Distribution range shift of plant pests, possibly due to climate change: examples in Japan

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Benefits for studying northward range extensions of plant pests on the Japanese Archipelago

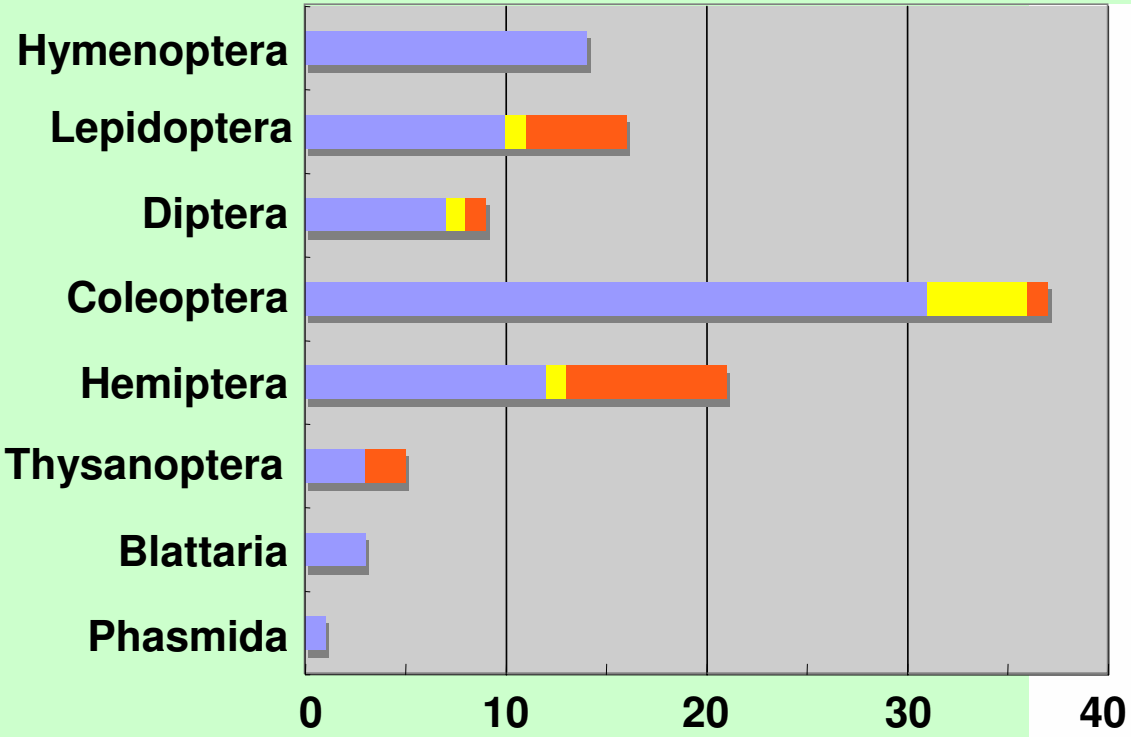
The Japanese Archipelago extends for about 2,000 km from south (24˚02'N) to north (45˚31'N)

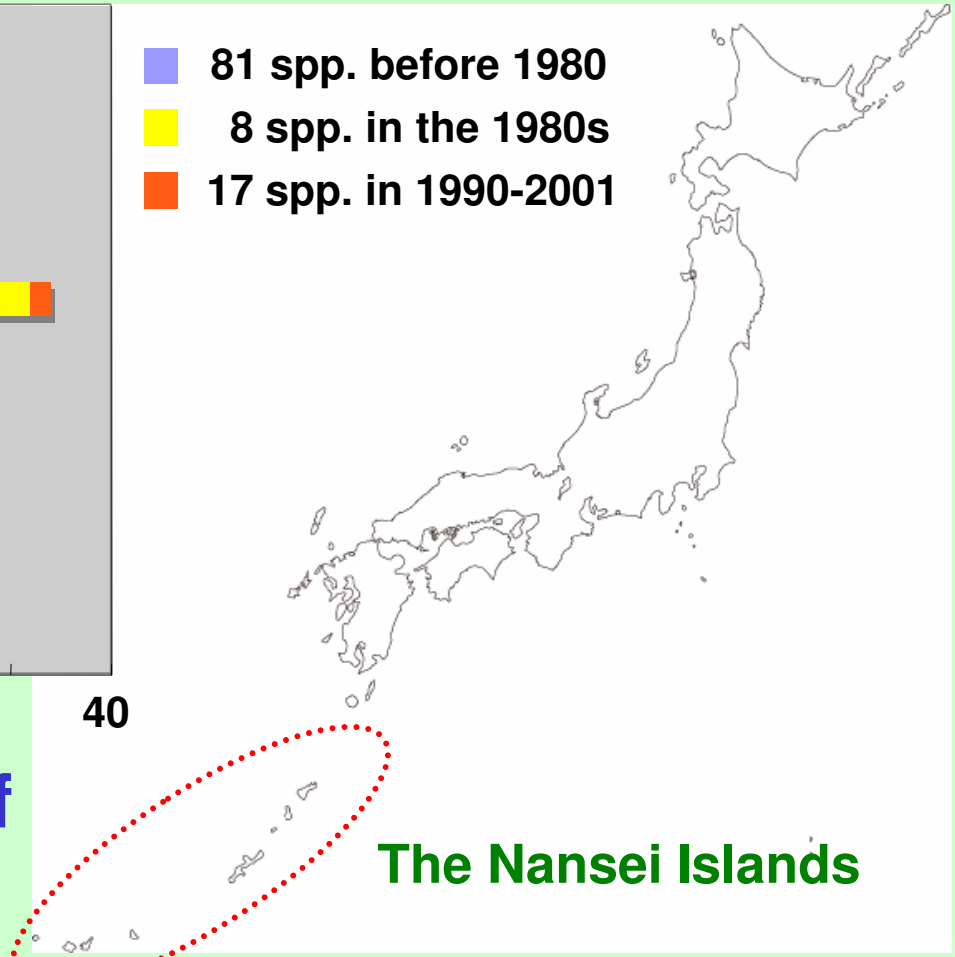
There are 4 distinct seasons in a year

Many armature entomologists have accumulated collection records of various insect species

