The spatial process of smallpox diffusion at a rural district in early modern Japan

— A case study of Nakatsugawa district in the Dewa Province —

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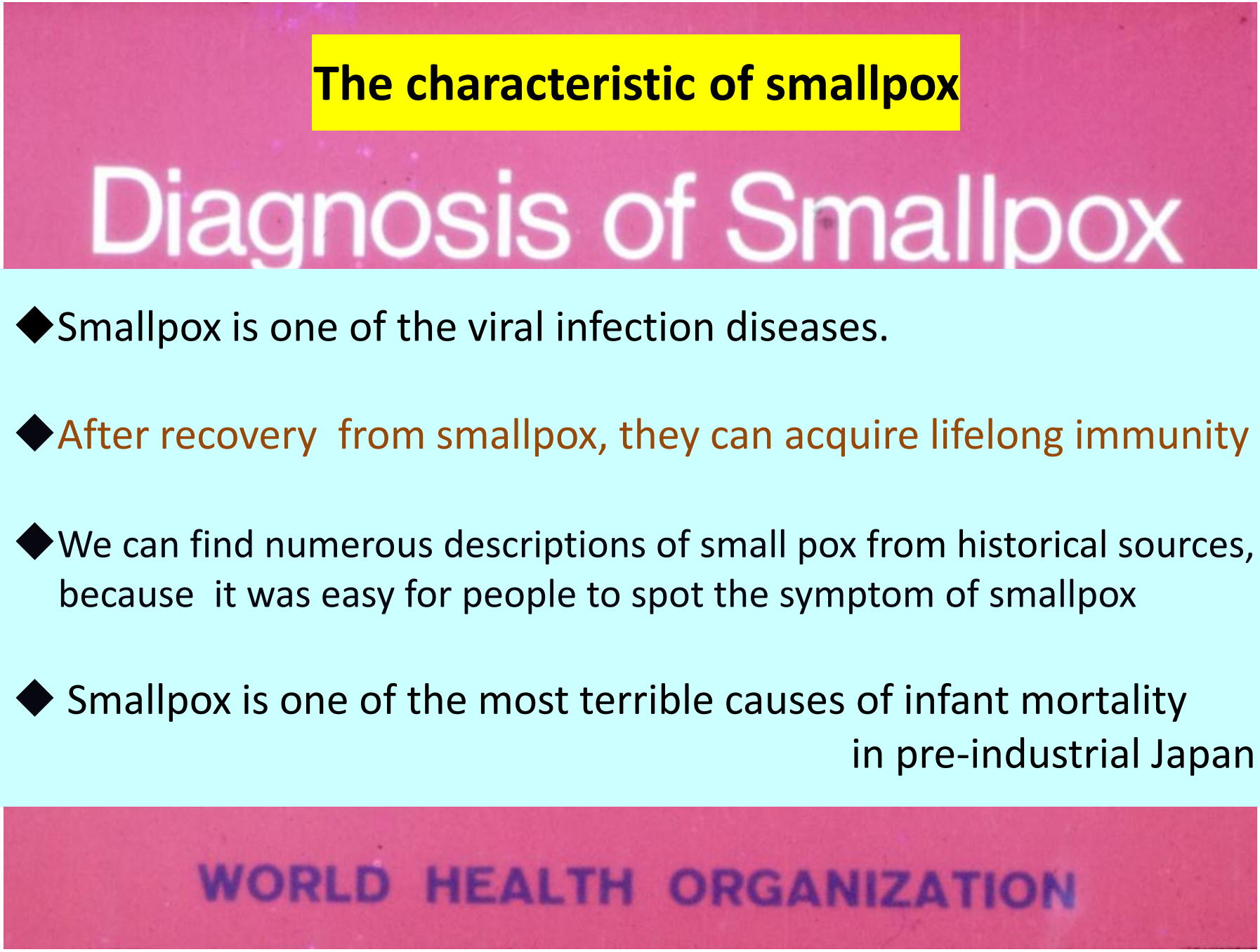
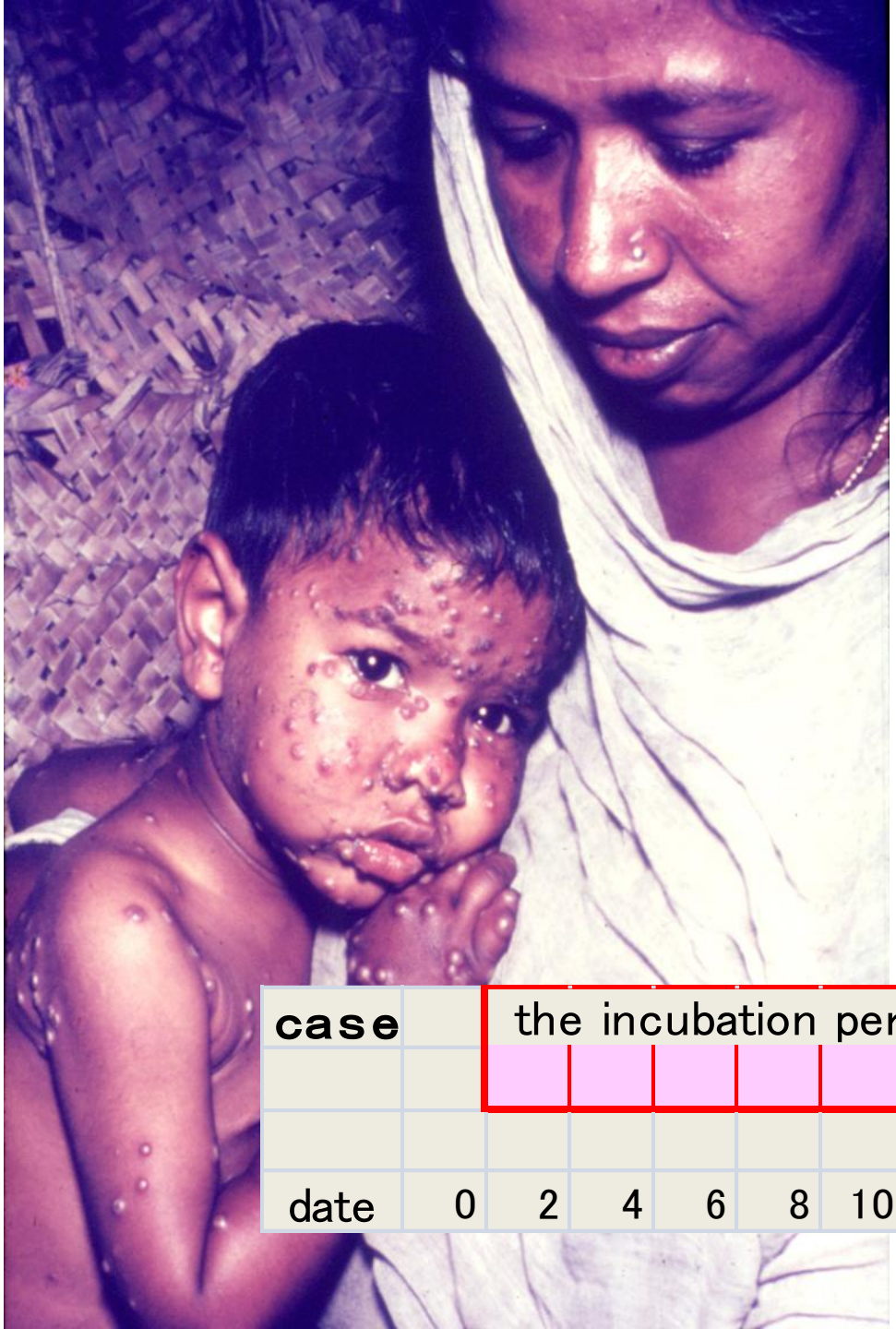
content

The characteristic of smallpox

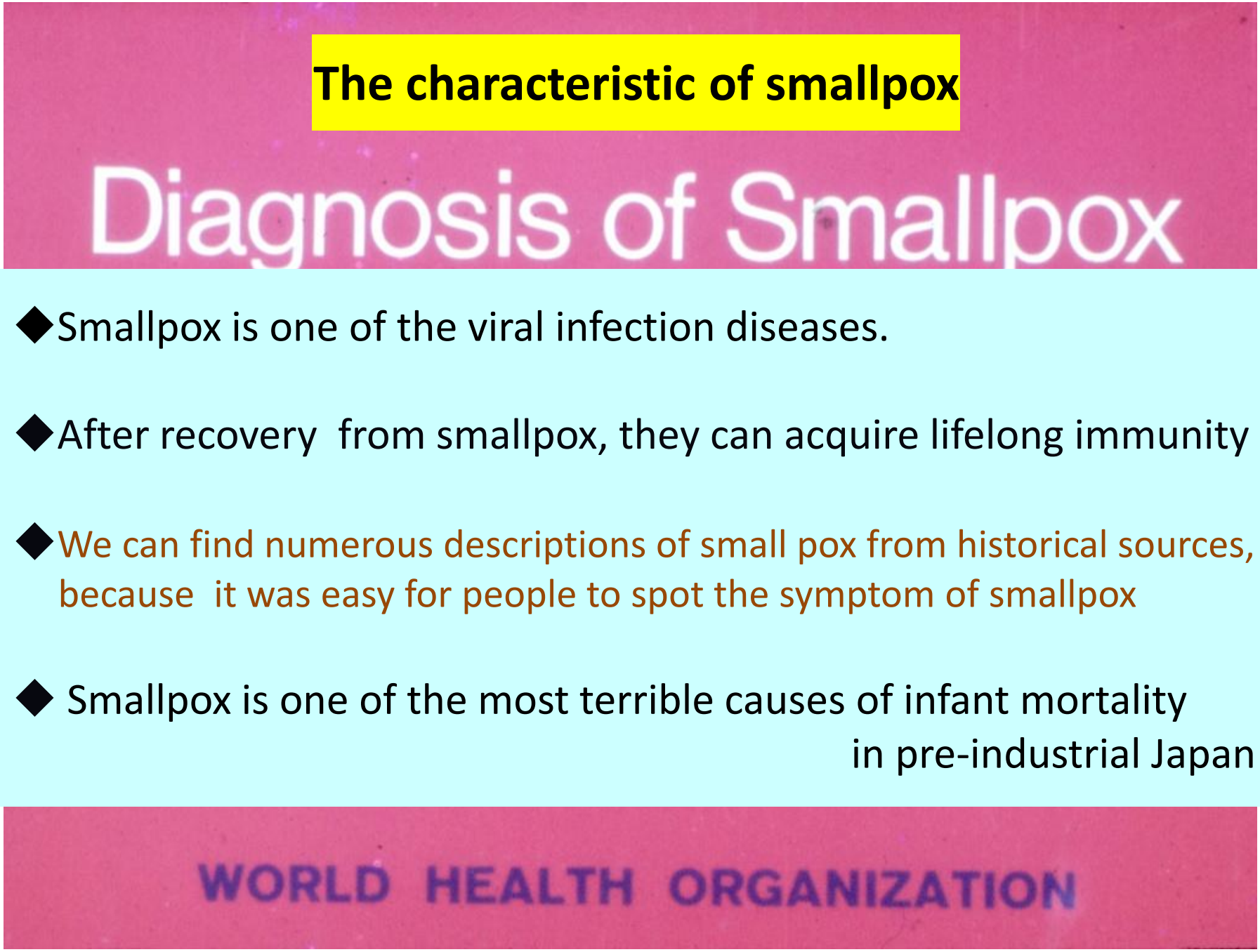


- Smallpox is one of the viral infection diseases.
- After recovery from smallpox, they can acquire lifelong immunity
- We can find numerous descriptions of small pox from historical sources, because it was easy for people to spot the symptom of smallpox
- Smallpox is one of the most terrible causes of infant mortality in pre-industrial Japan



case		the incubation period						Onset-of-a-disease period							
date	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28

