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Characteristics of Climatic Environmental Changes of the Quaternary in Our Country

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Abstract In the paper, we reconstructed climatic environment that was reflected in the sporo-pollen flora with the time and studied the character of the climate change of the Quaternary in our country based on temperature and precipitation index of the plants which form the sporo-pollen flora. The character of the climate change of the Quaternary in our country is that it roughly reached the present point through the periodical repetition of warm-temperate and cold seasons drawing the main cycle 11 times. And there is not so different between the warm-temperate and cold seasons.
Key words climate environment, Quaternary, sporo-pollen flora

Introduction

The great leader Comrade **Kim Jong Il** said as follows.

"Scientists and technicians should also boldly buckle down to finding scientific and technical solutions to the problems arising in rapidly improving the branches which lag behind developed countries."("**KIM JONG IL** SELECTED WORKS" Vol. 10 P. 195)

The character of climate change of the Quaternary in our country was concretely studied with different ages on the basis of sporo-pollen flora which was known in several areas.

Thus, the sporo-pollen flora of the Early Pleistocene was studied around the Hwang isle on the lower River Songchon in Hamhung City, South Hamgyong Province, in Sophyong-ri and Sanbuk-ri in Suan County, North Hwanghae Province, Kangdon-ri in Hoeyang County, Kangwon Province and Komunmoru site in Sangwon County, North Hwanghae Province, and that of the Middle Pleistocene in Kunbong site in Soksong-ri, Hwadae County, North Hamgyong Province, Taehyon-dong site in Ryokpho District, Pyongyang City, Jenam Cave site in Tokchon City, South Phyongan Province and the site of Jungri Cave in Sangwon County, North Hwanghae Province, and that of the Late Pleistocene in Chongphadae Cave site in Hwangju County and the site of Ryonggok Cave No.1 in Sangwon County, North Hwanghae Province, in Songam Cave in Kaechon City, South Phyongan Province, in Onjinsan glacial site area in the borderland of Yonsan County and Suan County, North Hwanghae Province, and that of the Holocene in Namyang coastal zone in Sukchon County, South Phyongan Province, in the site of Dolmen tomb No.17 in Mangyongdae District, the Anhak Palace in Taesong District and the Taehwa Palace in Ryongsong District, Pyongyang City [1, 2, 4, 6－9].

1. Temperature Index and Precipitation Index of Sporo-Pollen Plants

The temperature index of the sporo-pollen plant consists of plant temperature, the sporo-pollen plant temperature and accumulation temperature, and the precipitation index, the plant precipitation, the sporo-pollen plant precipitation, accumulation precipitation, etc. What is important among them indices is plant temperature and plant precipitation, because the rest of these indices are calculated by them[3, 5].

In order to stipulate plant temperature five levels of the adaptation temperature of ecological environment are established within 5℃ from the yearly mean temperature 0℃ to 25℃ considering the character of temperature occurring in the mid-latitude zone in Northern Hemisphere including our country, and each scope of the level of the adaptation temperature of ecological environment is used as a criterion.

Most of plants continually increased the scope of adaptation temperature necessary to their own self-growth through evolution. It enabled them to grow in several levels of adaptation temperature of ecological environment as well as the optimum adaptation temperature when the species of plants came into being.

The plant temperature of the sporo-pollen plant was decided by dividing the temperature level which they can grow well and that which they can grow locally on the ground of the distribution of the climatic zone of the existing plant according to the kind of plant in several temperature levels, averaging the temperature level they can grow well, and considering the temperature level they can grow locally [10, 12].

In the regulation of plant precipitation, 5 levels of adaptation precipitation of ecological environment are fixed within 400mm from less than the yearly mean precipitation 200mm to more than 1400mm on the basis of atmospheric precipitation of our country, and each extent of the level of adaptation precipitation became a standard.

As in the plant temperature, the plant precipitation was also defined by averaging the precipitation level they can grow well and considering which they can grow locally.

The adaptation scope of ecological environment of the temperature and precipitation indices must be well determined to fully reconstruct the climatic environment in the sporo-pollen flora.

The division of temperature indices of plants which formed the sporo-pollen flora was based on the scope of adaptation temperature of ecological environment connected with climatic zones.

Our country is surrounded by sea on three sides, so that it gets much influence from marine climate. This shows itself in the development of the flora and produces certain characters in the geographical distribution of plants, so in the classification of climatic zones the subtropics was divided into the south and north, and the temperate zone into the south, middle and north [3].

