Pourquoi tant de mâles chez certaines Oléacées ?

Paradoxe et modélisation

Chaire Mathématiques et Modélisation de la biodiversité, 27 février 2013

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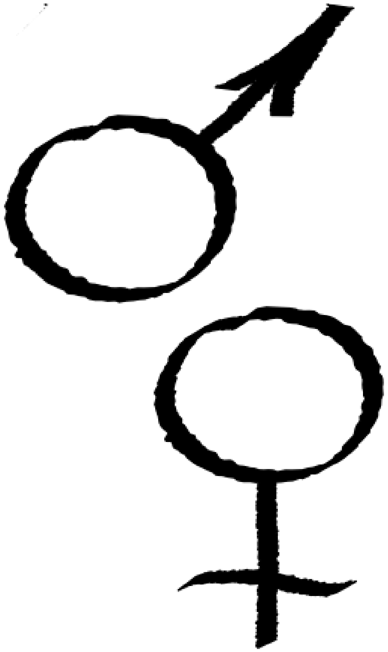
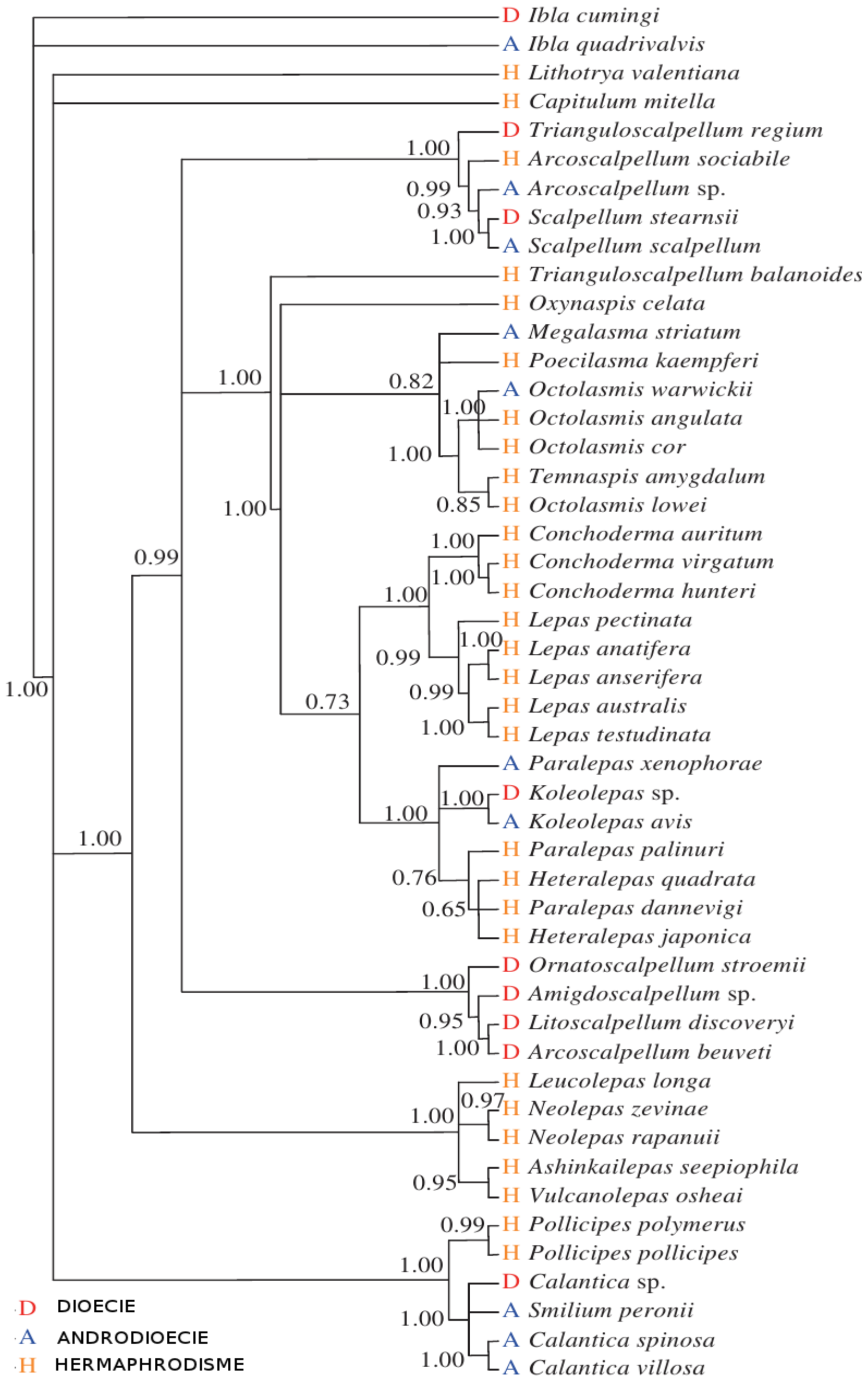
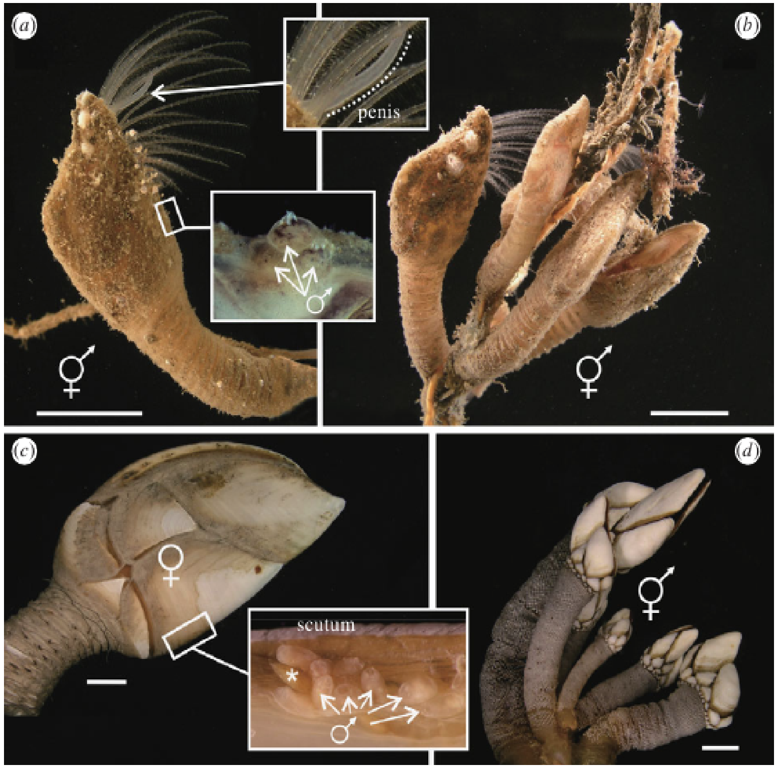
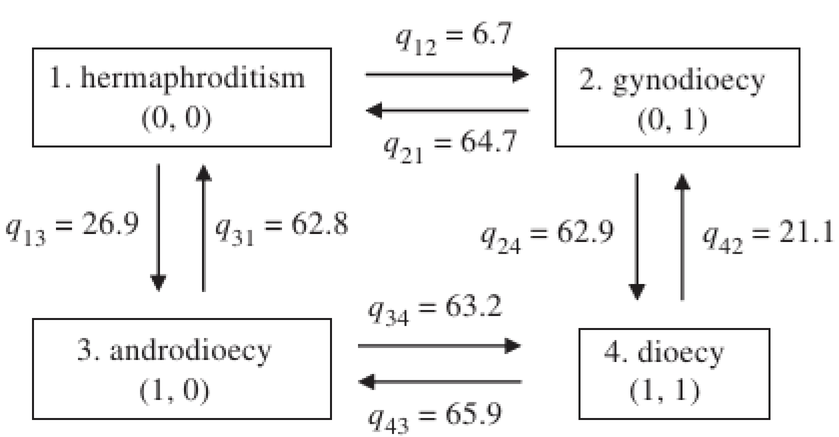
Les genres



