UMONS
Université de Mons

The high climatic risk of European bumblebees

par Pierre **Rasmont**

25.II.2016
LLN

Some of the most common European bumblebees

Bourdon des prés
(Bombus pascuorum)

Bourdon élégant
(Bombus mesomelas)

Bourdon variable
(Bombus humilis)

Bourdon des Pyrénées
(Bombus pyrenaeus)

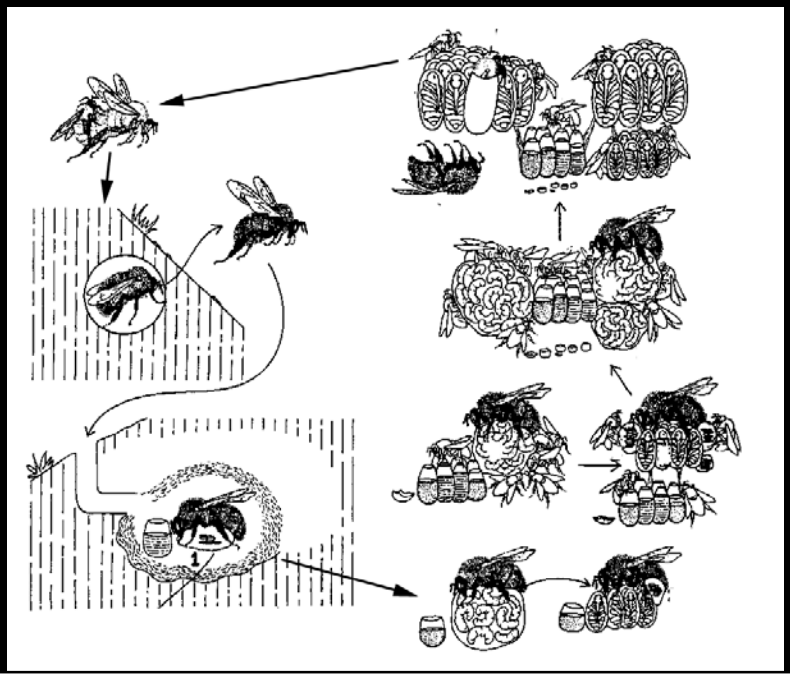
Bourdon des poubelles
(Bombus ruderatus)

Bourdon de Sichel
(Bombus sichelii)

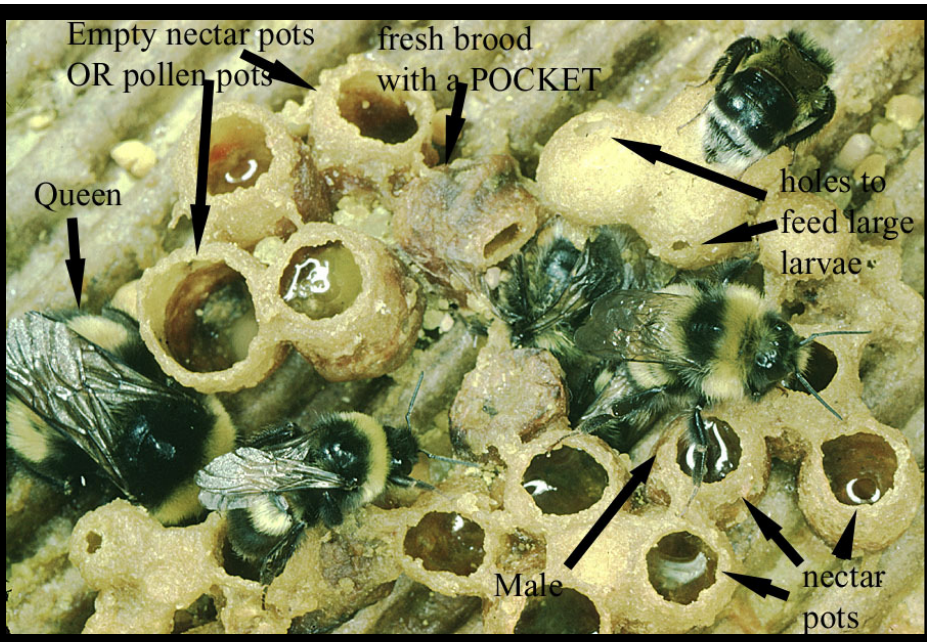
Bourdon de Brodmann
(Bombus brodmannicus)
Alpes, Caucase

Bombus sylvicola
(Alaska)

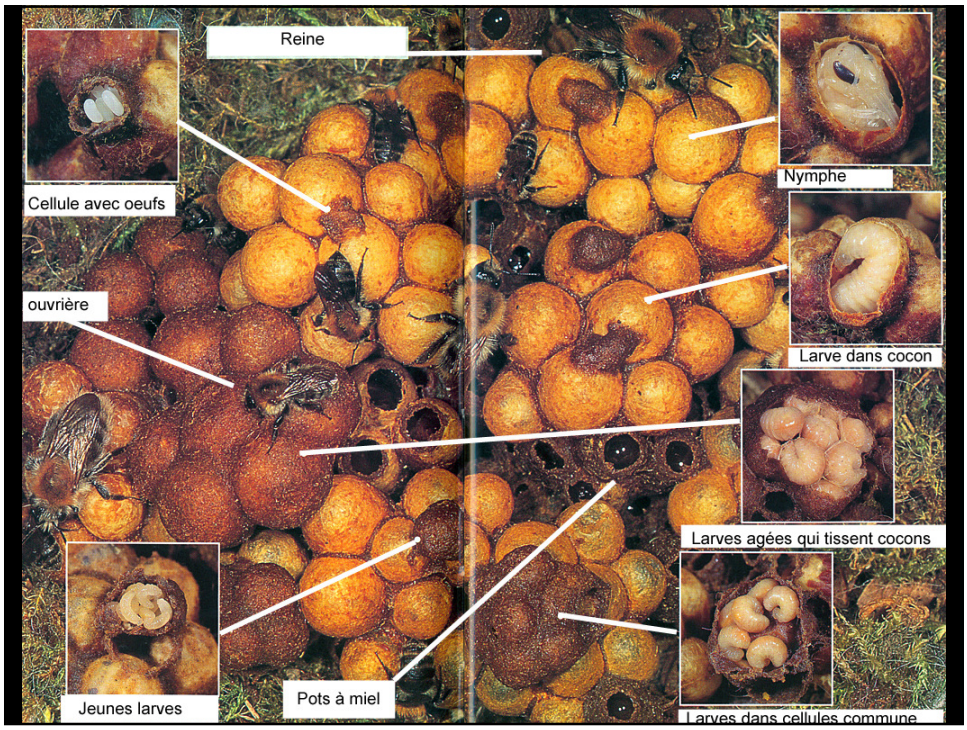
Solitary phase: August to May *Social phase: June-July*



Bombus soroeensis lectitatus **nest (Pyrénées)**

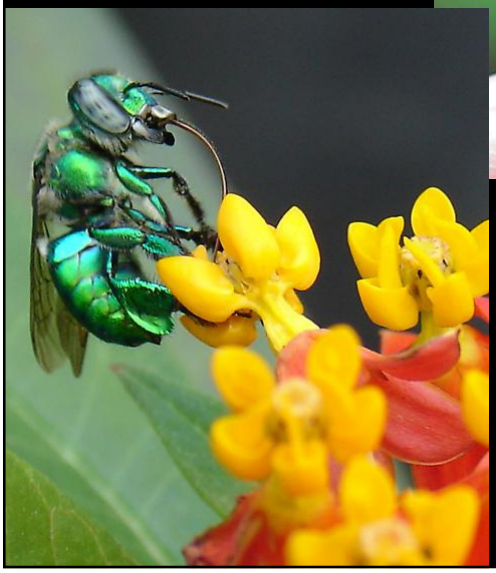


***Bombus soroeensis lectitatus* nest (Pyrénées)**



Euglossa liopoda **(Amérique du Sud)**

Exaerete azteca
(Amérique Centrale)



Euglossa viridissima
Amérique du Sud

Bumblebees are the only pollinator insects in Arctic biomes, e.g. in N. Alaska or in N. Scandinavia

***Bombus monticola rondoui* Vogt**

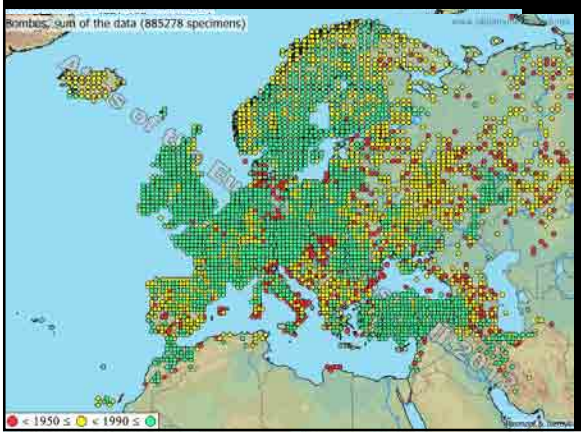
Blueberries *(Vaccinium* spp.) and roots of Arctic sainfoin *Hedysarum alpinum* are main food of grizzly bear in N. Alaska, as also in traditional life of Inuits.

Grizzly bear digging for sainfoin roots (photo PR)

2010-2015
FP7 STEP project

2011	1 391 538	data
2013	2 232 396	data
2015	**3 277 936**	**data**

Data bases contributions (all bees)



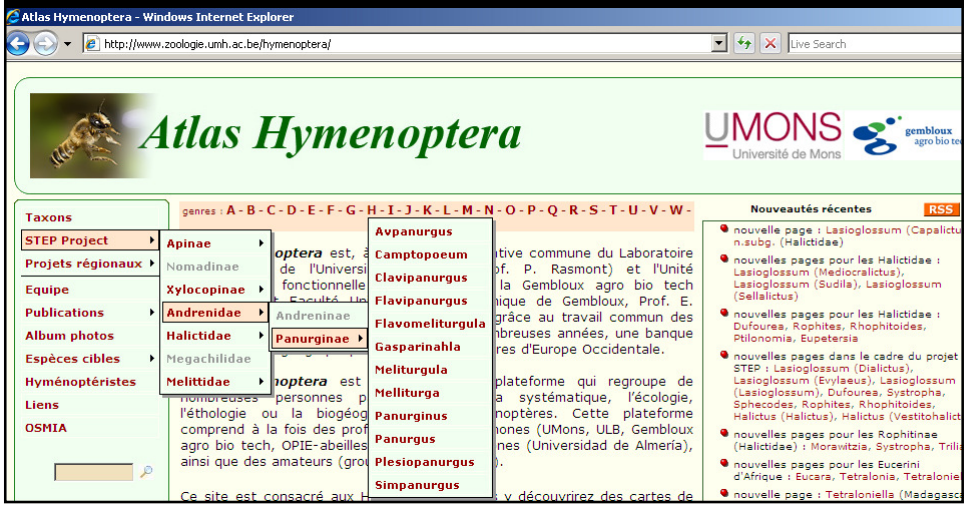
2013	all inclusive	
data_source	Nind	%
BDFGM (Belgium)	861 787	38.60
UZF (Andrena)	451 693	20.23
CSCF (Switzerland)	280 271	12.55
BWARS (UK)	164 850	7.38
NEUMAYER (Austria)	90 018	4.03
STRAKA (Czech R.)	84 086	3.77
EISN (Netherland)	76 427	3.42
SSIC (Sweden)	70 230	3.15
WID (Belgium)	47 040	2.11
PAWLIKOWSK (Poland)	27 834	1.25
NBDC (Eire)	26 239	1.18
FMNH (Finland)	9 368	0.42
G. Mahé (France)	6 860	0.31
NSIC (Norway)	3 741	0.17
L. Dvorak (Czech R.)	3 702	0.17
Baldock (Portugal)	3 690	0.17
SPM Roberts (UK)	2 957	0.13
A. Gogala (Slovenia)	2 552	0.11
A. Manino (Italy)	2 551	0.11
L. Baliteau (France)	2 444	0.11
L. Castro (Spain)	1 971	0.09
X. Lair (France)	1 748	0.08
INRA AVIGNON (France)	1 596	0.07
Gabriele (Italy)	1 169	0.05
BUWB (Germany)	1 070	0.05
S. Bailey (France)	1 015	0.05
M. Cornalba (Italy)	945	0.04
UGMD	909	0.04
J. Smit (Netherland)	845	0.04
Remaining	2 788	0.12
GRAND TOTAL	2 232 396	100

(Few contributions from Germany)

Bumblebees data

Gestionnaires (banque de données)	Pays	Données
P. Rasmont & E. Haubruge (BDFGM)	Europe	426 559
S.P.M. Roberts (BWARS)	UK	112 313
B. Cederberg (SSIC)	Suède	97 448
J. Neumayer	Autriche	90 053
M. Reemer (EISN)	Pays-Bas	76 427
F. Odegaard (NSIC)	Norvège	52 713
Y. Gonseth (CSCF)	Suisse	40 810
T. Pawlikowski	Pologne	21 734
U. FitzPatrick (NBDC)	Irlande	15 358
J. Paukkunen (FMNH)	Finlande	14 367
J. Straka & L. Dvorak	Tchéquie	9 671
J. D'Haeseler (WID)	Belgique	9 857
G. Mahé	France	9 156
A. Manino	Italie	2 551
L. Castro	Espagne	1 962
L. Baliteau	France	1 538
Autres		4 600
Total *Bombus*		**988 187**

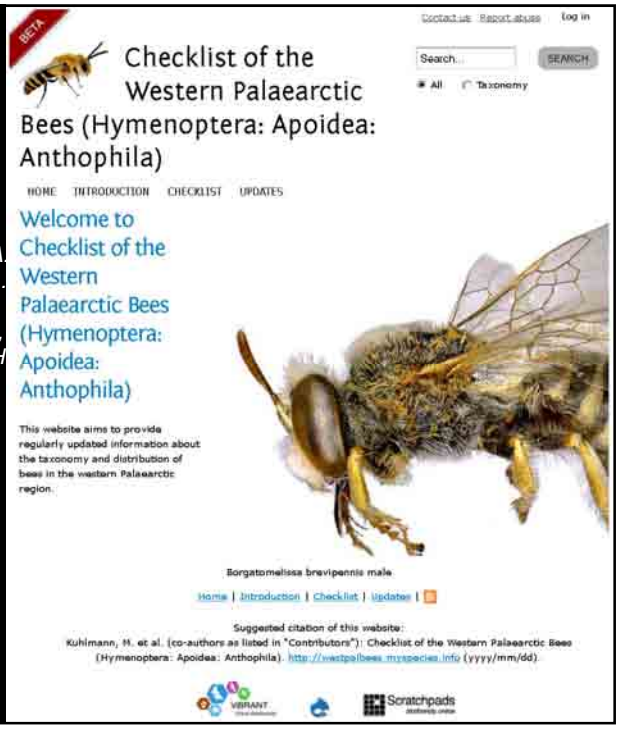
***All maps are on the website* Atlas Hymenoptera**
see *http://www.zoologie.umh.ac.be/hymenoptera*
and follow the menu ***STEP*** *(on the left)*
*or simply search for "**Atlas Hymenoptera**" on google*



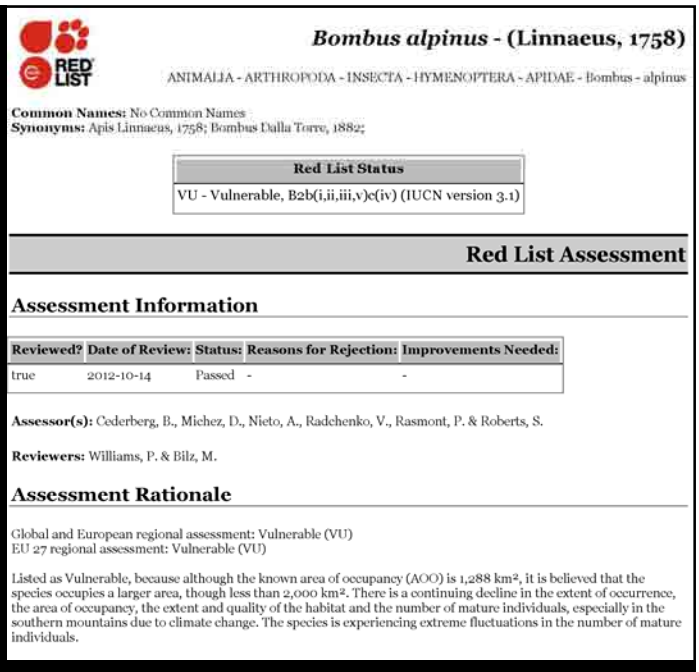
WP 1.2 Checklist of the WesternPalaearctic Bees

*Kuhlmann M., Dathe H.H., Ebmer A. Hartmann † P., **Michez D.**, Müller A. **Patiny S.**, **Pauly A.**, Praz C., **Rasmont P.**, Risch S., Scheuchl E., Schwarz M., **Terzo M.**, Williams P.H 2012. Checklist of the Western Palaearctic Bees (Hymenoptera: Apoidea: Anthophila).* http://westpalbees.myspecies.info

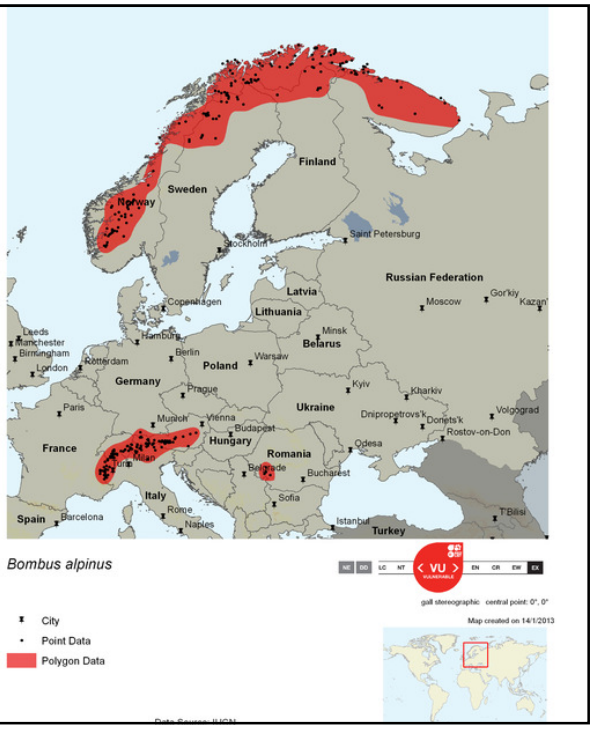
The checklist records 2000 bees species in Europe



Redlist of European bees 2015

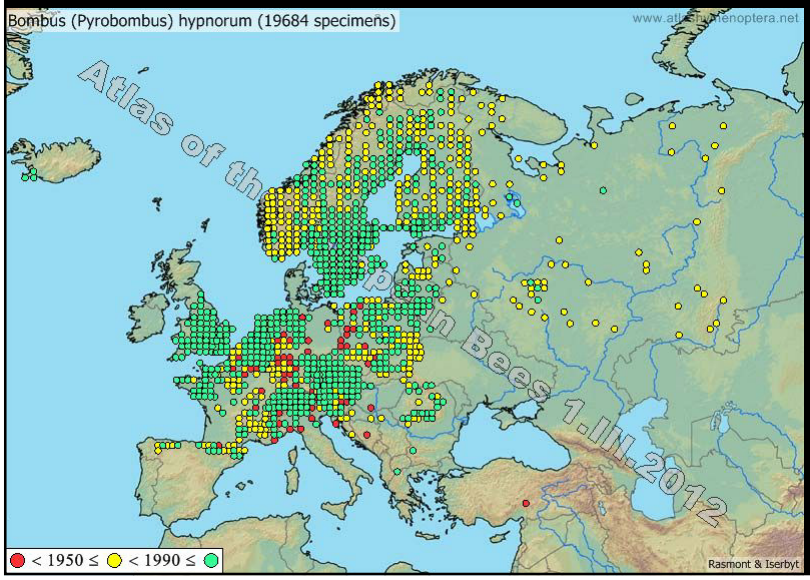


Redlist of European bees 2015



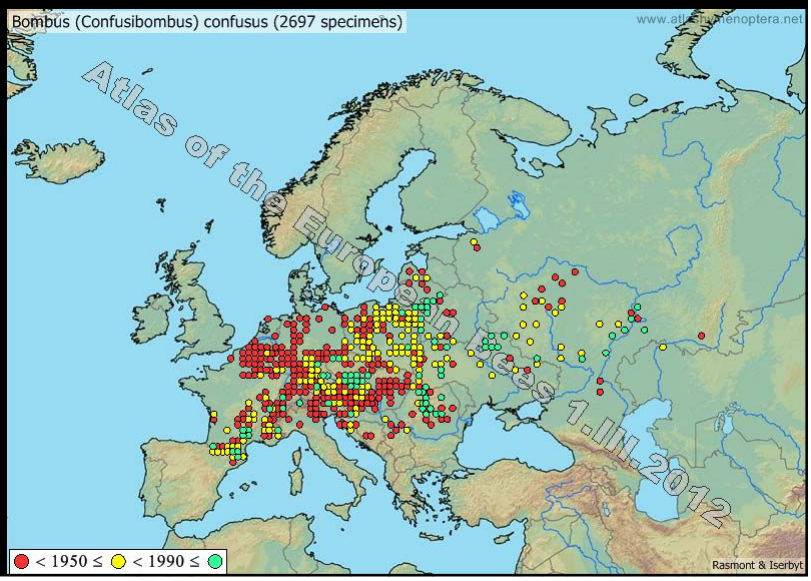
The species dynamics is more conspicuous using the 3 periods maps

