Southern dragonflies *(Odonata)* expanding in Wallonia (South Belgium) : a consequence of global warming?

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Talk plan

- Introduction
- Facts: observations during the last 2 decades
  - Global view
  - Species cases
- Expansion or sampling' increase?
- Hypotheses:
  - Habitat change?
  - Intrinsic population dynamics?
  - Climate change (t°)?
- Conclusions & recommendations

Introduction

- Climate change

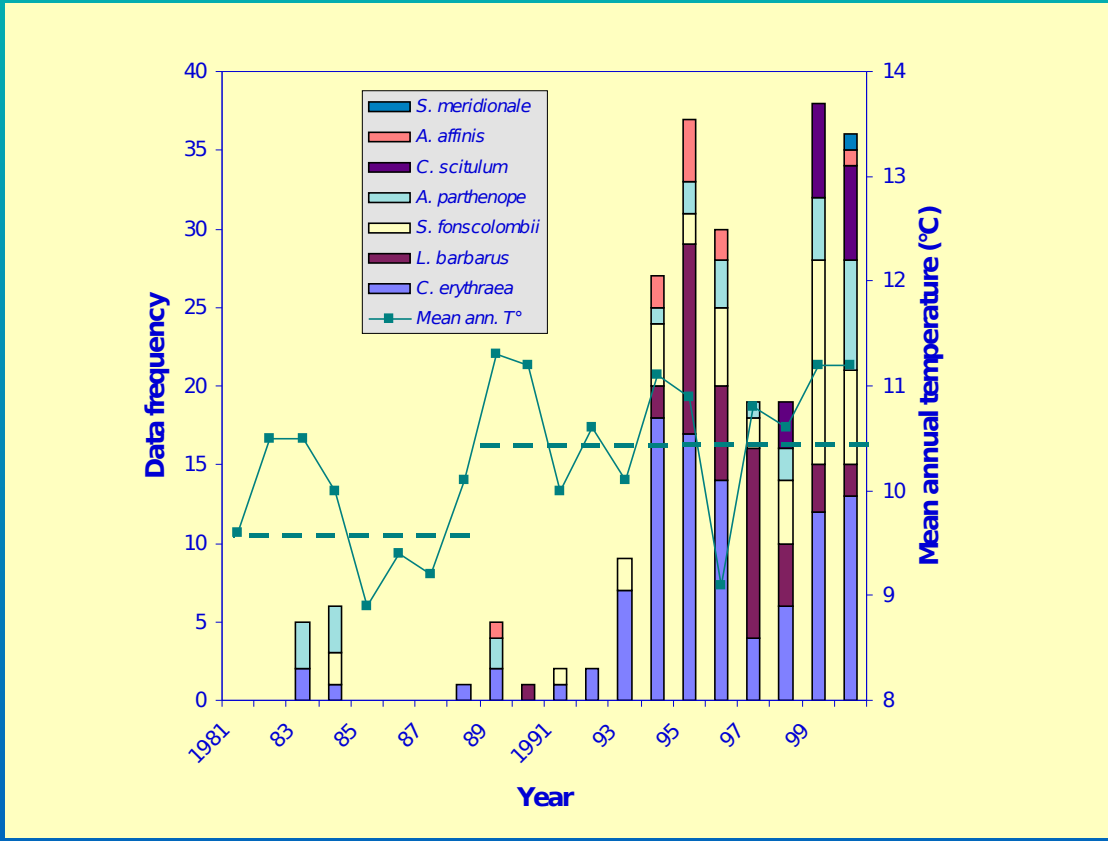
  > 6 main predicted (and now partly observed) impacts on life
  (Walther *et al.* 2002, Root *et al.* 2003, Parmesan & Yohe 2003, Thomas *et al.* 2004, GIEC 2007)
    - Distribution (poleward shifts)
    - Phenology, physiology
    - Evolutionary responses
    - Extinction risk of populations
    - Interactions in communities
    - Ecosystem structure

- Many evidences on insects, especially butterflies
  (Parmesan *et al.*, 1999, Hill *et al.*, 1999, Roy & Sparks, 2000, Warren *et al.* 2001, Thomas *et al.* 2001, Sparks *et al.*, 2005…)

