

Wild Berry Plants and Carpophagous Birds in the Taiga Zone of the Southern Russian Far East

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Abstract—Information about the role of birds in dissemination of wild berry plants in the south of the Russian Far East taiga zone is presented based on the authors' long-term ecological investigations and reviewed references are given. The dominant and subdominant species of carpophagous birds are determined. The participation of birds in dissemination of seeds of wild berry plants during the periods of nomad and seasonal migrations is discussed.

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Wild berry plants are considered as the most important plant resources of Russia. They are widely spread in taiga zone of the Far Eastern south, on plains and in mountains of Priamurie, Primorie regions, western area from the Sea of Okhotsk, on Sakhalin, the Kuril Islands and on the coasts of the Far Eastern seas. Many of them (crowberry, cowberry, blueberry, cranberry, bilberry, honeysuckle, service tree, etc.) take large areas and are characterized by regular and rich fruitage. They also are of high nutritive and medicinal value and are as objects of commercial harvesting. The average annual biological reserve of berries of the main wild berry plants in the Far East is approximately estimated as 1.3 million ton [1] and 90% of this reserve make cowberry, blueberry and cranberry.

Seasonal location, time and duration of nomadic life and migrations of birds of passage, also the number and concentration places of migrants as well as winter camps of carpophagous birds—all this depends on berry harvest. Berries are the mass and easy of access food for birds and mammals which use them, moreover, as “medicines”. A direct dependence is noted between cowberry yield and good health of hazel hen, willow grouse populations and other grouses. So, in the years rich with cowberry harvest hazel hens are normally fat, they survive easily in cold winter and are less exposed to such diseases as beriberi, helminthiasis, coccidiosis [2].

Somewhat about 150 berry (fruit and berry) plants grow in taiga zone of the Far Eastern south and 80 species of them are surely edible for people. All these plants are presented by different life forms, as trees, bushes, subshrubs, dwarf-shrubs, dwarf-subshrubs, lia-

nas and herbs. From them are the families of heather (*Ericaceae* Juss.), 10 species; crowberry (*Empetraceae* Lindl.), 5; rose (*Rosaceae* Juss.), 30 species; honeysuckle (*Caprifoliaceae* Juss.), 10; elder (*Sambucaceae* Link), 3; snowball (*Viburnaceae* Dumort.), 1; cornel (*Cornaceae* Dumort.), 3 species [3]. Data on 33 species of berry plants which have soft fruits and which in botanical classification are concerned to true and false berries and to stone fruits.

Species composition of birds, berry eaters is ascertained not enough. Not less than 60 species of carpophagous birds have been brought in the review paper of F. Turcek [4] for the European area, including also the European part of Russia and 50 bird species of them inhabit the Far Eastern south. In forests of the Kola Peninsula 28 species of birds-berry eaters were registered [5]. A special study on eating fruits of berry plants by birds was not carried out for the Far Eastern south. A brief information on birds-berry eaters is given in some ornithological papers in Primorsky krai [6–8], Nizhnee [9, 10] and Verkhnee [11] Priamurie regions, Sakhalin [12, 13], the southern Kuril Islands [14, 15]. Besides, the material on eating soft fruits by grouses, objects for the sport and trade hunting [2, 16–18] has been published as well.

OBJECTS AND METHODS

Our studies were performed from the year 1960 to the year 2008 in taiga zone of the Far Eastern south of Russia, mainly in southern regions of Primorsky krai and in Khabarovskiy krai (the Ul'chskii, Vaninskii, Verkhnebureinskii, Nanaiskii raions), on Sakhalin and the

southern Kuril Islands (Kunashir, Iturup). The collected information contains data on location of berry-fields, their productivity and time of berry fruitage, on species composition and number of carpophagous birds, on time of eating up berries by birds, also on frequency of occurrence of berries and seeds in craws and stomachs of birds as well as evidences on the role of birds in disseminating the berry plants. The content of not less than 500 craws and stomachs of grouses and more than 1000 stomachs of birds from other families captured in berry plant growing sites has been analyzed. The bird, berry eaters were divided into three categories in frequency of occurrence of berries and seeds in their craws and stomachs: the main birds-berry eaters whose craws and stomachs are taken by berries and seeds from 20 to 100% of volume of contents, the secondary birds-berry eaters whose craws and stomachs are taken by berries and seeds from 5 to 20% and rare ones, less than 10% of volume of contents.

RESULTS AND DISCUSSION

In the result of performed studies 102 species of birds-berry eaters of 33 species of berry plants were found.

Empetraceae. Siberian crowberry (*Empetrum sibiricum* V. Vassil.), narrow-petaled crowberry (*E. stenopetalum* V. Vassil.), whitish crowberry (*E. albidum* V. Vassil.) grow in coniferous and deciduous forests, on moss bogs, boggy meadows and stony slopes of mountains and hills, in hilly and flat dwarf-shrub tundra, in brushwood of Siberian dwarf-pine (*Pinus pumila*) elfin wood, on cliffs, sand dunes and spits at sea shore; this plant species often forms dense brushwood on large areas. Fruiting time is July–August; berries of the previous year remain till July.