This is a species LC-Least Concern "expanding"

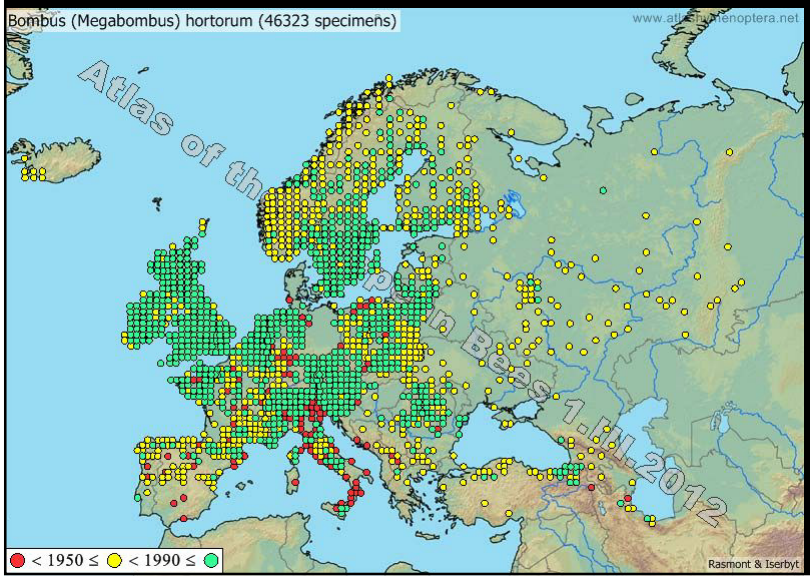


The redlist assessment is generally very conservative

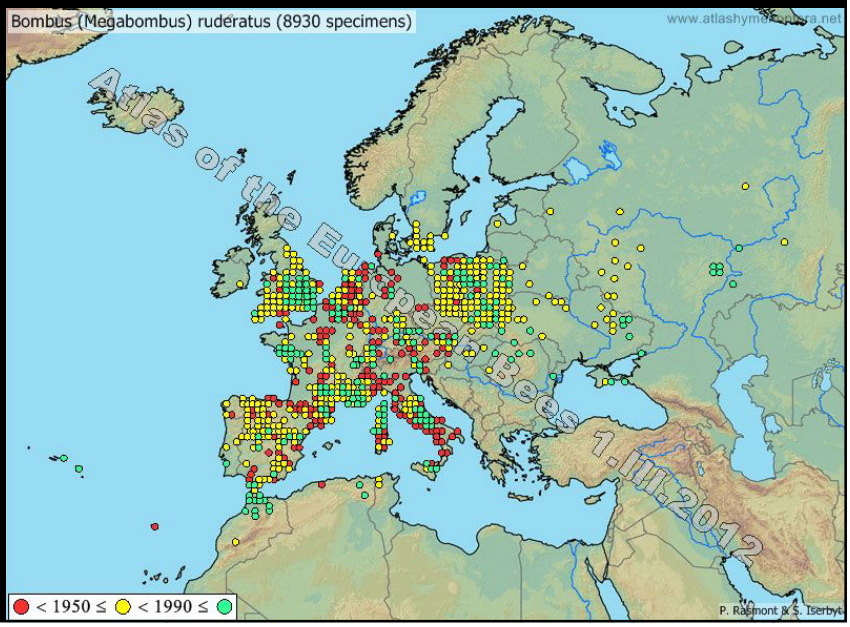
Even dramatically regressing this species is assessed as "VU - vulnerable"



This is a species in "good health" LC - Least Concern "stable"

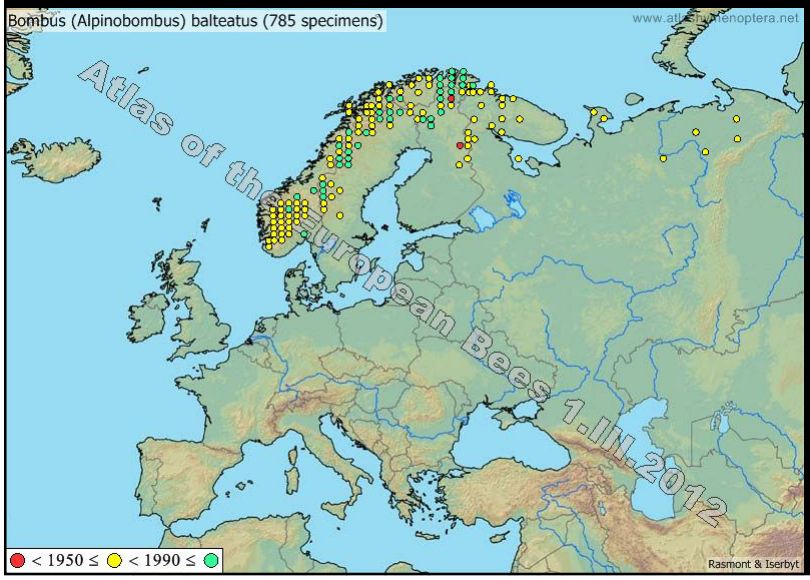


One more time, Redlist is quite conservative: This clearly regressing species is assessed as "LC - Least Concern"



With the 3 periods display, the species dynamics becomes very evident.

Even quite subtle tendences appear



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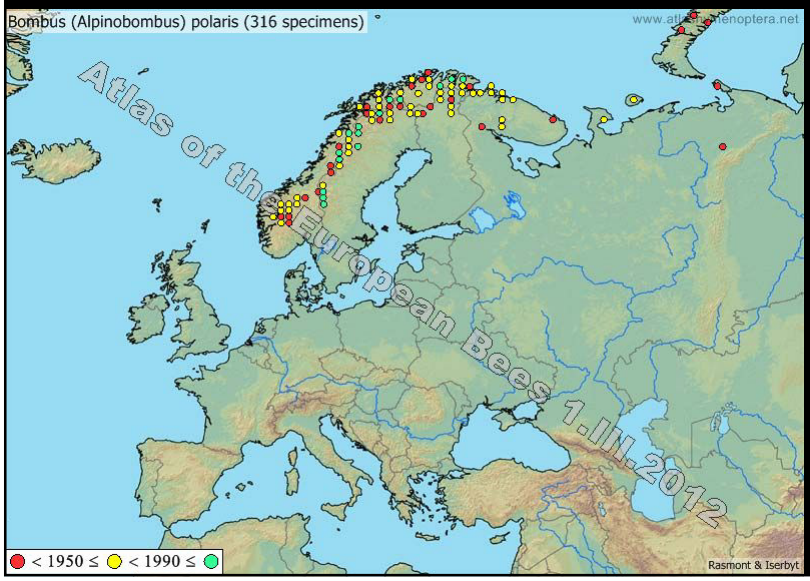
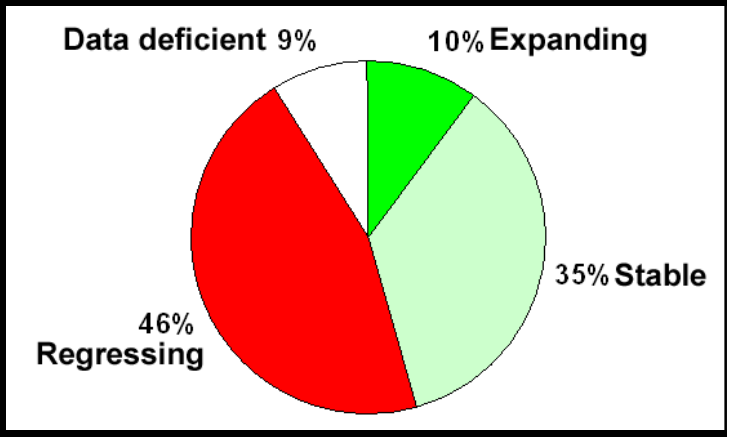


Redlist of European bees 2015

To summarize the bumblebees situation as assessed in 2015

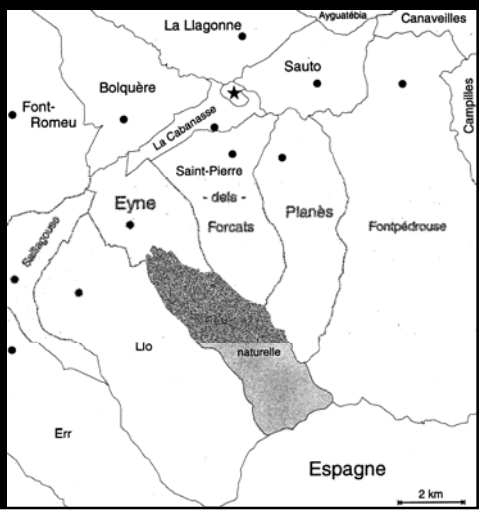
Redlist European Bombus 2015 68 species



The surprise is the main role played by climatic factors in this regression process, while we expected factors as pesticides, resources availability or landscape changes

We have now several evidence about climate impact:
- follow-up of mountain area
- heat waves impact
- modelling of climatic enveloppe in climate warming
- measures of heat-stress resistance
- meta-analysis of data from Europe and N. America
- ...

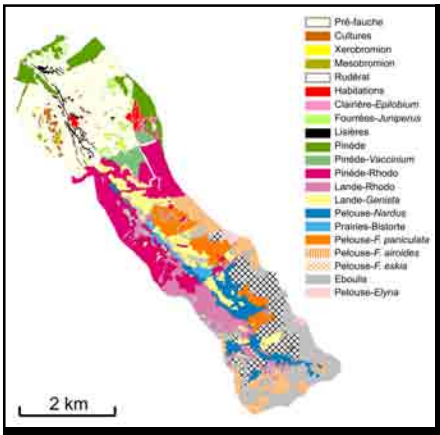
Eyne is a small town in East-Pyrenéees (France)



At first look, Eyne is a small charming village with nothing special

But it includes a Nature Reserve

And also the plateau de la Cerdagne



The Eyne 's vegetation is very diversified

The area is 20.18 km2
The altitudes are 1450-2850 m

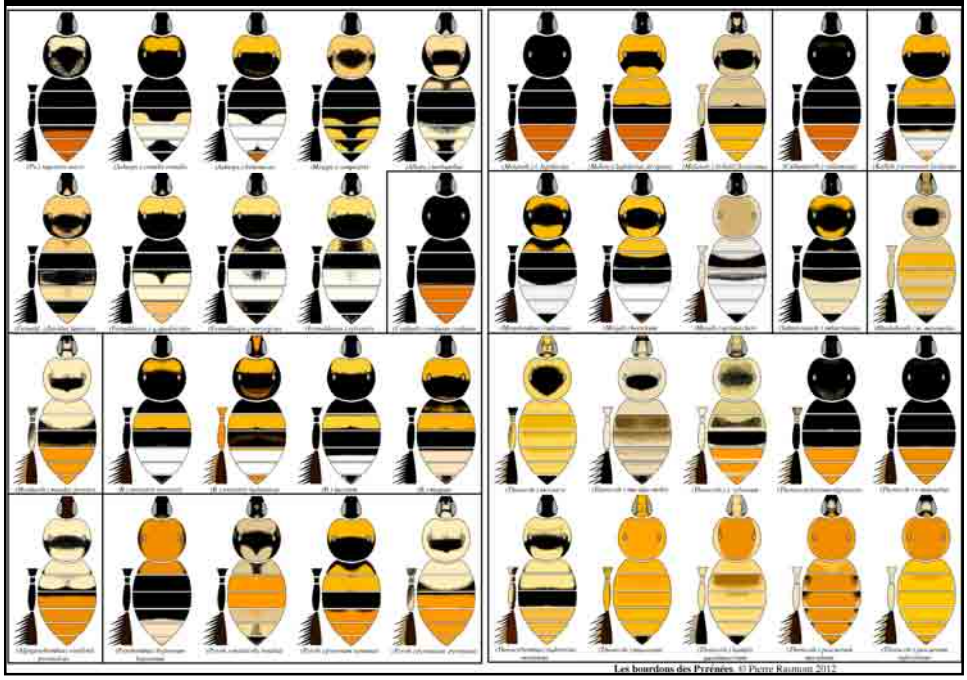
In this small area, Eyne concentrates 33 bumblebees species. It is the highest diversified bumblebee assemblage in the world.

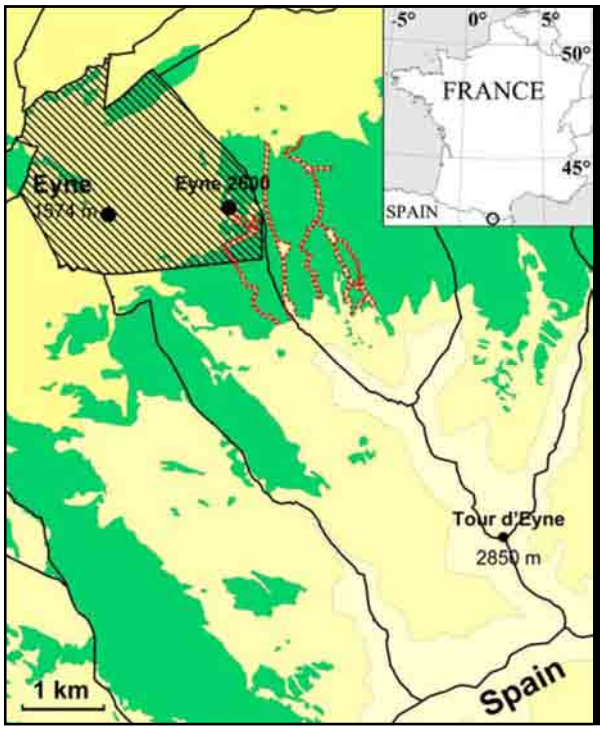
Ann. soc. entomol. Fr. (n.s.), 2008, 44 (2) : 211-241 ARTICLE

The remarkable diversity of bumblebees (Hymenoptera: Apidae: *Bombus*) in the Eyne Valley (France, Pyrénées-Orientales)

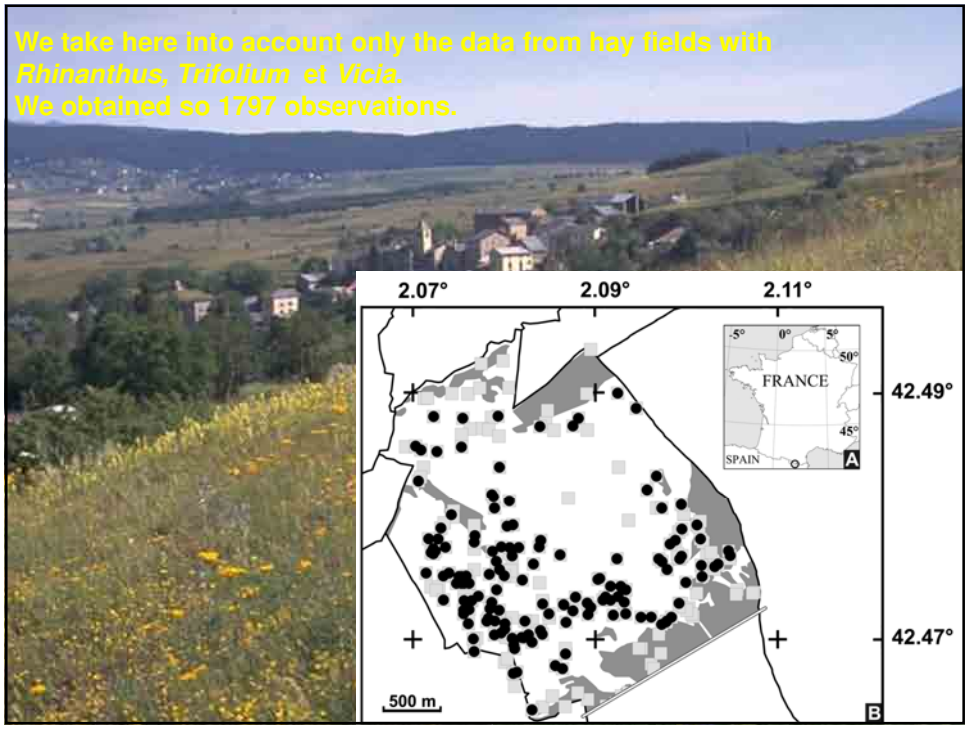
Stéphanie Iserbyt, Eve-Anne Durieux & Pierre Rasmont
Université de Mons-Hainaut, Laboratoire de Zoologie, Place du Parc 20, B-7000 Mons, Belgium

The 33 bumblebee species from Eyne





From 1999 to 2009, we sampled bumblebees in the shaded area, from July 9 to 28.



Climatic data obtained from the very near Saillagouse meteo station

Year	Precipitation (mm)		Mean of minimum temperature (°C)		Mean of maximum temperature (°C)		Mean minimum minimorum (°C)		Mean maximum maximorum (°C)		Emberger Index		Tendency	
	August - May	June - July	August - May	June - July	August - May	June - July	August - May	June - July	August - May	June - July	August - May	June - July	August - May	June - July
Aug 1998 –Jul 1999	429.8	193.0	3.0	10.8	13.5	22.9	-4.0	6.1	20.7	27.8	1346.5	765.9		Very damp
Aug 1999 - Jul 2000	468.5	115.0	3.2	10.1	14.2	22.6	-2.6	4.5	21.5	28.5	1461.2	478.5		
Aug 2000 - Jul 2001	419.5	92.5	3.7	10.7	13.9	23.9	-2.8	4.8	20.8	31.4	1284.1	384.8		Arid
Aug 2001 - Jul 2002	372.0	163.5	2.9	11.0	14.0	23.8	-2.3	4.0	21.6	30.7	1105.2	699.0		Damp
Aug 2002 - Jul 2003	485.5	144.8	3.0	12.8	12.9	25.8	-2.9	8.3	19.5	30.7	2110.7	554.2	Damp	Damp
Aug 2003 - Jul 2004	496.8	110.4	3.2	11.2	13.4	23.6	-2.3	5.0	20.7	30.3	1297.8	466.0		
Aug 2004- Jul 2005	345.1	101.2	2.8	11.6	13.8	25.1	-4.6	6.9	21.0	32.1	1162.7	366.1		Arid
Aug 2005 - Jul 2006	432.9	153.0	3.0	12.2	13.6	26.3	-3.4	5.8	20.6	30.2	1601.3	481.7		
Aug 2006 - Jul 2007	368.9	34.5	4.0	10.8	14.9	24.0	-1.5	4.8	21.8	29.1	1425.5	121.1		Very dry
Aug 2007 - Jul 2008	467.1	84.3	3.1	10.3	14.3	23.2	-3.1	3.9	21.6	29.9	1615.6	300.8		Arid
Aug 2008 - Jul 2009	387.8	101.4	2.8	11.3	13.5	24.8	-3.6	5.8	21.4	30.9	1166.1	328.0		Arid

	Rainfall (mm)		Mean minimum T° (°C)		Mean maximum T° (°C)		Mean minima minimorum (°C)		Mean maxima maximorum (°C)		Emberger index	
	August - May	June - July	August - May	June - July	August - May	June - July	August - May	June - July	August - May	June - July	August - May	June - July
B. ruderarius **(n=361)**												
B. subterraneus **(n=98)**												
B. terrestris **(n=47)**												
B. monticola **(n=29)**												
B. lucorum **(n=406)**		+0.70						+0.67		-0.68		+0.65
B. hortorum **(n=62)**											+0.68	
B. pyrenaeus **(n=40)**							-0.62					
B. humilis **(n=217)**										+0.68		
B. soroeensis **(n=162)**	-0.69			+0.62		+0.65						
B. sylvarum **(n=160)**		**-0.77**										**-0.81**
B. mesomelas **(n=74)**		**-0.77**	**+0.91**		**+0.87**		**+0.75**					-0.69
B. pascuorum **(n=46)**				-0.64	+0.68							
B. lapidarius **(n=27)**							**+0.86**		**-0.86**			
Ratio NB / SS		+0.63		+0.63				+0.68			**+0.78**	
Species number												

The abundance of four species is no correlated with any climatic parameter. ***That means that the abundance of the remaining 9/13 species is more or less correlated with at least one climatic parameter.***

	Rainfall (mm)		Mean minimum T° (°C)		Mean maximum T° (°C)		Mean minima minimorum (°C)		Mean maxima maximorum (°C)		Emberger index	
	August - May	June - July	August - May	June - July	August - May	June - July	August - May	June - July	August - May	June - July	August - May	June - July
B. ruderarius **(n=361)**												
B. subterraneus **(n=98)**												
B. terrestris **(n=47)**												
B. monticola **(n=29)**												
B. lucorum **(n=406)**		+0.70						+0.67		-0.68		+0.65
B. hortorum **(n=62)**											+0.68	
B. pyrenaeus **(n=40)**							-0.62					
B. humilis **(n=217)**										+0.68		
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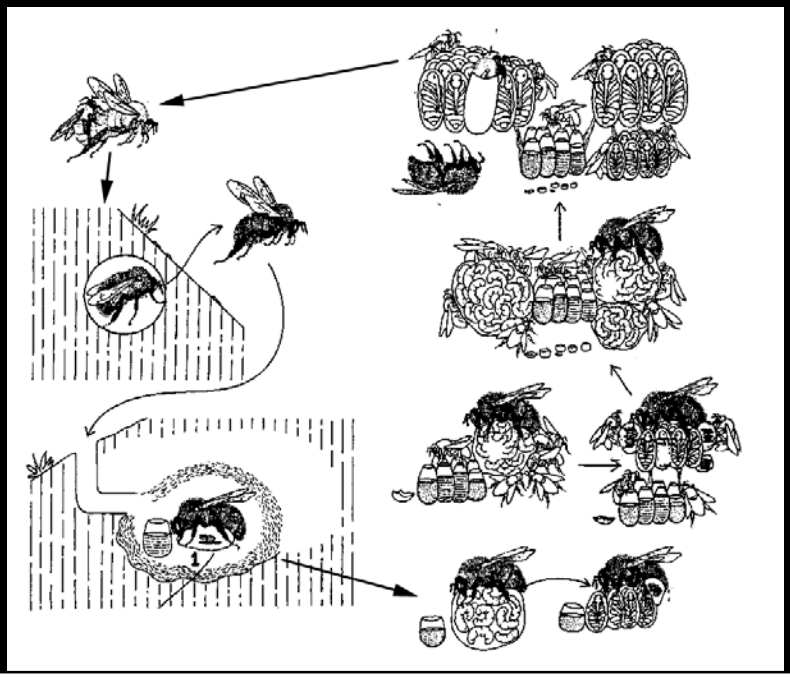
B. pascuorum **(n=46)**				-0.64	+0.68							
B. lapidarius **(n=27)**							**+0.86**		**-0.86**			
Ratio NB / SS		+0.63		+0.63				+0.68			**+0.78**	
Species number												

The abundance of 3 species and the number of bumblebees per sampled station are correlated with cold or wet conditions.
The abundance of 6 species is correlated with hot or dry situations.

