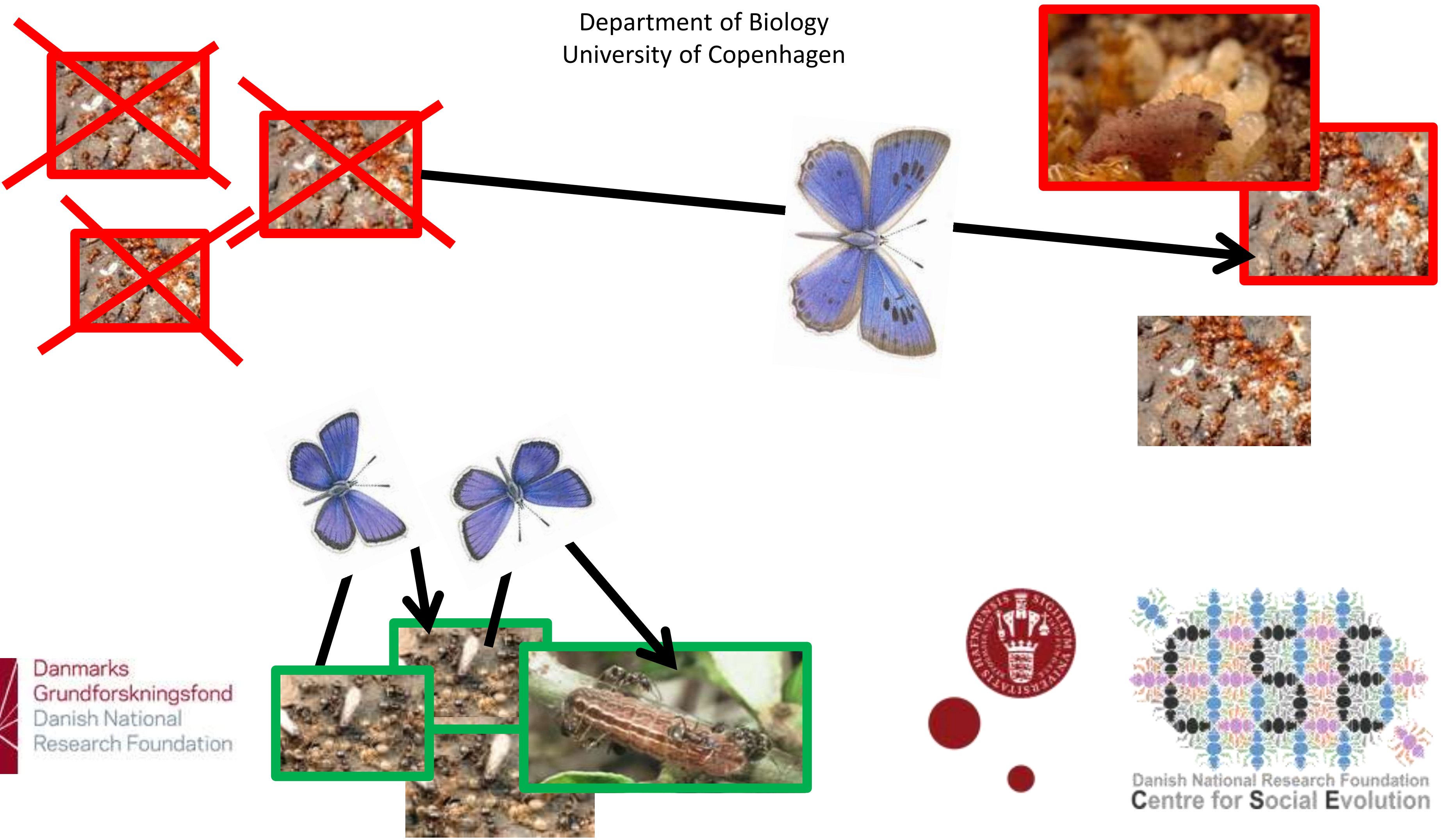
Virulence and transmission in polyommatine butterflies and ants

Schär S, Ugelvig LV, Fürst MA, Lomborg AE, Zeisset I, Nash DR
Centre for Social Evolution
Department of Biology
University of Copenhagen