The characteristic of smallpox



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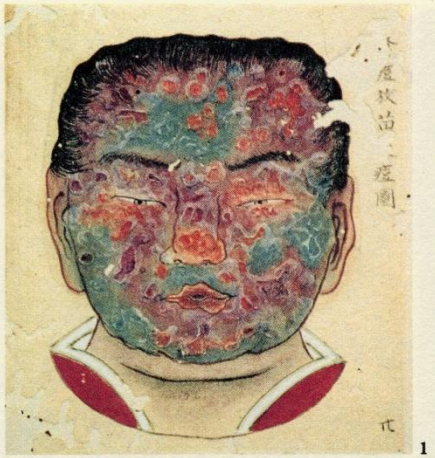

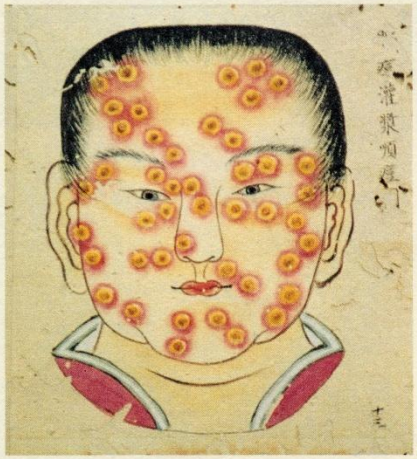

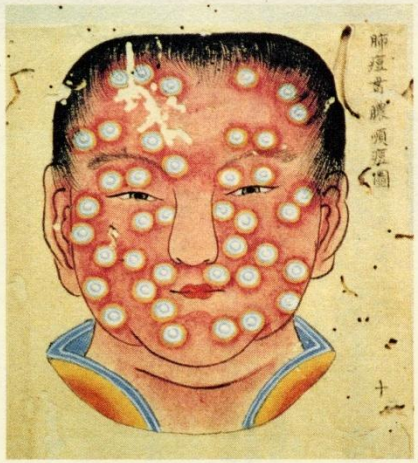

1～4——痘瘡に侵された子どもたち（長崎伝来「痘瘡図譜」、東京大学図書館）

The picture about the smallpox drawn in the early modern era

The characteristic of smallpox

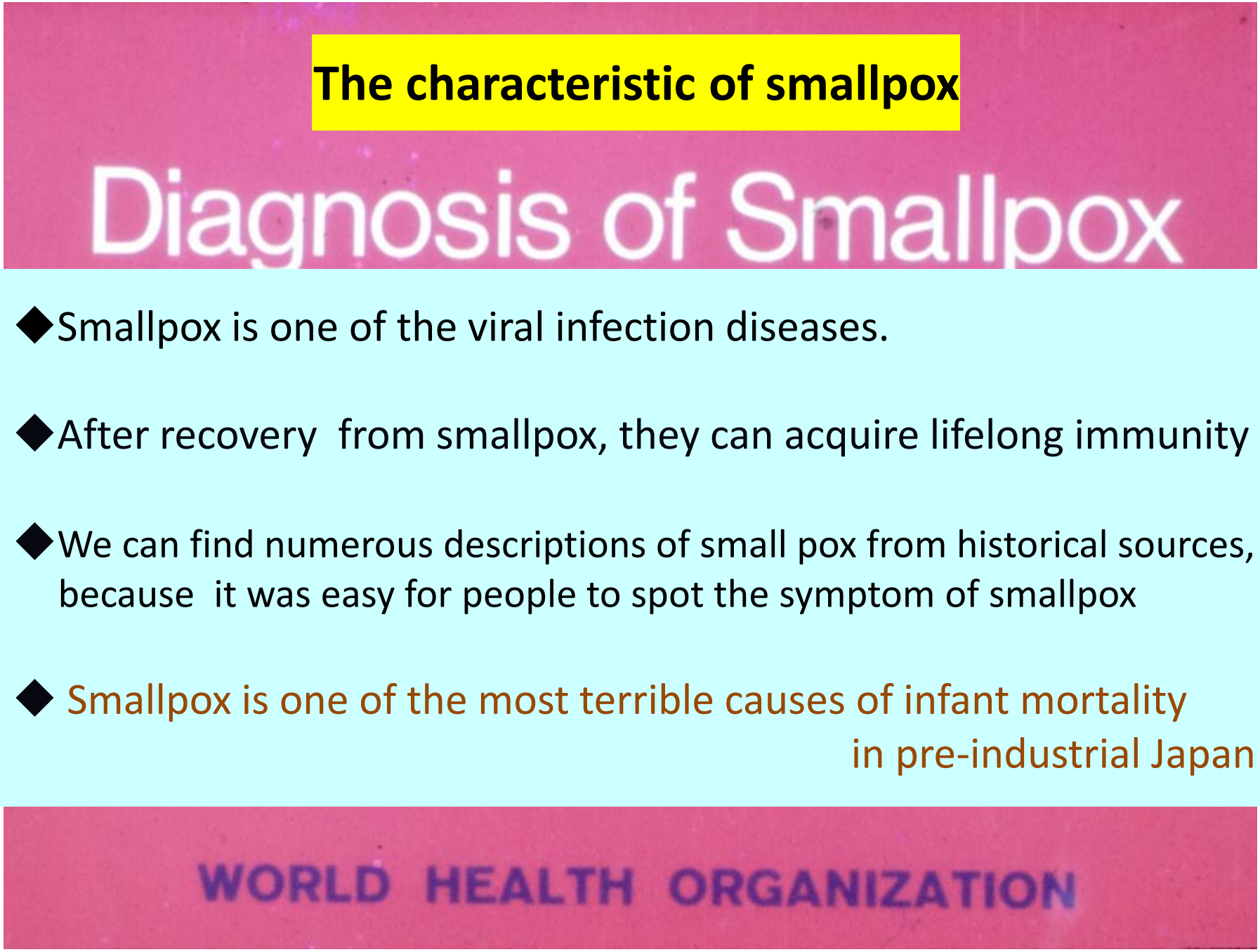

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図１　天然痘にかかった息子の看病をする母親
（山東京傳『昔話稲妻表紙』東京都立中央図書館所蔵）

The doll

People believed that
the God of smallpox disliked
something of red.

The spread pattern of measles

Short intervals
Densely
populated area

Long intervals
Dispersed
populated area

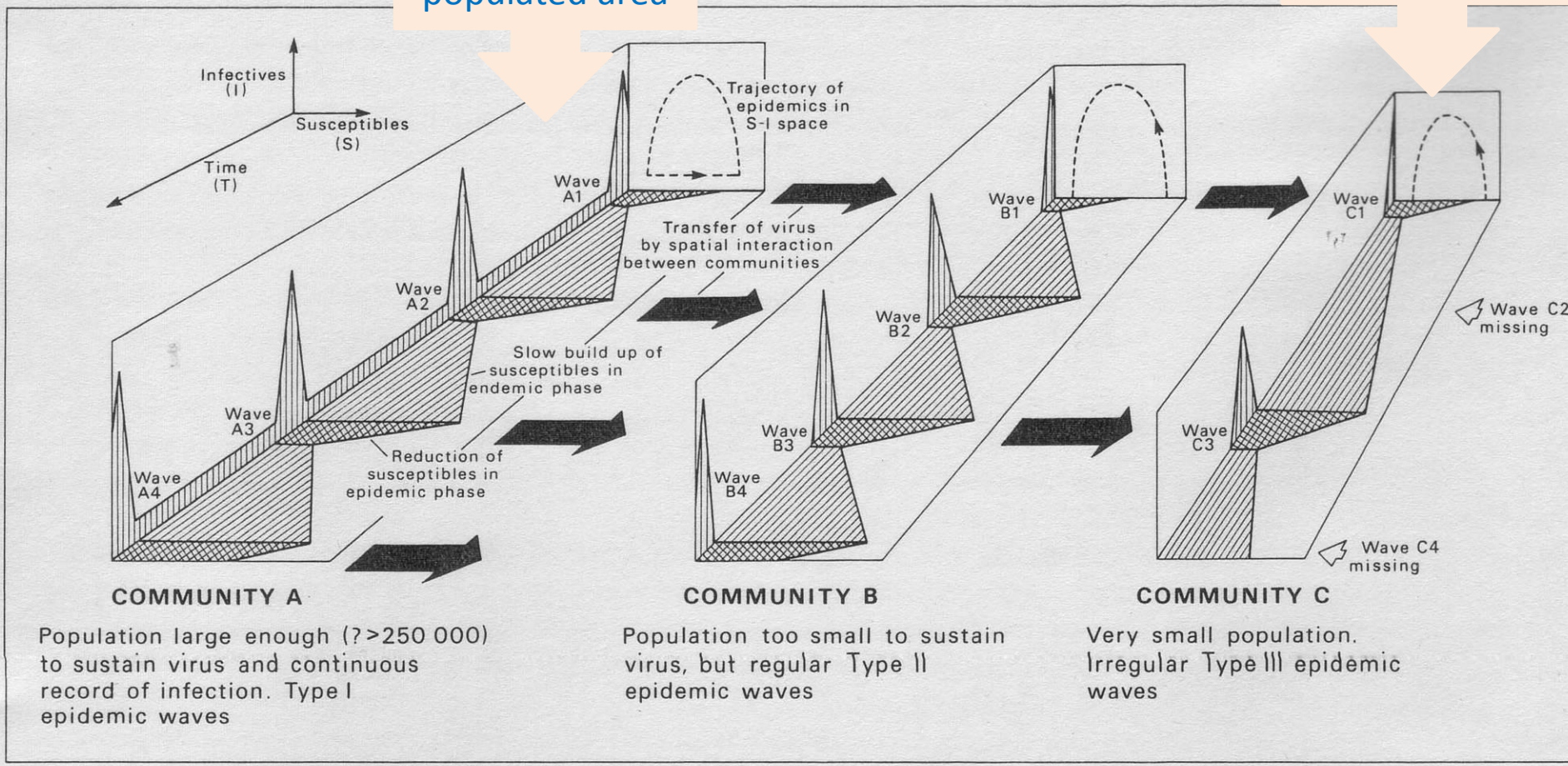


Figure 1.8 Conceptual view of measles waves in communities of different population sizes. Bartlett model of measles spread through communities of different population sizes. *Source*: Cliff and Haggett [1988, Figure 6.5(A), p. 246].