Solitary phase: August-May **Social phase: June-July**



	Rainfall (mm)		Mean minimum T° (°C)		Mean maximum T° (°C)		Mean minima minimorum (°C)		Mean maxima maximorum (°C)		Emberger index	
	August - May	June - July	August - May	June - July	August - May	June - July	August - May	June - July	August - May	June - July	August - May	June - July
B. ruderarius (n=361)												
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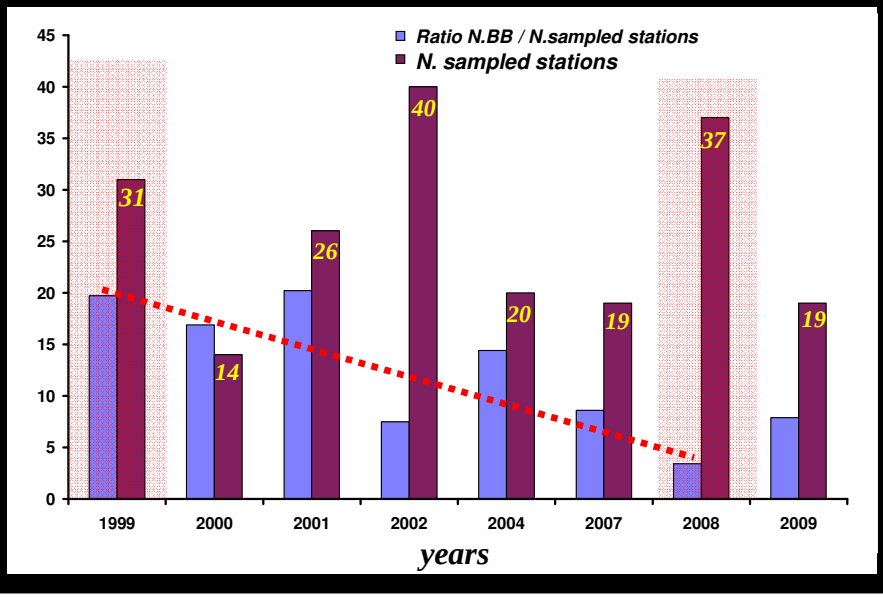
B. mesomelas (n=74)		-0.77	+0.91		+0.87		+0.75					-0.69
B. pascuorum (n=46)				-0.64	+0.68							
B. lapidarius (n=27)							+0.86		-0.86			
Ratio NB / SS		+0.63		+0.63				+0.68			+0.78	
Species number												

There are approximately the same number of correlations comparing the solitary phase (9) and the social phase (12) of the species.

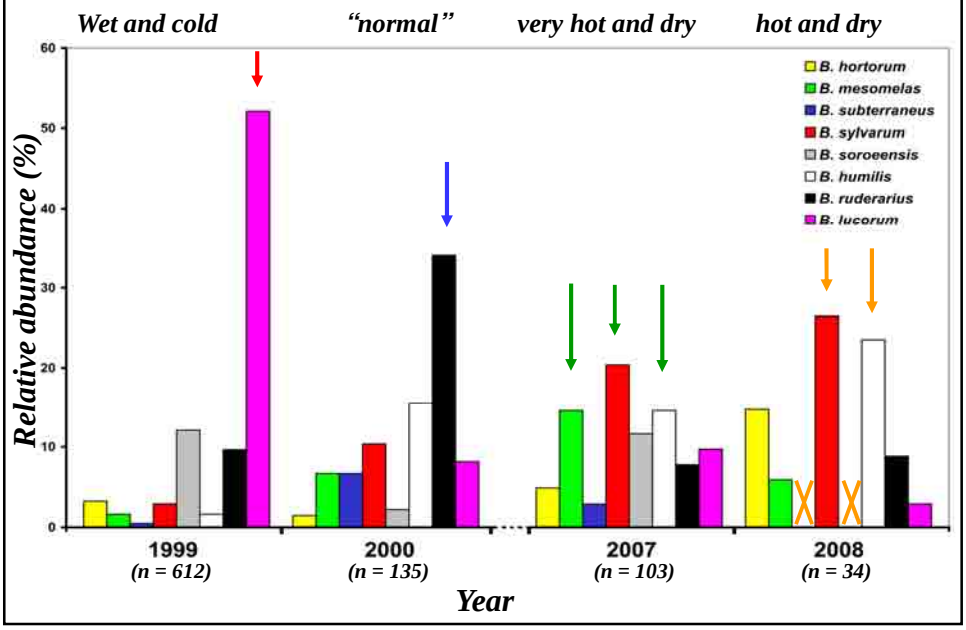
Some species, like ***Bombus confusus***, have been observed only a few times during the hotest years

This species was only present during the coldest and the most humid year, in 1999.

Global abundance of the bumblebees



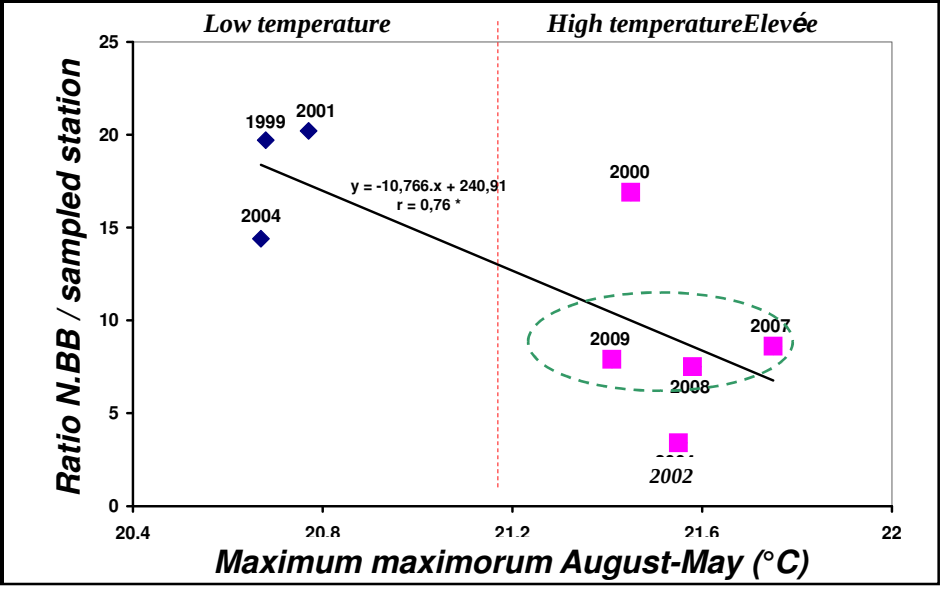
Yearly variations of the relative abundance



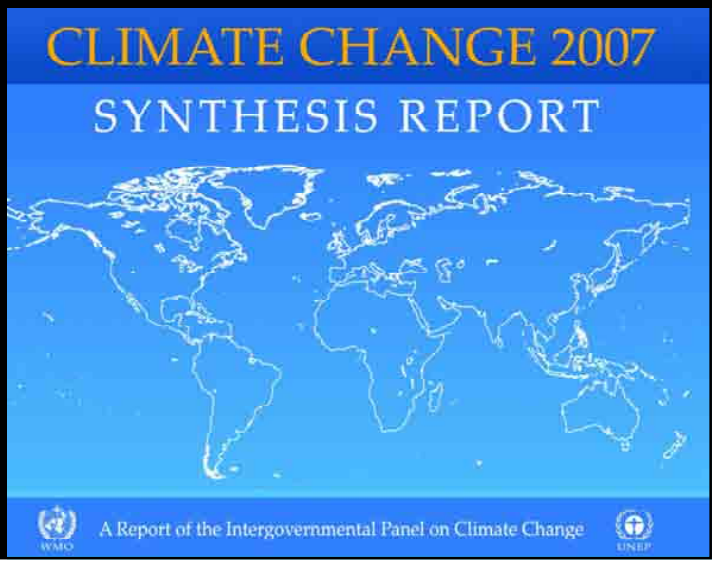
1999 : a cold and wet year, with a high abundance of bumblebees.

2005 : a hot and dry year, with a very low abundance of bumblebees.

Correlation of the absolute abundance with the maximum maximorum during the solitary phase



IPCC estimation for the 20°century : +0.74°C (1906-2005)
Air cooling with altitude = 5°C to 9°C / 1000m
The altitude shift during this period would have been +75 to +1



Impacts of climate warming and habitat loss on extinctions at species' low-latitude range boundaries

ALDINA M. A. FRANCO[1], JANE K. HILL[1], CLAUDIA KITSCHKE[1], YVONNE C. COLLINGHAM[2], DAVID B. ROY[3], RICHARD FOX[4], BRIAN HUNTLEY[2], CHRIS D. THOMAS[1]

Article first published online: 19 MAY 2006
DOI: 10.1111/j.1365-2486.2006.01180.x

Issue

Global Change Biology
Volume 12, Issue 8, pages 1545–1553, August 2006

Since 1970, for Erebia epiphron, in Britain, Franco et al. 2006 observed an uphill shift of +150m. That is at least 3 times more than the IPCC indication.

Wilson et al. 2005 observed an isothermic shift uphill of +225 m froçm 1967 to 2004 for 16 butterfly of the Sierra de Guadarrama

ECOLOGY LETTERS

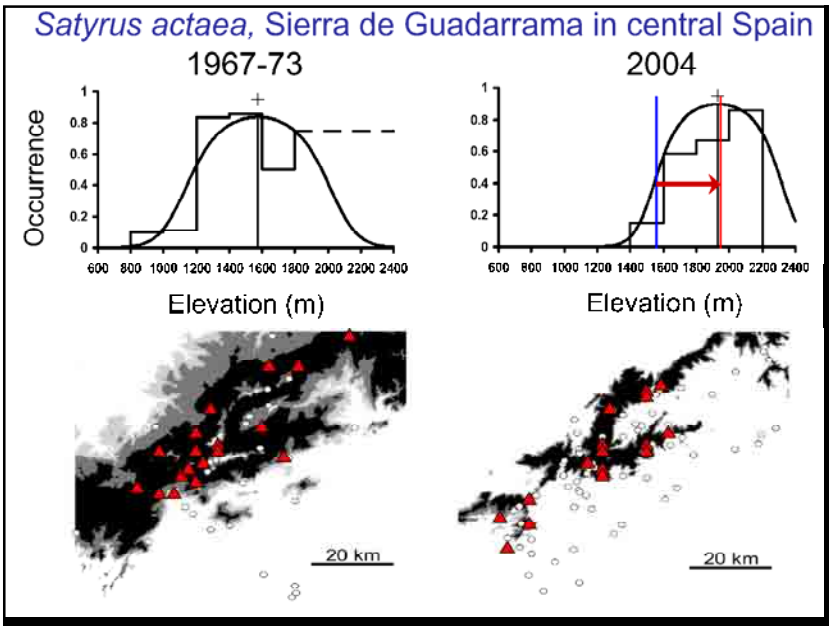
Changes to the elevational limits and extent of species ranges associated with climate change

Robert J. Wilson[1,*], David Gutiérrez[1], Javier Gutiérrez[1], David Martínez[1], Rosa Agudo[1], Víctor J. Monserrat[2]

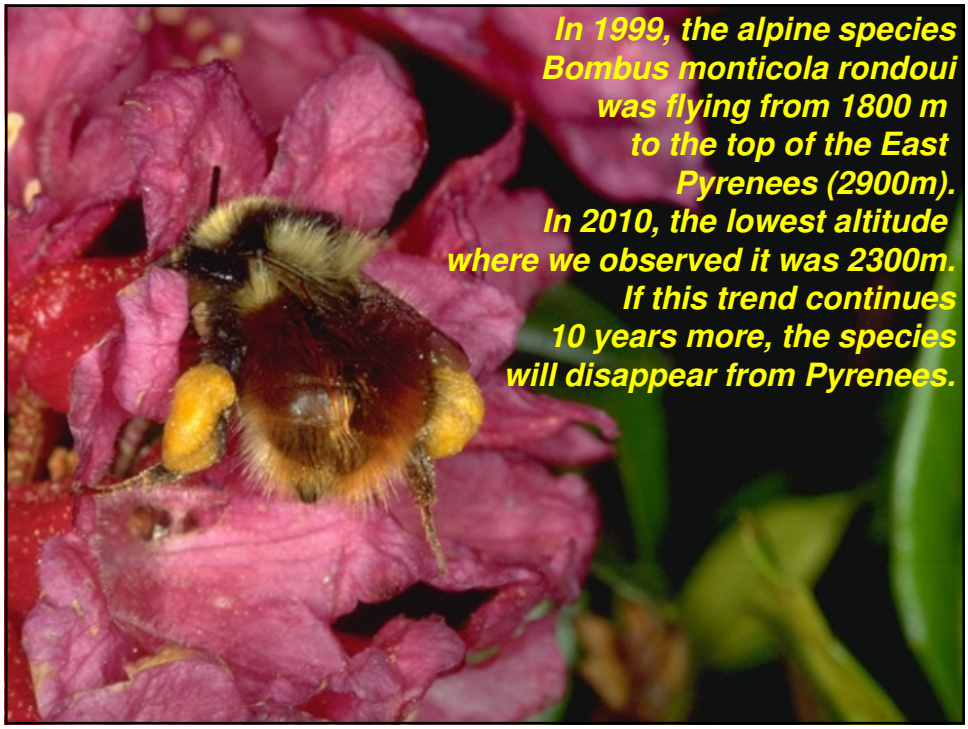
Article first published online: 6 OCT 2005
DOI: 10.1111/j.1461-0248.2005.00824.x

Issue

Ecology Letters
Volume 8, Issue 11, pages 1138–1146, November 2005



Once more, this is much more than the shift expected after the IPCC 0.74°C / century estimation.



In 1999, the alpine species Bombus monticola rondoui was flying from 1800 m to the top of the East Pyrenees (2900m). In 2010, the lowest altitude where we observed it was 2300m. If this trend continues 10 years more, the species will disappear from Pyrenees.

The perspective of a further temperature increase of 2-3°C (IPCC 2007) is worrying. It could lead to a further 500 m shift uphill. It could takes one century (following the IPCC) but could also be much faster, perhaps in the very next decades. In this case, we could expect the extinction of all alpine and subalpine bumblebees species (flavidus, gerstaeckeri, mendax, mesomelas, monticola, mucidus, pyreneus, sichelii). But it could also strongly deplete some abundant species, like Bombus lucorum, and even causes their local extinctions.

Despite the robustness of plant-pollinator assemblages against disturbance, it will be impossible to avoid major disruptions of the pollination network in the future.

For Williams et al. 2008 : *"Species that are susceptible to decline […] according to our results, will tend to be those bumblebee species that have narrower climatic ranges, are nearest to the edges of their climatic ranges and become active later in the season. In contrast, species that may do relatively well […] will tend to be those bumblebee species with broad climatic ranges that occur away from the edges of their climatic ranges and that become active early in the season."*

Conservation Biology

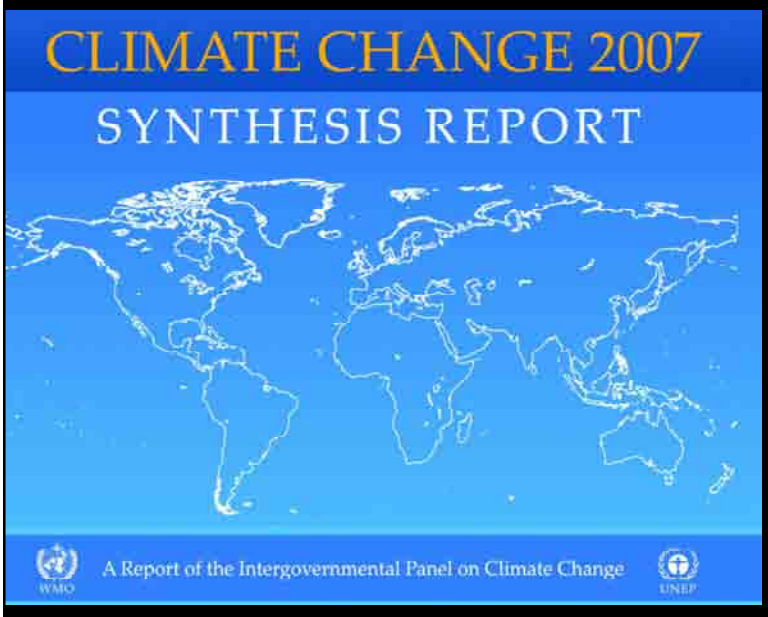
Bumblebee Vulnerability: Common Correlates of Winners and Losers across Three Continents

PAUL WILLIAMS,* SHEILA COLLA,† AND ZHENGHUA XIE‡

*Department of Entomology, The Natural History Museum, Cromwell Road, South Kensington, London SW7 5BD, United Kingdom email paw@nhm.ac.uk
†Department of Biology, York University, 4700 Keele Street, Toronto, Ontario M3J 1P3, Canada
‡Laboratory for Biodiversity and Environmental Studies, Department of Environment, Sichuan University, Moziqiao, Chengdu 610065, Sichuan, China

Abstract: *It is widely agreed that in many parts of the world some bumblebee (Bombus) species have*

The IPCC (2007) observed a "quite slow" global warming (0.74°C for the passed 100 years).



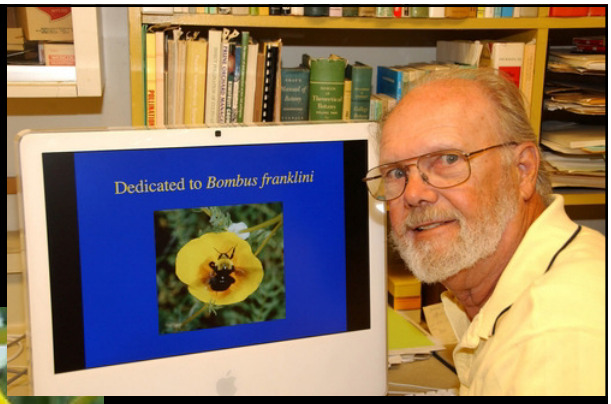
The IPCC Report does not represent the events occuring at local or regional scales. To figure a more accurate example, passing from the year 2000 to 2010, the meteorological station Le Luc (France, Var) recorded a mean temperature increase of +0.9°C, and a mean decreasing of -32% of the yearly precipitations

Even if it could be alarming, these indications are just means In addition, it could occurs too meteorological events like storms, drought and hot waves.

Have a look on the hot waves.

Do the hot waves impact the bumblebees fauna ?

For the World Meteorological Organization a hot wave occurs when the daily maximum temperature of more than five consecutive days exceeds the average maximum temperatur by 5°C
Robinson P.J. 2001. On the Definition of a Heat Wave. Journal of Applied Meteorology, 40: 762-775.