Birds of 60 species, 5 classes and 14 families eat crowberry fruits in the south of the Far East (bird species designated after L. S. Stepanyan [19] and E. A. Kobik et al. [20]). The main crowberry eaters are grouses (Tetraonidae Leach): willow grouses (*Lagopus lagopus* (L.)), rock ptarmigans (*L. mutus* (Montin)), rock capercaillies (*Tetrao parvirostris* Bonaparte), spruce grouses (*Falcapennis falcapennis* (Hartlaub)), hazel grouses (*Tetrastes bonasia* (L.)); black grouses (*Lyrurus tetrix* (L.)) eat berries more seldom. They are settled or settled-migrating (which migrate in separate years) birds eating berries in the nesting site or in the nearest sites. The birds eat berries beginning from July to snow falling. In winter the willow grouses and rock ptarmigans dig out the snow when searching berries; berries of the previous year they eat in spring and in summer beginning, also nestlings eat berries. In the contents of craws and stomachs of 26 hazel-grouses captured in August in the northern Sakhalin berries and seeds of crowberry made 30.7% of occurrence but in stomachs of 10 willow grouses (the northeastern shore of Sakhalin) crowberry fruits and seeds made already up to 80% of occurrence [13]. In mountainous larch-spruce forests of the Verkhnebu-

reinskii raion (Sofievka Village) in August–September the crowberry seeds made 22.2% of occurrence in stomachs of 18 hazel-grouses and 50%, in stomachs of spruce grouses.

The main crowberry fruit eaters among sandpipers are scolopacids (Scolopacidae Rafines.), from them, whimbrels *Numenius phaeopus* (L.) which come flying to the southern part of the Far East during seasonal migrations. Fruit coats and seeds of crowberry made 80–100% in stomachs of 36 birds captured in August on the shore of the Chaivo and Nabil'sky bays (the northern Sakhalin) [13]. During flyby in the third ten-day period of July–September the whimbrels form numerous aggregations (150–200 birds) on sandy shores, dunes of the Sea of Okhotsk and the Strait of Tartary; eating berries here they greatly fatten. Not regularly also other species of sandpipers eat the berries [21]: from scolopacid they are redshanks *Tringa totanus* (L.), ruffs *Philomachus pugnax* (L.), red-necked stints *Calidris ruficollis* (Pall.), black-bellied sandpipers *C. alpina* (L.), long-toed stints *C. subminuta* (Midd.), large stints *C. tenuirostris* (Horsf.), common snipes *Gallinago gallinago* (L.), Australian curlews *Numenius madagascariensis* (L.), black-tailed godwits *Limosa limosa* (L.), bar-tailed godwits *L. lapponica* (L.); among shorebirds (Charadriidae Leach) they are: Asian golden plovers *Pluvialis fulva* (Gm.) and also oysters *Haematopus ostralegus* L. As also whimbrels some of abovementioned sandpipers (black-bellied sandpipers, red-necked stints, black-tailed and bar-tailed godwits and others) aggregate in seasonal migrations to numerous flocks (up to 1000 birds and more) on shores of the Far Eastern seas. Besides coastal invertebrates they eat here crowberry fruits.

Berries are with pleasure pecked by slaty-backed gulls *Larus schistisagus* Stejn. from the gull group (Laridae Rafines.); remains of berries were found in food of nestlings of these gulls [22, 23]. Common gulls *Larus canus* L., eastern lesser black-backed gulls *L. heuglini* Bree and burgomasters *L. hyperboreus* Gunn., as well as Arctic *Stercorarius parasiticus* (L.) and long-tailed *S. longicaudus* Vieill. skuas from the skua group (Stercorariidae G. R. Gray)—they eat berries not often. It should be noted that slaty-backed gulls and other gull species build their nests on shores and islands of the Far Eastern seas, often in crowberry growing sites and eat these berries both in nesting season and in migration periods.

