Environment development of East Asia in Pleistocene-Holocene (boundaries, factors, stages of Human mastering). Proceedings of International Scientific Conference, September 14–18, 2009, Vladivostok, Russia. – Vladivostok: Dalnauka, 2009. – P. 149–152.

BASIC HOLOCENE SECTION OF SOUTH WEST SAKHALIN

Yu.A. Mikishin[1], I.G. Gvozdeva[1], L.A. Orlova[2]

[1]Far East Geological Institute, FEB RAS, Vladivostok, Russia
e-mail: yurimikishin@fegi.ru, gvozdika@fegi.ru
[2]Institute of Geology and Mineralogy, SB RAS, Novosibirsk, Russia
e-mail: orlova@uiggm.nsc.ru

The history of studies of nature changes in the Holocene of Sakhalin Island dates back to more than 50 years ago. Although a number of studies have been performed since then, particularly in recent decades (Alexandrova, 1982; Mikishin, Gvozdeva, 1996; Marine terraces…, 1997; Igarashi and Igarashi, 1998), the dynamic of these changes has not been addressed in detail as yet. It is interesting also to see this dynamic in the island's each landscape zone on the example of a series of basic sections most fully reflecting the history of the nature. Taken as a basic section for the south-taiga sub-zone of coniferous forests consisting of dark-needle forests dominated by fir might be the peat-bog section in the southwestern part of Sakhalin Island on the Sea of Japan coast near Penzenskoye village. The peat-bog lies on a 2–5-meter terrace of the right bank of Cheremshanka River in 0.8 km upstream of its mouth (fig. 1). The first paleobotanical study of the Cheremshanka peat-bog was undertaken in early 1970 s (Kulakov et al., 1973).

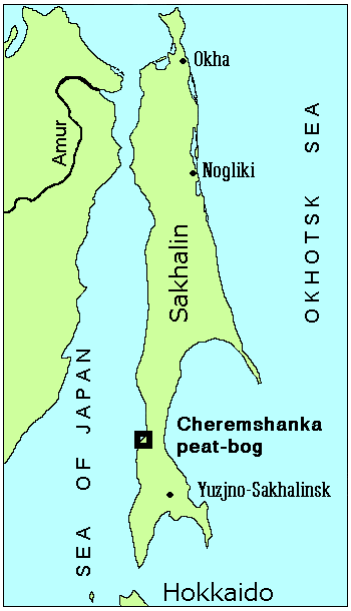

Fig. 1. Location of Cheremshanka peat-bog in Sakhalin Island

Recently, a detailed palynologic study was conducted on three sections in the Cheremshanka peat-bog (126 samples) in which radiocarbon dating methods were widely used (30 dates). Two sections («Penzenskiy-I» and «Penzenskiy-II») were located in an abandoned peat quarry in 20 meters from each other (47°54′27.0″ N, 142°09′18.1″ E). They lie near the rear edge of a terrace at an absolute height of 5.2 m. The third section («Penzenskiy-III») is located in 300 m closer to the channel of Cheremshanka River at an absolute height of 2.4 m (47°54′15.4″ N, 142°09′10.5″ E). The results on the latter section («Penzenskiy-III»), which is older than two others, had been published earlier (Gvozdeva, Mikishin, 2008).

Pollen complexes and spectra have been found in the sections by referring them to the modified Blytt-Sernander-Nilsson scheme of Holocene periods (Khotinsky, 1989; Khotinsky et al., 1991).

Boreal Period. The phase of birch/nut and spruce/fir forests is reflected in the pollen spectra Pz-2 of buried soils in the near-bottom layer of the «Penzenskiy-III» section (interval 320–326 cm – 1 on fig. 2). They are dominated by pollen of birches – *Betula* – (22–36 %), spruce – *Picea* – (10–25 %), walnut – *Juglans* – (13–18 %), with oak – *Quercus* – (6–10 %), elm – *Ulmus* – (5–7 %) observed less frequently. They had fixed a warming in the middle of Boreal Period, surpassing the recent climate in its parameters. The date of circa 10350 Cal. yr BP, assigned to this layer by radiocarbon dating, is most likely too early and does not match the timing of the

event. This phase is, in our opinion, a southern variety of the middle Boreal vegetation of Sakhalin, developed during a climatic optimum in early Holocene around 9350–9970 Cal. yr BP. In the northern areas of Sakhalin coast, birches forests were spreading with some broad-leaved species dominated by elm and, in a lesser degree, spruce forests (Mikishin et al., 1998; Marine terraces…, 1997). A similar phase of the vegetation of Boreal Period was earlier found in the central part of Hokkaido Island, lying in 400 km south of the section being studied, in peat strata dated at circa 9050 Cal. yr BP (Igarashi et al., 1993).