Les transitions de genre

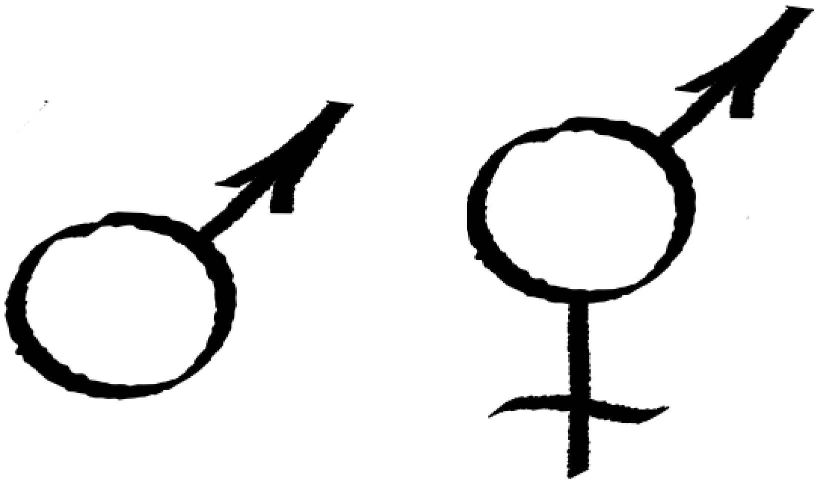






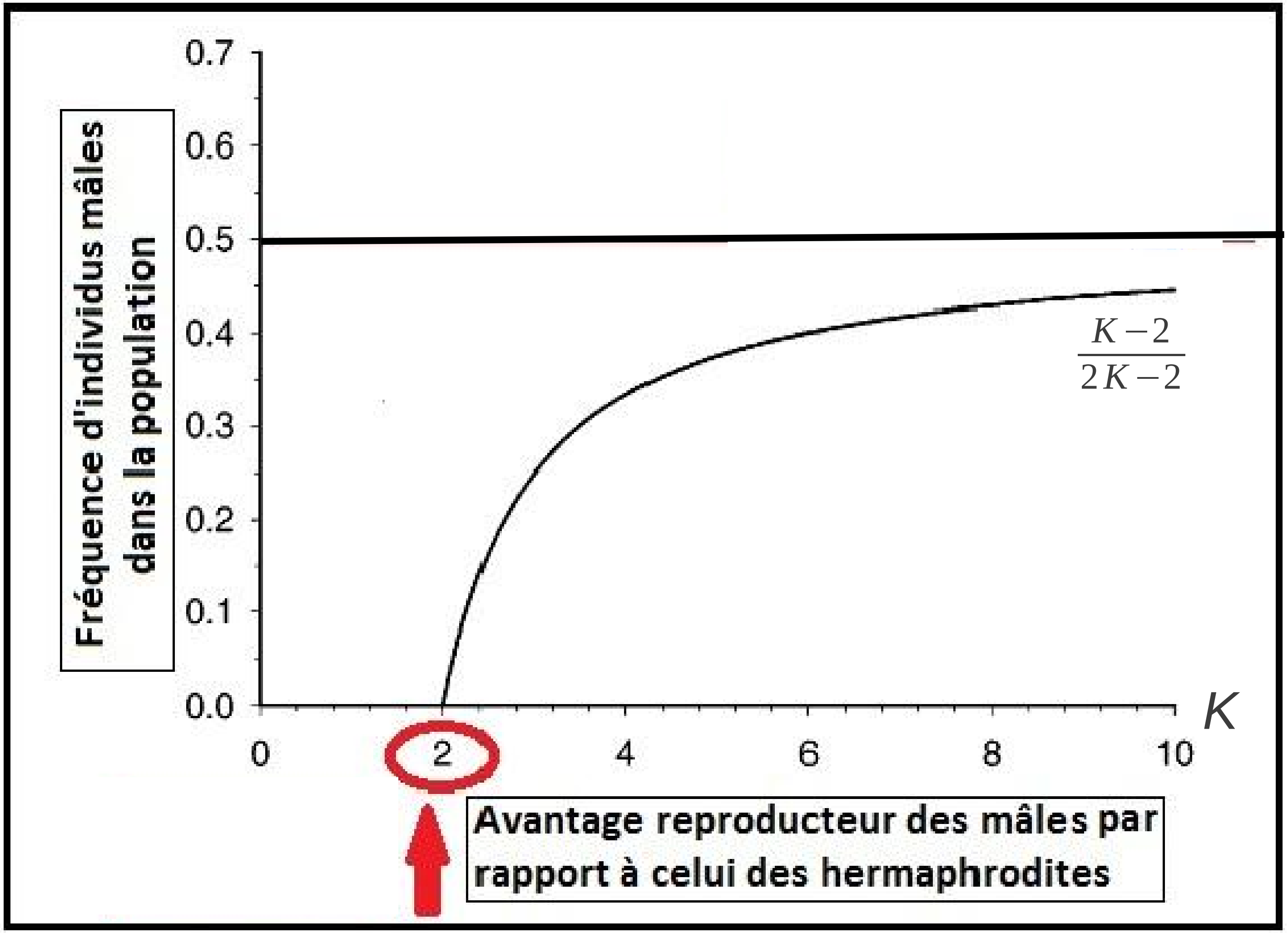
Yusa et al. 2011

Androdioécie



Rare chez les angiospermes

Fréquence de mâles généralement faibles

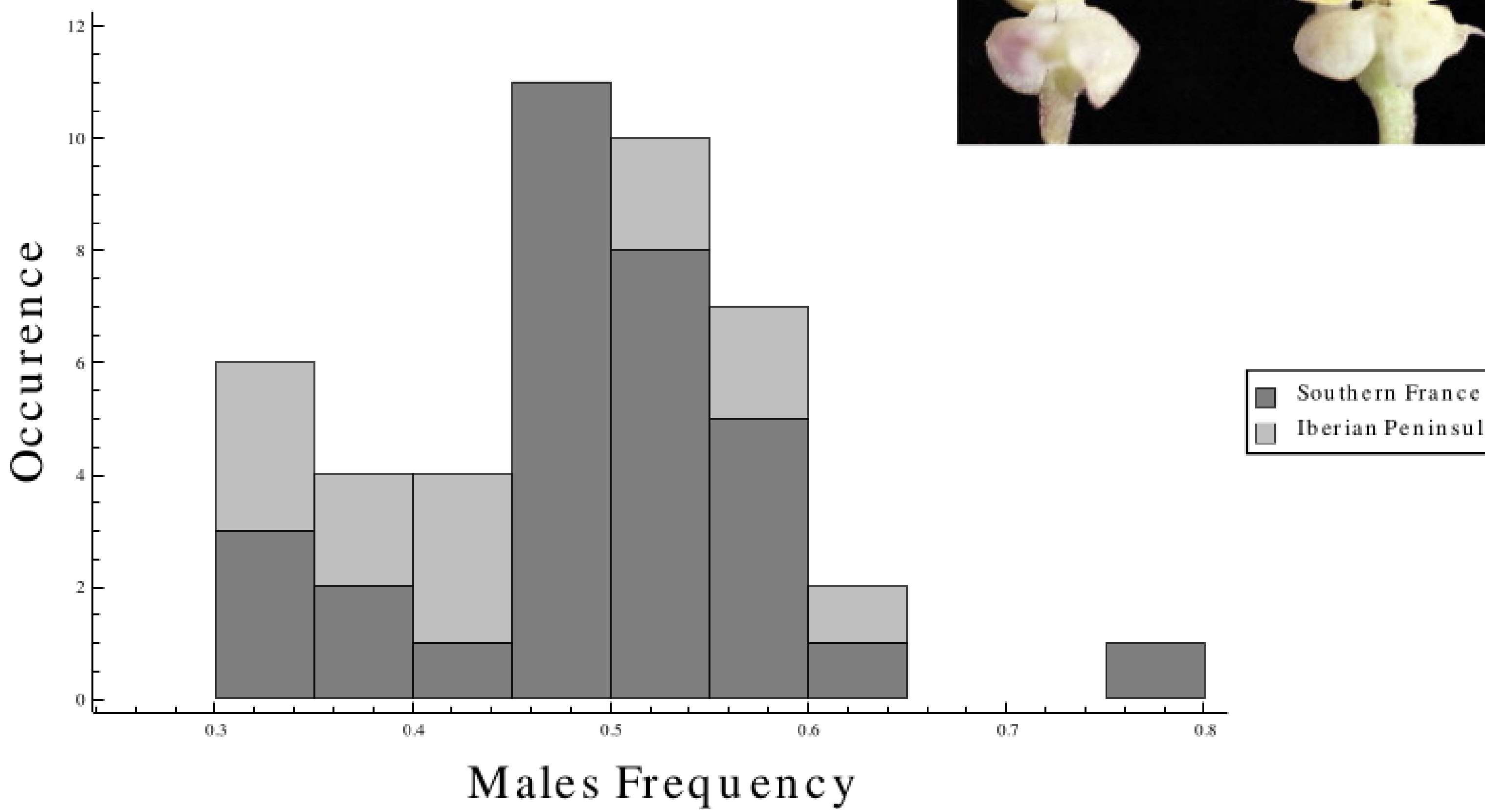

Fréquence d'individus mâles dans la population
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
2
4
6
8
10
K
$\frac{K-2}{2K-2}$
Avantage reproducteur des mâles par rapport à celui des hermaphrodites

