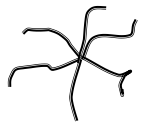
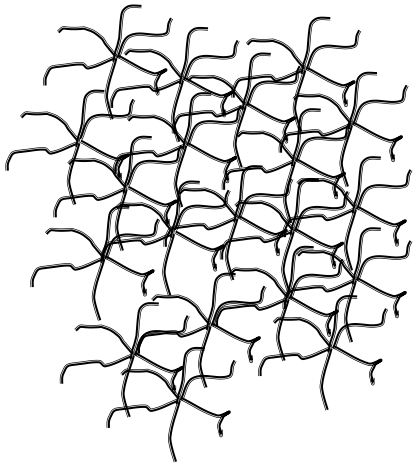
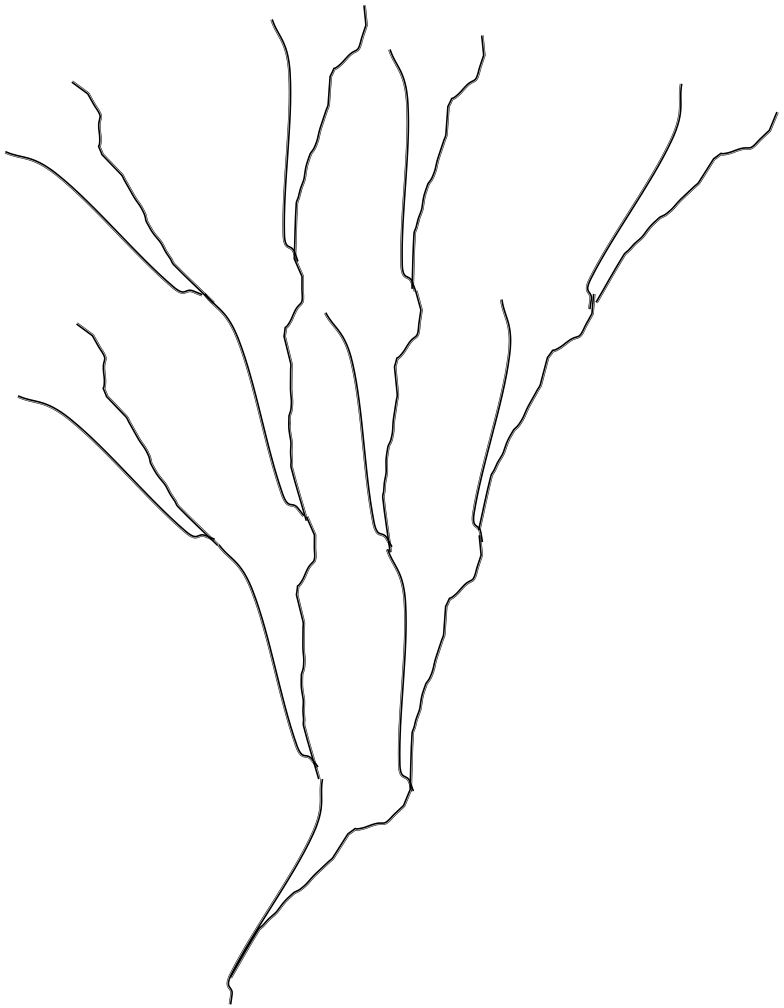
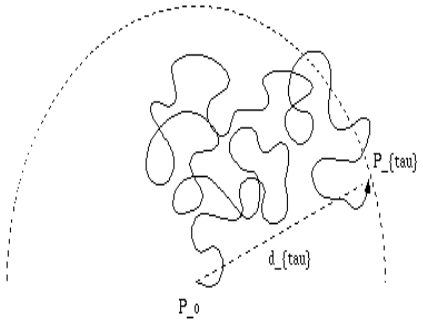
개체들은 움직이고 자손을 생산함:
개체군을 이룬 후 공간 패턴 형성



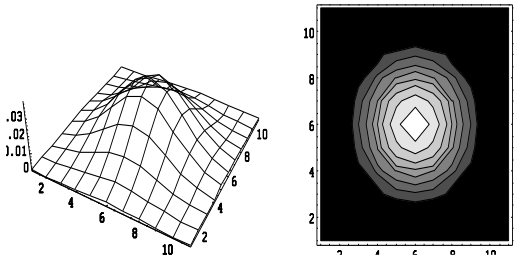




개체움직임에서 개체군 분산으로 확대
From individual movement, diffusion process and population dispersal (Pine needle Gall Midge from 1968 to 1992)



Individual movement tracks



Diffusion process

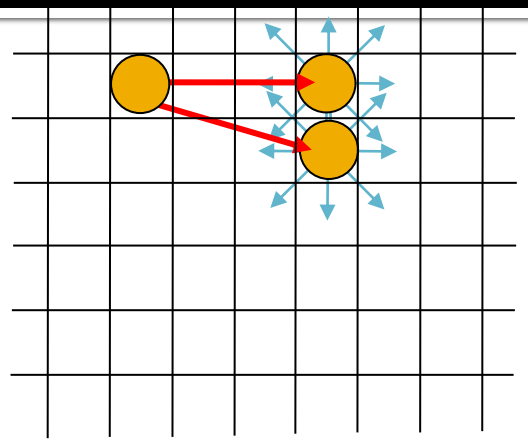
Dispersal of PNGM in 1968, 1976, 1984, and 1992 in Korea

EnFRA

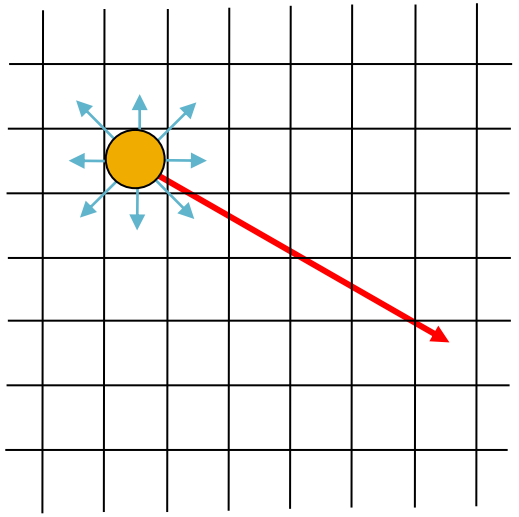
피해 임지

Our Model based on Cellular Automata

1. **Reproduction**



2. **Short and Long distance movement**



Power Law or

2Dt Distribution

Diffusion by Power Law

(cf. Lévy Flight)