Fig. 2. Summary pollen diagram of Cheremshanka peat-bog

Atlantic Period. The phase of nut/oak and birch/alder forests, developing in the beginning of the warming of early Atlantic Period, is reflected in pollen spectra Pz-3 of the «Penzenskiy-III» section (interval 308–320 cm – 2 on fig. 2). These spectra are dominated by pollen of birches (24–29 %), walnut (11–30 %), oak (10–21 %), and, less frequently, alder – *Alnus* – (6–12 %), spruce (4–9 %), elm (4–6 %). The date of circa 9250 Cal. yr BP, assigned to this layer by radiocarbon dating, is also, same as for the previous layer, too early. The age of this event most likely does not exceed 8600 Cal. yr BP.

The oak forest phase was forming at the end and in the first half of middle Atlantic Period, in warm/temperate climatic conditions, the most favorable in the entire Holocene. The first stage of the warming, which featured a more arid climate, is reflected by pollen spectra Pz-4 a of the «Penzenskiy-III» section (interval 290–308 cm – 3 a on fig. 2). They are dominated by pollen of broad-leaved trees, occupying 56–63 % of the spectrum: oak (32–41 %), walnut (8–13 %), and elm (9–11 %). The second-largest group of narrow-leaved tree pollen is dominated by birches (13–22 %), with alder (5–9 %) observed less frequently. The contribution of dark-

Environment development of East Asia in Pleistocene-Holocene (boundaries, factors, stages of Human mastering). Proceedings of International Scientific Conference, September 14–18, 2009, Vladivostok, Russia. – Vladivostok: Dalnauka, 2009. – P. 149–152.

---

coniferous tree species is insignificant: spruce (5–9 %), fir – *Abies* – (< 1%). The timing of this episode – circa 7800–8150 Cal. yr BP – is well consistent with the beginning of broad-leaved forest expansion in the southeast of Sakhalin Island (Mikishin, Gvozdeva, 1996).

The second, more humid, stage encompasses the first half of middle Atlantic Period – 7300–7800 Cal. yr BP. It is fixed by pollen spectra Pz-4 b of the «Penzenskiy-III» section (interval 260–290 cm – 3 b on fig. 2). In comparison with the preceding spectra, the role of spruce (9–27 %) pollen grows and that of walnut (3–10 %) pollen declines.

The phase of birches/alder and broad-leaved forests reflected the onset of cooler and dry climatic conditions of the latter half of middle Atlantic Period. It was fixed in pollen spectra Pz-5 of the «Penzenskiy-III» section (interval 250–260 cm – 4 on fig. 2). Their characteristic feature is a growing content of alder (19–26 %), birches (23–31 %) pollen and decreasing content of spruce (9–10 %) and, particularly, oak (down to 14 %) and walnut (2–6 %) pollen.

The phase of fir/spruce forests with some broad-leaved trees was developing in the beginning of late Atlantic Period, 6300–6550 Cal. yr BP. It was fixed in pollen spectra Pz-6 of the «Penzenskiy-III» section (interval 192–250 cm – 5 on fig. 2). In these spectra, the content of spruce (34–55 %), fir (3–4 %) pollen grows and that of birches (10–14 %) pollen and broad-leaved pollen declines: oak (5–11 %), walnut (3–4 %), elm (3–5 %). Climatic conditions on the seacoast were close to recent conditions but somewhat warmer.

A significant climate warming in the beginning of late Atlantic Period around 6300–6500 Cal. yr BP resulted in spread of broad-leaved forests dominated by oak and in a decreasing role of dark-needle trees. Pollen complexes (P-1 «Penzenskiy-I» – 285–312 cm and Pe-1 «Penzenskiy-II» – 270–307 cm – 6 on fig. 2) from the bottom layers of sections contain much oak pollen (29–59 %) and, in a lesser degree, pollens of other broad-leaved trees: elm (up to 7 %), walnut (up to 5 %), ash (*Fraxinus*), hornbeam (*Carpinus*), linden (*Tilia*), maple (*Acer*), chestnut (*Castanea*), lilac (*Syringa*), hazel (*Corylus*), snow-ball (*Viburnum*), grapes (*Vitis*) (0.7–3.5 % collectively). The content of dark-needle pollens reduced down to 12–23 %: spruce (7–29 %) and fir (2–5 %).

