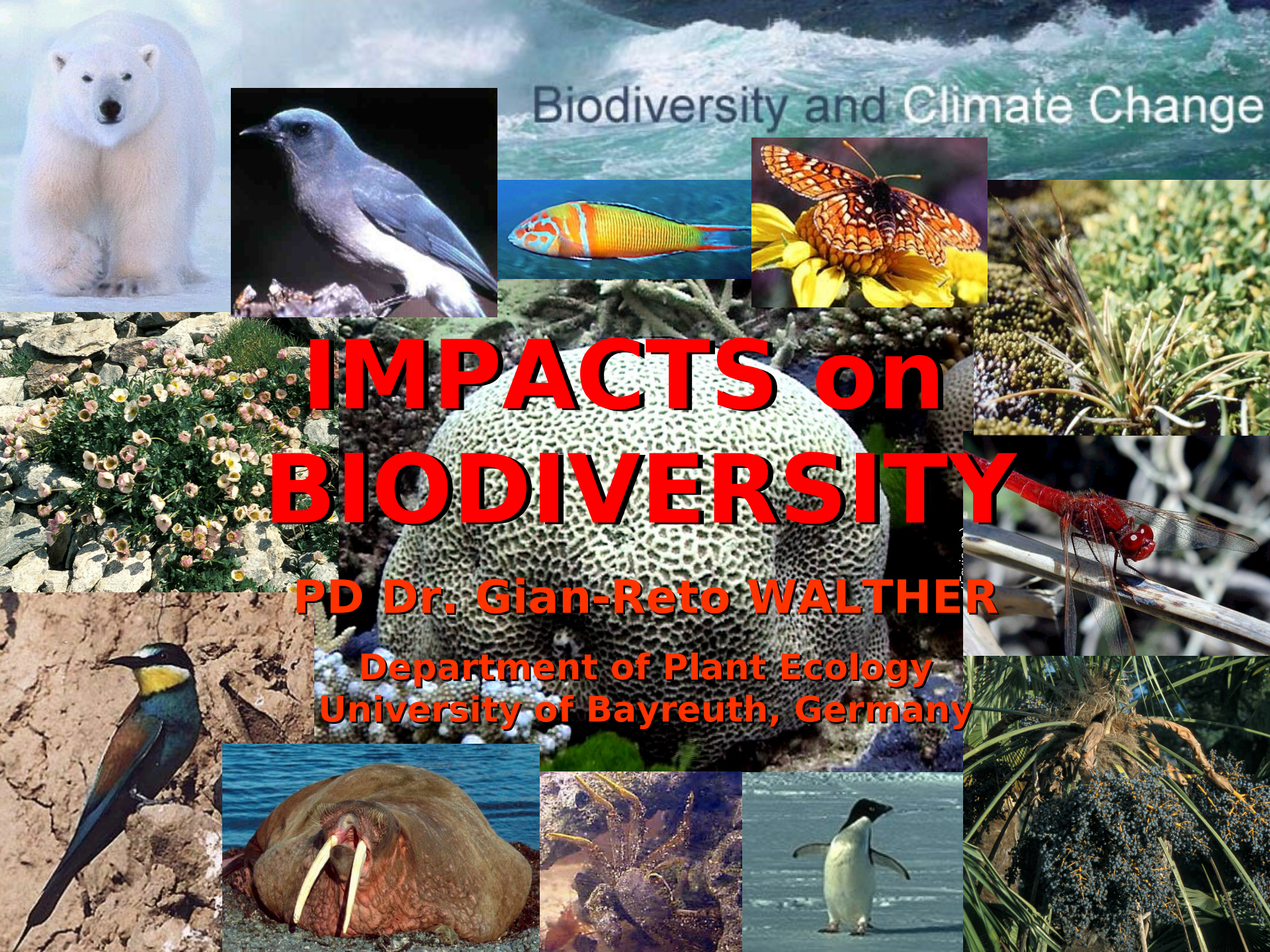

IMPACTS on BIODIVERSITY

PD Dr. Gian-Reto WALTHER

Department of Plant Ecology
University of Bayreuth, Germany

WMO

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

UNEP

Climate Change 2007: Impacts, Adaptation and Vulnerability

Working Group II Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report

---

Summary for Policymakers

This Summary for Policymakers was formally approved at the 8th Session of Working Group II of the IPCC, Brussels, April 2007

http://www.ipcc.ch/SPM13apr07.pdf

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

WMO

UNEP

"Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases.

There is very high confidence, based on more evidence from a wider range of species, that recent warming is strongly affecting terrestrial biological systems."

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This Summary for Policymakers was formally approved at the 8th Session of Working Group II of the IPCC, Brussels, April 2007

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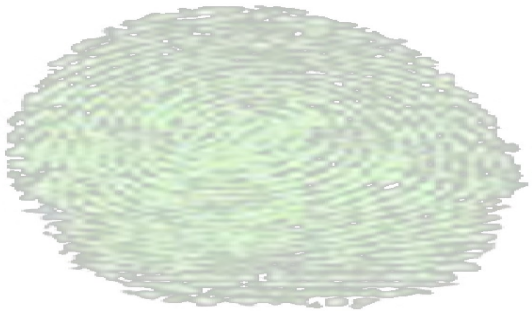

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Observed biotic responses to climate change

Climate effects on mountain plants

Georg Grabherr, Michael Gottfried
Harald Pauli
Department of Vegetation
Ecology and Conservation P
University of Vienna, PO
A1091 Vienna, Aus

NATURE · VOL 369 · 9 JUNE 1994

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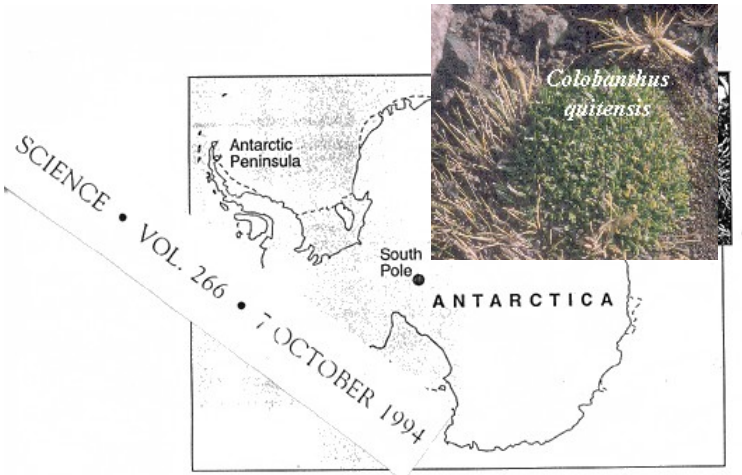

SCIENCE • VOL. 266 • 7 OCTOBER 1994

Gaining ground. Antarctic pearlwort responds to warming trend.

Greening of the Antarctic Peninsula

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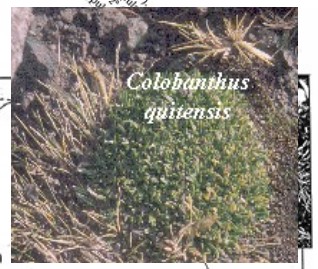
Climate and species' range

SCIENTIFIC CORRESPONDENCE

NATURE · VOL 382 · 29 AUGUST 1996



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Camille Parmesan*†, Nils Ryrholm‡, Constantí Stefanescu§, Jane K. Hill‖, Chris D. Thomas§, Henri Descimon#, Brian Huntley‖, Lauri Kaila☆, Jaakko Kullberg☆, Toomas Tammaru**, W. John Tennent††, Jeremy A. Thomas‡‡ & Martin Warren§§

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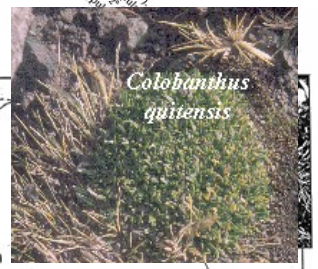

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Proc. Natl. Acad. Sci. USA
Vol. 96, pp. 5565–5569, May 1999
Ecology

Long-term trend toward earlier breeding in an American bird: A response to global warming?

Jerram L. Brown*†, Shou-Hsien Li†‡, and Nirmal Bhagabati*†

*Department of Biological Sciences, State University of New York, Albany, NY 12222; and ‡American Museum of Natural History, New York, NY 10024

Communicated by Gordon H. Orians, University of Washington (received for review October 14, 1998)

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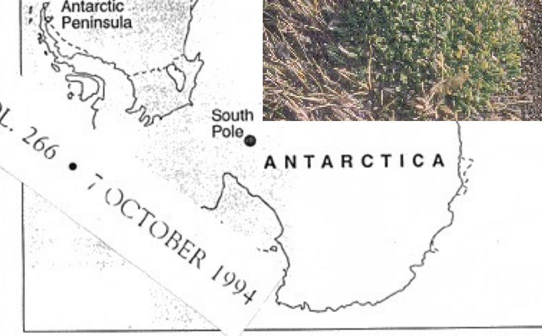

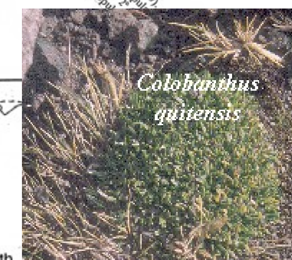

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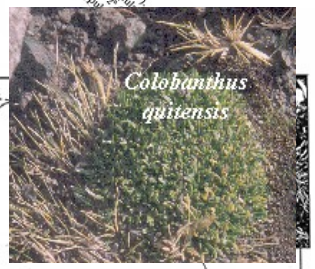

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NATURE | VOL 400 | 8 JULY 1999 |

White out: widespread coral bleaching would pose a severe threat to ecosystems and local economi...

Global warming 'could kill most coral reefs by 2100'

[SYDNEY] An Australian scientist has identified global warming as the most likely culprit for last year's widespread coral bleaching, and predicts that similar events are likely to occur annually in most tropical oceans within 30–50 years.

ever the temperature was only one deg... above ambient, mass death of corals occurr...

Now, in what is claimed to be the f... application of computer models to coral r... research, Hoegh-Guldberg has projected h... the climate will change in regions where co...

Poleward shifts in geographical ranges of butterfly species associated with regional warming

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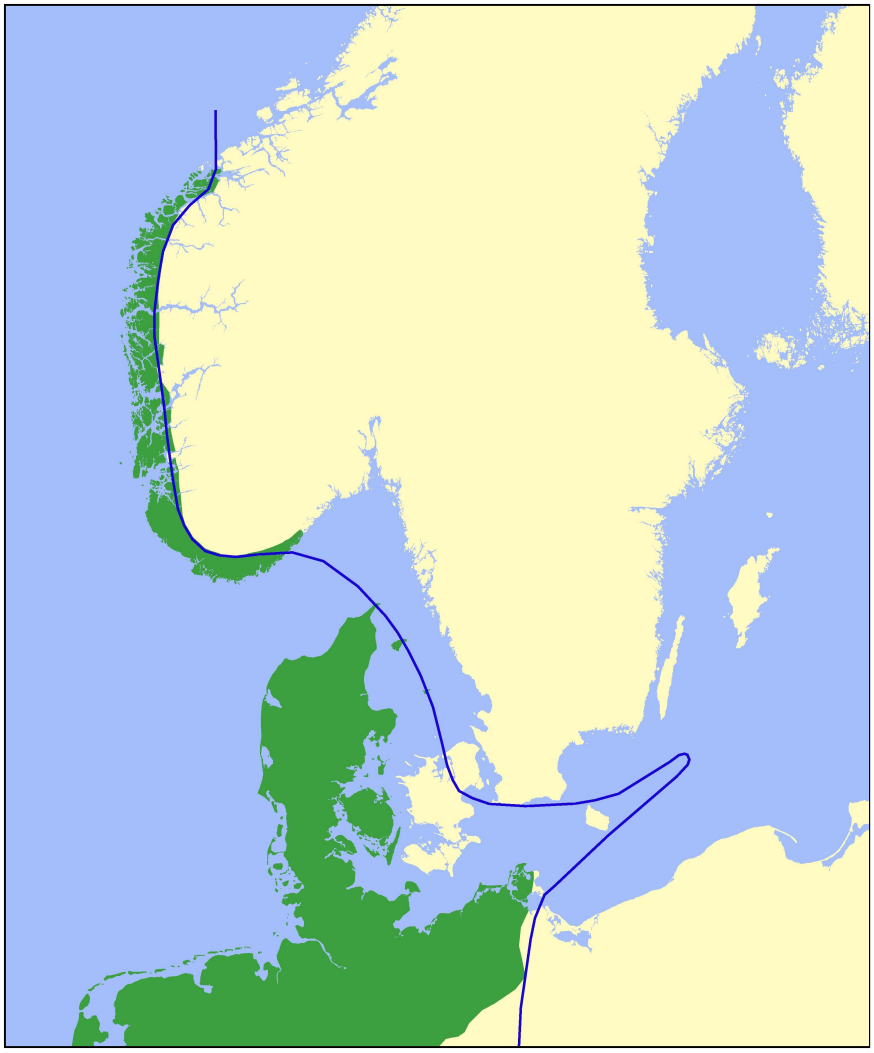
Evergreen broad-leaved species