Previous research about smallpox before the diffusion of vaccination

Suda,K.and Soekawa,M.(1983)

Smallpox mortality and outbreak interval in Gifu (=a mountain district)

90% of cases = children under 10

intervals =ranged from 4 to7 years

Short intervals
Densely populated area

Kawaguchi,H.(2001) in Tama (=a rural area)

Kobayashi,S.(2000)

Long intervals
Dispersed populated area

The outbreak pattern and the strategies in the Ryukyu island (=remote area)

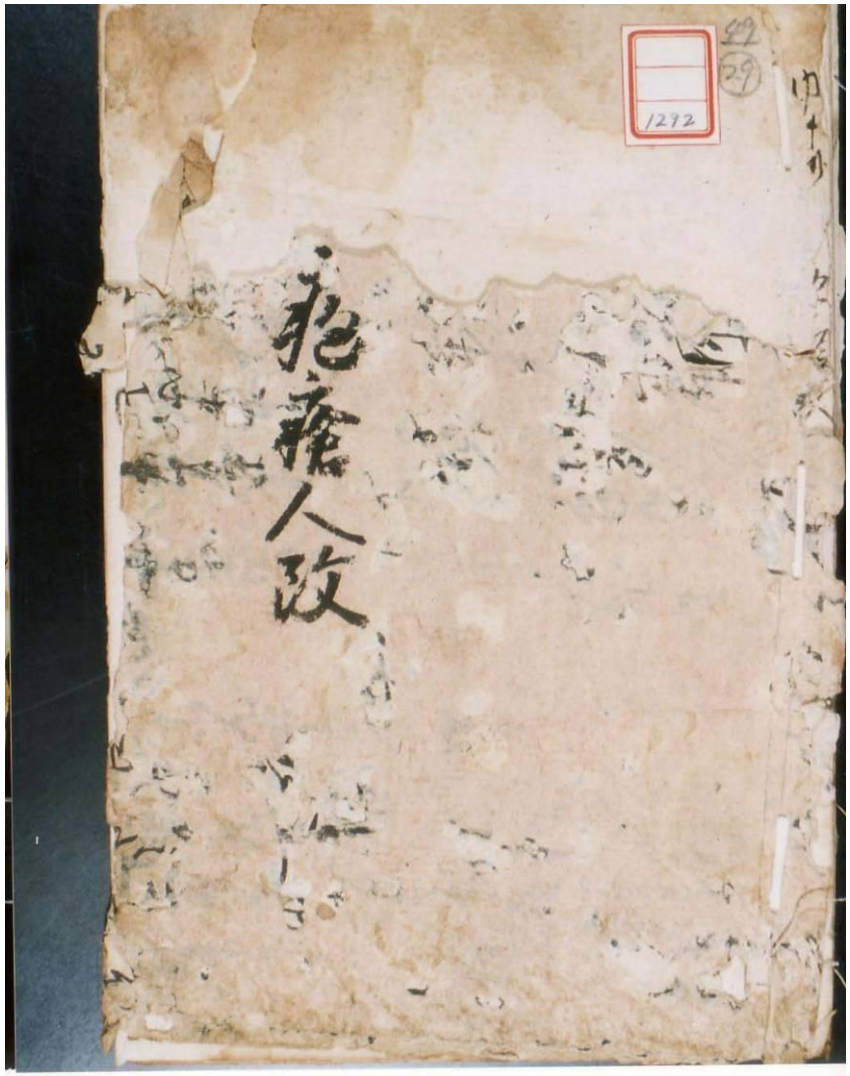
Patients = included many of adults / intervals= over from 10 to20 years

Purpose of this study

◆To describe and analyze the outbreak of smallpox before the diffusion of vaccinations in Japan during the early modern period.
(The first mass vaccination in Japan was performed in 1849)

- How outbreaks of smallpox affected the local communities
- How it was transmitted from village to village.

The historical source of smallpox



「疱瘡人改」＝
Research report of cases of smallpox

Time : during 1795-1796
Place : Nakatsugawa in Dewa Province, Northeast Japan
The person who reported :
Seizaemon Odagiri (小田切清左衛門)
Head of Nakatsugawa District
He learned the Oriental medicine from the medical specialist.
There was no medical specialist in particular district.