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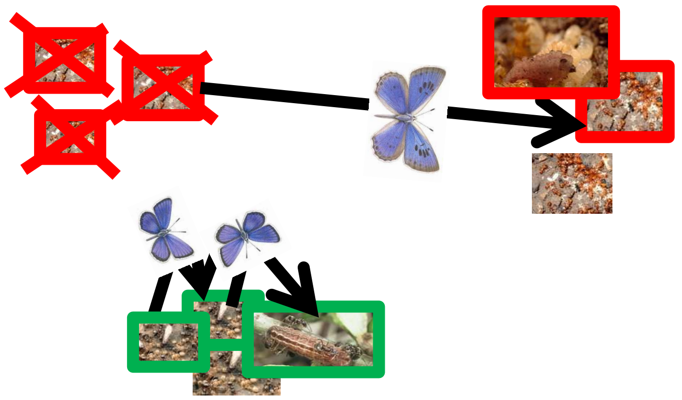
Virulence and mode of transmission

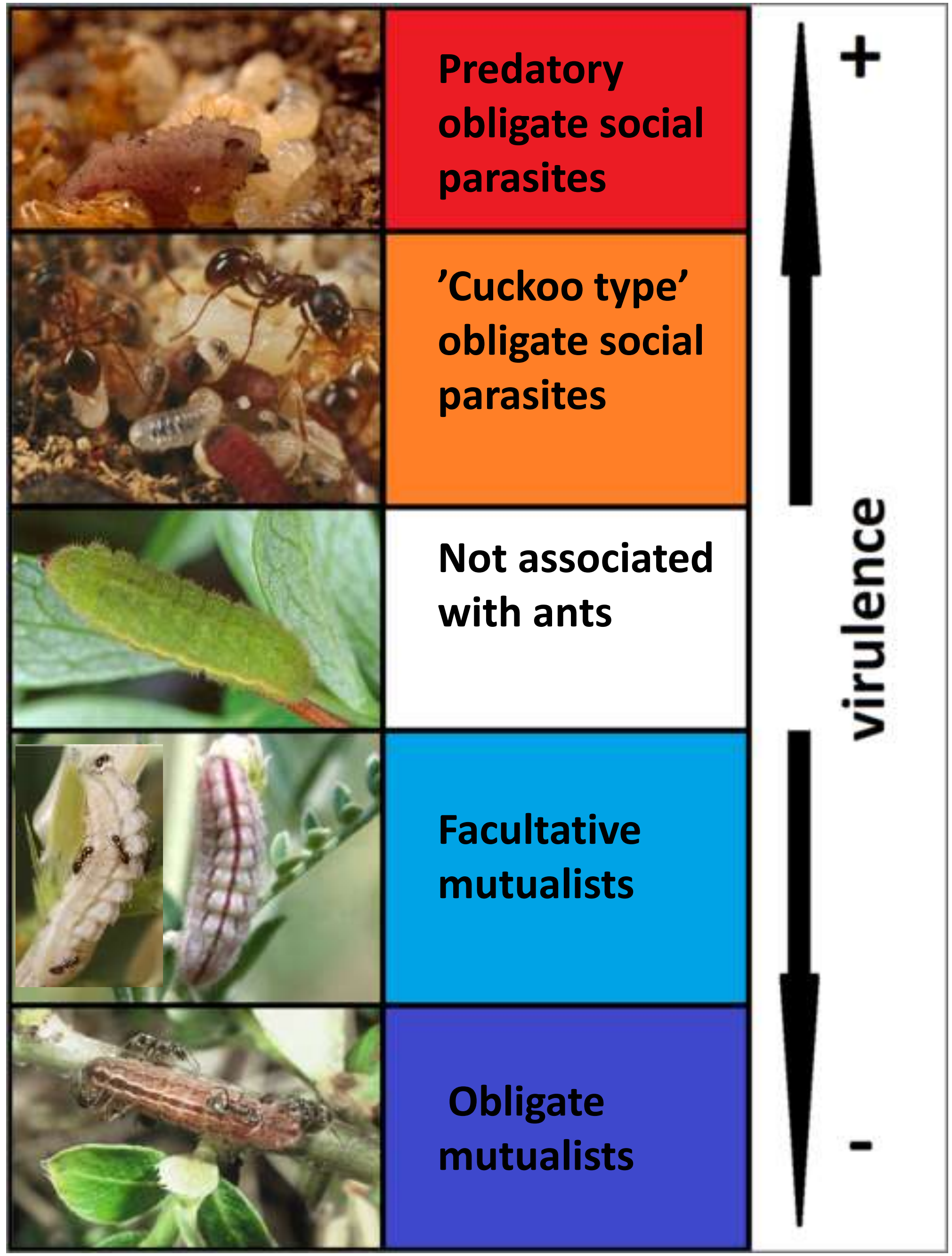
- Ewald 1987: Mode of transmission is related to severity of parasitism in microorganisms
- Vertical transmission favors evolution of mutualism. (Mutualism can be seen as negative virulence)
- High mobility of symbionts favors evolution of severe parasitism.
- Also true in butterflies and ants?
- <u>Relevance: </u>parasitic species might need larger habitats for successful conservation than mutualistic ones.



