

Spiders communities as bio-indicators in Irish plantation forests

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Meta mengei

Why identify indicators in plantations ?

- Sustainable forest management
- Managing for biodiversity
- Structural indicators
 - Environmental correlates with target taxonomic group
 - Potential in sustainable forest management
 - Implemented by non-specialists

Why use spiders as an indicator group?

- Abundant
- Positively influenced by vegetation structure
 - Prey
 - Web attachment
 - Hiding places for active hunters
 - Protection from predators
 - Suitable microclimates
- Found in all layers of vegetation
- Occupy a strategic position food webs
- Taxonomically well known

Aims of study

Spider communities :

- Change over forest cycle
- Differ between Sitka spruce and ash
- Identify indicators of spider biodiversity

Study sites

- 32 sites across Ireland
- Sitka spruce and ash
 - Conifer and broadleaf
 - Widely planted
- Sites allocated into groups by structural features
 - Mean distance between trees
 - DBH
 - Tree height
 - Tree cover

Pitfall traps



Sampling regime

- Five pitfalls per plot
- Five plots per site
 - Plots at least 50m apart
- 2-3 weeks in the ground
- Three changes during the season

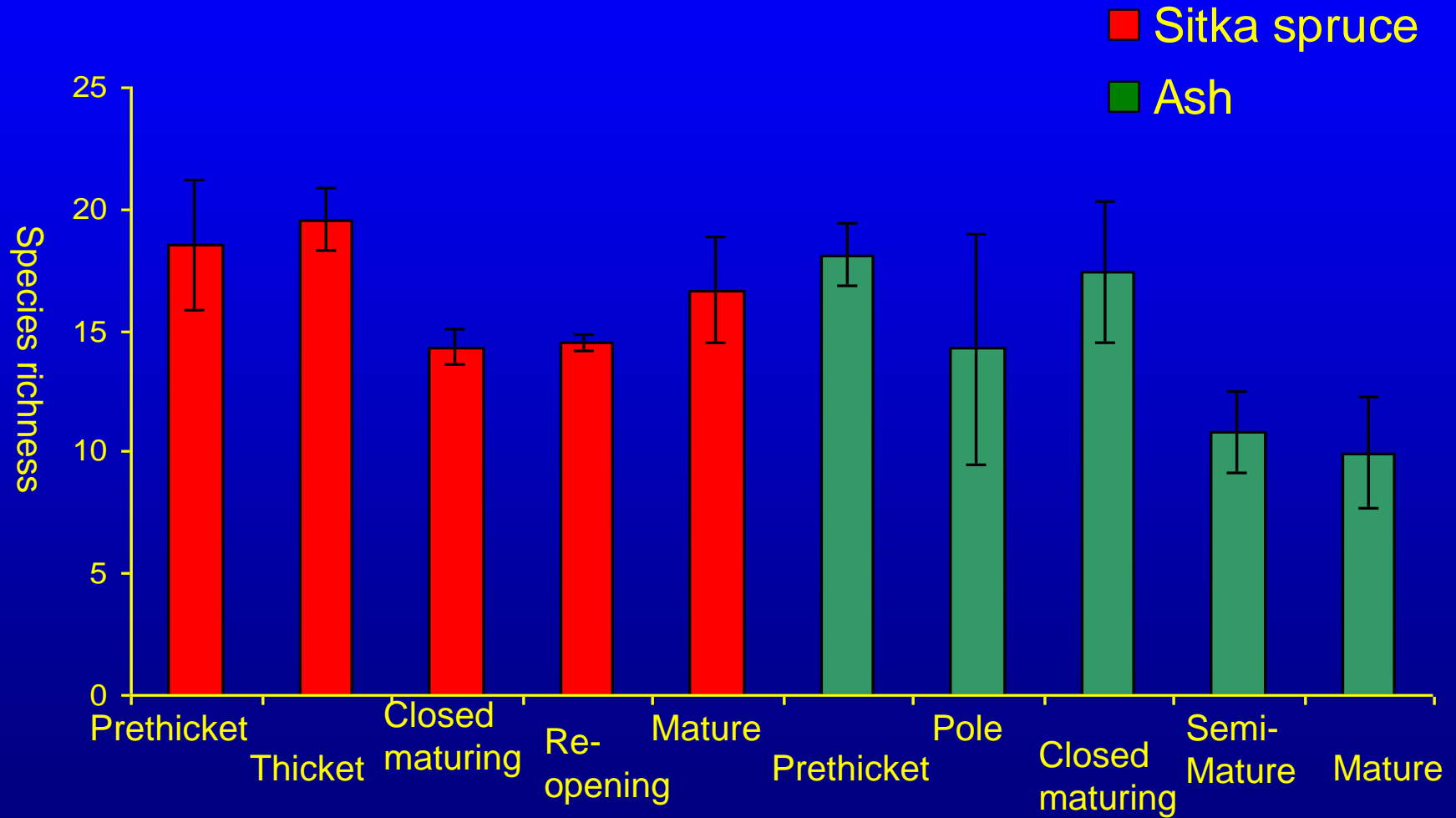
Habitat measures

- Cover abundance of plant structure
- Cover of deadwood
- Soil samples
 - Organic content
- Litter depth and cover

Results

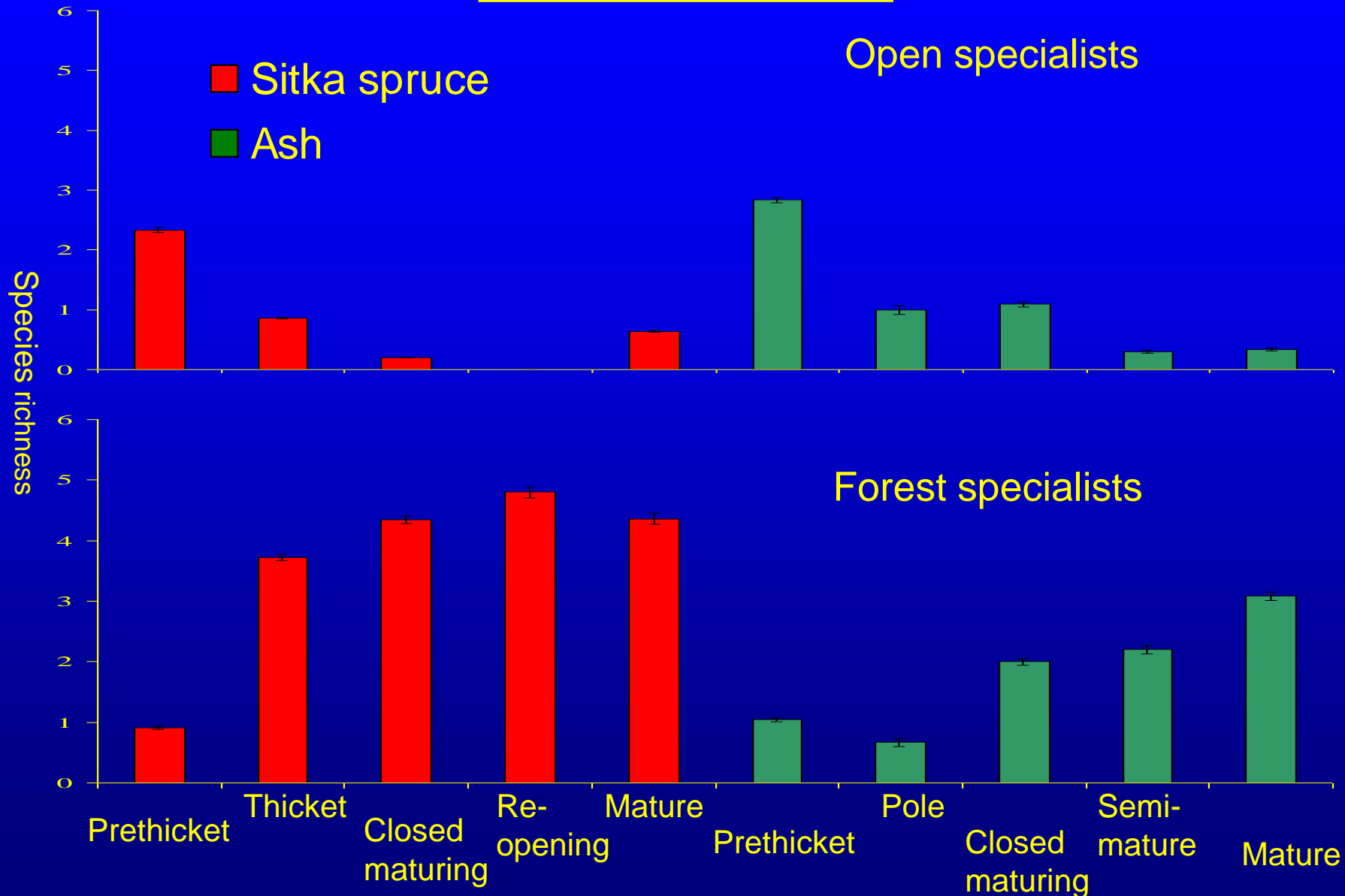
- 18730 individuals collected in 139 species
- Species classified by habitat preference:
 - 15 forest habitat specialists
 - 19 open habitat specialists

Mean species richness of spiders across the forest cycle. Bars indicate SE



Species richness of habitat specialists.

