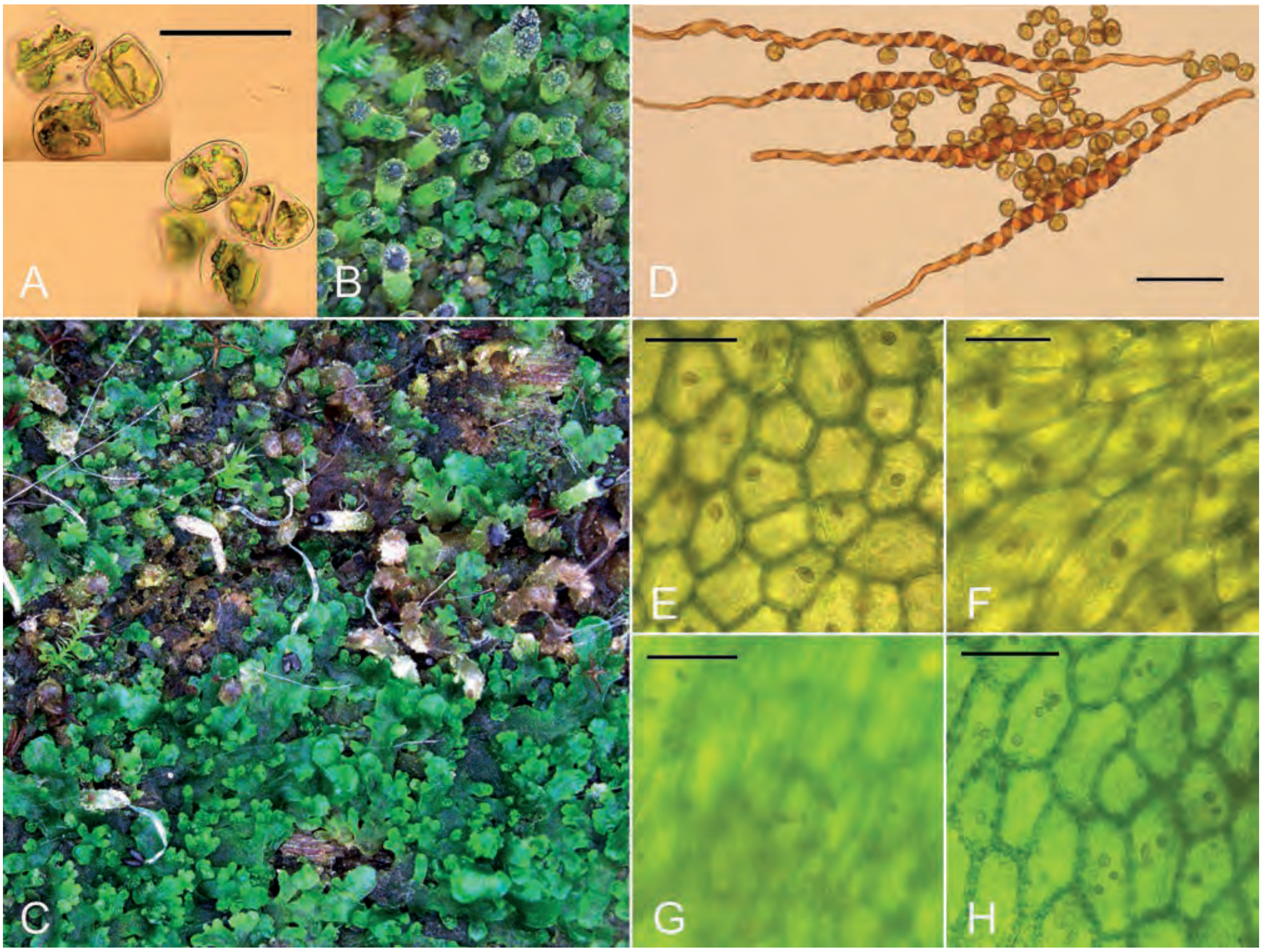

Figure 9 *Riccardia latifrons* (Lindb.) Lindb. A – gemmae (from Mag-28-27-13, VBGI). *Riccardia palmata* (Hedw.) Carruth. B, D–F: B, D – spores and elaters, E – outer cells, F – inner cells (B – from P-31-20-15, C – from P-36-3-15, D – from P-31-20-15, E, F – from S-43-21-16, all in VBGI). *Riccardia vitrea* Furuki C, G, H: C – plant habit, G – inner cells, H – outer cells (all from P-36-3-15, VBGI). Scales: 50 μm for A, D–H.

meadows it commonly braids basal parts of *Carex* stems, *Sphagnum* shoots or growing over mossy carpets.

Riccardia palmata (Hedw.) Carruth., J. Bot. 3: 302, 1865

Description. Plants green to greenish brownish, in loose pure patches or in the mixture with other hepatics (and rarely mosses), palmately or (rarely) irregularly pinnately branched, main axis 0.2–0.3 mm wide and 2–3 mm long. Epidermal cells 37–85 × 20–25 μm, thin-walled, with wanting to vestigial trigones; inner cells 90–140 × 30–45 μm, thin-walled, trigones vestigial; unistratose wing absent, margin entire. Oil bodies pale grayish to nearly colorless, 1–2 per epidermal cell, present in 40–90 % of cells, spherical to shortly oblong, in inner cells 1–2 per cell, shortly oblong. Cross section biconvex, epidermal cells 17–30(–33) μm, inner cells 17–35 μm, in 4–5(–6) rows of cells. Dioicous. Androecia terminal on short specialized branches, rarely intercalary. Spores brown, very finely papillose, 10–12 μm in diameter; elaters unispiral, 300–400 μm long, 10–13 μm thick, with long homogenous ends. (Figures 8: 5–8; 9: B–F).