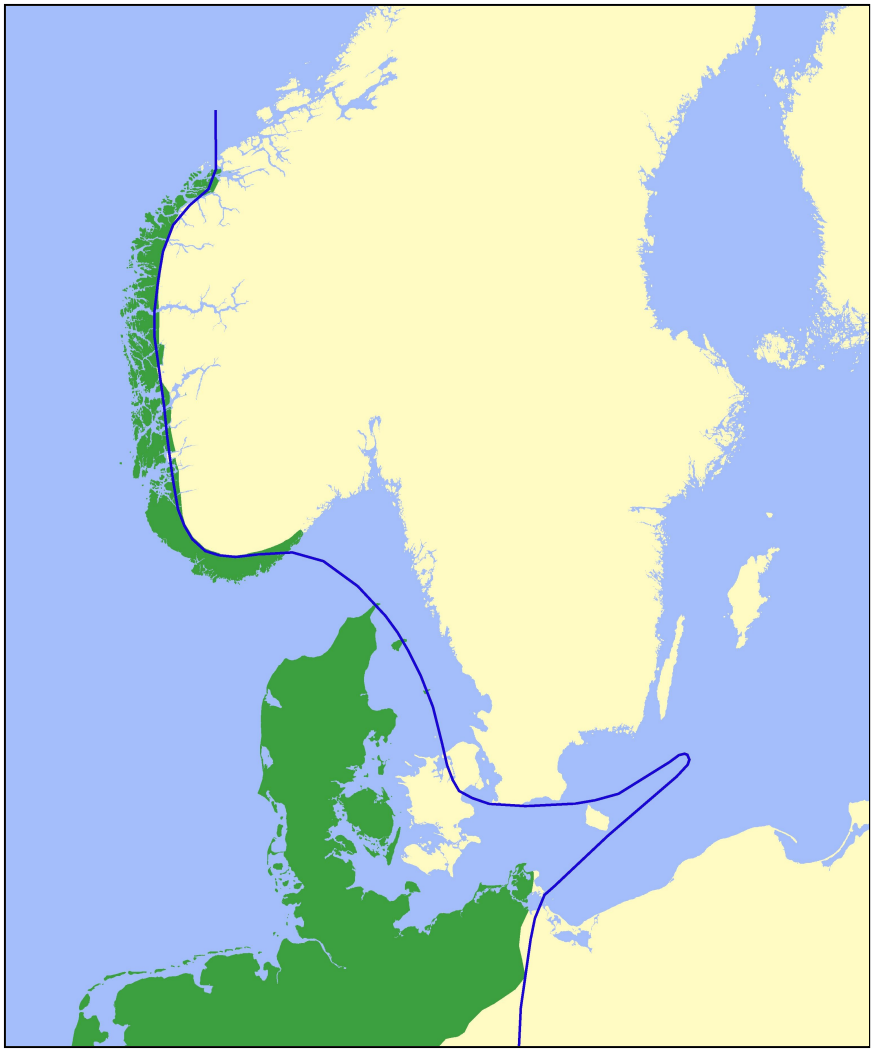


Walter & Straka 1970, *Arealkunde* (Ulmer, Stuttgart), modified

Holly *(Ilex aquifolium)*

0°C-January-Isoline

Evergreen broad-leaved species



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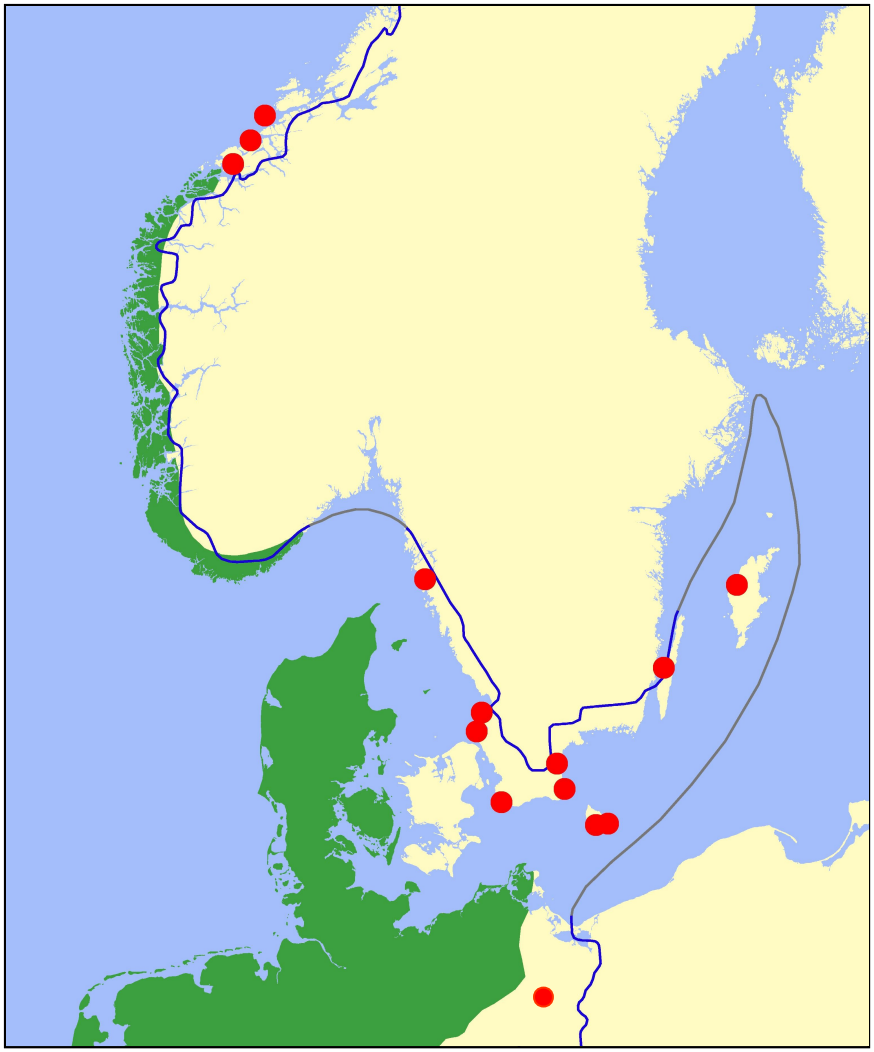
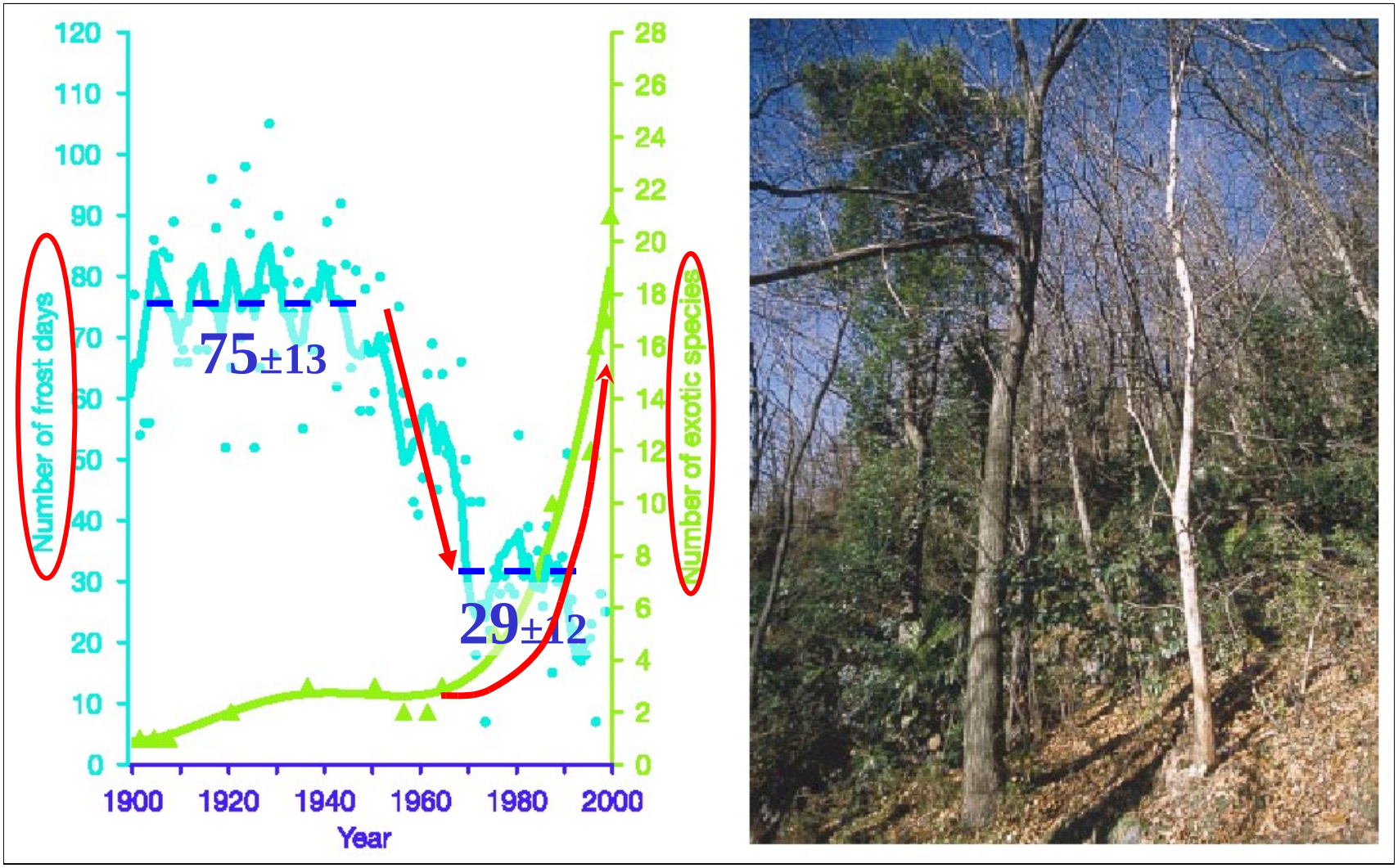


Walther *et al*. 2005, *Proc. R. Soc. Lond. B*, 272, 1427-1432

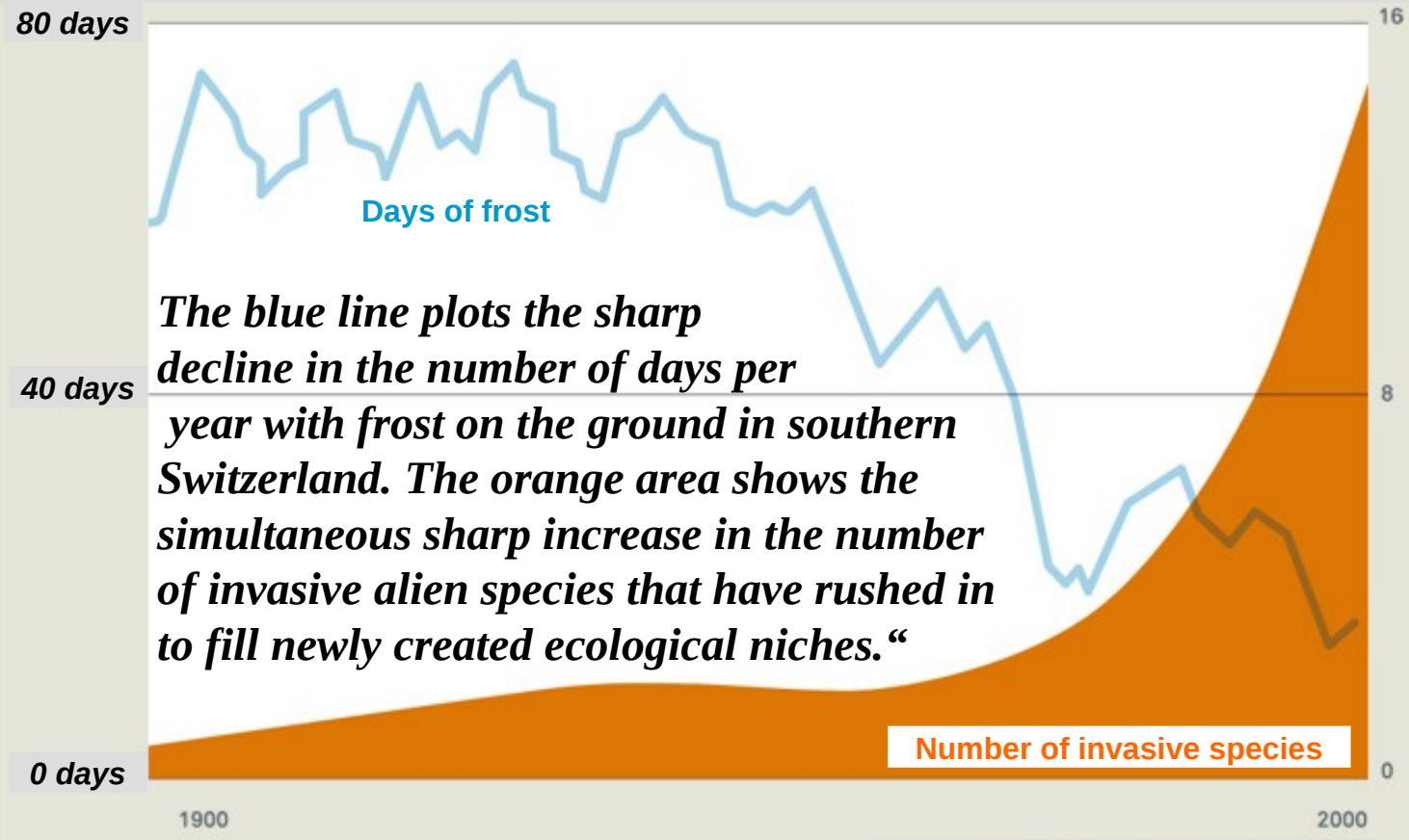

Cherry laurel
(Prunus laurocerasus)
Windmill palm
(Trachycarpus fortunei)
Laurel
(Laurus nobilis)

Milder winters favour evergreen exotics



Walther *et al*. 2002, *Nature* 416, 389-395

„Here is another example of how global warming disrupts the balance of nature as we have known it.



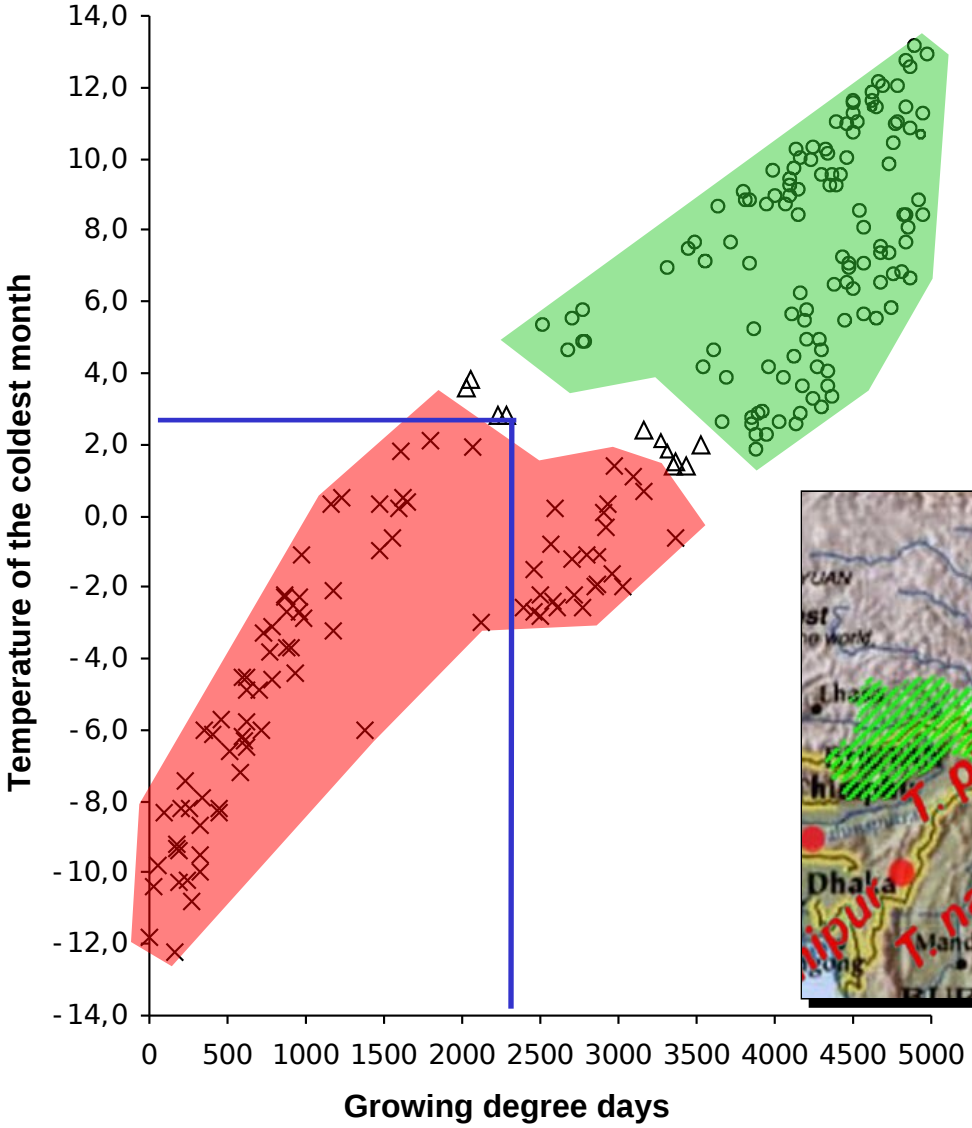
The blue line plots the sharp decline in the number of days per year with frost on the ground in southern Switzerland. The orange area shows the simultaneous sharp increase in the number of invasive alien species that have rushed in to fill newly created ecological niches.“

Gore 2006, *An inconvenient truth*, p. 154

Chusan palm (*Trachycarpus fortunei*)