Bars indicate SE

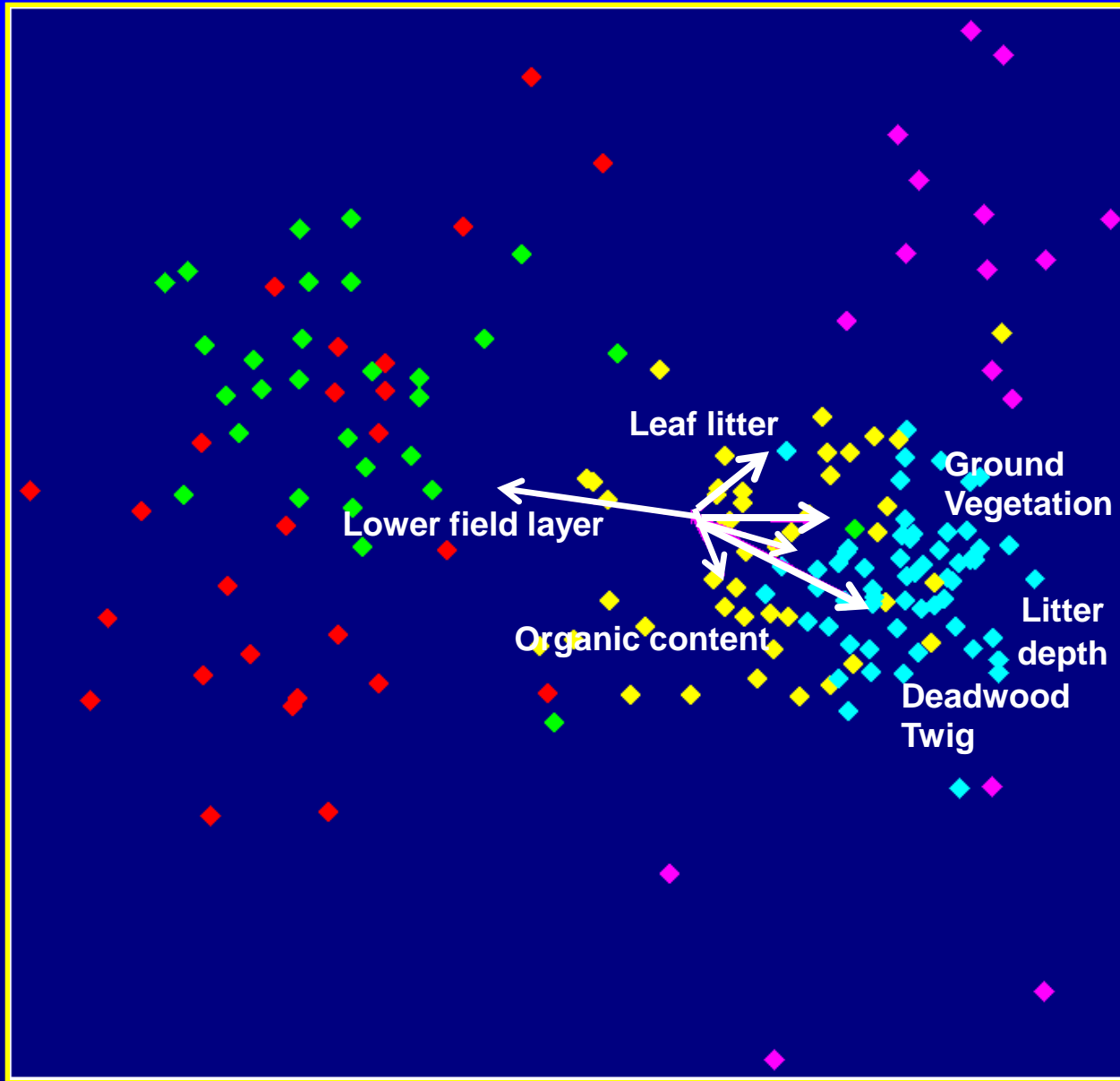


Species assemblages

- Cluster analysis indicated 5 groups:
 - 1) Young mix (n=20)
 - 2) Young ash (n=34)
 - 3) Mature ash (n=16)
 - 4) Closed canopy spruce (n=29)
 - 5) Open-spruce (n=44)
(n = no. of plots)
- Ordination revealed similar groups as cluster analysis