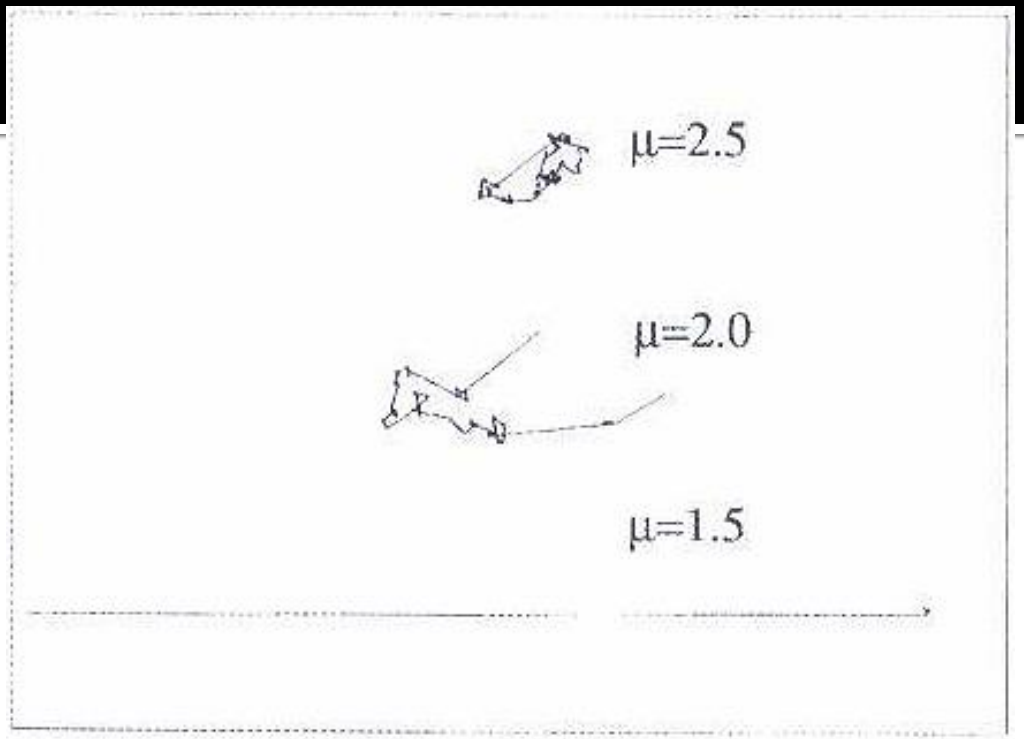
$$P(l_j) \sim l_j^{-\mu}$$

l : The step or flight lengths

$P(l)$: Density distribution

$1 < \mu \leq 3$

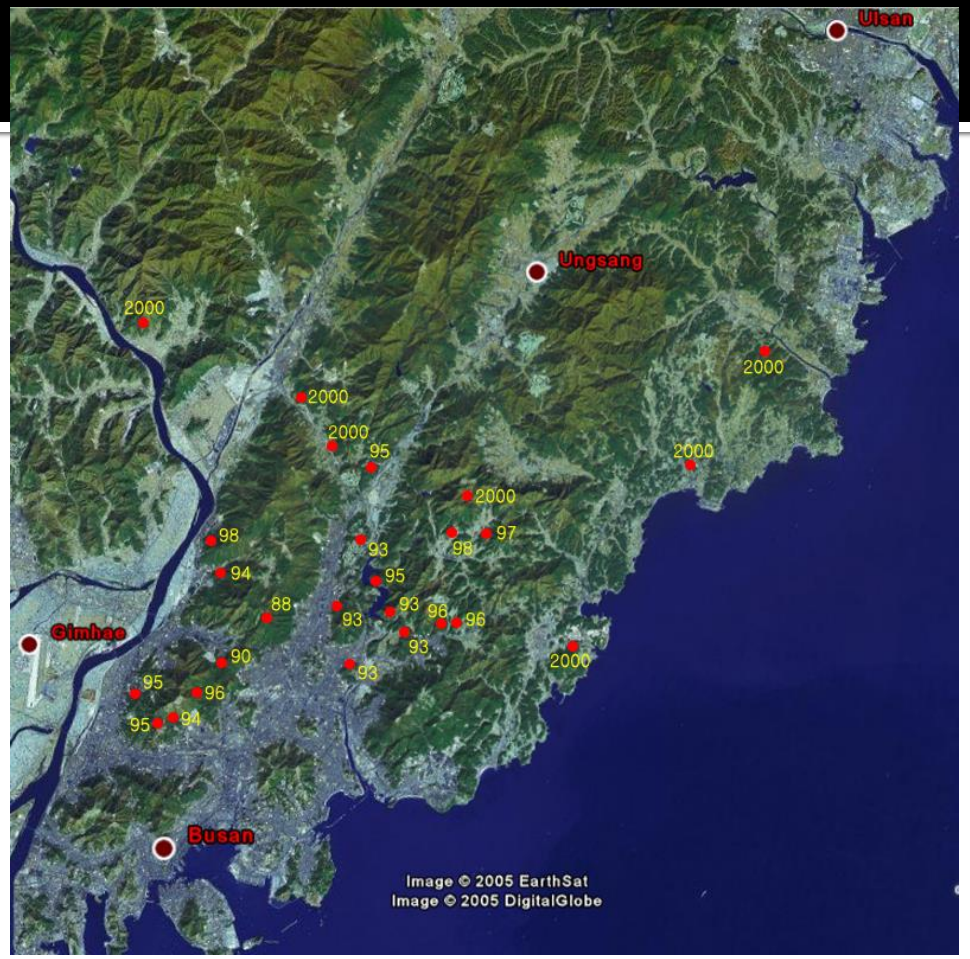
Cf. Gaussian behavior is a special case for μ > 3