The main berry eaters from perching birds (Passeriformes) are thrushes (Turdidae Rafines.) and crows (Corvidae Leach). Berries are gladly eaten by pallid, eye-browed and Siberian thrushes (*Turdus pallidus* Gm., *T. obscurus* Gm., *Zoothera sibirica* (Pall.)), more seldom by *Turdus hortulorum* Sclater, *T. chrysolais* Temm., *Zoothera varia* (Pall.). These thrush species eat berries in nesting period from July to August and during autumn migrations in September–October. Naumann's thrushes *Turdus naumanni* Temm. and brown thrushes *T. eunomus* Temm. are migrating and winter-

ing birds in the Far Eastern south, they keep together on berry fields as numerous flocks. The main berry eaters from the Corvidae are Siberian jays *Perisoreus infaustus* (L.), they eat berries from July to snow falling and in spring from April to May. Besides, these birds lay stores in autumn and eat these berries in winter. In breeding sites and in the period of migrations these berries are eaten by nutcrackers *Nucifraga caryocatactes* (L.), carrion and large-billed crows (*Corvus orientalis* Eversm., *C. macrorhynchos* Wagler) and ravens *C. corax* L., as well as by common waxwings and Japanese waxwings (*Bombycilla garrulus* (L.), *B. japonica* (Siebold)). As the secondary berry eaters are finches (Fringillidae Leach): pine grosbeaks *Pinicola enucleator* (L.), bullfinches *Pyrrhula pyrrhula* (L.), *P. griseiventris* Lafres., *P. cineracea* Cabanis, bramble finches *Fringilla montifringilla* (L.), Japanese greenfinches *Chloris sinica* (L.), scarlets and Siberian grosbeaks *Carpodacus erythrinus* (Pall.), *C. roseus* (Pall.), rosy finches *Leucosticte arctoa* (Pall.). Berries are seldom eaten by buntings, rustic buntings, gray, masked and pine buntings (*Emberiza rustica* Pall., *E. variabilis* Temm., *E. spodocephala* (Pall.), *E. leucocephala* Gm.) as well as rubythroats *Luscinia calliope* (Pall.). It should be noted that bullfinches, pine grosbeaks, Siberian grosbeaks and rubythroats feed their nestlings with crowberry fruits.

Crowberry fruits are also eaten by anseriformes (Anseriformes): white-fronted geese *Anser albifrons* (Scopoli), bean geese *Anser fabalis* (Latham), swan geese *Cygnopsis cygnoides* (L.) which in migration periods come to a stop on berry fields in swamp larch forests and at the seashore. Berries were also found in the food eaten by European teal *Anas crecca* L., captured on Sakhalin; berries and seeds made up to 50% of total content mass in its stomach [13]. Eastern turtle doves *Streptopelia orientalis* (Latham) eat berries seldom.

Ericaceae. Bearberry *Arctostaphylos uva-ursi* (L.) Spreng. It grows in dry thinned pine and larch forests among brushwood of Siberian dwarf pine (*Pinus pumila*) elfin wood. Time of fruiting is July–August; berries of the previous year remain till August. There are 6 bird species-berry eaters on Sakhalin: willow grouses, rock capercaillies, hazel grouses, whimbrels, Siberian jays and pine grosbeaks [13].

Arctous alpine (L.) Niedenzu and *Arctous japonica* Nakai. They grow in tussock and moss tundra among brushwood of Siberian dwarf pine (*Pinus pumila*) elfin wood. Time of fruiting is August–September; berries of the previous year remain till August. *Arctous* seeds were found in stomachs of whimbrels and carrion crow captured on the northern Sakhalin [13].

Bog bilberry *Vaccinium uliginosum* L. It grows in thinned larch forests, open forests, brushwood of Siberian dwarf pine (*Pinus pumila*) elfin wood, on peaty and sphagnum bogs; in some sites it forms heavy thickets. Time of fruiting is July–August; berries remain on branches till November.

The 50 species of birds-berry eaters have been determined. They are Tetraonidae Leach: willow grouses, rock ptarmigans, rock capercaillies, black grouses, spruce grouses, hazel grouses; Corvidae: Siberian jays, nutcrackers, large-billed and carrion crows, ravens; pallid, eye-browed and Siberian thrushes, Naumann's and brown thrushes. Secondary birds-berry eaters are: azure-winged magpies *Cyanopica cyanus* (Pall.), jays *Garrulus glandarius* (L.), *Turdus hortulorum* Sclater, *T. chrysolaus* Temm., *Zoothera varia* (Pall.), hooded cranes *Grus monacha* Temm.; sandpipers: whimbrels and Australian curlews, black-tailed and bar-tailed godwits, large stints, ruffs, oysters; skuas: Arctic and long-tailed skua; gulls: slaty-backed gulls and eastern lesser black-backed gull; gray starlings *Spodiopsar cineraceus* (Temm.), common and Japanese waxwings. However, wild ducks *Anas platyrhynchos* L., European teals, eastern turtle-doves, rubythroats, bluetails *Tarsiger cyanurus* (Pall.), pine grosbeaks, Japanese greenfinches, bullfinches, bramble finches, scarlet finches, rustic buntings eat berries seldom. Birds eat berries being in nesting sites in July–August and during autumn migrations in September–November. In craws and stomachs of 10 white grouses the bog bilberry fruits and seeds made up to 40% of occurrence [13]. Besides berries the grouses eat leaves, flowers and tillers of bog bilberry.

