B-52.1 Studies on Effects of ENSO under Global Warming on Plants in Monsoon Asia

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1.Introduction

The effects of global warming on vegetation would be regionally different. In the regions where global warming causes adverse impacts on the vegetation, the vegetation would decrease its competence to remove atmospheric CO2, and some species would be endangered to disappear. The aim of this study is to anticipate the effects of global warming on the phenology of several locations in Monsoon Asia regions.

2.Research Objective

The state of generation, strength and period, etc. of the monsoon because of the global warming have changed from East Asia to Southeast Asia in the monsoon Asian region. Especially, the relation between El Niño and La Niña (ENSO) is important. As for the report of IPCC(1995), this is pointed out. The global warming exerts various impacts on local weather and makes vulnerability vegetation. This means vegetation not only loses the function as the absorption source of carbon dioxide but also the inhabiting scene of various plants is lost. Then, these impacts forecasts to a vulnerability plant are done. The establishment of the evaluation method in which making of vulnerability vegetation and change the physiology mode are used is hoped for as an index of global warming. Especially, the change in blooming, budding, leaf-color, leaf-falling, and genital growth (the amount of crops is included) season of plant phenomenon aims the detection as the index of a local environmental change promisingly as the index.

In the research in the relation to regional, unusual weather depending on the impacts of the global warming, the monsoon, and ENSO, etc., not being done enough though it is important is a current state.

3.Reserach Method

The data of the effects in the global warming in the Asian-Pacific Ocean region, especially Monsoon and ENSO on local vegetation was collected to the analysis.

The phenological distribution map of the East Asia which included the region,

Japan, South Korea, and China which had not been elucidated up to now was made. A uniform data base of the blooming dates of cherry blossom (*Prunus yedoensis*) was constructed. The blooming date of *Prunus yedoensis* and ENSO was related and the impacts which unusual weather because of the global warming in recent years exerted on local vegetation was considered.

4. Result

This project team researches the effects under the global warming on the plant and a lot of researches have been done up to now[1)-15)]. Then, the result went up by this sub-theme is enumerated as follows.

1)The characteristic of geographic distribution on the day of the flowering of *Prunus yedoensis* in East Asia (average blooming, early-blooming, and late-blooming) was understood(Fig.1). It is the same as the difference on the 15 days is between the distribution chart where *Prunus yedoenisis* late-blooming and the distribution map which early-blooming and there was the south-north difference of about 3-4°N. The inland region remarkably appeared to the difference of time of both compared with the coast region. The difference at time appeared that northern regions are larger than in the southern regions.