Lloyd 1975

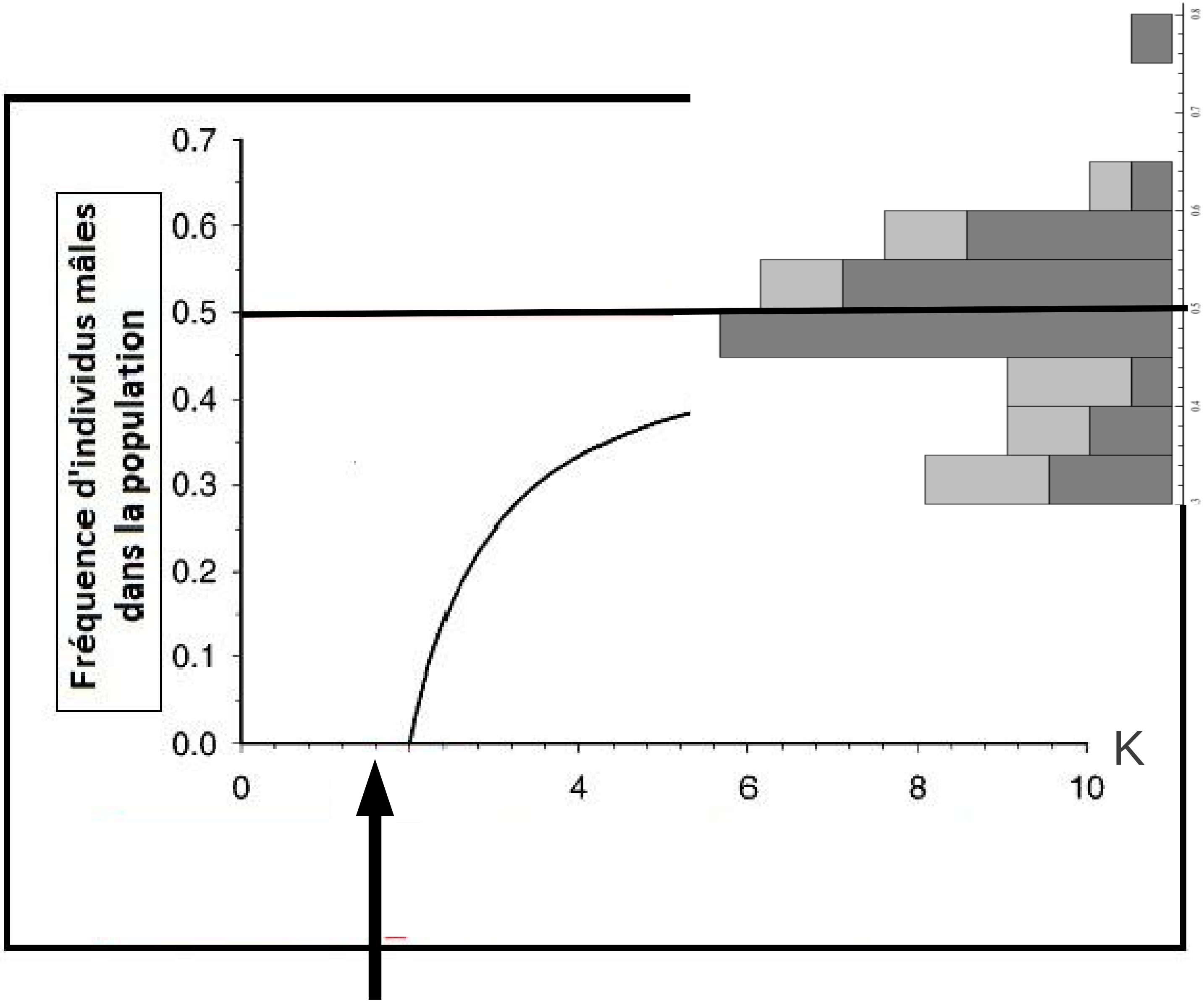

(a)

Chez le Phyllaire.