Bilberry *Vaccinium smallii* A. Gray and *V. axillare* Nakai grow in deciduous, coniferous and mixed forests, brushwood of Siberian dwarf pine (*Pinus pumila*) elfin wood, forest edges and bog margins. Fruitage period is in late of July–August. Berries remain on branches till November. Here 32 species of carpophagous birds have been revealed. The main of them are grouses: willow grouses, rock ptarmigans, rock capercaillies, spruce grouses, hazel grouses; Siberian jays, waxwings and Japanese waxwings, eye-browed, pallid thrushes, bramble finches and pine grosbeaks. The secondary ones are: nutcrackers, large-billed and carrion crows, bullfinches; Siberian, golden mountain thrushes. Grouses, eastern turtle doves, jays, azure-winged magpies, ravens, rubythroats, bluetails, mountain accentors *Prunella montanella* (Pall.), scarlet and Siberian grosbeaks, hawfinches *Coccothraustes coccothraustes* (L.). In the craw and stomach contents of 8 hazel grouses captured in August on the northern Sakhalin fruits and seeds of this berry species made 25% of occurrence [13]. Besides berries the grouses eat also leaves, flowers and tillers of this plant.

Bilberry *Vaccinium yatabei* Makino. It grows in brushwood of Siberian dwarf pine (*Pinus pumila*) elfin wood and Kurilian bamboo on the southern Sakhalin and Iturup Island (the Kuril Islands). Fruitage period is August–September. On the island of Sakhalin (Susunaiskii Ridge) berries of this plant are pecked by *Turdus chrysolaus* Temm., rubythroats and *Pyrrhula griseiventris* Lafres.

Vaccinium praestans Lamb. This berry plant grows in dark coniferous, deciduous and mixed forests, in

brushwood of Siberian dwarf pine (*Pinus pumila*) elfin wood, forest edges and burns. Fruiting period is August–September. Ten bird species have been registered here. The main berry eaters are: large-billed and carrion crows, *Turdus chrysolaus* Temm., *Pyrrhula griseiventris* Lafres. Berries are seldom eaten by hazel-grouses, whimbrels, nutcrackers, gray starlings, eye-browed thrushes, Japanese greenfinches.

Cowberry (*Vaccinium vitis-idaea* L., *V. minus* (Lodd) Worosch.). It grows in spruce, larch, birch forests, in brushwood of Siberian dwarf pine (*Pinus pumila*) elfin wood, hilly tundra, on felled areas, burns, rocky slopes and stone fields; they form unbroken thickets on large areas. Fruiting period falls on late August–September; berries remain on branches till July of the next year.

So, 36 species of carpophagous birds were determined here. The main berry-eaters are: grouses (willow grouses and rock ptarmigans, rock capercaillies, spruce grouses, hazel grouses); whimbrels, Siberian jays, waxwings and Japanese waxwings, also eye-browed, pallid and brown thrushes and Naumann's thrushes. As the secondary berry-eaters are: bean geese, black grouses, black-tailed godwits, nutcrackers, large-billed and carrion crows, ravens, *Turdus chrysolaus* Temm., scarlet and Siberian grosbeaks, pine grosbeaks, *Pyrrhula griseiventris* Lafres., *P. cineracea* Cabanis. Jays, azure-winged magpies, Siberian and golden mountain thrushes, rubythroats, bluetails, bramble finches, rustic buntings peck berries seldom. Willow grouses and rock ptarmigans besides berries eat also leaves, flowers and tillers. All bird species eat over-wintered berries but partridges and Siberian jays even in winter look for fruits under snow. These berries were found in food of nestlings of such birds as rubythroat, pine grosbeak and Siberian grosbeak. In 12 stomachs of hazel grouses captured in August–September in Verkhnebureinskii raion (Khabarovsk krai) in mountainous larch–spruce forests with Labrador tea the fruits and seeds made 70% of occurrence, but in 10 stomachs of hazel grouses captured on October 25–27 in coniferous forests of the Selednja upper river (Amur oblast) berries and seeds made 100% of occurrence.

European cranberry, bog cranberry (*Oxycoccus palustris* Pers., *O. microcarpus* Turcz. et Rupr.). This berry species grows in swamp larch forests, on sphagnum bogs; in some sites it forms an unbroken cover. Fruiting period falls on late August–September; berries remain on shoots up to the middle of the next year. The 32 species, bird eaters were registered here. The main berry eaters are: willow grouses and rock capercaillies. As secondary berry eaters are swan geese, bean geese, rock ptarmigans, grouses, hazel grouses, Australian curlews and whimbrels, black-tailed godwits, Siberian jays, large-billed and carrion crows, ravens, waxwings and Japanese waxwings, eye-browed pallid thrushes. However, white-fronted geese, hooded cranes, common snipes, slaty-backed gulls, eastern turtle doves, nutcrackers, Naumann's thrushes, brown thrushes, rubythroats, pine grosbeaks, bramble finches, *Pyrrhula griseiventris* Laf-

res., *P. cineracea* Cabanis. So, Tetraonidae, Scolopacidae, Corvidae and thrushes gladly peck berries of the last year.

