THE KOREAN JOURNAL OF QUATERNARY RESEARCH Vol. 22, No. 2, p. 6−11 (December. 2008)

The Environmental Change of Korea based on the Isopollen Map during the Holocene

Soon-Ock Yoon[1]

[1]*Department of Geography and Research Institute for Basic Sciences, Kyunghee University, Korea (soyoon@khu.ac.kr)*

Abstract

Vegetation change reconstructed by pollen analysis is effective to clarify natural conditions such as climate and soil as well as intensity of human activity. Pollen analysis in Korea is difficult to obtain peaty soil sedimented by low relief geomorphollogically and formation age is usually confined to obtain information during young Holocene as well as little absolute age data. Isopollen map was constructed in order to analyze the change of vegetation environment time−spatially during Holocene based on the 30 data with age dated from 78 results from pollen analysis in Korea. The indicatives for vegetation environment were the main trees in Korea such as *Alnus, Pinus, Quercus* and AP/NAP during the periods of 6,000 y.BP, 4,000 y.BP, 3,000 y.BP, 2,000 y.BP, 1,000 y.BP. As a result, the regional time−spatial patterns of vegetation distribution appeared clearly on the isopollen map. The dominant vegetation stage was repeated in the different pattern e.g. the dominance between *Alnus* and *Quercus* at West Coast and between *Pinus* and *Quercus* at East Coast competitively.

1. Introduction

Palynology has been recognized to be important since application on the stratigraphy by Von Post at first and applied to the reconstruction of environment during late Pleistocene, especially agricultural activities (Neil Roberts, 2002). The pollen studies in Korea have been accomplished by Oh (1971), Hong (1977), Jo (1979, 1980, 1986), Choi (1991, 1992), Yoon (1994a, 1994b, 1995, 1996, 2008) and so on, with the beginning of Yamaszaki (1940). But these ones were almost confined to any one position and insufficient to clarify the interrelations among all of them on the location. Recently some scientists have recovered vegetation environment by pollen data time-spatially, using pollen map. Stephen T. Jackson (1997) in U.S.A., Guoyu Ren & Lansheng Zhang (1998), Guoyu Ren (2000), Guoyu Ren & Hans-Juergen Beug (2002), Whittington *et al.*(2002) in North East Asia are representative.

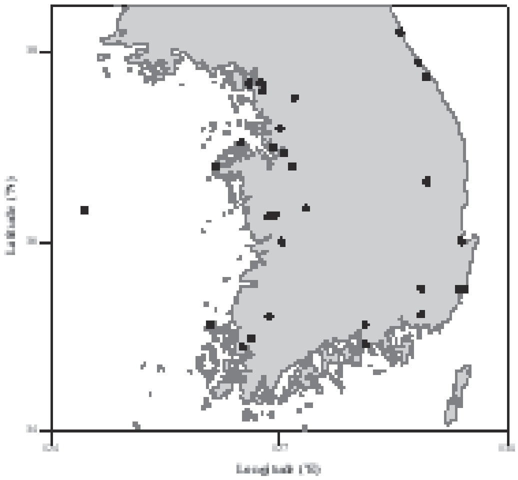
Vegetation change reconstructed by pollen analysis is effective to clarify natural conditions such as climate and soil as well as intensity of human activity. It is difficult to clarify information of environment and to draw isopollen map from previous data of pollen analysis in Korea, because it is difficult to obtain peaty soil by low relief and peat formation age is usually confined to the young Holocene with poor absolute age data.

The object of this study is on the construction of the isopollen map by the results of pollen analysis time-spatially in Korean peninsula and to investigate the environmental change of vegetation during the Holocene and clarify regional difference. Especially the map about vegetation ecology was focused on explanation of the interrelationship between climate and sea level change.

2. Methods

Some of dominant vegetation in Korea like *Pinus, Alnus* and *Quercus* and AP/NAP were known to explain the climate change. And isopollen map shows time-spatial patterns of vegetation distribution clearly. NAP is composed of Gramineae, *Artemisia*, Chenopodiaceae, *Persicaria*, Compositae and *Urtica* so on. And increase of their appearance rate is referred as indicatives of agriculture as well as coarse grass related with cooling climate.