Current Biology

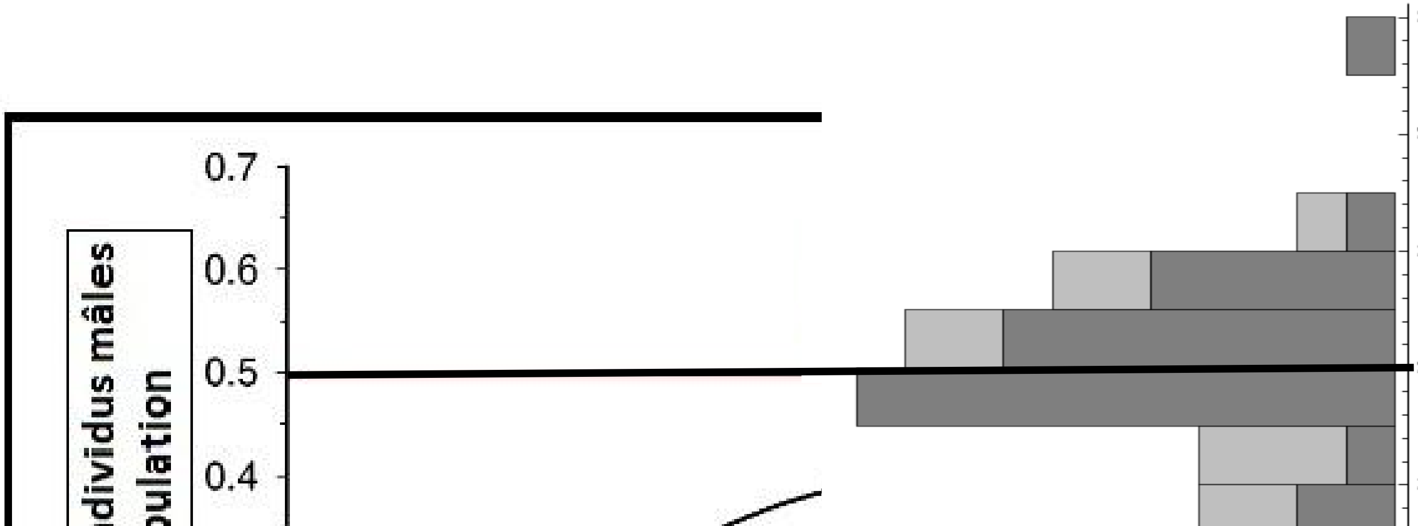


Lloyd 1975



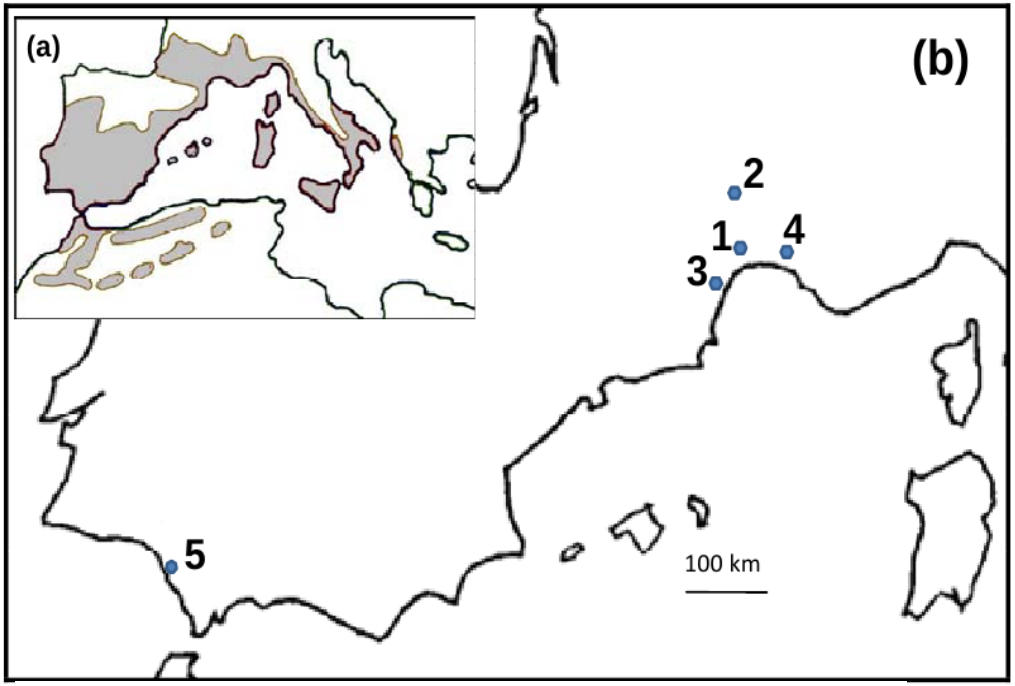
K observé = 1.8

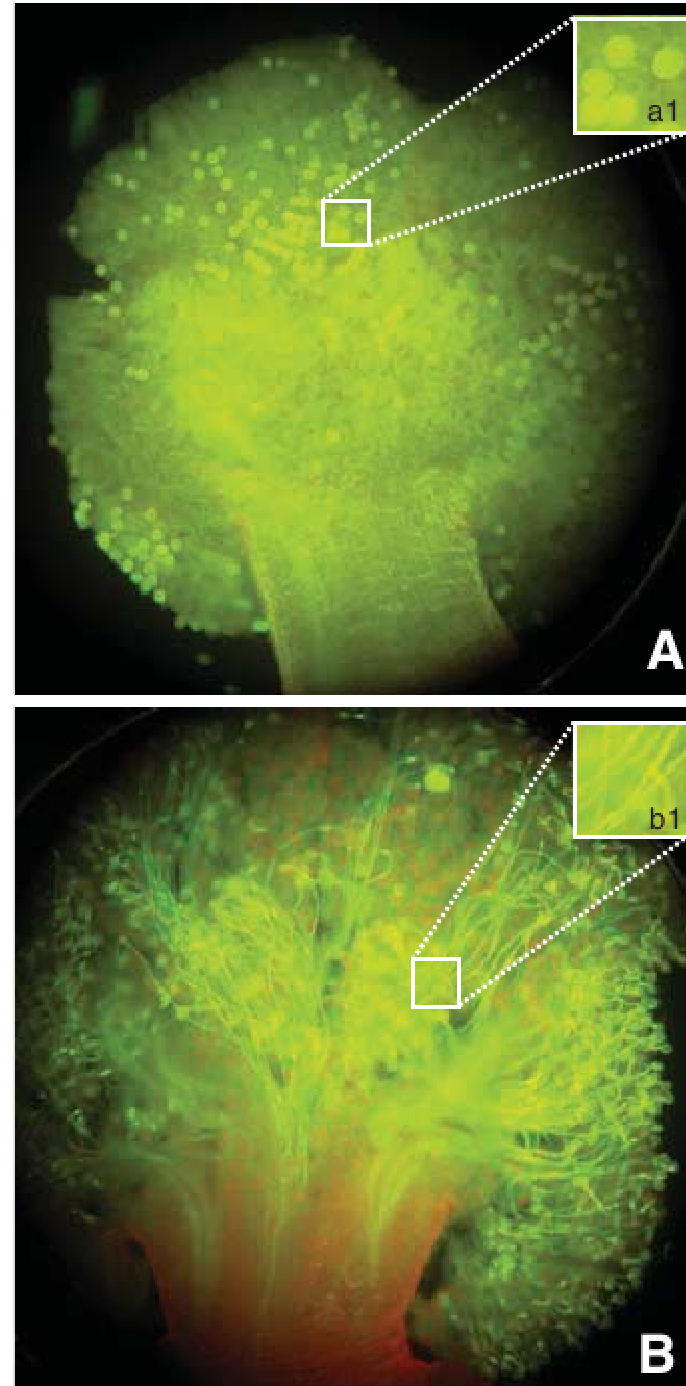
Lloyd 1975



Paradoxe !

- Observations incorrectes ?
- Modèle faux ?
- Les deux ?





(Pense-bête : tableau de croisements)

Saumitou-Laprade et al. 2010

Hypothèse 1 : 1 locus 3 allèles

Pollen donor

				[G_1]	[G_2]			[M]			
				S_1S_1	S_1S_2		S_2S_2	S_2S_3		S_1S_3	
				S_1	S_1	S_2	S_2	S_2	S_3	S_1	S_3
Stigma recipient	[G_1]	S_1S_1	S_1	Incompatible	S_1S_1 [G_1] 1/2	S_1S_2 [G_2] 1/2	S_1S_2 [G_2] 1	S_1S_2 [G_2] 1/2	S_1S_3 [M] 1/2	S_1S_1 [G_1] 1/2	S_1S_3 [M] 1/2
	[G_2]	S_1S_2	S_1	S_1S_1 [G_1] 1/2	Incompatible			S_1S_2 [G_2] 1/4	S_1S_3 [M] 1/4	S_1S_1 [G_1] 1/4	S_1S_3 [M] 1/4
			S_2	S_1S_2 [G_2] 1/2				S_2S_2 [G_2] 1/4	S_2S_3 [M] 1/4	S_1S_2 [G_2] 1/4	S_2S_3 [M] 1/4
		S_2S_2	S_2	S_1S_2 [G_2] 1				S_2S_2 [G_2] 1/2	S_2S_3 [M] 1/2	S_1S_2 [G_2] 1/2	S_2S_3 [M] 1/2

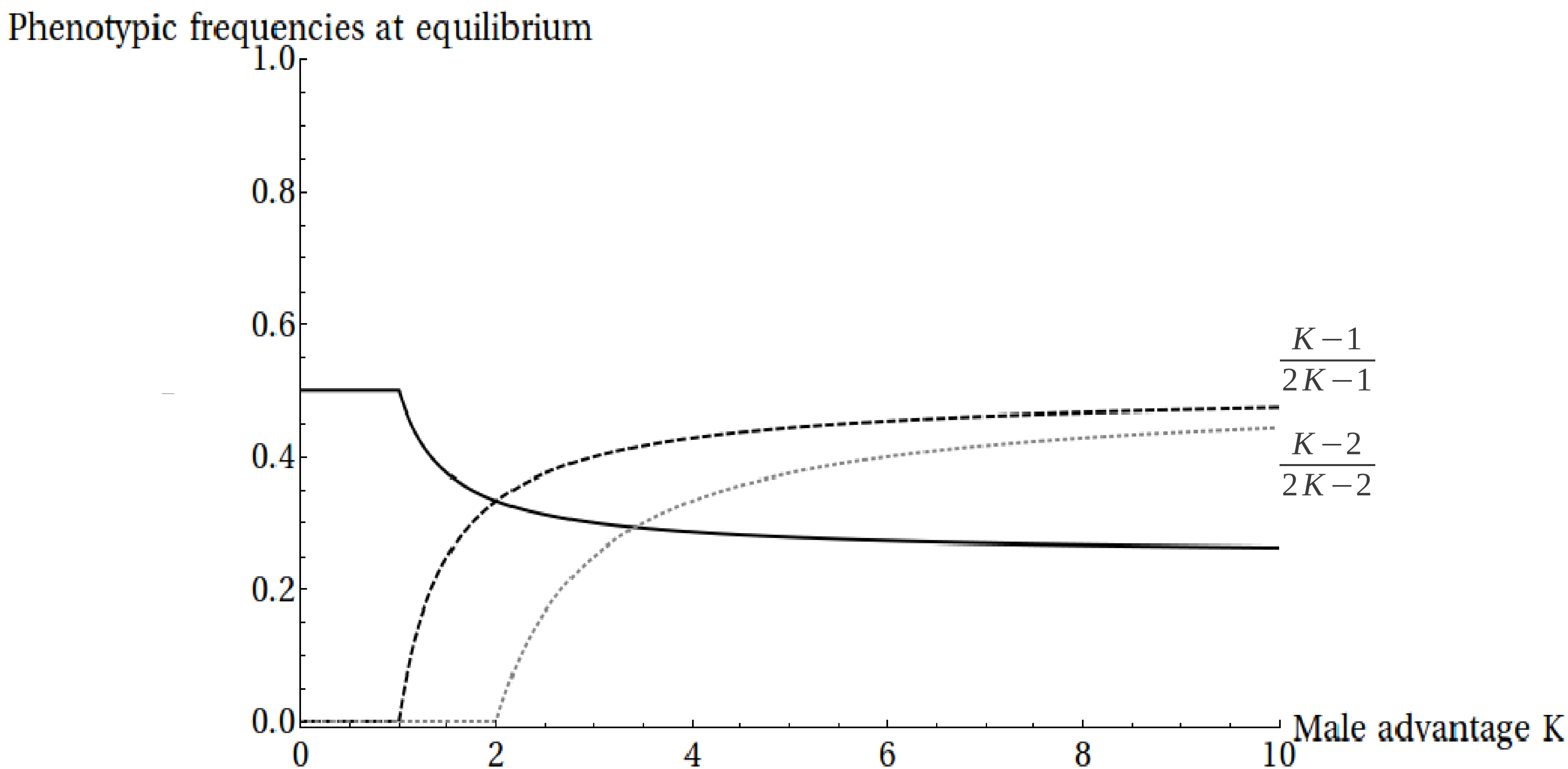
Table 1: Genetic control of breeding system in *Phillyrea angustifolia* under sporophytic incompatibility determinism as suggested in Saumitou-Laprade et al. (2010)