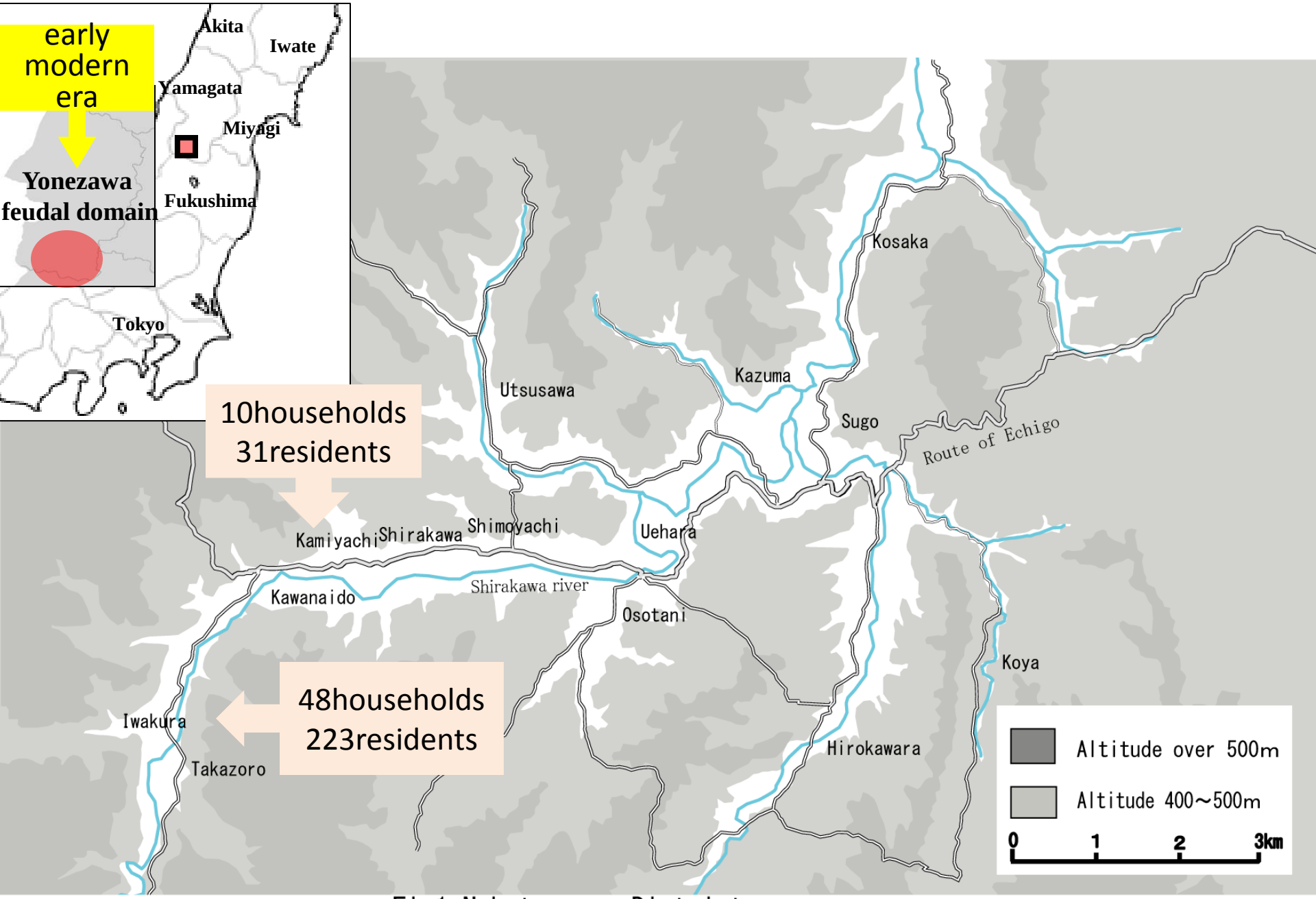


Fig1. Nakatsugawa District

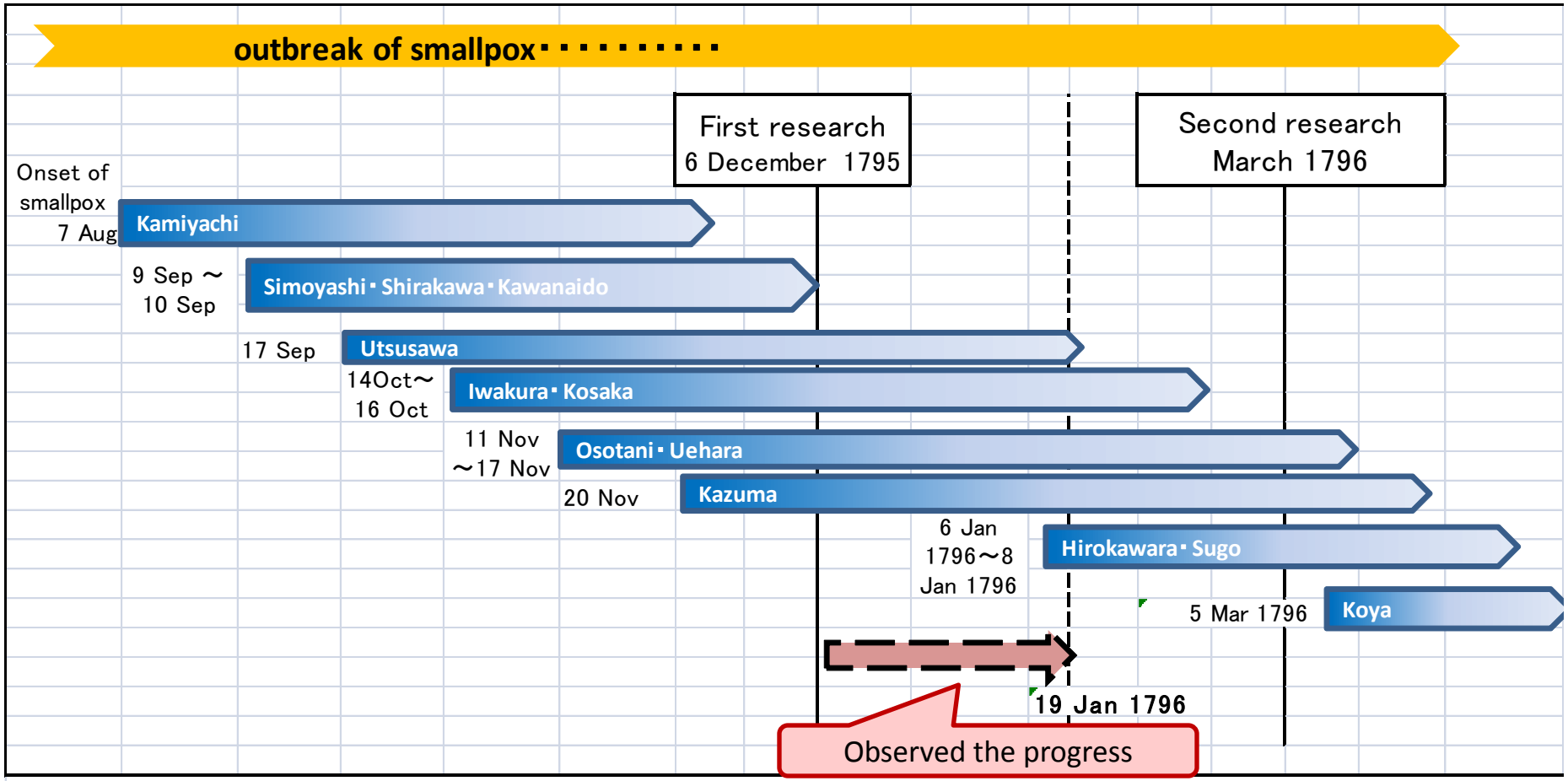
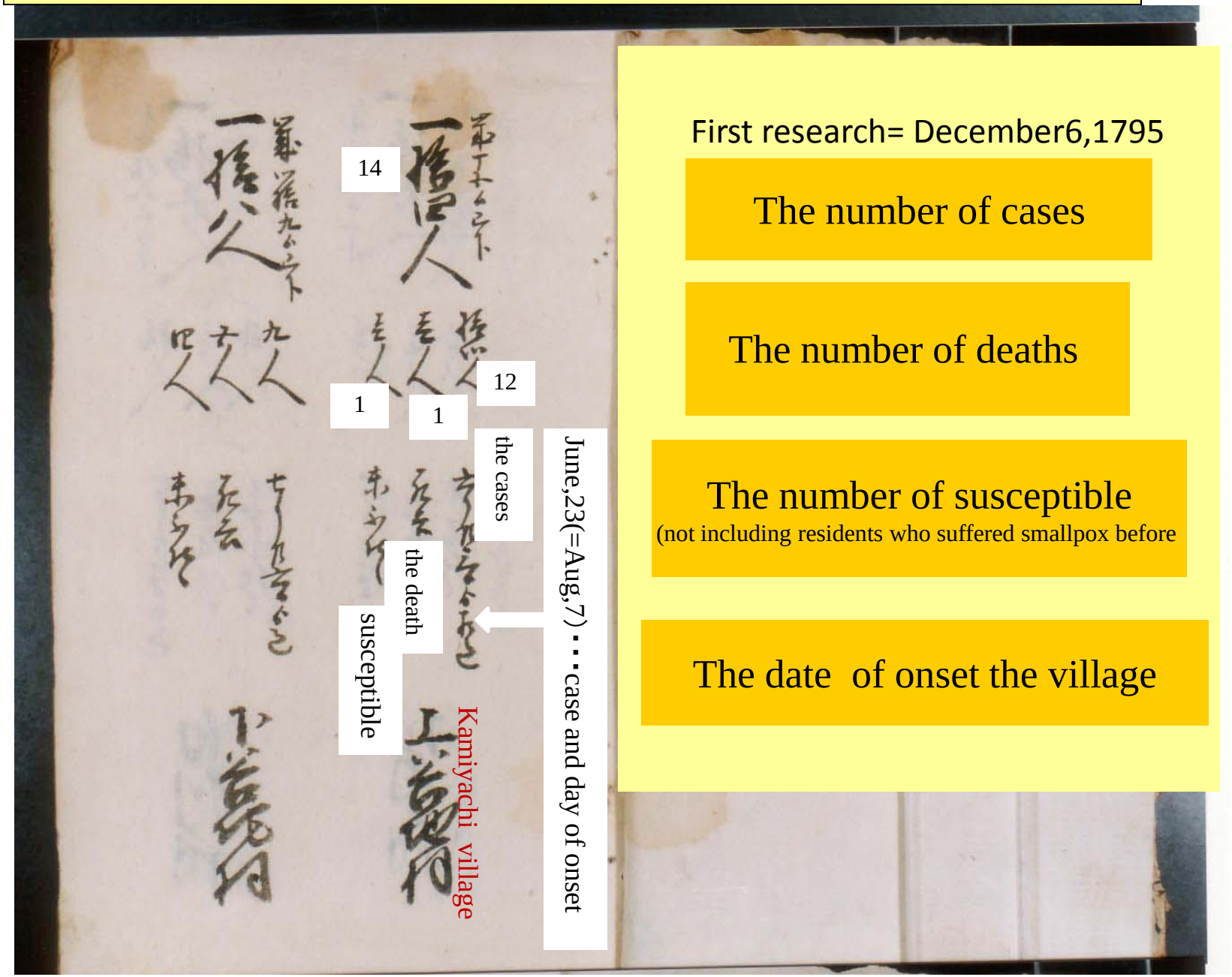