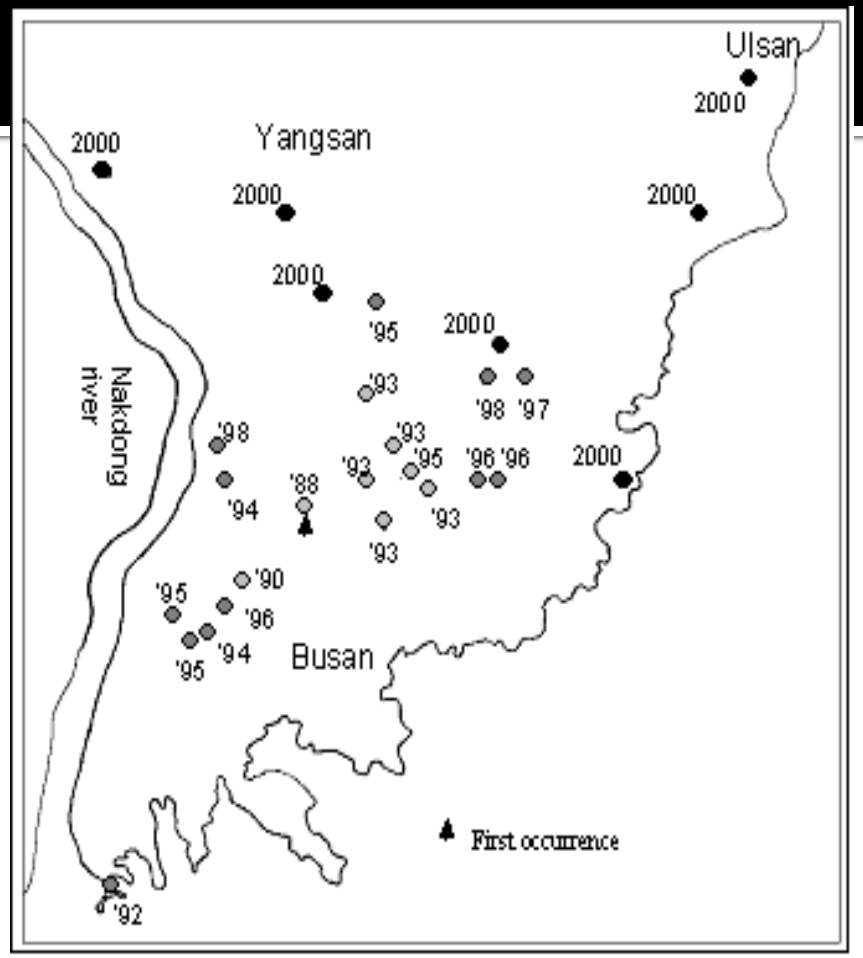


2–D random walks for μ = 2.5, 2.0, and 1.5, respectively, with identical total lengths of 10^3 units. Micro-organisms, mammals,birds,and insects show episodes of approximately straight locomotion randomly interrupted by re-orientation events.

(Sang Hee Lee)