The division of precipitation indices of plants in the sporo-pollen flora was based on the extent of adaptation precipitation of ecological environment related with the atmospheric humidity which changes according to atmospheric precipitation [5].

2. Accumulation Temperature and Accumulation Precipitation

Accumulation temperature in the the sporo-pollen flora is a temperature indicative parameter which the sporo-pollen plant temperature calculated by the plant temperature and the distribution ratio of the plants in a given flora was added together. Thus, it denotes the character of temperature in a concerned area during the formation of the sporo-pollen flora.

And accumulation precipitation is a precipitation indicative parameter that all the precipitation of sporo-pollen plants were added together, so it denotes the change character of the atmospheric precipitation.

The climatic environment of the Quaternary in our country which is seen in the accumulation temperature and precipitation is as follows.

The climatic environment in the Early Pleistocene of the Quaternary can be seen in table 1.

Table 1. Palaeoclimatic environment during the Early Pleistocene of Quaternary

Region	Sporo-pollen flora	Accumulation temperature /℃	Accumulation precipitation /mm	Palaeoclimatic environment
Komunmoru site	Ⅵ	1 346.0	91 420	Climate of the lower moist zone in the south of temperate zone
	Ⅴ	1 379.8	9 820	Climate of the lower moist zone in the north of subtropics
	Ⅳ	1 321.4	95 660	Climate of the lower moist zone in the south of temperate zone
	Ⅲ	1 278.9	98 910	
	Ⅱ	1 277.3	90 310	
	Ⅰ	1 324.5	94 200	
Kangdon-ri area		1 310.5	118 280	Climate of the moist zone in the south of temperate zone
Sanbuk-ri area		1 336.5	102 130	
Sophyong-ri area		1 384.8	95 930	Climate of the lower moist zone in the north of subtropics
Around Hwang isle area		1 377.9	96 460	

As we can see in table 1, the palaeoclimatic environment during the Early Pleistocene was generally mild. The first flora around Hwang Isle, Sophyong-ri and Komunmoru site was formed in the climate of the northern part of subtropics. The formation of the sporo-pollen flora in the rest except Sanbuk-ri and Kangdon-ri was made in the climate of the lower moisture zone.

The climate in the Middle Pleistocene of the Quaternary is presented in table 2.

As we can see in table 2, the climatic environment in the middle Pleistocene of the Quaternary changed from the climate in the south of the temperate zone during the formation of the first flora around Kunbong site to that in the north of the subtropics during the formation of the second and third flora ,and the climate in the south and the middle of the temperate zone were alternatively changed during the flora formation from Taehyondong site to Jungri cave site. And the precipitation during the formation of the flora in all the site showed the climate of the lower moisture zone.

Table 2. Palaeoclimatic environment in the Middle Pleistocene of the Quaternary

Region	Sporo-pollen flora	Accumulation temperature/℃	Accumulation precipitation/mm	Palaeoclimatic environment
Jung-ri cave site	Ⅱ	1 244.8	99 610	Climate of the lower moist zone in the middle of temperate zone
	Ⅰ	1 280.1	94 970	Climate of the lower moist zone in the south of temperate zone
Jenam cave site	Ⅲ	1 219.3	90 230	Climate of the lower moist zone in the middle of temperate zone
	Ⅱ	1 178.0	92 070	
	Ⅰ	1 324.1	91 280	Climate of the lower moist zone in the south of temperate zone
Taehyondong site	Ⅱ	1 242.1	88 730	Climate of the lower moist zone in the middle of temperate zone
	Ⅰ	1 339.7	94 410	Climate of the lower moist zone in the south of temperate zone
Kunbong site	Ⅲ	1 375.1	85 130	Climate of the lower moist zone in the north of subtropics
	Ⅱ	1 363.0	89 500	
	Ⅰ	1 277.1	83 790	Climate of the lower moist zone in the south of temperate zone

The climatic environment in the Late Pleistocene of Quaternary is found in table 3.