Fig.The outline of the histrical source reported about the smallpox outbreak

The characteristic of the source



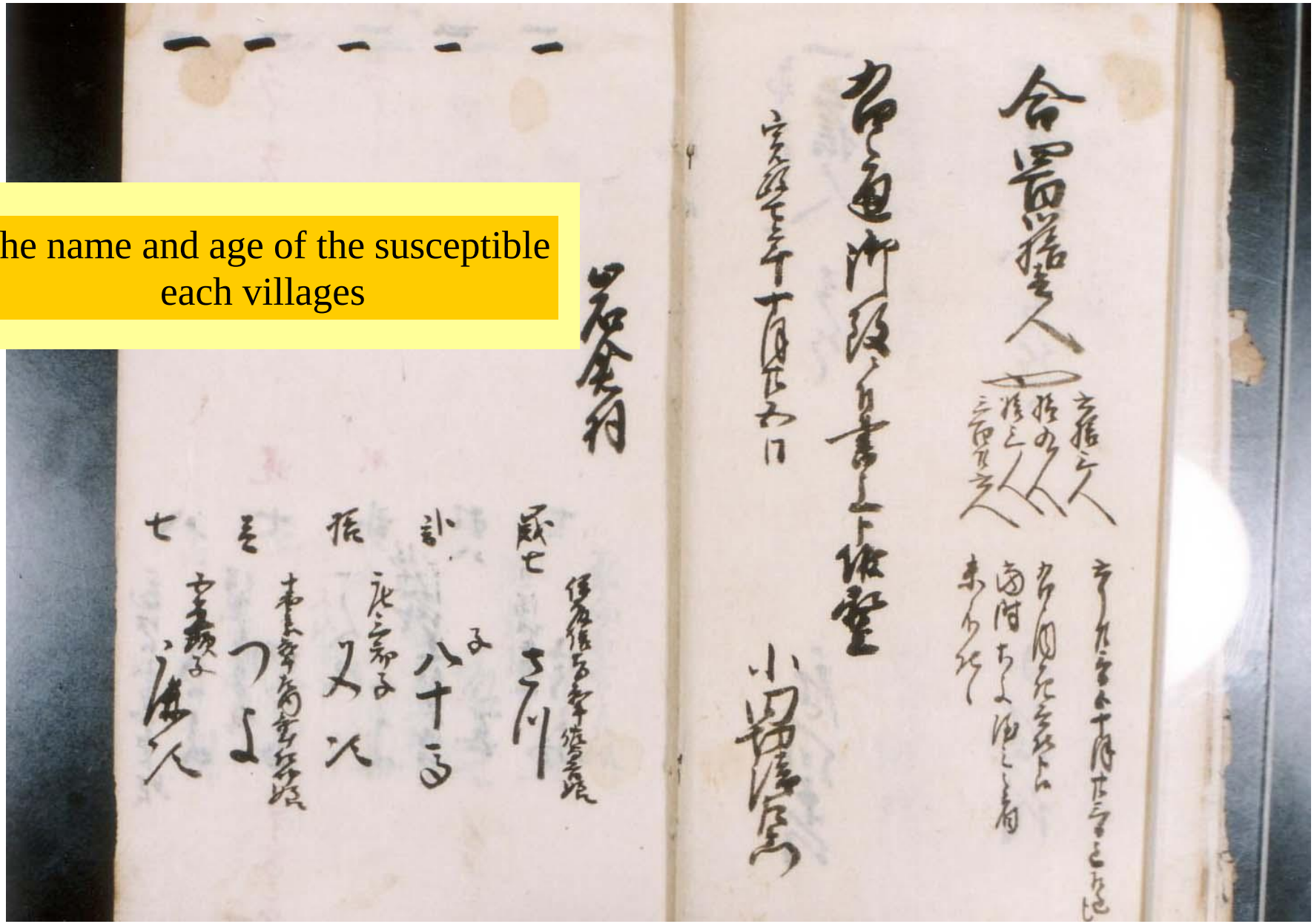
First research= December6,1795

The number of cases

The number of deaths

The number of susceptible
(not including residents who suffered smallpox before

The date of onset the village



The name and age of the susceptible each villages

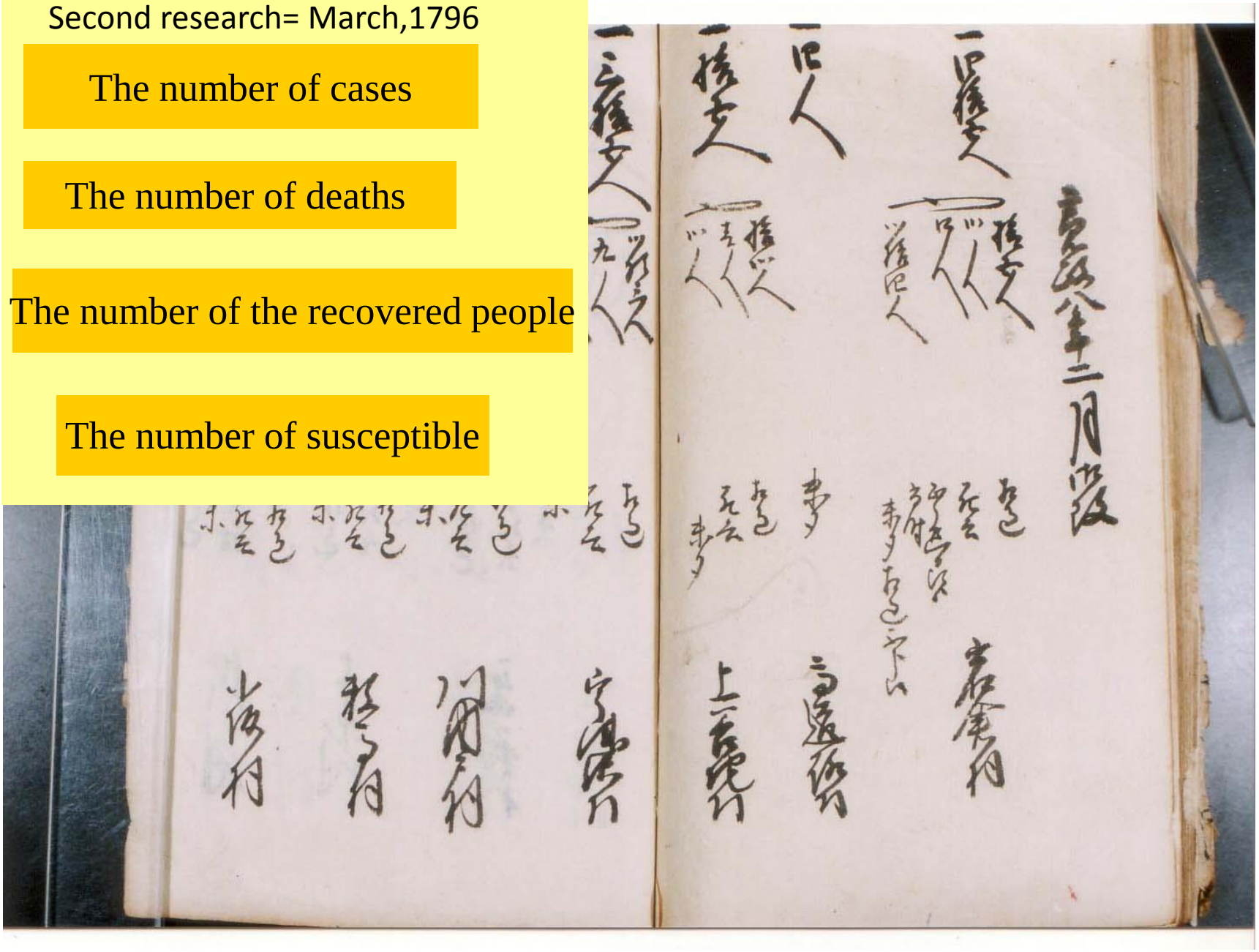
Second research= March,1796

The number of cases

The number of deaths

The number of the recovered people

The number of susceptible



December 6.1795

The prevalence of smallpox in villages on Dec.6, 1795

	infected pepole（人）	the death（人）	the susceptible（人）
Kamiyachi	12	1	1
Shimoyach	9	5	4
Shirakawa	10	3	2
Kawanaido	12	1	2
Utsusawa	12	7	15
Iwakura	5	0	39
Kosaka	6	0	28
Osotani	8	0	21
Uehara	—	1	31
Kazuma	2	1	19
Takazoro	0	0	3
Sugo	0	0	44
Hirokawara	0	0	60
Koya	0	0	57
Total	76	19	326

March 9.1796

The prevalence of smallpox in villages during March.9, 1796

	recovered pepole	the death	the susceptible	infected pepole
Kamiyachi	12	1	2	0
Shimoyach	9	5	4	0
Shirakawa	10	3	3	0
Kawanaido	12	1	2	0
Utsusawa	23	9	3	0
Iwakura	15	2	24	4
Kosaka	27	5	3	0
Osotani	26	3	1	0
Uehara	5	2	28	0
Kazuma	14	4	4	0
Takazoro	0	0	4	0
Sugo	21	5	13	6
Hirokawara	25	4	31	1
Koya	0	0	58	2
Total	199	44	180	13

＋123　＋25　－146

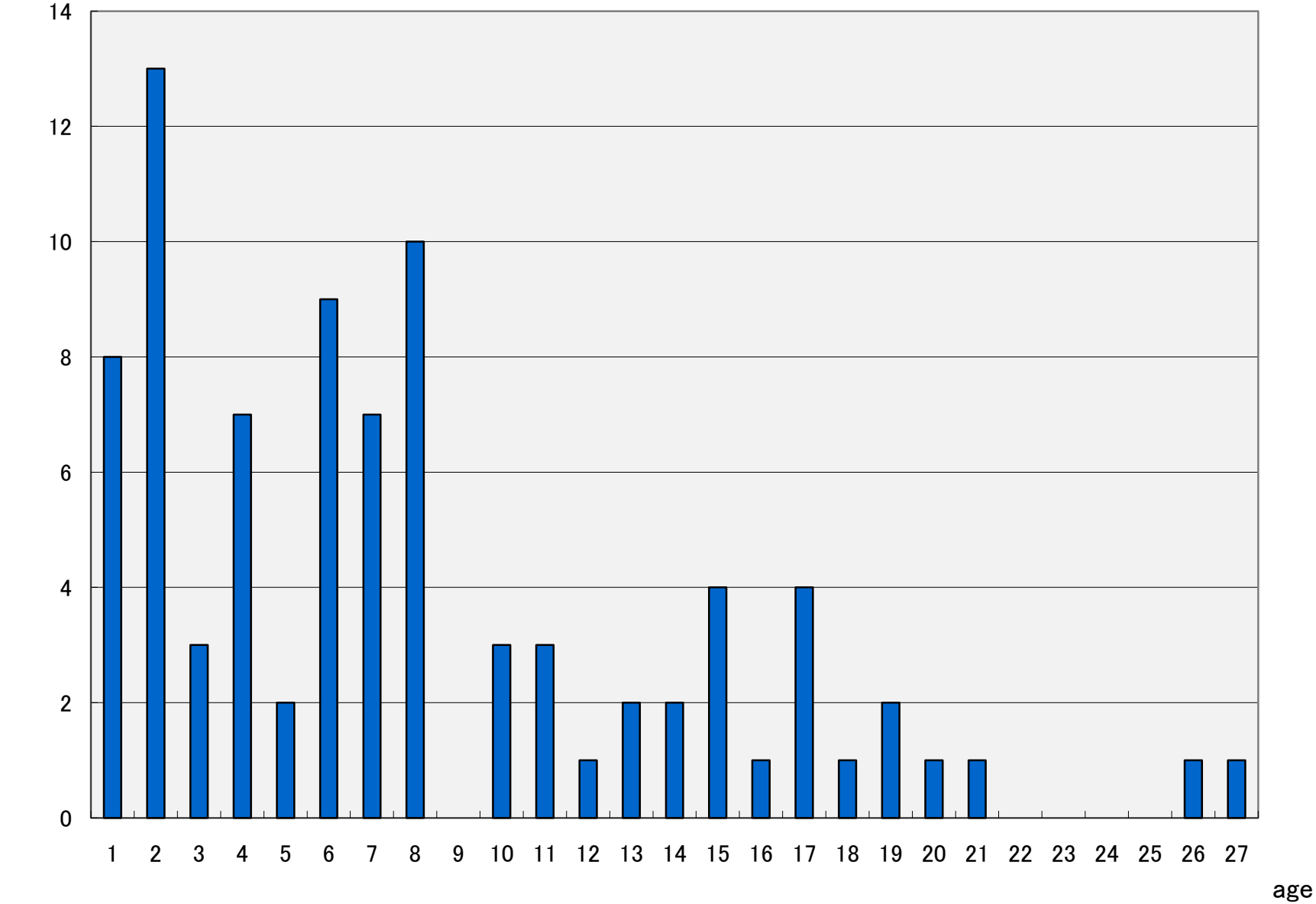


Fig2.The age structure of the persons infected during Dec 6, 1795 ～Jan 19,1796

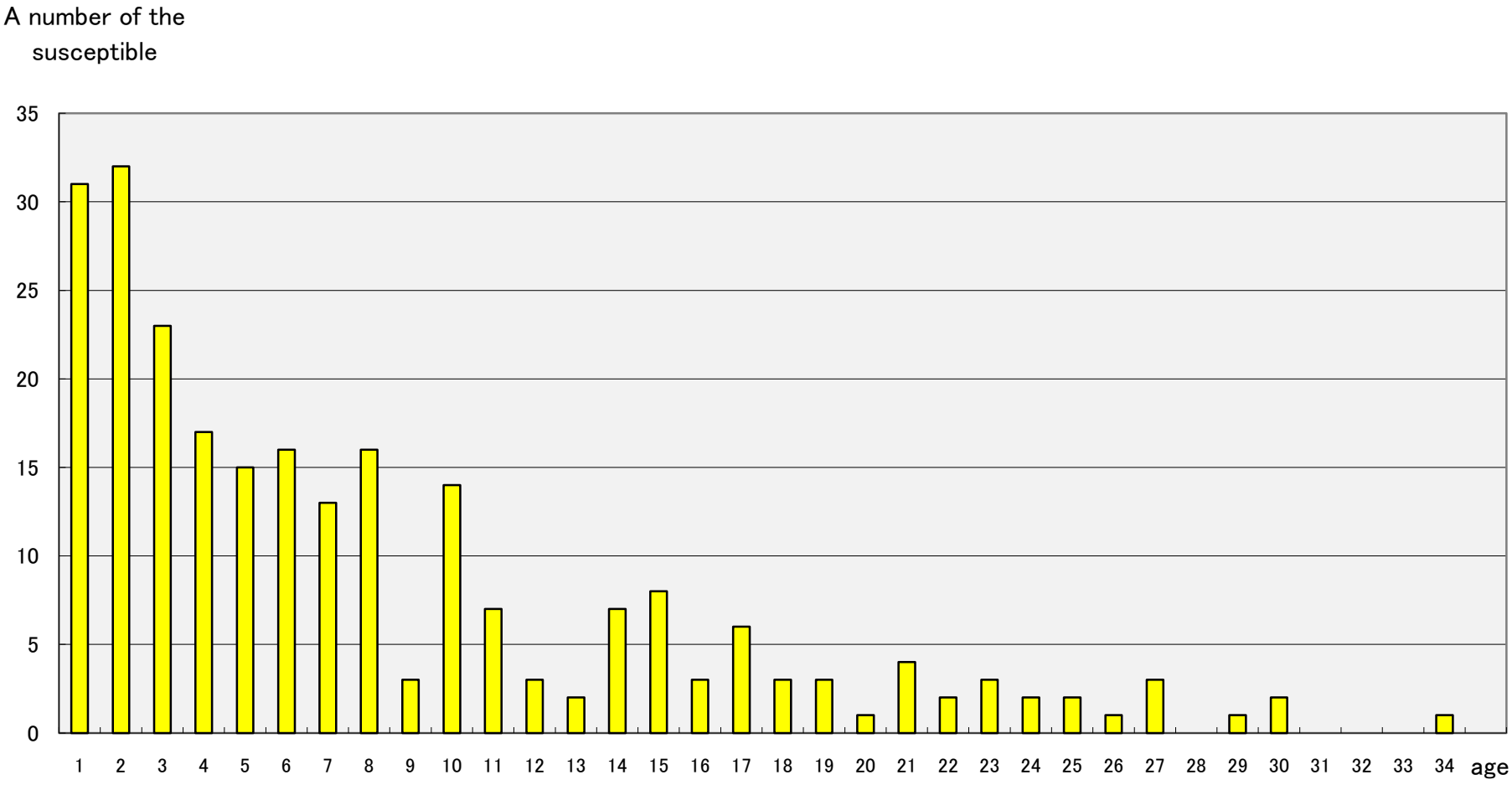


Fig3.The age structure of the susceptible in 10 villages (Dec 6.1795)