NMS ordination of plots

Axis 2
($r^2 = 0.20$)

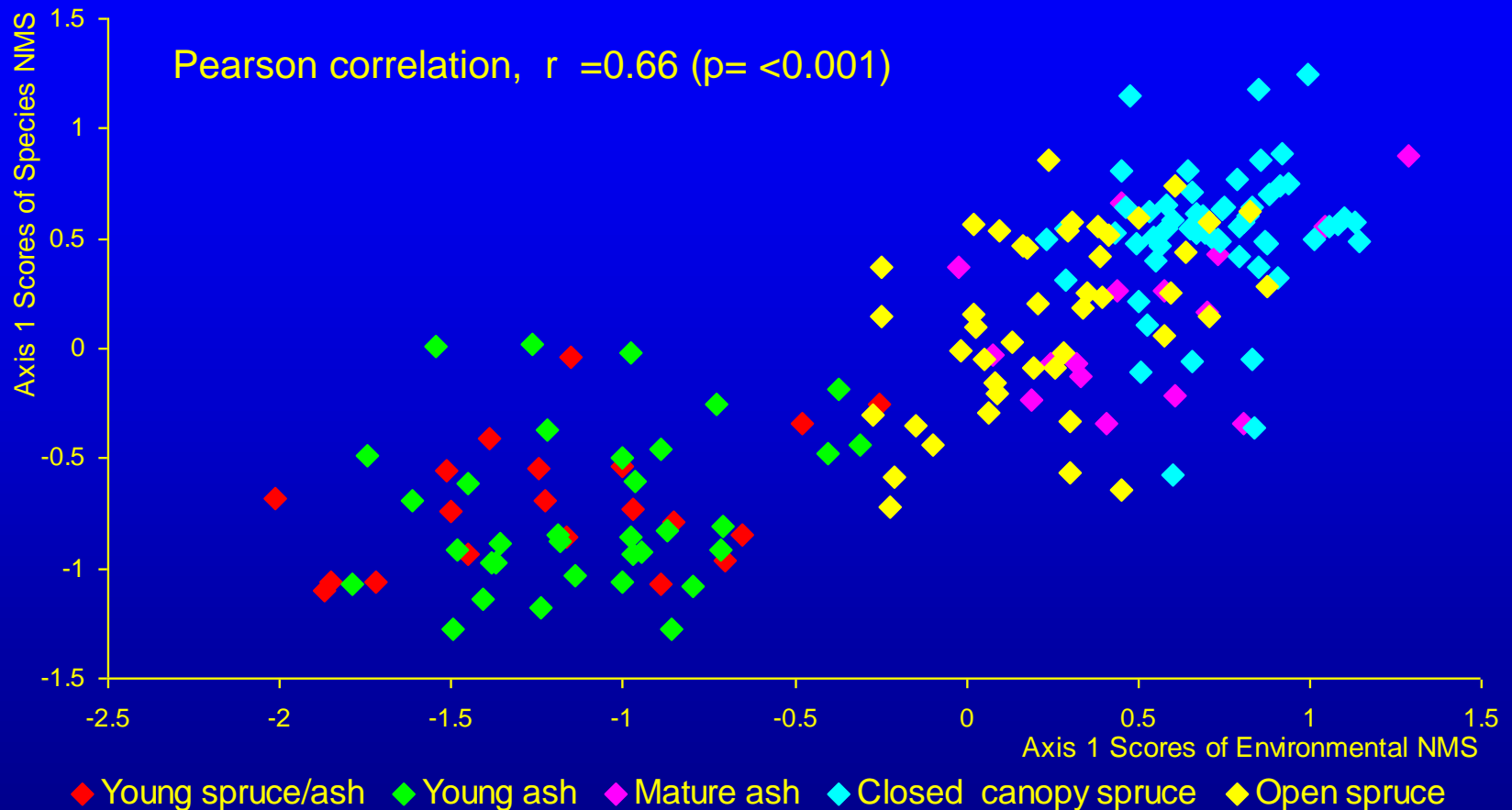


Axis 1 ($r^2 = 0.61$)