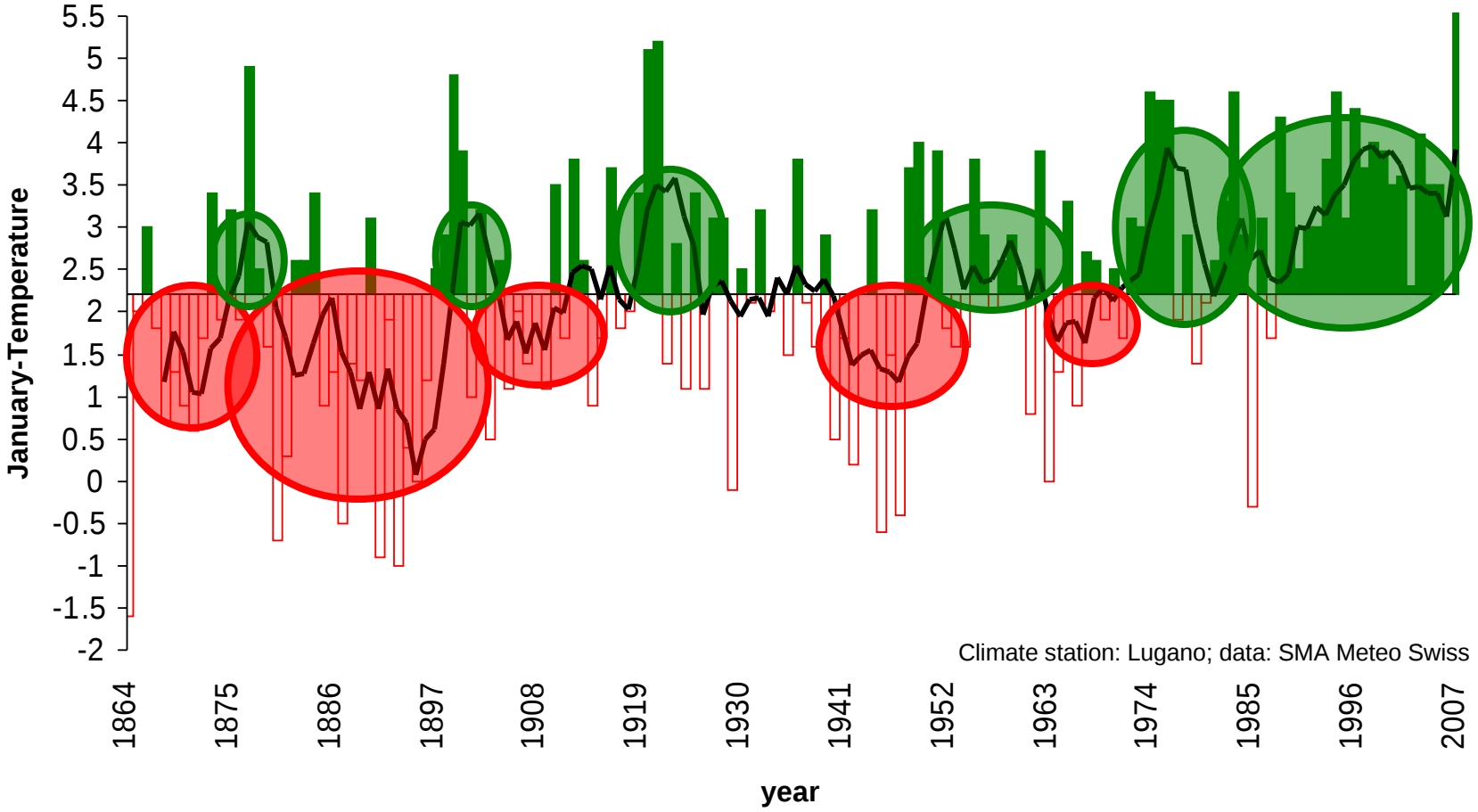
at the southern foot of the Alps

Climatic limits in the native range



Walther *et al*.2007, *Global Ecology & Biogeography*, published online

Winter temperature in the introduced range (1864-2004)



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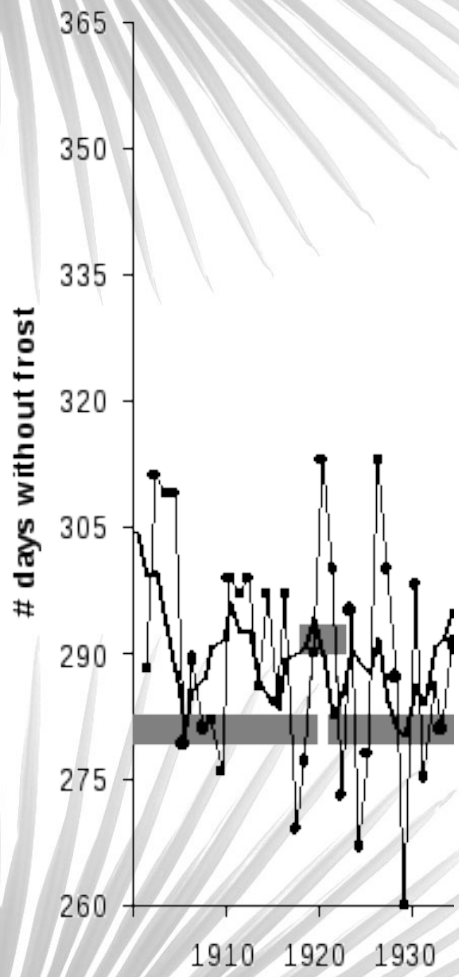
Establishment of *Trachycarpus fortunei*



stages of invasion process

planted in gardens and parks

Walther *et al*.2007, *Global Ecology & Biogeography*, published online

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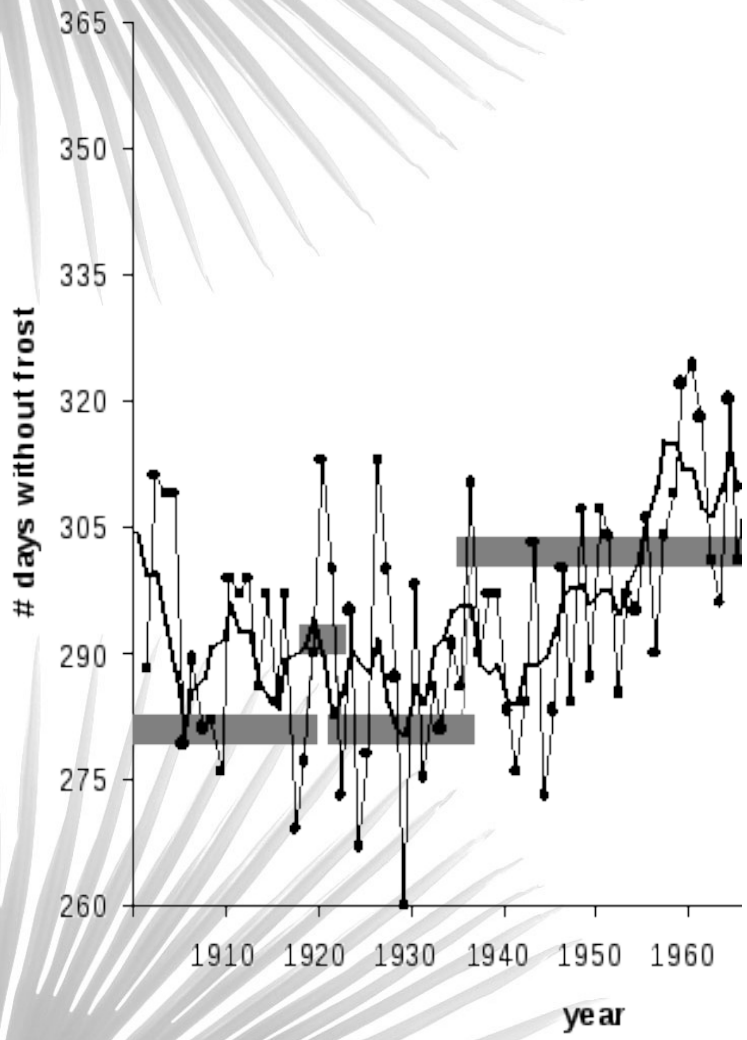

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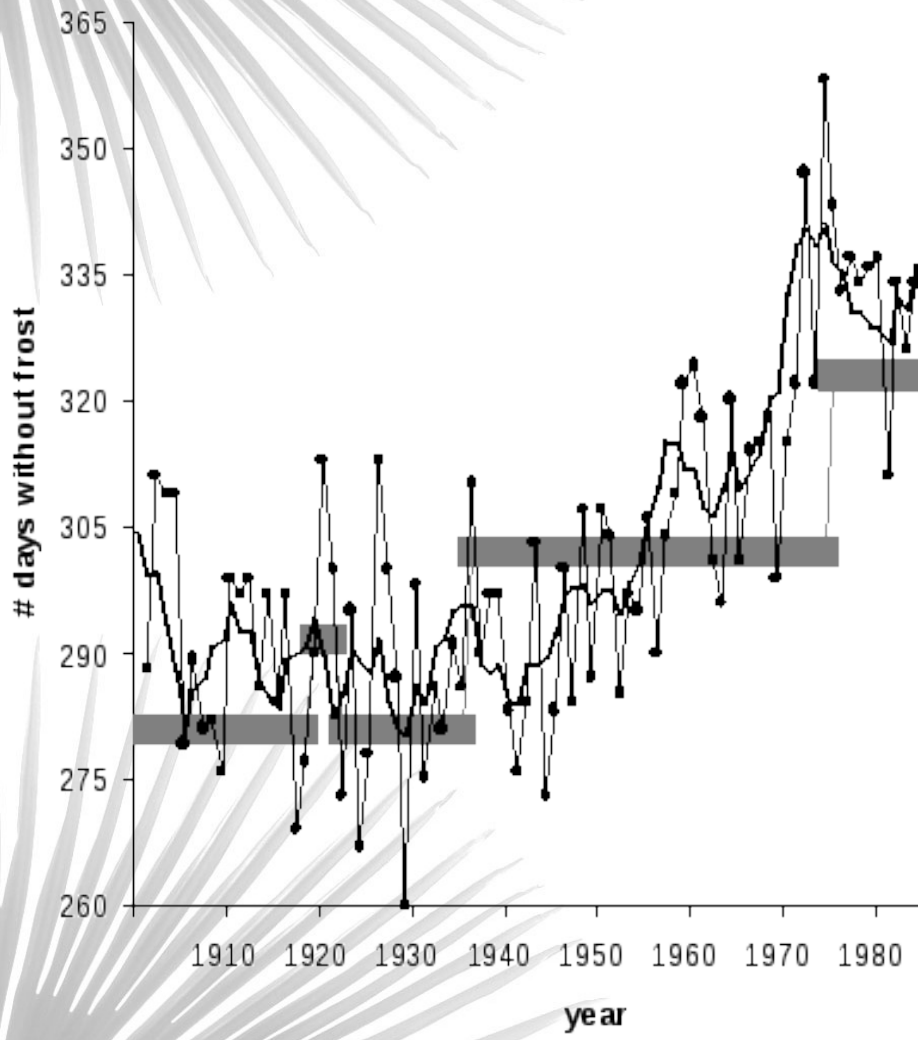

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juvenile palms in herb layer

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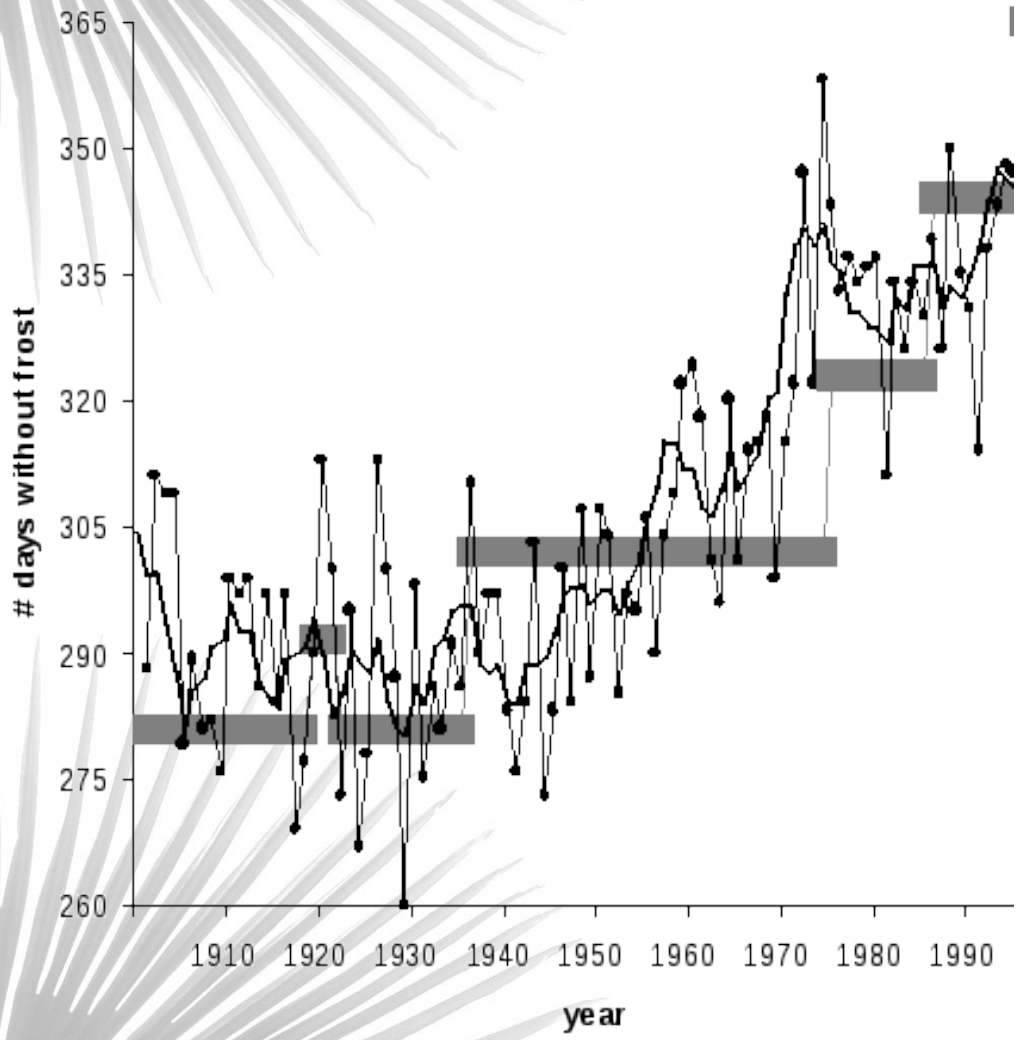

stag[illegible]rocess

juvenile palms in shrub layer

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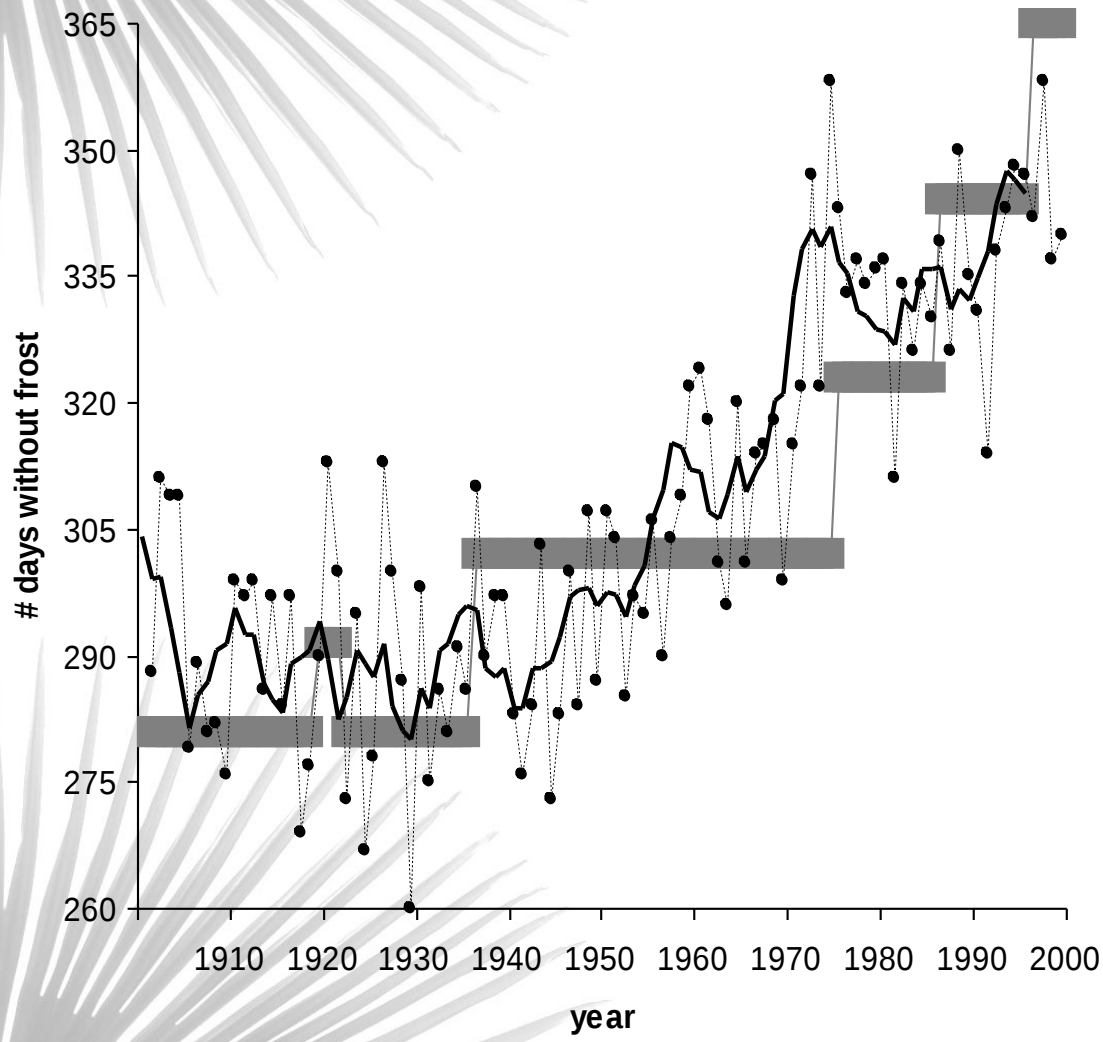