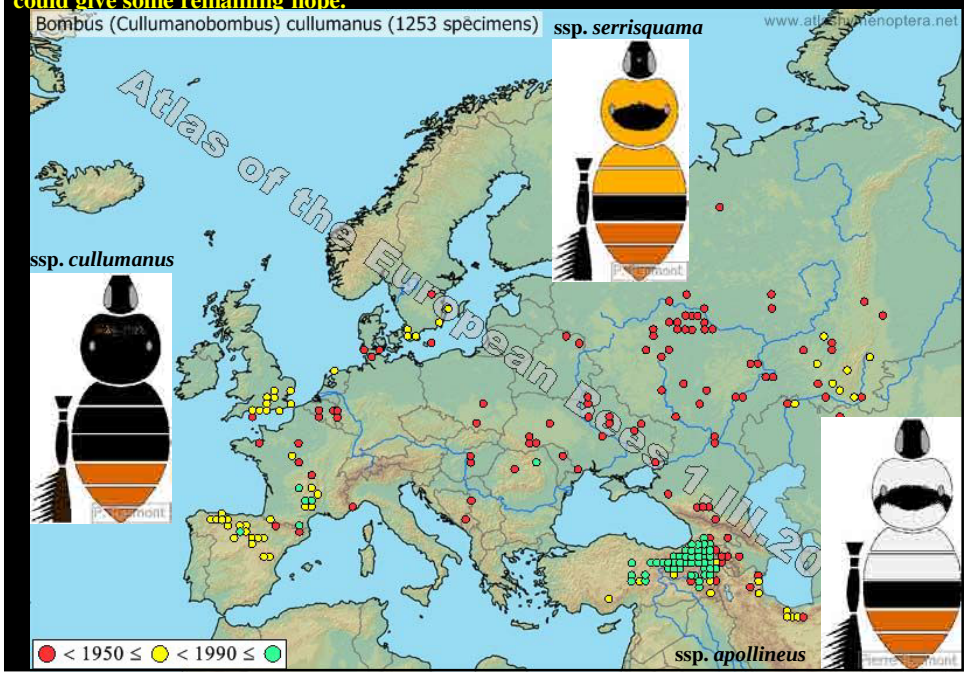
Robbin Thorp, hypothesized an epizootic disease in North America to explain the disparition of ***B. franklini***

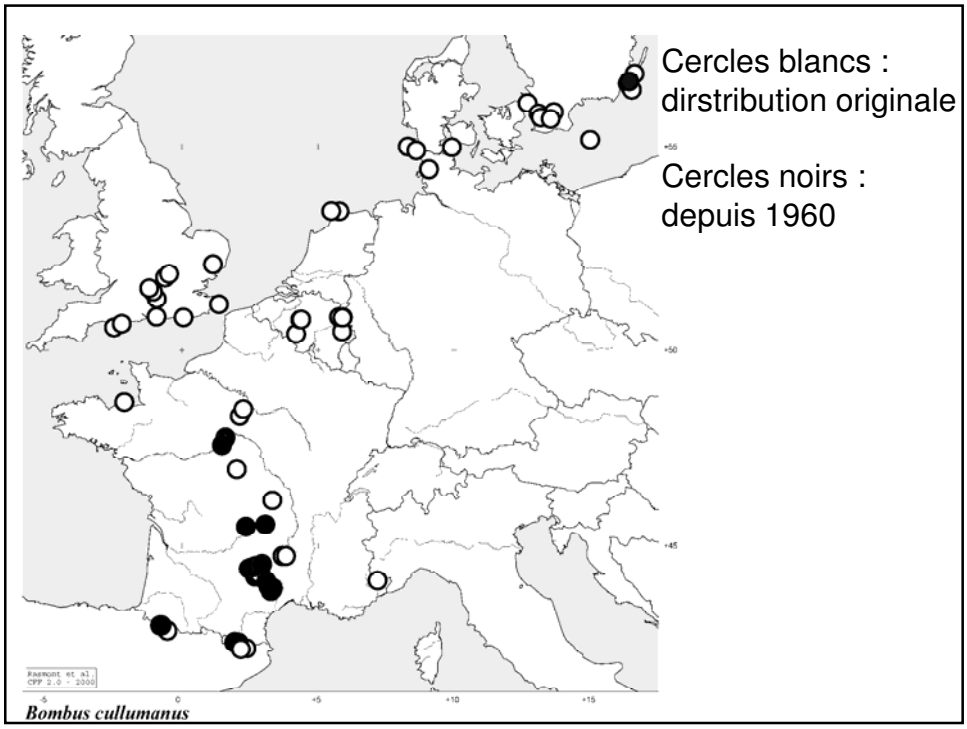
Bombus franklini, **from the Californian Rocky Mountains**

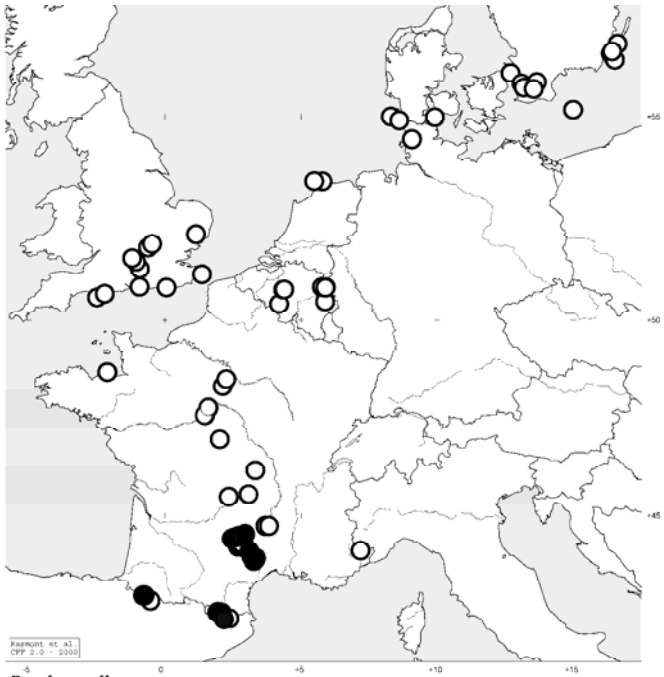
But Europe also experiences a fast regression of most bumblebee species.

Bombus cullumanus **is now vanished from its last localities in Pyrenees and Massif Central. This is the very last specimen ever seen (in 2004).**

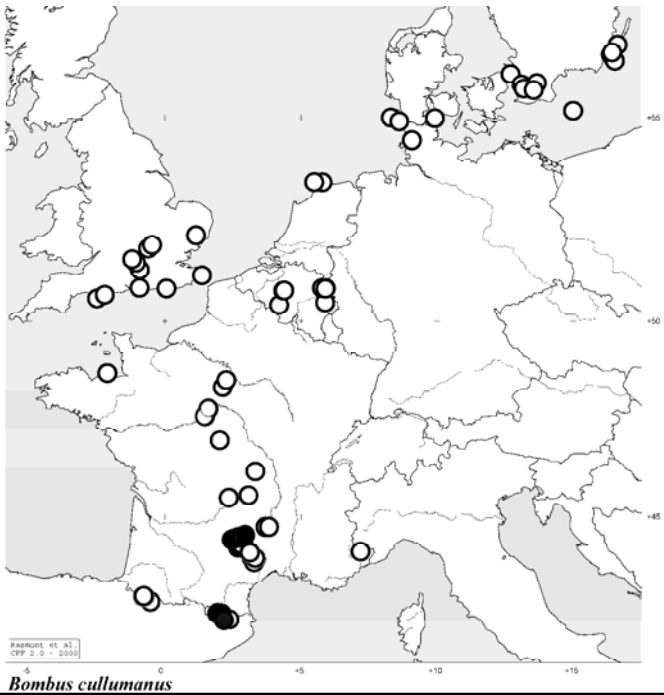
Taking into account not only the European distribution but the whole West-Palaearctic could give some remaining hope.



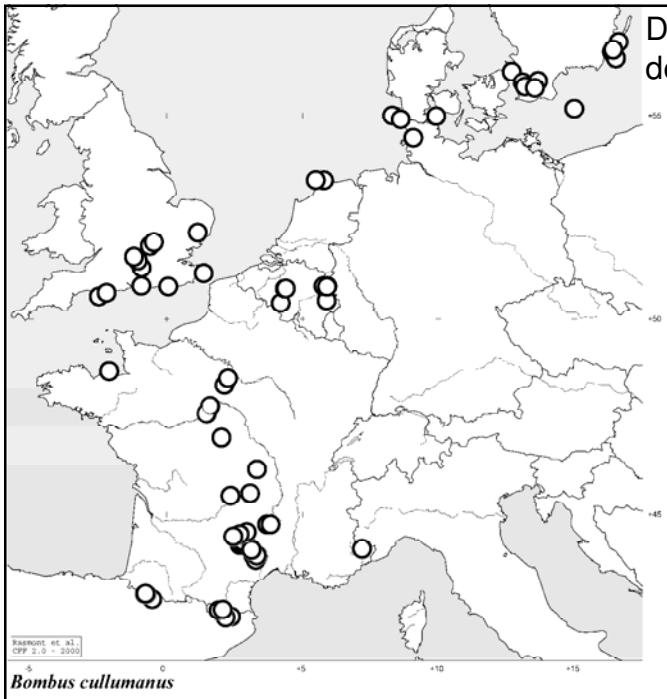




Depuis 1980



Depuis 1990



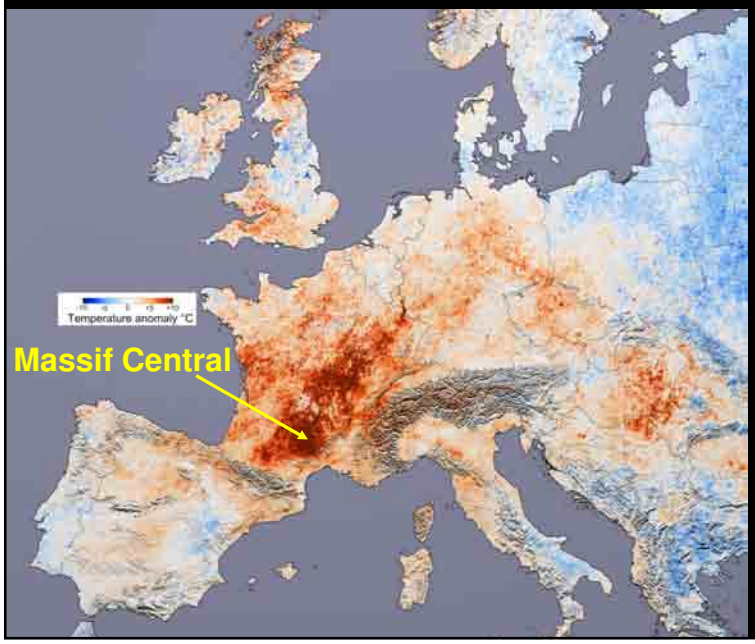
Dernières observations de *B. cullumanus*

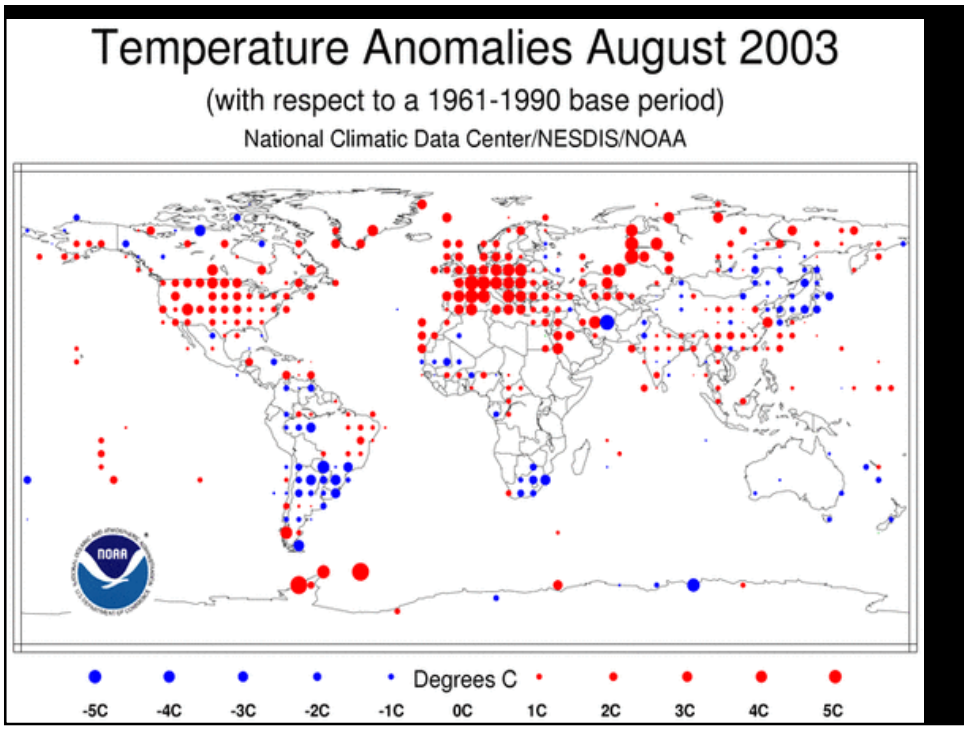
Belgique: 1918
Ile-de-France: 1923
UK: 1930
Allemagne: 1938
Pays-Bas: 1950
C-France: 1963
Suède: 1979
Pays Basque:1982
E-Pyrenées: 2001
Massif Central: 2004

L'extripation de *B. cullumanus* de ses tout derniers refuges dans des massifs isolés et bien préservés est la mieux expliquée par les canicules et les sêcheresse extrêmes des années 2002-2008, du Sud-Ouest de la France.

Larzac, Massif Central, France

This is a NASA image of the 2003 heat wave. The last stations of *Bombus cullumanus* were in the worst area.





Heat wave 2003 (France)

Other parts of the fauna could be affected.

Climate change increases the likelihood of catastrophic avian mortality events during extreme heat waves

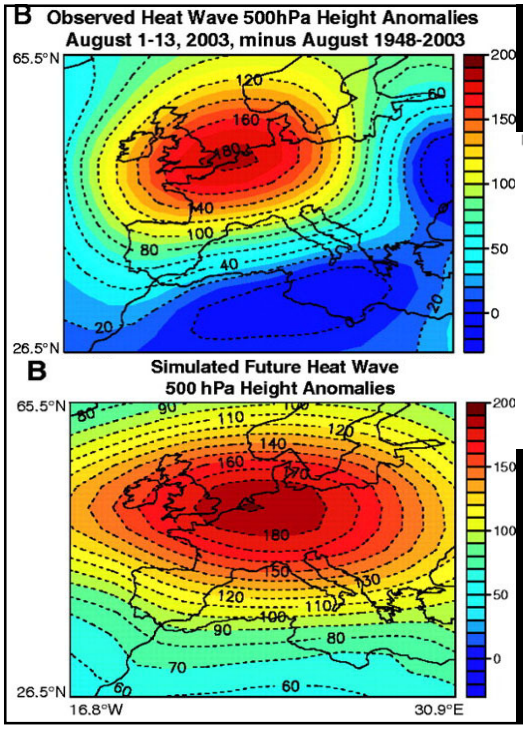
Andrew E. McKechnie[1,*] and Blair O. Wolf[2,*]
*Authors for correspondence (aemckechnie@zoology.up.ac.za; wolf@unm.edu).
Accepted September 7, 2009.

http://rsbl.royalsocietypublishing.org/content/6/2/253.abstract

Abstract

Severe heat waves have occasionally led to catastrophic avian mortality in hot desert environments. Climate change models predict increases in the intensity, frequency and duration of heat waves. A model of avian evaporative water requirements and survival times during the hottest part of day reveals that the predicted increases in maximum air temperatures will result in large fractional increases in water requirements (in small birds, equivalent to 150–200 % of current values), which will severely reduce survival times during extremely hot weather. By the 2080s, desert birds will experience reduced survival times much more frequently during mid-summer, increasing the frequency of catastrophic mortality events.

Welbergen J.A, Klose S.M., Markus N. & Eby P. 2008. Climate change and the effects of temperature extremes on Australian flying-foxes. Proc R Soc B 275, 419-425



Modelized frequency of heat waves 1948-2003

More Intense, More Frequent, and Longer Lasting Heat Waves in the 21st Century

Gerald A. Meehl* and Claudia Tebaldi

A global coupled climate model shows that there is a distinct geographic pattern to future changes in heat waves. Model results for areas of Europe and North America, associated with the severe heat waves in Chicago in 1995 and Paris in 2003, show that future heat waves in these areas will become more intense, more frequent, and longer lasting in the second half of the 21st century. Observations and the model show that present-day heat waves over Europe and North America coincide with a specific atmospheric circulation pattern that is intensified by ongoing increases in greenhouse gases, indicating that it will produce more severe heat waves in those regions in the future.

The future is worrying !

Modelized frequency of heat waves in the Future

The Abnormal Bumblebees Scarcity syndrom

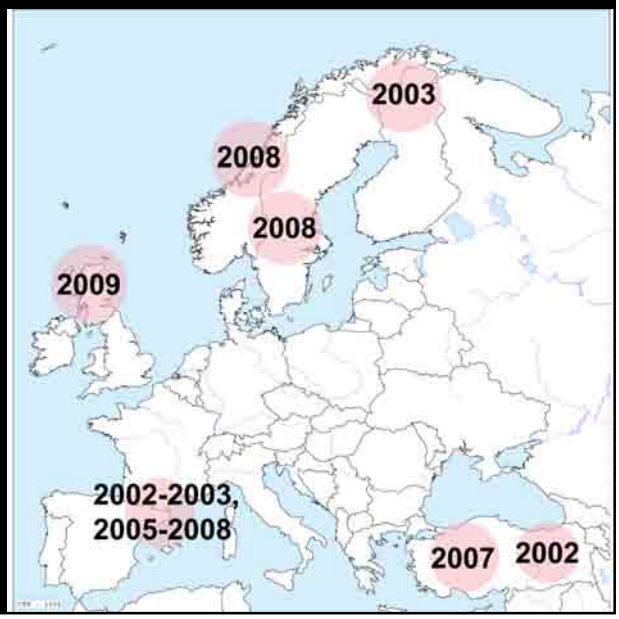
- Returning in places where you personnaly experienced abundance of bumblebees
- In pertinent time relative to phenology
- With the normal density of flower resources
- With a good weather.

Despite of all these apparently favourable parameters, you observe a very few number of bumblebees, sometimes no one

In the worst situation, you cannot find any bumblebees day after day.

We personnaly met such heat waves followed by ABS in the ne places:

2002 Pyrenees
2002 E Anatolia
2003 Pyrenees
2003 N Fennoscandia
2005 Pyrenees
2007 W Anatolia
2008 Pyrenees
2008 C Sweden
2008 W Norway
2009 Scotland

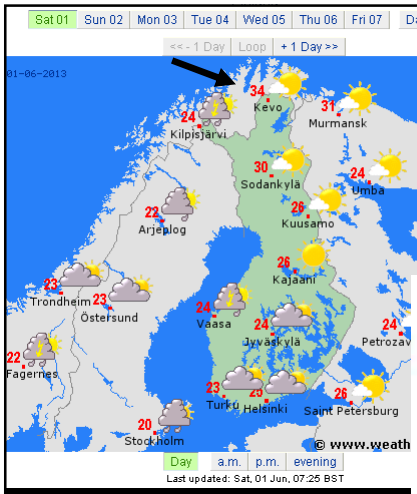


Dried steppic vegetation inYozgat, C-Anatolia, 2007

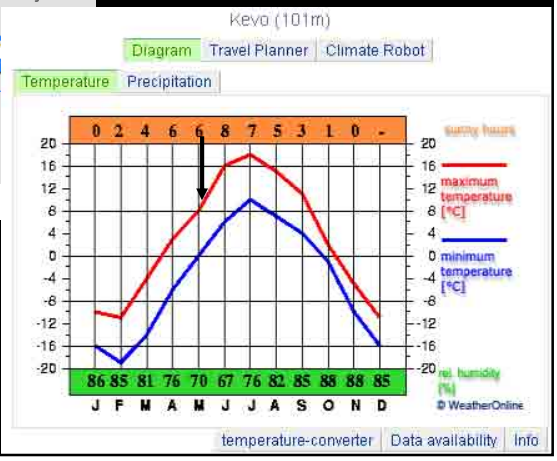
Dried peat-bog in Flatanger, Central Norway, 2008

Dried heather in Brora, Scotland, 2009.

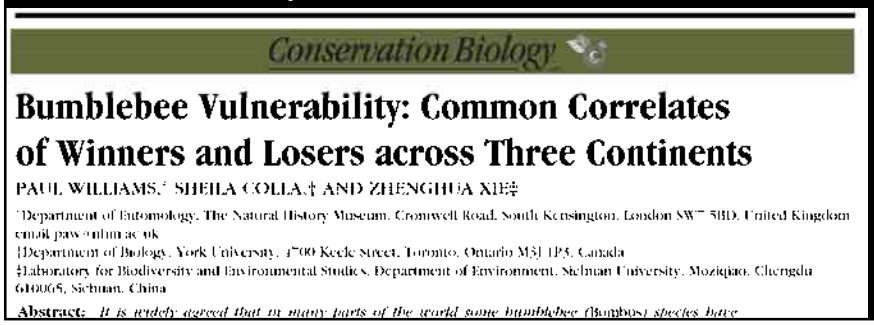
Estives d'Osséjà, août 2012. Végétation alpine déssèchée, mourante



Kevo, Arctique Finlandais
31 mai 2013



For Williams et al. 2008 : "*Species that are susceptible to decline owing to reduced abundances of their most suitable food plants, according to our results, will tend to be those bumblebee species that have narrower climatic ranges, are nearest to the edges of their climatic ranges and become active later in the season. In contrast, species that may do relatively well where reductions in food plants drive other species to pronounced declines will tend to be those bumblebee species with broad climatic ranges that occur away from the edges of their climatic ranges and that become active early in the season."*



Conservation Biology

Bumblebee Vulnerability: Common Correlates of Winners and Losers across Three Continents

PAUL WILLIAMS,* SHEILA COLLA,† AND ZHENGHUA XIE‡

*Department of Entomology, The Natural History Museum, Cromwell Road, South Kensington, London SW7 5BD, United Kingdom, email paw@nhm.ac.uk

†Department of Biology, York University, 4700 Keele Street, Toronto, Ontario M3J 1P3, Canada

‡Laboratory for Biodiversity and Environmental Studies, Department of Environment, Sichuan University, Moziqiao, Chengdu 610065, Sichuan, China

Abstract: *It is widely agreed that in many parts of the world some bumblebee (Bombus) species have*

Bombus magnus

Les canicules peuvent aussi être la cause des régressions rapides et récentes de *Bombus magnus* et *Bombus muscorum*

Bombus muscorum

PLOS ONE

RESEARCH ARTICLE

A Protocol to Assess Insect Resistance to Heat Waves, Applied to Bumblebees (*Bombus* Latreille, 1802)

Baptiste Martinet*, Thomas Lecocq, Jérémy Smet, Pierre Rasmont

OPEN ACCESS

Citation: Martinet B, Lecocq T, Smet J, Rasmont P (2015) A Protocol to Assess Insect Resistance to Heat Waves, Applied to Bumblebees (Bombus Latreille, 1802). PLoS ONE 10(3): e0119591. doi:10.1371/journal.pone.0119591

Academic Editor: Glancarlo López-Martínez, New Mexico State University, UNITED STATES

Received: November 25, 2014

Accepted: January 21, 2015

Published: March 4, 2015

Abstract

Insect decline results from numerous interacting factors including climate change. One of the major phenomena related to climate change is the increase of the frequency of extreme events such as heat waves. Since heat waves are suspected to dramatically increase insect mortality, there is an urgent need to assess their potential impact. Here, we determined and compared the resistance to heat waves of insects under hyperthermic stress through their time before heat stupor (THS) when they are exposed to an extreme temperature (40°C). For this, we used a new experimental standardised device available in the field or in locations close to the field collecting sites. We applied this approach on different Arctic, Boreo-Alpine and Widespread bumblebee species in order to predict consequences of heat waves. Our results show a heat resistance gradient: the heat stress resistance of species with a centred arctic distribution is weaker than the heat resistance of the Boreo-Alpine species with a larger distribution which is itself lower than the heat stress resistance of the ubiquitous species.