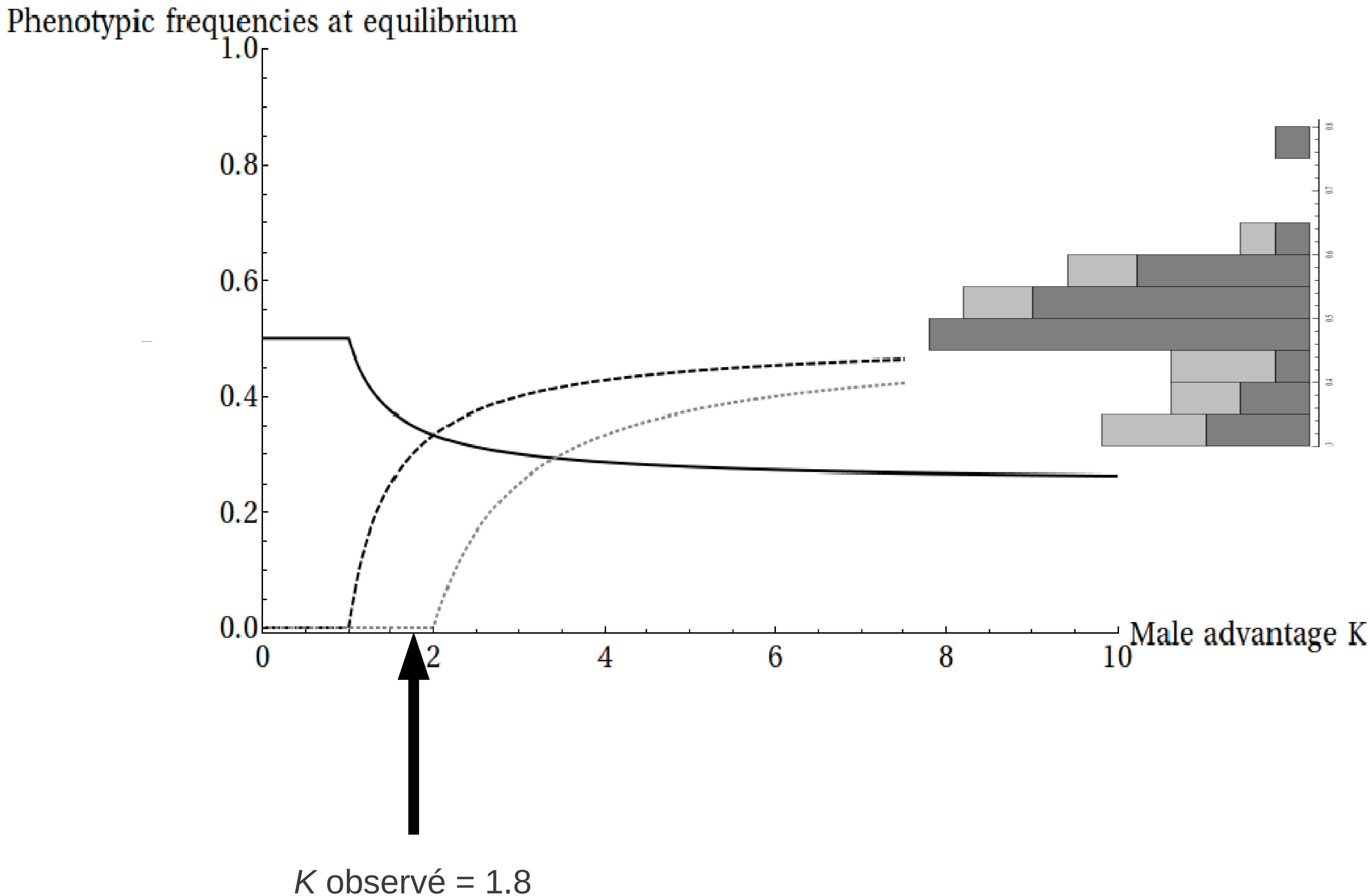
(Husse et al. Sous presse)

			$[G_1]$	$[G_2]$			[M]			
			S_1S_1	S_1S_2		S_2S_2	S_2S_3		S_1S_3	
			S_1	S_1	S_2	S_2	S_2	S_3	S_1	S_3
$[G_1]$	S_1S_1	S_1	Incompatible	S_1S_1 $[G_1]$ 1/2	S_1S_2 $[G_2]$ 1/2	S_1S_2 $[G_2]$ 1	S_1S_2 $[G_2]$ 1/2	S_1S_3 [M] 1/2	S_1S_1 $[G_1]$ 1/2	S_1S_3 [M] 1/2
t $[G_2]$	S_1S_2	S_1	S_1S_1 $[G_1]$ 1/2	Incompatible			S_1S_2 $[G_2]$ 1/4	S_1S_3 [M] 1/4	S_1S_1 $[G_1]$ 1/4	S_1S_3 [M] 1/4
		S_2	S_1S_2 $[G_2]$ 1/2				S_2S_2 $[G_2]$ 1/4	S_2S_3 [M] 1/4	S_1S_2 $[G_2]$ 1/4	S_2S_3 [M] 1/4
	S_2S_2	S_2	S_1S_2 $[G_2]$ 1				S_2S_2 $[G_2]$ 1/2	S_2S_3 [M] 1/2	S_1S_2 $[G_2]$ 1/2	S_2S_3 [M] 1/2

$$X+\frac{dX}{dt}=\begin{pmatrix} \frac{1}{\sigma}\left(\frac{x_{11}}{2}\,\frac{x_{12}+Kx_{13}}{\theta_1}+\frac{x_{12}}{4}\,\frac{2x_{11}+Kx_{13}}{\theta_2}\right) \\ \frac{1}{\sigma}\left(\frac{x_{11}}{2}\,\frac{x_{12}+2x_{22}+Kx_{23}}{\theta_1}+\frac{x_{12}}{4}\,\frac{2x_{11}+Kx_{13}+Kx_{23}}{\theta_2}+\frac{x_{22}}{2}\,\frac{2x_{11}+Kx_{13}}{\theta_3}\right) \\ \frac{1}{\sigma}\left(\frac{x_{22}}{2}\,\frac{Kx_{23}}{\theta_3}+\frac{x_{12}}{4}\,\frac{Kx_{23}}{\theta_2}\right) \\ \frac{1}{\sigma}\left(\frac{x_{11}}{2}\,\frac{Kx_{13}+Kx_{23}}{\theta_1}+\frac{x_{12}}{4}\,\frac{Kx_{13}+Kx_{23}}{\theta_2}\right) \\ \frac{1}{\sigma}\left(\frac{x_{22}}{2}\,\frac{Kx_{13}+Kx_{23}}{\theta_3}+\frac{x_{12}}{4}\,\frac{Kx_{13}+Kx_{23}}{\theta_2}\right), \end{pmatrix}$$