stages of invasion process

regeneration in forests

juvenile palms in shrub layer

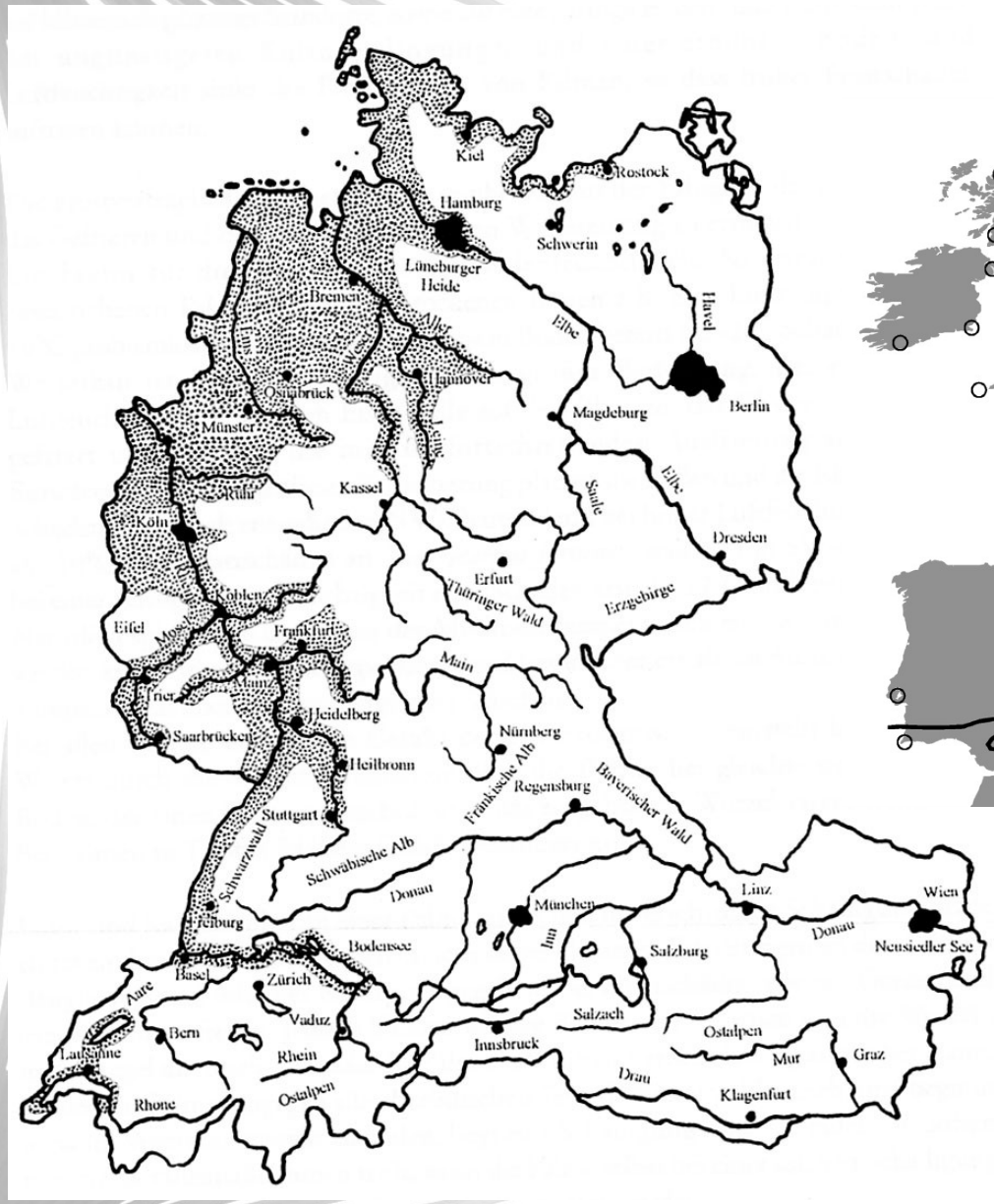
juvenile palms in herb layer

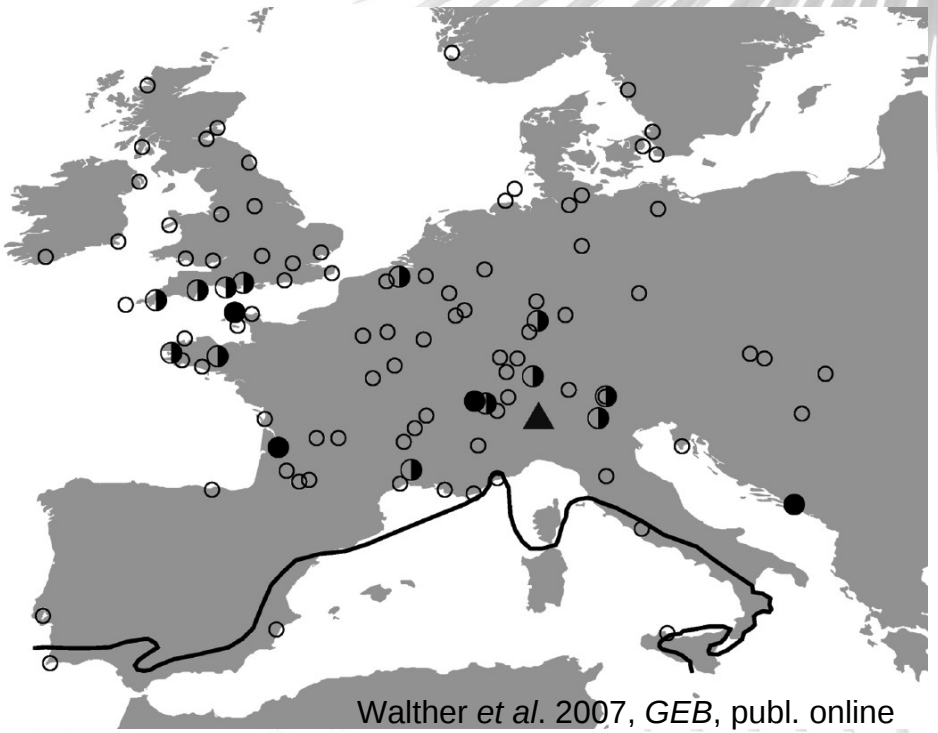
seeds freely in gardens

planted in gardens and parks

Walther *et al*.2007, *Global Ecology & Biogeography*, published online

Suitable areas for palm cultivation in Europe





Walther *et al*. 2007, *GEB*, publ. online

- established
- planted
- seeds freely in gardens
- seeds freely in the wild

Stähler 2000, *Palmen in Mitteleuropa* (The European Palm Society, Munich)

Palms in Belgium

Gembloux Agricultural University - Botanical Garden

Trachycarpus fortunei
(Hook.) H.A. Wendl.

Planted: 1958 (plot 14/section 04)

Stem height: 3 metres 70 centimetres
(May 2003)

"*This plant is cultivated in the open air and is probably one of the oldest palm trees in Belgium.*"


© johanok @ gmail.com

The Journal of The European Palm Society - No. 42 - 2001

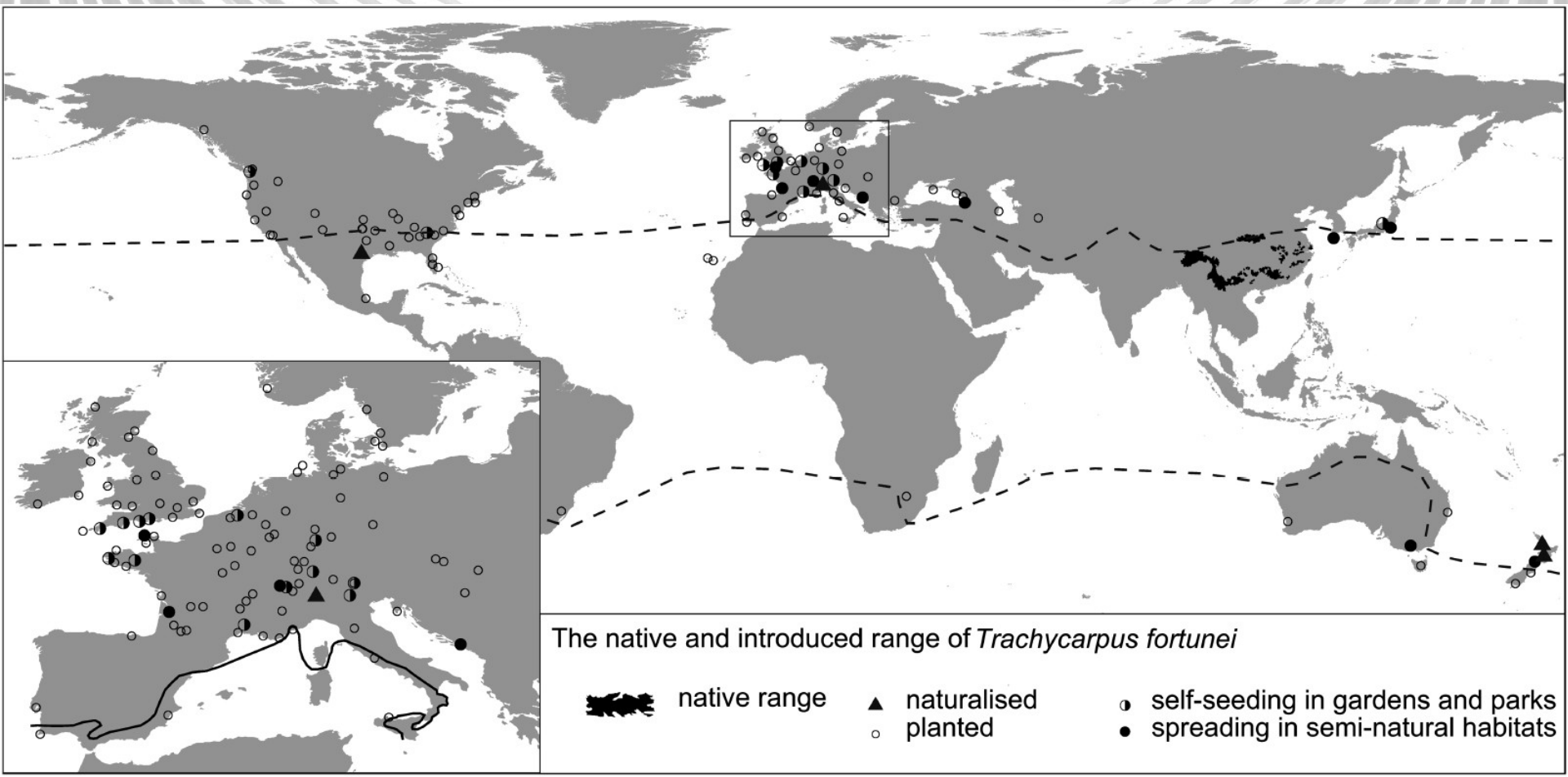
Chamaerops

42

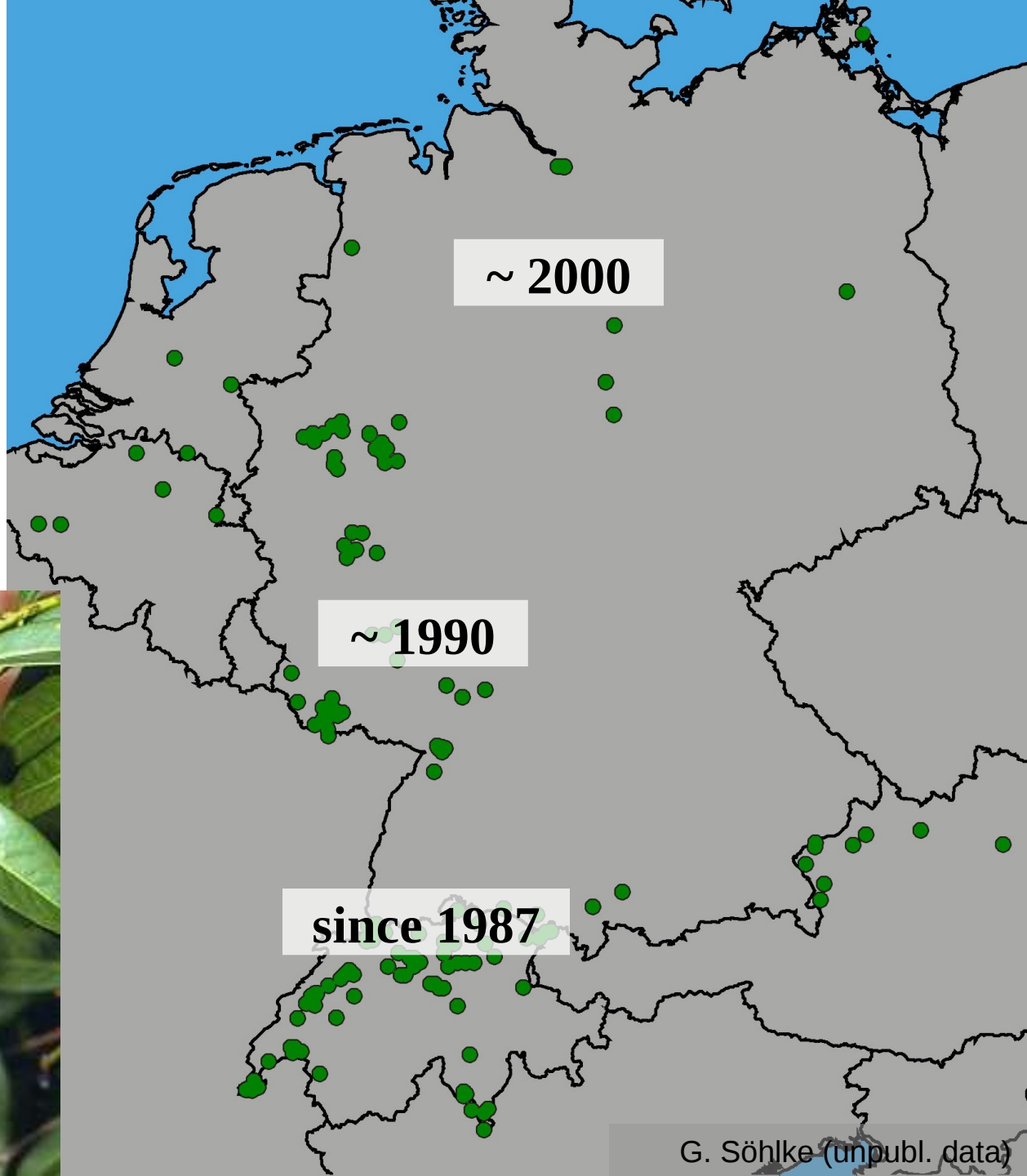
A Lifetime of Experience

Eric van Speybroeck, Zevergem (De Pinte), Belgium

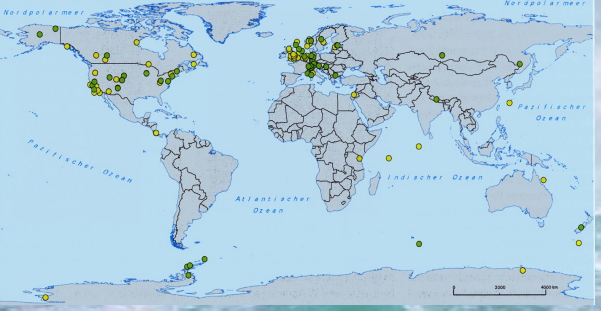
In the spring of 1975 most palms were in full bloom, and my surprise came in the summer of 1976 when I discovered some small palms only a few centimeters high growing in the shadows of the big ones. They survived the winter of 1985 and by now have reached 3 1/2 to 4m with trunks 2 1/2 to 3m high.