Comment. This is a very variable species commonly characterized by dioicous inflorescence and oil bodies present in outer and inner cells. However, one specimen (P-74-9-11) is morphologically indistinguishable from *R. palmata*, although inflorescence is autoicous (that may suspect *R. latifrons* due to the plant size), but oil bodies are absent in outer cells and present in inner cells, but 3–7, granulate and grayish. The molecular investigation of this specimen is needed.

Distribution. Essentially boreal to warm temperate circumpolar, with rare remote occurrences in New World Arctic (as far as 77°N in Greenland, cf. Schuster 1992), not known in Eurasian Arctic. In the areas adjacent to the Russian Far East it is distributed through the East (not known in its Arctic part) and South Siberia vanishing northward and abundant in the south, mostly in lower elevations in dark coniferous (*Picea*, *Abies*) forests, rarely occurring in *Larix* communities. Common in Japan through Hokkaido to Kyushu, where ranging from 300 m a.s.l. in Hokkaido to 2200 m a.s.l. southward in Honshu, although even in the southernmost localities (like Miyazaki Pref. in Kyushu) it also may be observed at relatively low elevation, ca. 300 m a.s.l. (Furuki 1991). Sparsely distributed (although locally abundant) in Korean Peninsula. In China reported from the North-East (Jilin Province), then in Shaanxi Province and in southern China as far as from Yunnan, Hunan, Zhejiang, Fujian and Taiwan Provinces (Piippo 1991). In the Russian Far East ranging from Kamchatka (one confirmed locality in Central Kamchatka, where in tundra belt), middle elevations of northern Sikhote-Alin in Khabarovsk Territory, uncommon in Sakhalin Province, where it is restricted to low elevations (80–150 m a.s.l.) dark coniferous forests in 46 to 51°N in Sakhalin Island. Widespread in Primorye Territory where ranges from 60 to 1000 m a.s.l., being most common in the elevations between 500 and 700 m a.s.l. The reports for northern part of Khabarovsk Territory (Bakalin 2010), Amur Province (Gambaryan & Cherdantseva 1998) and Magadan Province (Blagodatskikh & Duda 1988) were not confirmed in the present study.

Ecology. Acidophilic mesophyte. Contrary to all other taxa of the genus in the Russian Far East, *Riccardia palmata* prefers shady decaying wood, only as exception occurring in mountain tundras over wet mossy patches. Due to the latter, the most common associate plants of the species are the obligate or facultative epixylous taxa like *Blepharostoma trichophyllum* (L.) Dumort. s. str., *Fuscocephaloziopsis lunulifolia*, *Lophocolea heterophylla* (Schrad.) Dumort., *Nowellia curvifolia*, *Scapania apiculata* Spruce, *S. carinthiaca* J.B. Jack ex Lindb., etc. Contrary to other taxa of the genus, *Riccardia palmata* commonly occurs in forests, starting from boreal coniferous forests (including oroboreal belt in the mountains) then to hemiboreal mixed and broadleaved temperate forest in southern part of the Russian Far East. The species is freely spreading southward of the Russian Far East and occurs as far as in southern Japan in low elevation belts (where also occupies decaying wood) in the southern variant of evergreen subtropical forests (with Arecaceae).

Riccardia subalpina Furuki, J. Hattori Bot. Lab. 70: 367, 1991

Comment. The species was described by Furuki (1991) who noted its common distribution "in and above subalpine zone" in Hokkaido and Honshu. Unfortunately he (l.c.) does not provide specimen citation from Hokkaido, all localities in Honshu are between 1600 and 2000 m a.s.l. The species prefers decaying wood in oro-boreal dark coniferous (subalpine belt in Japanese tradition means *Abies* and *Picea* mountain forests). Therefore the habitat is quite similar to that for *Riccardia palmata*. Moreover the morphology of *R. subalpina* is quite similar to the latter taxon too that was also noted by Furuki (1991). The only difference provided by the latter author is difference in sex distribution. *R. palmata* is uniformly dioicous, whereas *R. subalpina* is heteroicous, with male, female and paroicous branches are abundant. Certainly it brings up the question what we can do if only dioicous branches are available for study. Other differentiation, not mentioned by Furuki, (applicable only when fresh material is available) may be probably found in oil bodies. *R. subalpina* has oil bodies by 1 in epidermis (where scattered like those in *R. palmata*) and inner cells, whereas *R. palmata* has 1–2(–4) oil bodies in outer and inner cells. However, there are populations of *R. palmata* where number of oil bodies is limited by 1, like in *R. subalpina*.

The specimen mentioned above (P-74-9-11) under *Riccardia palmata*, should be discussed here again. Originally I suspect it belongs to *R. subalpina*, however, it has only autoicous inflorescence and several oil bodies in inner tissue cells (both features are not noted in *R. subalpina*). The specimen may belong to poorly known *R. flagellifrons* C. Gao from North-East China, but we do not have the material to compare our plants with the latter species.

Riccardia vitrea Furuki, J. Hattori Bot. Lab. 70: 327, 1991

Description. Plants brownish greenish to yellowish brown, in dense patches, closely adjacent to the substratum, irregularly pinnately or palmately (rarely very irregularly bipinnately) branched, main axis 0.4–0.7 mm wide and 2–5 mm long. Epidermal cells subisodiametric to shortly oblong, 5–7-gonal, thin-walled, trigones vestigial, walls brownish, 32–75 × 17–50 μm; inner cells 67–108 × 25–58 μm, thin-walled, trigones wanting; unistratose wing absent. Oil bodies brownish, finely granulate, 3–5 per epidermal cell, spherical, 3-6 μm in diameter to shortly ellipsoidal 4–5 × 4–8 μm, in inner cells 1–3 per cell, shortly ellipsoidal to irregularly shortly oblong in shape, 5–7 × 5–10 μm. Cross section concave(dorsal)-convex; epidermal cells 37–58 μm (commonly oblong along margin); inner cells 40–75 μm, irregular in shape, trigones wanting, in 2–3 rows of cells. Gemmae 57–65 × 35–38 μm, bicellular, in masses over dorsal surface over pinnule apices. [Dioicous. Elaters shortly tapered, 75–200 × 10–12 μm; spores 11–13 μm in diameter (Furuki 1991)]. (Figures 9: G, H; 10).