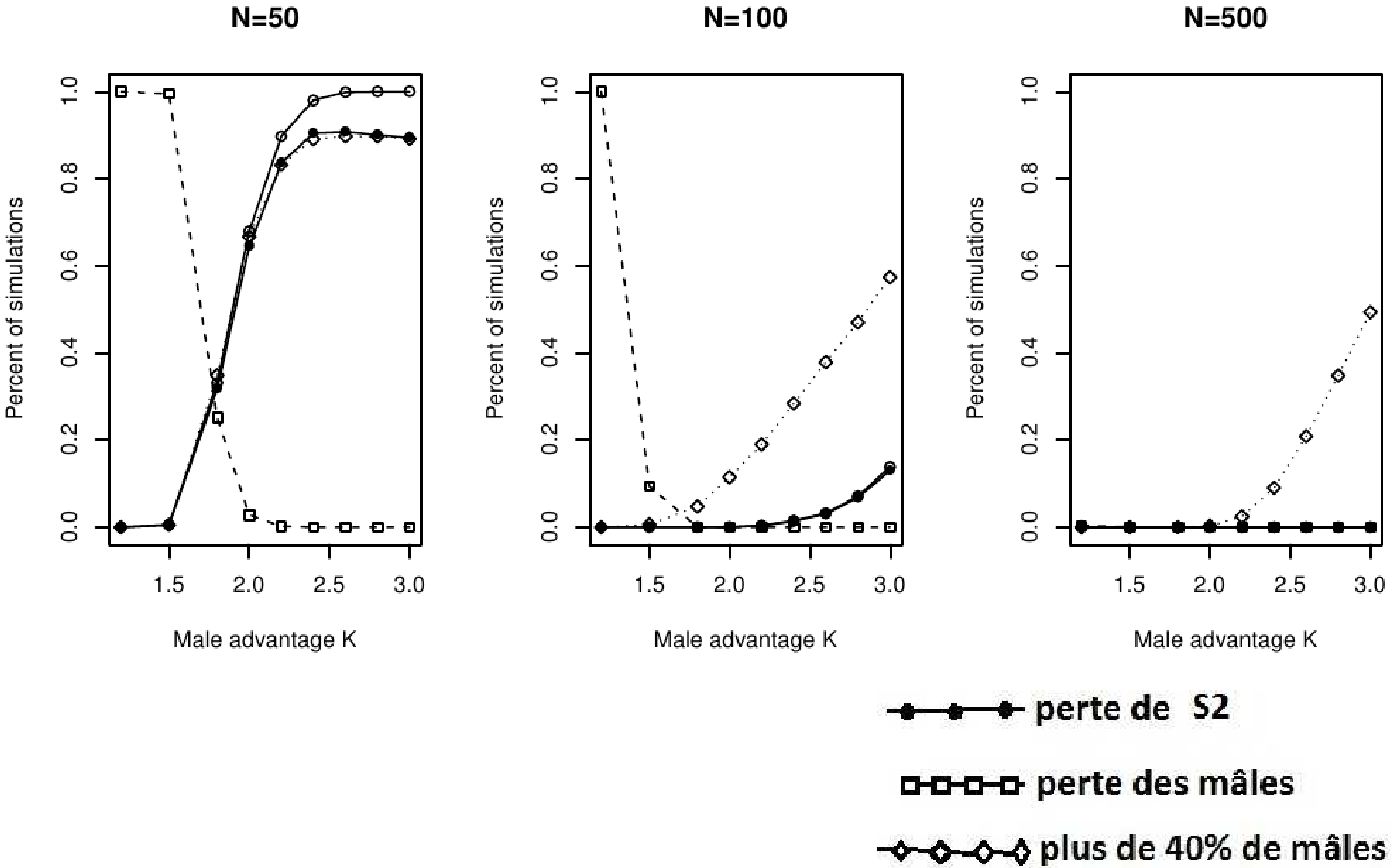
$X+dX/dt$


Phenotypic frequencies at equilibrium
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
Male advantage K
$\frac{K-1}{2K-1}$
$\frac{K-2}{2K-2}$



Phenotypic frequencies at equilibrium
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
Male advantage K
K observé = 1.8

Attendus en populations finies



Donneur de Pollen

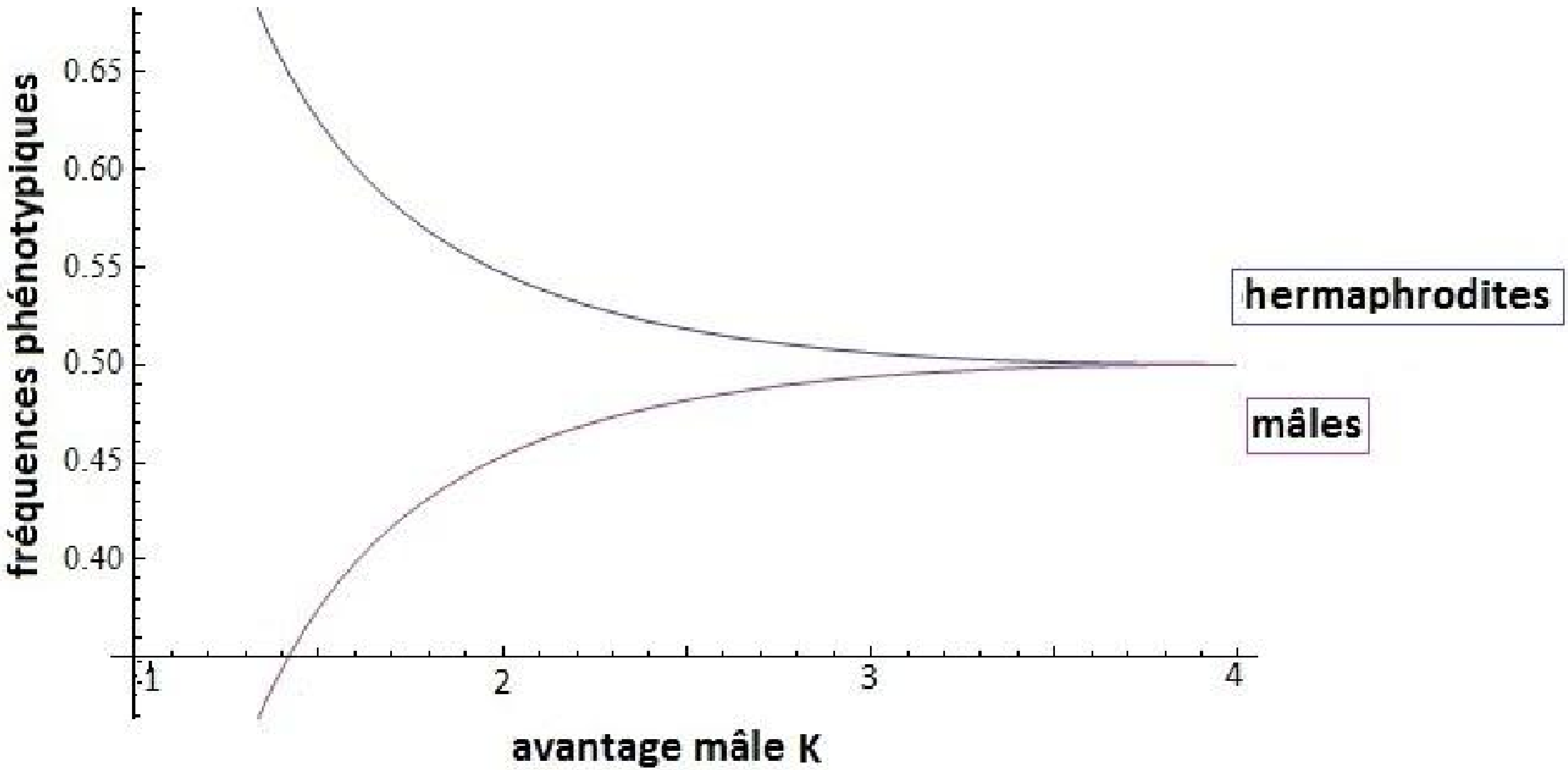
Hermaphrodite receveur

			[G2]	[G1]		[M1]		[M2]				[M3]	
			m/m S_1/S_1	m/m S2/S1		M/m S_1/S_1		M/m S_2/S_1				M/m S_2/S_2	
			1 mS_1	1/2 mS_1	1/2 mS_2	1/2 MS_1	1/2 mS_1	1/2 MS_1	1/2 MS_2	1/2 mS_1	1/2 mS_2	1/2 MS_2	1/2 mS_2
[G2]	m/m S_1/S_1	1 mS_1		1/2 m/m S_1/S_1 [G2]	1/2 m/m S_2/S_1 [G1]	1/2 M/m S_1/S_1 [M]	1/2 m/m S_1/S_1 [G2]	1/4 M/m S_1/S_1 [M]	1/4 M/m S_2/S_1 [M]	1/4 m/m S_1/S_1 [G2]	1/4 m/m S_2/S_1 [G1]	1/2 M/m S_2/S_1 [M]	1/2 m/m S_2/S_1 [G1]
						50% M : 50% G2		50% M : 25% G1 : 25% G2				50% M : 50 G1	
[G1]	m/m S_2/S_1	1/2 mS_1	1/2 m/m S_1/S_1 [G2]			1/4 M/m S_1/S_1 [M]		1/8 M/m S_1/S_1 [M]	1/8 M/m S_2/S_1 [M]			1/4 M/m S_2/S_1 [M]	
						100% M		100% M				100% M	
		1/2 mS_2	1/2 m/m S_2/S_1 [G1]			1/4 M/m S_2/S_1 [M]		1/8 M/m S_2/S_1 [M]	1/8 M/m S_2/S_2 [M]			1/4 M/m S_2/S_2 [M]	