- Dragonflies: numerous chorological observations (Eur, Am..), but few quantitative studies (with link to climate change)
  (Hickling *et al.* 2005, *in Global Change Biology*)

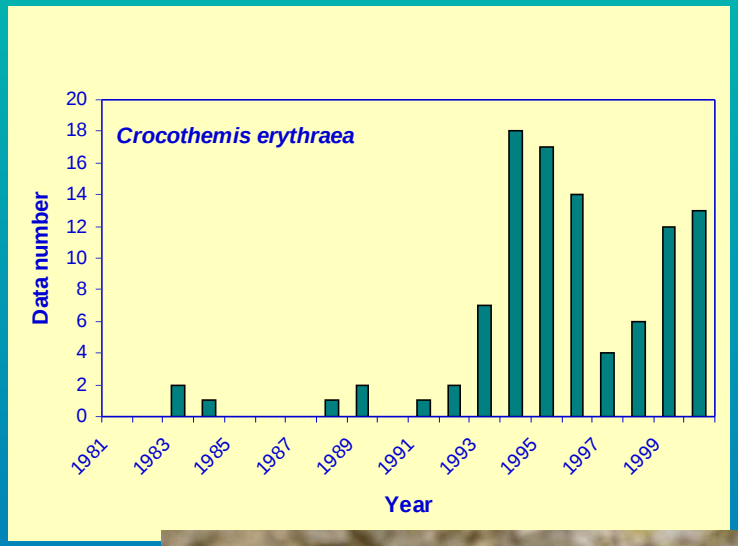
Facts:
observations during the last 2 decades

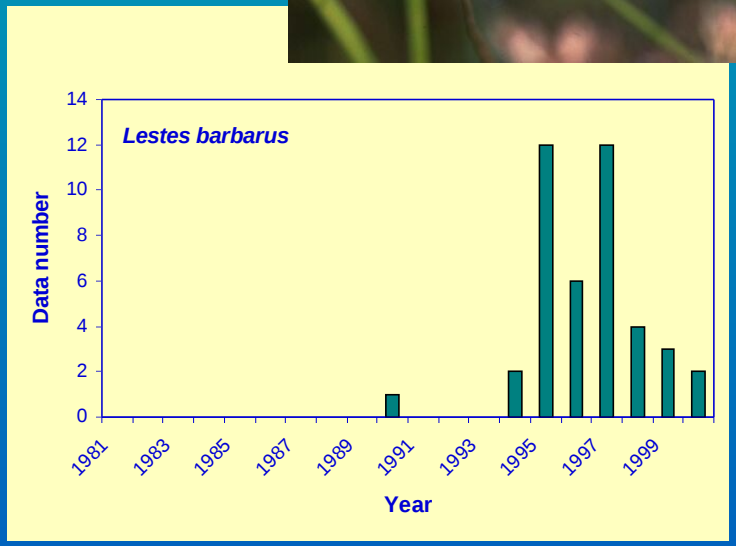
Temporal pattern of 7 (former) rare southern species