Data

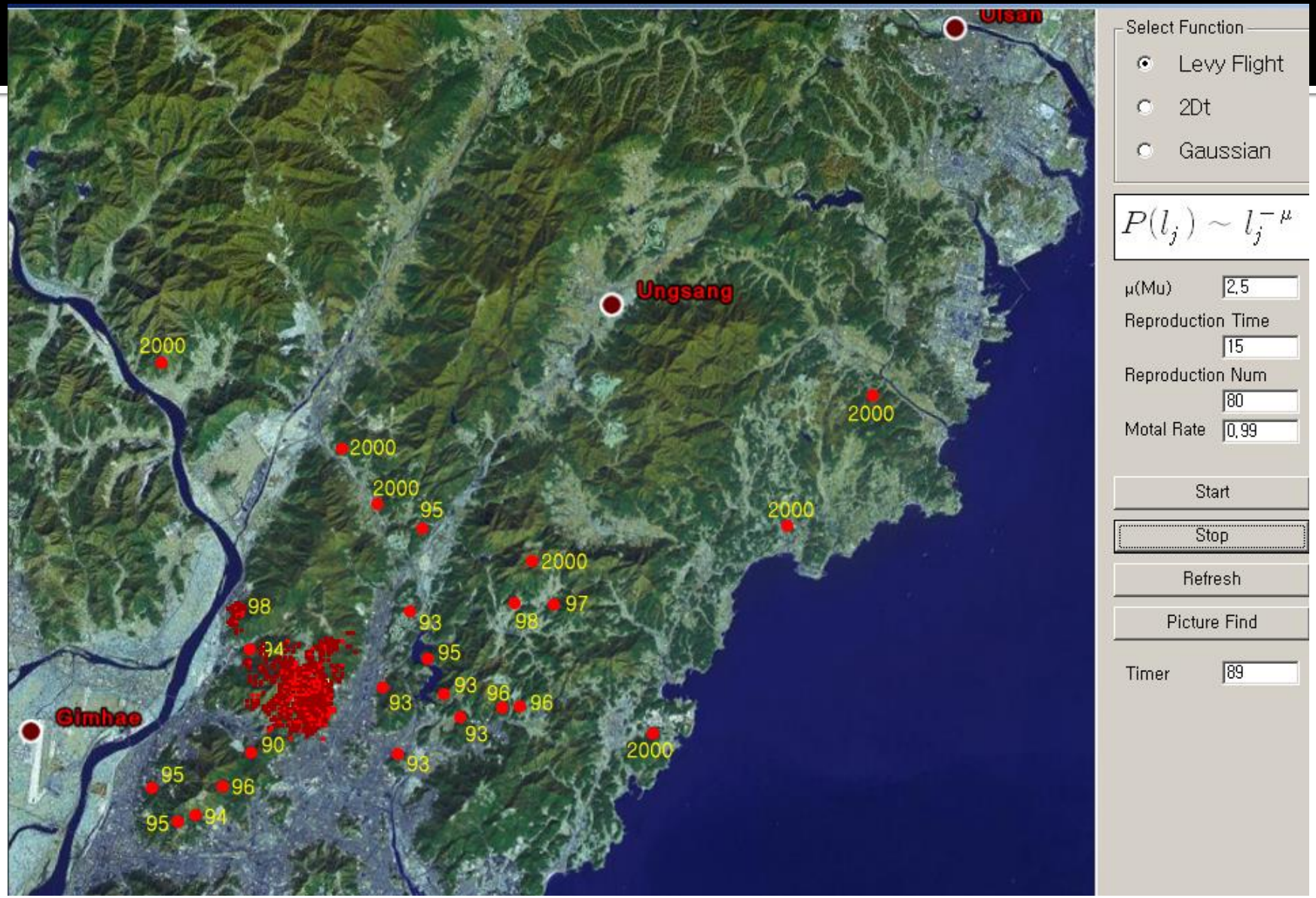




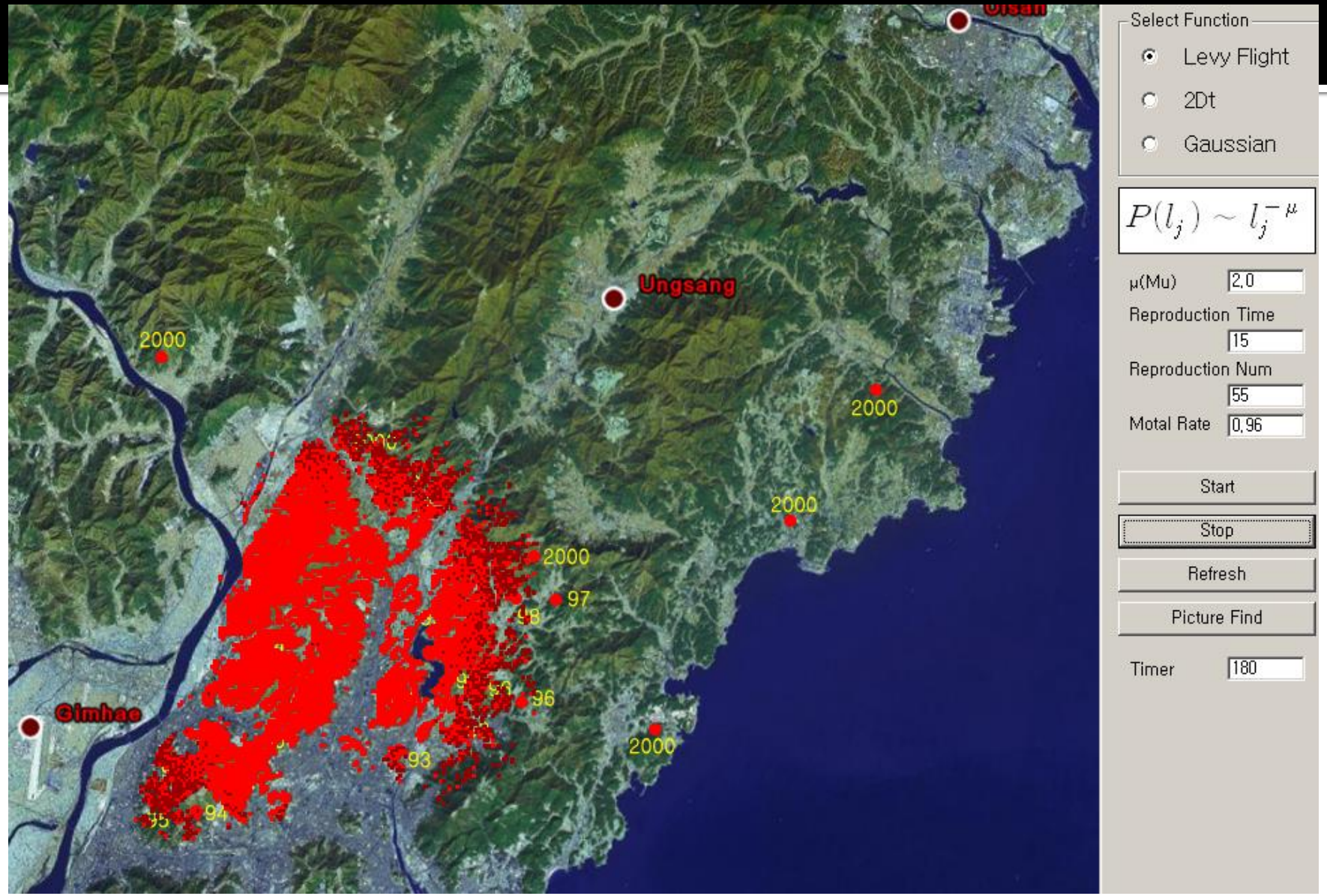
Occurrence distribution of pine wood nematode in Busan region

산림과학원

Simulation


Ulsan
Ungsang
Gimhae
2000
95
98
94
93
97
96
90
Select Function
Levy Flight
2Dt
Gaussian
$P(l_j) \sim l_j^{-\mu}$
μ(Mu)
2,5
Reproduction Time
15
Reproduction Num
80
Motal Rate
0,99
Start
Stop
Refresh
Picture Find
Timer
89

Simulation


Ulsan
Ungsang
2000
2000
2000
2000
97
96
93
94
Gimhae
Select Function
Levy Flight
2Dt
Gaussian
$P(l_j) \sim l_j^{-\mu}$
μ(Mu) 2.0
Reproduction Time
15
Reproduction Num
55
Motal Rate 0.96
Start
Stop
Refresh
Picture Find
Timer 180