Comment. This species was already recorded from southernmost flank of Kunashir Island that is the southernmost tip or the insular Russian Far East. However *Riccardia vitrea* may be distributed slightly wider than it was estimated, and the reason of its rarity may be in its misidentification for other taxa, especially for *R. latifrons* or *R. palmata* (when sterile and dry material is at hand). However, the presence of oil bodies in fresh material (contrary to virtual absence in *R. latifrons*) and their regular occurrence, smaller size and more numerous in epidermal cells (versus scattered and smaller in *R. palmata*), relatively small cells (highly unstable feature) and well developed main axis help the delimitation of the taxon from other our species.

Distribution. Cool- to warm temperate amphi-Pacific East Asian. Regarded as Japan endemic plant by Furuki (1991) with several records from Honshu to Yakushima, throughout restricted to low elevations with the highest in Yakushima (600 m a.s.l.). After it was recorded in southernmost Kurils (Kunashir, Bakalin et al. 2009) where it was found very near to sea level and then found in Primorye Territory also at low elevation and very near to sea coast. Another report is also from lower altitude (60 m a.s.l.) from the southernmost flank of the Far East (Kedrovaya Pad' Reserve in East Manchurian Mts.), where the species was collected on decaying wood in broadleaved deciduous temperate forest. The latter habitat contradicts the habitats described in Furuki (1991) and also our records. The report from Iturup (Bakalin 2010) could not be confirmed in the present study (the voucher was not found).

Ecology. Within Japan, this species occurs in moist rocks, bare soil (including roadsides) and wet gravel (Furuki 1991). These preferences are similar to two specimens from the Russian Far East, both found in open moist soil, although in Primorye Territory it is clayish ground, whereas in Kunashir (one of the wettest lowland areas in the Far

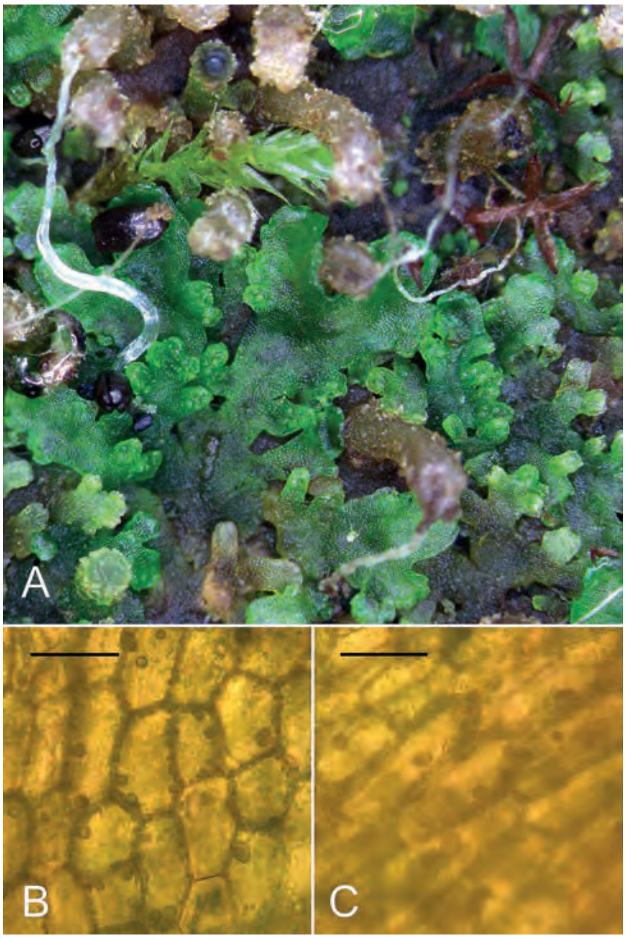

Figure 10 *Riccardia vitrea* Furuki: A – plant habit, B – inner cells of the thallus, C – inner cells of the thallus (A – from P-36-3-15, B, C – from P-41-15a-16, all in VBGI). Scales: 50 μm for B, C

East) it is growing on wet sand. The species forms pure patches or associated with *Solenostoma rotundatum* Amakawa. The habitat in one locality of the species in the Russian Far East contradicts to other known species (worth to be noted, only a few is known on ecology of the species also outside of treated area), the species was collected on decaying wood in part shade in broadleaved deciduous temperate forest.

PHYTOGEOGRAPHIC COMPARISONS

The frequency of *Riccardia* in the Russian Far East shows high correlation with air moisture in the area and the duration of vegetation season. The genus is more taxonomically diverse and taxa are more abundant locally in the areas wetted with air masses going from the Pacific or due to the local air circulation features. The richest flora in the area is in the South Kurils and then diversity decreases to Primorye Territory, Sakhalin and Kamchatka. The lowest number of taxa is in Amurskaya and Magadan Provinces and Chukotka Autonomous district. Moreover, at the distance from sea coast, where lower layer of air masses is poor in moisture, the representatives of the family are more abundant in higher elevations that intercept moist air masses going from the Pacific. Certainly, the lower number of taxa (e.g. only 1 recorded for Amur Province) may be explained partly by poor studies, although the general regularity of decreased number of taxa recorded far from the Ocean should remain.