Facts:
observations during the last 2 decades

Species cases





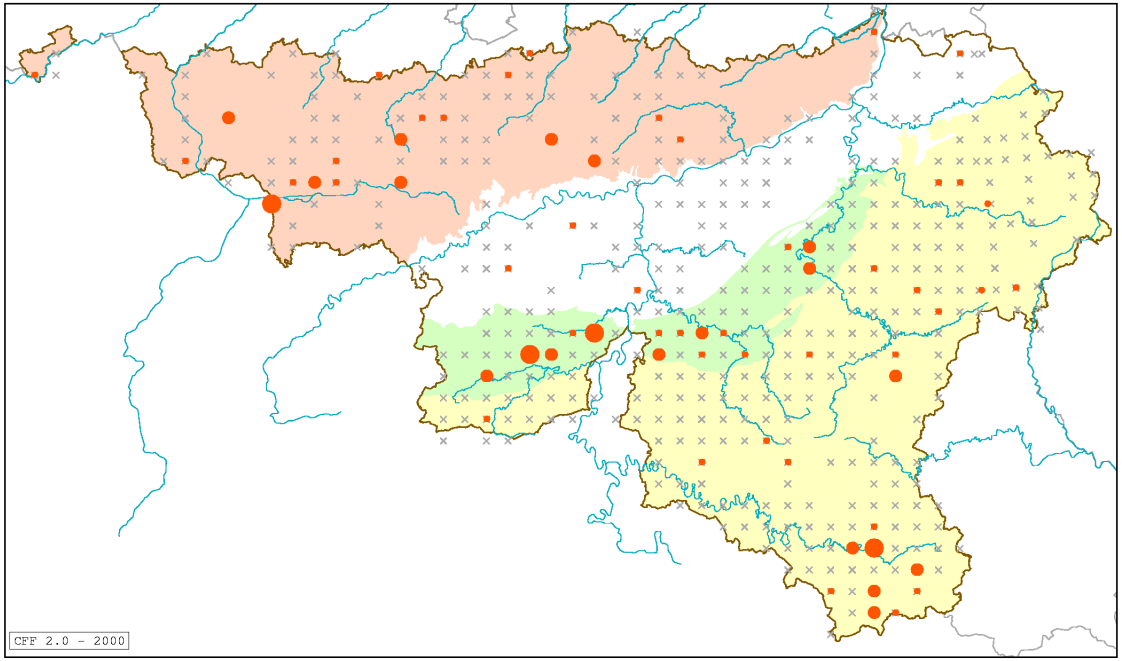
Facts:
observations during the last 2 decades

Synthetic data on these (former) rare southern species

Species	Data				First reproduction reported
	before 1980	1981 to 1990	after 1990	Total	
Crocothemis erythraea	yes	6	94	**109**	**1993 (egg-laying, emergences)**
Lestes barbarus	yes	1	41	**48**	**1996 (egg-laying, emergences)**
Sympetrum fonscolombii	yes	2	39	**51**	**1998 (egg-laying, emergences)**
Anax parthenope	no	8	20	**28**	**2000 (egg-laying, >1 year populations)**
Coenagrion scitulum	yes	0	15	**23**	**1999 (egg-laying, >1 year populations)**
Aeshna affinis	yes	1	9	**13**	**1995 (>1 year populations)**
Sympetrum meridionale	yes	0	1	**9**	**2000 (emergence)**
Total (southern spp.)	6 spp.	**18**	**219**	**237**	
Total (all spp.)	(3345)	**6436**	**16956**	**23392**	

Facts:
data distribution during the last decade

Number of these (former) rare southern species by 5 km UTM square



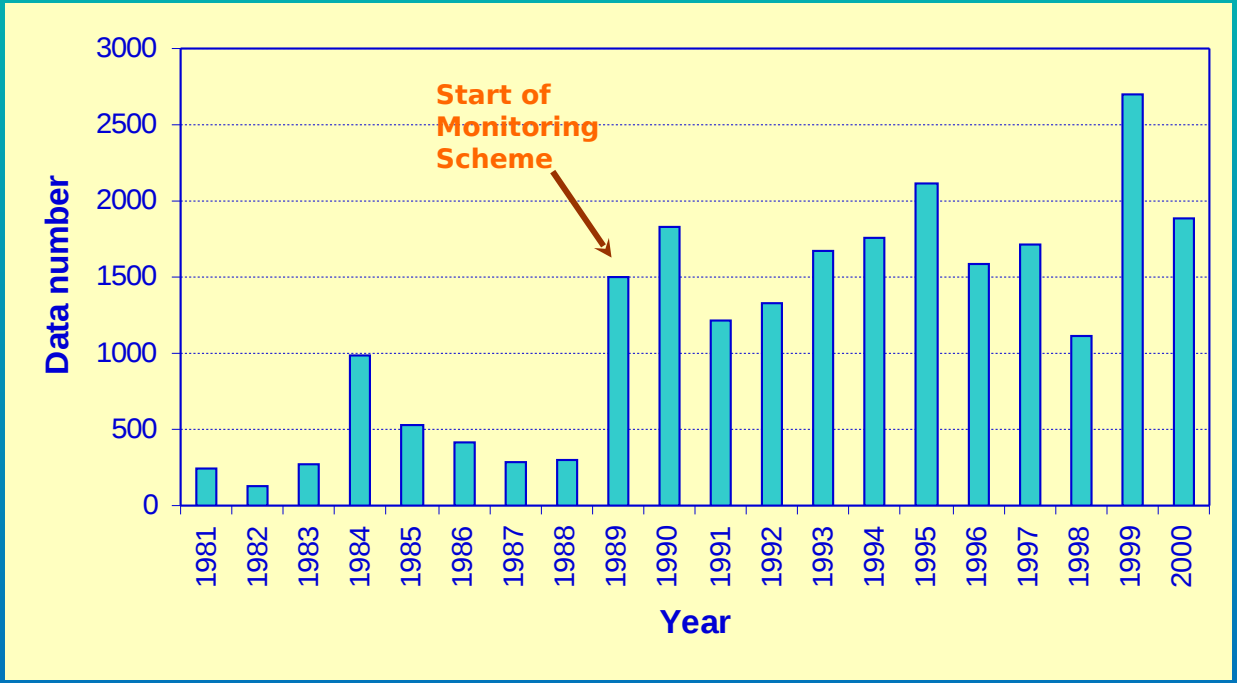
Number of southern species (UTM 5 km)