2Dt Distribution

General 2Dt model

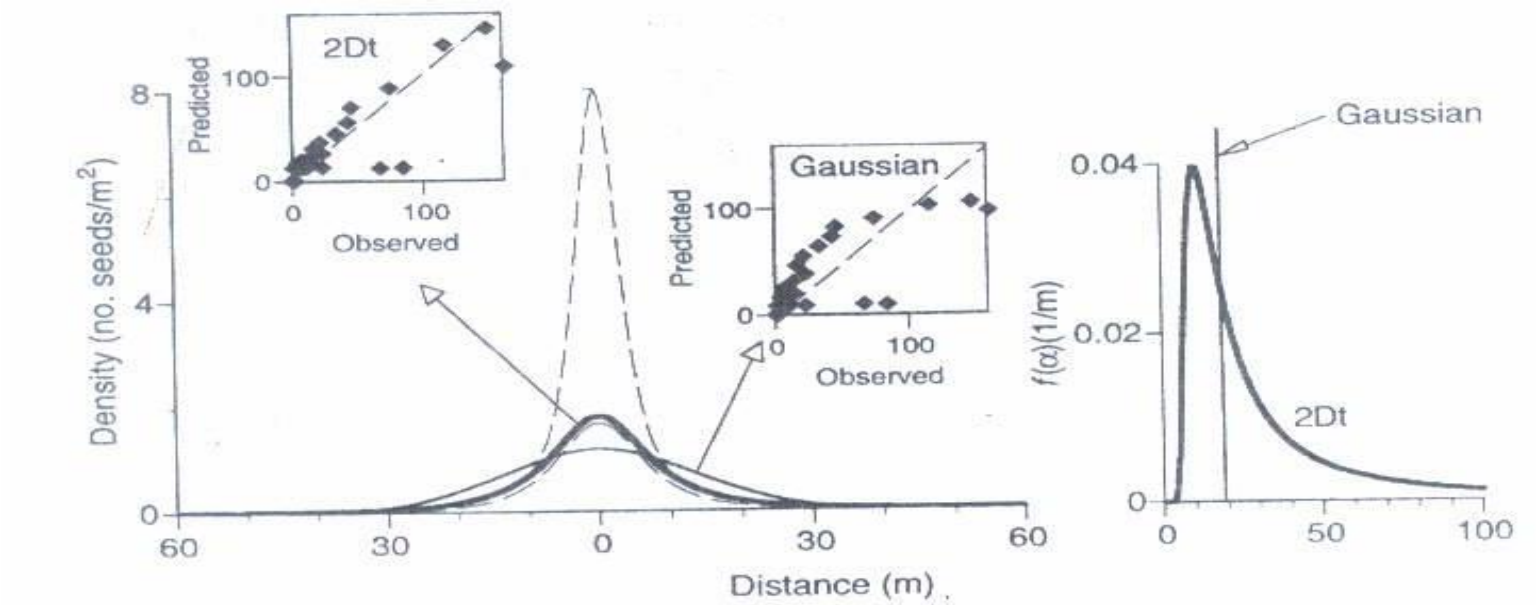
$$f(\alpha) = \frac{2u^p}{\alpha^{2p+1}\Gamma(p)} exp[-\frac{u}{\alpha^2}]$$

u Scaling parameter

p Shape parameter

$p \longrightarrow$ Large : Gaussian

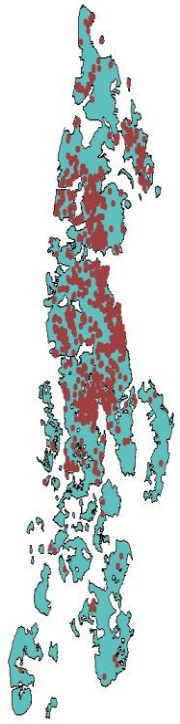
$p \longrightarrow$ Zero : Cauchy



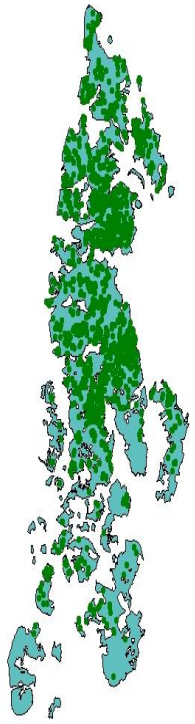
Demonstration of how the 2Dt model better describes seed rain data than does the Gaussian model for most of the species that we analyzed.

GIS data for dispersal (Gijang area)

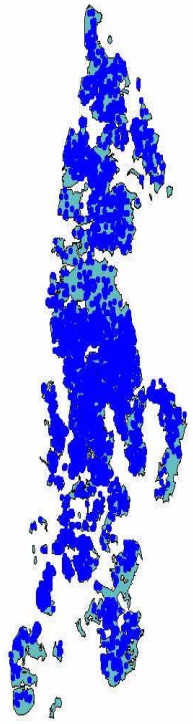
(From Korean Forestry Research Institute KFRI))