A sharp and short-time climate cooling, comparable with modern conditions, occurred in the beginning of late Atlantic Period. It is represented by the P-2 pollen spectrum from the near-bottom peat layer of «Penzenskiy-I» section (interval 275–285 cm – 7 on fig. 2). Again, the role of dark-needle pollens grows and reaches 72 %: spruce – 36 %, fir – 37 %. The content of broad-leaved trees pollens dominated by oak drops to 15 %.

A climate warming in the middle – at the end of late Atlantic Period around 5350–6200 Cal. yr BP resulted in restoration on the coast of broad-leaved forests dominated by oak and in a significantly smaller role of dark-needle forests. This event has been fixed in spore and pollen complexes of all sections: P-3 – 225–275 cm, Pe-2 – 230–270 cm, Pz-7 – 167–192 cm (8 on fig. 2). The highest pollen content was registered for broad-leaved trees – 31–55 %, of which oak was dominating (18–35 %) will a smaller role of elm (3–11 %), walnut (2–9 %), ash (up to 7 %), hazel (up to 2 %) as well as other taxa with a pollen content under 1 %: cork tree (*Phellodendron*), hornbeam, aralia (*Aralia*), snow-ball, maple, chestnut, beech (*Fagus*). The content of spruce pollen went down to 7–27 % and that of birches grew to 16–36 %.

Subboreal Period. The phase of fir/spruce and broad-leaved forests has most likely reflected the initial stage of an early Subboreal cooling. In P-4 pollen complex (section «Penzenskiy-I» – 205–225 cm – 9 on fig. 2), there is much pollen of dark-needle tree species (39–72 %) with fir (27–33 %) dominating over spruce (12–33 %). The content of broad-leaved

Environment development of East Asia in Pleistocene-Holocene (boundaries, factors, stages of Human mastering). Proceedings of International Scientific Conference, September 14–18, 2009, Vladivostok, Russia. – Vladivostok: Dalnauka, 2009. – P. 149–152.

---

tree pollen decreases to 18–33 %.

The phase of small-leaved, dark-needle and broad-leaved forests was developing in the beginning of the middle Subboreal Period, around 4450–4600 Cal. yr BP, in a warmer and more humid climate than modern conditions. It is reflected in pollen complexes of P-5 in the section «Penzenskiy-I» – 185–205 cm, Pe-3 and Pe-4 in the section «Penzenskiy-II» – 180–200 cm (10 on fig. 2). Small-leaved tree pollen shows the highest content (39–48 %), with alder (6–40 %) dominance over birches in a larger number of cases. Dark-needle tree pollen (19–30 %) plays a less important role, with fir (7–27 %) often showing a slightly higher content than spruce (6–18 %). Broad-leaved tree pollen average content is 10–29 %: oak (4–23 %), elm (3–12 %), walnut (up to 3 %).

A middle Subboreal warming and relative aridness of the climate around 4250–4400 Cal. yr BP resulted in a growing role of oak forests in vegetation and lesser role of dark-needle forests. This is reflected in Pz-8 pollen complex of «Penzenskiy-III» section (interval 140–167 cm – 11 on fig. 2). It is dominated by broad-leaved trees pollen (46–48 %), mostly oak (24–25 %), less frequently elm (10–14 %), walnut (3–8 %), ash (1–5 %). Small-leaved trees play a smaller role (34–41 %) and are largely represented by birches pollen (20–28 %). Pollen of dark-needle trees contains a little (3–10 %).

The maximum spread of fir/spruce forests growing in a cooler and more humid climate than in the preceding phase of the middle Subboreal Period has been fixed by pollen complexes P-6 and P-7 in section «Penzenskiy-I» – interval 120–185 cm – 12 on fig. 2. They contain the largest quantity of dark-needle tree pollen (62–83 %) with roughly equal contributions of spruce (28–50 %) and fir (19–53 %). Small-leaved and broad-leaved tree pollens account for 9–26 % and 5–8 % respectively.

The phase of small-leaved and fir/spruce forests with broad-leaved species presence was developing in a drier and warm climate of the first half of the late Subboreal Period around 3100–3500 Cal. yr BP. Birches (16–31 %) and alder (8–26 %) pollens dominate in Pe-5 complex (section «Penzenskiy-II» – 150–180 cm – 13 on fig. 2), with a lower content of spruce (17–28 %) and fir (11–30 %). Broad-leaved trees pollen content increased to 10–20 %.