Table 3. Palaeoclimatic environment in the Late Pleistocene of Quaternary

Region	Sporo-pollen flora	Accumulation temperature/℃	Accumulation precipitation/mm	Palaeoclimatic environment
Site of Ryonggok cave No.1	Ⅴ	1 250.0	93 990	Climate of the lower moist zone in the south of temperate zone
	Ⅳ	1 231.6	74 090	
Onjinsan glacial site	Ⅱ	1 216.9	94 690	Climate of the lower moist zone in the middle of temperate zone
	Ⅰ	1 181.7	89 630	
Paekhuadong	Ⅲ	1 275.1	82 200	
	Ⅱ	1 261.7	88 040	Climate of the lower moist zone in the south of temperate zone
	Ⅰ	1 254.9	88 840	
Songam cave Moraedong	Ⅷ	1 306.4	92 060	
	Ⅶ	1 322.8	101 880	Climate of the moist zone in the south of temperate zone
	Ⅵ	1 306.2	95 310	
	Ⅴ	1 278.1	91 350	Climate of the lower moist zone in the south of temperate zone
	Ⅳ	1 322.6	98 360	
	Ⅲ	1 235.8	92 670	Climate of the lower moist zone in the middle of temperate zone
	Ⅱ	1 228.7	102 740	Climate of the moist zone in the middle of temperate zone
	Ⅰ	1 348.7	96 220	Climate of the lower moist zone in the south of temperate zone
Site of Ryonggok cave No.1	Ⅲ	1 373.7	102 000	Climate of the moist zone in the north of subtropics
	Ⅱ	1 280.9	96 910	Climate of the lower moist zone in the south of temperate zone
	Ⅰ	1 339.8	97 000	
Chongphadae cave sites	Ⅲ	1 356.4	98 530	Climate of the lower moist zone in the north of subtropics
	Ⅱ	1 306.1	95 070	Climate of the lower moist zone in the south of temperate zone
	Ⅰ	1 328.2	87 800	

As we can see in table 3, the climatic environment in the Late Pleistocene of Quaternary was climate in the south of the temperate zone and the north of subtropics during the formation period of the sporo-pollen flora in Chongpadae Cave site and the site of Ryonggok Cave No.1 and the rest was observed as an alternative change of the climate in the south and middle of the temperate zone. And the precipitation showed the climate of the moist zone during the formation of the third flora in Ryonggok Cave site No.1 and the second and seventh flora in Moraedong of Songam Cave, and the rest was in the climate of the lower moist zone.

The climatic environment in Holocene of Quaternary is shown in table 4.

Table 4. The palaeoclimatic environment in Holocene of Quaternary

Region	Sporo-pollen flora	Accumulation temperature/℃	Accumulation precipitation/mm	Palaeoclimatic environment
Taehwa Palace site	Ⅵ	1 285.3	98 840	Climate of the lower moist zone in the south of temperate zone
	Ⅴ	1 273.1	94 640	
	Ⅳ	1 281.1	96 070	
	Ⅲ	1 267.1	101 610	Climate of the moist zone in the south of temperate zone
	Ⅱ	1 213.8	101 020	Climate of the moist zone in the middle of temperate zone
	Ⅰ	1 268.7	82 320	Climate of the lower moist zone in the south of temperate zone
Anhak Palace site	Ⅴ	1 224.7	91 340	Climate of the lower moist zone in the middle of temperate zone
	Ⅳ	1 296.6	100 340	Climate of the moist zone in the south of temperate zone
	Ⅲ	1 259.3	94 560	Climate of the lower moist zone in the south of temperate zone
	Ⅱ	1 279.3	89 650	
	Ⅰ	1 221.3	91 100	Climate of the lower moist zone in the middle of temperate zone
Dolmen tomb site No.17	Ⅴ	1 243.9	104 030	Climate of the moist zone in the middle of temperate zone
	Ⅳ	1 219.7	101 910	
	Ⅲ	1 228.2	96 800	Climate of the lower moist zone in the middle of temperate zone
	Ⅱ	1 248.1	91 860	
	Ⅰ	1 257.3	107 150	Climate of the moist zone in the south of temperate zone
Namyang coastal zone	Ⅷ	1 283.0	101 370	
	Ⅶ	1 303.9	91 380	Climate of the lower moist zone in the south of temperate zone
	Ⅵ	1 263.0	93 100	
	Ⅴ	1 270.9	103 530	Climate of the moist zone in the south of temperate zone
	Ⅳ	1 318.3	102 850	
	Ⅲ	1 355.2	97 600	Climate of the lower moist zone in the north of subtropics
	Ⅱ	1 348.4	109 830	Climate of the moist zone in the north of subtropics
	Ⅰ	1 328.4	106 280	

In Holocene of Quaternary it was the climate in the north of subtropics during the formation of the first and third flora around the Namyang coastal zone and the rest was observed as a periodical repetition of the climates in the south and middle of the temperate zone. And the precipitation was in the climate of the moisture during the formation of the 1st, 2nd, and 5th and 8th flora around the Namyang coastal zone, the 1st, 4th, and 5th flora of the site of Dolmen tomb No.17, the 4th flora around Anhak Palace site and the 2nd and 3rd flora of Taehwa Palace site, and the rest was in the climate of the lower moist zone.