The number of alien pest species that have established in the Nansei Islands, Japan

(including both natural invasion and accidental introduction)



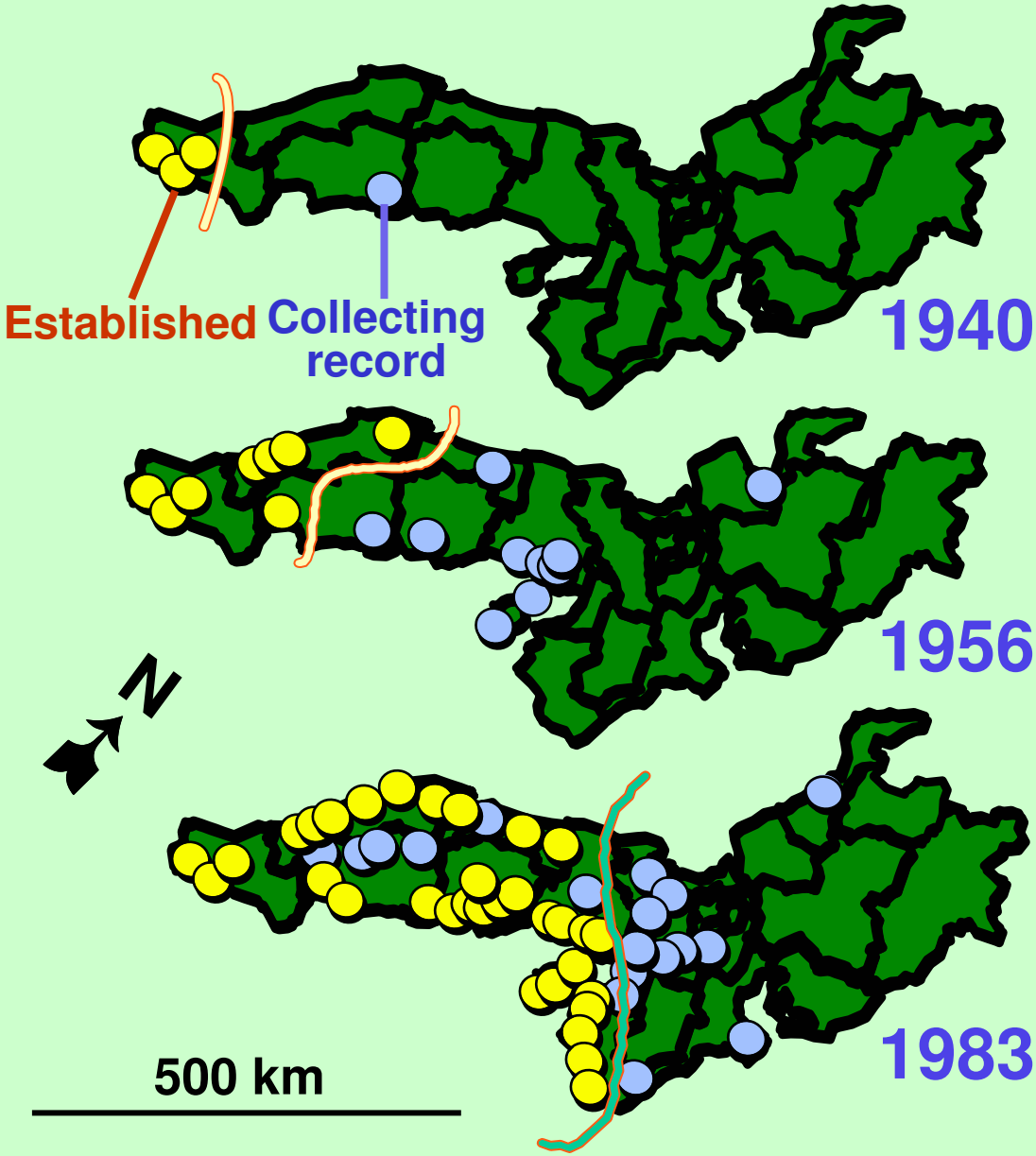


Data indicate an increase of alien pest species from 81 to 106 in recent years

About 250 butterfly species occur in Japan. At least 40 of them are exhibiting northward range extensions in recent years

Recently, 15 species newly arrived naturally and established on the Nansei Islands

Papilio memnon, a pest of citrus trees, has extended its distribution rage in western Honshu