The phase of small-leaved and broad-leaved forests with oak dominance as well as of fir/spruce forests reflected a significant climate warming in the latter half of the late Subboreal Period around 2800–3000 Cal. yr BP. The pollen complexes (Pz-9 «Penzenskiy-III» – 120–140 cm and Pe-6 «Penzenskiy-II» – 120–150 cm – 14 on fig. 2) contain much pollen of birches (19–36 %) and alder (8–25 %). Broad-leaved trees are represented by oak (7–27 %), elm (6–13 %), walnut (up to 8 %), ash (up to 6 %) hazel (up to 2 %), aralia, cork tree, maple, elder (*Sambucus*), hornbeam, chestnut, grapes, beech (up to 1 % collectively) pollens, dark-needle trees – by spruce (7–23 %) and fir (4–15 %).

Subatlantic Period. The phase of fir/spruce and small-leaved forests was developing in a cooler and humid climate of the first half of the early Subatlantic Period around 2200–2500 Cal. yr BP. The pollen complexes (P-8 «Penzenskiy-I» – 90–120 cm and Pe-7 «Penzenskiy-II» – 100–120 cm – 15 on fig. 2) are dominated by dark-needle (43–50 %) and small-leaved (34–42 %) trees pollens: spruce (18–38 %), fir (13–22 %), birches (22–35 %), alder (9–18 %). Broad-leaved trees pollen was registered less frequently and averaged at 9–11 %.

An intensive climate warming in the latter half of the early Subatlantic Period resulted in spread of broad-leaved trees and, in a lesser degree, of small-leaved and spruce/fir forests. The Pz-11 («Penzenskiy-III» – 100–115 cm – 16 on fig. 2) pollen complex is characterized by

Environment development of East Asia in Pleistocene-Holocene (boundaries, factors, stages of Human mastering). Proceedings of International Scientific Conference, September 14–18, 2009, Vladivostok, Russia. – Vladivostok: Dalnauka, 2009. – P. 149–152.

---

dominance of broad-leaved trees pollen (35–52 %): oak (16–25 %), elm (7–12 %), walnut (5–11 %), ash (3–5 %), hazel, hornbeam, snow-ball (< 1.6 % collectively). Small-leaved tree pollen was dominated by birches (15–24 %), that of dark-needle trees – by spruce (8–18 %) and less frequently by fir (5–9 %).

A climate cooling in the first half of the middle Subatlantic Period resulted in disappearance of broad-leaved forests, increasing role of spruce/fir and small-leaved forests, appearance of frigid shrubs around 1700–1800 Cal. yr BP. The Pe-8 pollen complex (section «Penzenskiy-II» – 65–100 cm – 17 on fig. 2) contains roughly equally dominant contents of dark-needle (spruce – 21–35 %, fir – 7–18 %) and small-leaved (birches – 28–35 %, alder – 5–11 %) pollens, with much lesser role of broad-leaved trees (oak – 3–7 %, elm – 3–5 %) and frigid shrub (alder bush – *Alnaster* – 1–13 %, pine bush – *Pinus pumila* – up to 4 %) pollens.

The phase of small-leaved, broad-leaved and, in a lesser degree, fir/spruce forests was developing during a short-time climate warming occurring amid the cold epoch of the first half of the middle Subatlantic Period around 1400–1500 Cal. yr BP. Pollen complexes Pz-12 and Pz-13 («Penzenskiy-III» – 85–100 cm – 18 on fig. 2) contain much small-leaved (alder – 16–62%, birches – 11–14%), broad-leaved (oak – 11–22 %, walnut – 4–10 %, elm – 3–8 %, ash – up to 2 %) trees pollen and considerably less that of dark-needle tree species (spruce – 3–12 %, fir – 2–13 %).

A climate cooling and growing more humid at the end of the first half of the middle Subatlantic Period around 1400 Cal. yr BP resulted in spread of fir/spruce forests and a significant decrease in the role of small-leaved and particularly broad-leaved trees. The P-9 pollen complex («Penzenskiy-I» – 50–90 cm – 19 on fig. 2) is dominated by dark-needle tree pollen (spruce – 31–52 %, fir – 19–36 %). Other trees are represented by lower pollen contents: birches – 10–15 %, alder – 3–16 %, elm – up to 3 %, oak – less than 1.4 %.

The phase of fir/spruce and broad-leaved forests has most likely fixed a climate warming in the latter half of the middle Subatlantic Period. Dark-needle tree pollen content decreases in the pollen complex Pz-14 of «Penzenskiy-III» section (interval 70–85 cm – 20 on fig. 2): spruce – 14–39 %, fir – 23–34 %, while that of broad-leaved trees goes up (oak – 7–16 %, elm – 3–12 %, walnut – 2–4 %, ash, hazel, cork tree – less than 1 %).