Conclusion

The character of the climatic change of the Quaternary in our country is a continuous exchange of the moist zone and the lower moist zone in the periodical repetition of the climate in the north of the subtropics and that in the south and middle of the temperate zone.

The feature of change of the climatic environment in our country is well expressed in the change of temperature, the main element of the climate. Especially it is found in detail in the curve of the change character of accumulation temperature in the sporo-pollen flora concerned with a given era (Fig.).

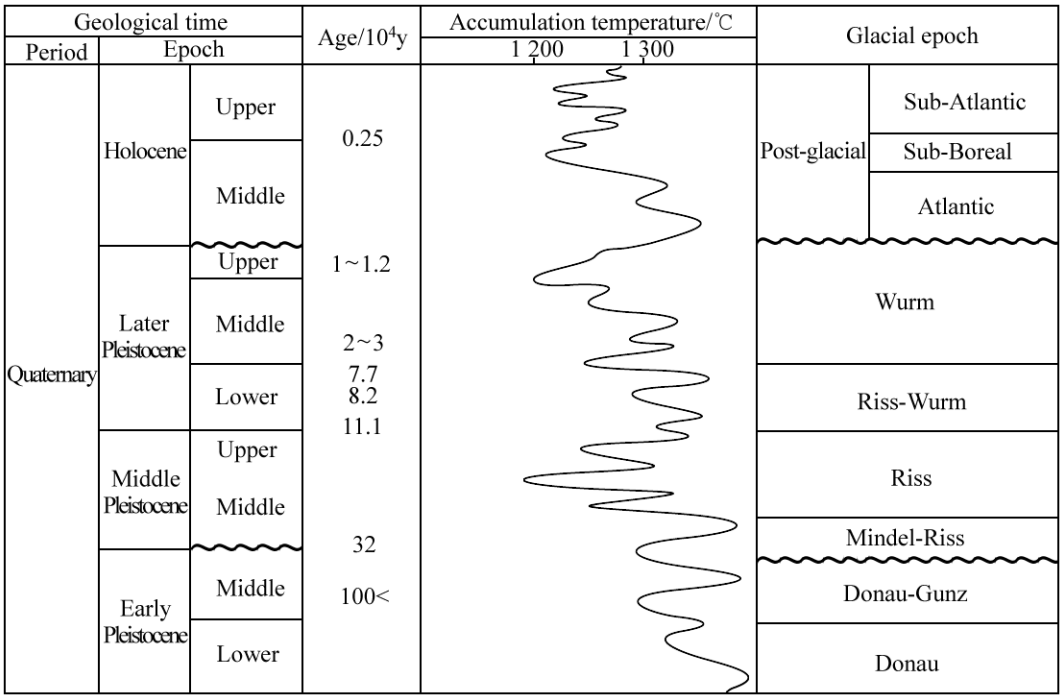

Fig. Characteristic curve of air-temperature changes of Quaternary in our country

The curve of character of the vertical exchange of accumulation temperature in the sporo-pollen flora of the Quaternary well known in our country shows that it roughly reached the present point through the periodical repetition of warm temperature and cold seasons drawing the main cycle 11 times.

Mildness in a warm temperature season gradually decreased from the Donau glacial age to postglacial age and on the contrary coldness in a cold season increased little by little until Wirum glacial age [11].

The difference of temperature between the maximum warm temperature season and a maximum cold season in our country is 206.8℃ in accumulation temperature.

The yearly mean temperature of this one is about 2℃, which shows that our country got comparatively less influence from the glacier of Quaternary. We can say that it is because our country is a maritime one which is surrounded on three sides by sea, so that it was greatly effected by the marine climate occurring in the Pacific.

The climate in our country was relatively mild in an ice age as well as an interglacial age owing to the peculiar change of climate of the Quaternary, and such a climate was very favorable to biological evolution.

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