In 2000, *P. memnon* arrived in Tokyo

A case study: Distribution range shift of *Nezara viridula* and *N. antennata*

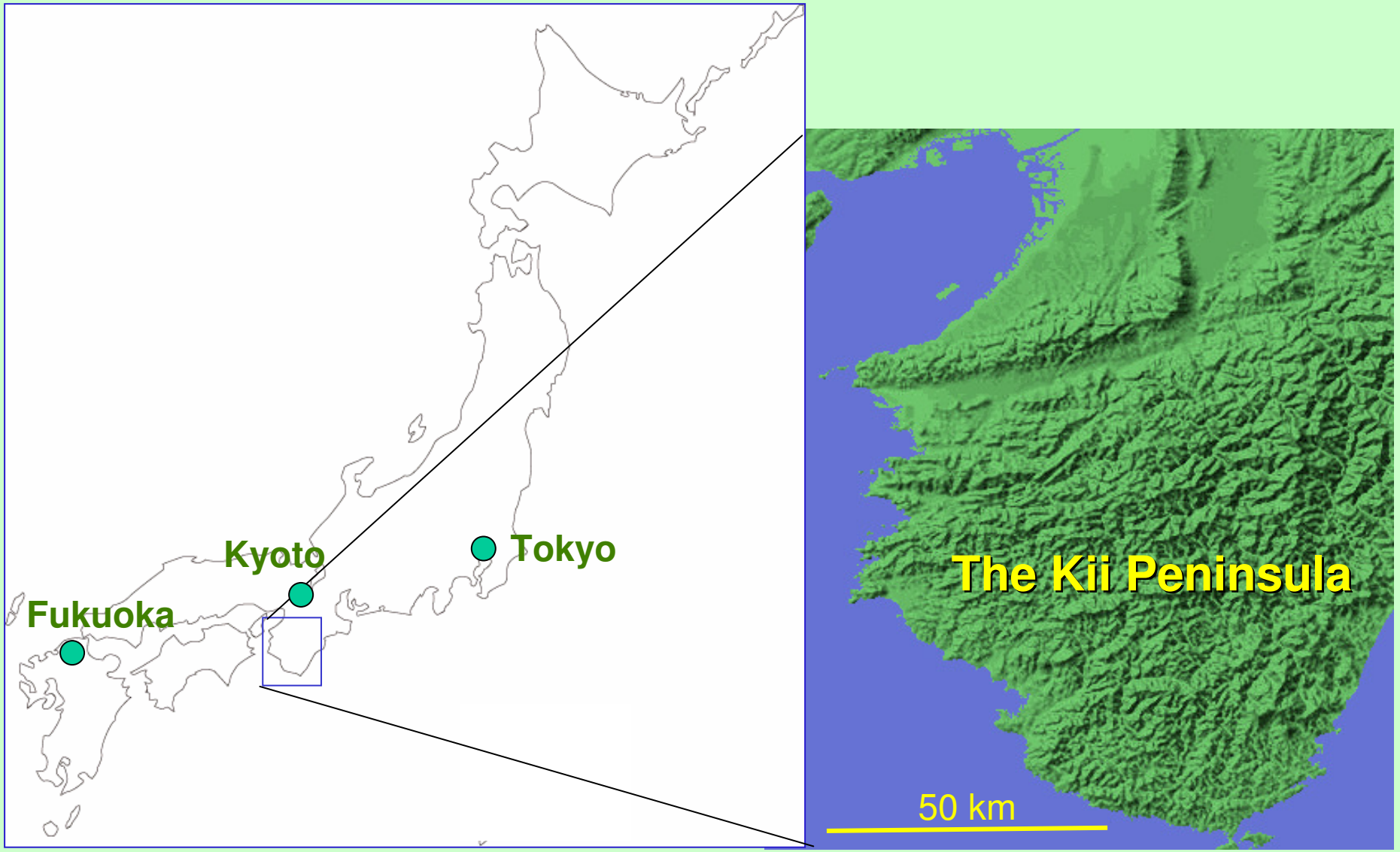
Both species are pests of various crops, such as rice, soybean, corn, tomato, eggplant, etc.

