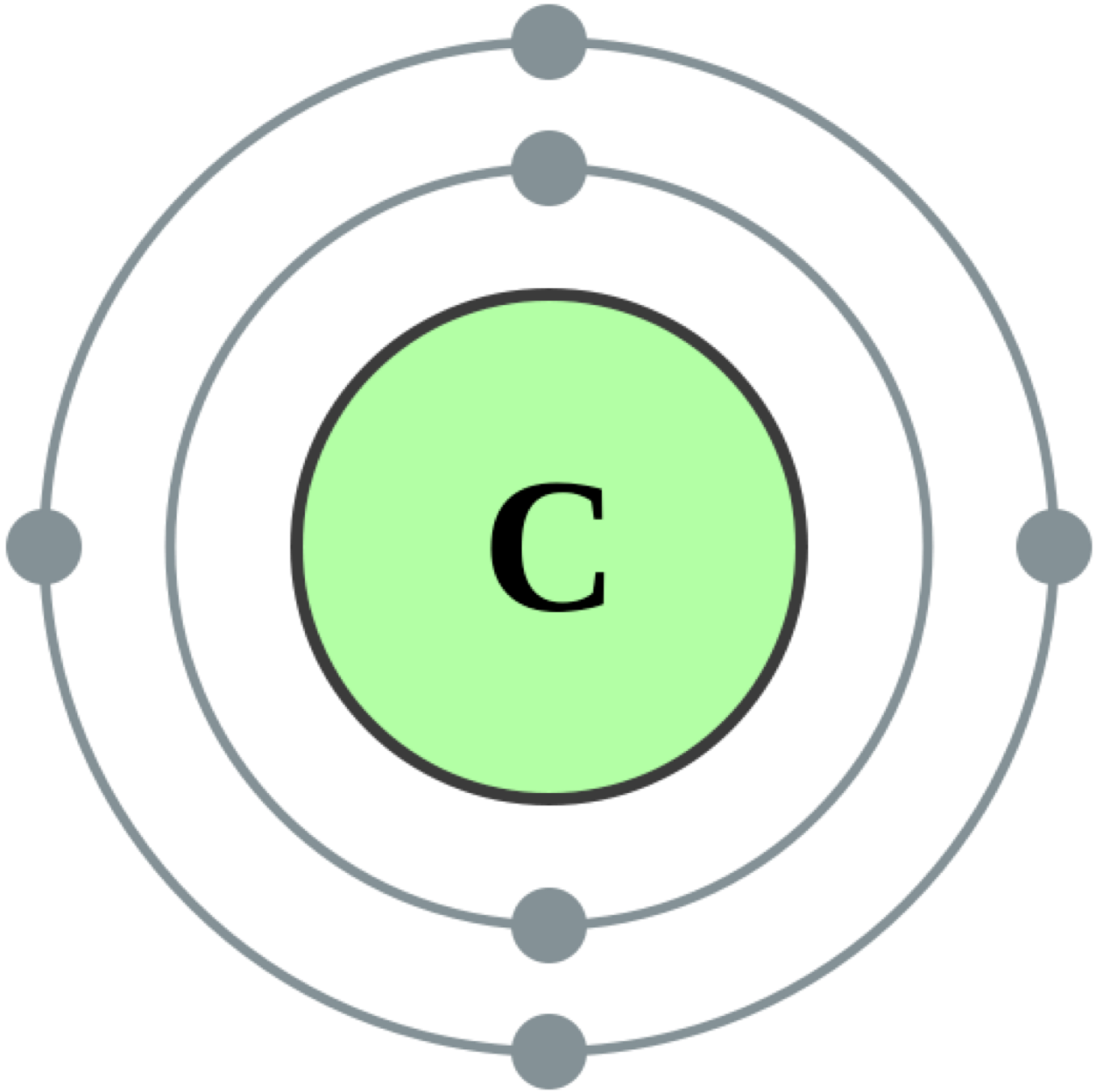
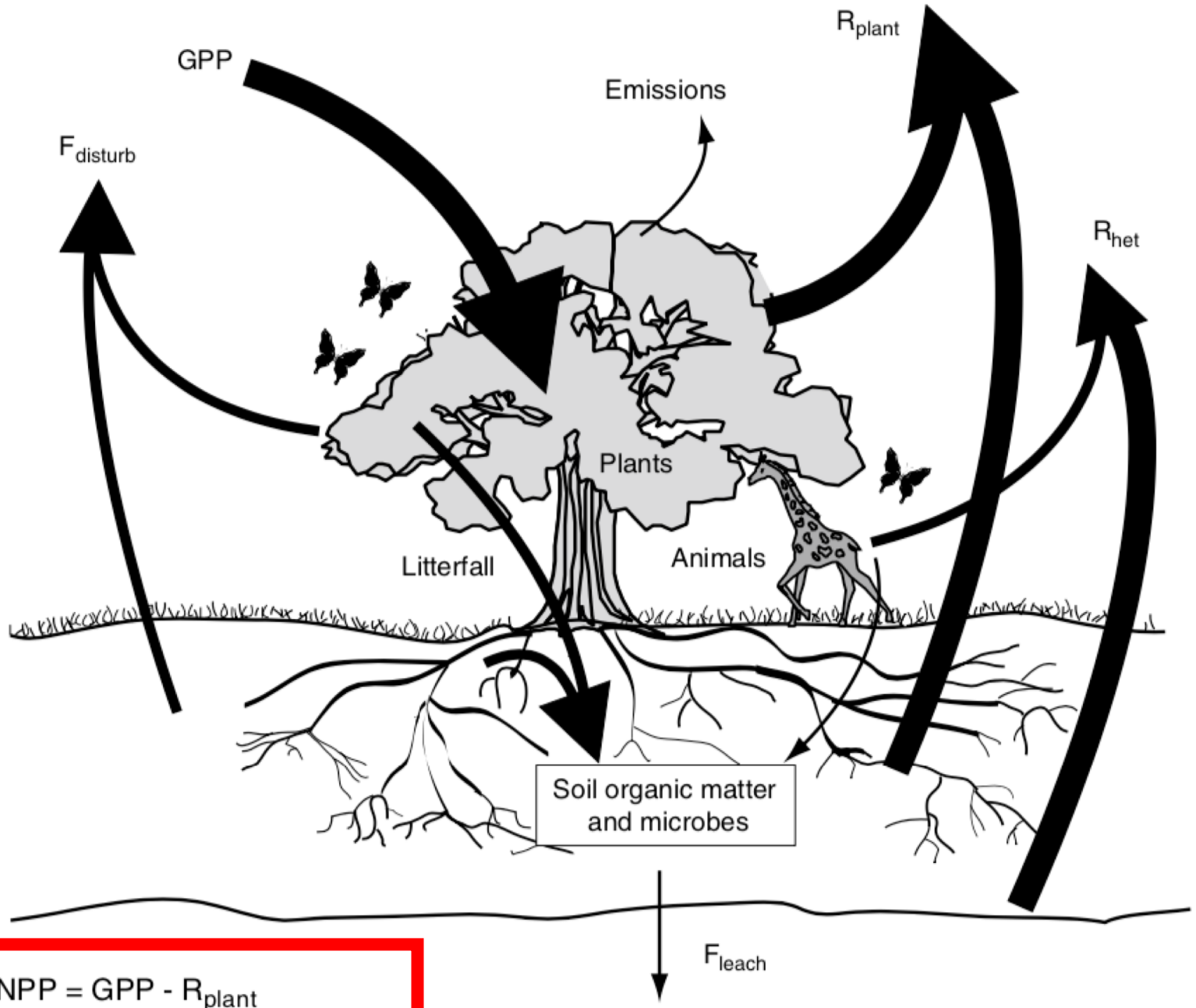