Rosaceae. Mountain ash *Sorbus sambucifolia* Cham. et Schlecht. This plant grows in deciduous and mixed forests, in brushwood of Siberian dwarf pine (*Pinus pumila*) elfin wood; at the upper timberline and in the subgoltsy belt it forms thickets. Fruitage time is August–September; the part of berries remains till November. So, 32 species of carpophagous birds have been observed here. The main birds-berry eaters are: willow grouses and rock ptarmigans, rock capercaillies, spruce grouses, hazel grouses, Siberian jays, waxwings and Japanese waxwings, pallid and eye-browed thrushes, Naumann's thrushes, *Turdus chrysolaus* Temm., *Zoothera varia* (Pall.). As the secondary birds, berry eaters are nutcrackers, large-billed and carrion crows, ravens, pine grosbeaks, bramble finches, *Pyrrhula griseiventris* Lafres., *P. cineracea* Cabanis, grosbeaks. Such birds as grouses, eastern turtle doves, jays, azure-winged magpies, golden mountain thrushes, rubythroats, mountain accentors, rustic buntings, greater-spotted woodpeckers *Dendrocopus major* (L.) eat berries seldom. Besides berries grouses eat leaves, buds and flowers.

Cloudberry (*Rubus chamaemorus* L., *R. pseudo-chamaemorus* Tolm.). Both species grow in swamp larch forests, on moss bogs, in tundra, among brushwood of Siberian dwarf pine (*Pinus pumila*) elfin wood. Fruitage period falls on July–August. Berries are eaten by 38 bird species. The main berry eaters are: willow grouses and rock ptarmigans, rock capercaillies, black grouses, spruce grouses, hazel grouses, waxwings and Japanese waxwings, Siberian jays, large-billed and carrion crows, eye-browed and pallid thrushes. The secondary ones are: swan geese, bean geese, wild ducks, European teals, whimbrels and Australian curlews, black-tailed and bar-tailed godwits, common snipes, slaty-backed gulls, eastern turtle doves, ravens, golden mountain thrushes, Siberian thrushes and *Turdus chrysolaus* Temm. Seldom the berries are eaten by gray starlings, rubythroats, pine grosbeaks, bramble finches, *Pyrrhula griseiventris* Lafres., *P. cineracea* Cabanis, Japanese greenfinches, scarlet grosbeak and *Carpodacus roseus* (Pall.), rustic buntings. Cloudberry seeds made up to 60% of occurrence in stomachs of willow grouse captured in August on the northern Sakhalin [13].

Arctic raspberry *Rubus arcticus* L. It grows in coniferous, deciduous and mixed forests, open forests, brushwood of Siberian dwarf pine (*Pinus pumila*) elfin wood, tundra, on bogs, meadows, forest edges. The period of fruiting is August–September. Berries are eaten by not less than 26 bird species. The main berry eaters are: hazel grouses, Siberian jays, large-billed and carrion crows, waxwings and Japanese waxwings, pallid, eye-browed, brown thrushes Naumann's thrushes. As secondary ones are: willow grouses, rock capercaillies, spruce grouses, jays, ravens. Berries are seldom eaten by nutcrackers, golden mountain thrushes, rubythroats, pine grosbeaks,

Pyrrhula griseiventris Lafres., *P. cineracea* Cabanis, bramble finches, scarlet grosbeaks and *Carpodacus roseus* (Pall.); besides, seeds have been found in stomach of a bog bird, water rail *Rallus aquaticus* L. [13].

Sakhalinian raspberry *Rubus sachalinensis* Level. It grows in forests, brushwood, flood plains of rivers and brooks, on burns, felled areas, forest edges, rocky slopes and stone fields; it often forms thickets. Fruiting is in August.