Cluster groups

- ✂ Young mix
- ✂ Young ash
- ✂ Mature ash
- ✂ Closed-canopy spruce
- ✂ Open spruce

Axes 1 scores from NMS ordinations of both species and habitat data



Species NMS Axis 1 r^2 value = 0.61

Habitat NMS Axis 1 r^2 value = 0.65

Correlation of total species richness and environmental variables

Cluster group	Environmental variable	Pearson (r)
Young mix (n=20)	Organic content	0.57**
	Lower field layer	0.45*
Young ash (n=34)	Soil cover	-0.33*
	Lower field layer	0.40*
	Deadwood cover	-0.50***
Closed-canopy spruce (n=29)	Soil cover	-0.47*
Open spruce (n=44)	Lower field layer	0.26*

*p = <0.05; **p = <0.01; *** p = <0.005

Correlation of open specialist species richness and environmental variables

Cluster group	Environmental variable	Pearson (r)
Young ash (n=34)	Deadwood cover	-0.47***
	Soil cover	-0.47***
Closed-canopy spruce (n=29)	Canopy cover	-0.31*
Open spruce (n=44)	Ground vegetation	-0.32*

*p = <0.05; **p = <0.01; *** p = <0.005

Correlation of forest specialist species richness and environmental variables

Cluster group	Environmental variable	Pearson (r)
Young ash (n=34)	Twig cover	0.34*
	Ground vegetation	0.36*
	Leaf litter cover	0.54***
	Soil cover	0.45**
Mature ash (n=16)	Lower field layer	-0.58*
Closed-canopy spruce (n=29)	Upper field layer	-0.27*
Open spruce (n=44)	Twig cover	0.46***
	Ground vegetation	0.45***
	Upper field layer	-0.48***

* p = <0.05; ** p = <0.01; *** p = <0.005

Discussion

Changes over the forest cycle

- Decrease in overall S in both ash and spruce
- Decrease in open species
- Increase in forest species

Early stages

- Pre-thicket has highest S
- Also highest S of open specialists
- Highest cover of lower field layer vegetation
 - More web attachment points
 - Hiding places for active predators
 - Prey availability

Pre-canopy
closure,
Sitka spruce



Effects of canopy closure

- Decrease in lower field layer vegetation
 - Reduced light
- Increase in forest associated variables
 - Litter layers
 - Dead wood
- Effects on spiders:
 - Overall S and open species richness is reduced
 - Forest species benefit from litter layers