November, 2002

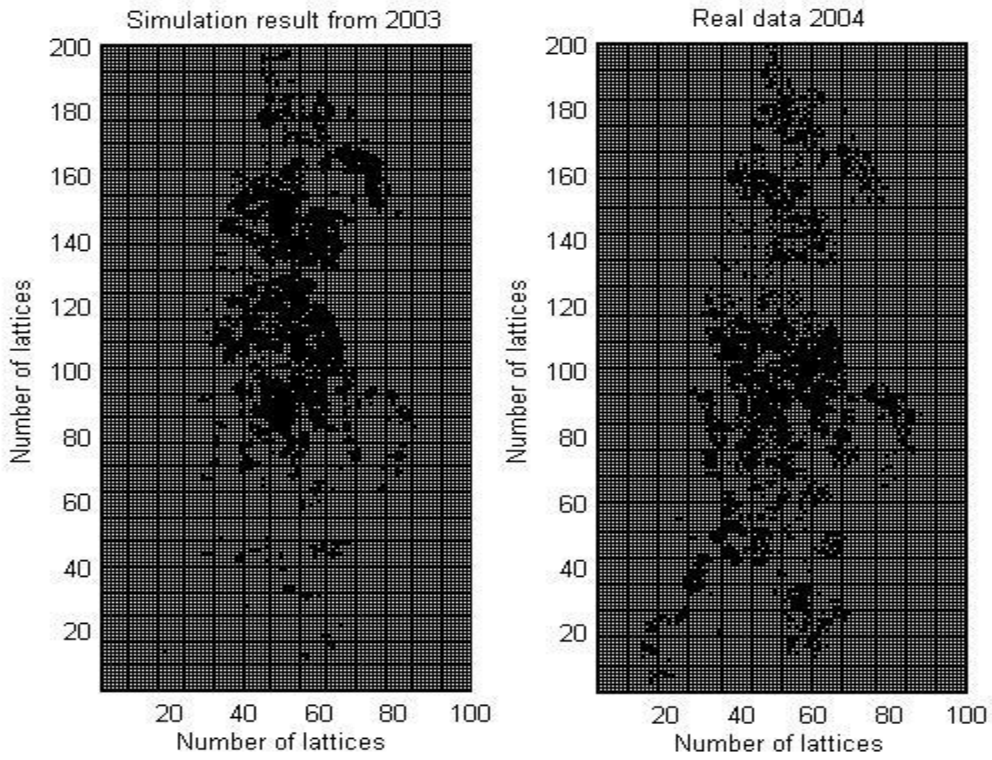


November, 2003

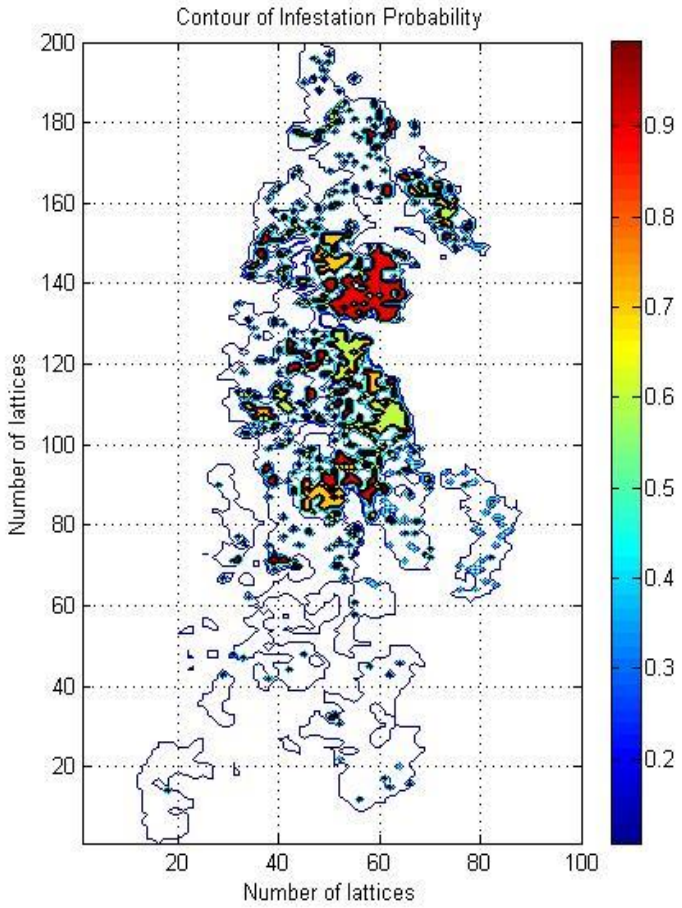


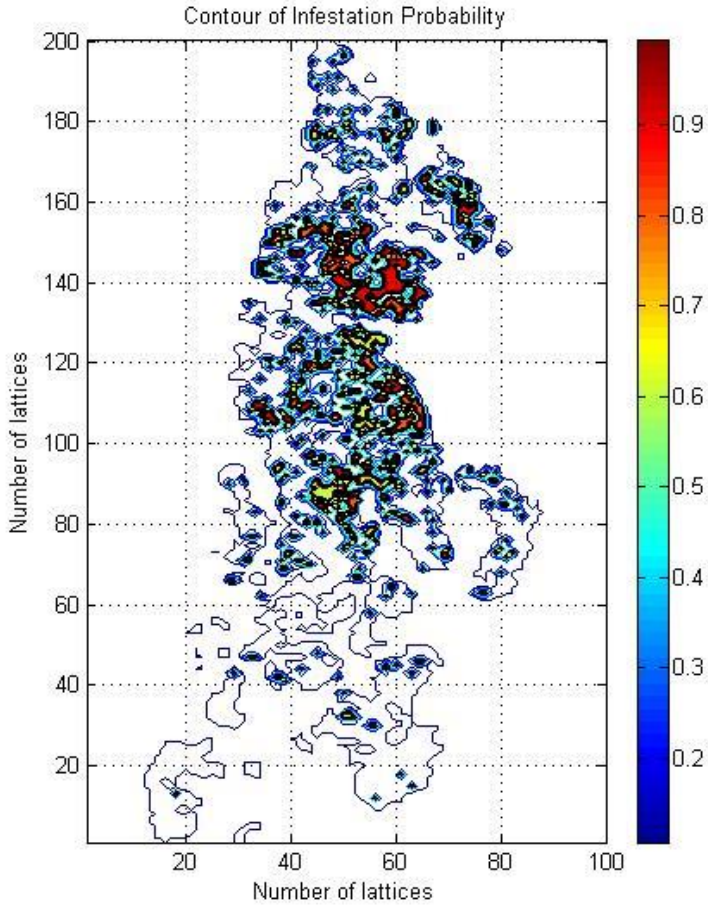
November, 2004

Simulation result compared to actual data 2004: no wind effect



해충 발현 확률에 대한 공간 지도:
Simulation results: infestation probability
(no wind effect)





Two-Dimensional Cross-correlation (with no normalization)

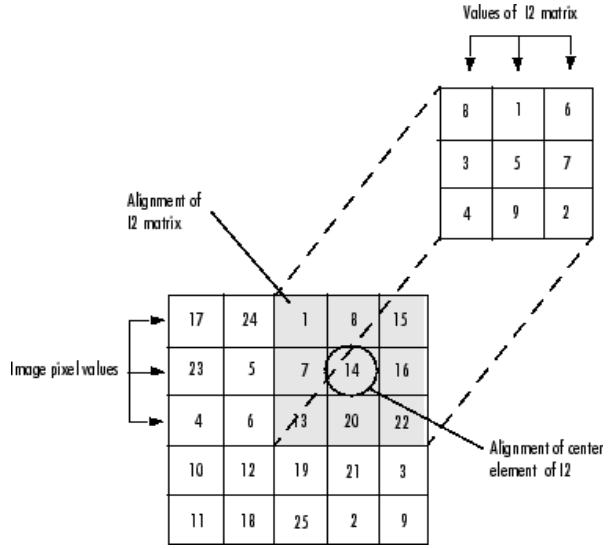
If the matrix A has dimensions (M_1,N_1) and the matrix B has dimensions (M_2,N_2)