The 45 species of carpophagous birds have been registered. The main of them are: English pheasant *Phasianus colchicus* L., Tetraonidae Leach (rock capercaillies, black grouses, spruce grouses, hazel grouses), Corvidae Leach (Siberian jays, nutcrackers, azure-winged magpies, *Pica pica* (L.) magpies, jays, large-billed and carrion crows, ravens), waxwings and Japanese waxwings, eye-browed, pallid, Siberian, thrushes, *Turdus chrysolais* Temm., *T. hortulorum* Sclater., *Zoothera varia* (Pall.). The secondary ones are: eastern turtle doves, gray and Daurian starlings *Sturnia sturnina* (Pall.), red-cheeked starlings *Sturnia philippensis* (Forster), bluetails, rubythroats, *Luscinia sibilans* (Swinhoe), Japanese robins *Luscinia akahige* (Temm.), Daurian redstarts *Phoenicurus aureus* (Pall.), bullfinches *Pyrrhula griseiventris* Lafres and *P. cineracea* Cabanis, bramble finches, Japanese greenfinches, scarlet grosbeaks and *Carpodacus roseus* (Pall.), pine grosbeaks. These berries are seldom eaten by cettias *Horeites canturians* (Swinhoe), millerbirds *Horeites diphone* (Kittlitz), European nutcrackers *Sitta europaea* L., grosbeaks, rosy finches, rustic buntings, masked buntings and *Emberiza personata* Temm. In craws and stomachs of 8 hazel grouses captured on southern Sakhalin in August–early September raspberry fruits and seeds made up to 75% of occurrence and in those ones of 12 birds from Verkhnebureinskii raion berries and seeds made 50%.

Briers *Rosa amblyotis* C. A. May, *R. acicularis* Lindl., *R. daurica* Pall., *R. rugosa* Thunb. These plants grow in coniferous and mixed forests, brushwood of Siberian dwarf pine (*Pinus pumila*) elfin wood, on river banks, cliffs, rock slopes, on seashore. Fruiting falls on August–September; part of fruits remains on branches till spring of the next year.

The 38 species of carpophagous birds have been observed here. The main berry eaters of them are: English pheasants, Tetraonidae (rock capercaillies, spruce grouses, black grouses, hazel grouses), Corvidae (Siberian jays, jays, azure-winged magpies, large-billed and carrion crows,), waxwings and Japanese waxwings, eye-browed, pallid thrushes, *Turdus chrysolais* Temm., *T. hortulorum* Sclater., *Zoothera varia* (Pall.), Nauman's thrushes. As the secondary berry eaters are: willow grouses, eastern turtle doves, magpies, ravens, Siberian thrushes, *Zoothera varia* (Pall.), pine grosbeaks, bullfinches *Pyrrhula griseiventris* Lafres and *P. cineracea* Cabanis, Japanese greenfinches, brambles, grosbeaks, scarlet grosbeaks and *Carpodacus roseus* (Pall.), gray starlings. Berries are seldom pecked by beard partridges *Perdix daurica* (Pall.), Daurian

jackdaws *Corvus dauricus* Pall., European nutcrackers, rustic buntings. In Verkhnebureinskii raion in August–September the brier seeds were found in the stomach of rock capercaillie (up to 80 % of contents mass) and in stomachs of 12 hazel grouses the seeds made from 20 to 70% of occurrence.

Caprifoliaceae. *Lonicera edulis* Turcz. ex Freyn, *L. caerulea* L. This berry species grows in dark coniferous and larch forests, on forest edges, stone fields and cliffs, on banks of rivers and brooks. Fruiting is in the third ten-day period of June–July. So, 36 species of carpophagous birds have been registered. The main of them are: Tetraonidae (rock capercaillies, spruce grouses, black grouses, hazel grouses), Corvidae (Siberian jays, jays, azure-winged magpies, large-billed and carrion crows), gray and Daurian starlings, eye-browed, pallid, Siberian thrushes, *Turdus hortulorum* Sclater., waxwings and Japanese waxwings. The secondary ones are: willow grouses, black-tailed and bar-tailed godwits, whimbrels and Australian curlews, nutcrackers, ravens, magpies, rubythroats, bluetails, *Luscinia sibilans* (Swinhoe), pine grosbeaks, bullfinches *Pyrrhula griseiventris* Lafres and *P. cineracea* Cabanis, brambles, scarlet grosbeaks and *Carpodacus roseus* (Pall.), also grosbeaks and rustic buntings.

Viburnaceae. *Viburnum sargentii* Koehne. It grows in valley dark coniferous, deciduous and mixed forests, brushwood, near rivers and brooks, at forest edges. Fruitage period is in September–October; the part of berries remains on branches till spring.

Thus, 30 species of birds-berry eaters have been noted. The main of them are: Tetraonidae (black grouses, hazel grouses), English pheasants, Corvidae (Siberian jays, azure-winged magpies, large-billed and carrion crows), waxwings and Japanese waxwings, eye-browed, pallid, brown thrushes, *Turdus hortulorum* Sclater., Naumann's thrushes. The secondary ones are: jays, magpies, ravens, *Turdus chrysolais* Temm., grosbeaks, bramble finches and pine grosbeaks. Rare berry eaters are: rock capercaillies, spruce grouses, Daurian redstarts, bullfinches *Pyrrhula pyrrhula* (L.), *P. griseiventris* Lafres and *P. cineracea* Cabanis, scarlet grosbeaks and *Carpodacus roseus* (Pall.).