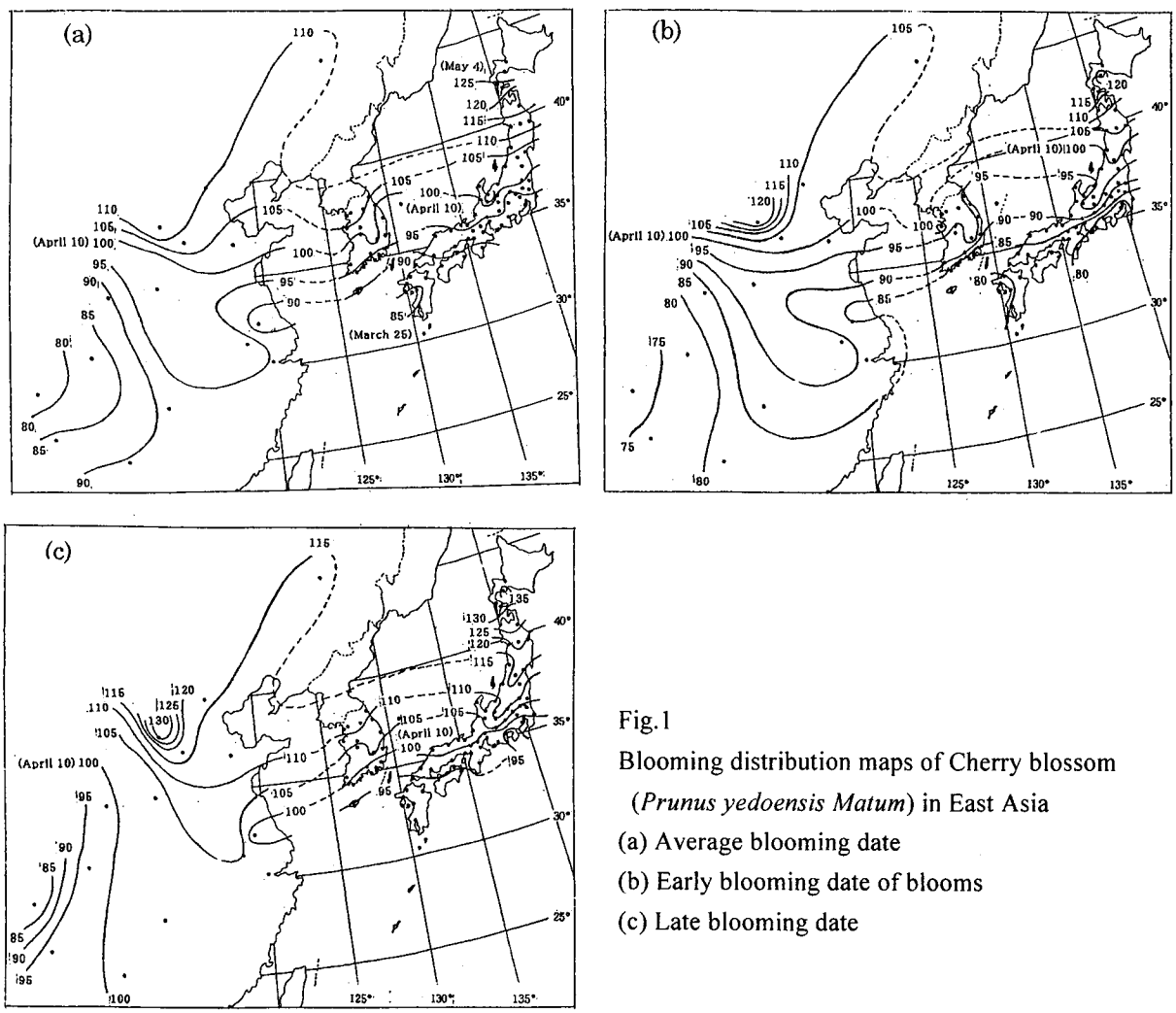

Fig.1
Blooming distribution maps of Cherry blossom (*Prunus yedoensis Matum*) in East Asia
(a) Average blooming date
(b) Early blooming date of blooms
(c) Late blooming date

2)Empirical formula by which the relation among a day of the blooming of *Prunus yedoenisis* in each observation point, latitude, a longitude, and altitude was shown was made and whether it was possible to adjust also to an academic life climate law and east Asia of the phenomenon of the season of Hopkins(1938) was verified[16] .

$$y = a + b(\phi - 35^\circ) + c(\lambda - 135^\circ) + dh \quad (1)$$

y :blooming date of *Prunus yedoensis*, ϕ :latitude(n-35° N), λ :longitude,(e-135° E), h:altitude(100m). When Akashi in Japan is calculated as a standard value, it is the next expression.

$$y = 7.683 + 4.793\,n - 0.614\,e + 0.012\,h \qquad (R^2 = 0.932) \quad (2)$$

A statistical analysis was done by using the absolute value of a geographic index of the observation point in Japan, South Korea, and China in this research.

$$y = 80.81 + 3.220\,n - 0.747\,e + 0.026\,h \qquad (R^2 = 0.635) \quad (3)$$

As a result, an advanced 0.7 days according to the above the altitude of 0.2 days according to the longitude of 0.8 days according to latitude earlier tendency was seen compared with North America as for the phenomenon of the season of east Asia which had been seen on the average blooming date of *Prunus yedoensis*.

3)The relation to the temperature in the spring and the winter which related closely to the blooming of the plant was quantitatively considered.

An monthly mean temperature in January and March and positive close, correlation are shown on the day of the blooming of *Prunus yedoensis*. Especially, the average blooming of *Prunus yedoensis* date became about 2.6-3.6 days earlier when the mean temperature in March rose at 1℃ and the tendency which became about 1.6-3.2 days earlier when the mean temperature rose at 1℃ in January was shown.

4)The relation between the phenology in China[17] and the phenology in Japan was clarified. The biological climate calendar in China and Japan at the phenology when the global warming was made based on the blooming of *Prunus yedoensis* and the annual mean temperature. How much other phenological phenomena shifted based on the day of the blooming of *Prunus yedoensis* in Japan was shown at the annual mean temperature(Fig.2). In addition, how much phenology (*Juniporus chinenesis and Salix babylonica*) of China shifted based on the day of the flowering of *Prunus yedoensis* of Japan was shown at the annual mean temperature(Fig.3).

5) Analysis of the ENSO data and impacts of global warming on local vegetation growth in monsoon Asia

The El Niño year and La Niña events year were compared by using the season phenomenon of biological climate.