Total: 7 species

- > 3 spp.
- 2 - 3 spp.
- 1 spp.

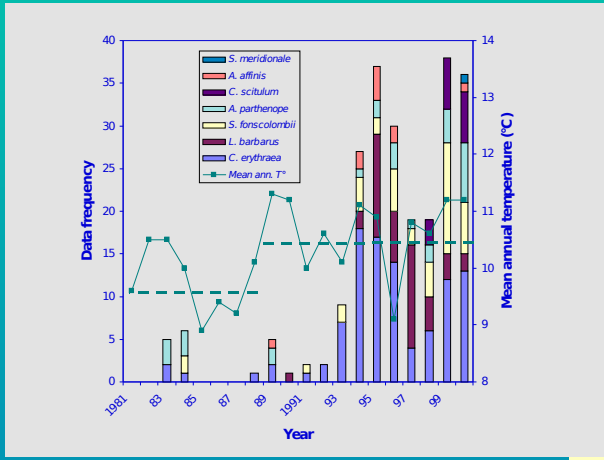
Expansion or sampling' increase?

Data gathered by the Dragonfly Working Group « *Gomphus* »
(based mainly on visual observations)

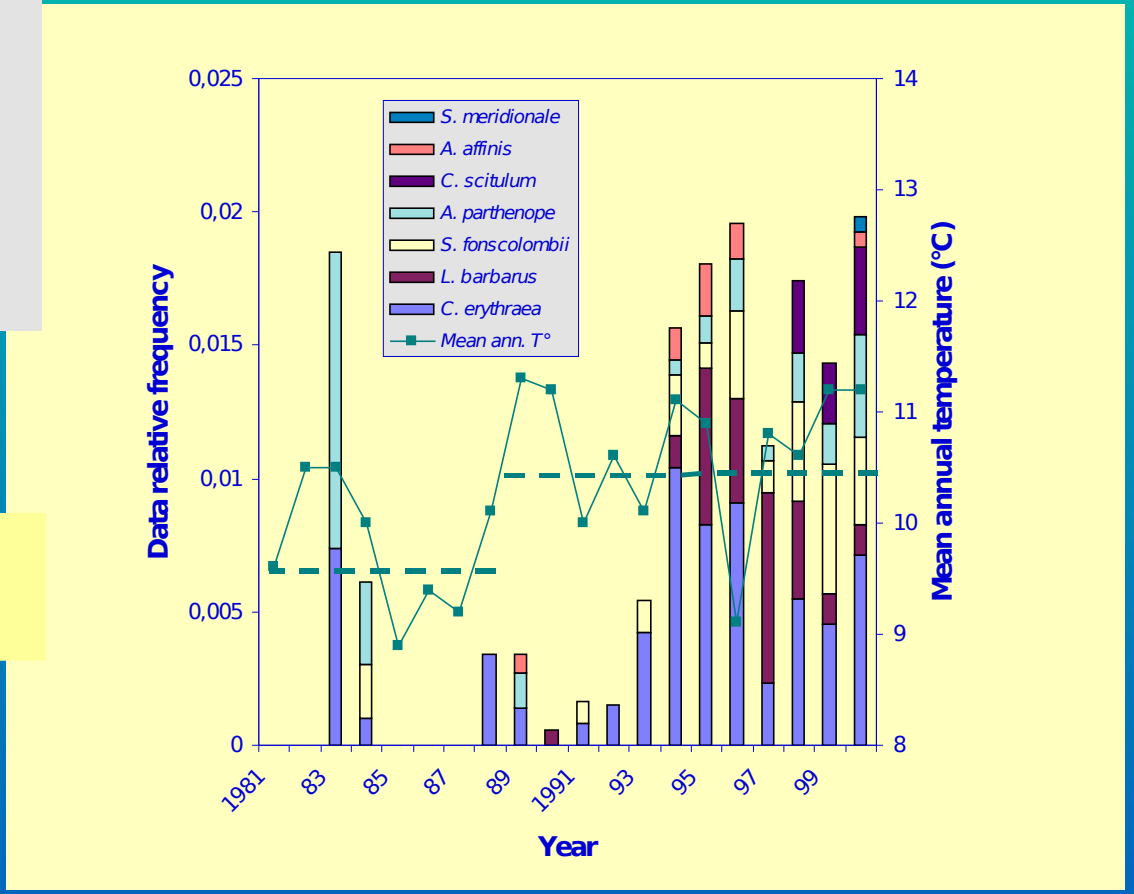


NB: Old data (< 1981) = collections data, with biased frequencies!

Expansion or sampling' increase?



> Corrected data frequencies (rates)!



NB: similar global pattern !

Expansion or sampling' bias?