The elements used on the map as environmental indicatives of vegetation were the main trees of Korea such as *Alnus*, *Pinus*, *Quercus* and AP/NAP. Each element was constructed on iospollen map during the periods of 6,000 y.BP, 4,000 y.BP, 3,000 y.BP, 2,000 y.BP, 1,000 y.BP. The map was drawn with computer program of surfer 7.0.



	location	latitude, longitude	^{14}C dates	possibility	origin
1	Gyeonggi-Do, Pyungtaek	36°58′N, 127°03′E	0	1	Oh, 1971
2	Gyeonggi-Do, Gunja-Ri	37°22′N, 126°45′E	2	0	Kim et al., 1980
3	Chonnam-Do, Gaheung-Ri	34°59′N, 126°38′E	1	1	Kim et al.,, 1981
4	Gyeongnam, Bangeojin	35°29′2″, 120°25′48″E	3	0	Kim et al.,, 1982
5	Gangwon-Do, Youngnang-ho	38°12′55″, 128°35′03″	5	0	Chang et al., 1982
6	Gyeonggi-Do, Hwangdeung	36°00′18″, 126°57′58″	2	0	Jo, 1986
7	Gangwon-Do, Jumunjin	37°53′20″, 128°49′32″	2	1	Jo, 1987
8	Gyeongnam-Do, Bangeojin	35°29′02″, 129°25′55″	3	0	Jo, 1987
9	Gyeongpook-Do, Pohang	36°00′25″, 129°22′31″	3	1	Jo, 1979, 1987
10	Gangwon-Do, Mt. Daeam	36°13′N, 128°7′30″	8	0	Chang et al., 1987
11	Gyeongnam, Samrangjin	°′″, °′″	0	1	Jo, 1983
12	Gyeonggi-Do, Ilsan	37°40′30″, 126°45′10″	6	0	Yoon, 1994, 1997
13	Gyeongnam, Sacheon	34°50′N, 128°07′E	0	2	Yoon, 1996
14	Gangwon-Do, Unsan	37°44′N, 127°10′E	2	0	Yoon, 1998
15	Gyeonggi-Do, Gimpo	37°35′37″, 126°46′15″	2	0	Yoon et al., 2002
16	Gyeongnam-Do, Geumcheon-Ri	35°30′N, 128°52′E			Yoon et al., 2003
17	Chungnam-Do, Taean	36°47′43″, 126°09′07″	0	1	Park, 1990
18	Gyeonggi-Do, Pyungtaek	36°56′50″, 127°03′10″	0	3	Park, 1993
19	Gyeonggi-Do, Hanam	37°31′30″, 127°11′30″	1	0	Choi, 1991
20	Gyeonggi-Do, Ilsan	36°56′50″, 126°45′10″	9	0	Choi, 1992a
21	Chonbuk-Do, Iksan	36°00′18″, 127°01′12″	0	1	Choi, 1992b
22	Chonnam-Do, Gwangju	35°12′34″, 126°51′05″	2	1	Choi, 1995

	location	latitude, longitude	^{14}C dates	possibility	origin
23	Chonnam-Do, Muan	34°53′N, 126°30′E	2	1	Park et al., 1996
24	Gyeonggi-Do, Pyungtaek, Anjung	37°02′N, 126°55′E	1	0	Yi et al, 1996
25	Daejeon, Yuseong	36°21′13″, 127°20′15″	0	2	Yi et al, 1998
26	Gyeonggi-Do, Hwaseong	37°11′49″, 126°59′41″	0	1	Yi et al 1999
27	Chonbuk-Do, Gochang	35°29′22″, 126°27′56″	1	2	Yi et al, 2004
28	Chonnam-Do, Sinan	35°07′20″, 126°5′30″E	2	0	Kim et al, 2000
29	Gangwon-Do, Hyang-ho	37°54′28″, 128°45′30″	5	0	Fujiki et. al., 2004
30	Gangwon-Do, Gyeongpo-ho	37°44′N, 127°10′E	3	0	Yoon, 2008

3. Vegetation Change of Environment during the late Holocene on the Korean Peninsula

1) Ecological characteristics from regional pollen composition by previous data.