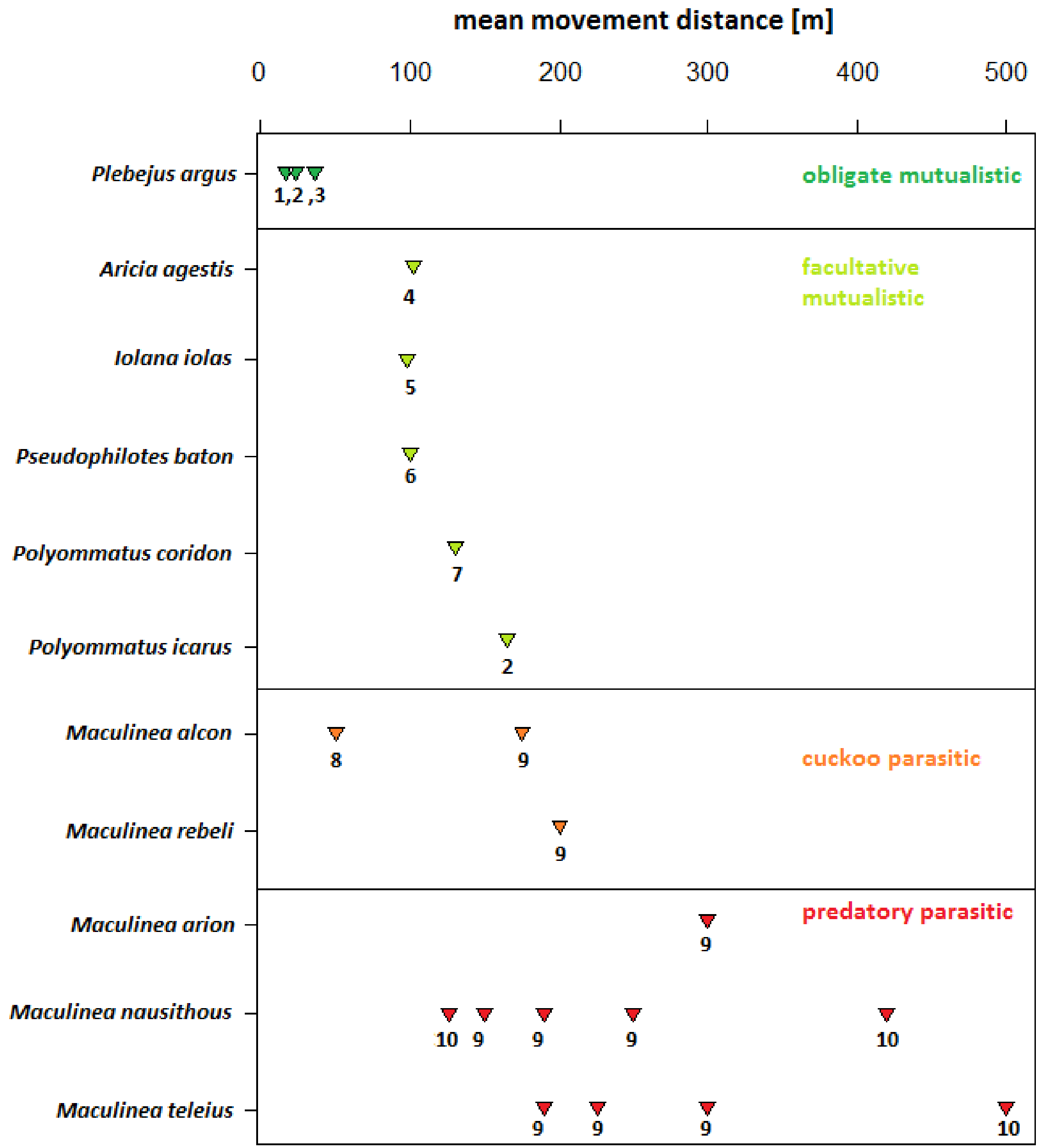
Ant associations of polyommatines

- Five different life history strategies in regards to ants
- Contiunuum between parasitsim and mutualism
- Most species are faculative mutualists, single species follow other strategies
- Transmission can be aproximised by measuring dispersal