Sambucaceae. *Sambucus sibirica* Nakai, *S. williamsii* Hance, *S. miquelii* (Nakai) Kom. These plants grow in open sites, at edges of coniferous, deciduous and mixed forests, at edges of stone fields, at feet of cliffs, on slopes. Time of fruiting is July–August. The 58 species of birds-berry eaters have been registered here. The main are: hazel grouse, eastern turtle dove, Siberian jay, azure-winged magpie, large-billed and carrion crows, waxwings and Japanese waxwings, eye-browed, pallid, *Zoothera sibirica* (Pall.), *Turdus hortulorum* Sclater, *T. chrysolais* Temm., *Zoothera varia* (Pall.), *T. eunomus* Temm. and Naumann's thrushes. The secondary ones are: English pheasants, nutcrackers, jays, magpies, ravens, gray, Daurian and red-cheeked starlings, Chinese orioles *Oriolus chinensis* (L.), greater-

spotted woodpeckers, white-backed woodpeckers *Dendrocopos leucotos* (Bechst.), Daurian redstarts, blue-tails, rubythroats, *Luscinia sibilans* (Swinhoe), blue nightingales *Luscinia cyane* (Pall.), *Luscinia akahige* (Temmm.), blue flycatchers *Cyanoptila cyanomelana* (Temmm.), flycatchers *Muscicapa daurica* (Pall.), *M. sibirica* J. F. Gmelin, *M. griseisticta* (Swinhoe), *Ficedula zanthopygia* (Hay), *F. narcissina* (Temmm.), *F. mugimaki* (Temmm.), white-eyes *Zosterops eurythropleura* Swinhoe, pine grosbeaks, bullfinches *Pyrrhula griseiventris* Lafres and *P. cineraceae* Cabanis, bramble finches, Japanese greenfinches, grosbeaks. Berries are seldom eaten by tree sparrows *Passer montanus* (L.), blackcaps *Saxicola torquata* (L.). Besides, seeds of *Sambucus miquelii* (Nakai) Kom. were revealed on Kunashir island in stomachs of Japanese green pigeon *Treron sieboldii* (Temmm.), *Dendrocopos kizuki* (Temmm.), bamboo millerbird, Japanese accentor *Prunella rubida* (Temmm. et Schleg.), eastern titmouse *Parus minor* Temmm. et Schleg., *Parus varius* Temmm. et Schleg., European nutcracker, gray bunting [14, 15] as well as in stomachs of such near-water birds as brown dipper *Cinclus pallasii* Temmm. and sandpiper *Actitis hypoleucos* (L.). In stomachs of 8 hazel grouses captured on Sakhalin the seeds of *Sambucus sibirica* Nakai made up to 50% of contents mass. However, the seeds of *S. miquelii* (Nakai) Kom. were found in 12 (from 15) stomachs of *Ficedula narcissina* (Temmm.) and in 6 (from 10) stomachs of rubythroats captured on Kunashir Island (data of V. A. Nechaev).

Cornaceae. Low cornel *Chamaepericlymenum canadense* (L.) Aschers. et Graebn., dwarf cornel *Ch. suecicum* (L.) et Graebn. These plants grow in dark coniferous, larch and mixed forests, at forest edges, in brushwood, at edges of swamp forests. Fruiting is in August–September. Berries remain on branches till spring of the next year. The 35 species of carpophagous birds were determined. And the main of them are: Tetraonidae (willow grouses and rock ptarmigans, rock capercaillies, spruce grouses, hazel grouses), Corvidae Leach (Siberian jays, large-billed and carrion crows), waxwings and Japanese waxwings, eye-browed, pallid thrushes, *Zoothera sibirica* (Pall.), *Turdus chrysolaus* Temmm., *T. eunomus* Temmm. and Naumann's thrushes. As the secondary ones are: whimbrels, black-tailed godwits, eastern turtle doves, nutcrackers, jays, ravens, pine grosbeaks, bramble finches, bullfinches *Pyrrhula purrhula* (L.), *P. griseiventris* Lafres., *P. cineracea* Cabanis, scarlet and *Carpodacus roseus* (Pall.), rosy finches, rubythroats, Japanese robins, bluetails, pine buntings, rustic buntings. In the northern Sakhalin the seeds of *Chamaepericlymenum canadense* (L.) Aschers. et Graebn. were found in stomachs and craws of 22 (from 26) hazel grouses and it made 84.6% of occurrence and in the southern Sakhalin seeds were in 5 (from 8) stomachs and it made 62.5%.