Terrestrial ecosystem carbon budgets



Terrestrial Ecosystem Carbon Cycle

$NPP = GPP - R_{plant}$

$NEP = GPP - (R_{plant} + R_{het})$

$$NEP = GPP - (R_{plant} + R_{heterotroph})$$

Net ecosystem production (total flux of C into ecosystem; per ground area)

$$\boxed{NEP} = GPP - (R_{plant} + R_{heterotroph})$$

Heterotrophic respiration (C flux out from heterotrophs; per ground area)

$$NEP = GPP - (R_{plant} + R_{heterotroph})$$

What stands out about this table?

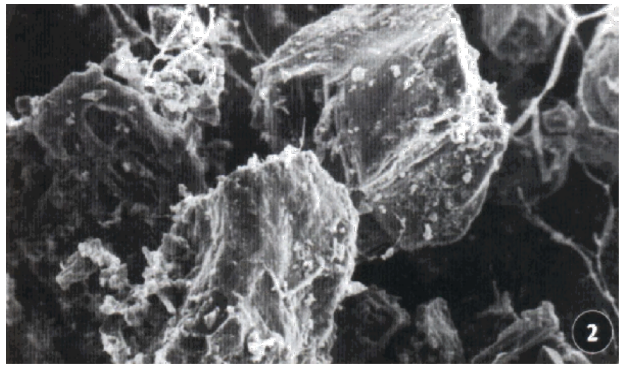
Nutrient	Source of plant nutrient (% of total)		
	Atmosphere	Weathering	Recycling
Temperate forest			
N	7	0	93
P	1	<10?	>89
K	2	10	88
Ca	4	31	65
Arctic tundra			
N	4	0	96
P	4	<1	96

Source: Chapin 1991.