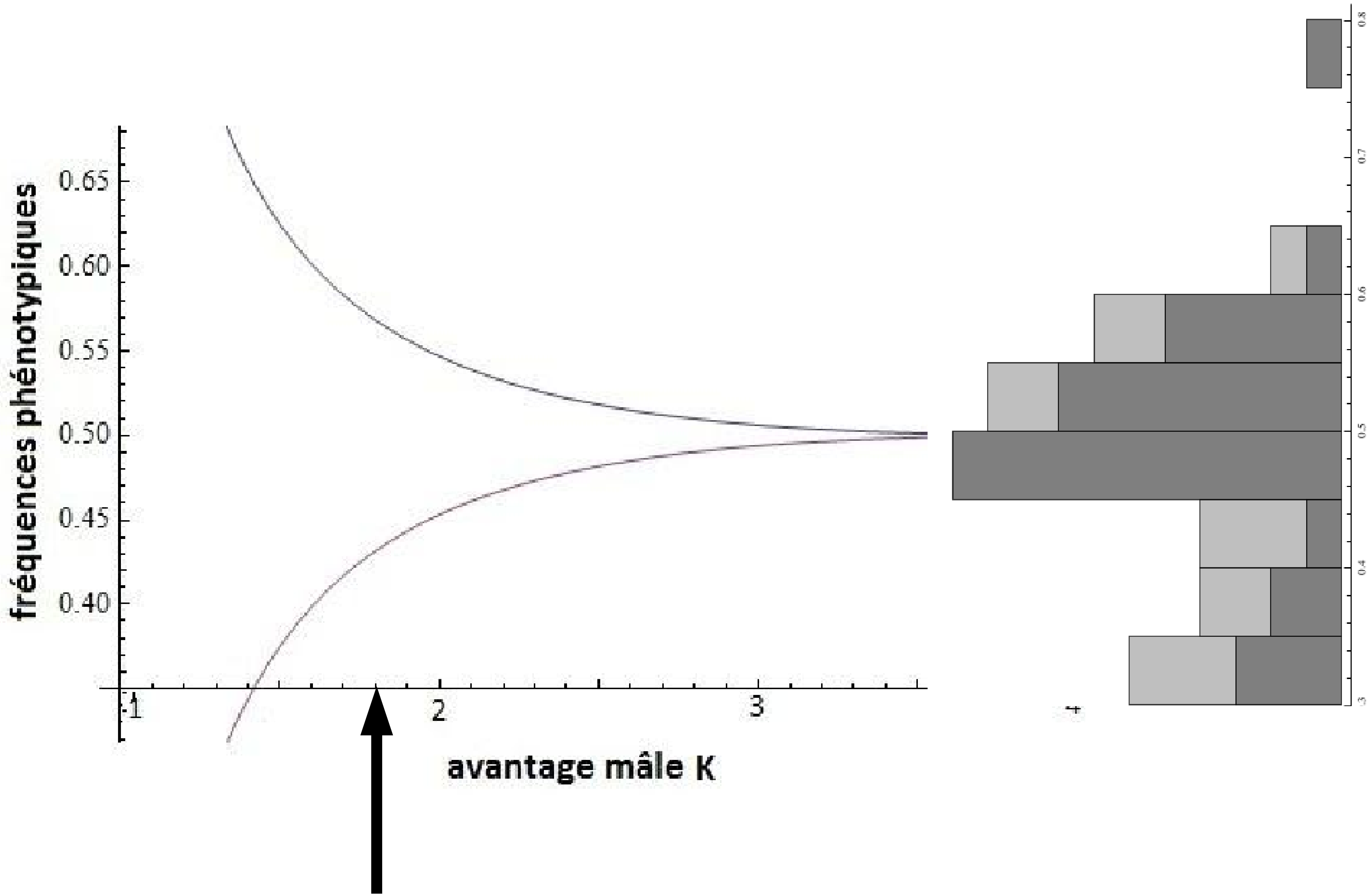
<u>Hypothèse 2</u> : 2 locus 2 allèles et distorsion

$$X + \frac{dX}{dt} = \left(\begin{array}{l} x'_1 = \frac{1}{\sigma}\left(\frac{x_1}{4}\frac{2x_2 + 2Kx_3 + Kx_4}{\theta_1} + \frac{x_2}{2}\frac{x_1}{\theta_2} \right) \\ x'_2 = \frac{1}{\sigma}\left(\frac{x_1}{4}\frac{2x_2 + Kx_4 + 2Kx_5}{\theta_1} + \frac{x_2}{2}\frac{x_1}{\theta_2} \right) \\ x'_3 = \frac{1}{\sigma}\left(\frac{x_1}{4}\frac{2Kx_3 + Kx_4}{\theta_1} + \frac{x_2}{8}\frac{2Kx_3 + Kx_4}{\theta_2} \right) \\ x'_4 = \frac{1}{\sigma}\left(\frac{x_1}{4}\frac{Kx_4 + 2Kx_5}{\theta_1} + \frac{x_2}{4}\frac{Kx_3 + Kx_4 + Kx_5}{\theta_2} \right) \\ x'_5 = \frac{1}{\sigma}\left(\frac{x_2}{8}\frac{Kx_4 + 2Kx_5}{\theta_2} \right) \end{array} \right)$$