Alnus, *Pinus*, *Quercus* as main trees are composed of almost over 90% during the Holocene. They have different distribution and appearance rate time-spatially in Korea.

It is very interestingto clarify the distributional characteristics and reasons of the trees and AP/NAP, which are used to indicate climate change and intensity of agriculture.

(1) East Coast

Tsukada et al. (1977) recovered vegetation environment since late glacial period at site L. Youngnang-ho. Pollen were composed of cold climate indicators like *Larix*, *Abies*, *Picea*, means the forest was thin with needle trees during late glacial period. But the forest was flourished and warm during 10,000-6,700 y.BP because of lots of pollen from dominant oak trees. And the thin forest during 6,700-1,400 y.BP because of lots of pine tree pollen responded again drying and cooling of climate.

Jo (1979, 1987) has related the change of vegetation environment of Quercus-dominance and Pinus-dominance since 10,000 y.BP to the change of sea-level and climate. The dominant Oak trees indicate warm climate and sea leveL was getting increased during the period between 10,000 and 6,000 y.BP. And then Pinus-dominance period since 6,000 y.BP indicated cooling of climate and stable sea-level.

(2) West Coast

Yoon (1994) and Hwang et al. explained at Ilsan that dominance of *Alnus*-EMW is the result from sea level rising and warming climate during Pollen zone Ⅰ (8,000-4,200 y.BP), increase of Pinus during pollen zone Ⅱ 4,200-2,300 y.BP) and dominance of NAP and abrupt increase of Pinus were cooling of climate by the stable or falling of sea level and human impact.

Yoon (1994, 1997) at alluvium of R. Dodaecheon, correlated vegetation change to the sedimentary environnment of deposits. She obtained the result that the main AP, Alnus and Quercus have variation corresponding to sea level variation; the dominance of Alnus to the period of sea level rising and the dominance of Quercus to the period of sea level falling.

(3) South Coast

Pollen data from Sacheon, Gyeongnam-Province from Yoon (1996) showed the pollen composition of *Quercus, Alnus* and *Pinus* indicating transitional characteristics between East Coast and West Coast.

2) Ecological characteristics of main trees as climate indicators and isopollen map

Isopollen map was constructed in order to investigate time-spatial distributional characteristics using

Quercus, Alnus and *Pinus* and NAP/AP as climate indicators in Korean Peninsula during Holocene.

(1) *Alnus*

Adler relatively likes to live in warm and wet soil conditions around lowlands like alluvial plain, wetlands and lakes ecologically. Normally Alnus has high percentage on the peatlands due to those characteristics. The indicators on the Isopollen map show clear distribution difference regionally.