The native and introduced range of *Trachycarpus fortunei*
native range
naturalised
planted
self-seeding in gardens and parks
spreading in semi-natural habitats

Subspontaneous occurrences of *Prunus laurocerasus* in central Europe



G. Söhlke (unpubl. data)



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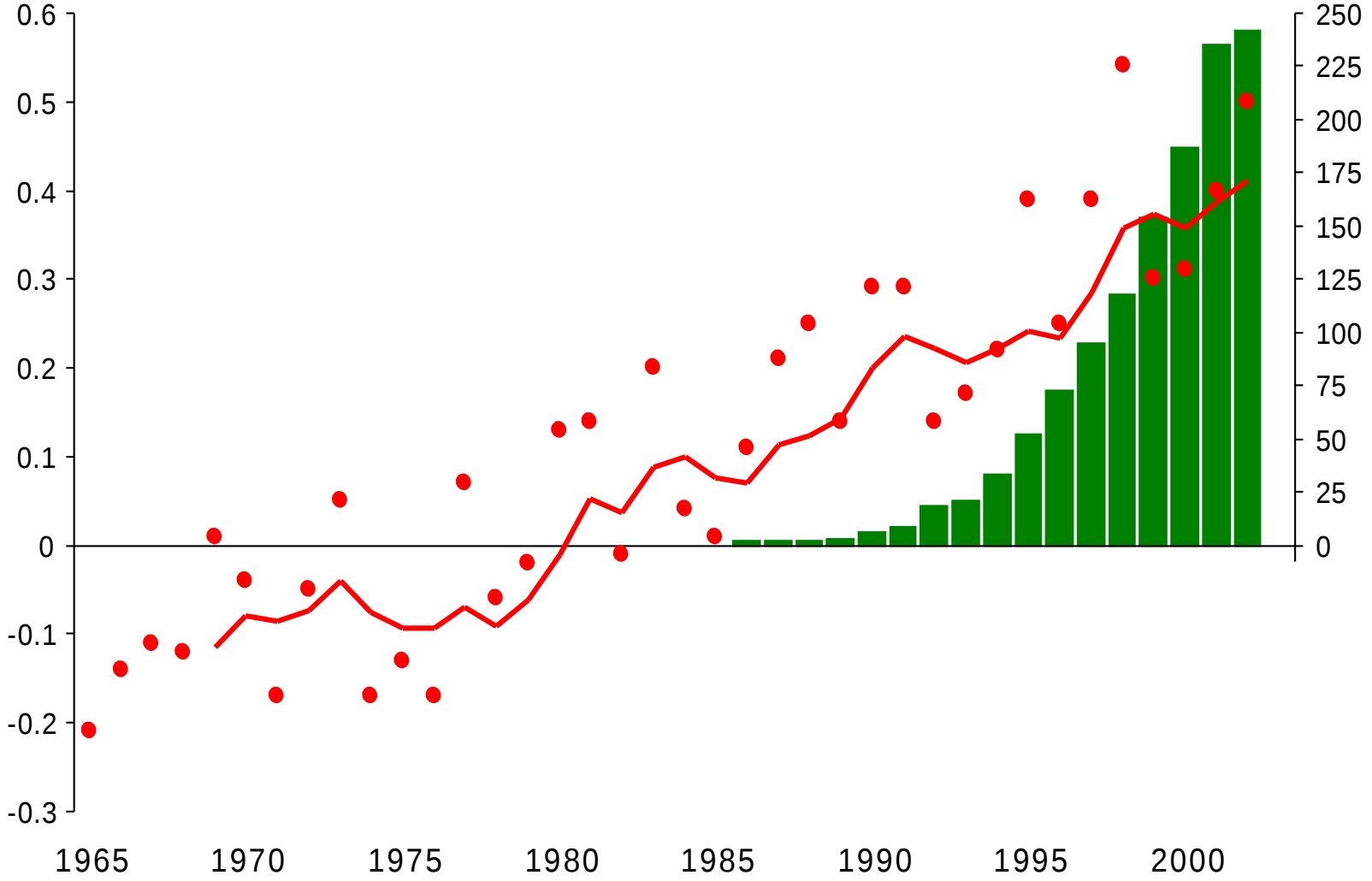
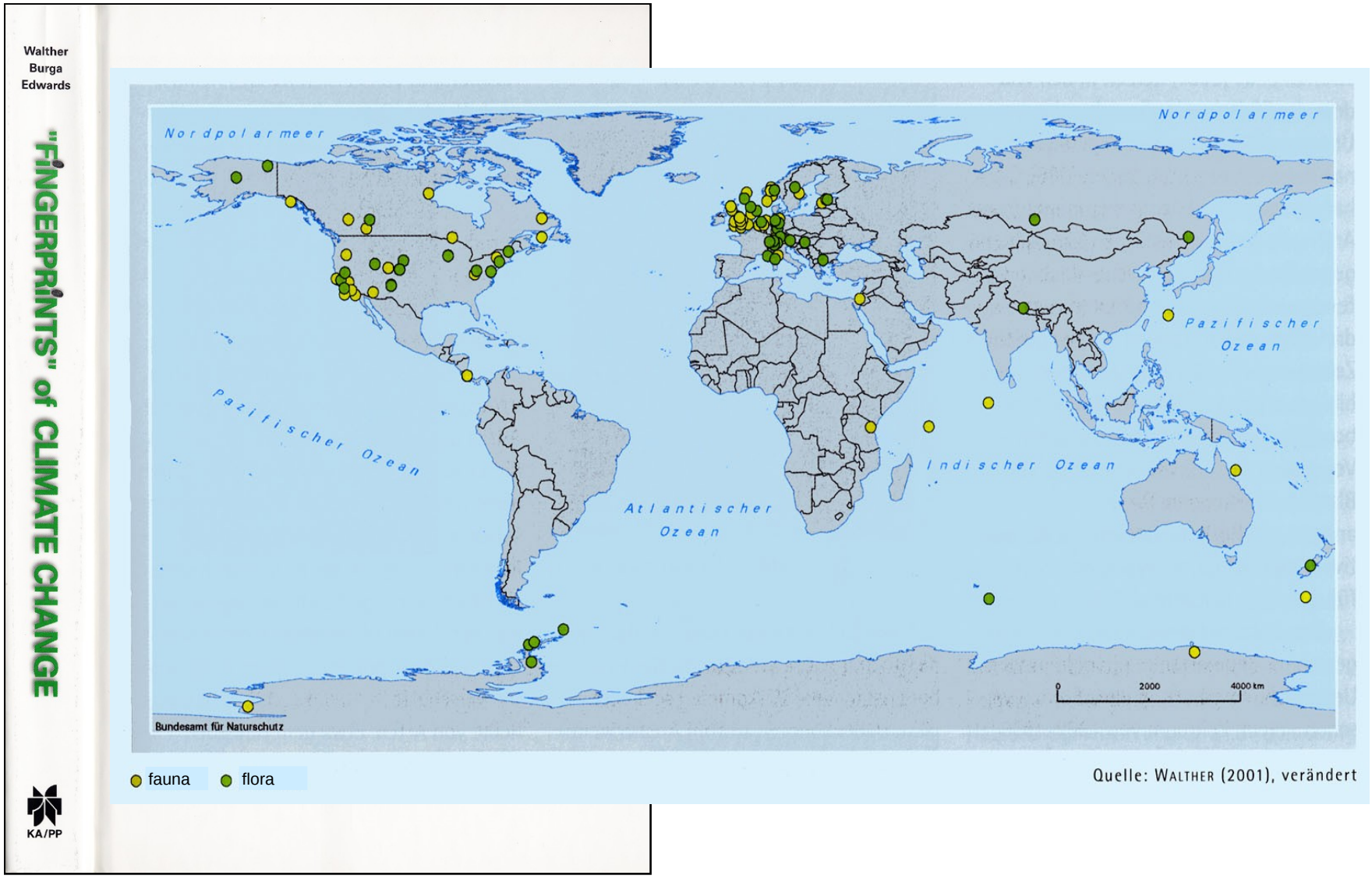
Reported biotic responses and global temperature anomalies



Walther *et al*. 2005, *TREE* 20(12), 648-649

Global distribution of ecological 'fingerprints' of climate change



from Walther 2001, '*Fingerprints' of Climate Change*, modified

Review articles on observed climate impacts

NATURE | VOL 416 | 28 MARCH 2002 | www.nature.com

review article

Ecological responses to recent climate change

Gian-Reto Walther*, Eric Post†, Peter Convey‡, Annette Menzel§, Camille Parmesan‖, Trevor J. C. Beebee¶, Jean-Marc Fromentin#, Ove Hoegh-Guldberg☆ & Franz Bairlein**

* *Institute of Geobotany, University of Hannover, Nienburger Str. 17, 30167 Hannover, Germany*
† *Department of Biology, The Pennsylvania State University, 208 Mueller Lab, University Park, Pennsylvania 16802, USA*
‡ *British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge CB3 0ET, UK*
§ *Department of Ecology, Technical University Munich, Am Hochanger 13, 85354 Freising, Germany*
‖ *Integrative Biology, Patterson Labs 141, University of Texas, Austin, Texas 78712, USA*
¶ *School of Biological Sciences, University of Sussex, Falmer, Brighton BN1 9QG, UK*
# *IFREMER, Centre Halieutique Méditerranéen et Tropical, Bvld Jean Monnet, BP 171, 34203 Sète Cedex, France*
☆ *Centre for Marine Studies, University of Queensland, St Lucia, 4072 Queensland, Australia*
** *Institute for Avian Research 'Vogelwarte Helgoland', An der Vogelwarte 21, 26386 Wilhelmshaven, Germany*

There is now ample evidence of the ecological impacts of recent climate change, from polar terrestrial to tropical marine environments. The responses of both flora and fauna span an array of ecosystems and organizational hierarchies, from the species to the community levels. Despite continued uncertainty as to community and ecosystem trajectories under global change, our review exposes a coherent pattern of ecological change across systems. Although we are only at an early stage in the projected trends of global warming, ecological responses to recent climate change are already clearly visible.

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NATURE | VOL 416 | 28 MARCH 2002 | www.nature.com

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☆ Centre for Marine Studies, University
** Institute for Avian Research 'Vogelwar

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review exposes a coherent patte
trends of global warming, ecolo

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Fingerprints of global warming on wild animals and plants

Terry L. Root*, Jeff T. Price†, Kimberly R. Hall‡, Stephen H. Schneider§, Cynthia Rosenzweig‖ & J. Alan Pounds¶

A globally coherent fingerprint of climate change impacts across natural systems

Camille Parmesan* & Gary Yohe†

Synthesis reports on climate impacts

Review articles on observed climate impacts

Ecological and Evolutionary Responses to Recent Climate Change

Camille Parmesan

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Annu. Rev. Ecol. Evol. Syst. 2006. 37:637–69

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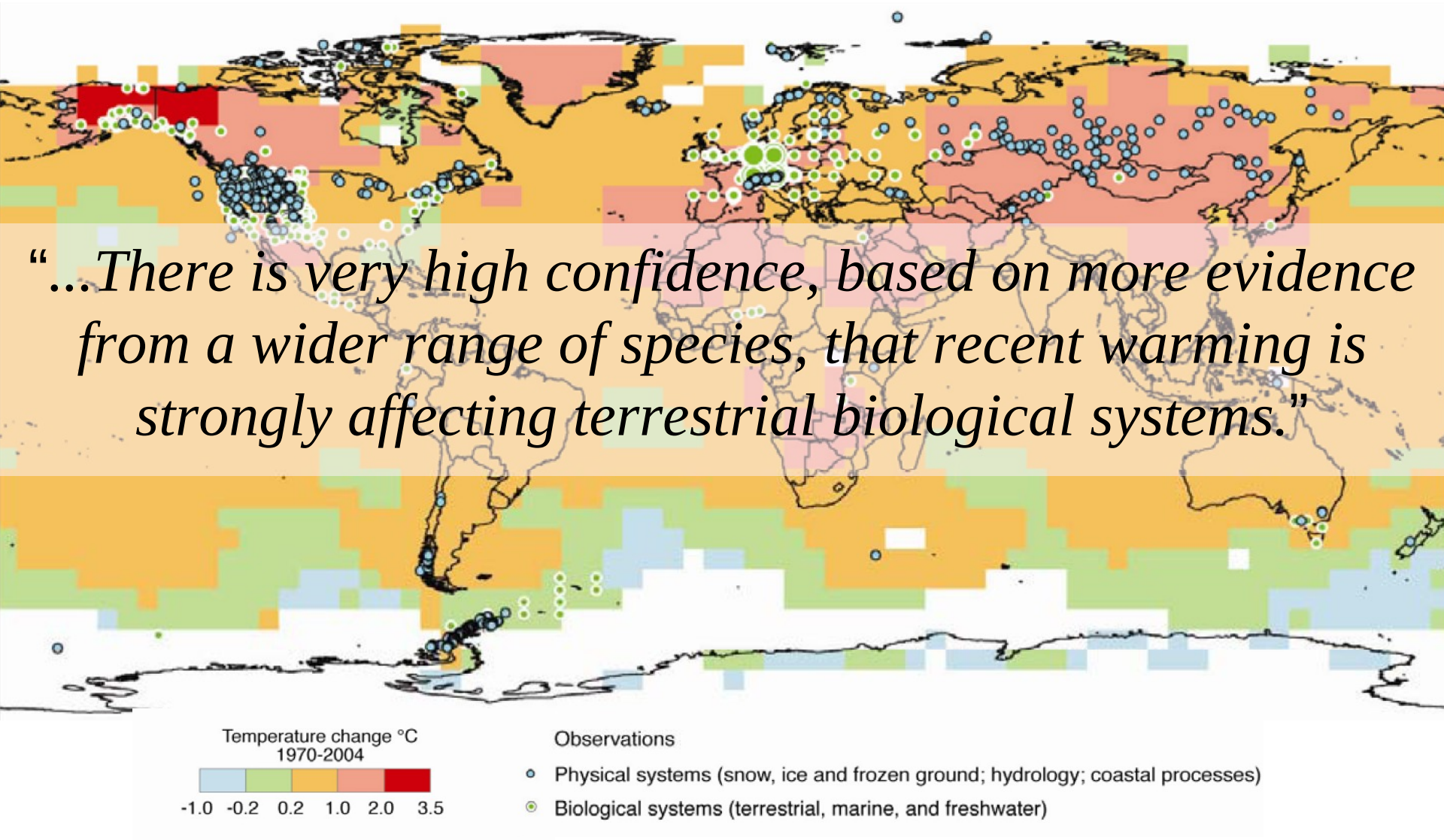
The *Annual Review of Ecology, Evolution, and Systematics* is online at http://ecolsys.annualreviews.org

This article's doi: 10.1146/annurev.ecolsys.37.091305.110100

"Notably, the publication rate of climate-change responses increases sharply each year. The number of publications between 1899 and January 2003 [...] was 528. Therefore, approximately 40% of the 866 papers compiled for this review were published in the past three years (January 2003 to January 2006)."

Parmesan 2006, *Ann. Rev. Ecol. Evol. Syst.* 37, 637-669

Changes in physical and biological systems and surface temperature 1970-2004



"...There is very high confidence, based on more evidence from a wider range of species, that recent warming is strongly affecting terrestrial biological systems."