Heat stress resistance - Protocol

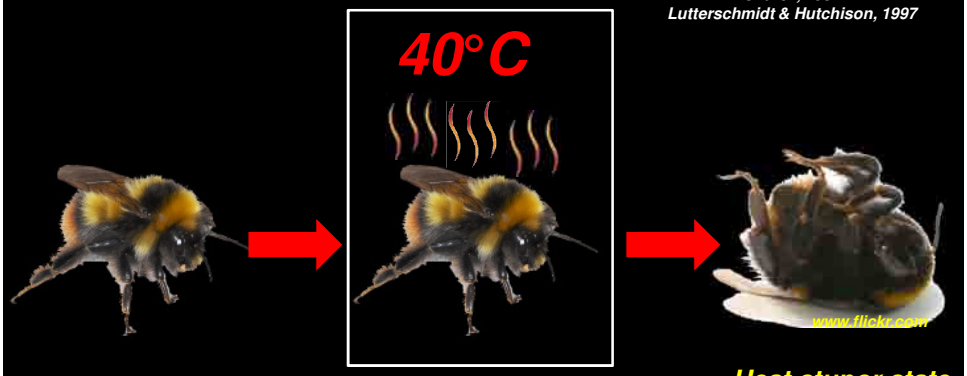
Martinet et al., 2015

PLOS ONE

Time before Heat Stupor (THS)

What is the « *Heat stupor* » ?

Uvarov, 1931
Lutterschmidt & Hutchison, 1997

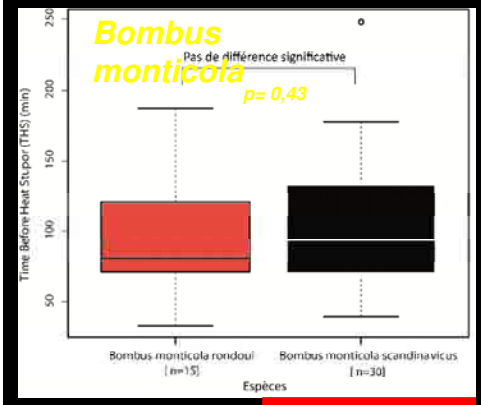


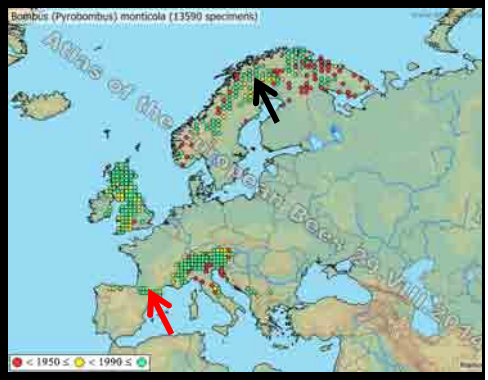
Normal state

Overheating state

Heat stupor state

B) Heat stress resistance: ***variability within allopatric conspecific populations***





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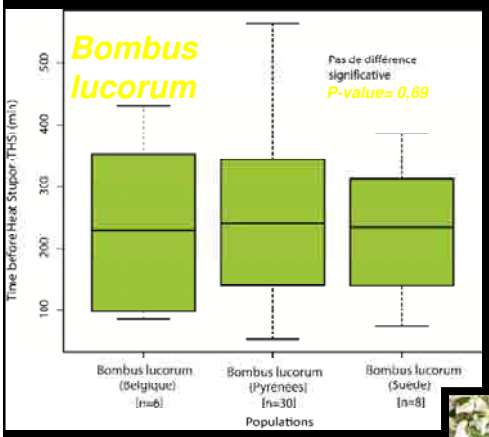
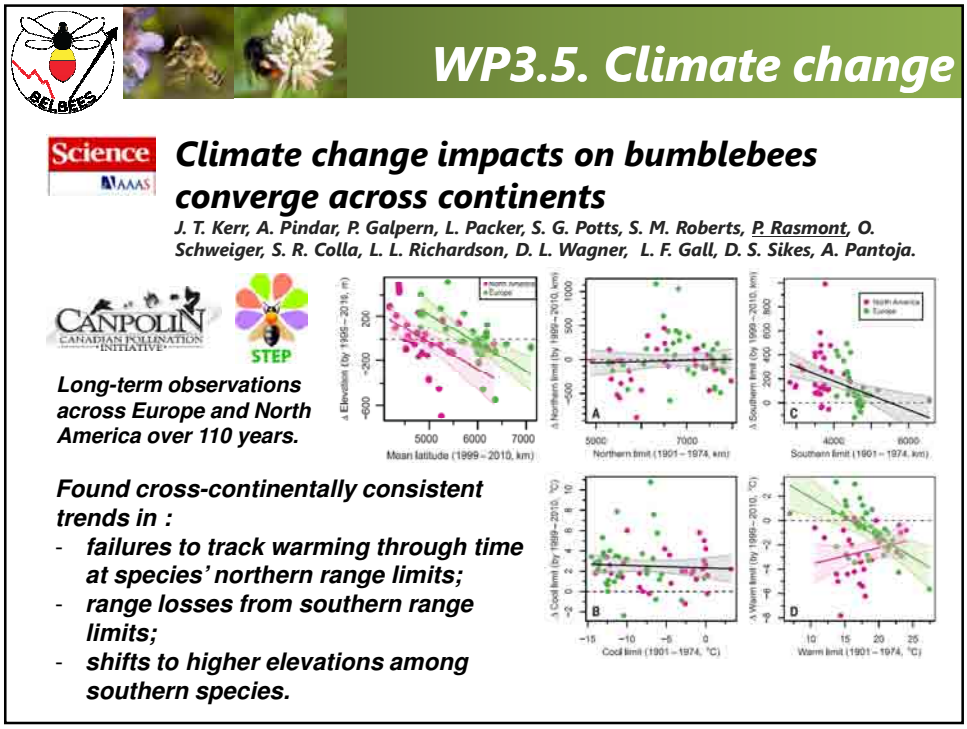
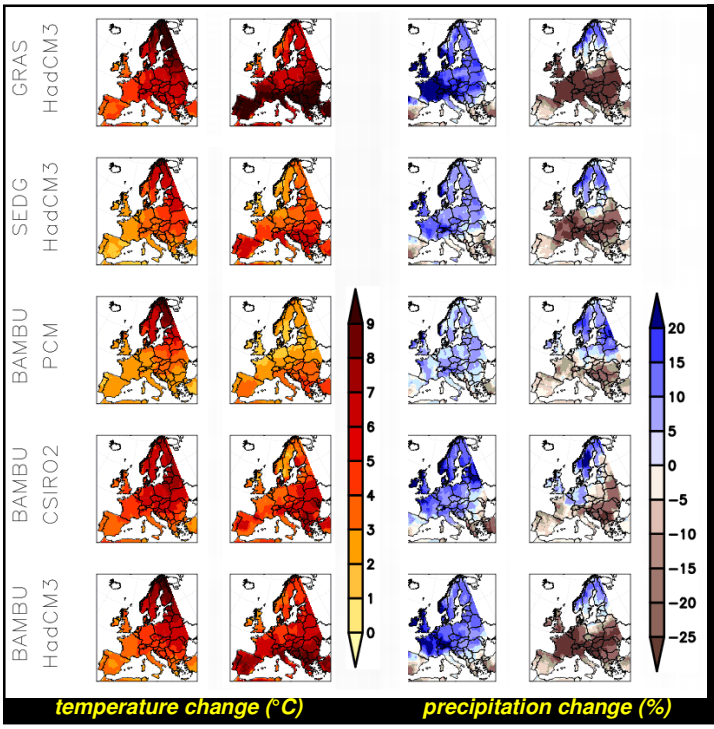


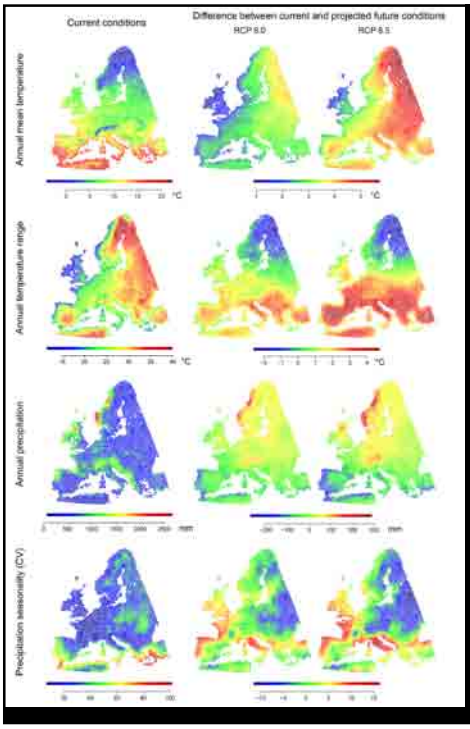
Livre, Editions Pensoft (Sofia) ou PDF Open access (paru le 15



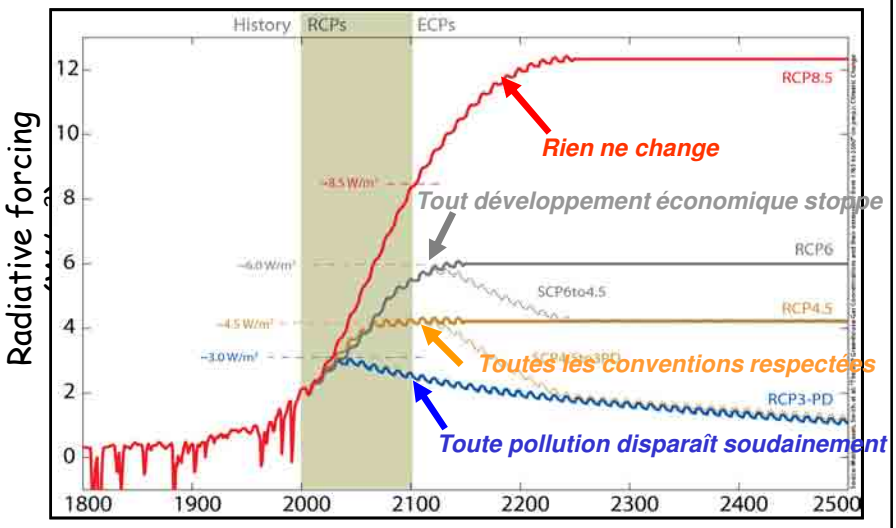


Winter (December-January-February, left column) and summer (June-July-August, right column) ALARM scenarios, 2071-2100 relative to 1961-1990.

Fronzek, S., Carter, T.R. and Jylhä, K. 2012. Representing two centuries of past and future climate for assessing risks to biodiversity in Europe. Global Ecology and Biogeography 21(1), 19-35, doi:10.1111/j.1466-8238.2011.00695.x



Les nouveaux scénarios de réchauffement climatique



Source: Potsdam Institute for Climate

Les scénarios climatiques

- *SEDG (Sustainable Europe Development Goal) – a storyline for moderate change: The scenario of moderate change approximates the IPCC B1 climate change scenario. Mean expected temperature increase in Europe until 2080 is 2.4°C.*
- *BAMBU (Business As Might Be Usual) – a storyline for intermediate change: The scenario of intermediate change approximates the IPCC A2 climate change scenario. Mean expected increase in temperature is 3.1°C.*
- *GRAS (GRowth Applied Strategy) – a storyline for maximum change: The scenario of maximum change approximates the IPCC A1FI climate change scenario. Mean expected increase in temperature is 4.1°C.*

Les scénarios climatiques

- *SEDG (Sustainable Europe Development Goal) – a storyline for moderate change: The scenario of moderate change approximates the IPCC B1 climate change scenario. Mean expected temperature increase in Europe until 2080 is 2.4°C.*
- *BAMBU (Business As Might Be Usual) – a storyline for intermediate change: The scenario of intermediate change approximates the IPCC A2 climate change scenario. Mean expected increase in temperature is 3.1°C.*
- *GRAS (GRowth Applied Strategy) – a storyline for maximum change: The scenario of maximum change approximates the IPCC A1FI climate change scenario. Mean*

0,46 °C DE PLUS pour la température moyenne terrestre entre 2001 et 2010, par rapport à la moyenne 1961-1990 : c'est le plus fort réchauffement jamais enregistré pour une décennie.

© Pour la Science - n° 399 - Janvier 2011

35,6 MILLIARDS DE TONNES : c'est la masse des émissions de CO_2 estimées en 2012. Soit 58 pour cent de plus qu'en 1990, et 2,6 pour cent de plus qu'en 2011.

© Pour la Science - n° 423 - Janvier 2013

Bombus cingulatus *Bombus hyperboreus* *Bombus polaris*

Scénario GRAS 2100

Même les espèces actuellement abondantes sont menacées



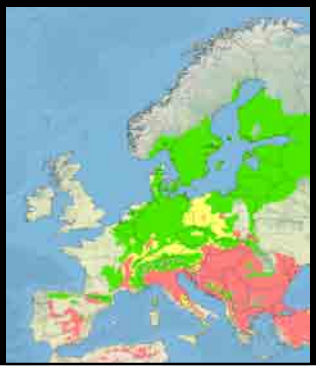
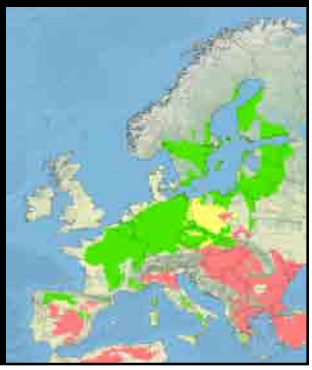
Bombus pascuorum *Bombus pratorum* *Bombus terrestr*



Trois espèces de bourdons pourraient étendre leur distributio

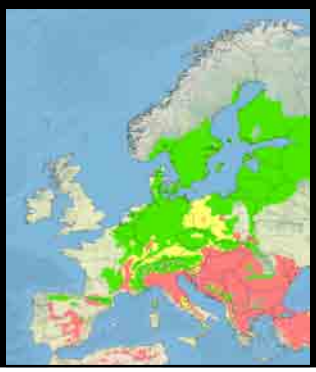


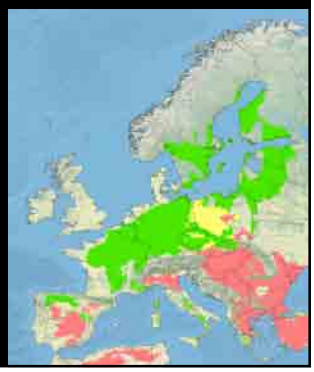
Bombus argillaceus *Bombus haematurus* *Bombus niveatu*

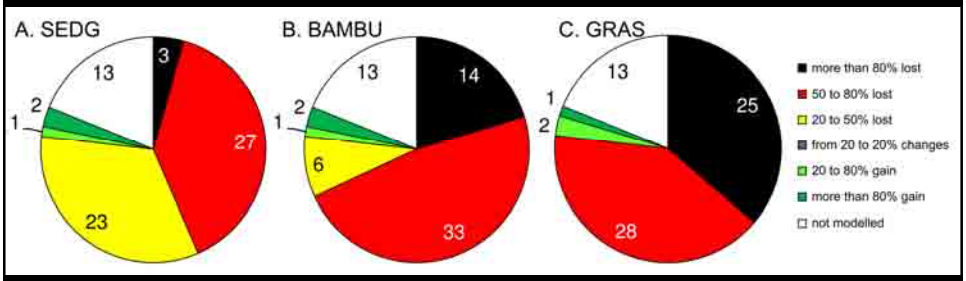
Dans de nombreuses régions de France et de Belgique, elles pourraient être les seules espèces encore présentes

Bombus argillaceus **Bombus haematurus** **Bombus niveatu**





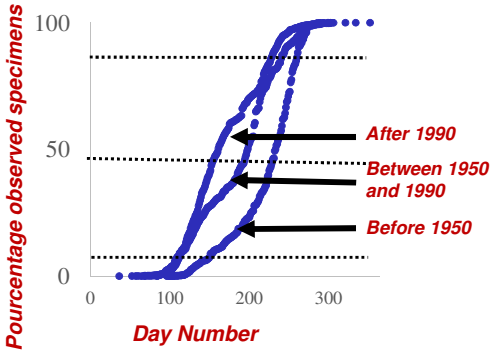
Quel que soit le scénario, le bilan est très néga voire même cataclysmique



destin des espèces en 2100

WP3.5. Climate change

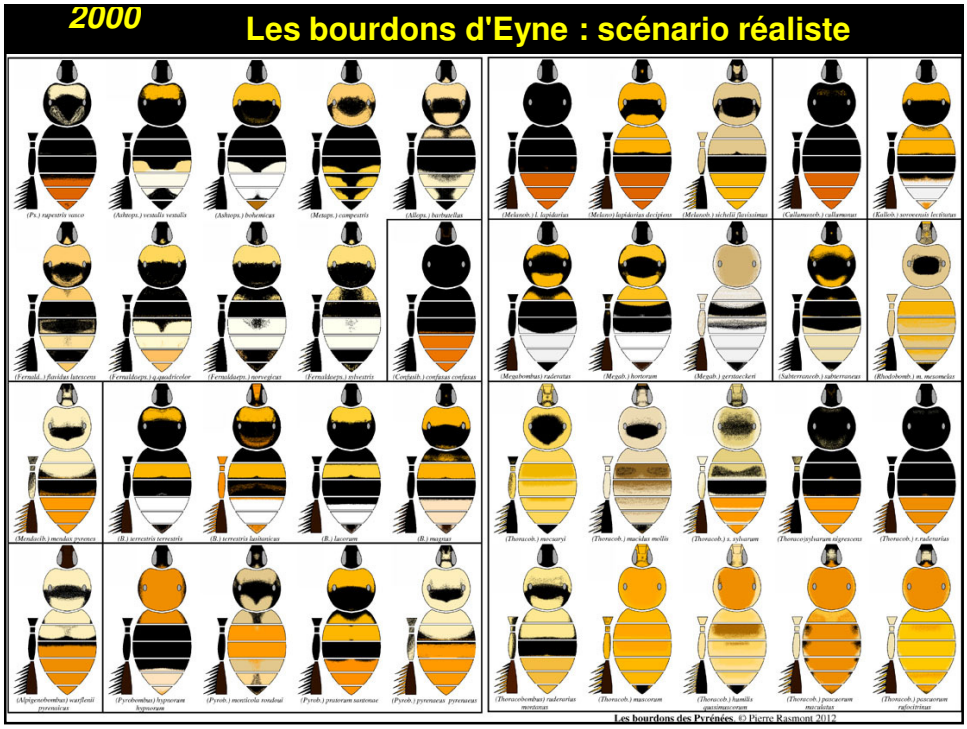
→ Study the global phenological changes in **all Belgian bumblebee** species and **characterize** these changes.