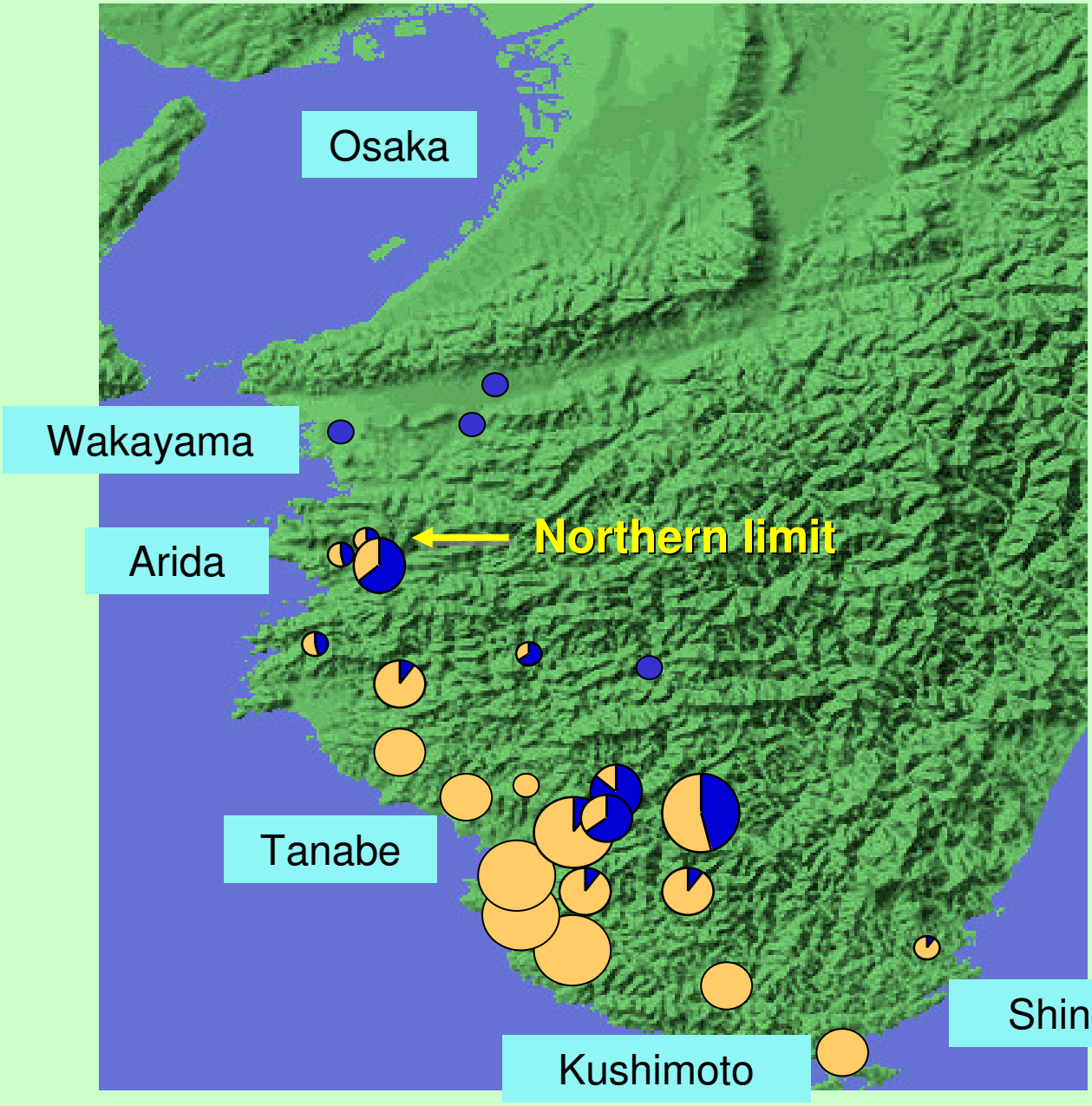
← *N. antennata* is distributed in Japan, Korea, China, and southeastern Asian countries

← *N. viridula* is distributed widely in the tropics, subtropics, and southern temperate zones

In Japan, it was first recorded in 1874 and has been increasing since the 1950s in southwestern parts of Japan in association with the prevalence of early-planted rice