Spatio-temporal heterogeneity of sampling !!

> **Methodology to counter this bias**

> Data from 1989 to 2000 (12 years) (Monitoring Scheme)

> Comparisons of two periods: 1989-1994 / 1995-2000

> **Selection** of grid cells which were sampled at both periods during the main flight period of the species

> G tests (goodness of fit) between p1 & p2 on:

- Number of grid cells with observation(s)
- Observation rate per visit

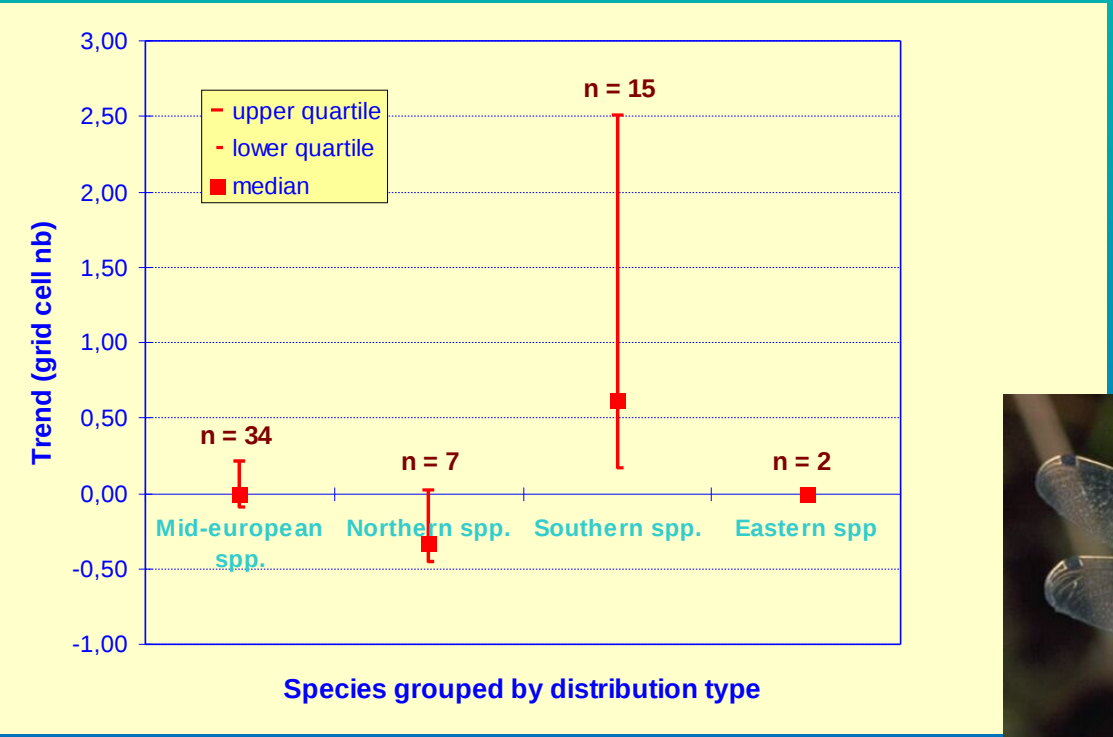
Expansion or sampling' bias?