$$C(i,j) = \sum_{m=0}^{M_1-1} \sum_{n=0}^{N_1-1} A(m,n) * conj(B(m+i, n+j))$$

$$where 0 \le i \le M_1 + M_2 - 1, 0 \le j \le N_1 + N_2 - 1$$

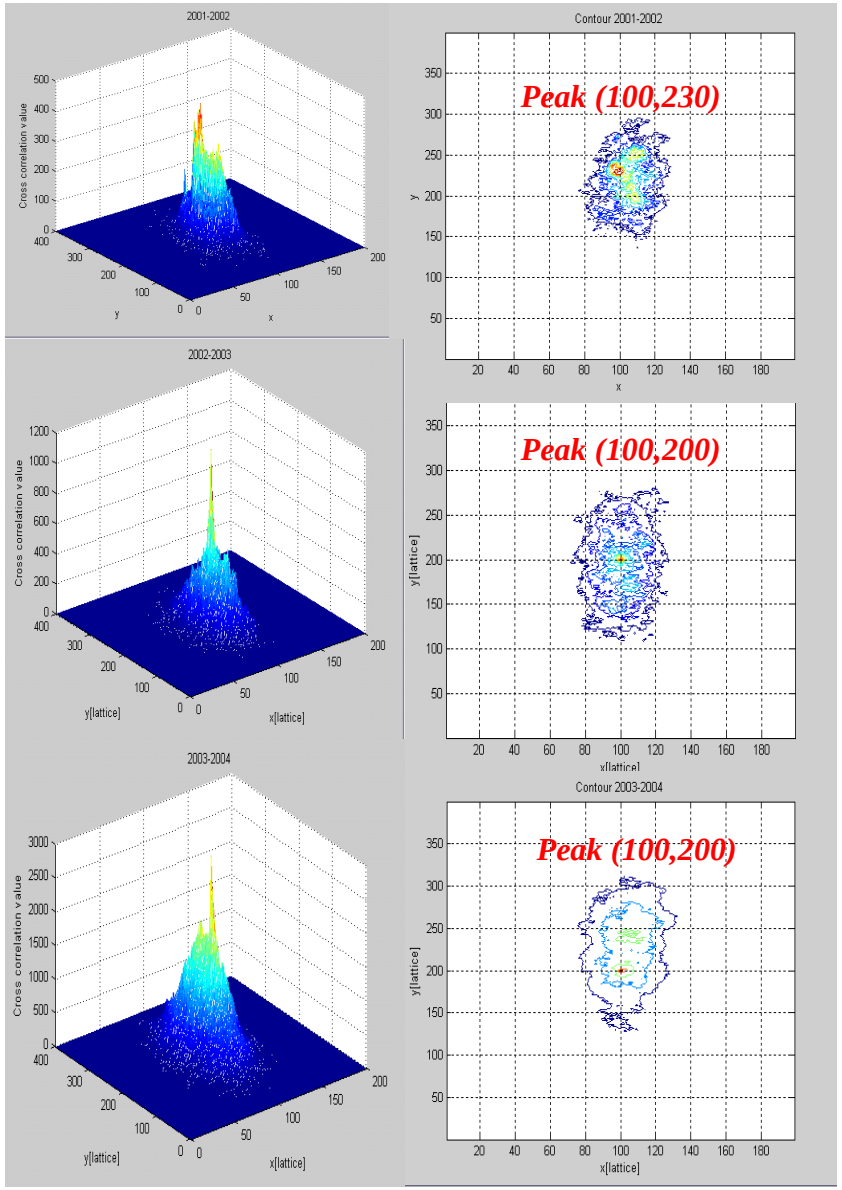
Conj(X) is complex conjugate of X

1.8 + 8.1 + 15.6 + 7.3 + 14.5 +16.7 + 13.4 + 20.9 +22.2 = 585



Two dimensional-
Spatial Cross-correlation

- *The range in difference of cross correlation in different years: approximately 150 lattice (7.5km)*
- *The peak of 2001-2002 (100,230) shows downward movement: 30 lattices (1.5km) (control effect, wind effect , food source, preference habitats)*
- *The peak of 2002-2003 (100,200) stayed at the same position (2004-2004: 100.200), but the fields of coefficients moved up (strong wind effects of the Gijang area in this period)*