Attendu déterministe

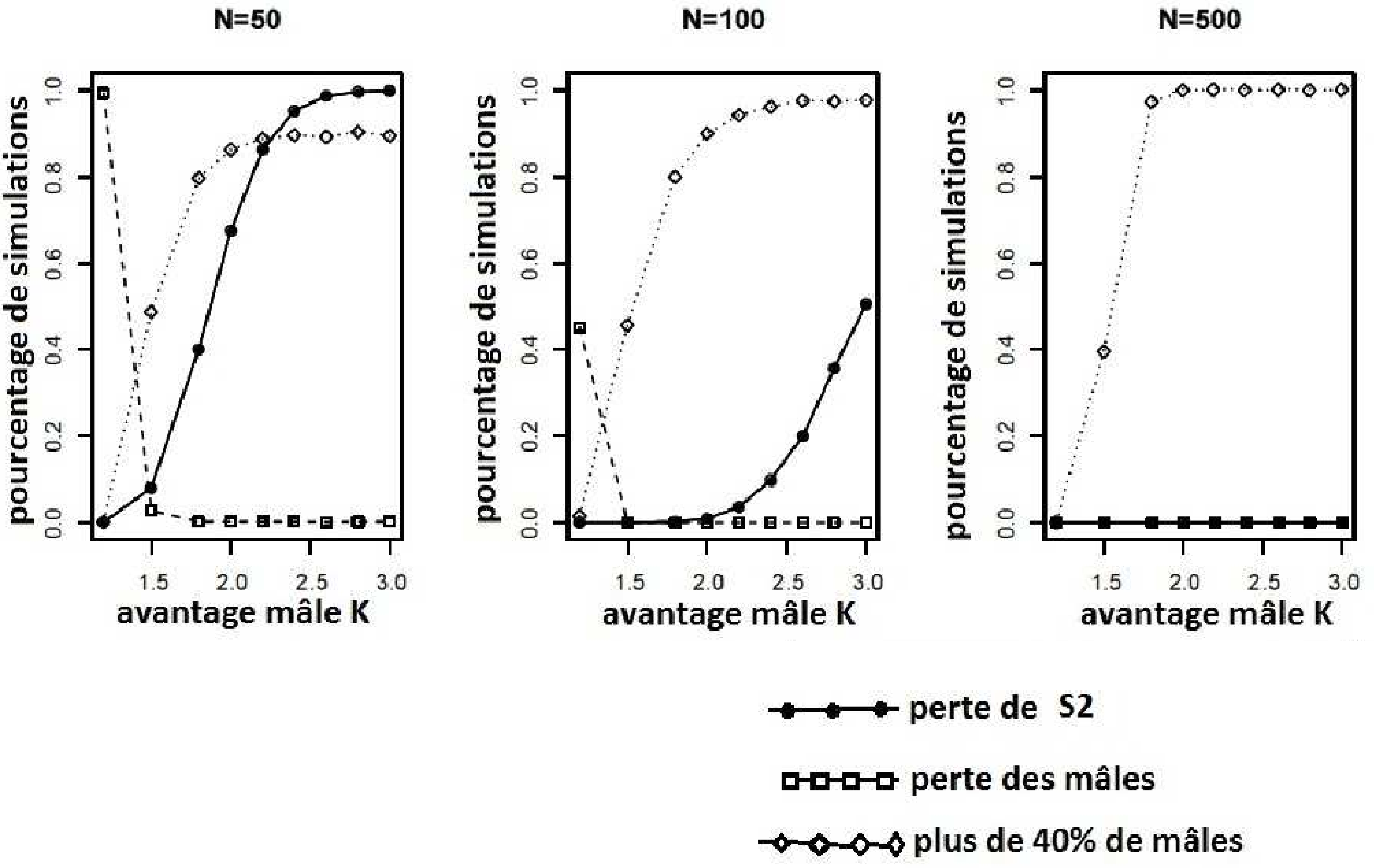


Attendu déterministe



K observé = 1.8

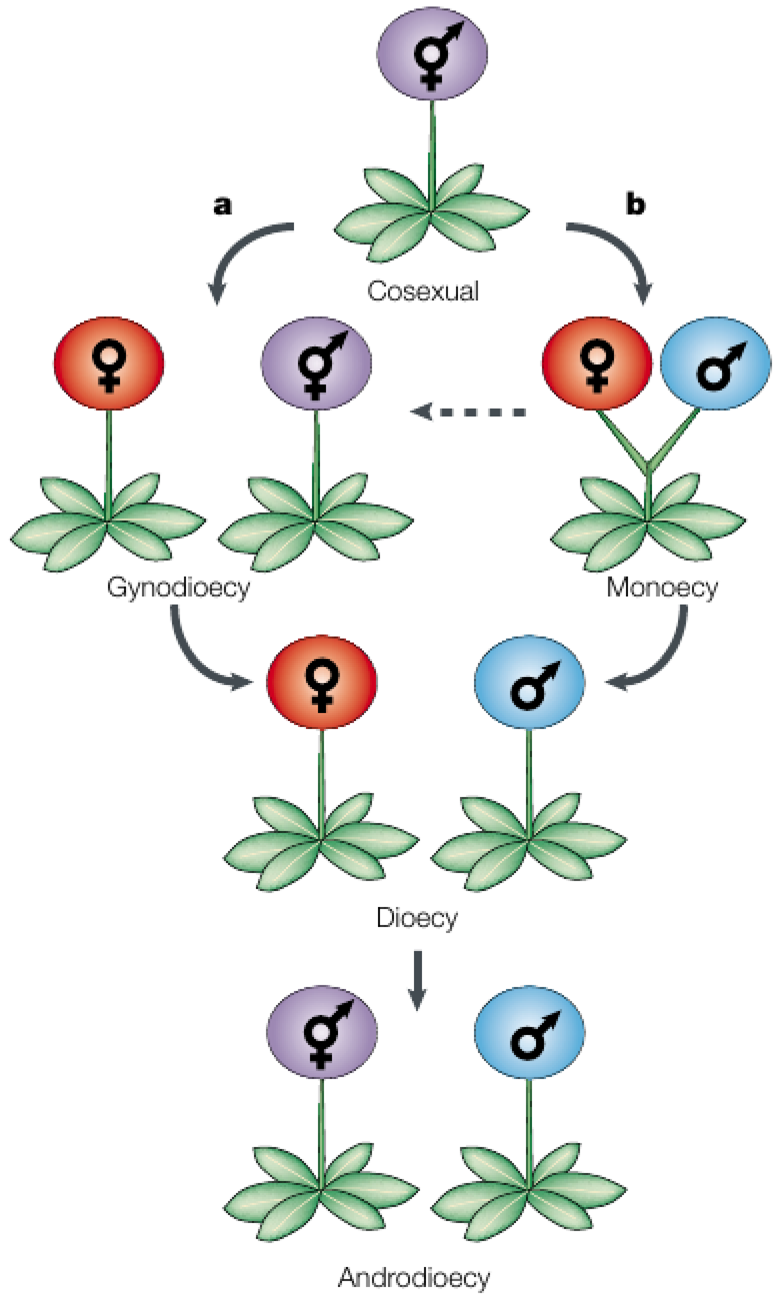
Attendus en populations finies



Paradoxes et modélisation: succès aller-retour observations / théorie

Un intérêt pratique et appliqué : l'olivier

Portée en biologie évolutive : évolution vers des sexes séparés



Barrett 2002

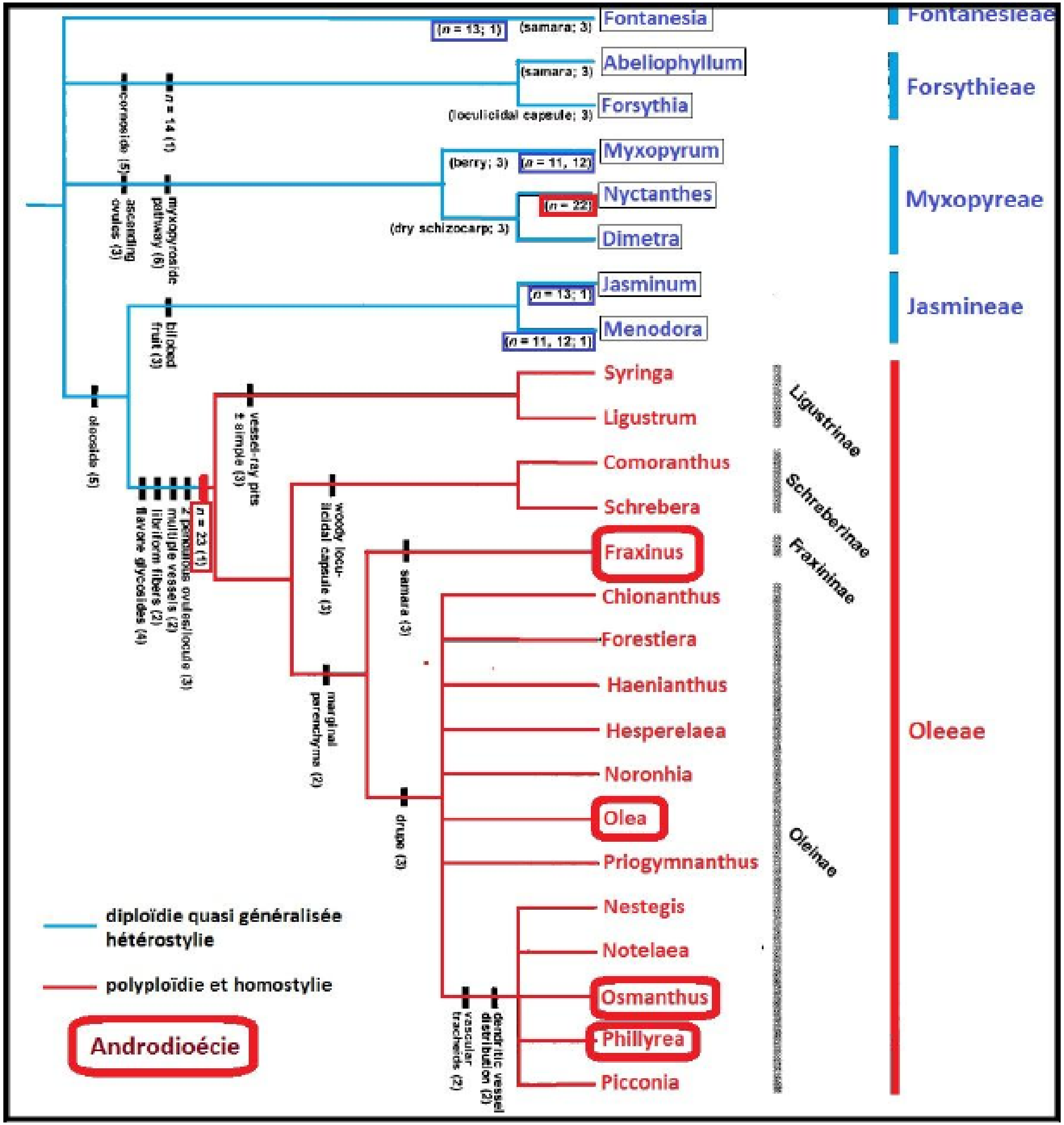


Figure 3 **Phylogénie de la famille des** ***Oleaceceae*** **(d'après Wallander and Albert 2000).**