Detritus

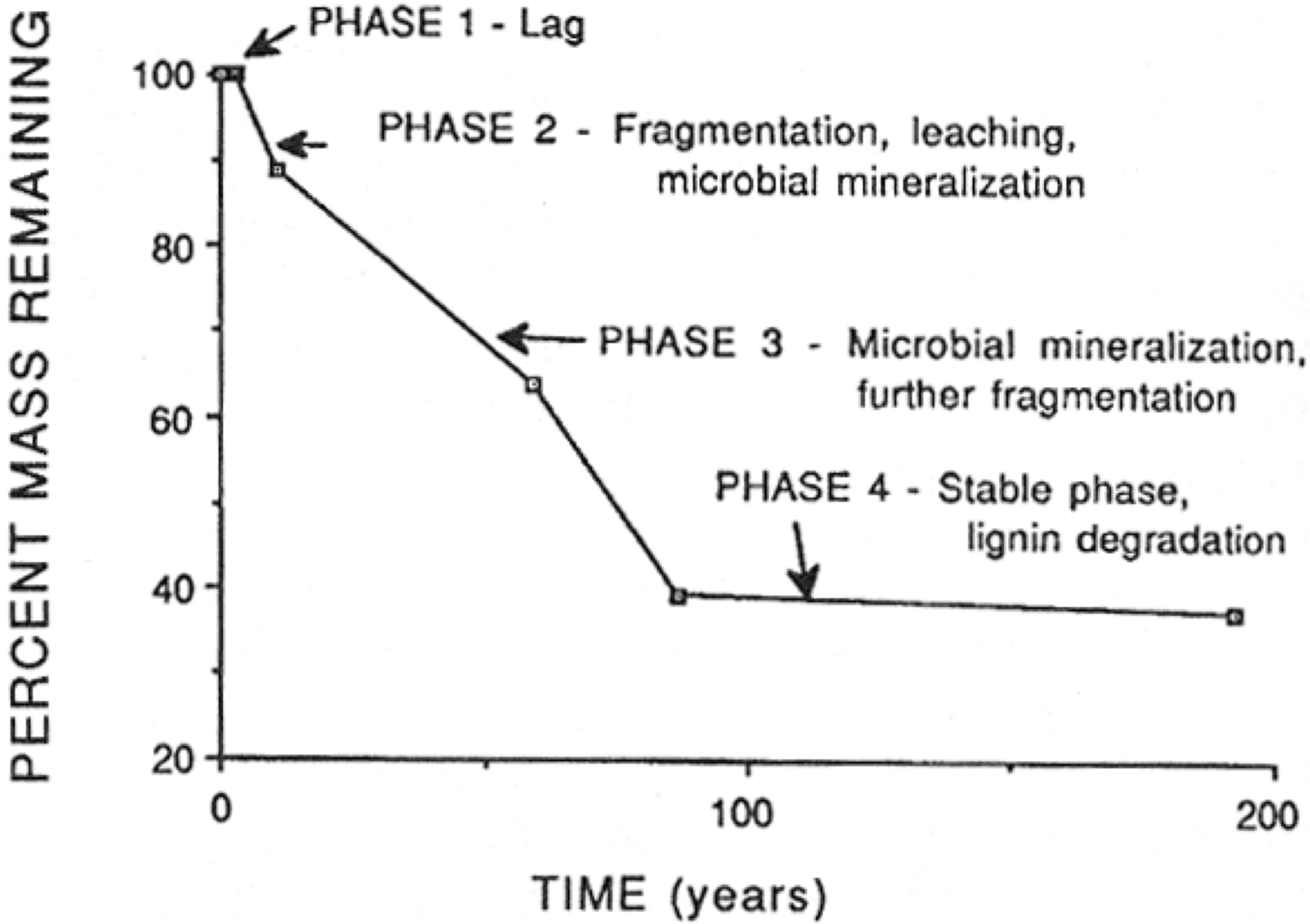
Decomposition of Organic Matter

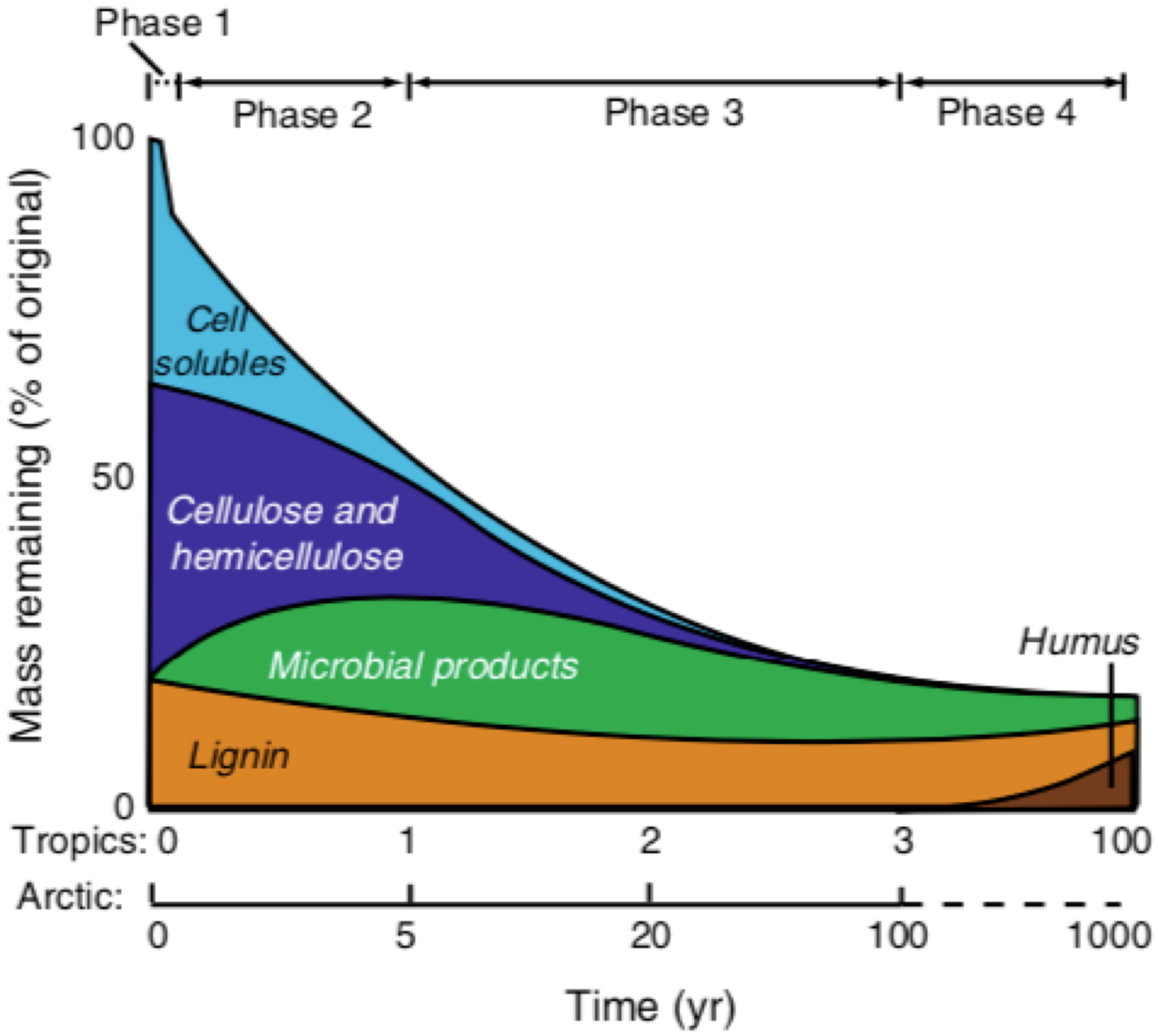
Decomposition is a process that includes many different biochemical reactions that lead to loss of organic material as CO_2 and the release of mineral nutrients and water