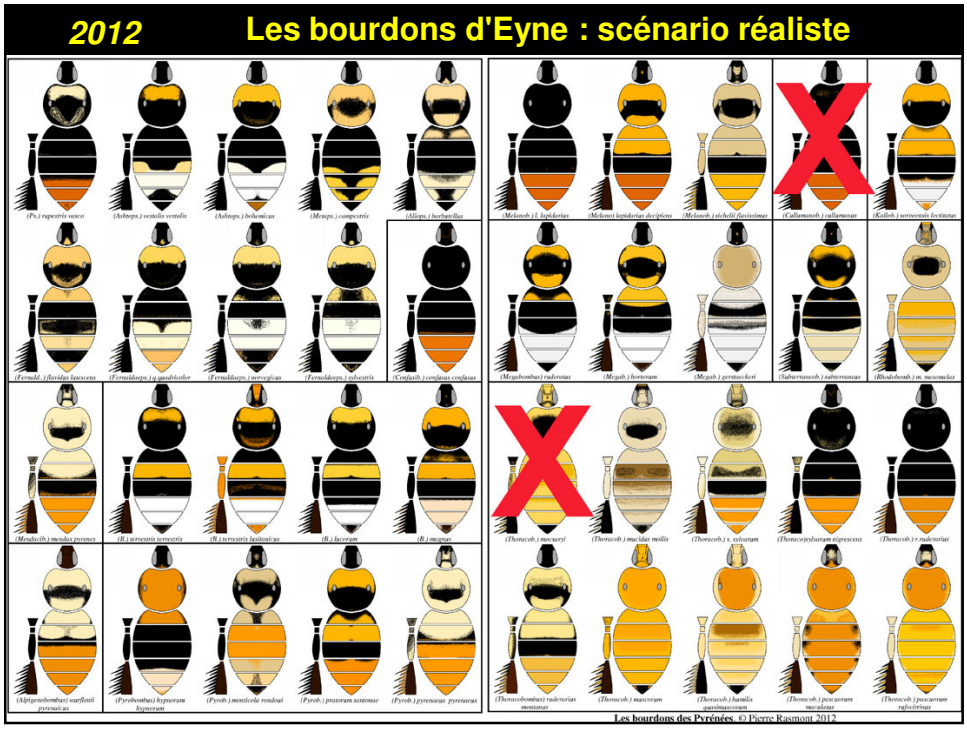


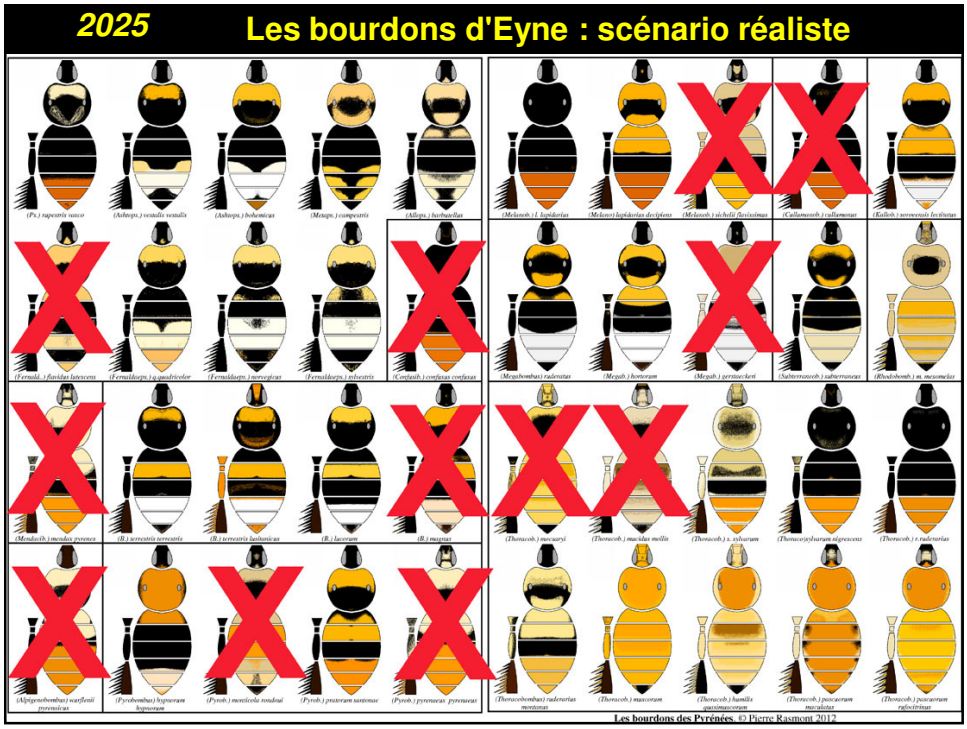
→ ***Study the effect of these changes on the pollination service in the past, present and future.***

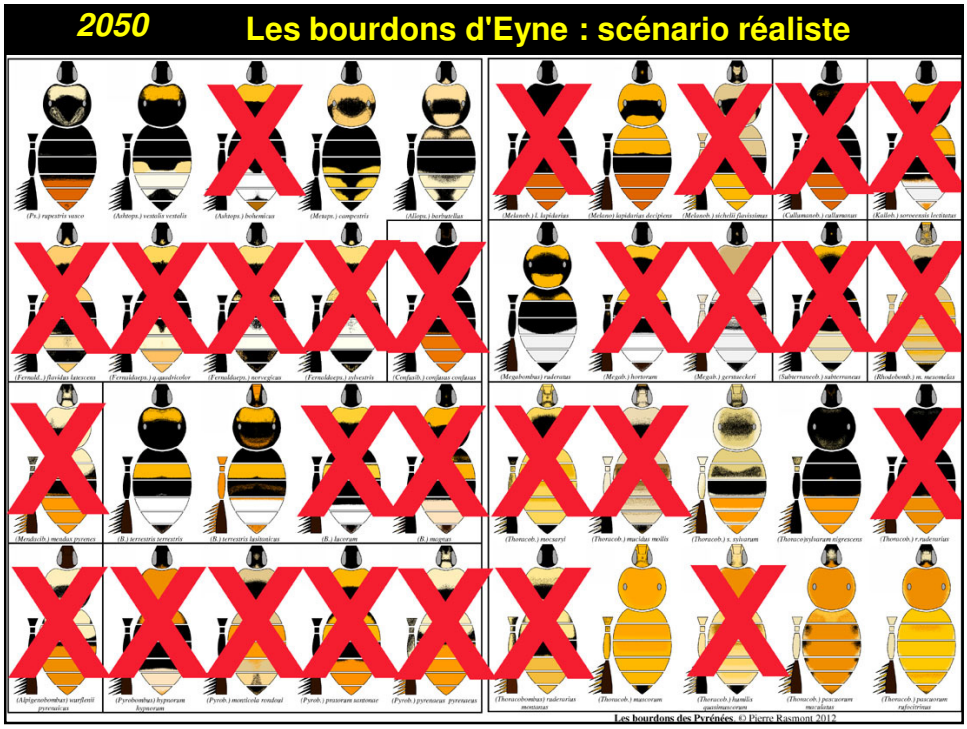
→ ***Investigate the possible impact on the bumblebee-plant relationship. What are the risks?***

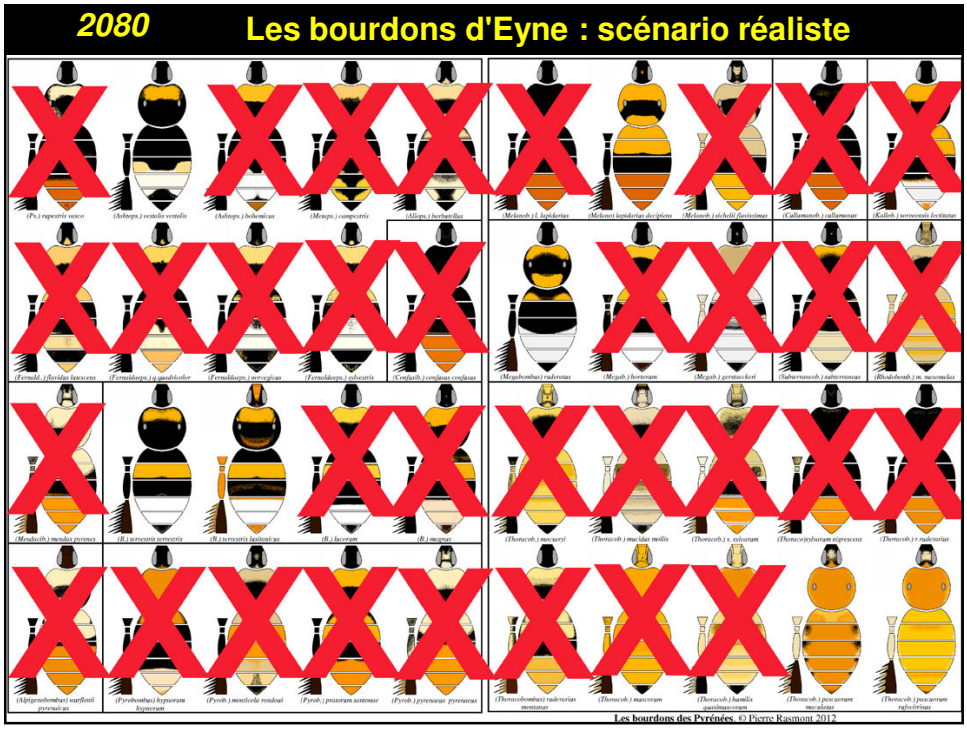
Que seront les bourdons de France et de Belgique en 2100 ?

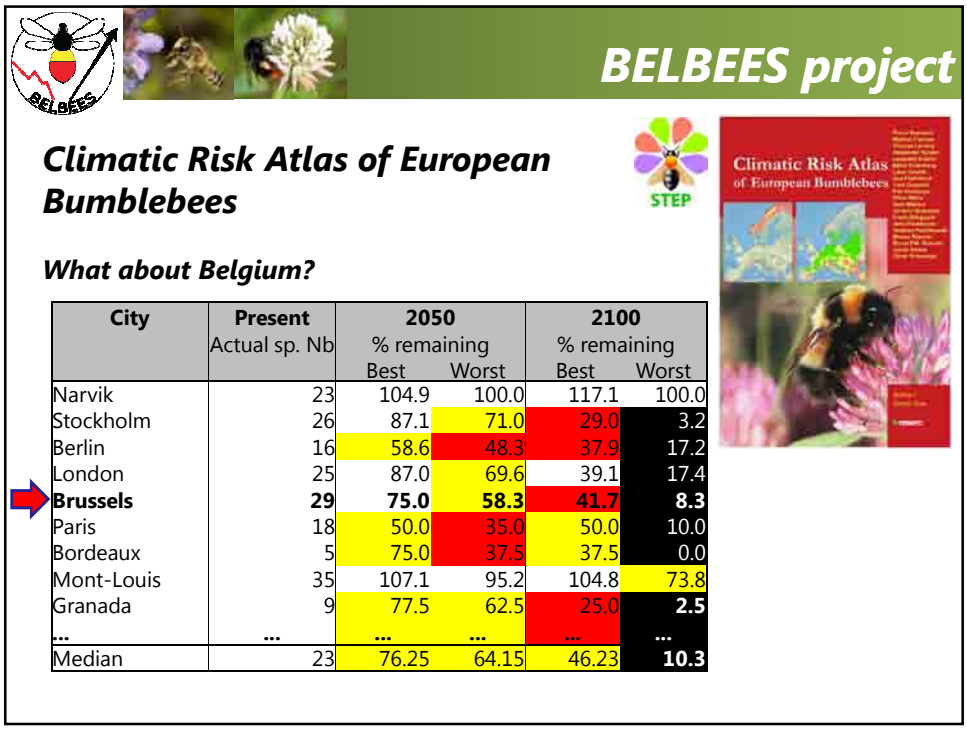

2000
Les bourdons d'Eyne : scénario réaliste
Les bourdons des Pyrénées. © Pierre Rasmont 2012


2012
Les bourdons d'Eyne : scénario réaliste
Les bourdons des Pyrénées. © Pierre Rasmont 2012


2025
Les bourdons d'Eyne : scénario réaliste
Les bourdons des Pyrénées. © Pierre Rasmont 2012


2050
Les bourdons d'Eyne : scénario réaliste
Les bourdons des Pyrénées. © Pierre Rasmont 2012



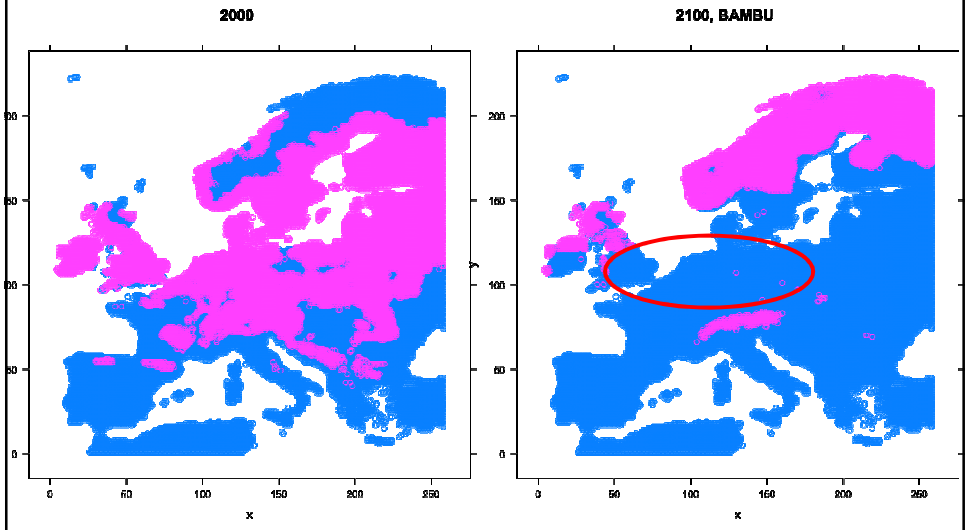


City	Present Actual sp. Nb	2050 % remaining Best	2050 % remaining Worst	2100 % remaining Best	2100 % remaining Worst
Narvik	23	104.9	100.0	117.1	100.0
Stockholm	26	87.1	71.0	29.0	3.2
Berlin	16	58.6	48.3	37.9	17.2
London	25	87.0	69.6	39.1	17.4
Brussels	**29**	**75.0**	**58.3**	**41.7**	**8.3**
Paris	18	50.0	35.0	50.0	10.0
Bordeaux	5	75.0	37.5	37.5	0.0
Mont-Louis	35	107.1	95.2	104.8	73.8
Granada	9	77.5	62.5	25.0	**2.5**
...	...	...	...	...	...
Median	23	76.25	64.15	46.23	**10.3**

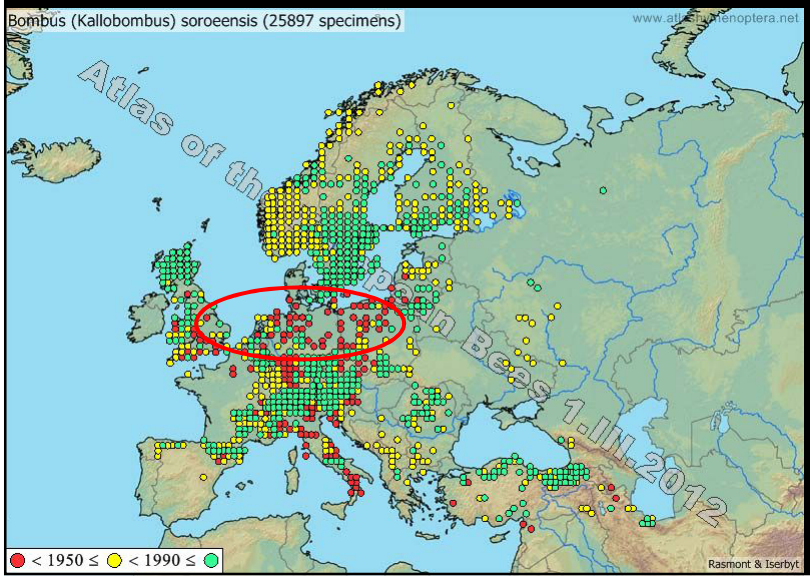
Modelisation of bumblebee distribution, past and present

by M. Franzen, O. Schweiger & P. Rasmont

Bombus soroeensis



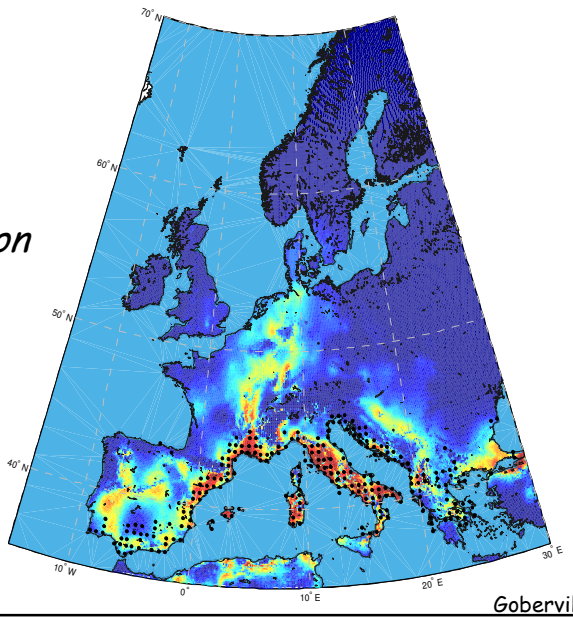
La régression actuelle de *Bombus soroeensis* montre que la situation prévue pour 2100 commence à s'installer

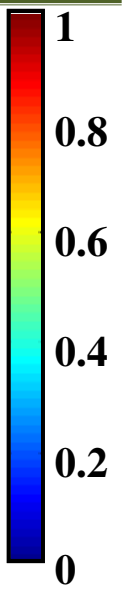


Distribution modélisée de Clematis flammula

Bonne modélisation

(Swets 1988)

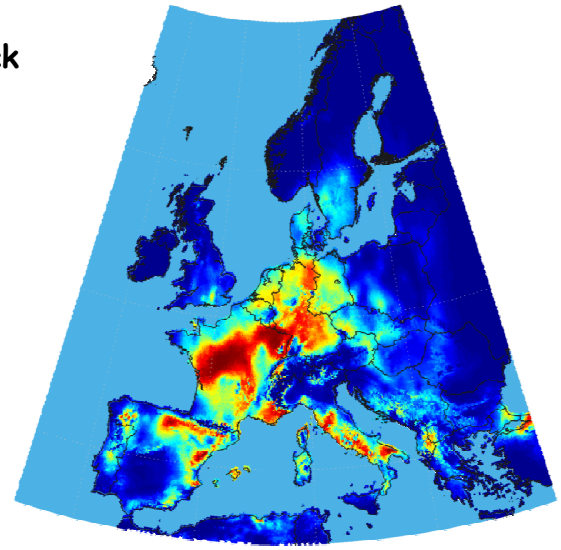


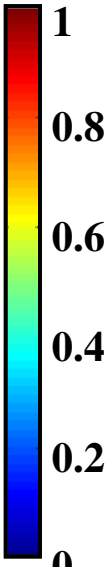


Goberville et al. (in prep)

RCP *4.5* radiative forcing scenario à la fin du siècle

Max Planck Institut model

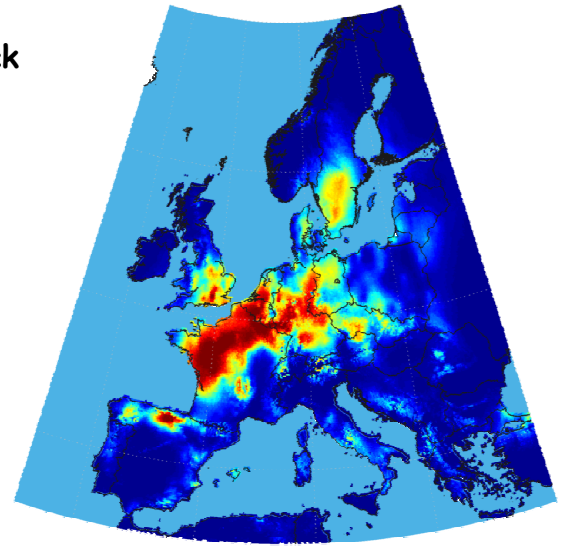


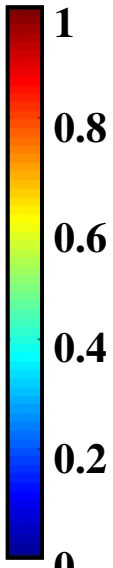


Goberville et al. (in prep)

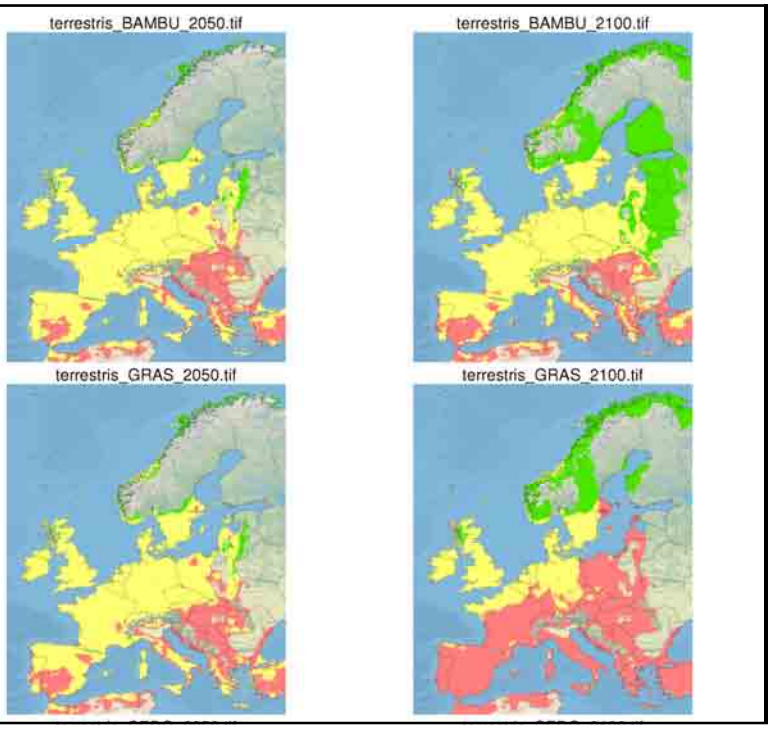
RCP *8.5* radiative forcing scenario à la fin du siècle