(After Fiedler 1991, Thomas et al. 1998)



Evidence from literature? (Direct measurements of dispersal)

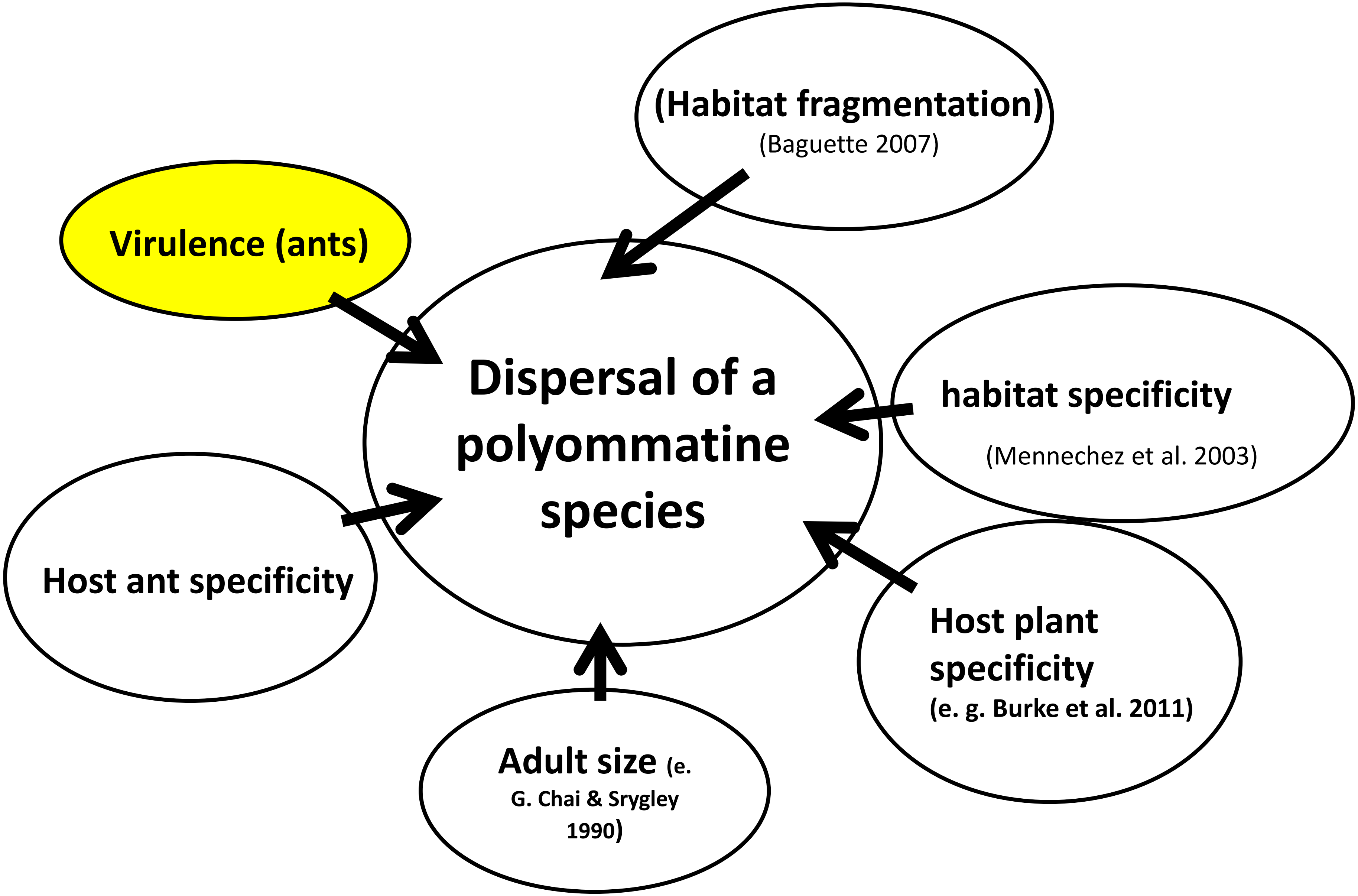


no.	study	measurement
1	Ravenscroft 1989	"mean recapture distance"
2	Gutierrez et al. 2001	"mean recapture distance"
3	Lewis et al. 1998	"mean recapture distance"
4	Bourn & Thomas 1993	"mean recapture distance"
5	Rabasa et al. 2007	"mean recapture distance"
6	Väisänen et al. 1994	"mean recapture distance"
7	Lortscher et al. 1997	"mean recapture distance"
8	Hovestadt et al. 2005	94% of observations
9	Nowicki et al. 2005	"typical intersite movements"
10	Hovestadt et al. 2005	"mean dispersal distance"