Population Relationships

Z : Super predator

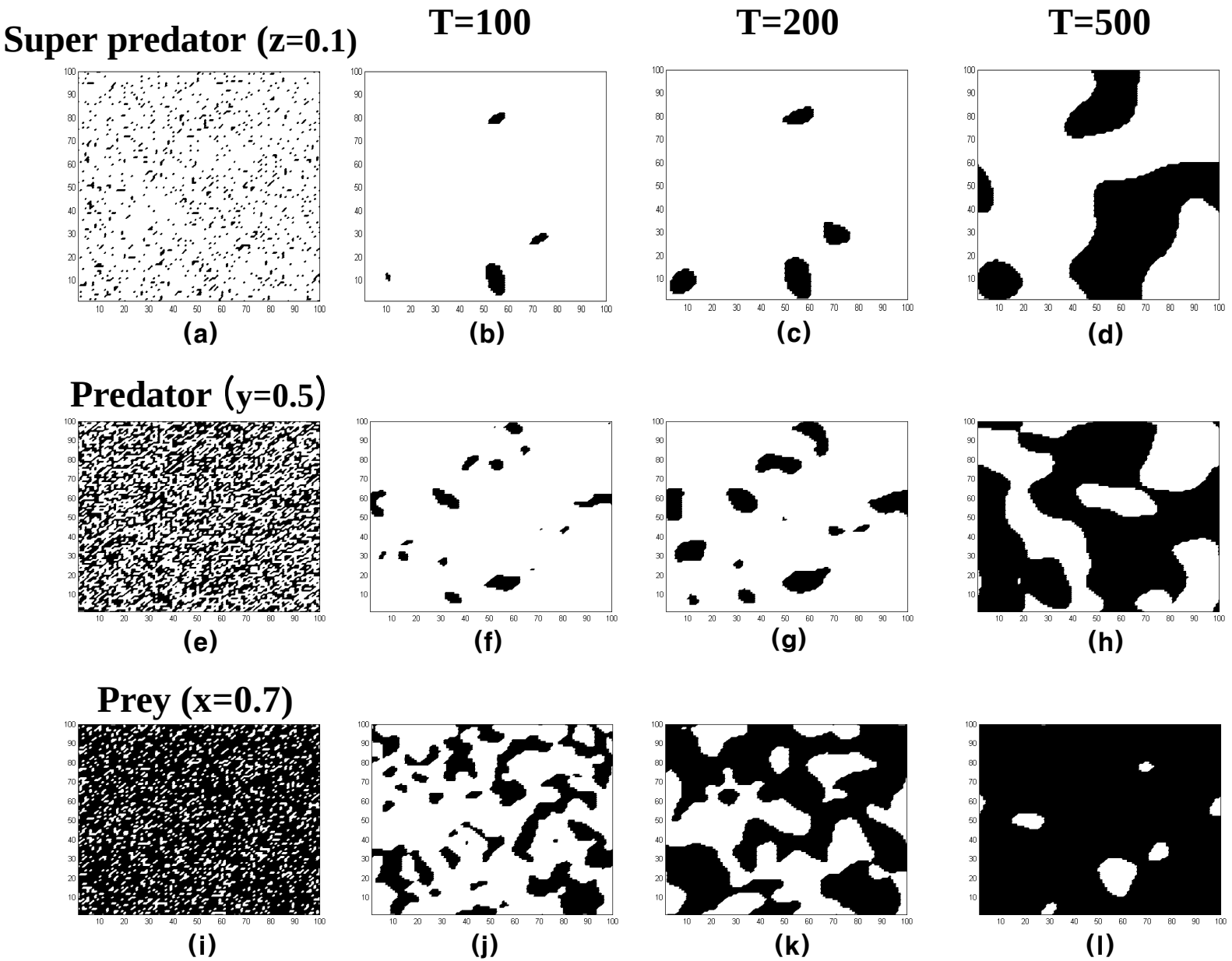
Y : Predator

X: Prey

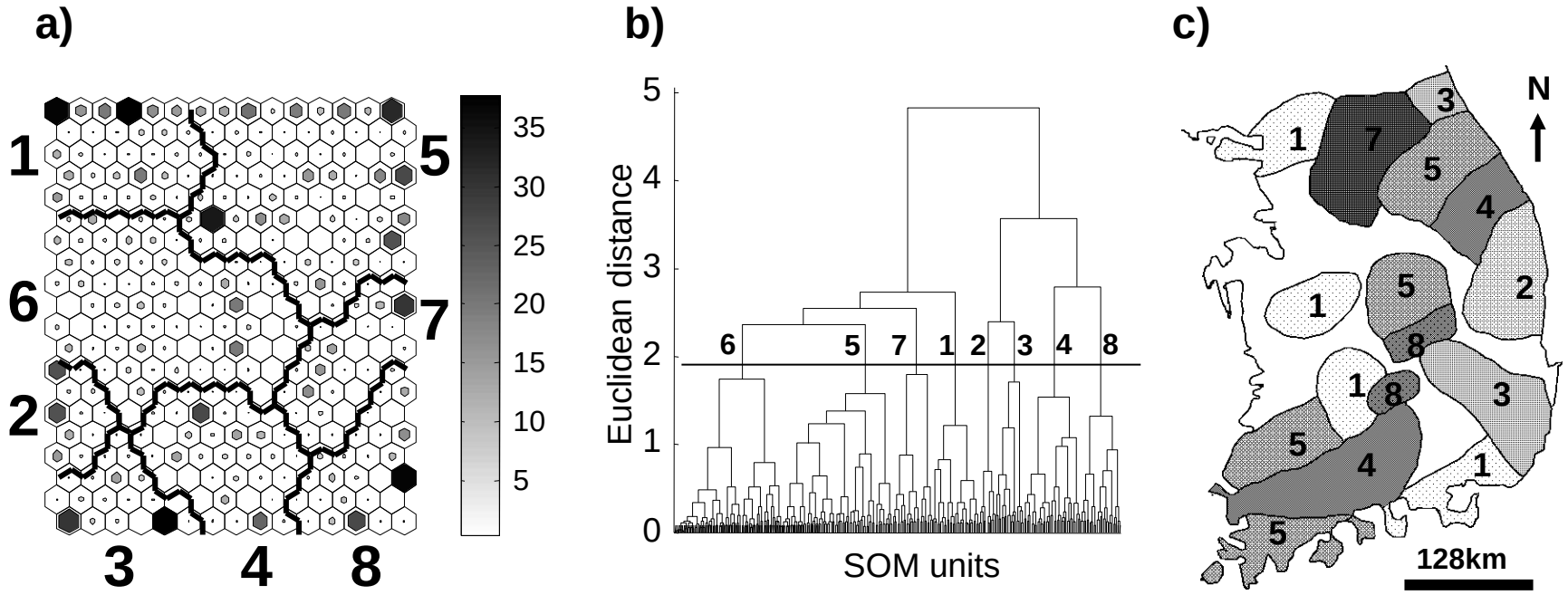
diffusion	predation	mortality
$\frac{\partial Z}{\partial T} = D_Z \nabla^2 Z$	$+\frac{b_2 ZY}{k_2 Z + Y}$	$-\mu_2 Z$
$\frac{\partial Y}{\partial T} = D_Y \nabla^2 Y$	$+\frac{b_1 YX}{k_1 Y + X} - \frac{b_2 YZ}{k_2 Z + Y}$	$-\mu_1 Y$
$\frac{\partial X}{\partial T} = D_X \nabla^2 X$	$-\frac{b_1 YX}{k_1 Y + X}$	$+R\left(1-\frac{X}{K}\right)X$

(Sang Hee Lee)

Time evolution of domain patterns of each species



생태정보기법을 이용한 생물권 지도:
Patterning of Communities in National Scale Data



Clustering of sites on SOM based on benthic macroinvertebrate communities measured in different sampling sites, a) the SOM map; b) the groups clustering map based on the result of SOM; c) the actually distribution of the sampling sited (*Park et al.*)