White cornel *Swida alba* (L.) Opiz. It grows on banks of rivers; in some places it forms heavy thickets. Fruiting period is in August–September. The 32 species

of birds-berry eaters have been determined. And the main of them are: English pheasants, hazel grouses, Siberian jays, magpies, large-billed and carrion crows, waxwings and Japanese waxwings. The secondary ones are: azure-winged magpies, jays, eastern turtle doves, ravens, gray, Daurian and red-cheeked starlings, Chinese orioles, also pallid, eye-browed and Siberian thrushes (*Turdus pallidus* Gm., *T. obscurus* Gm., *Zoothera sibirica* (Pall.)), *Turdus hortulorum* Sclater, *T. chrysolaus* Temmm., *Zoothera varia* (Pall.)), Naumann's thrushes as well as brown and golden mountain thrushes, Siberian flycatchers, Daurian redstarts, rubythroats, blue-tails, white-eyes *Zosterops eurythropleura* Swinhoe, *Pyrrhula griseiventris* Lafres., *P. cineracea* Cabanis, grosbeaks.

It is well known that there are complex and multi-form biocenotic relations between plants and birds; birds are not only berry eaters but they are also important agents of disseminating the plants. The wild berry plants above listed are concerned to ornithochorous ones; thanks to birds these plants colonize new areas.

The main berry and seed disseminators are the birds which swallow berries whole or in parts but seeds are not destroyed in their digestive system. They are orioles, starlings, crows and ravens, waxwings, thrushes, flycatchers, gulls, in particular slaty-backed gulls that excrete castings and excrements during 3–5 hours. Germinating capacity of seeds (crowberry) increases after passing through the digestive tract [23]. As the secondary ones are those ones which swallow berries and seeds whole or in parts and then the seeds are fully destroyed in stomachs by grinding them by gastrolithes; the part of small seeds with hard coating is not destroyed in digestive tract and is thrown out with excrements. These birds are ducks, black grouses, pheasants, snipes, shorebirds, pigeons. Insignificant birds are those one which swallow fruits whole or in parts and the seeds are fully destroyed by their beaks and later hard coatings of fruits and seeds are grinded by gastrolithes in their stomachs; “kernels” of seeds are, mainly, used for food; soft shells, however, are usually thrown out; small seeds are not destroyed and are excreted too. These birds are brambles, buntings, tree sparrows and some other birds.

Carpophagous birds bring seeds of berry plants at different distances from feeding places: settled and settled-migrating birds (Tetraonidae and some Corvidae) are within nesting area and wandering sites, this is not more than 2–3 km from permanent habitat. The main role in spreading seeds of berry plants, undoubtedly, is played by migrant birds. In the end of summer–autumn they collect into numerous flocks in sites comfortable for resting and feeding in mountains, on plains and seashore. One of the most important flyways of the far and near migrants—near-shore birds (Scolopacidae, Charadriidae, Laridae, etc.) is just along the seashore. Flocks of Corvidae, Fringillidae, Turdidae come to a stop here as well. Birds eat gladly berries of crowberry, cowberry,

cloudberry, cornel and other berry plants and flying to the south they bring seeds for large distances, often some tens and thousands kilometers. So, some Charadriidae (plovers) and Scolopacidae (sandpipers) do not eructate castings, can keep seeds in digestive tract for a long time and bring them for some thousands kilometers. Germinating capacity of seeds remains during 24–48 hours after eating berries. Some near-shore birds keep seeds more than 100 and even 200–300 hours if the diameters of seeds are less than 1 mm and if they have a hard coating. Thus, sandpipers during the far flights bring seeds to the sea and ocean islands which are thousands kilometers from their feeding sites [24]. Our data also show abilities of migrant birds to bring seeds of berry plants for large distances. So, the crowberry seeds were found in contents mass of a bramble captured on September 1, 1971 on Iona Island located in the central part of the Sea of Okhotsk at the distance 120 miles (240 km) from the near continent; it should be especially noted that the crowberry plants do not grow on this island [25].

CONCLUSIONS

Fruits of wild berry plants are a mass and easily gained food for birds in the taiga zone of the Russian Far East. In nesting sites in migration periods birds not only eat soft juicy berries but also bring their seeds for different distances. In the result of the many-year fauna studies the species composition of carpophagous birds (102 species from 14 families) have been determined which are as dissemination agents of 33 berry plants (crowberry, cowberry, bilberry, cloudberry, etc.). The main seed disseminators are Turdidae, Bombycillidae, Corvidae, Sturnidae, Muscicapidae, Charadriiformes (Scolopacidae, Charadriidae, Laridae). In bird stomachs of all these families only the soft food (fruit pulp) is digested but seeds are not destroyed and do not lose germinating capacity. Woodpeckers, geese, ducks and pigeons are birds—“disseminators” in a lesser degree. Tetraonidae, Phasianidae and Fringillidae are occasional agents of ornithochorous berry plants; the part of undamaged berries they lose to the ground during feeding and therewith assist to seed distribution but only for the near distance. Thus, birds-berry eaters are one of the main factors of dissemination and natural regeneration of berry plants on felled areas, burns, coastal, sea and ocean islands. Thanks to birds the crowberry, cowberry and other berry plants occupied some volcanic islands of the Kuril Ridge and clinkers of Kamchatka.

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