Measuring dispersal (~transmission)

Type	Method	Pro	Contra
Direct	Mark-release-recapture studies (MRR studies)	Cheap	•Underestimating long distance dispersal •Requires time and human resources
Indirect	Morphometric	Easy and cheap	No prove for dispersal
	Genetic (microsatellites)	Relatively appropriate	Expensive
	Genetic (allozymes or mitochondrial DNA)	Relatively cheap	Only moderate variability compared to microsatellites

Potential confounders

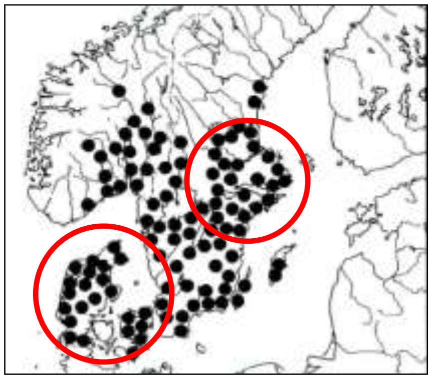


Study species

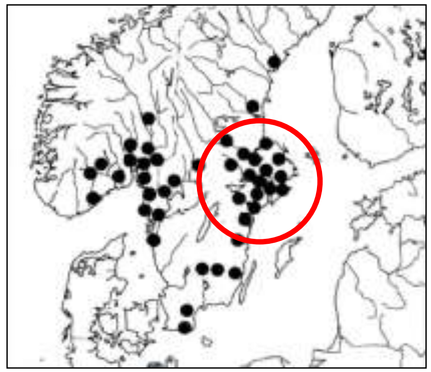
Species	Adult	Larva	Life history stragey	virulence
Maculinea arion (Linnaeus, 1758)			Predatorily parasitic	+
Maculinea alcon (Denis & Schiffermüller, 1775)			Cuckoo parasitic	
Vacciniina optilete (Knoch, 1781)			Non associated	
Agrodiaetus amandus (Schneider 1792)			Facultatively mutualistic	
Glaucopsyche alexis (Poda 1761)				
Plebejus idas (Linnaeus, 1761)			Obligatorily mutualistic	
Plebejus argus (Linnaeus, 1758)			(Fiedler 1991)	-