Decomposition results from:

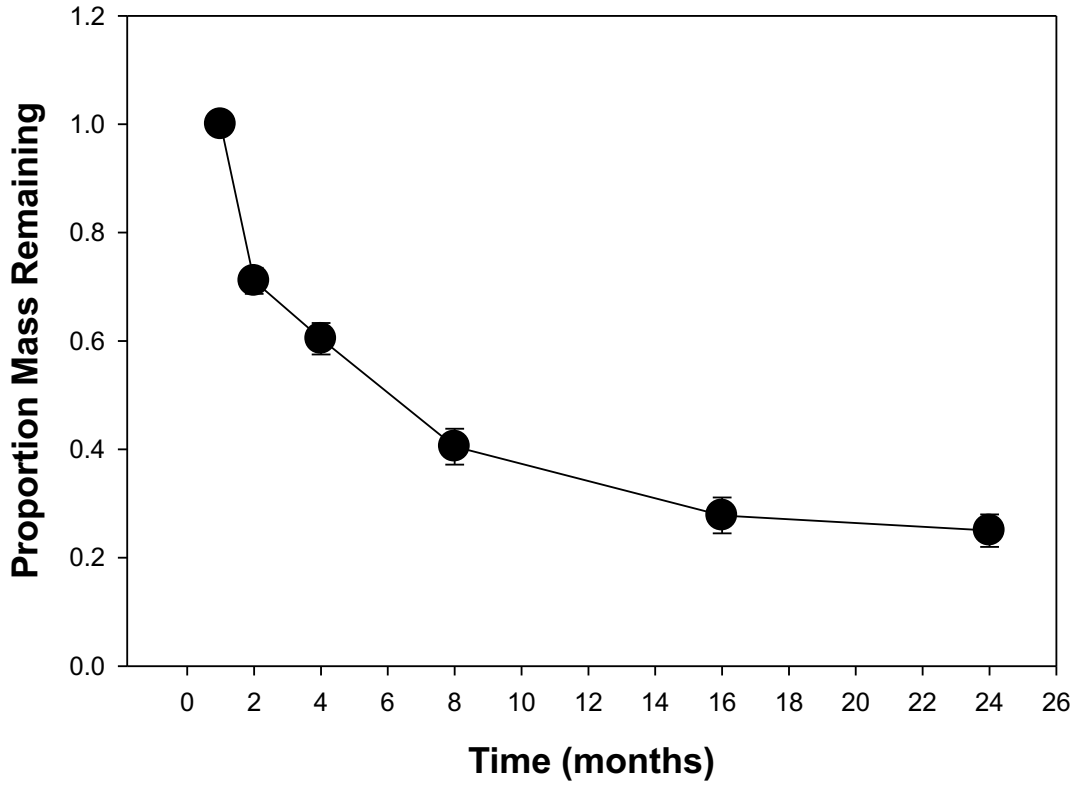
1. **Leaching** – compounds out of detritus
2. **Fragmentation** – breakdown of protective coating
3. **Chemical alteration** of OM by bacterial and fungal enzymes