Trends' results for the 17 southern species known in Wallonia

Species	Grid cell nb > 1989	Sampled grid cell (p1 & p2)	% change (grid cell nb)	Sign. Level	% change (obs. nb)	Sign. Level	Synthesis
Gomphus pulchellus	142	51	0%	ns	22%	ns	→
Erythromma viridulum	90	36	61%	ns	70%	**	↑
Cercion lindenii	54	21	900%	***	872%	***	↑
Crocothemis erythraea	40	21	45%	ns	85%	*	↑
Lestes barbarus	23	11	350%	*	861%	***	↑
Orthetrum brunneum	23	11	-22%	ns	-50%	ns	↘ ?
Sympetrum fonscolombii	20	9	350%	*	466%	***	↑
Oxygastra curtisii	16	4	100%	ns	125%	ns	⇧ ?
Sympecma fusca	16	7	33%	ns	9%	ns	⇧ ?
Anax parthenope	11	6	150%	ns	307%	*	↑
Coenagrion mercuriale	10	3	50%	ns	-32%	ns	⇨ ?
Coenagrion scitulum	8	1	*1000%*	-	*1000%*	-	?
Aeshna affinis	4	5	100%	ns	80%	ns	⇧ ?
Gomphus simillimus	2	1	-100%	-	-100%	-	?
Ceriagrion tenellum	1	1	0%	ns	10%	ns	?
Sympetrum meridionale	1	0	-	-	-	-	?
Onychogomphus uncatus	0	0	-	-	-	-	?

Expansion or sampling' bias?

Trends for 58 species (from 66) in relation to « distribution type »



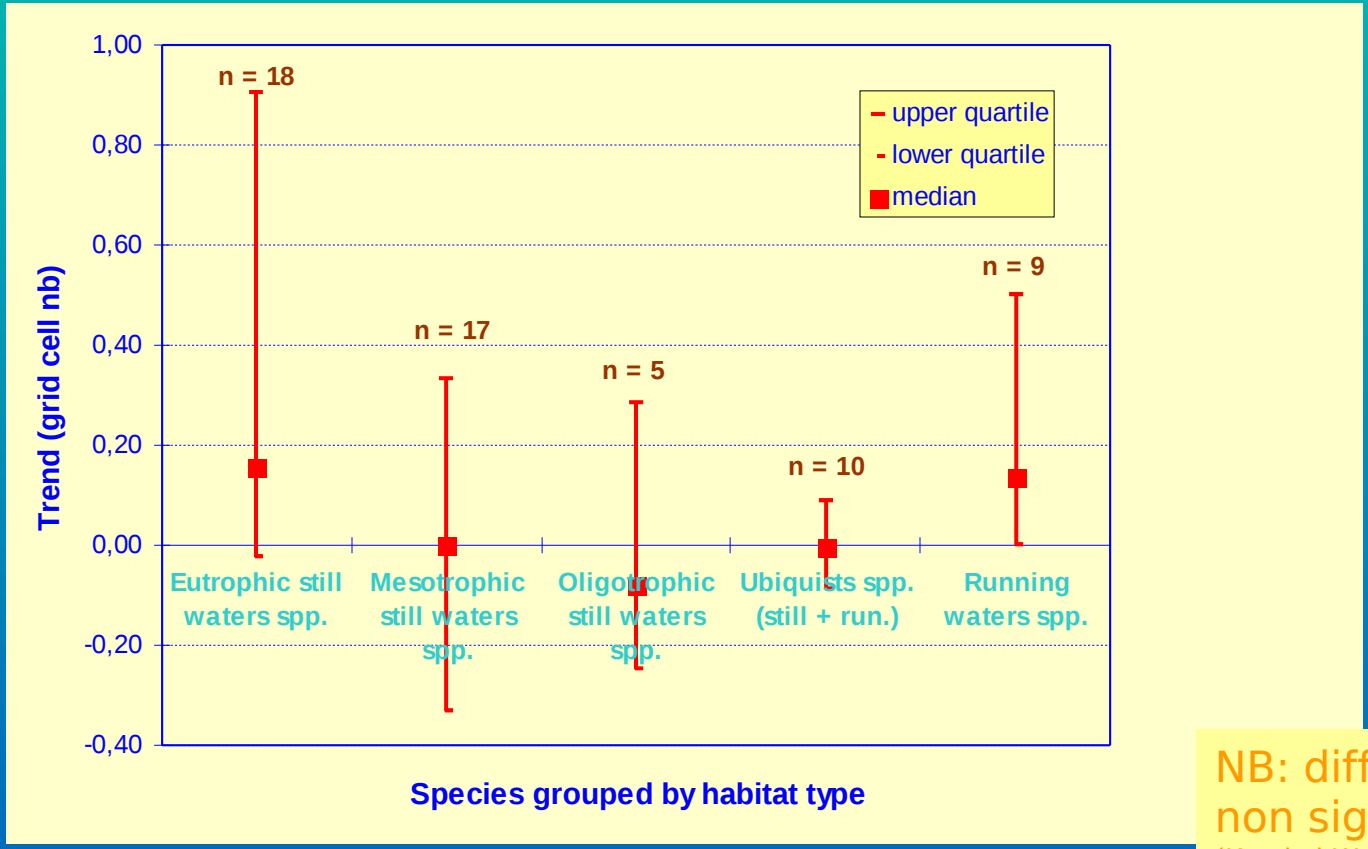
NB: northern species globally in decline (- 33%), but unsignificant
(median tests)