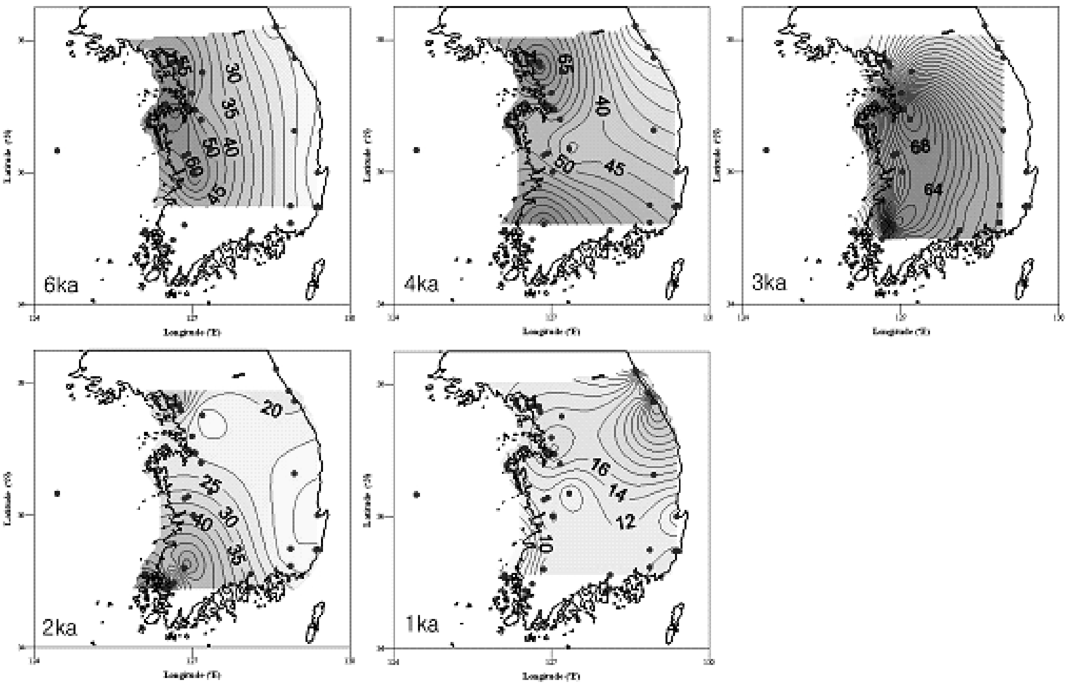
Appearance rate around 6,000 y.BP was very high with 60-70% in the West Coast, but very low with 5-10% in the East Coast. For example, over 70% at Ilsan and Gimpo, 2.3%, 10.26% in the West Coast, Youngnang-ho and Hyang-ho and under 10% at Pohang in the East Coast.

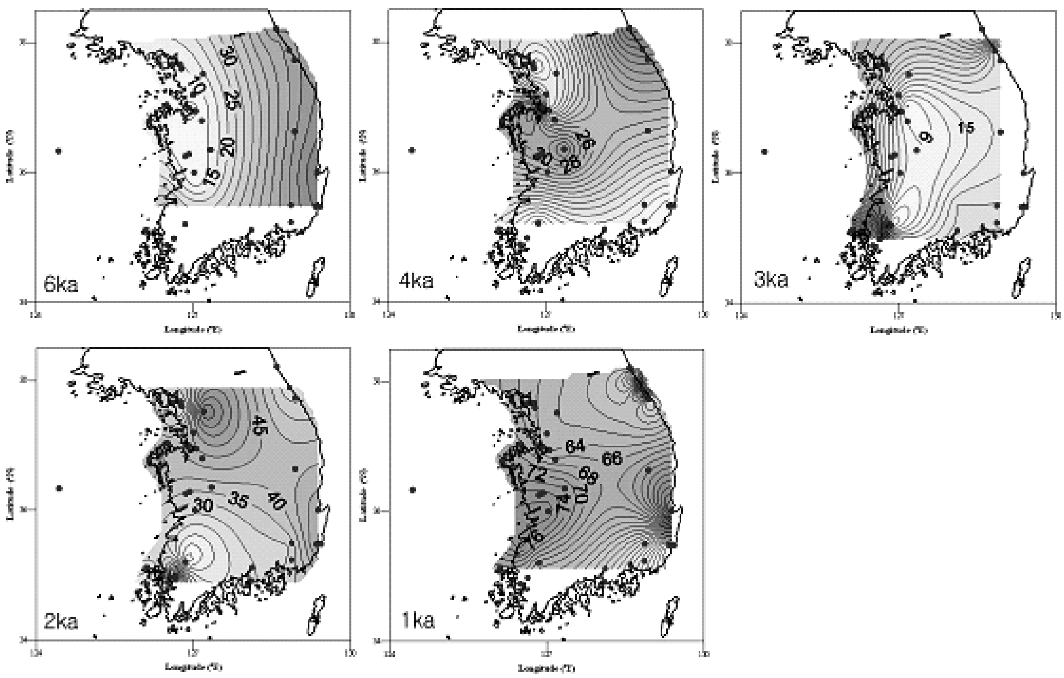
Alnus still concentrated over 60% in the West Coast during 4,000 y.BP and 3,000 y.BP, but regional difference decreased. Appearance rate decreased with 30-40% during 2,000 y.BP. And all the area of Korea has only 10-15% during 1,000 y.BP with similar distribution pattern.