Species distributions and study areas

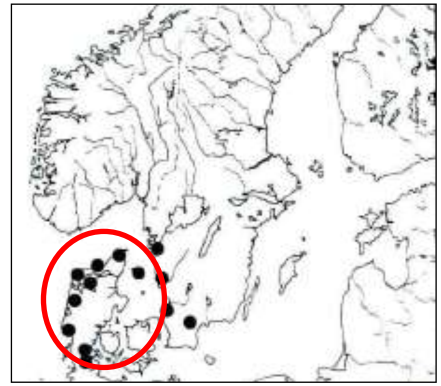
Agrodiaetus amandus



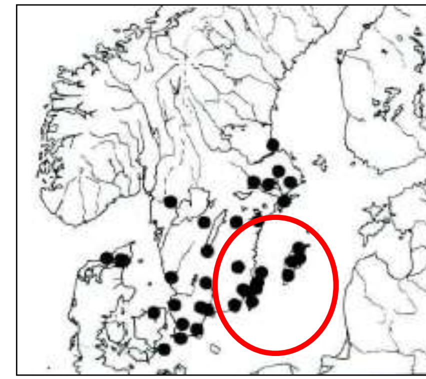
Glaucopsyche alexis



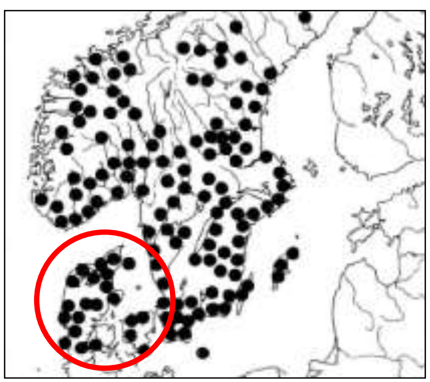
Maculinea alcon



Maculinea arion

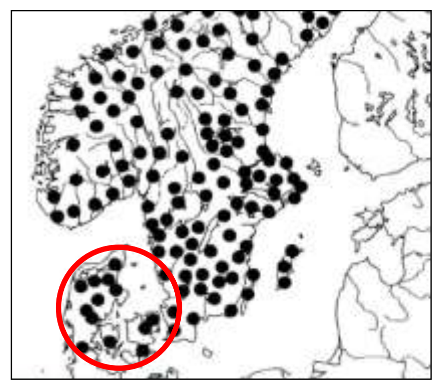


Plebejus argus



Plebejus idas

Vacciniina optilete

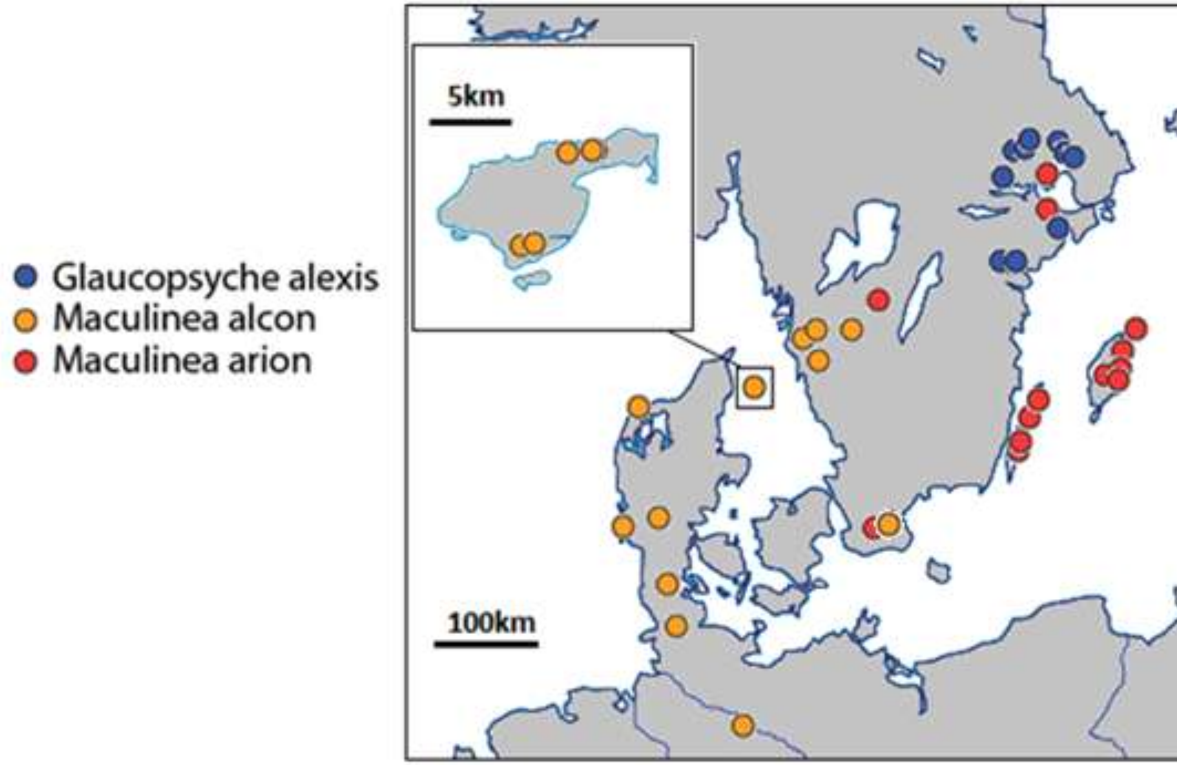


(Henriksen & Kreutzer 1982)

Screening of polyommatine microsatellite markers

Target species	Microsatellite marker	Species						
		Agrodiaetus amanda	***Glaucopsyche alexis***	***Maculinea alcon***	***Maculinea arion***	***Plebejus argus***	***Plebejus idas***	***Vacciniina optilete***
Polyommatus	Lb1/51					(X)		
(Lysandra bellargus)	Lb1/41					(X)	X	
(Harper	Lb4/18						X	
	Lb4/19						(X)	
	LbG2							
Maculinea species	Macu8			X	X			
	Macu9			X	X			
	Macu11			X	X			
	Macu15	(X)	(X)	X	X	(X)	(X)	
	Macu16			X				
	Macu17			X	X			
	Macu20			X	X			
	Macu26	(X)	X	X	(X)			
	Macu30			X				
	Macu31			X				
	Macu44	X	X	X	X		(X)	X
	Macu45		X	X	X			(X)
Maculinea arion	Macari02			(X)	X			
	Macari05			(X)	X	(X)		
	Macari07	(X)			X			
	Macari08				X			
	Macari12				X			
	Macari16				X			
	Macari18				X			
	Macari19				X			
	Macari22				X			
	Macari23				X			