Leucorrhinia dubia, male

> Trends of southern spp. significantly differ from those of other groups
(Kruskal-Wallis test: p = 0,0016; median tests)

Expansion or sampling' bias?

Trends for 59 species (from 66) in relation to « habitat type »



NB: differences non significant !
(Kruskal-Wallis test)

Expansion or sampling' bias?

Species enrichment of particular sites (regularly sampled)

> ex: Virelles

1989-1994: **23** spp. per year

1995-2000: **29** spp. per year

Anax parthenope, male
Photo: N. Titeux

Hypotheses
1) Habitat change ?

What? eutrophication

Why?

northern spp >> oligotrophic habitats

southern spp >> eutrophic habitats

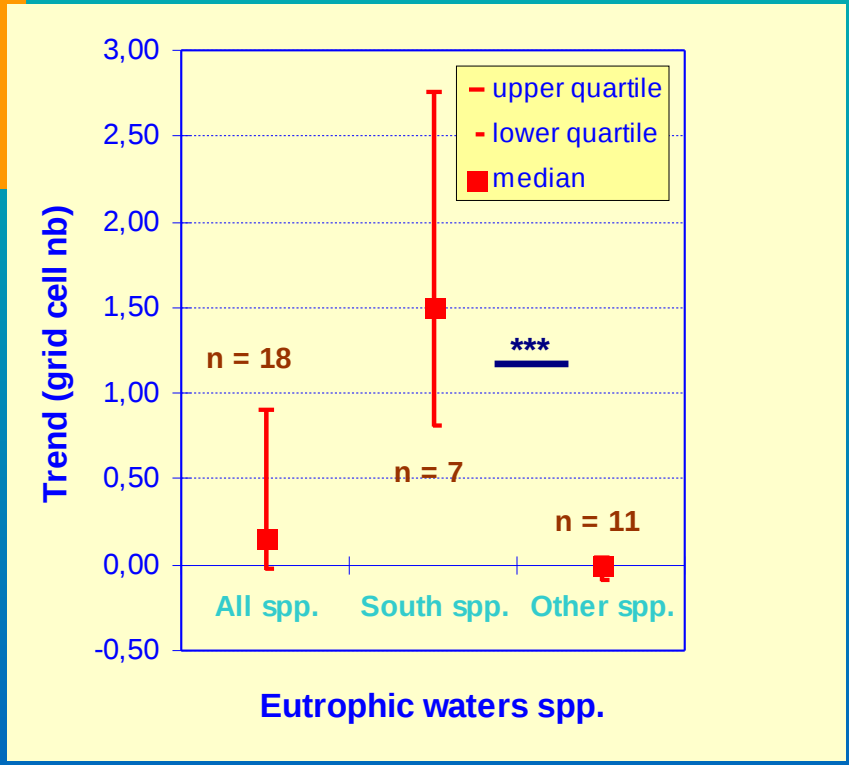
> Prediction 1 : southern spp. should be observed on eutrophic waters in Wallonia

Obs: southern spp. were found on diverse kinds of waters (incl. oligotrophic)!