First, problems discussing the impacts of global warming on the local vegetation and its conservation were discussed. Secondly, secular change of El Niño and La Niña years were shown by the number of seasons prolonged, respectively. In this study,

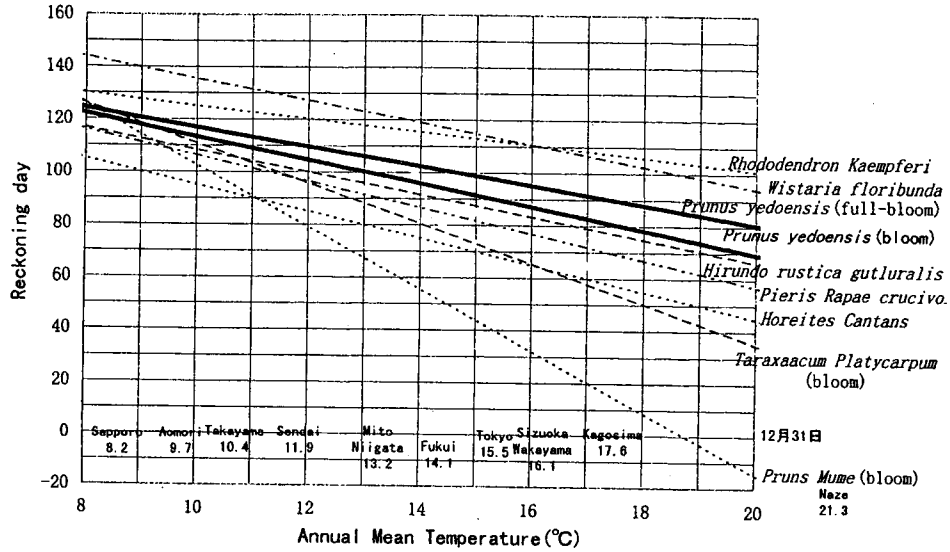

Fig.2 Relation between annual mean temperature and phenological phenomenon in spring of Japan

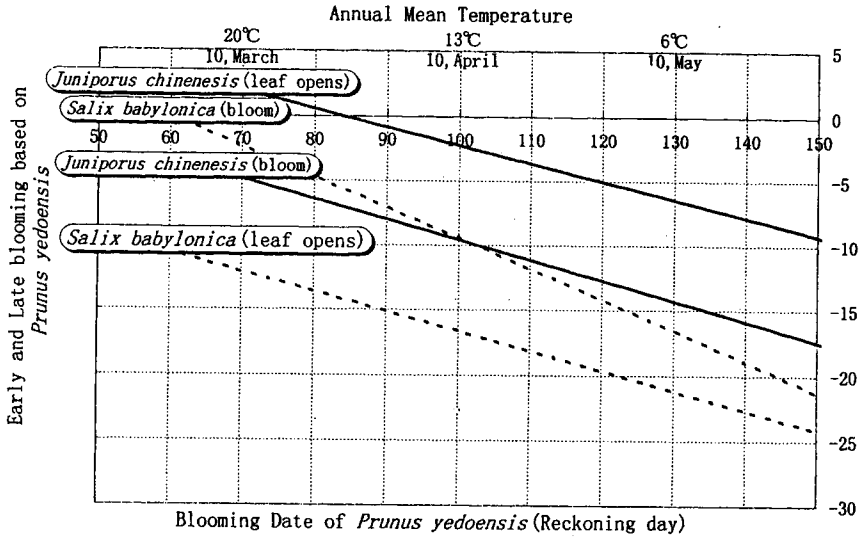

Fig.3 Early and late phenological date (*Juniporus chinenesis, Salix babylonica*) in China based on blooming date of *Prunus yedoesnis*

differences of the composed mean values between the El Niño and La Niña years were shown for the flowering date of cherry blossoms (*Prunus yedoensis*) and other indicators of local vegetation growth. The important points obtained are: (1) The positive or negative impacts of El Niño and La Niña years are different in the periods, which is located in the increasing part or decreasing part of long-term trends/cycles.
The blooming date of *Prunus yedoensis* became early in most regions in year of the El Niño and slowing of plain in most regions appeared extremely in year of La niña.

It has been understood that an unusual weather exerts a large impacts on the seasonal variation of local vegetation.

5. Discussion

As a problem in the future, It is enumerated to examine the relation and the influence of the amount change of crops which the relation between the transitions of the

season phenomenon such as important budding ,leaf-color change, and leaf-falling for the existence of not only the blooming of the plant but also the plant and climates (unusual weather) and is these syntheses, the combinations with the animal season, and climates (unusual weather) in detail.

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