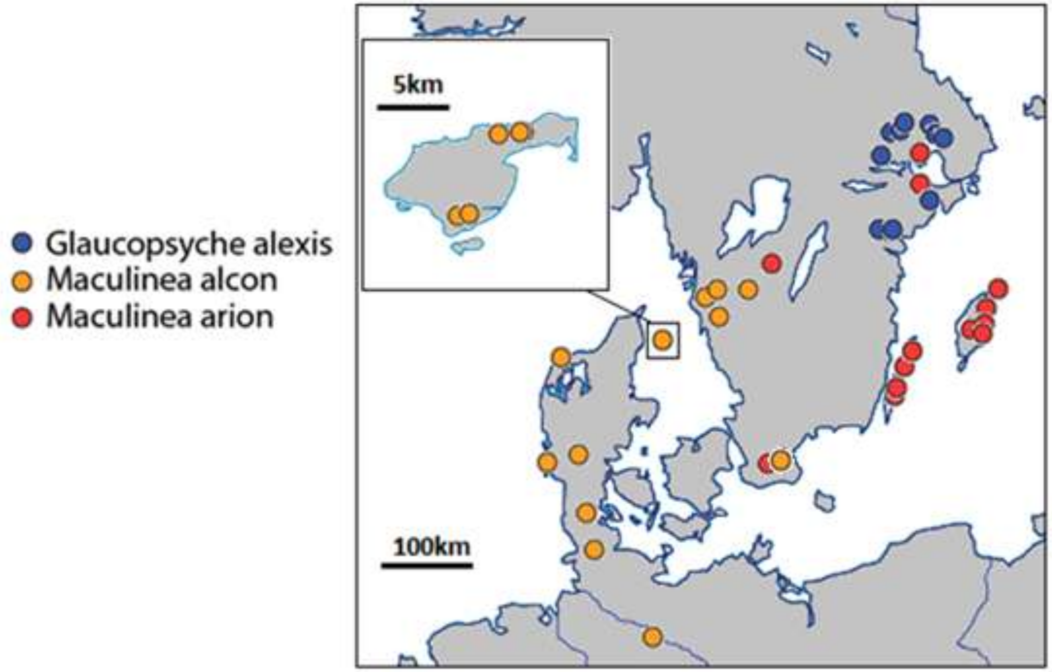
Isolation by distance on regional scale



ARLEQUIN
3.5
(Excoffier et al. 2005)
1000 permutations

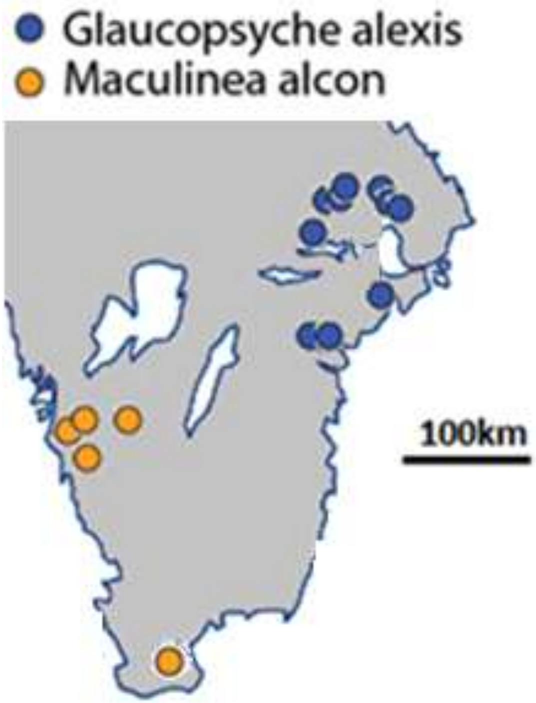
				Mantel-test (FST/(1-FST) vs (log(distance [km])			
Species	**No. of loci**	**Virulence**	**Area**	**r**	**R^2**	**P**	**References**
Maculinea arion	8	high	S-Sweden	0.04	0.01	0.123	Ugelvig et al. 2012 accepted
Maculinea alcon	4	low	S-Scandinavia	0.47	0.22	<0.001***	