(2) *Pinus*

Pinus which lives relatively well on the dry ridge of exposed rock slope, soil layer with thin thickness, and bareland, indicates environment with dry and cool climate like *Pinus densiflora* (Jo, 1980). The indicators on the Isopollen map show clear distribution difference between East- and West Coast.

Appearance rate around 6,000 y.BP was very high with 55-80%, in the East Coast but very low under 10% in the West Coast. *Pinus* still has high rate over 40-50% in the East Coast during 4,000 y.BP and 3,000 y.BP, with decreased regional difference. Appearance rate increased during 2,000 y.BP with little difference. Exceptionally, 80% at Gaheung and 5% at Muan, Chonnam-Do. And high rate of 50-90% recorded at all the area during 1,000 y.BP, especially over 80% at Bangeojin, Jumunjin and Pohang.

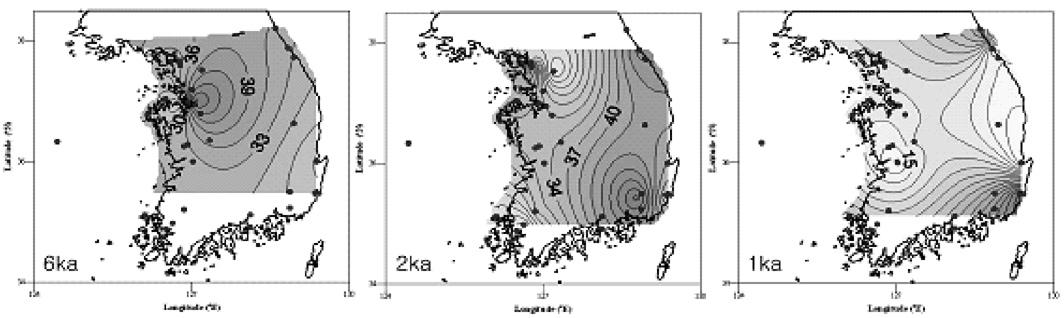




(3) *Quercus*

There are many species among *Quercus*, usually evergreen broadleaved trees, but some are composed of shrubs. And they live over broad area from temperate zone to equatorial zone. Generally needle tree forest like Pinus succeeds to broadleaved trees including *Quercus*and finally climax. *Quercus*, indicating warm, humid climate, usually lives in a thick and organic soil layer of deep valley, opposed to the pine trees. *Quercus*characterizes warm and humid condition, but *Pinus* does cool and dry condition as climate indicator,

Quercus characterizes high rate with 30-40% over the Holocene in Koreawithout regional difference.E.g. usually 30-40% in Korea and 52% at Pyeongtaek during 6ka BP. High differential rate with 10-70% regionally during 4-3ka BP, e.g. over 50% at Youngnang-ho, Jumunjin and Bangeojin of East Coast, but under 10% at Gimpo, Ilsan and Gwangju, 26% at Pyeongtaek of West Coast. Moreover 40% at Gochang, 10% at Sinan of South Coast. Decreased differential rate shows 10-60% with high rate during 2ka BP and became very low with 10-50% during 1ka BP.



3) Time-spatial rate of rate NAP/AP

NAP dominance is caused by abrupt increase of grasses such as Gramineae and Artemisia indicating agricultural activity by human beings. Periodically this phenomenon is correspondent to the late Holocene

NAP/AP rate over 1.0 indicates NAP-dominance and under 1.0 is AP-dominance. NAP/AP rate over 1.0 means human impact and rate is getting higher, intensity of human interference is getting stronger. NAP/AP rate is only 0.08-0.4 under 1.0, indicating meaningless human impacts during 6,000 y.BP. The value over 1.0 appears at Ilsan, Gimpo, Naju in the West Coast during 4,000 y.BP. The value is increasing coming to the Recent from 0.4-1.8 during 3,000 y.BP and 0.5-3.7 during 2,000 y.BP with climax.