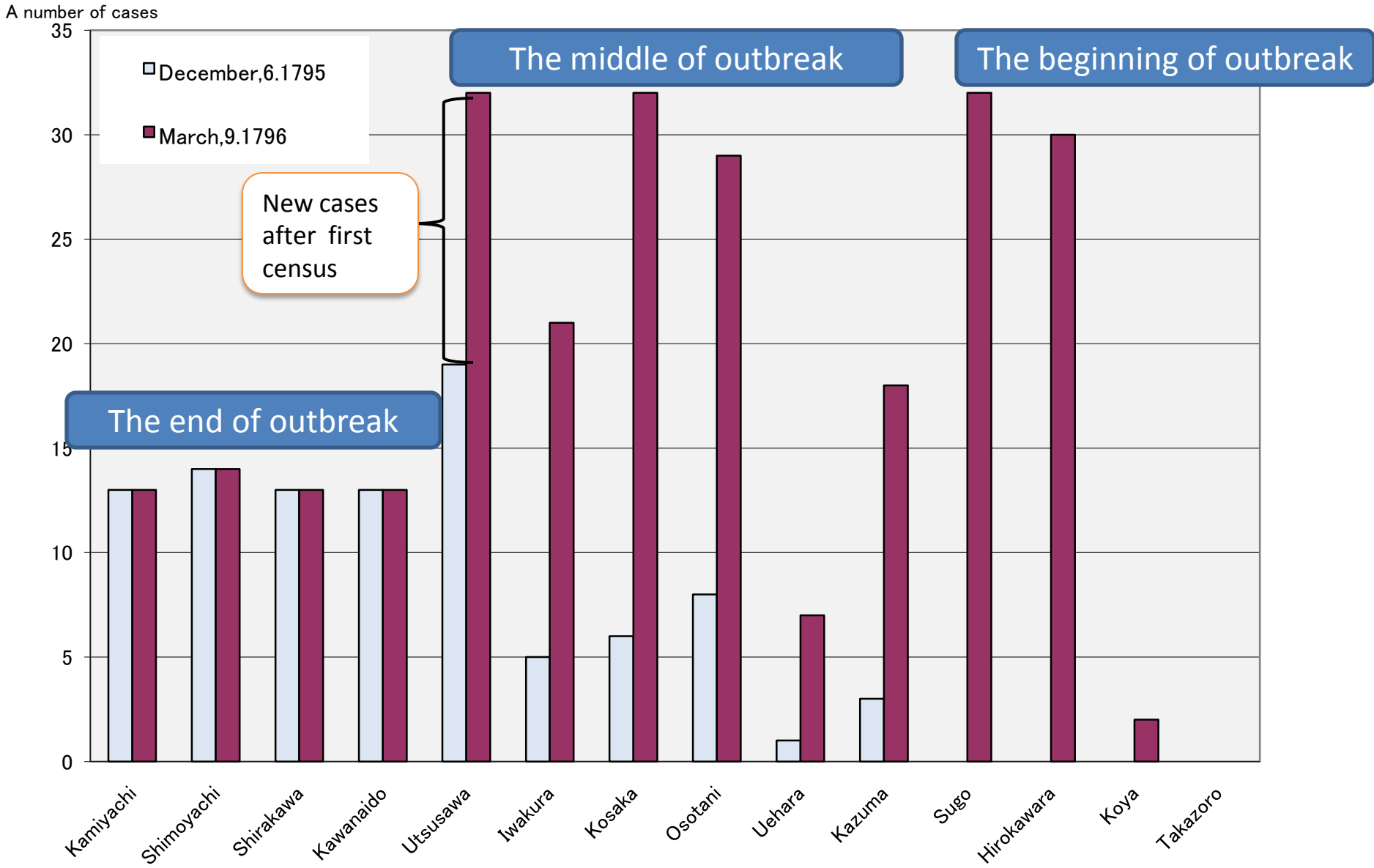


Fig.The change of the number of infected persons (Dec 6,1975 and May 9, 1796)

The prevalence and case fatality rate from smallpox in 4 villages, where infection had finished （May.9, 1796）

	Score(cases /susceptible)	Mortality rate
Kamiyachi	92.86	7.14
Shimoyach	77.78	26.32
Shirakawa	86.67	18.75
Kawanaido	86.67	7.14
average	85.99	14.84

Finished outbreak villages

wide range

Percentage of susceptible infected

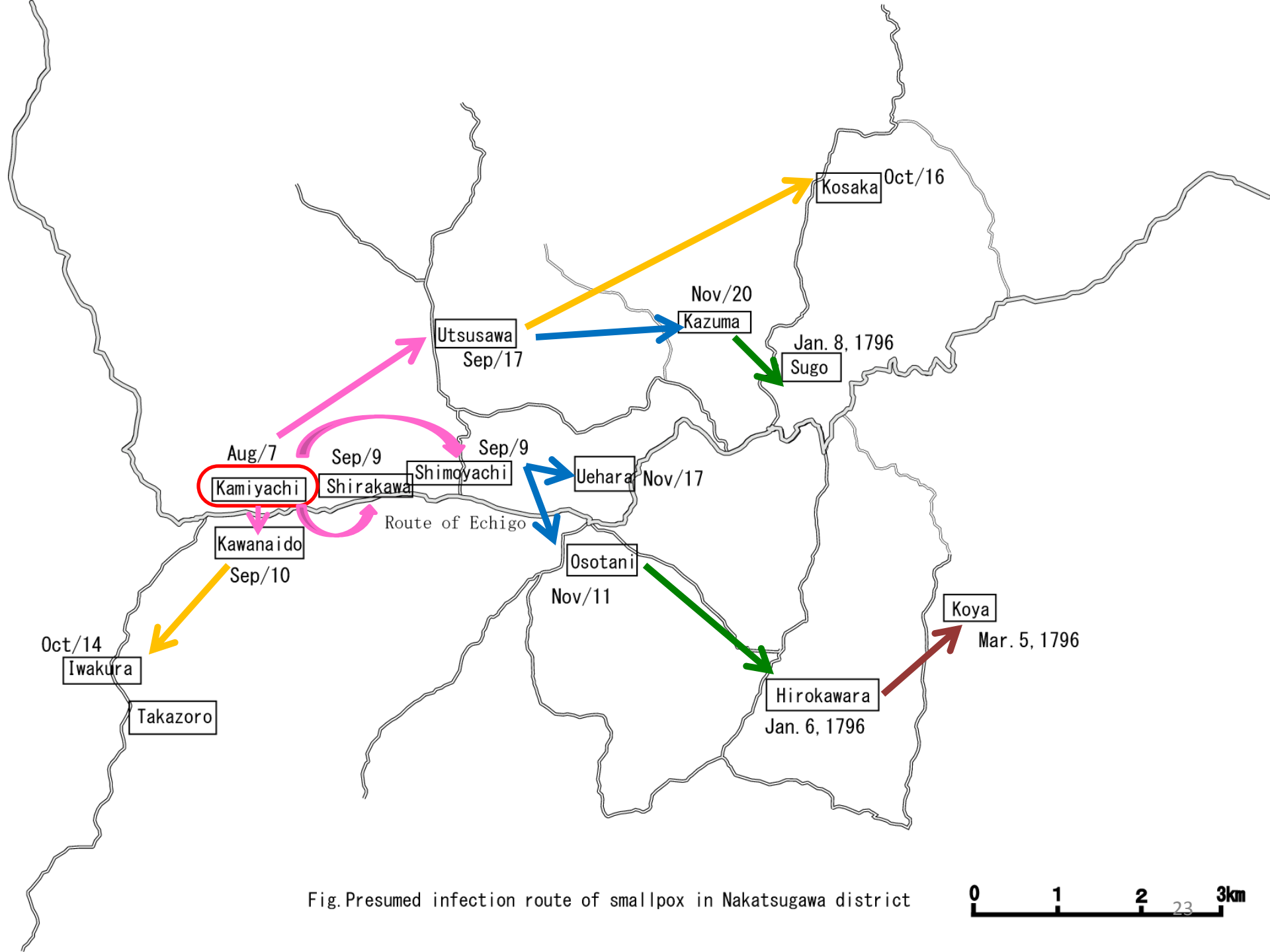


Fig. Presumed infection route of smallpox in Nakatsugawa district

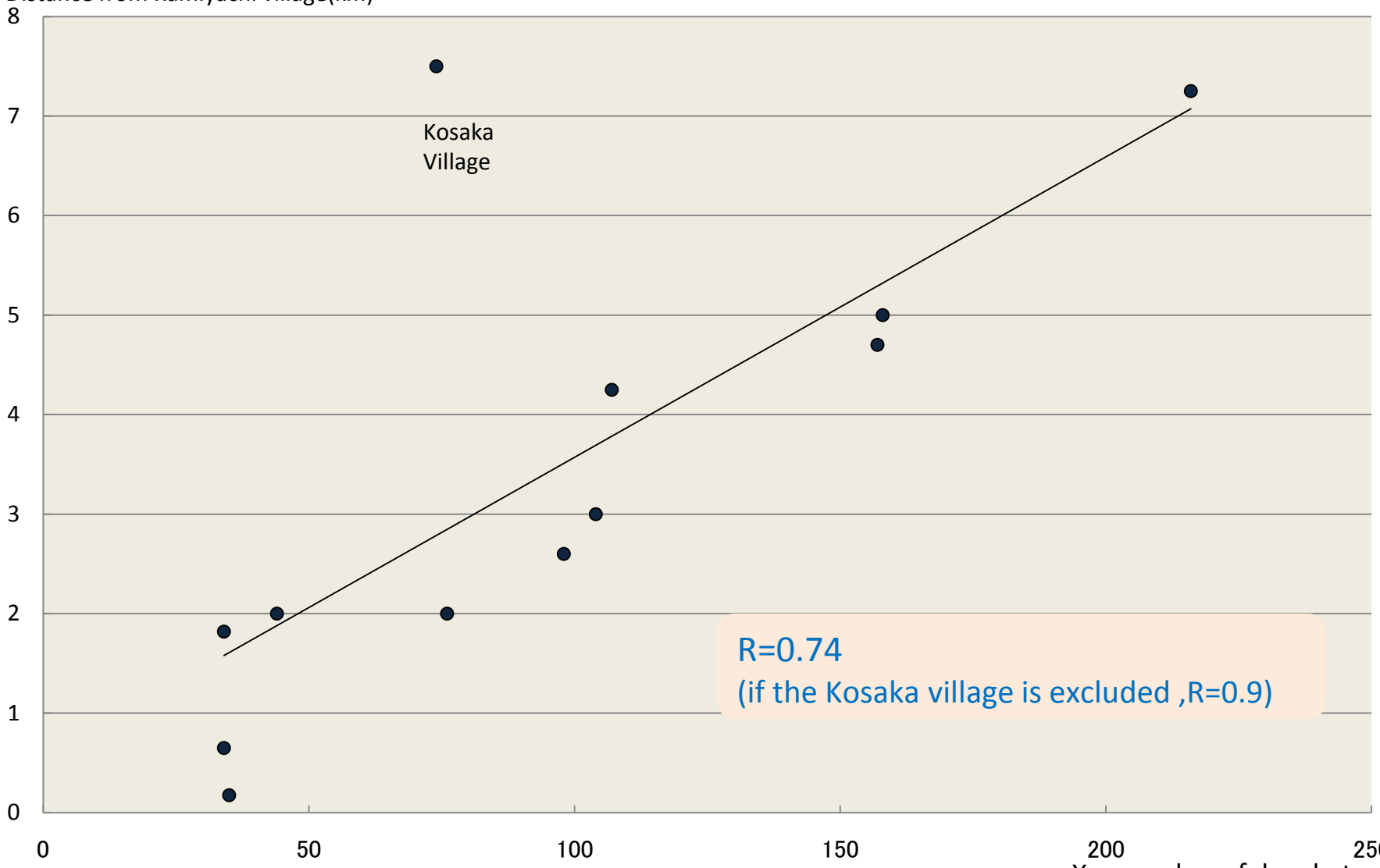


Fig5.The relation between distance from Kamiyachi village and the date of the onset of smallpox outbreak

X : a number of days between the date of the onset of smallpox in Kamiyachi and one of each villages.