IPCC WGII 2007, *Fourth Assessment Report* (SPM)

IMPACTS on BIODIVERSITY

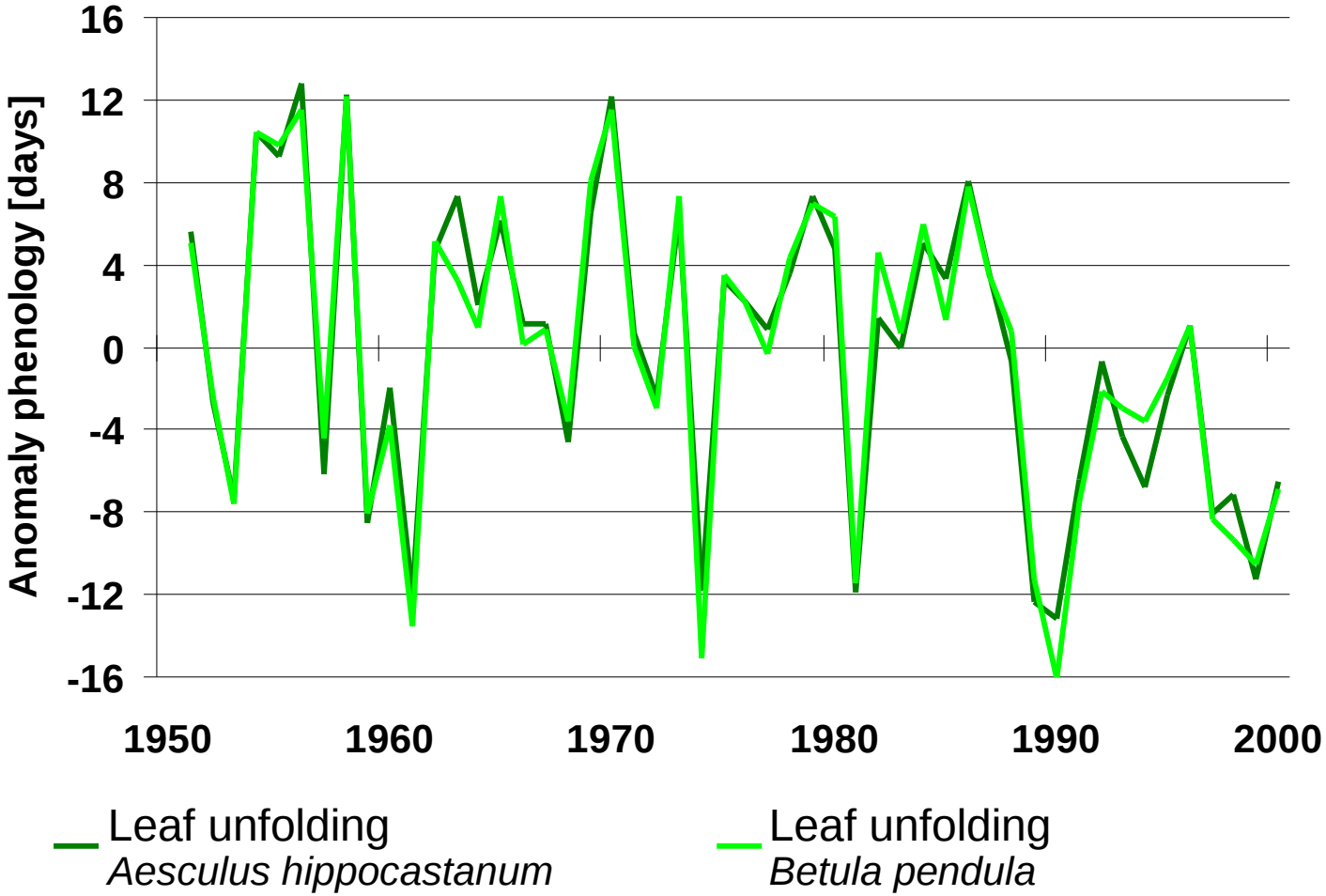
Contents

- case studies of observed biotic responses to climate change
  => ecological ‘fingerprints’ of climate change
- example for the improved understanding of the mechanistic basis for the observed biotic responses to climate change
- multiplicity of ‘fingerprints‘ of climate change
  => reviews & synthesis reports
- ‘knowns’ and ‘unknowns’

known

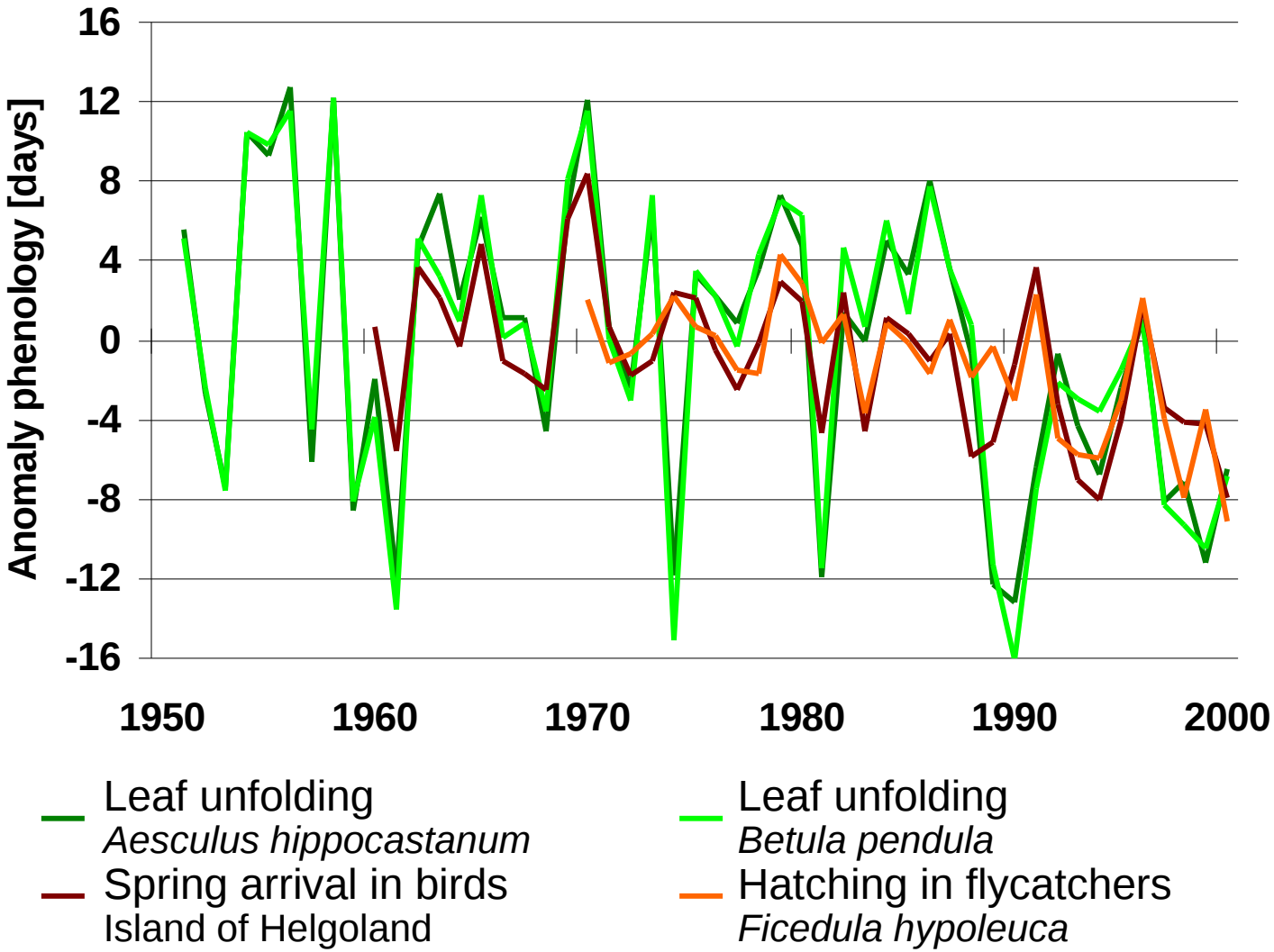
- ✓ phenological adaptation

Anomalies of different phenological phases



Walther *et al*. 2002, *Nature* 416, 389-395

Anomalies of different phenological phases



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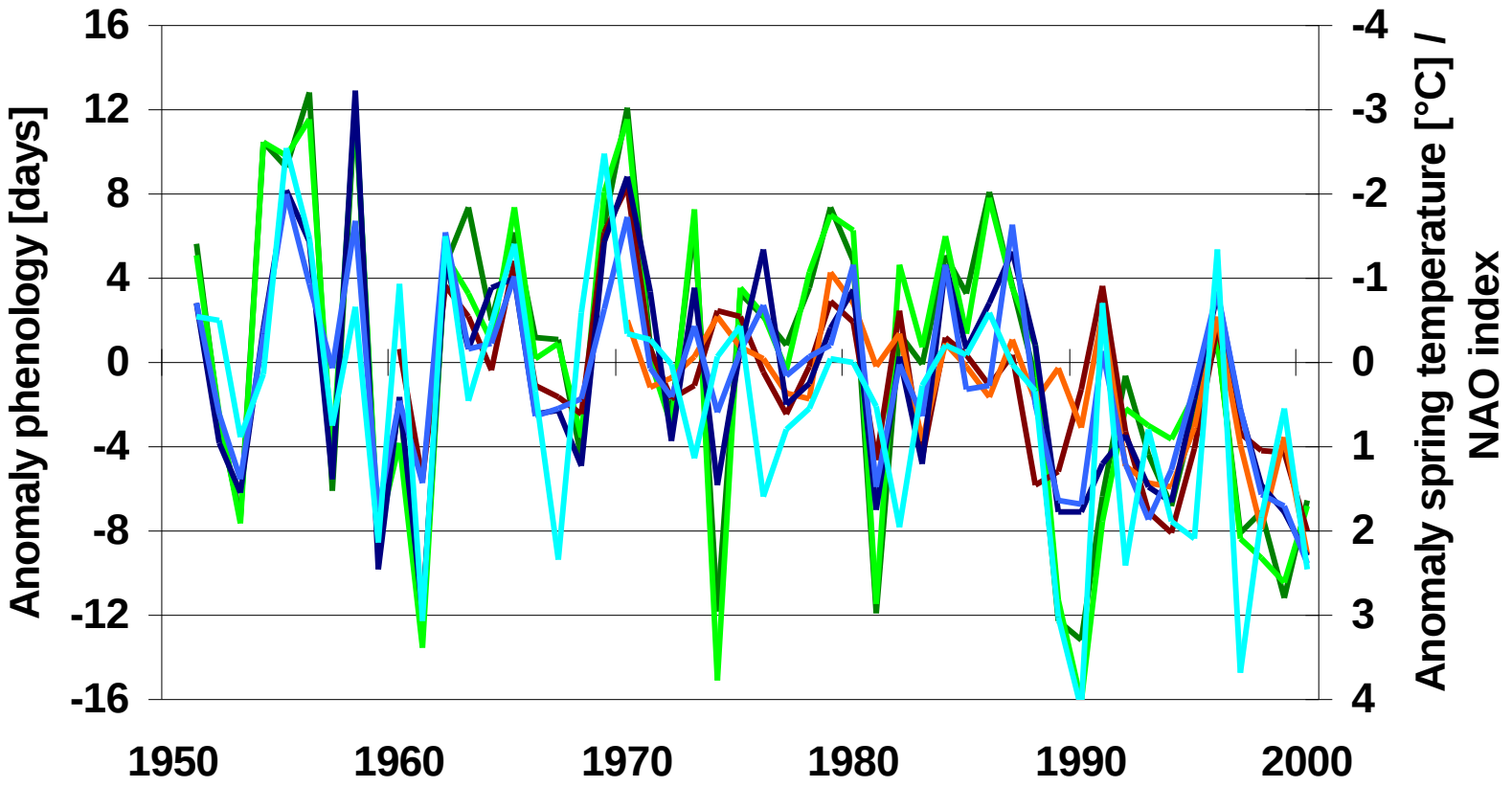
Anomalies of different phenological phases



Walther *et al*. 2002, *Nature* 416, 389-395

Changes in phenology of plant species

	Location	Period	Phenochange (day year^{-1})	Number of species	Reference
1	Hungary	1851–1994	–0.06–0.02	1	Walkovszky (1998)
2	Japan	1900–1988	–0.07–0.05	1	Yoshino & Park-Ono (1996)
3	Alberta, Canada	1900–1997	–0.26	1	Beaubien & Freeland (2000)
4	Estonia	1919–1996	–0.17–0.05	4	Ahas (1999)
5	Norway	1928–1977	–0.53–0.27	7	Post & Stenseth (1999)
6	Wisconsin	1936–1947 1976–1998	–0.12	55	Bradley et al. (1999)
7	Estonia	1948–1996	–0.5–0.3	13	Ahas et al. (2000)
8	Europe	1951–1996	–0.28–0.02	16	Menzel (2000)
9	Germany	1951–1996	–0.53–0.03	9	Menzel et al. (2001)
10	Switzerland	1951–2000	–0.23	13	Defila & Clot (2001)
11	Cardedeu, NE-Spain	1952–2000	–0.77–0.17	24	Penuelas et al. (2002)
12	South-central England	1954–2000	–1.17–+0.77	385	Fitter & Fitter (2002)
13	Western United States	1957/1968–1994	–0.38–0.2	2	Cayan et al. (2001)
14	Europe	1959–1993	–0.20	16	Menzel & Fabian (1999)
15	North America	1959–1993	–0.18–0.14	1	Schwartz & Reiter (2000)
16	China	1963–1996 excl. 1968–70	–0.13–+0.27	18	Zheng et al. (2002)
17	Washington DC	1970–1999 excl. 1984	–1.53–+0.35	100	Abu-Asad et al. (2001)
18	Europe	1984–1999	–1.1	1	Emberlin et al. (2002)