Distribution of *Nezara* bugs in the Kii Peninsula



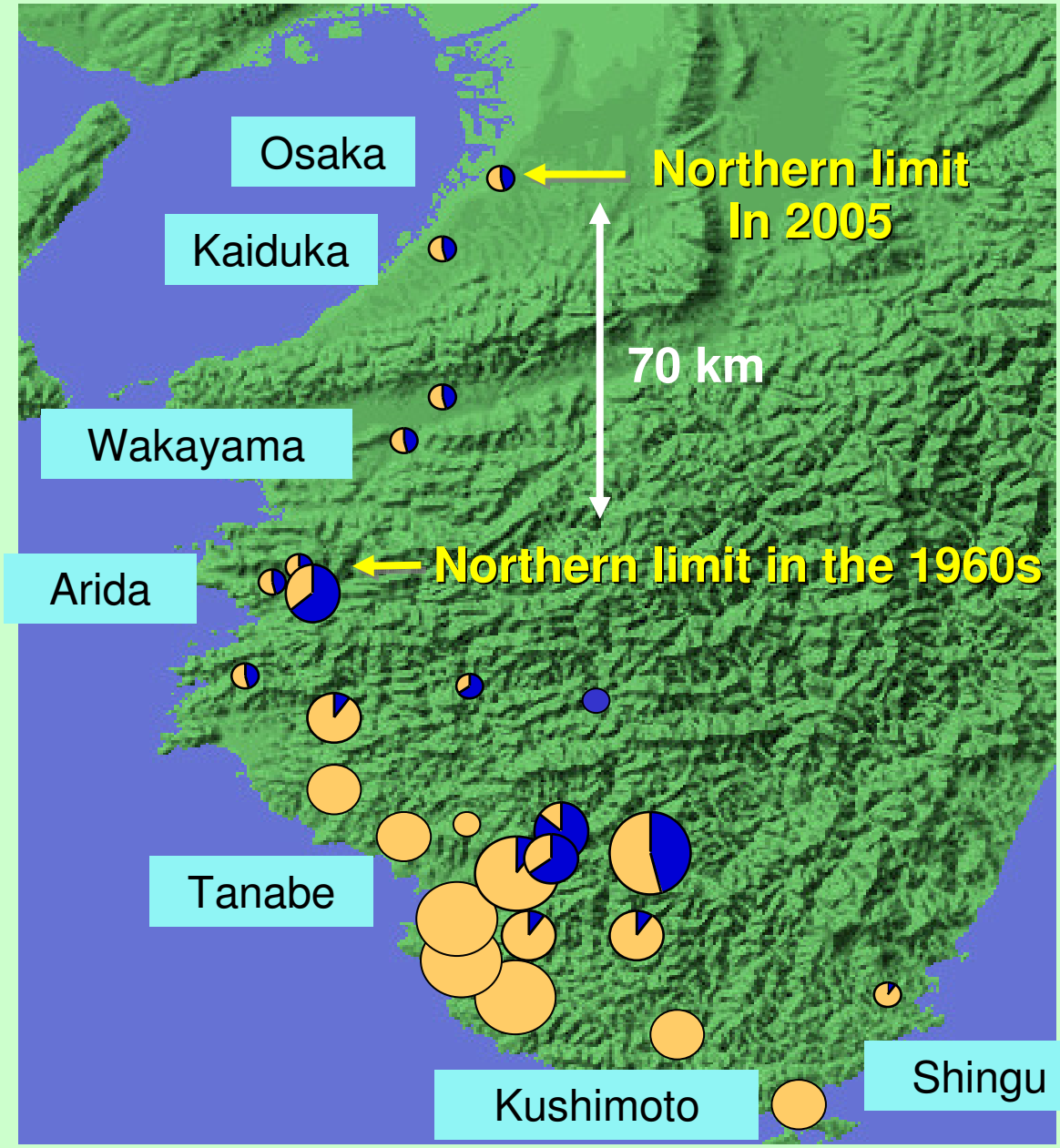


Distribution map of *N. viridua* and *N. antennata* in the Kii Peninsula in the 1960s

N. viridula

N antennata

***N. viridula* was distributed along the sea coast and south of Wakayama**



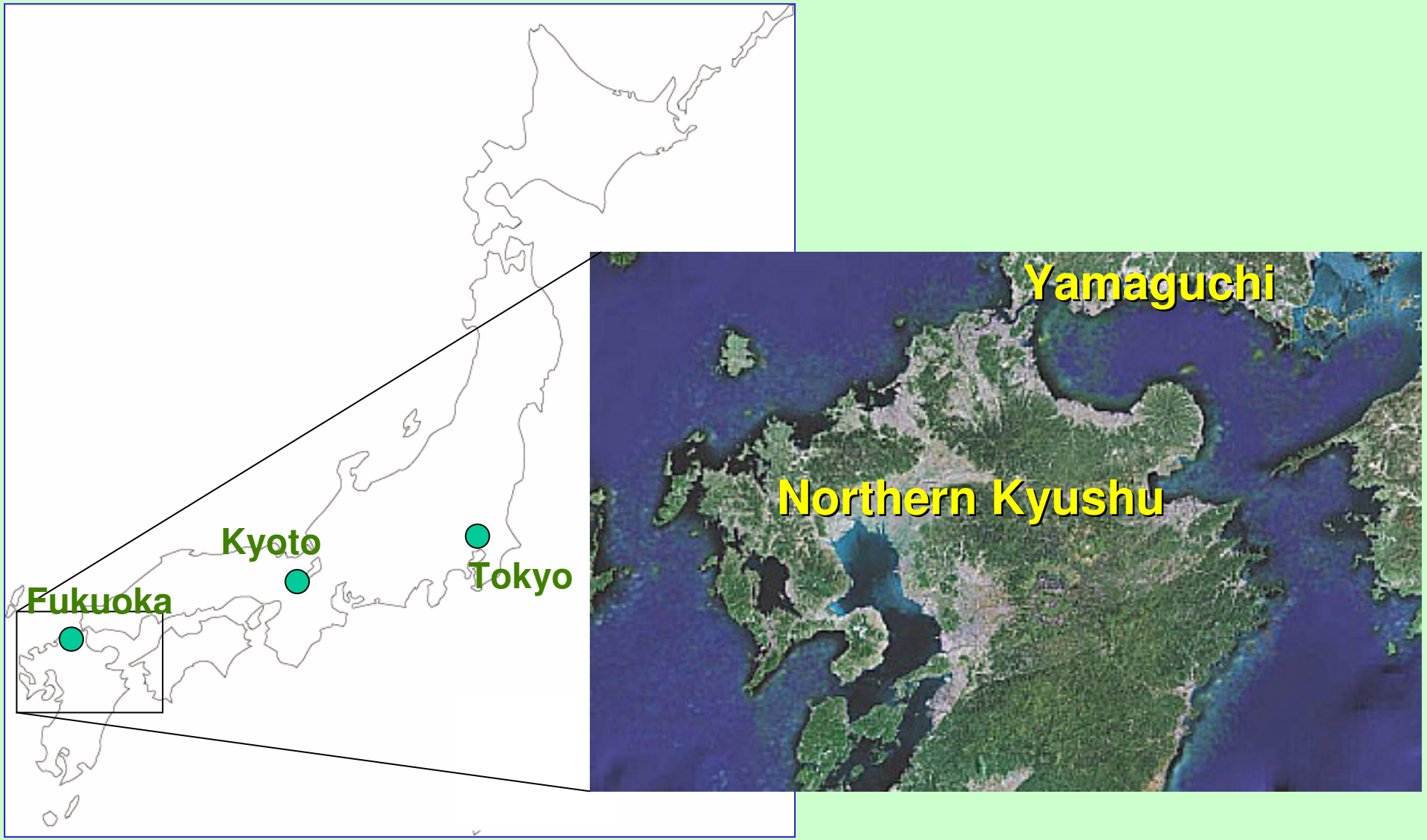
Distribution map of *N. viridua* and *N. antennata* in the Kii Peninsula in 2005