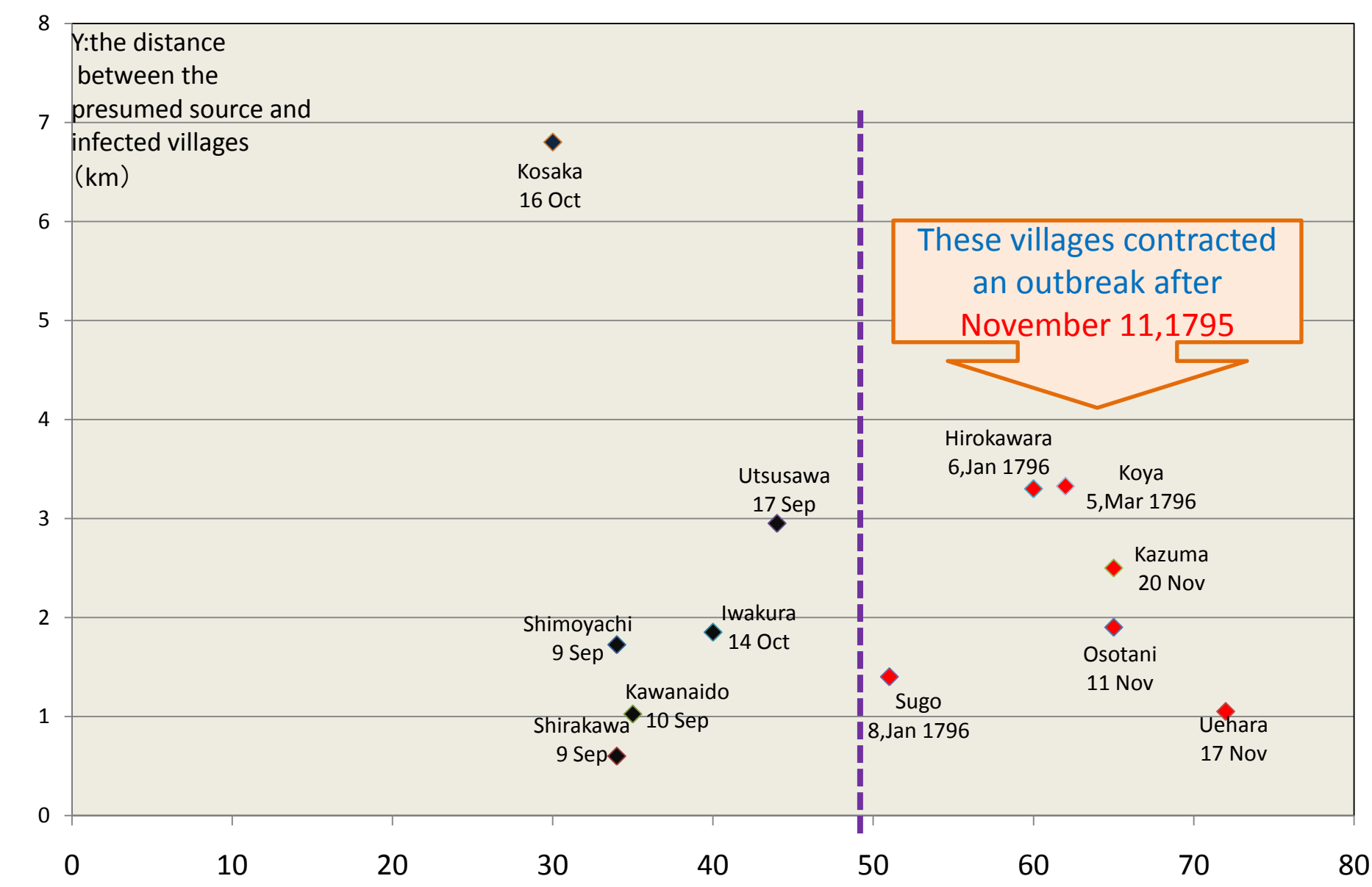
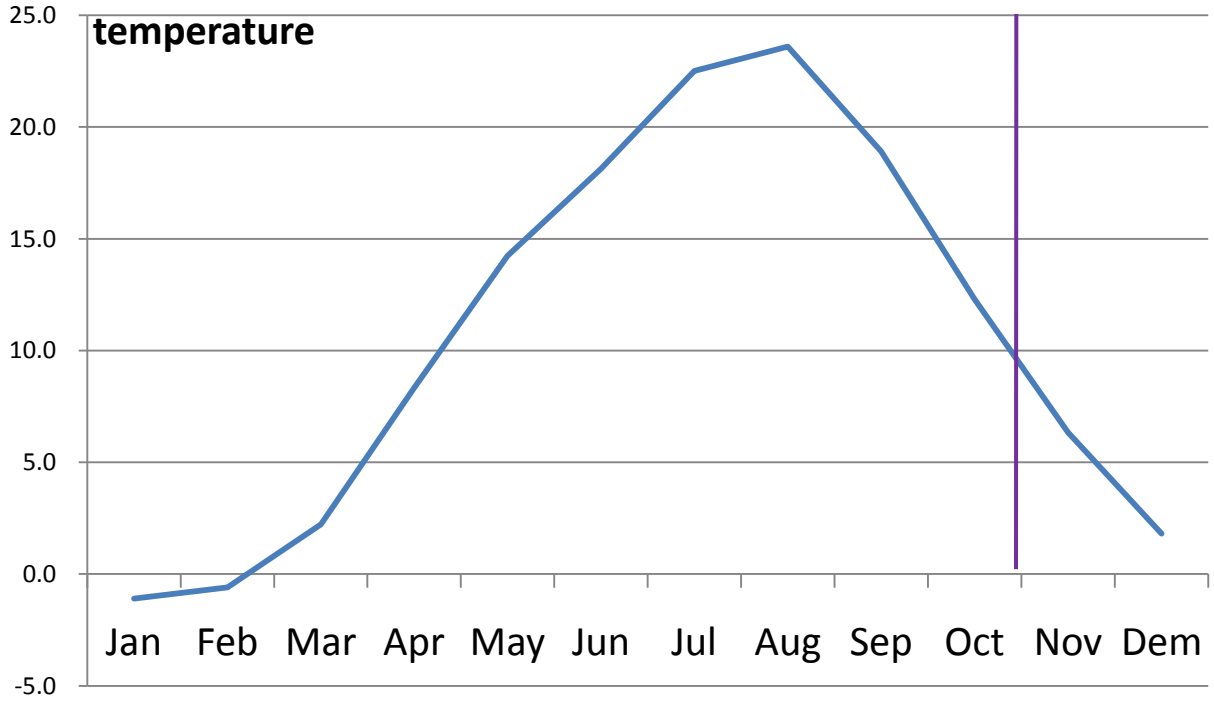


Fig6.The relation between the time lag of the onset of smallpox outbreaks and the distance between the presumed source and infected villages

X : a number of days between the date of the onset of smallpox between the presumed source and infected villages

Snowy days and the maximum depth of snow cover by months, 1958–1968

	Nov	Dem	Jan	Feb	Mar
Snowy days	5	24	31	28	29
New snowy days	6	20	27	23	17
the maximum depth of snow (cm)	12	80	174	224	181



The average temperature by months,1958-1968

The knitted footwear made of straw

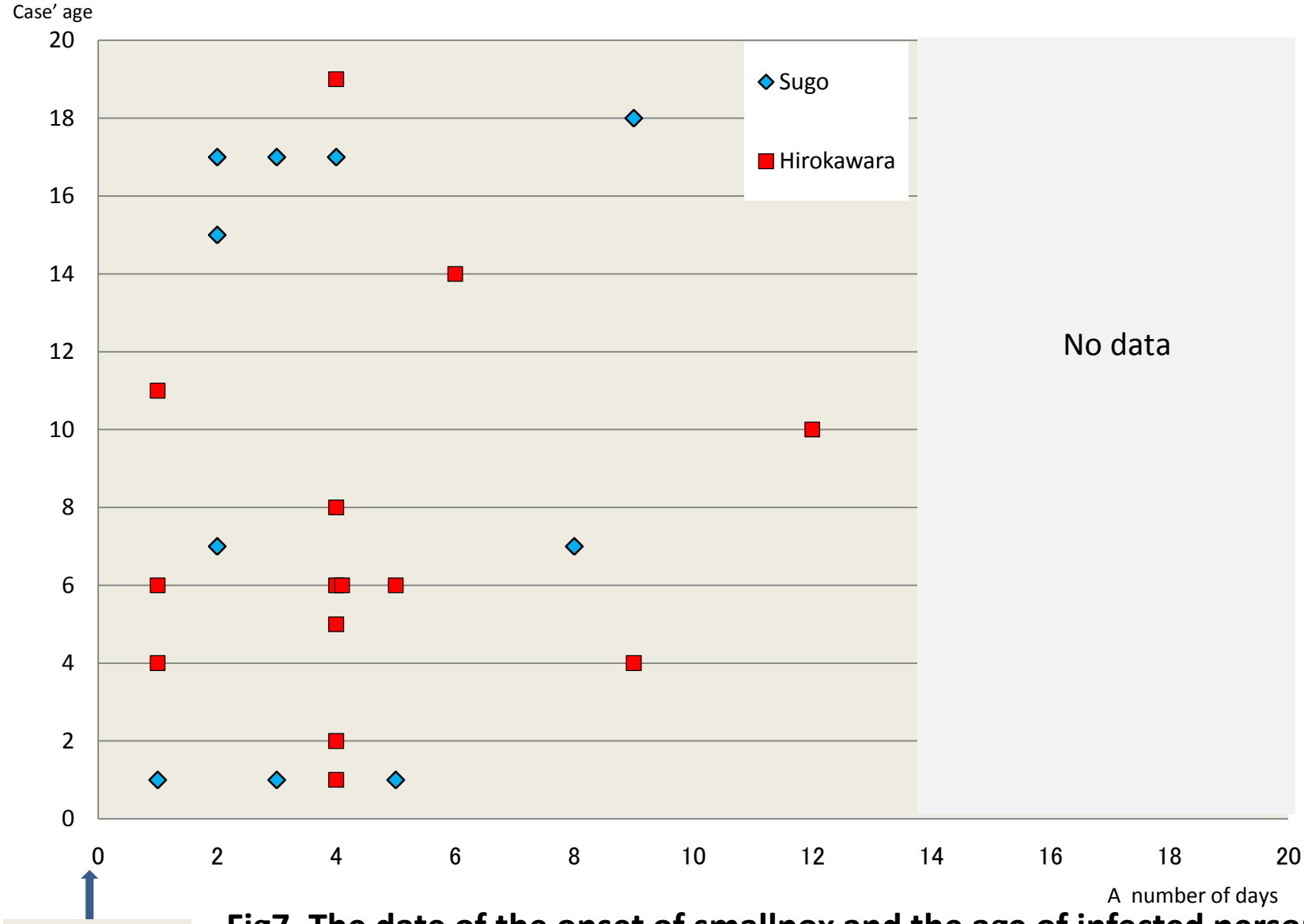


Fig7. The date of the onset of smallpox and the age of infected persons (Sugo village and Hirokawara village)