PERCENT MASS REMAINING
100
80
60
40
20
0
100
200
TIME (years)
PHASE 1 - Lag
PHASE 2 - Fragmentation, leaching, microbial mineralization
PHASE 3 - Microbial mineralization, further fragmentation
PHASE 4 - Stable phase, lignin degradation

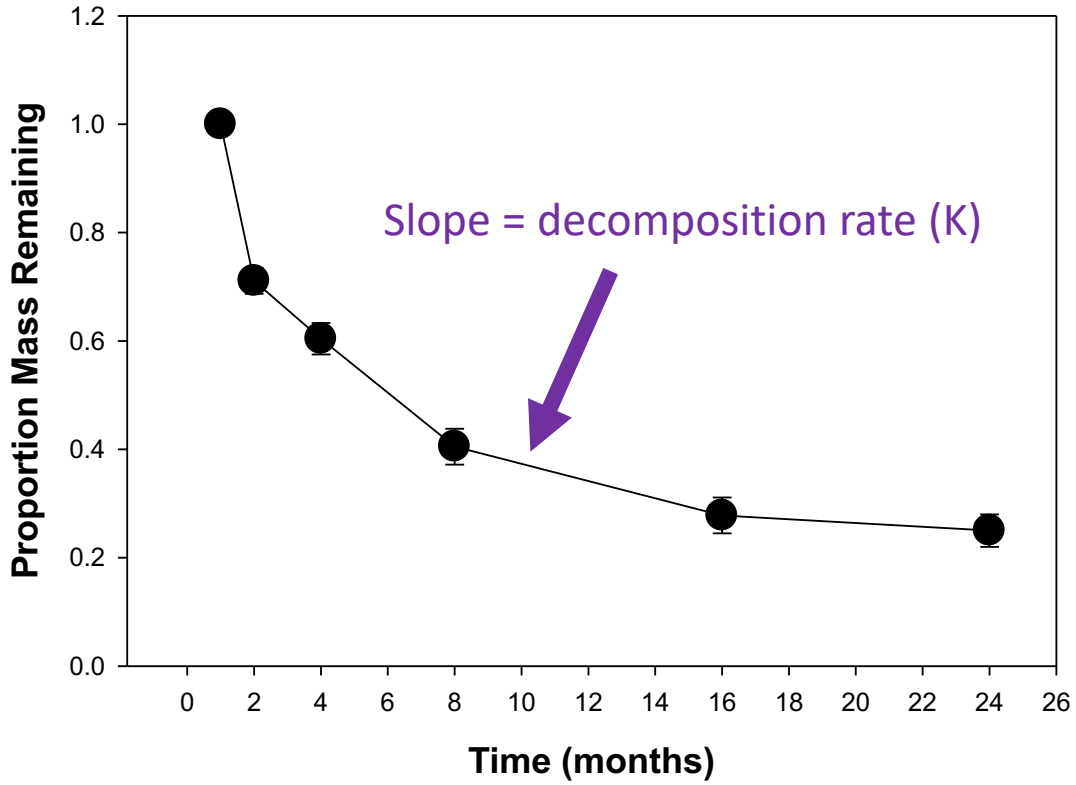


Microbes break down easy stuff before moving to more recalcitrant material

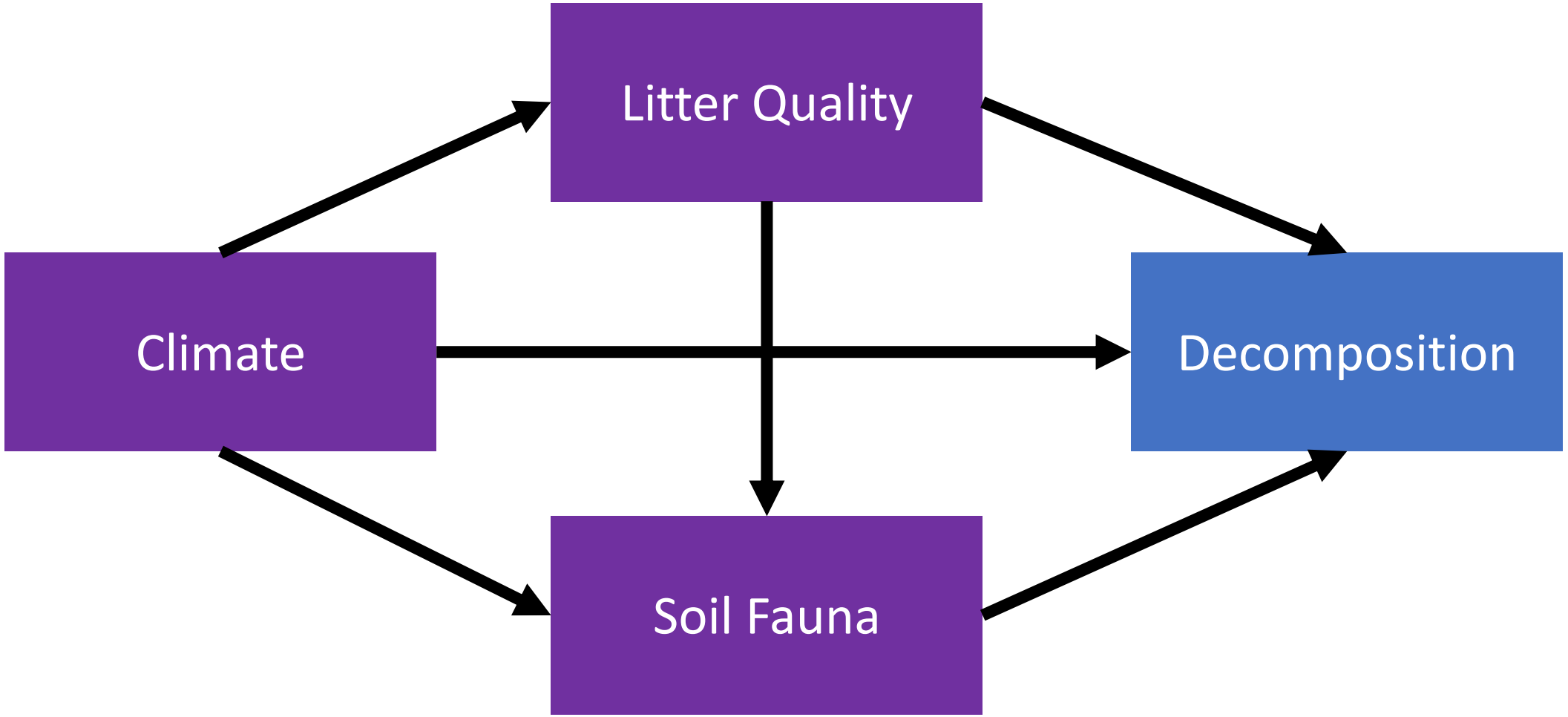