- ***N. viridula***
- ***N antennata***

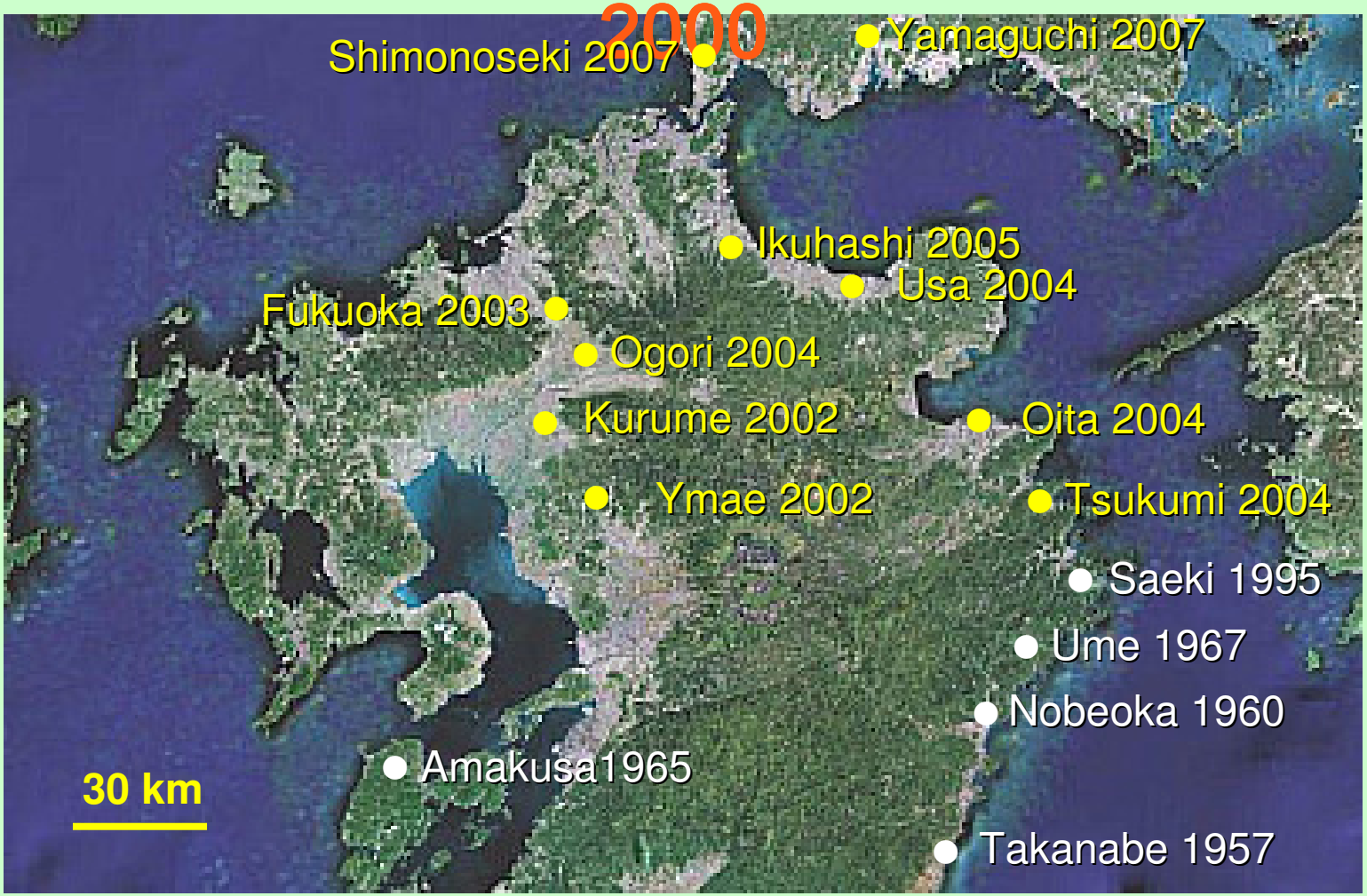
N. viridula **was found in northern parts of the Kii Peninsula**

Northern limit moved 70 km northward

Distribution range shift of *Nezara viridula* in northern Kyushu and Yamaguchi Prefecture