The sketch about children in a Japanese rural area which the foreign traveler drew at 1877-78

By Bird,I.L.
(English traveler)

By Morse,E.S (American zoologist)

During early modern period,
this kind of playmate group might have been usual and formed a unit of transmission of smallpox.

This transmission pattern reflects
high morbidity rate in a household.

morbidity rate in a household

Benin・・・・・・・・・31%

(located West Africa : *Republic of Benin*) (refer to Henderson,R.D., and Yekpe,M.1969)

Nakatsugawa ・・・・ 76% (Sugo village)
82% (Hirokawara village)

Conclusion

◆ the majority of the infected = children under the age of 10

↑ this pattern is observed widely among smallpox epidemics in early modern Japan

◆ 86% of the susceptible were infected in this outbreak.

↑ This point is vital to consider when thinking about the durability of a community under repeated outbreaks.

◆ Children's mobility was so low that it took 1 month to transmit the disease between adjacent villages on average.

↑The spread of smallpox was much slower than would be normally expected.

◆ The spread pattern was reflected by the behavior of children

↑Therefore they were infected at the same time.

↑The infected rate in Nakatsugawa was higher than Benin.

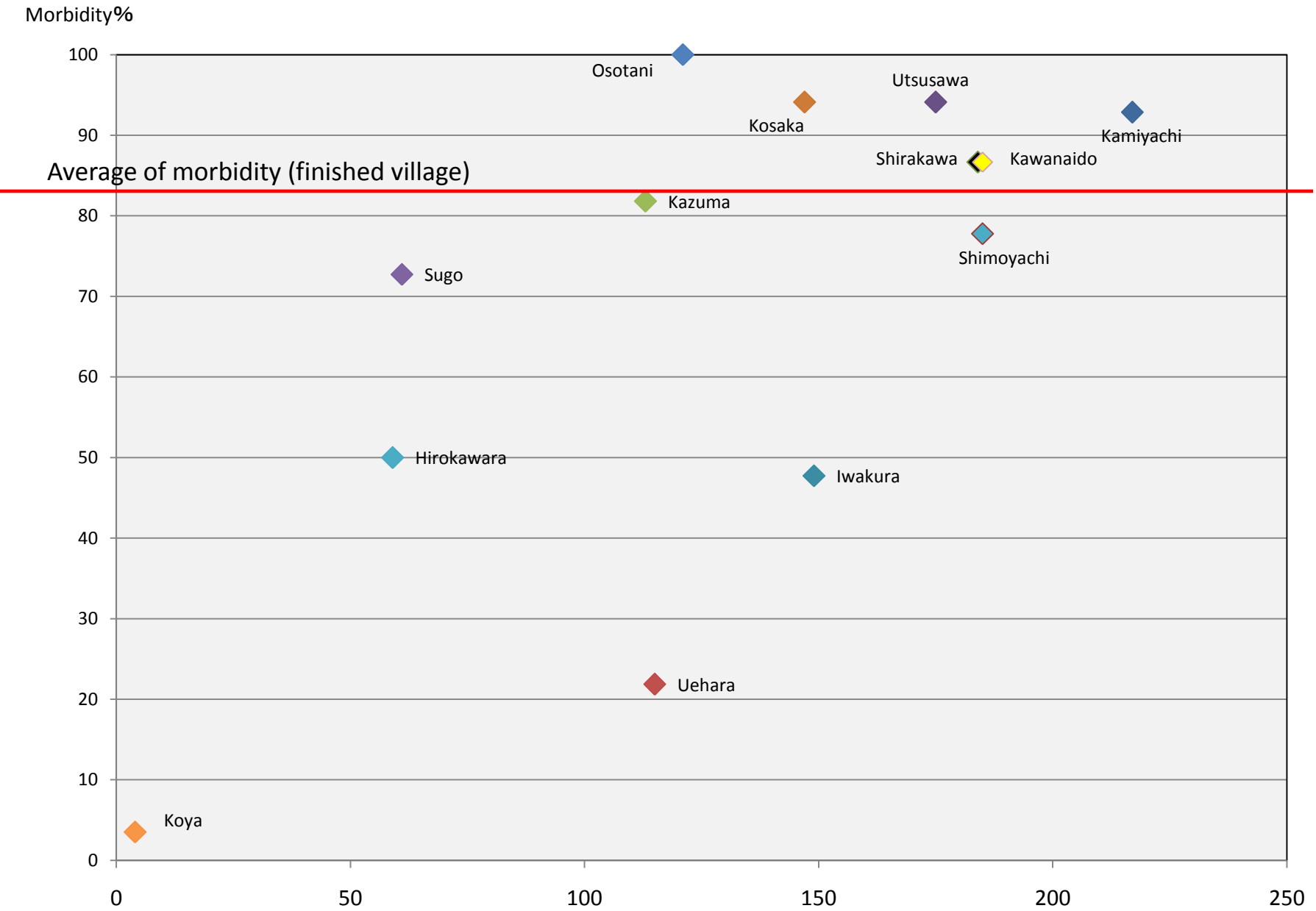


Fig15.The relation between the duration of transmission and morbidity of smallpox

A number of days from the days of onset to March9,1796

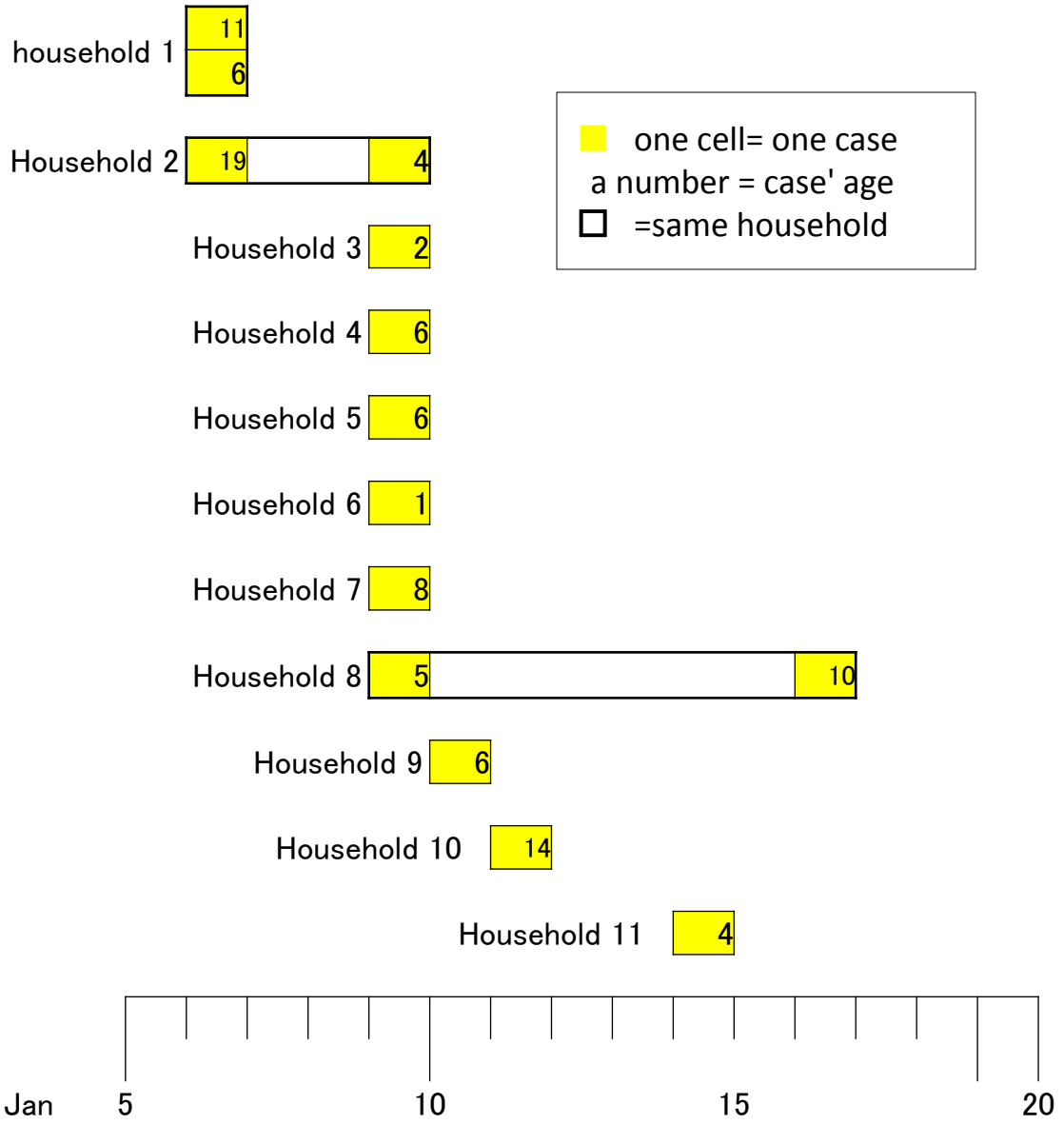


Fig10.Probable course of smallpox transmission in Hirokawara village, 1795–1796

The morbidity

Table4.The morbidity of the smallpox during May.9, 1796

		①using thepopulation data of 1786	②using the population data of 1805
Finished outbreak villages	Kamiyachi	41.94	24.53
	Shimoyachi	17.28	22.58
	Shirakawa	15.85	15.85
	Kawanaido	29.55	35.14
	Kosaka	24.24	24.81
	Osotani	25.00	21.48
	Average	25.64	24.06
	standard deviation	8.648	5.768