Contrary to *Riccardia*, the distribution of *Aneura* within the Russian Far East is better understood. The first reason I see is the larger size of plants that is difficult to overlook. However there is the complex problem of taxa boundaries in *A. pinguis* group. Basically 'hygrophyte' race is distributed in northern areas only slightly penetrate southward along mountain ranges. On the other hand the 'mesophyte epixylous' race is abundant in southern half of the Far East and vanishing north of 50°N. *Aneura maxima* is entering to the Far East in the southernmost Kurils and Sakhalin only. The absence of this species northward may be explained by both thermal regime and decreasing of air moisture.

Due to the data at hand, the total diversity of *Riccardia* is still need in further study and the new records for this large and relatively diverse land are possible. The knowledge of intra-Far Eastern distribution of taxa is still fragmentary. Taking into account noticeable genetic diversity within Aneuraceae together with limited number of operable features in sterile and dried material, the study of fresh material with preserved oil bodies, as well as the large sampling for DNA investigations is urgently necessary for the future understanding of taxonomic diversity of the family in northern Pacific.

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APPENDIX: SPECIMENS EXAMINED

(all materials are in VBGI, the collector name is given in full with the exception of V. Bakalin who is abbreviated to VB)

Aneura maxima JAPAN, Fukuoka Pref., Hiko Mt., (33°27'33''N 130°53'48''E), 570 m alt., VB, 14.III.2014, J-4-58-14, (33°28'20''N 130°54'07''E), 800 m alt., VB, 17.III.2014, J-7-46-14, Kochi Pref., Shiofuri Falls, (33°48'09''N 133°41'15''E), 500 m alt., VB, 25.III.2015, J-11-43-15, Miyazaki Pref., Kaeda Stream Valley, (31°46'49''N 131°22'29''E), 200 m alt., VB, 07.X.2015, J-91-6-15, Tottori Pref., Amedaki waterfall, (35°28'43''N 134°24'04''E), 391 m alt., VB, 12.III.2013, J-10-9-13. REPUBLIC OF KOREA, Gyeongsang Prov., (34°50'58''N 128°41'20''E), 540 m alt., VB, 07.XII.2014, Kor-44-1-14. RUSSIA, Sakhalin Province, Iturup Island, (45°11'28''N 148°20'41''E), 10 m alt., VB, 20.IX.2015, K-80-21-15, (45°21'26''N 148°37'11''E), 20 m alt., VB, 12.IX.2015, K-72-22-15, (45°11'28''N 148°20'41''E), 20 m alt., VB, 20.IX.2015, K-80-29-15, (44°45'18''N 147°13'51''E), 10 m alt., VB, 17.VIII.2007, K-30-19-07, Makarovsky District, (48°26'50''N 142°42'21''E), 60 m alt., VB, 30.IX.2016, S-47-1-16. VIETNAM, Lao Cai Prov., SaPa, (22°18'11''N 103°46'31''E), 3100 m alt., VB, 17.III.2016, V-3-21-16.