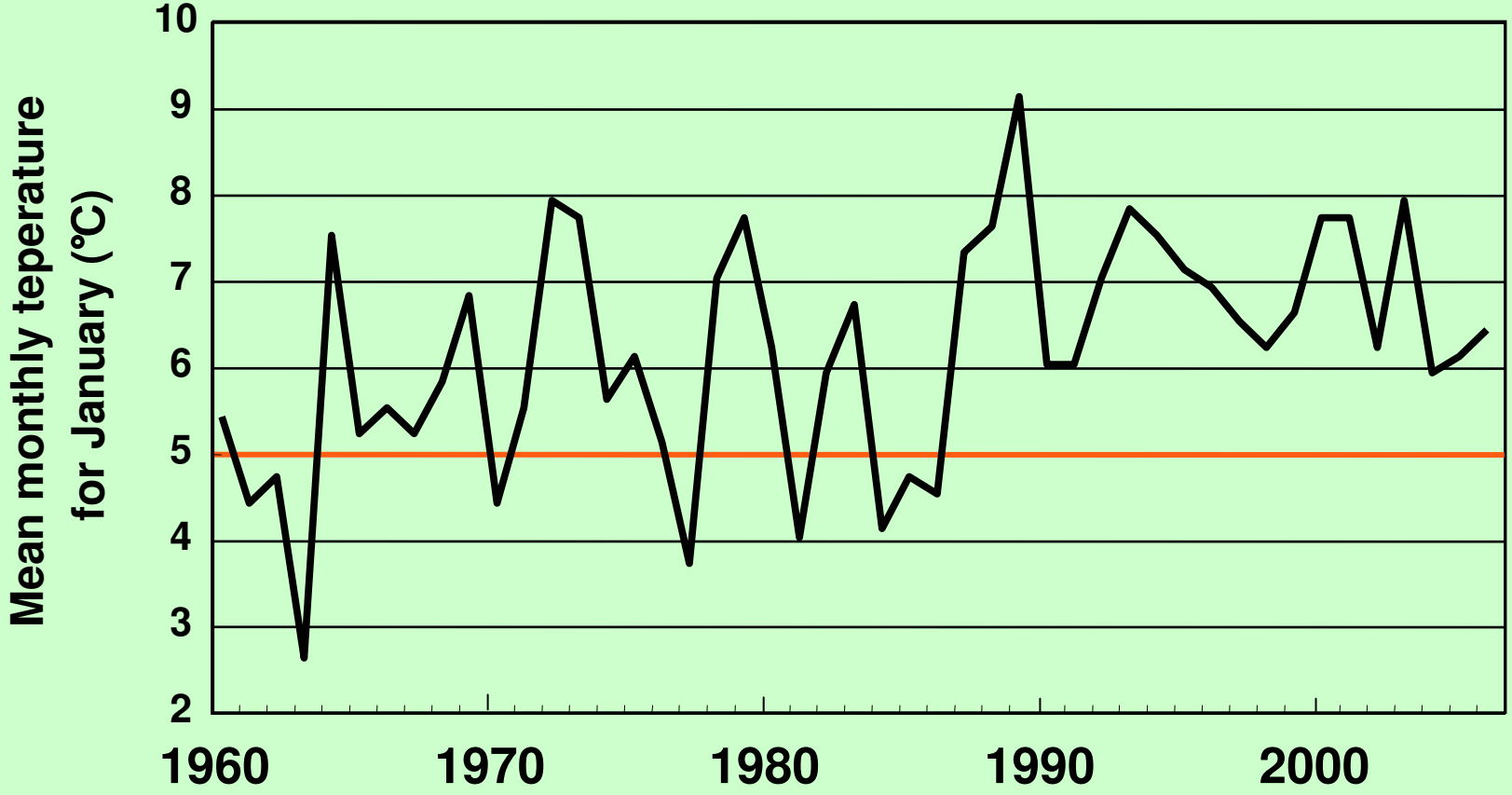


Collecting records of *N. viridula* before and after 2000



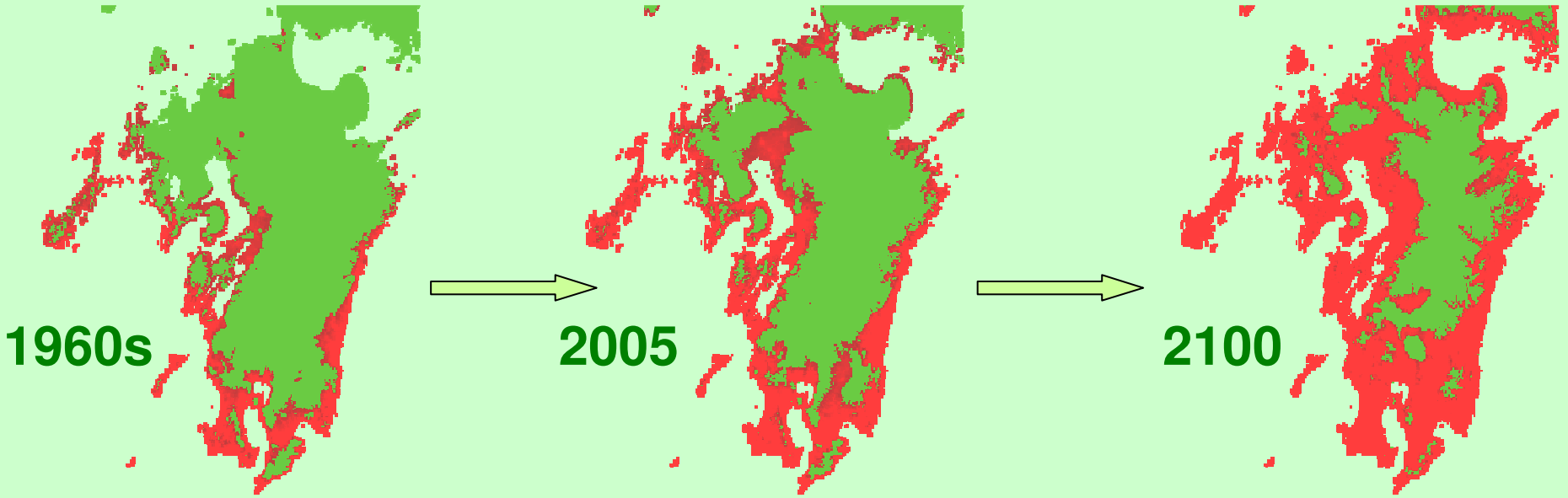
***N. viridula* has extended its range northward also in northern Kyushu**

Changes in mean monthly temperature for January in northern Kyushu for 48 years from 1960 to 2007



Since 1986, the temperature has exceeded 5˚C that is the lowest thermal limit for *N. viridula* to overwinter successfully.