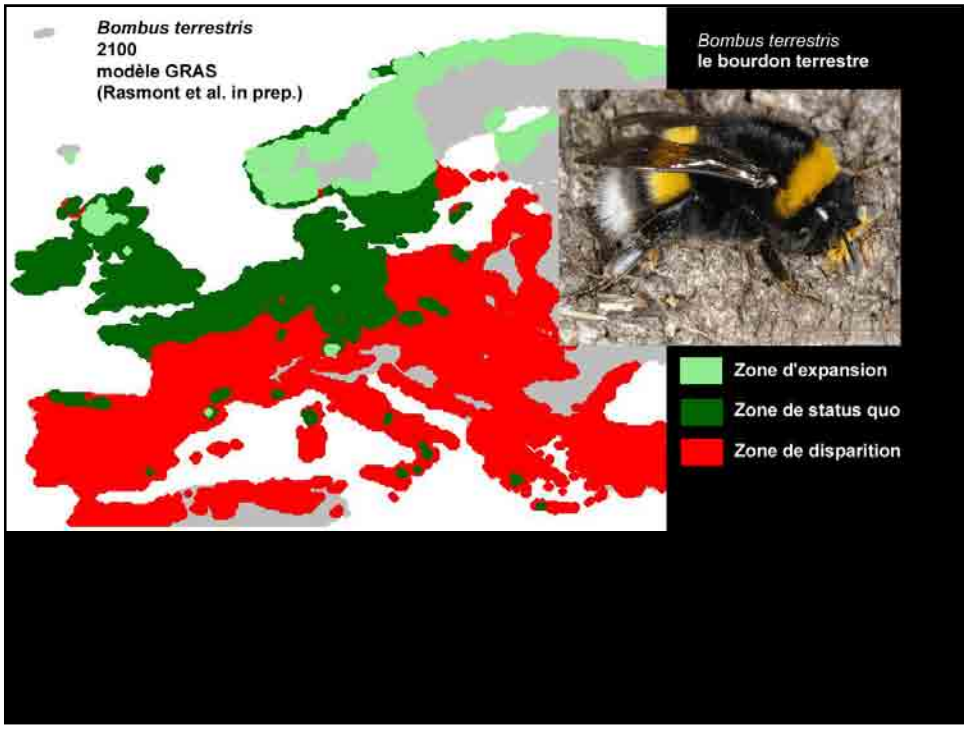
Max Planck Institut model





Goberville et al. (in prep)





Annales de la Société entomologique de France (N.S.), 2015
http://dx.doi.org/10.1080/00379271.2015.1118357

Taylor & Francis

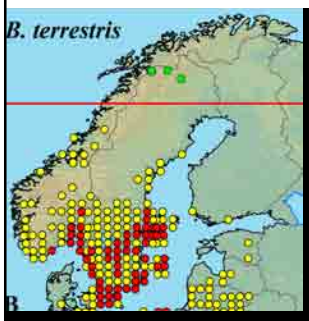
Forward to the north: two Euro-Mediterranean bumblebee species now cross the Arctic Circle

Baptiste Martinet[a]*, Pierre Rasmont[a], Björn Cederberg[b], Dimitri Evrard[a], Frode Ødegaard[c], Juho Paukkunen[d] & Thomas Lecocq[a]

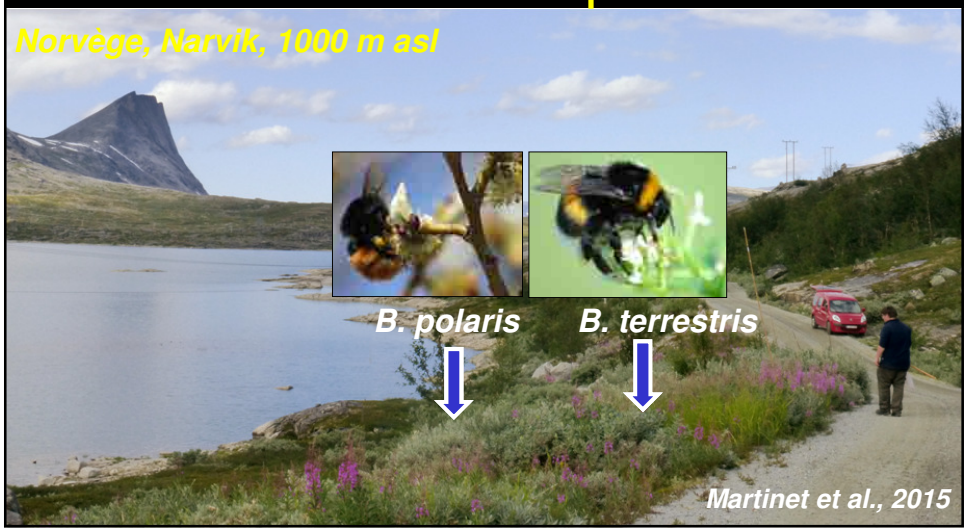
[a]Laboratory of Zoology, Research Institute of Biosciences, University of Mons, Place du Parc 20, 7000 Mons, Belgium; [b]Swedish Species Information Centre, Swedish University of Agricultural Sciences, PO Box 7007, 750 07 Uppsala, Sweden; [c]Department of Terrestrial Ecology, Norwegian Institute for Nature Research – NINA, PO Box 5685, Sluppen, NO-7485 Trondheim, Norway; [d]Finnish Museum of Natural History, Zoology Unit, University of Helsinki, PO Box 17, FI-00014 Helsinki, Finland

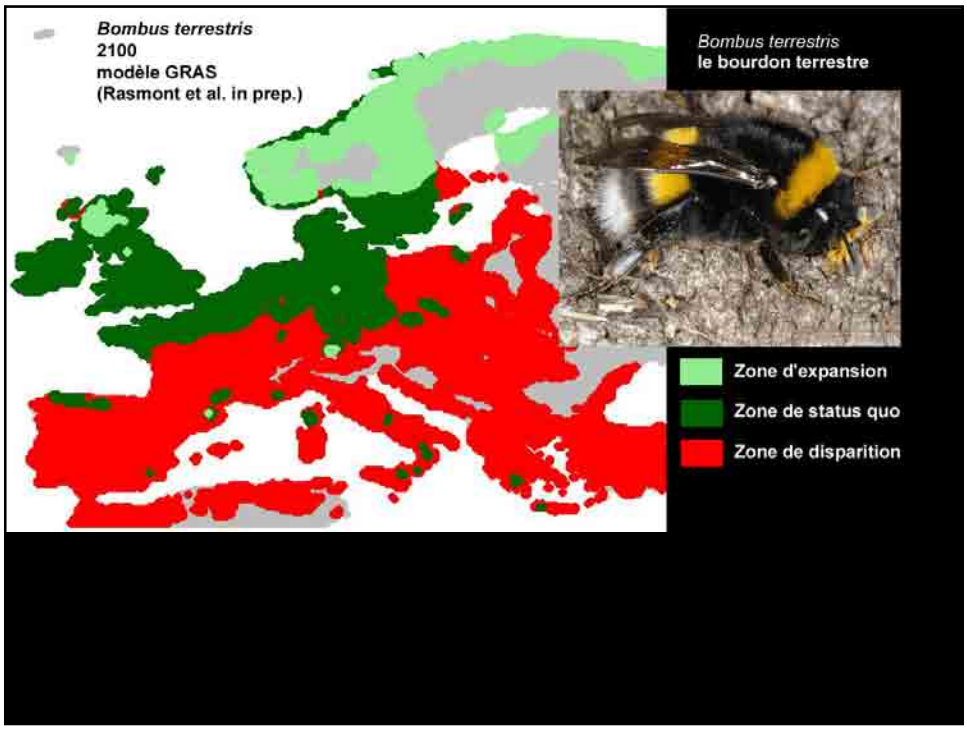
(Received 18 February 2015; accepted 6 November 2015)

Summary. In recent decades, several animal and plant species have been in regression (population size decrease and geographical distribution shrinking). This loss of biodiversity can be due to various factors such as the destruction and fragmentation of habitat, urban development, pesticides or climate change. However, some species benefit from these changes and expand their distribution. Here we report observations (in 2013 and 2014) of two Euro-Mediterranean bumblebee species: *Bombus terrestris* for the first time and *Bombus lapidarius*, north of the Arctic Circle in Fennoscandia.



Competition between arctic wildlife and new southern species

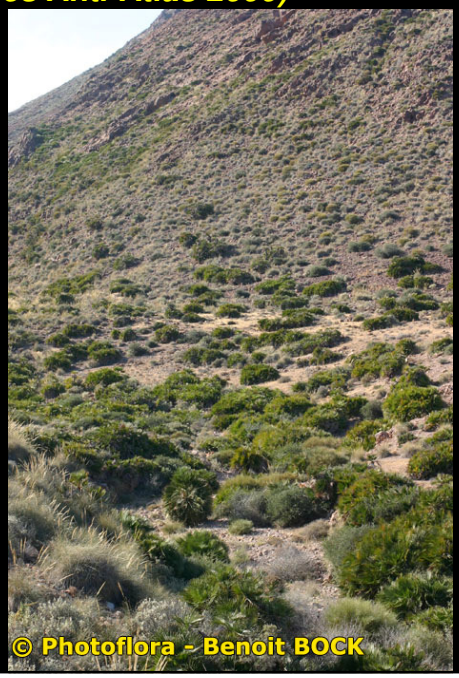




Alpages des Pyrénées 2080 (d'après le Haut-Atlas 2000)

Le maquis du Var 2080 (d'après Anti-Atlas 2000)

Le maquis du Var 2080 (d'après Anti-Atlas 2000)



Le maquis du Var 2080 : une fiction ?

Le palmier nain est arrivé en France vers 2000

Le Lavandou 2006

Le maquis du Var 2080 : une fiction ?

Le palmier nain est arrivé en France vers 2000

Le Lavandou 2007 : il fleurit

Le maquis du Var 2080 : une fiction ?

Le palmier nain est arrivé en France vers 2000

Hyères 2007 : il fructifie

We should abandon soon our present "Nature Conservation paradigm", mainly based on sanctuarising Natural Areas.

It should be replaced by a dynamic paradigm, with two very different concerns:

- Trailing edge conservation
  How to maximize the survival of non-moving species in their original areas ?
- Leading edge conservation
  How to manage the move of species toward their new areas ?

The trailing edge conservation is likey not very different from the present policy.

However, it should focuse on microclimatic areas.

Such areas could play a "Noah's Arch" role for recovering the species AFTER the climatic crisis.

An example is the Forêt de la Sainte-Baume in south-eastern France.Thanks to the shelter of a high cliff, a large beech (Fagus sylvatica) and yew (Taxus baccata) forest persists there since at least two thousand years, while the surrounding area with dry Mediterranean vegetation is deeply impacted by recent droughts. Here rare wild bees survive, whilst they disappeared in the surrounding area. Most hills and mountains include such areas of potential microrefugia and thus they should be of particular conservation concern, monitored with appropriate programmes.

Figure 13.6 The Forêt de la Sainte-Baume, near Marseille (Photo Georges Millet). On the right, the canopy of the beech forest sheltered by the cliff; on the left, the dry Mediterranean vegetation.

The leading edge conservation

will DEEPLY questions the present management of "invasive taxa" (see the case of the Dwarf Palm). Southern species are already arriving.

La chasse à l'ibis sacré contestée par des scientifiques

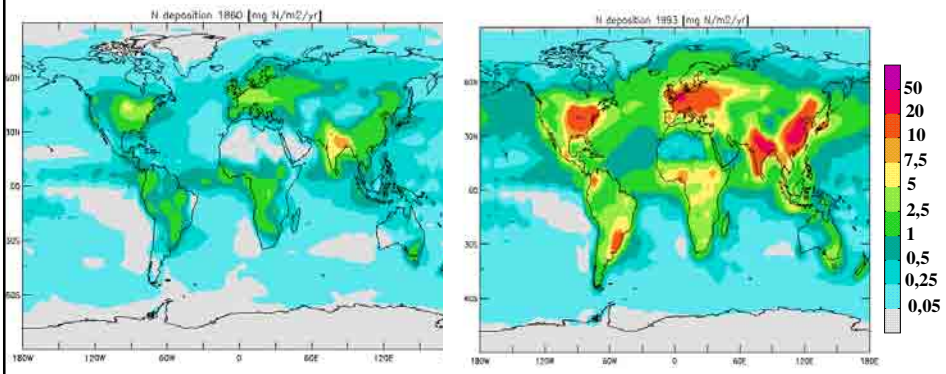
30 janvier 2014 / Régis Pluchet (Nature et progrès)

Alors qu'il s'était multiplié sur les côtes atlantiques et méditerranéennes, l'ibis sacré, oiseau mythique, est

Galloway, *AAAS*, Feb 2003

Nitrogen Deposition

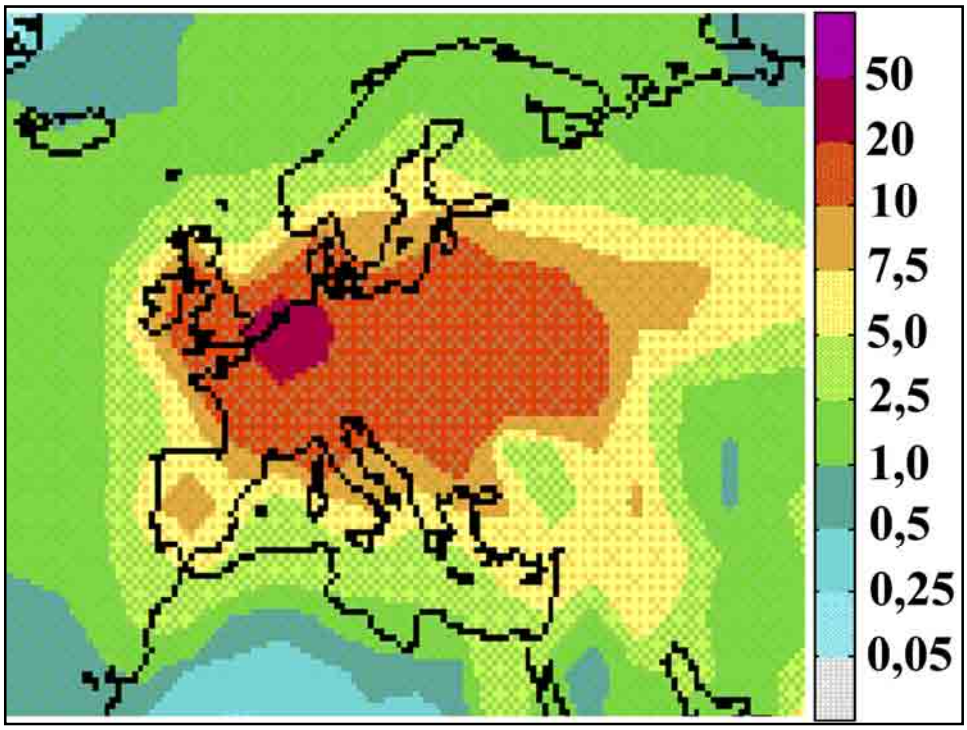
Past and Present



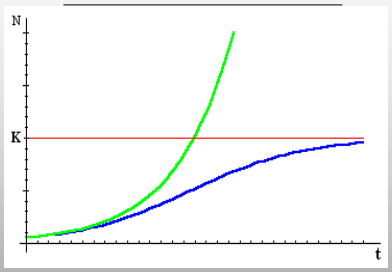
1860

1993

Galloway and Cowling, 2002; Galloway et al., 2002b



L'équation de Verhulst ou Equation logistique de croissance des populations



$$\frac{dN}{dt} = \left(\frac{K - N}{K}\right) * rN$$

Temps en abscisse, effectif de la population en ordonnée

La courbe verte représente l'expansion théorique de la population en absence de facteur limitant (courbe malthusienne). La courbe bleue représente la courbe lorsque la population est dans un environnement limité. K représente la limite absolue de population en fonction des ressources disponibles.

Au cas, par exemple, où une simple bactérie de l'espèce *Escherischia coli* se multipliait sans limitation, elle formerait en 24h 2^{72} descendants, d'un poids individuel de 2.10^{-12} g, soit une masse totale de 9440 T. En 48 heures, sans limitation, un seul coliforme produirait une population d'une masse totale équivalente à 7460 fois la masse totale de la Terre. L'environnement est donc TOUJOURS limité.

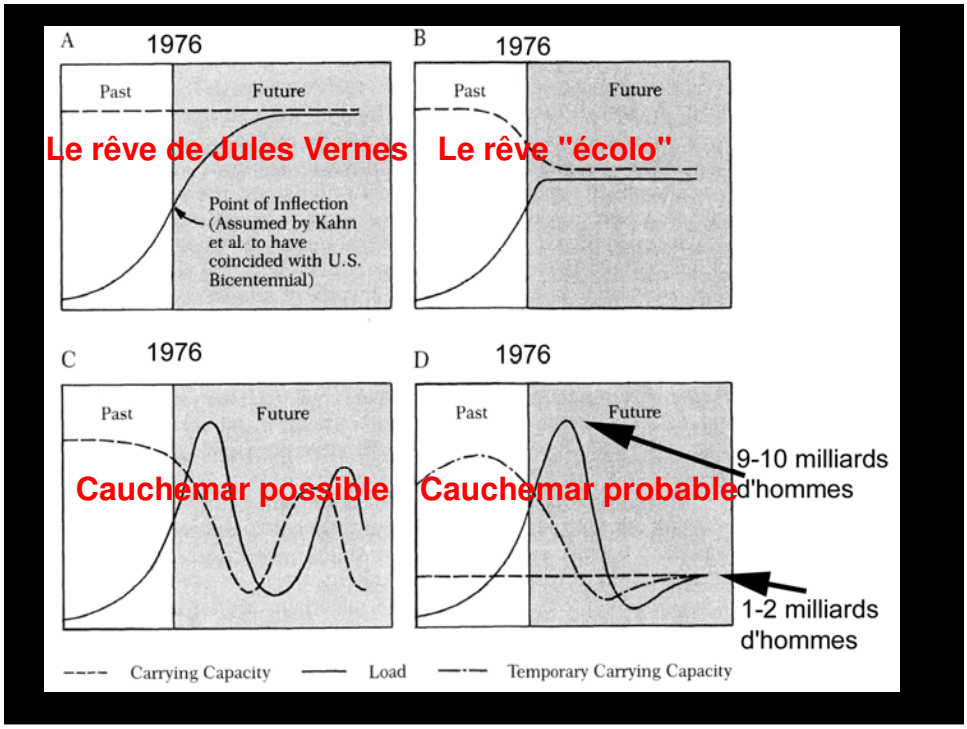
Les individus surnuméraires, qui représentent la différence entre la courbe verte idéale et la courbe bleue réaliste, ces individus sont donc éliminés. Ces individus éliminés de manière inexorable sont, en moyenne, un peu moins performants que ceux qui ont survécu. C'est la "bousculade" pour la vie ("*struggle for life*").

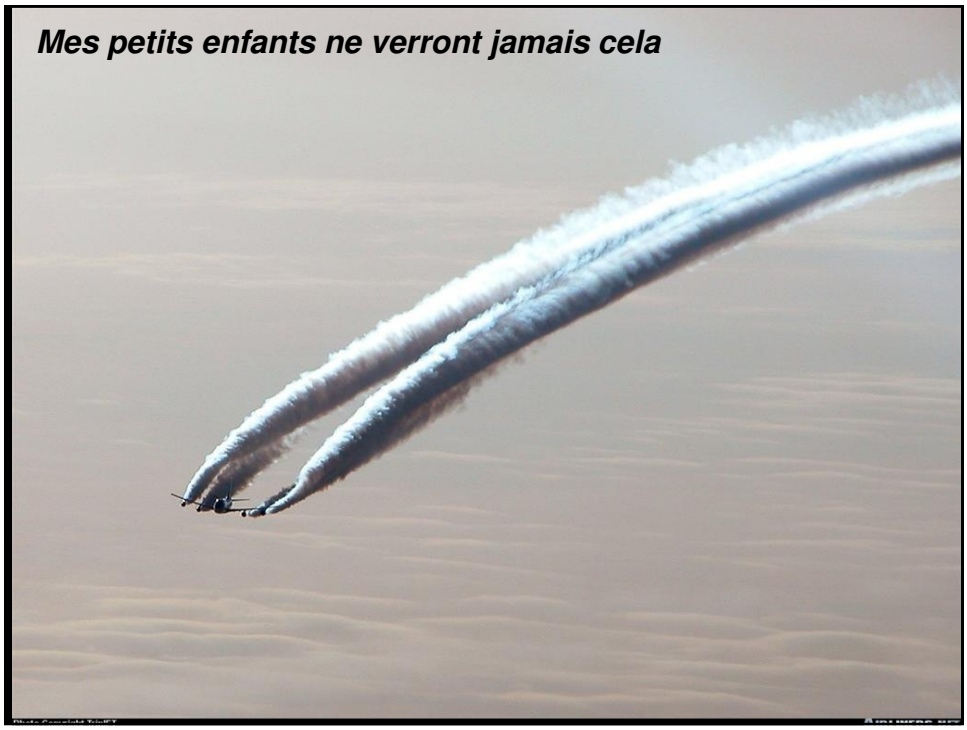
OVERSHOOT

The Ecological Basis of Revolutionary Change

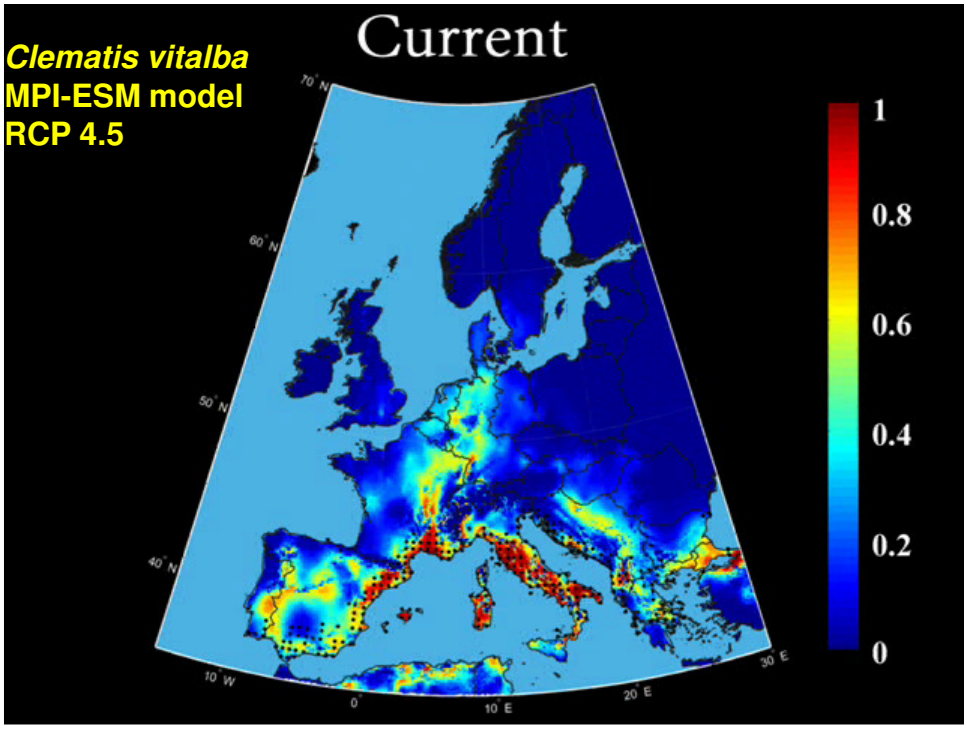
carrying capacity:	maximum permanently supportable load.
cornucopian myth:	euphoric belief in limitless resources.
drawdown:	stealing resources from the future.
cargoism:	delusion that technology will always save us from
overshoot:	growth beyond an area's carrying capacity, leading to
crash:	die-off.