Walther 2004, *PPEES* 6, 169-185

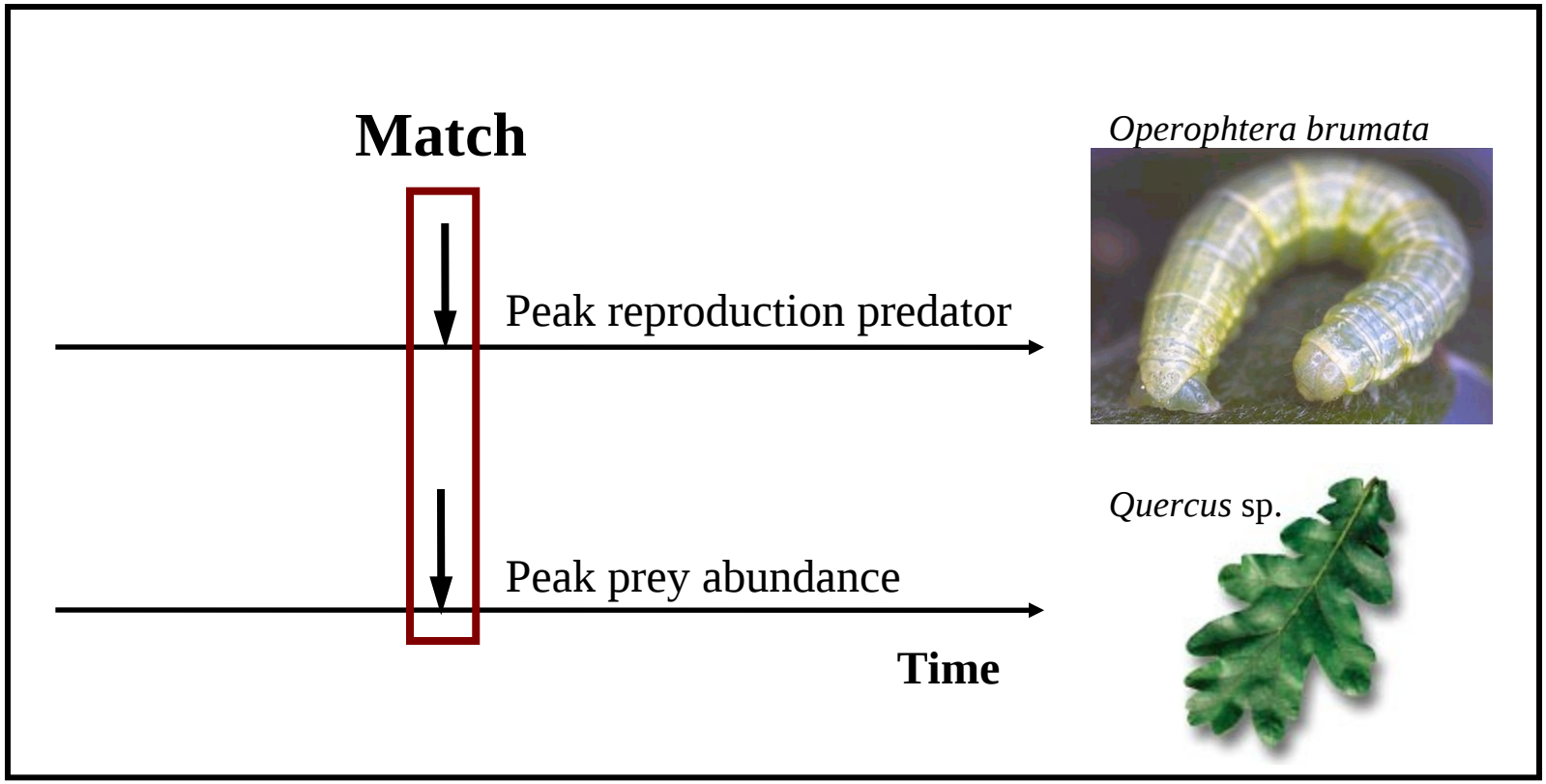
known

✓ phenological adaptation

unknown

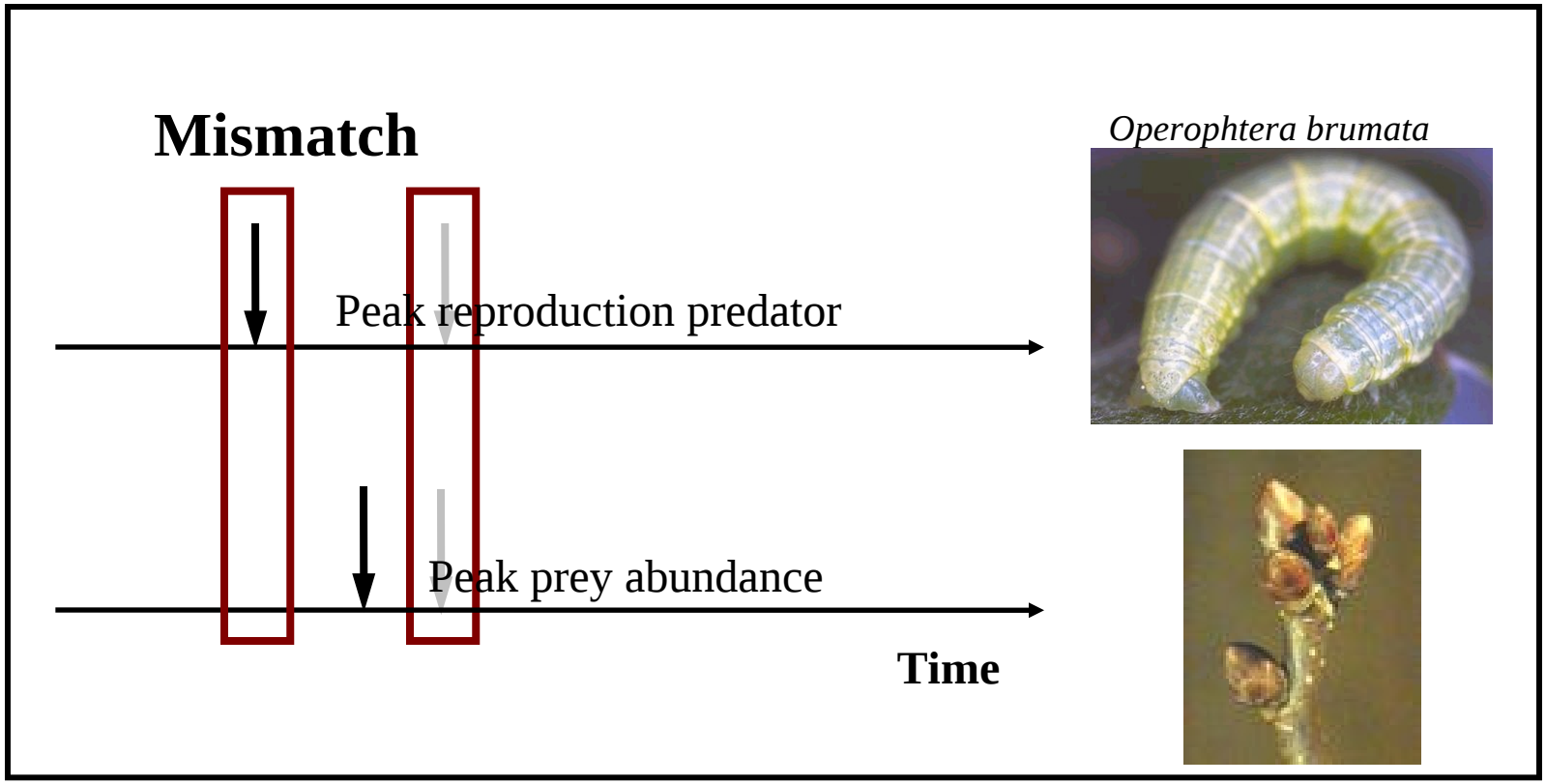
? phenological & trophic interaction

Present match...



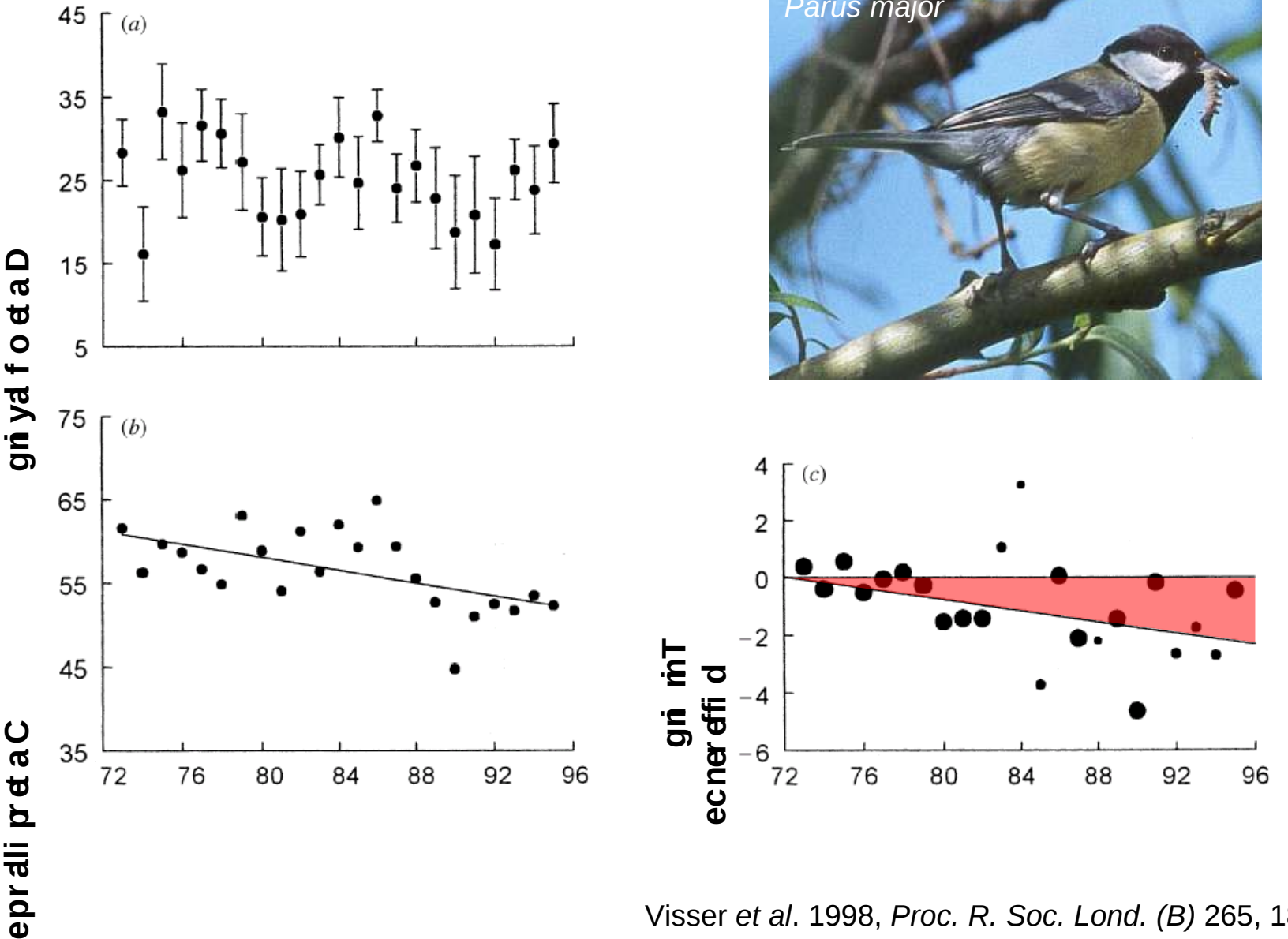
Stenseth *et al*. 2002, *Science* 297, 1292-1296

...future mismatch?



Stenseth *et al*. 2002, *Science* 297, 1292-1296

Present match…future mismatch?



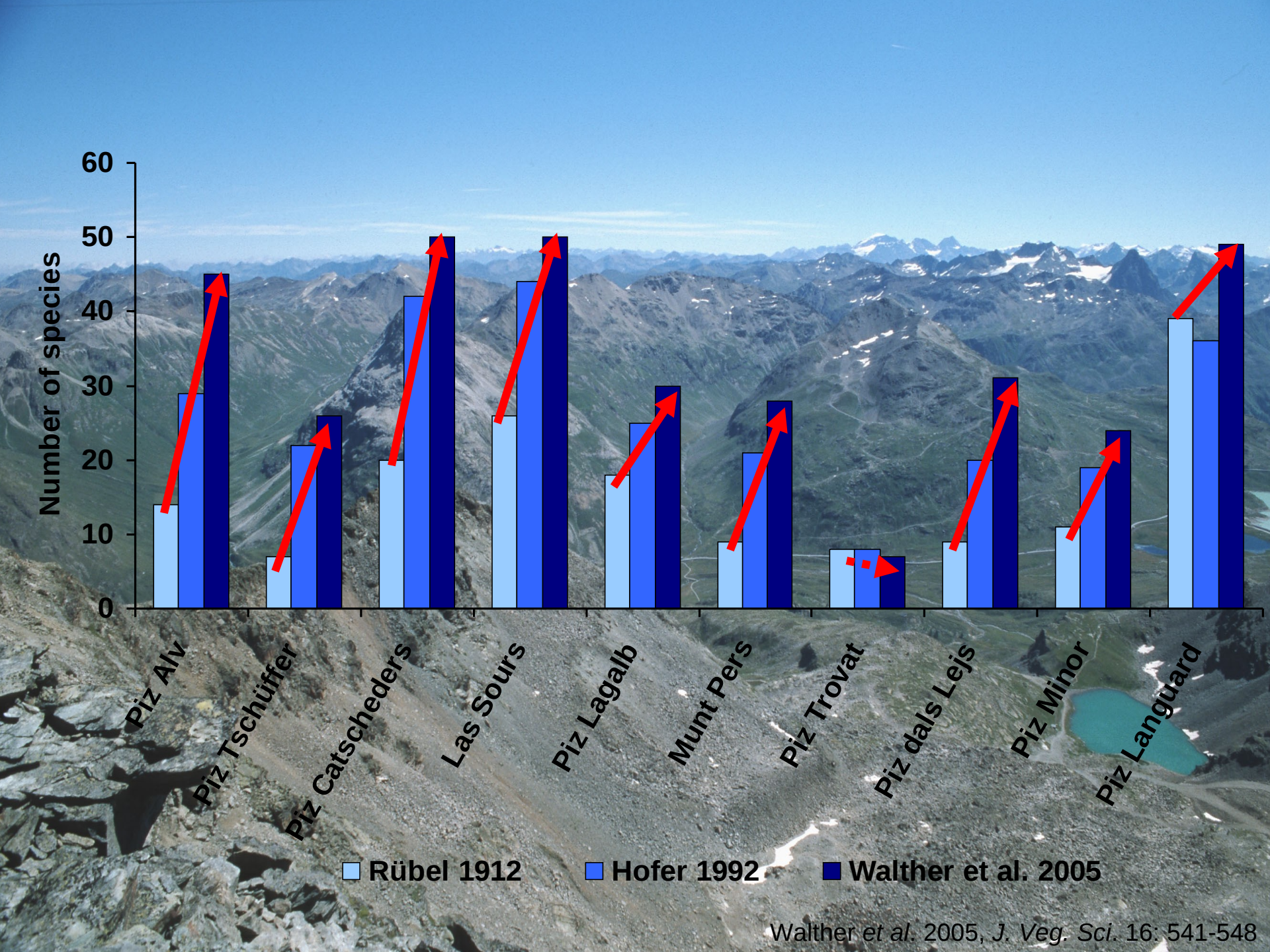
Visser *et al*. 1998, *Proc. R. Soc. Lond. (B)* 265, 1867-1870

known

- ✓ phenological adaptation
- ✓ range shift at northern/upper margin

unknown

- ? phenological & trophic interaction



Walther *et al.* 2005, *J. Veg. Sci.* 16: 541-548

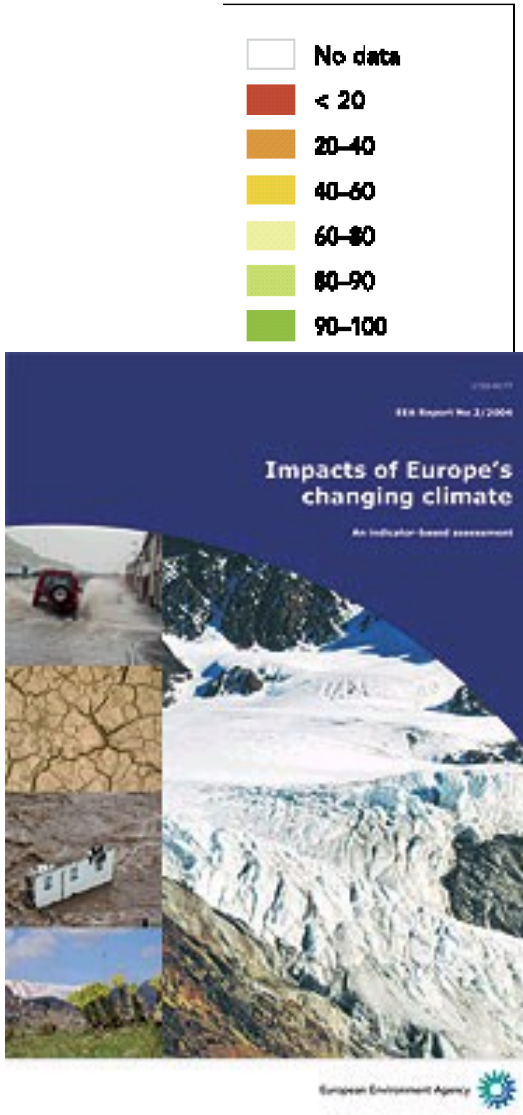
known

- ✓ phenological adaptation
- ✓ range shift at northern/upper margin

unknown

- ? phenological & trophic interaction
- ? range shifts at southern/lower margin

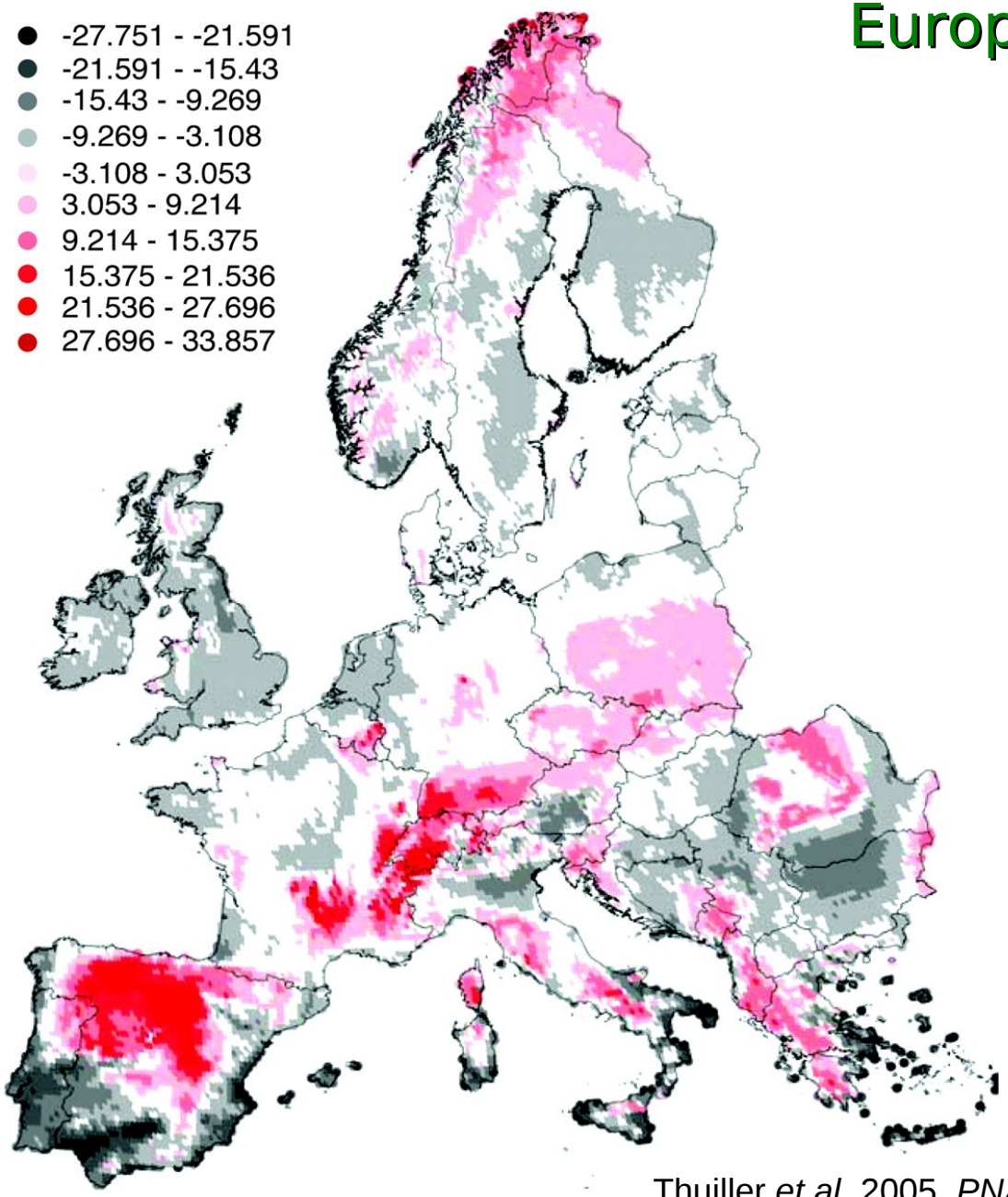
Share of stable species in 2100 compared to 1990