Aneura pinguis JAPAN, Kochi Pref., Hiraishi, (33°49'15''N 133°27'30''E), 820 m alt., VB, 24.III.2015, J-8-4-15, Yasu-cho, (33°35'00''N 133°50'20''E), 240 m alt., VB, 23.III.2015, J-4-21-15, Miyazaki Pref., Sakatani, (31°38'15''N 131°14'46''E), 180 m alt., VB, 07.II.2014, J-2-34-14, Yamanashi Pref., Komagadake, (35°44'44''N 138°14'02''E), 2270 m alt., VB, 01.X.2015, J-88-6-15. REPUBLIC OF KOREA, Dong River, (37°17'11''N 128°38'01''E), 256 m alt., VB, 26.IV.2015, Kor-19-1-15, Ilunmyeon, (34°50'58''N 128°41'20''E), 540 m alt., VB, 07.XII.2014, Kor-44-9-14, Namhae Island, (34°42'46''N 127°58'43''E), 65 m alt., VB, 21.V.2011, Kor-23-03-11, Seokbyeong, (37°33'46''N 128°51'14''E), 675 m alt., VB, 25.IV.2015, Kor-14-2-15. RUSSIA, Kamchatka Territory, Aag Volcano, (53°26'56''N 158°38'17''E), 1280 m alt., VB, 18.VIII.2015, K-66-1-15, Alnej Mt., (56°39'20''N 159°29'28''E), 1000 m alt., VB, 13.IX.2004, K-133-73-04, Anadyrka River, (59°25'15''N 160°30'24''E), 48 m alt., VB, 15.VI.2003, K-28-6-03, Apacha Hot Springs, (52°52'58''N 159°19'49''E), 184 m alt., VB, 07.VI.2003, K-16-2-03, Bakening Volcano, (53°54'34''N 158°03'35''E), 1450 m alt., VB, 07.VIII.2015, K-50-8-15, (53°56'27''N 158°01'31''E), 900 m alt., VB, 03.VIII.2015, K-43-22-15, Karaginsky Island, (58°57'39''N 164°15'43''E), 602 m alt., VB, 01.VIII.2005, K-20-1-05, (58°57'39''N 164°14'14''E), 324 m alt., VB, 01.VIII.2005, K-18-10-05, Klyuchevskoy Dol (55°59'56''N 160°56'56''E), s.d., Chernyadjeva I.V., 22.VIII.2004, s.n., Mednyj Island, (54°44'00''N 167°36'50''E), 200 m alt., VB, 04.VII.2004, K-63-9-04, (54°44'00''N 167°38'50''E), 300 m alt., VB, 02.VII.2004, K-42-4-04, (54°46'45''N 167°35'00''E), 268 m alt., VB, 02.VII.2004, K-50-6-04, Nalychevo, (53°34'30''N 158°50'23''E), 460 m alt., VB, 17.VIII.2015, K-63-5-15, (53°33'17''N 158°49'16''E), 388 m alt., VB, 15.VIII.2015, K-59-1-15, (53°30'33''N 158°46'40''E), 374 m alt., VB, 15.VIII.2015, K-58-8-15, Oksinskiye Hot Springs, (56°17'07''N 159°10'59''E), s.d., VB, 16.IX.2002, K-51-6-02, Sobolevo Settl., s.d., 10 m alt., O. Chernyagina, VII.1990, s.n., Ushkovsky Volcano, (56°10'55''N 160°21'32''E), 1166 m alt., VB, 21.VII.2003, K-44-7-03, (56°11'00''N 160°21'00''E), s.d., VB, 25.VII.2003, K-64-7-03, Khabarovsk Territory, Badzhal, (50°16'52''N 134°42'45''E), 570 m alt., VB, 11.VIII.2016, Kh-25-7-16, (50°17'10''N 134°42'49''E), 550 m alt., VB, 31.VII.2016, Kh-14-63-16, Tardoki-Yani Mt., (48°53'14''N 138°02'46''E), 2010 m alt., VB, 22.VIII.2013, Kh-36-24-13, (48°53'49''N 138°03'14''E), 1850 m alt., VB, 23.VIII.2013, Kh-39-2-13, (48°53'17''N 138°02'53''E), 1940 m alt., VB, 24.VIII.2013, Kh-40-7-13, (48°50'40''N 138°04'20''E), 871 m alt., VB, 20.VIII.2013, Kh-33-17-13, Krasnodar Territory, Msmyta, (43°31'37''N 40°00'03''E), s.d., N. Konstnatinova, 07.X.2009, K200-2-09, Krasnoyarsk Territory, Taimyr, (69°14'27''N 90°08'04''E), s.d., V. Fedosov, 17.VII.2015, 15-0317, Magadan Province, Kamennyj Venets, (59°31'13''N 150°40'17''E), 10 m alt., VB, 13.VIII.2013, Mag-28-18-13, Kilgansky Gory range, (61°11'43''N 153°55'56''E), 899 m alt., VB, 08.VIII.2012, Mag-21-17-12, (61°11'51''N 153°58'07''E), 1138 m alt., VB, 09.VIII.2012, Mag-25-1-12, (61°10'32''N 153°53'33''E), 886 m alt., VB, 11.VIII.2012, Mag-34-20-12, (61°11'46''N 153°58'20''E), 1180 m alt., VB, 09.VIII.2012, Mag-26-10-12, (61°11'39''N 153°56'36''E), 977 m alt., VB, 08.VIII.2012, Mag-23-22-12, (61°12'22''N 153°53'52''E), 1060 m alt., VB, 10.VIII.2012, Mag-32-32-12, Olskoye Plateau, (60°39'11''N 151°28'12''E), 1056 m alt., VB, 05.VIII.2014, Mag-29-25-14, (60°38'10''N 151°31'45''E), 1078 m alt., VB, 14.VIII.2012, Mag-38-18-12, (60°39'34''N 151°21'30''E), 1200 m alt., VB, 08.VIII.2011, Mag-50-9-11, (60°38'46''N 151°27'25''E), 1166 m alt., VB, 09.VIII.2011, Mag-

54-24-11, (60°39'09"N 151°21'35"E), 1400 m alt., VB, 08.VIII.2011, Mag-51-9-11, (60°41'09"N 151°14'44"E), 1085 m alt., VB, 11.VIII.2011, Mag-59-3-11, (60°39'01"N 151°24'59"E), 1200 m alt., VB, 09.VIII.2011, Mag-55-21-11, Zamkovaya Mt., (63°21'16"N 152°37'53"E), 630 m alt., VB, 31.VII.2011, Mag-44-27-11, Murmansk Province, Kandalaksha Bay, (66°33'00"N 33°07'00"E), s.d., N. Konstnatinova, 19.VIII.1992, s.n., Khibiny Mts., (67°40'23"N 33°38'17"E), 480 m alt., VB, 14.VI.2015, Mur-33-6-15, Primorye Territory, Elomovskiye Waterfalls, (43°14'45"N 133°43'05"E), 570 m alt., VB, 06.VI.2015, P-31-18-15, (43°14'45"N 133°43'05"E), 570 m alt., VB, 10.IX.2014, P-34-20-14, (43°14'05"N 133°44'07"E), 350 m alt., VB, 23.IX.2011, P-74-42-11, (43°14'45"N 133°43'05"E), 570 m alt., VB, 06.VI.2015, P-31-21-15, Falaza Mt., (43°06'03"N 132°47'21"E), 700 m alt., VB, 20.IX.2013, s.n., (43°06'18"N 132°47'15"E), 1000 m alt., VB, 26.VI.2012, P-17-21-12, Gorno-tayezhnaya scientific station, (43°42'04"N 132°08'38"E), s.d., M.A. Moskalyuk, 18.X.2005, s.n., Kedrovaya River, (43°05'19"N 131°32'02"E), 320 m alt., VB, 11.VII.2015, P-40-6-15, Khasansky District, (42°50'45"N 131°17'29"E), 12 m alt., VB, 28.IV.2016, P-6-2-16, Krasnoarmeysky District, (45°47'11"N 135°19'21"E), 255 m alt., VB, 07.XI.2009, s.n., Milogradovka River Basin, (43°26'32"N 134°13'20"E), 800 m alt., VB, 21.IX.2012, P-45-1-12, Povorotnaya Pad', (43°21'34"N 133°30'59"E), 340 m alt., VB, 22.IX.2011, P-71-4-11, Puzikov Pass, (43°39'06"N 133°35'03"E), 1250 m alt., VB, 14.IX.2014, P-37-23-14, Sikhote-Alin Reserve, (45°10'13"N 135°51'51"E), 745 m alt., K. Klimova, 21.VIII.2017, Prim-89-8-17, (45°09'13"N 135°52'54"E), 671 m alt., K. Klimova, 15.VIII.2017, Prim-73-10-17, Vladivostok City, (43°12'35"N 131°59'22"E), 46 m alt., VB, 11.X.2003, P-115-15-03, (43°12'33"N 131°59'49"E), 64 m alt., VB, 09.VI.2012, P-11-6-12, Republic of Karelia, Petrozavodsk City, s.d., s.d., N. Gruzdeva, 1998, s.n., Vidany Settl., (61°57'18"N 33°53'28"E), s.d., VB, 16.V.1998, s.n., Zaozer'ye, (61°52'46"N 34°22'34"E), s.d., VB, 12.IX.1997, s.n., Sakhalin Province, Bol'shoye Vavayskoye Lake, (46°34'39"N 143°18'33"E), 10 m alt., VB, 27.IX.2016, S-43-19-16, Iturup Island, (45°21'45"N 148°37'13"E), 23 m alt., VB, 10.IX.2015, K-70-6-15, (45°20'02"N 148°37'04"E), 100 m alt., VB, 11.IX.2015, K-71-33-15, Kunashir Island, (44°17'20"N 146°18'00"E), 40 m alt., VB, 12.IX.2006, K-56-13-06, Paramushir Island, (50°15'20"N 155°32'45"E), 70 m alt., VB, 02.VIII.2004, K-114-4a-04, (50°38'55"N 156°07'32"E), 10 m alt., VB, 13.VII.2004, K-75-14-04, Shumshu Island, (50°41'15"N 156°15'50"E), 170 m alt., VB, 15.VIII.2004, K-125-15-04, Stavropol' Territory, Kislovodsk, (43°53'18"N 42°44'37"E), 935 m alt., M. Dulin, 24.XII.2015, s.n. SWITZERLAND, Valais, canton, Champex, (46°01'44"N 07°05'24"E), 2000 m alt., VB, 28.IX.2013, Sw-48-15-13. U.S.A., California, Shasta County, (40°31'00"N 121°27'00"W), 1950 m alt., M. Ignatov, 27.VIII.1989, s.n., Wyoming, Fremont County, (42°50'00"N 109°04'00"W), 3100 m alt., Ye. Kosovich-Anderson, 08.VIII.2012, 13393. VIETNAM, Lai Chau, Hoang Lien Son Range, (22°20'55"N 103°46'03"E), 1800 m alt., VB, 13.III.2016, V-1-110-16