Closed-canopy

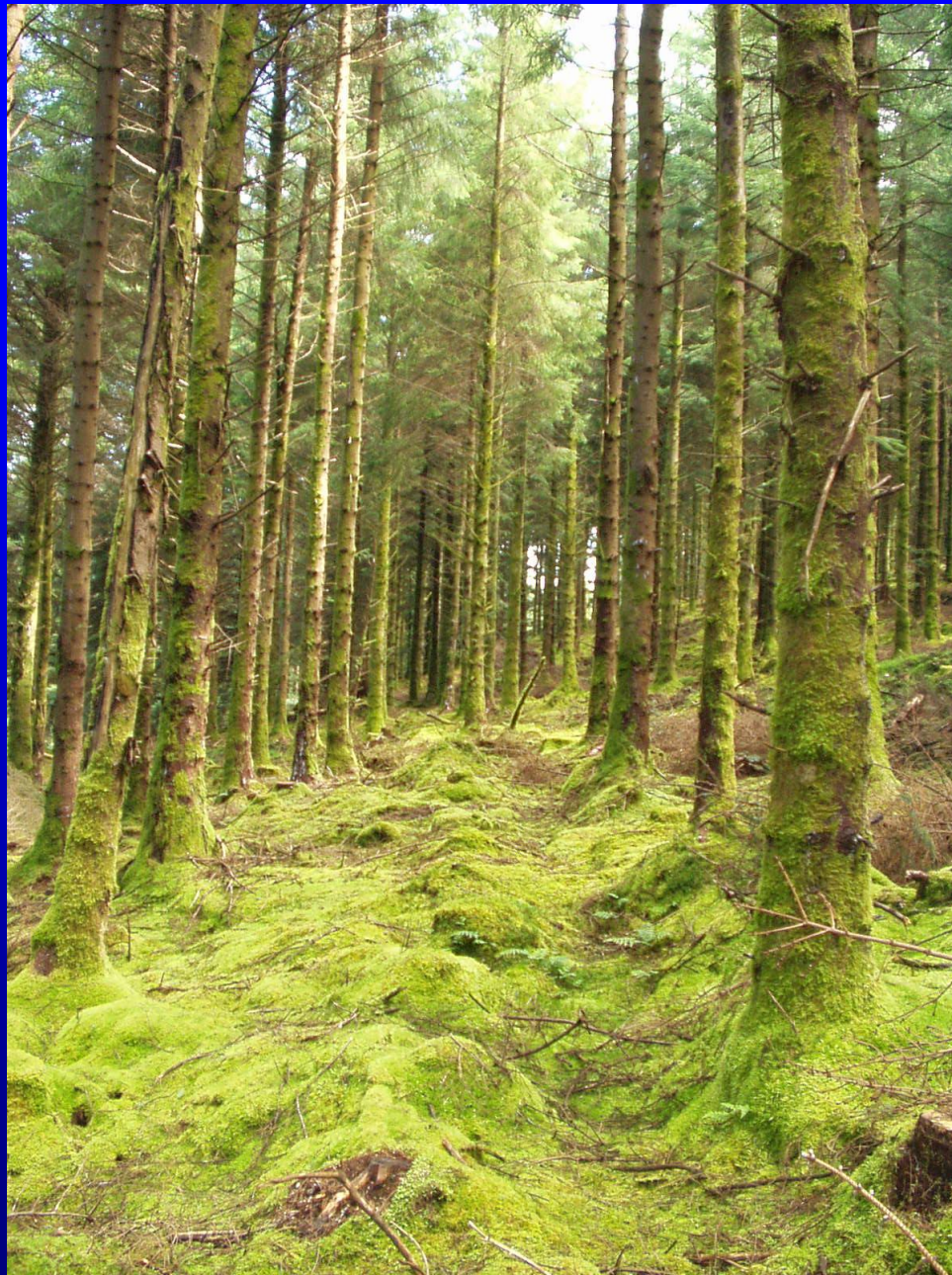
Sitka spruce



Reopening of the canopy

- Mechanisms of reopening
 - Thinning
 - Wind throw event
 - Disease
- Outcomes of reopening
 - Early on:
 - Typical forest ground vegetation
 - After successive thins:
 - Increase in lower field layer
 - Open species recolonise
 - Thinning allows coexistence of both forest and open specialists
- Open spruce cluster group

Re-opening
canopy
Sitka spruce



Mature
plantation
Sitka spruce



Differences between ash and spruce

- Prethicket ash and spruce do not form such a distinct group from each other as mature sites
 - Minimal effect of trees
 - Preplanting habitat type
 - Soil differences

Mature ash distinct

- Litter cover
 - Ash and spruce - equally high litter cover
 - BUT varying litter depths:
 - ↓ Ash
 - ↑ Spruce
 - Litter dwelling forest species
- Field layer cover:
 - Both spruce and ash have high field layer cover
 - Spruce: grass, ferns, brambles
 - Ash: Ivy dominated
 - Less structurally diverse

Structural indicators of Spider biodiversity

- Lower field layer cover:
 - Important determinant of total spider species richness
 - Diversification of habitat structure
 - Evident in more open sites with high species richness

- Canopy cover and upper field layer:
 - Negative effect on lower field layer vegetation
 - Allows colonisation of forest ground vegetation
 - Benefits forest specialists

- Forest associated variables

- Such as:

- Needle litter
 - Leaf litter
 - Deadwood
 - Litter depth

- Overall negative effect on total and open species richness
 - Positive affect on forest specialists

Conclusions

- Sitka spruce and ash have different spider assemblages which change over the forest cycle:
 - Canopy closure has profound effects on spider communities
 - Species richness in spiders is strongly influenced by vegetation structure
 - Sites with a more open canopy contain a more complex vegetation structure

- **Forest species must not be overlooked:**
 - Open and forest species show opposite trends over the forest cycle
 - Paucity of natural woodlands in Ireland
 - Plantations could potentially be an important habitat for these species
 - Balance between factors affecting open and forest species in management
- **Real data and structural indicators**

Acknowledgements



- Myles Nolan, Bob Johnston and Peter Merrett for help with identification of difficult specimens
- Maire Buckley and Noreen Burke for help in the field
- Thanks to Ed Nieuwenhuys for use of spider photographs (www.xs4all.nl/~ednieuw/)
- Bioforest project for funding the research ([//bioforest.ucc.ie/](http://bioforest.ucc.ie/))
- Thanks to COFORD for providing funding to attend the BES meeting