Percentage of total number of species in 1990

(Global warming by 2100 is 3°C, European warming is 3.3°C)

Regional projections of species loss and turnover in European flora



Thuiller *et al*. 2005, *PNAS* 102, 8245-8250

known

- ✓ phenological adaptation
- ✓ range shift at northern/upper margin
- ✓ indigenous and exotic species

unknown

- ? phenological & trophic interaction
- ? range shifts at southern/lower margin

Migration vs. invasion


Sardina pilchardus


Psittoculo krameri


Merops apiaster


Crocothemis erythraea


Trachycarpus fortunei


Cacyreus marshalli


Hemiramphus far

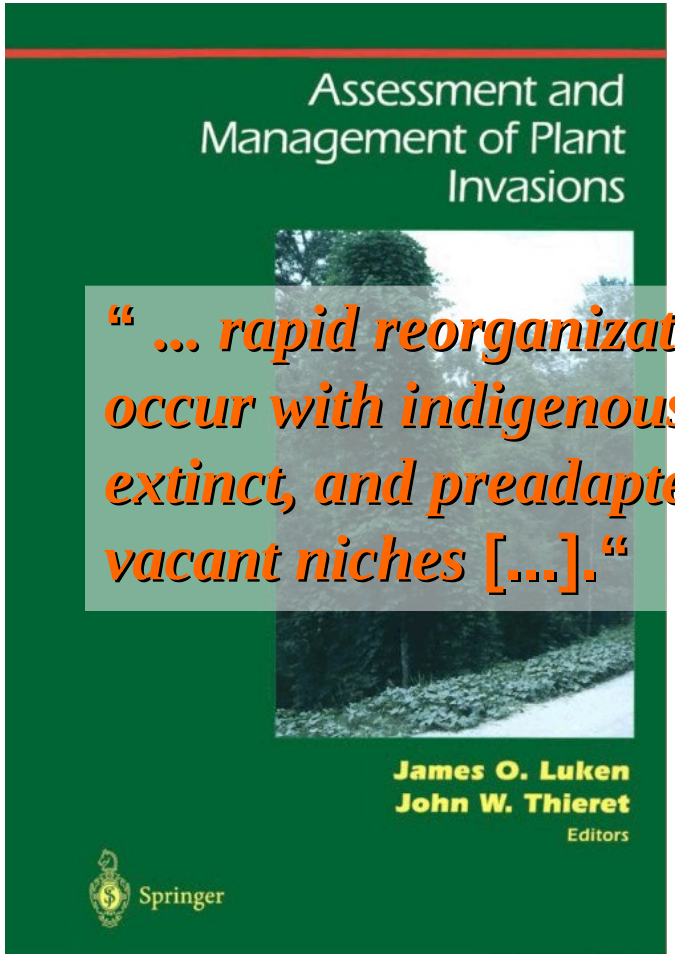

Trapaeolum majus


Thalassoma pavo


Percnon gibbesi

Photo: ESA, MSG-1, 26. August 2003, 12:00

Benefits of non-indigenous plants?



3

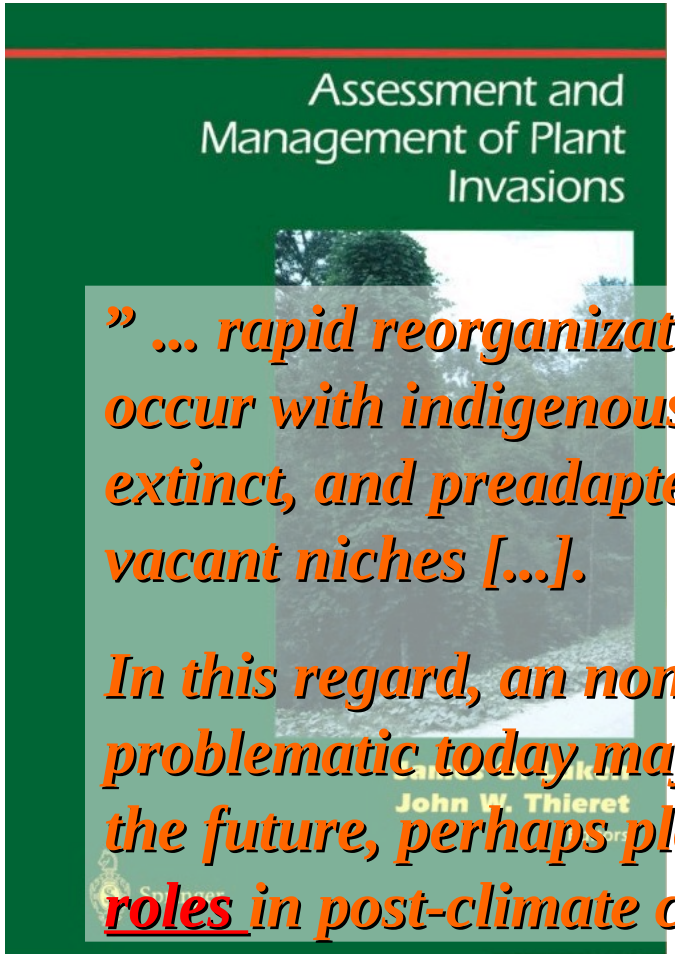
Potential Valuable Ecological Functions of Nonindigenous Plants

Charles E. Williams

" ... rapid reorganization of ecological communities will occur with indigenous species shifting ranges or becoming extinct, and preadapted non-indigenous species invading vacant niches [...]."

Williams 1997, in *Assessment and Management of Plant Invasions*, pp. 26-36

Benefits of non-indigenous plants?



3

Potential Valuable Ecological Functions of Nonindigenous Plants

Charles E. Williams

" ... rapid reorganization of ecological communities will occur with indigenous species shifting ranges or becoming extinct, and preadapted non-indigenous species invading vacant niches [...].

In this regard, an non-indigenous species considered problematic today may have considerable ecological value in the future, perhaps playing key structural and functional roles in post-climate change communities."

Williams 1997, in *Assessment and Management of Plant Invasions*, pp. 26-36

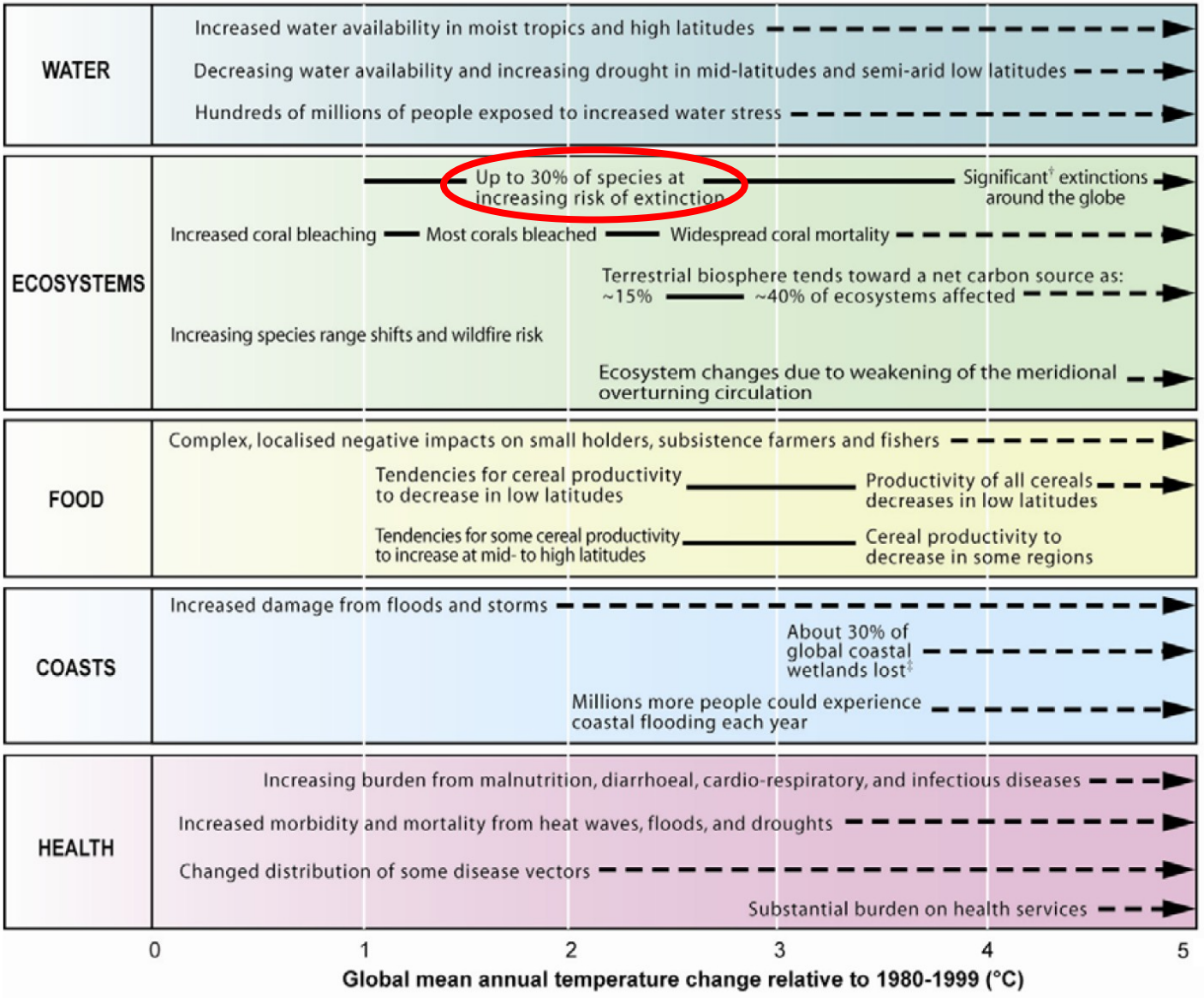
known

- ✓ phenological adaptation
- ✓ range shift at northern/upper margin
- ✓ indigenous and exotic species

unknown

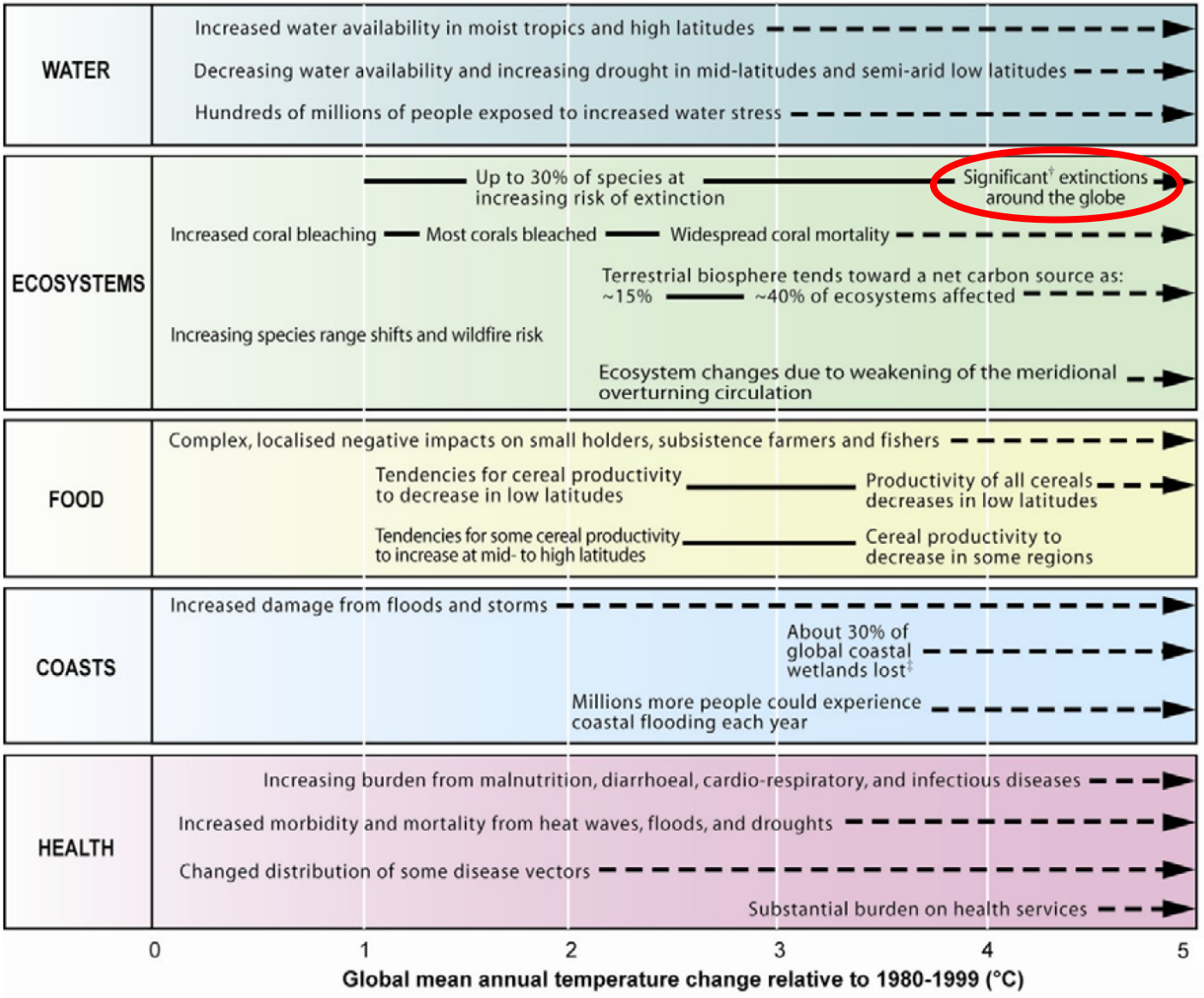
- ? phenological & trophic interaction
- ? range shifts at southern/lower margin
- ? rare and endangered species

Key impacts as a function of increasing global average temperature change



IPCC WGII Fourth Assessment Report

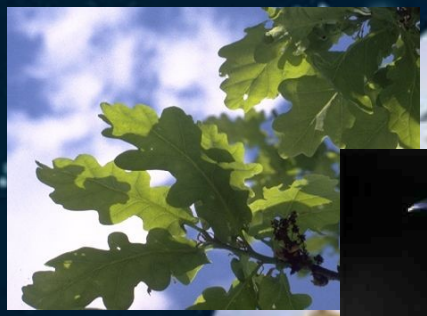
Key impacts as a function of increasing global average temperature change



IPCC WGII Fourth Assessment Report

Conclusions & take home messages

- species do not encounter climate change in isolation
- separate process based knowledge from expectations/speculation
- climate change is part of global change

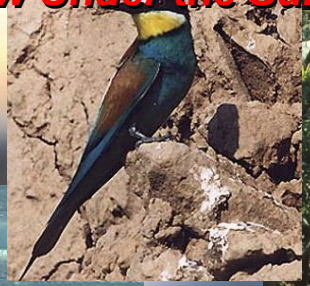





"The human race, without intending anything of the sort, has undertaken a gigantic uncontrolled experiment on the earth."

McNeill 2001, *Something New Under the Sun*





Wo wachsen die Palmen in 100 Jahren?

2091-2100 A1FI HadCM3

Tc_{min} 2,2
GDD 2500
Drought index 0,26