Sandpool in Hainaut

Hypotheses
1) Habitat change ?

> Prediction 2 :
among « eutrophic » species, non-southern ones should expand like southern ones!



Obs: this is not the case!!
Non-southern species were stable when southern ones have much increased
(median test: p = 0,0004)

Hypotheses
2) Intrinsic population dynamics?

What? increase for unknown reasons, intrinsic to species

> Prediction 1:
expansions should not be synchronized between spp.

Obs: it was rather highly synchronized in Wallonia

> Prediction 2:
expansions should affect as well northern as southern, or mid-european spp.

Obs: this is not the case here!! (see before)

Hypotheses
3) Climate change (t°)?

What: rise of mean and extreme temperatures and associated events (southern winds)

> Prediction 1:
Should affect the majority of southern spp.

Obs: this is the case, here!! (see before)

> Prediction 2:
Should affect them in a rather synchronized way (temporal correlation of expansions)

Obs: this is the case, here!!
Migrants waves (see before)

Hypotheses
3) Climate change (t°)?

> Prediction 3:
at the limit of their range, southern spp. should select (develop on) thermically favourable regions and habitats

Obs: this seems to be the case, in Wallonia!!

> mainly in Lorraine, Fagne, Famenne
> mainly on sunny and shallow waters

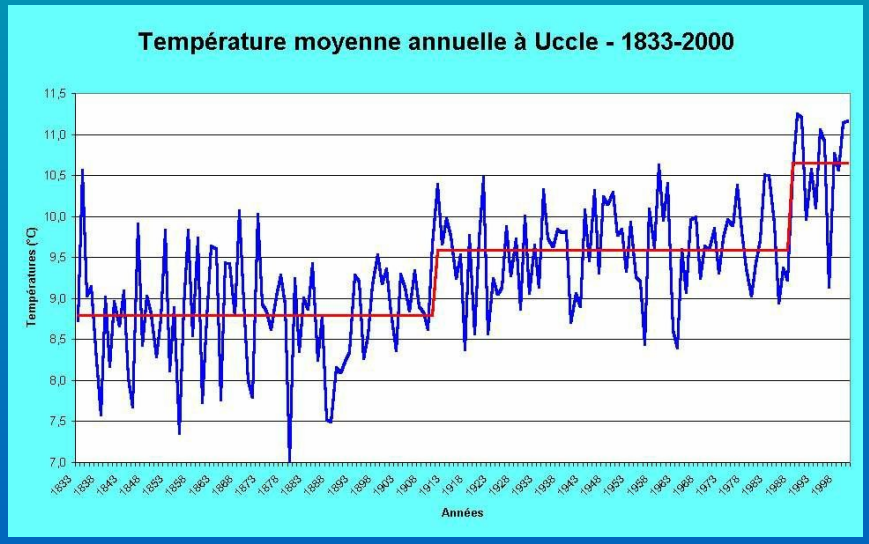
> Prediction 4:
should also affect the northern spp.
at their limits of range

Obs: this could be the case, here, but it is difficult to ascertain!! (see before)

Conclusions & last comments

- Recent expansion of several southern species in Wallonia
- Establishment of reproductive populations
- Global warming

  > main explaining factor !



Conclusions & last comments

> Is it good news?

Maybe not, because:

- Northern species could disappear in our regions...
- These changes are very rapid !
- Organisms with low mobility and/or highly fragmented habitat network could have problems to follow these changes and find refuges !

Recommendations

- **conservation and restauration of high quality aquatic habitats,** especially those of peatbogs, to ensure maintenance of their present fauna

- **development of a better ecological network** to allow and favour fauna and flora movements in relation to climate change

- **continuation and reinforcement of biodiversity' survey and monitoring programs in our regions** to track range shifts and changes in status

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