Isolation by distance on landscape scale

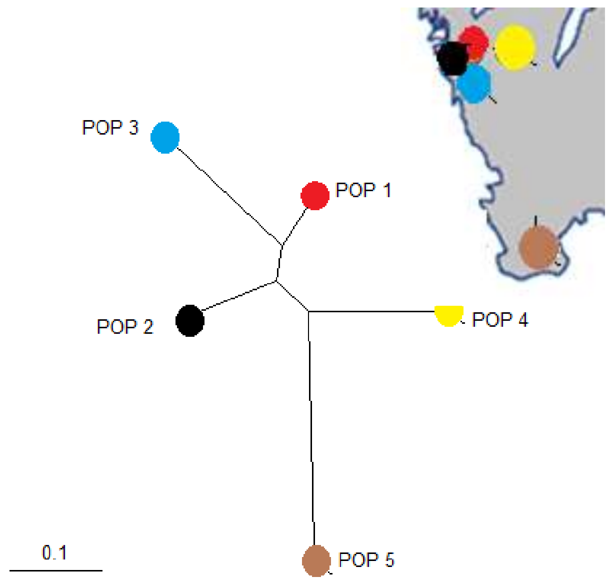


					Mantel-test (FST/(1-FST) vs (log(distance [km])			
Species	N	Virulence	No. of loci	Area	r	R^2	P	References
Maculinea arion		high	8	Gotland (S)	0.32	0.01	0.012*	Ugelvig et al. 2012 accepted
				Öland N (S)	0.66	0.03	0.001***	
				Öland S (S)	0.94	0.04	0.001***	
Maculinea alcon	784	low	4	Læsø (DK)	0.58	0.33	0.01**	
				Mainland (S)	0.18	0.03	0.3	
				Jutland (DK)	0.44	0.19	0.037*	
Glaucopsyche alexis	63	negative	3	Stockholm (S)	0.17	0.03	0.003**	

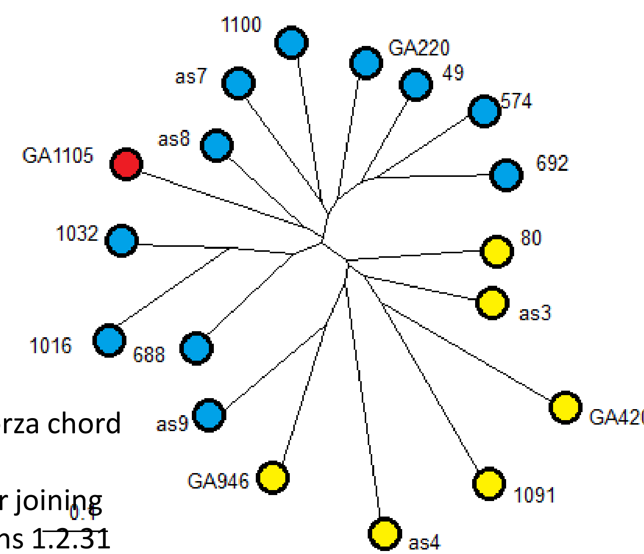
Maculine alcon & *Glaucopsyche alexis*



M. alcon



G. alexis



Cavalli Sforza chord distance
Neighbour joining
Populations 1.2.31
TreeView

Species	area	No. of clusters identified (BAPS5)	Probability
M. alcon	mainland (SE)	4	P = 1
G.alexis	mainland (SE)	4	P = 0.68

Next step:

- 454 sequencing of several polyommatine species
- Search for polymorphic microsatellites shared across genera

Reference	**species**	**No. of polymorphic markers**	**part of plate**
Abdelkrim et al. (2009)	blue duck (Hymenolaimus malacorhynchos)	13	1/16
Csencsics et al. (2010)	Dwarf Bulrush (Typha minima)	15	
Saarinen & Austin (2010)	Okaloosa darter	30	1/8

Conclusions/Discussion

- Evidence for association between virulence and dispersal in *Maculinea* butterflies
- Within species variation in isolation by distance patterns
- Selection against dispersal on islands?
- Only few cross amplifications of microsatellite markers between polyommatine genera
- New microsatellite markers are required for comparative studies across genera

Thank you!

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