The rate of decomposition



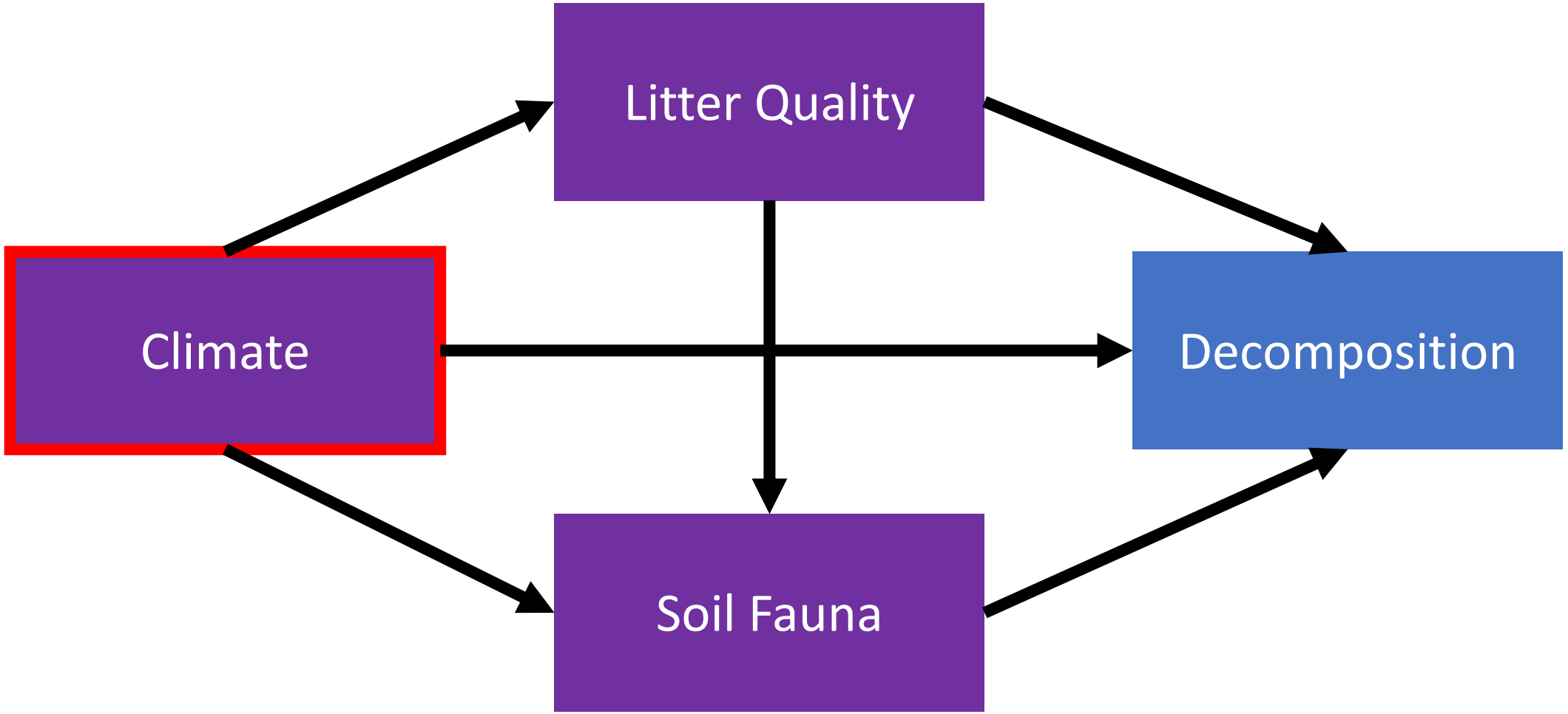
The rate of decomposition



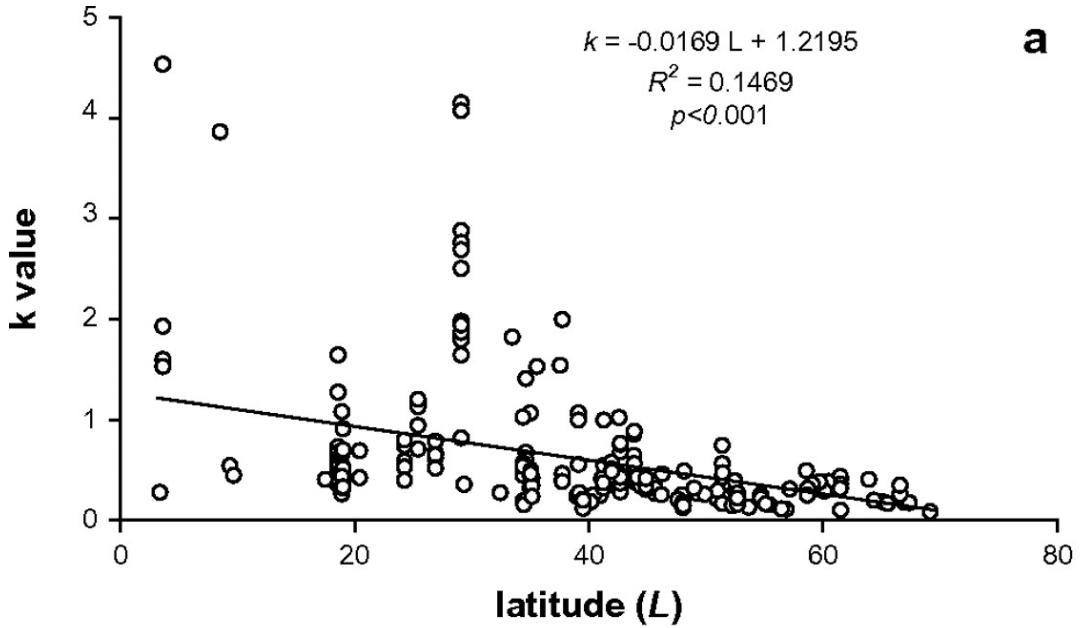
Major controls of decomposition



Major controls of decomposition