Riccardia aeruginosa RUSSIA, Sakhalin Province, Iturup Island, (45°21'45"N 148°37'13"E), 23 m alt., VB, 10.IX.2015, K-70-1-15, Kunashir Island, (44°03'19"N 145°50'18"E), 15 m alt., VB, 09.IX.2006, K-51-7-06.

Riccardia chamedryfolia JAPAN, Tottori Pref., Amedaki Falls, (35°28'43"N 134°24'04"E), 391 m alt., VB, 12.III.2013, J-10-11-13, Fukuro-gawa, (35°28'43"N 134°24'04"E), 391 m alt., VB, 12.III.2013, J-10-8-13. RUSSIA, Chukotka Autonomous Region, Sireniki Settl., (64°29'06"N 173°43'19"E), s.d., A. Katenin, 12.VII.1986, s.n., (64°29'06"N 173°43'19"E), s.d., A. Katenin, 20.VIII.1986, s.n., Kamchatka Territory, Mednyj Island, (53°43'30"N 167°40'45"E), 40 m alt., VB, 01.VII.2004, K-24-6-04, (53°43'30"N 167°40'45"E), 40 m alt., VB, 01.VII.2004, K-24-18-04, Nalychevo, (53°30'33"N 158°46'40"E), 374 m alt., VB, 15.VIII.2015, K-58-7-15, (53°30'33"N 158°46'40"E), 374 m alt., VB, 15.VIII.2015, K-58-2-15, Nasekina River, (52°50'00"N 156°15'00"E), 10 m alt., VB, 04.VI.2003, K-11-4-03, (52°50'00"N 156°15'00"E), 10 m alt., VB, 05.VI.2003, K-14-19-03, Petropavlovsk-Kamchatsky, (52°57'59"N 158°42'33"E), 56 m alt., VB, 30.V.2004, K-7-3-04, Magadan Province, Bol'shoj Tuonnakh Range, (63°15'50"N 151°03'28"E), 1106 m alt., VB, 23.VII.2011, Mag-28-41-11, Kilgansky Gory range, (61°10'32"N 153°53'33"E), 886 m alt., VB, 11.VIII.2012, Mag-34-45-12, Magadan city, (59°34'13"N 150°38'32"E), 150 m alt., VB, 08.VIII.2014, Mag-33-9-14, Seimchan River, (63°17'12"N 152°09'51"E), 387 m alt., VB, 14.VI.2010, Mag-16-14-10, Sukhokhy Stream, (62°06'46"N 149°28'58"E), 1090 m alt., VB, 29.VII.2014, Mag-22-30-14, Primorye Territory, Il'inka Settl., (44°45'00"N 131°58'00"E), 90 m alt., VB, 11.VII.2010, P-24-1-10, Republic of Karelia, Paanajarvi, s.d., s.d., VB, 10.VIII.1997, s.n., Sakhalin Province, Iturup Island, (45°21'26"N 148°37'11"E), 20 m alt., VB, 12.IX.2015, K-72-17-15, Kamyshovyy Range, (50°52'56"N 142°21'44"E), 365 m alt., VB, 05.IX.2009, S-57-30-09, Kunashir Island, (44°03'19"N 145°50'18"E), 15 m alt., VB, 09.IX.2006, K-50-15-06, (44°03'19"N 145°50'18"E), 15 m alt., VB, 09.IX.2006, K-50-16-06, Nevelsky Pass, (46°44'23"N 142°01'12"E), 311 m alt., VB, 17.IX.2009, S-68-16-09, (46°42'25"N 142°08'03"E), 242 m alt., VB, 17.IX.2009, S-67-1-09, Yuzhno-Sakhalinsk Mud Volcano, (47°04'43"N 142°34'49"E), 268 m alt., VB, 04.IX.2005, s.n., (47°04'43"N 142°34'49"E), 268 m alt., VB, 04.IX.2005, s.n., (47°04'43"N 142°34'48"E), 268 m alt., VB, 04.IX.2005, S-40-51-05, Zhdanko Mt., (48°05'28"N 142°31'30"E), 250 m alt., VB, 01.X.2016, S-48-28-16 U.S.A., California, Mono Co., (37°58'00"N 119°16'00"W), 3100 m alt., M. Ignatov, 03.IX.1989, s.n.