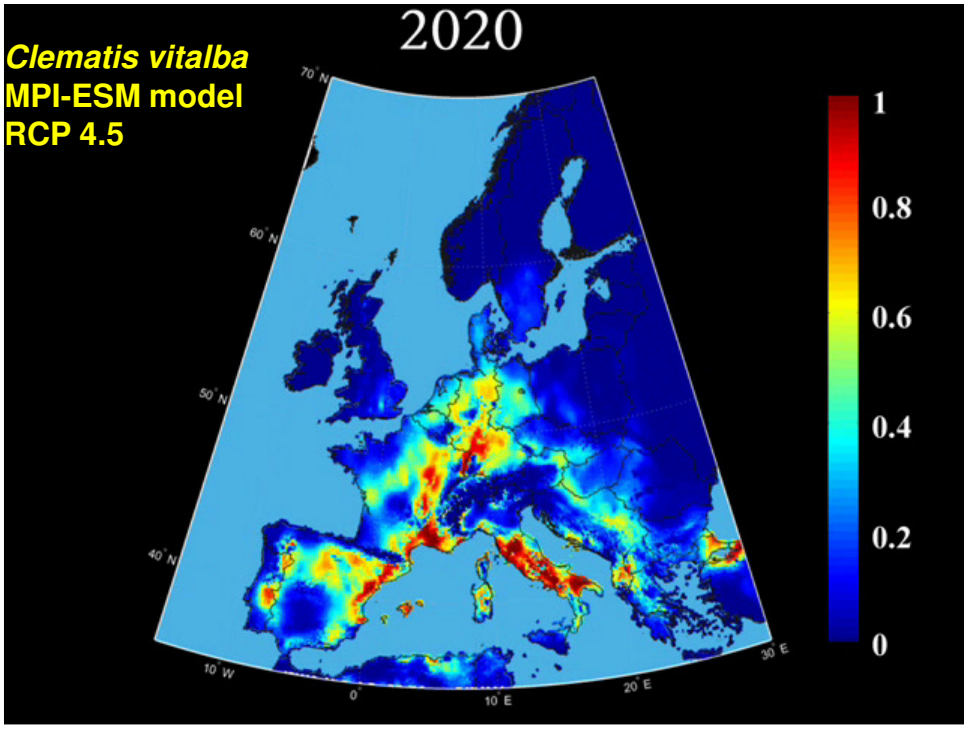
William R. Catton, Jr.
1980

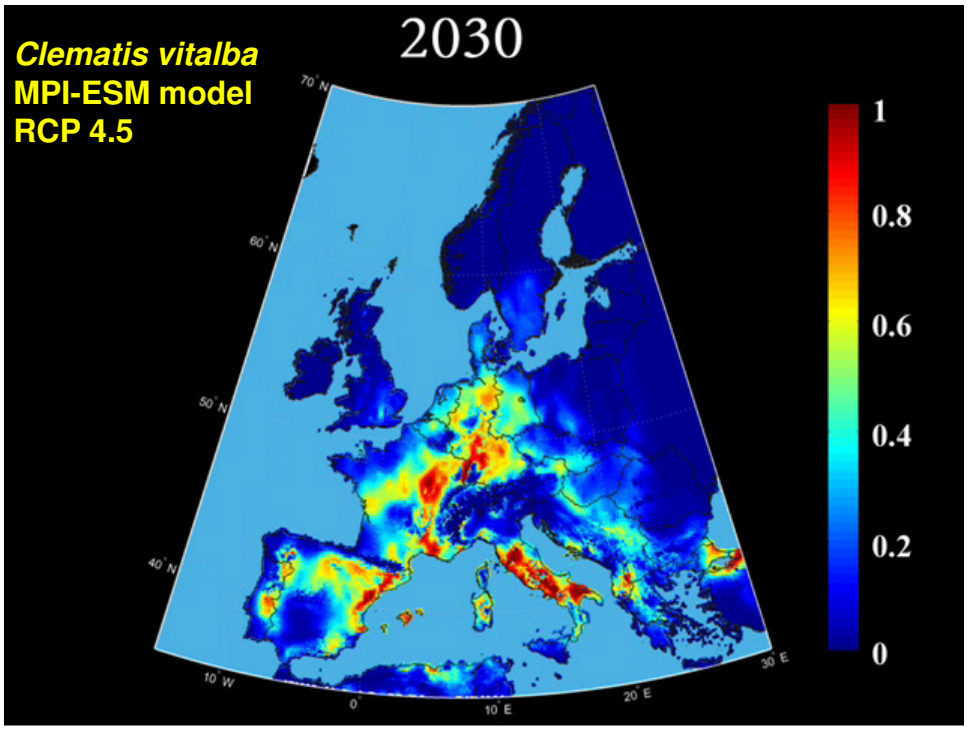

A
1976
Past
Future
Le rêve de Jules Vernes
Point of Inflection (Assumed by Kahn et al. to have coincided with U.S. Bicentennial)
B
1976
Past
Future
Le rêve "écolo"
C
1976
Past
Future
Cauchemar possible
D
1976
Past
Future
Cauchemar probable
9-10 milliards d'hommes
1-2 milliards d'hommes
Carrying Capacity
Load
Temporary Carrying Capacity

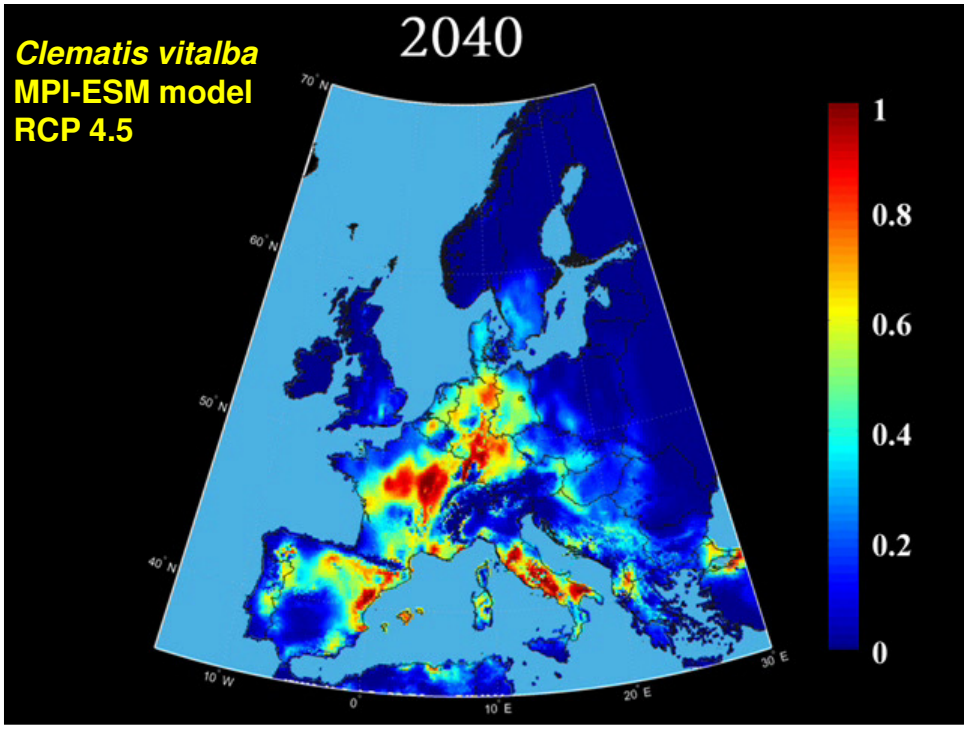

Mes petits enfants ne verront jamais cela

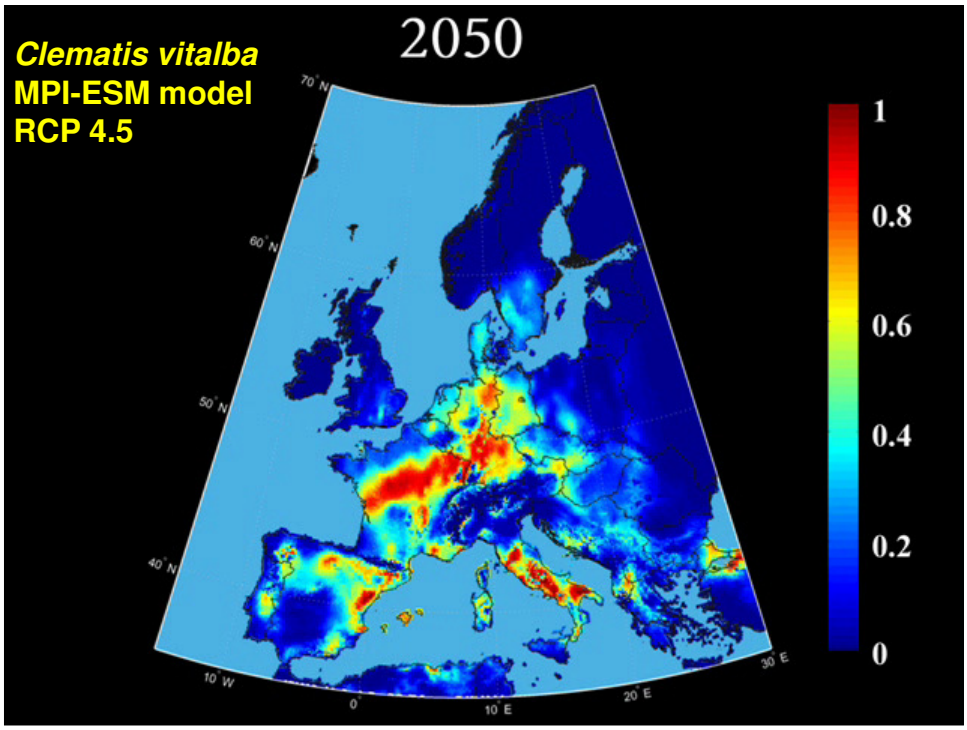

Mon cœur se serre !
COPYRIGHT SPENCER WILMOT
AIRLINERS.NET

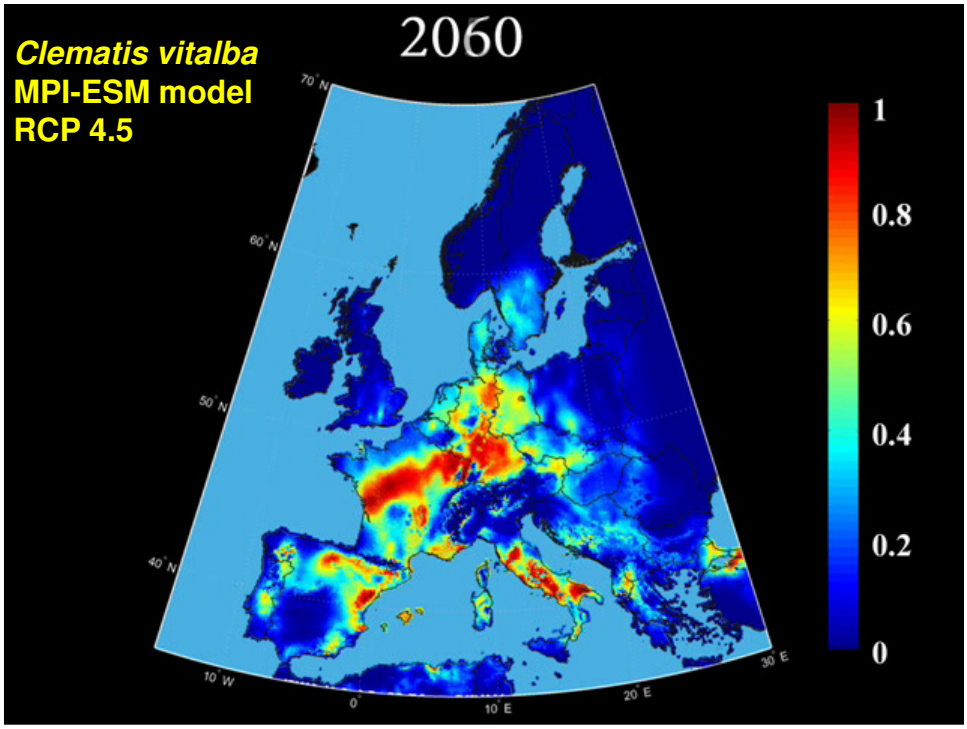

Clematis vitalba
MPI-ESM model
RCP 4.5
Current
70° N
60° N
50° N
40° N
10° W
0
10° E
20° E
30° E
1
0.8
0.6
0.4
0.2
0

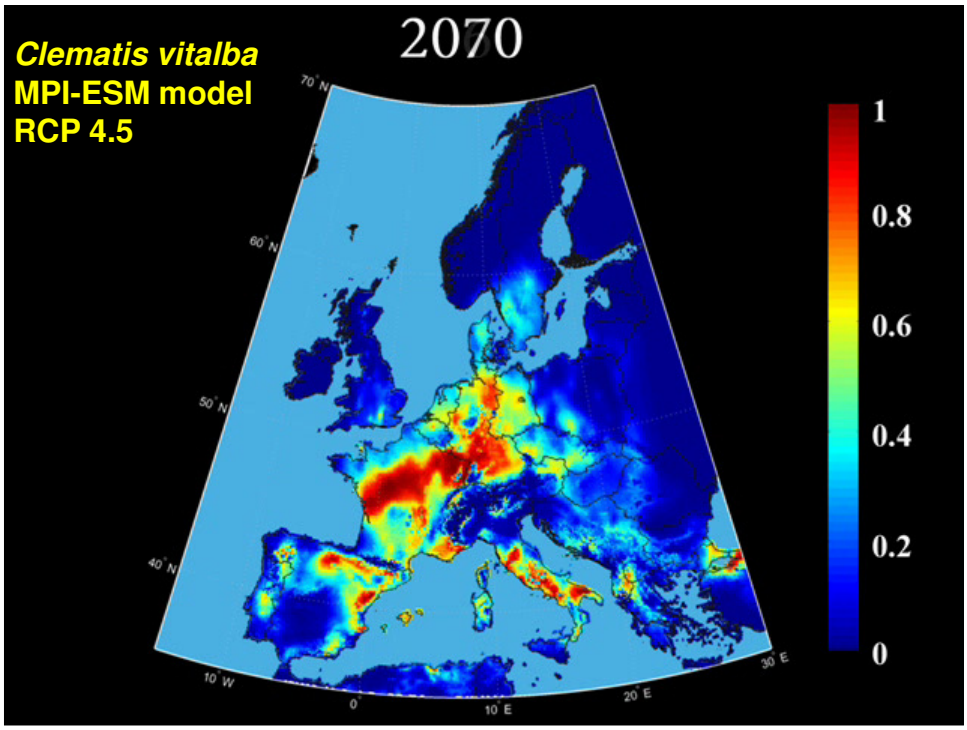

2020
Clematis vitalba
MPI-ESM model
RCP 4.5
70˚N
60˚N
50˚N
40˚N
10˚W
0˚
10˚E
20˚E
30˚E
1
0.8
0.6
0.4
0.2
0

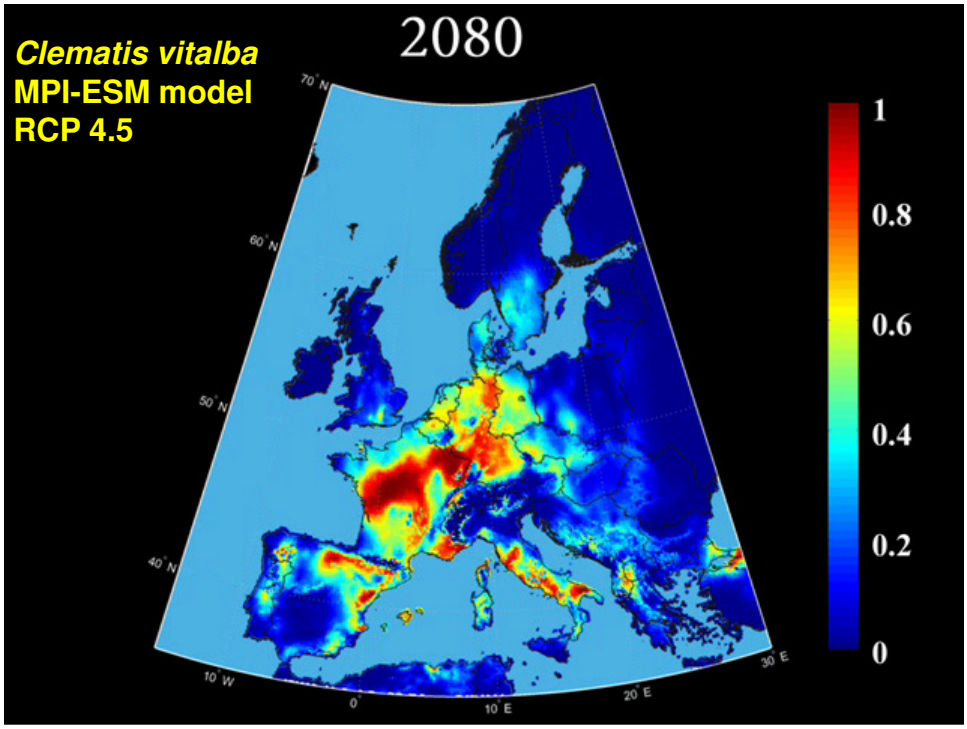

2030
Clematis vitalba
MPI-ESM model
RCP 4.5
70˚N
60˚N
50˚N
40˚N
10˚W
0˚
10˚E
20˚E
30˚E
1
0.8
0.6
0.4
0.2
0


2040
Clematis vitalba
MPI-ESM model
RCP 4.5
70° N
60° N
50° N
40° N
10° W
0°
10° E
20° E
30° E
1
0.8
0.6
0.4
0.2
0


2050
Clematis vitalba
MPI-ESM model
RCP 4.5
70° N
60° N
50° N
40° N
10° W
0°
10° E
20° E
30° E
1
0.8
0.6
0.4
0.2
0


2060
Clematis vitalba
MPI-ESM model
RCP 4.5
70° N
60° N
50° N
40° N
10° W
0°
10° E
20° E
30° E
1
0.8
0.6
0.4
0.2
0


2070
Clematis vitalba
MPI-ESM model
RCP 4.5
70° N
60° N
50° N
40° N
10° W
0°
10° E
20° E
30° E
1
0.8
0.6
0.4
0.2
0


Clematis vitalba
MPI-ESM model
RCP 4.5
2080
70° N
60° N
50° N
40° N
10° W
0°
10° E
20° E
30° E
1
0.8
0.6
0.4
0.2
0

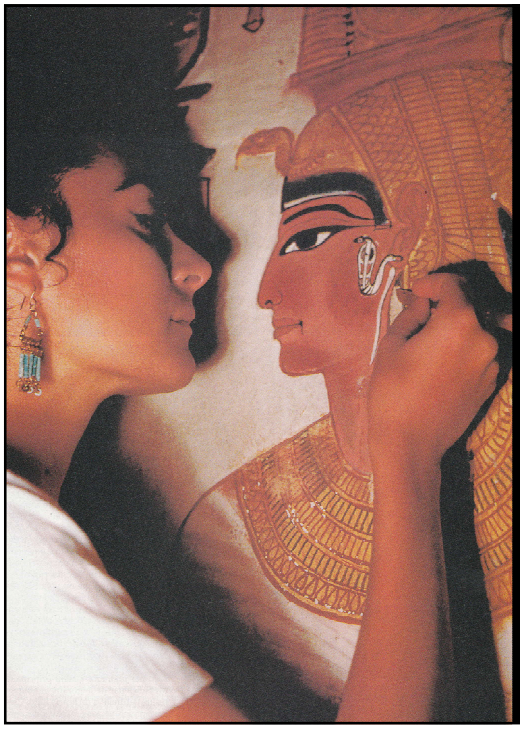

Lilium pomponium
In all cases, a lot of nice species will vanish
Testudo kleinmanni
Panthère des neige
Lilium pyrenaicum

The last Bombus distinguendus of Belgium was found by my father in the family garden in Brussels 1954. It needs now to go in North Scotland or in Sweden to see this species.

These good old times !

Thanks you for attention

De beaux objets technologiques seront perdus à jamais



Faut-il être définitivement pessimistes ?

Même après les pires cataclysmes,
la beauté peut renaître !

Lorenza d'Alessandro (conservatrice) restaure le portrait de Nefertari, épouse de Ramses II (1200 ans BC)