Previous, present, and future distribution range of *Nezara viridula* in Kyushu, Japan（■）



In **red-colored areas**, mean temperature for January exceeds 5˚C, allowing *N. viridula* to overwinter successfully

In 2005, temperature is about 1˚C higher than in the 1960s. **Red-colored areas** coincide well with the actual range of *N. viridula* in 2005

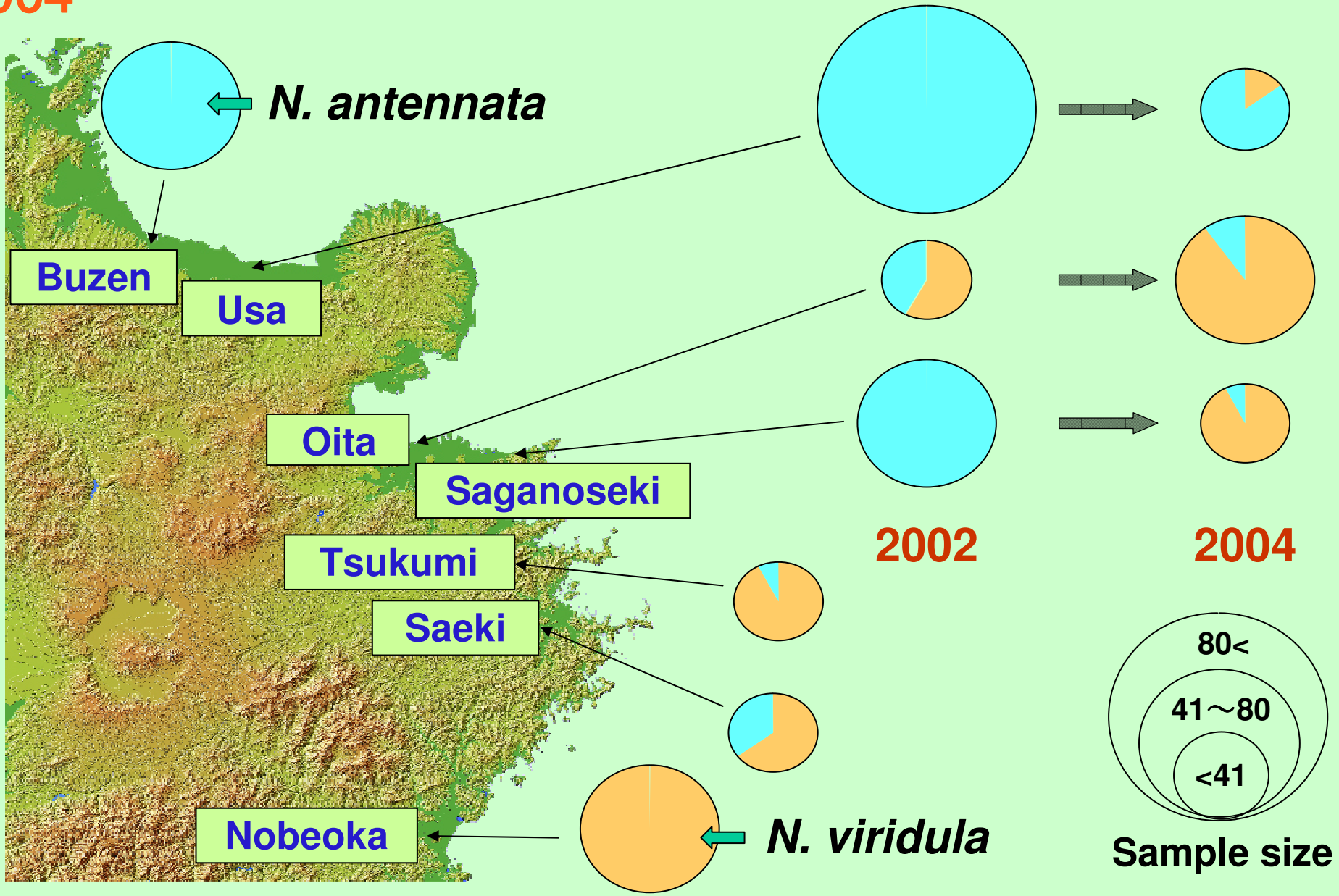
N. viridula will cover a large area of Kyushu in 2100, if the temperature rises by 1.4˚C, which is the minimum prediction by Houghton *et al*. (2001)

Interspecific mating occurs in the field between the two *Nezara* bugs

N. viridula has higher reproductive potential than *N. antennata* in terms of fecundity and the number of generations a year (**3 in *viridula*, while 2 in *antennata***)

Interspecific mating caused a decline of *N. antennata* reducing the chance of intraspecific mating, resulted in the replacement of *N. antennata* by *N. viridula* in many places

Ratio of *N. viridula* to *N. antenna* increased from 2002 to 2004



Summary of the case study

N. viridula **has been extending its distribution range northward, possibly due to global warming**

The northern range limit of *N. viridula* is determined by the mean monthly temperature for January

N. antennata **has been replaced by *N. viridula* in many places as a result of interspecific competition.**

This is an indirect effect of climate change on the range shift of a congener.

This study is a good example to indicate that climate change affects biodiversity

In order to investigate and predict northward extensions of plant pests, we need to gather information about:

Detailed biological traits of the plant pests

Distribution records in the past and present

Factors limiting northward extension, such as

(1) Cold hardiness in relation to winter temperature

(2) Presence or absence of host plants, effective natural enemies, and competitors

(3) Reproductive potential and ability of dispersal

(4) Geographical barriers

Thank you for your kind attention