Riccardia decrescens JAPAN, Kochi Pref., Hiraishi, (33°49'15"N 133°27'30"E), 820 m alt., VB, 24.III.2015, J-8-24-15, (33°49'15"N 133°27'30"E), 820 m alt., VB, 24.III.2015, J-8-22-15. RUSSIA, Kamchatka Territory, Mednyj Island, (53°43'30"N 167°40'45"E), 40 m alt., VB, 01.VII.2004, K-24-4-04, (53°43'30"N 167°40'45"E), 40 m alt., VB, 01.VII.2004, K-24-6-04, (54°43'30"N 167°40'45"E), 40 m alt., VB, 01.VII.2004, K-24-11-04, Nalychevo, (53°26'42"N 158°41'40"E), 550 m alt., VB, 18.VIII.2015, K-64-6-15, (53°26'42"N 158°41'40"E), 550 m alt., VB, 18.VIII.2015, K-64-4-15, Khabarovsk Territory, Badzhal, (50°17'10"N 134°42'49"E), 550 m alt., VB, 31.VII.2016, Kh-14-5-16, (50°15'06"N 134°40'26"E), 585 m alt., VB, 14.VIII.2016, Kh-31-17-16, Sakhalin Province, Igrivaya River, (46°26'58"N 143°23'08"E), 85 m alt., VB, 16.IX.2009, S-65-11-09, Iturup Island, (45°21'45"N 148°37'13"E), 23 m alt., VB, 10.IX.2015, K-70-2-15, (45°21'45"N 148°37'13"E), 23 m alt., VB, 10.IX.2015, K-70-20-15, (45°21'26"N 148°37'11"E), 20 m alt., VB, 12.IX.2015, K-72-11-15, Kamyshovyy Range, (50°52'56"N 142°21'44"E), 365 m alt., VB, 05.IX.2009, S-57-32-09, Kunashir Island, (44°15'21"N 146°05'57"E), 27 m alt., VB, 17.IX.2006, K-63-6-06, (44°15'21"N 146°05'57"E), 27 m alt., VB, 17.IX.2006, K-63-21-06, (44°15'21"N 146°05'57"E), 27 m alt., VB, 17.IX.2006, K-63-19-06, Paramushir Island, (50°25'30"N 155°50'45"E), 310 m alt., VB, 28.VII.2004, K-106-3-04, Shikotan Island, (43°51'45"N 146°45'58"E), 290 m alt., VB, 06.IX.2007, K-65-20-07, Shumshu Island, (50°41'16"N 156°15'52"E), 170 m alt., VB, 15.VIII.2004, K-125-7-04, Yuzhno-Sakhalinsk Mud Volcano, (47°04'43"N 142°34'48"E), 268 m alt., VB, 04.IX.2005, S-40-29-05.

Riccardia latifrons GERMANY, Sachsen, Droben, s.d., s.d., M. Reimann, 16.VII.2000, s.n. JAPAN, Tottori Pref., Ouchi-dani Park, (35°30'05"N 134°15'00"E), 60 m alt., VB, 10.III.2013, J-1-3-13. RUSSIA, Kamchatka Territory, Anaun Mt., (56°08'18"N 158°55'47"E), 1300 m alt., VB, 08.IX.2004, K-130-11-04, Petropavlovsk-Kamchatsky, (52°57'59"N 158°42'33"E), 56 m alt., VB, 30.V.2004, K-7-1-04, Khabarovsk Territory, De Castri, (51°24'40"N 140°14'14"E), 85 m alt., E. Royenko, 04.VIII.2011, s.n., Levaja Bureja River, (51°58'00"N 134°52'00"E), 840 m alt., M. Ignatov, 21.VIII.1997, s.n., Okhotsk Settl., (59°26'11"N 143°30'24"E), 124 m alt., VB, 25.VII.2008, Kh-38-5-08, Tardoki-Yani Mt., (48°49'43"N 138°05'44"E), 617 m alt., VB, 28.VIII.2013, Kh-45-14-13, Krasnoyarsk Territory, Putorana Plateau, s.d., s.d., V. Fedosov, 16.VII.2015, 15-0241, Magadan Province, Bolshoj Tuonnakh Range, (63°15'50"N 151°03'28"E), 1106 m alt., VB, 23.VII.2011, Mag-28-46-11, (63°15'50"N 151°03'28"E), 1106 m alt., VB, 25.VII.2011, Mag-37-5-11, (63°13'19"N 151°16'58"E), 946 m alt., VB, 27.VII.2011, Mag-39-12-11, Kamennyj Venets, (59°31'13"N 150°40'17"E), 10 m alt., VB, 13.VIII.2013, Mag-28-27-13, Kilgansky Gory range, (61°12'22''N 153°53'52''E), 1060 m alt., VB, 10.VIII.2012, Mag-31-7-12, Seimchan River, (63°17'12''N 152°09'50''E), 387 m alt., VB, 14.VI.2010, Mag-16-15-10, Sukhokhy Stream, (62°06'46''N 149°29'58''E), 1090 m alt., VB, 26.VII.2014, Mag-22-28-14, Primorye Territory, Amgu River, (45°53'54''N 135°51'51''E), 424 m alt., K. Klimova, 03.IX.2017, Prim-111-20-17, Chistovodnoye Settl., (43°03'28''N 133°33'10''E), 242 m alt., L. Bardunov & V. Cherdantseva, 13.IX.1977, s.n., Ikryanka River, (43°14'20''N 133°27'21''E), 317 m alt., S. Gambaryan, 24.IX.1981, s.n., Sakhalin Province, Bolshoj Garomaj, (52°31'39''N 143°07'46''E), 9 m alt., VB, 24.VIII.2009, S-31-5-09, Bolshoje Vavajskoye Lake, (46°34'39''N 143°18'33''E), 10 m alt., VB, 27.IX.2016, S-43-20-16, Kamyshovyy Range, (50°52'56''N 142°21'44''E), 365 m alt., VB, 05.IX.2009, S-57-3-09, Kunashir Island, (44°27'40''N 146°06'49''E), 500 m alt., VB, 30.VIII.2006, K-40-4a-06, (44°00'20''N 145°26'23''E), 60 m alt., VB, 10.IX.2006, K-53-4-06, Vaida Reserve, (49°52'21''N 143°28'38''E), 947 m alt., VB, 20.VIII.2006, S-32-2a-06, Yuzhno-Sakhalinsk Mud Volcano, (47°04'43''N 142°34'48''E), 268 m alt., VB, 04.IX.2005, S-40-34-05.