Climatic conditions, similar to modern conditions and existing in the middle of the Late Subatlantic Period around 600–700 Cal. yr BP, have been reflected in the phase of small-leaved and spruce/fir forests with broad-leaved tree presence. The pollen complex Pe-9 («Penzenskiy-II» – 45–65 cm – 21 on fig. 2) shows roughly equal dominance of small-leaved (birches – 26–37 %, alder – 7–14 %) and dark-needle (spruce – 21–26 %, fir – 4–18 %) trees pollen. Broad-leaved trees pollen plays a lesser role (oak – 4–9 %, elm – 1–5 %, hazel – up to 2 %, ash, hornbeam – up to 1 %). Frigid shrub pollen was registered occasionally (alder bush – 4–10 %, pine bush – 3–5 %).

A cooling of the «Little Ice Age» in the second half of the late Subatlantic Period was fixed in the pollen complexes (P-10 in the section «Penzenskiy-I» – 30–50 cm and Pe-10 «Penzenskiy-II» – 20–45 cm – 22 on fig. 2) with a growing role of dark-needle pollen (48–75 %) and small contribution of broad-leaved trees (oak – no more than 5 %, elm – up to 2 %). The absolute age of deposited beds is 200–600 Cal. yr BP.

A modern climate warming is reflected in the pollen complexes (23 on fig. 2) of the peat-bog top layers in a decreasing role of dark-needle vegetation and growing role of small-leaved and broad-leaved trees.

Environment development of East Asia in Pleistocene-Holocene (boundaries, factors, stages of Human mastering). Proceedings of International Scientific Conference, September 14–18, 2009, Vladivostok, Russia. – Vladivostok: Dalnauka, 2009. – P. 149–152.

The results of the study on Cheremshanka peat-bog have made it possible for the first time ever to present a most comprehensive paleogeographic development picture for the South-West Sakhalin in the Holocene.

References

Alexandrova A.N. Pleistocene of Sakhalini. – Moscow: Nauka, 1982. – 192 pp. (In Russian).

Gvozdeva I.G., Mikishin Yu.A. Stratigraphy and paleogeography of southwestern Sakhalin // Natural & Engineering Sciences. 2008. № 3. – P. 177–183. (In Russian).

Igarashi Y., Igarashi T. Late Holocene vegetation history in south Sakhalin, northeast Asia // Japanese Journal of Ecology. 1998. № 48. – P. 231–244. (In Japanese, with English abstracts).

Igarashi Y., Igarashi T., Daimaru H., Yamada O., Miyagi T., Matsushita K., Hiramatsu K. Vegetation History of Kenbuchi Basin and Furano Basin in Hokkaido, North Japan, since 32,000 yrs BP // Quaternary Research. 1993. V. 32, № 2. – P. 89–105.

Khotinsky N.A. Discussible problems of Holocene paleoclimate reconstruction and correlation // Paleoclimates of Late Glacial Period and Holocene. Moscow: Nauka, 1989. – P. 12–17. (In Russian).

Khotinsky N.A., Aleshinskaya Z.V., Guman M.A., Klimanov V.A. Cherkinsky A.Ye. New periodic scheme of landscape & climate change in Holocene // Proceedings of USSR Academy of Sciences, Geographic Series, 1991. № 3. – P. 30–42. (In Russian).

Kulakov A.P., Nikolskaya V.V., Fedorova R.V. On landscape development in southwestern Sakhalin // VGO Proceedings. 1973. V. 105, № 2. – P. 133–141. (In Russian).

Marine terraces and Quaternary history of Sakhalin Island shelf /A.M. Korotky A.M., V.S. Pushkar V.S., T.A. Grebennikova et al. – Vladivostok: Dalnauka», 1997. – 195 p. (In Russian).

Mikishin Yu.A., Gvozdeva I.G. Natural Evolution in the South-Eastern part of Sakhalin Island in Holocene. – Vladivostok: Publishing Far Eastern State University, 1996. – 130 pp. (In Russian, with English resume).

Mikishin Yu.A., Gvozdeva I.G., Pevzner M.M. Boreal thermal maximum of Holocene at Sakhalin and the latest data on «Uandy» section // Reports of the 7-th TEACOM Meeting and International Workshop on Global Change Studies in Far East Asia. TEACOM publication № 4. – Vladivostok: Dalnauka, 1998. – P. 135–144.