Riccardia palmata CHINA, Guizhou Province, Doupeng Mt., (26°22'23''N 107°21'21''E), 1300 m alt., VB, 22.XI.2013, China-56-22-13. GEORGIA, Adjara, Mtirala, (41°40'30''N 41°52'58''E), 400 m alt., VB, 12.V.2013, G-12-60-13, Kakheti, Lagodekhi, s.d., s.d., K. Tigishvili, 14.VII.1978, s.n. GERMANY, Baden-Wurtemburg, Cronhutte, s.d., s.d., M. Reimann, 19.IV.1998, s.n. JAPAN, Yamanashi Pref., Komagadake, (35°44'44''N 138°14'02''E), 2270 m alt., VB, 01.X.2015, J-88-59-15 RUSSIA, Kamchatka Territory, Esso Settl., (55°55'00''N 158°40'00''E), 1000 m alt., VB, 09.IX.2003, K-107-14-03, Khabarovsk Territory, Tardoki-Yani Mt., (48°50'40''N 138°04'20''E), 871 m alt., VB, 20.VIII.2013, Kh-33-13-13, (48°49'43''N 138°05'44''E), 617 m alt., VB, 28.VIII.2013, Kh-45-38-13, Primorye Territory, Elomovskiye Waterfalls, (43°14'45''N 133°43'05''E), 570 m alt., VB, 06.VI.2015, P-31-20-15, (43°14'05''N 133°44'07''E), 350 m alt., VB, 23.IX.2011, P-74-9-11, Falaza Mt., (43°06'50''N 132°47'24''E), 571 m alt., K. Klimova & VB, 15.X.2016, Prim-16-18-16, (43°07'08''N 132°45'45''E), 400 m alt., VB, 18.IX.2012, P-40-7-12, (43°08'06''N 132°48'44''E), s.d., VB, 20.IX.2013, s.n., Kavalerovo Settl., (44°27'53''N 135°23'18''E), 542 m alt., VB, 15.IX.2011, P-62-9-11, Kedrovaya River, (43°05'18''N 131°31'19''E), 330 m alt., VB, 11.VII.2015, P-41-11-15, (43°05'52''N 131°32'30''E), 150 m alt., VB, 09.VII.2015, P-37-1-15, Litovka Mt., (43°06'18''N 132°47'15''E), 1000 m alt., VB, 26.VI.2012, P-17-18-12, Lukjanovka Settl., (43°08'50''N 132°42'05''E), 142 m alt., VB, 24.X.2004, P-142-45-04, Olkhovaya Mt., (43°20'50''N 133°39'22''E), 1600 m alt., VB, 10.IX.2010, P-44-44-10, Sikhote-Alin Reserve, (45°10'13''N 135°51'51''E), 745 m alt., K. Klimova, 21.VIII.2017, Prim-89-3-17, (45°10'13''N 135°51'51''E), 745 m alt., K. Klimova, 21.VIII.2017, Prim-89-8-17, Sakhalin Province, East-Sakhalin Range, (51°23'57''N 143°15'08''E), 80 m alt., S. Dudov, 29.IX.2016, 2016_Br_0085, Vengeri River, (50°35'49''N 143°41'50''E), 80 m alt., VB, 03.VII.2017, S-15-7-17, Yuzhno-Sakhalinsk City, (46°58'14''N 142°47'27''E), 150 m alt., VB, 23.IX.2015, K-84-3-15, U.S.A., California, Humboldt Co., (40°52'00''N 124°05'00''W), 1000 m alt., M. Ignatov, 22.VIII.1989, s.n.

Riccardia vitrea RUSSIA, Primorye Territory, Kedrovaya River, (43°06'12''N 131°32'28''E), 60 m alt., VB, 08.VII.2015, P-36-3-15, Vatovskogo Peninsula, (43°53'01''N 135°30'37''E), 35 m alt., VB, 28.VIII.2016, P-41-15a-16, Sakhalin Province, Kunashir Island, (43°44'05''N 145°32'34''E), 20 m alt., VB, 08.IX.2006, K-49-1-06.