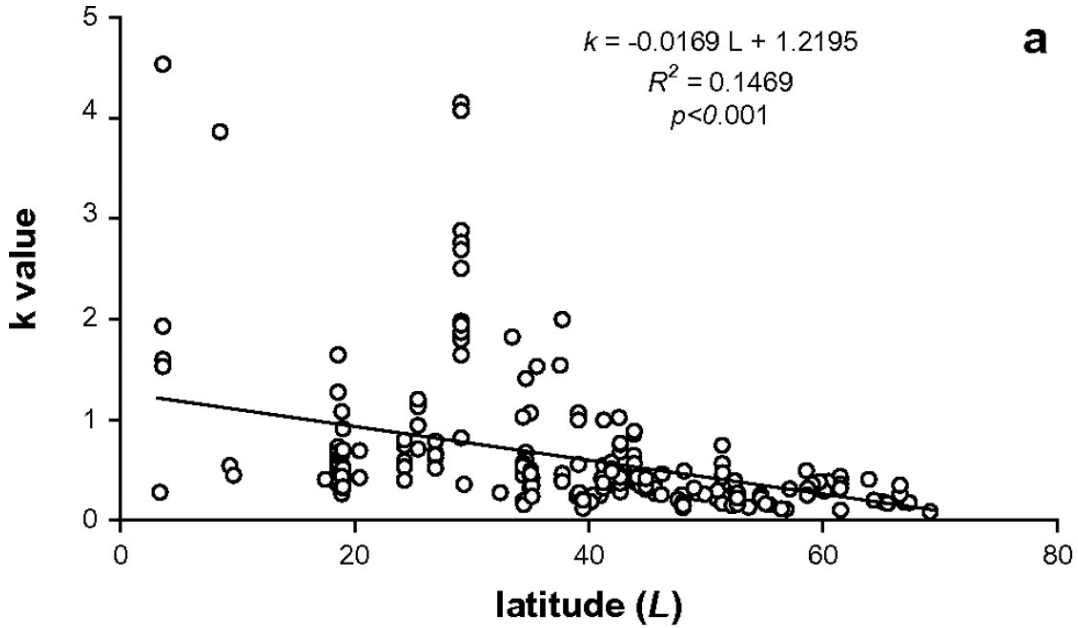


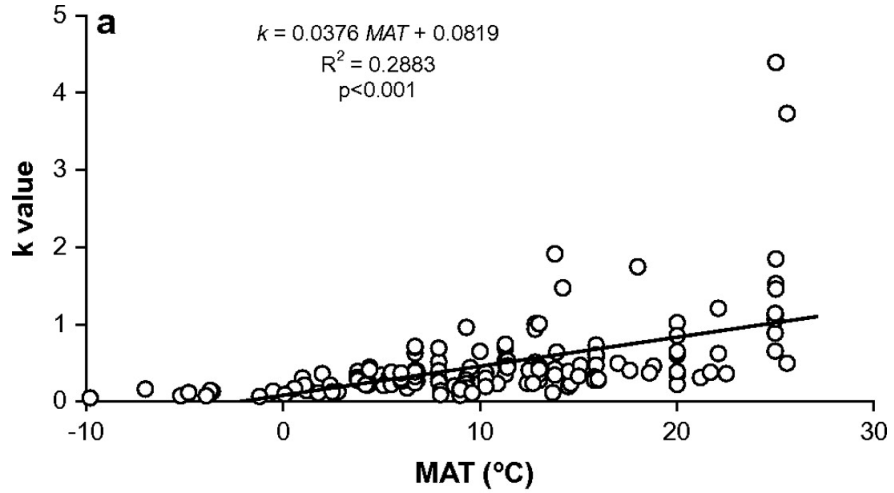
Climate and decomposition

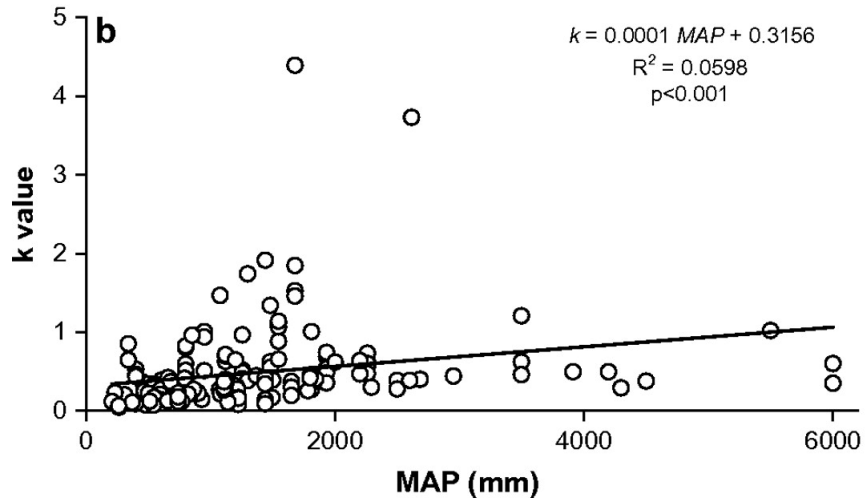


Zhang et al. 2008

Climate and decomposition

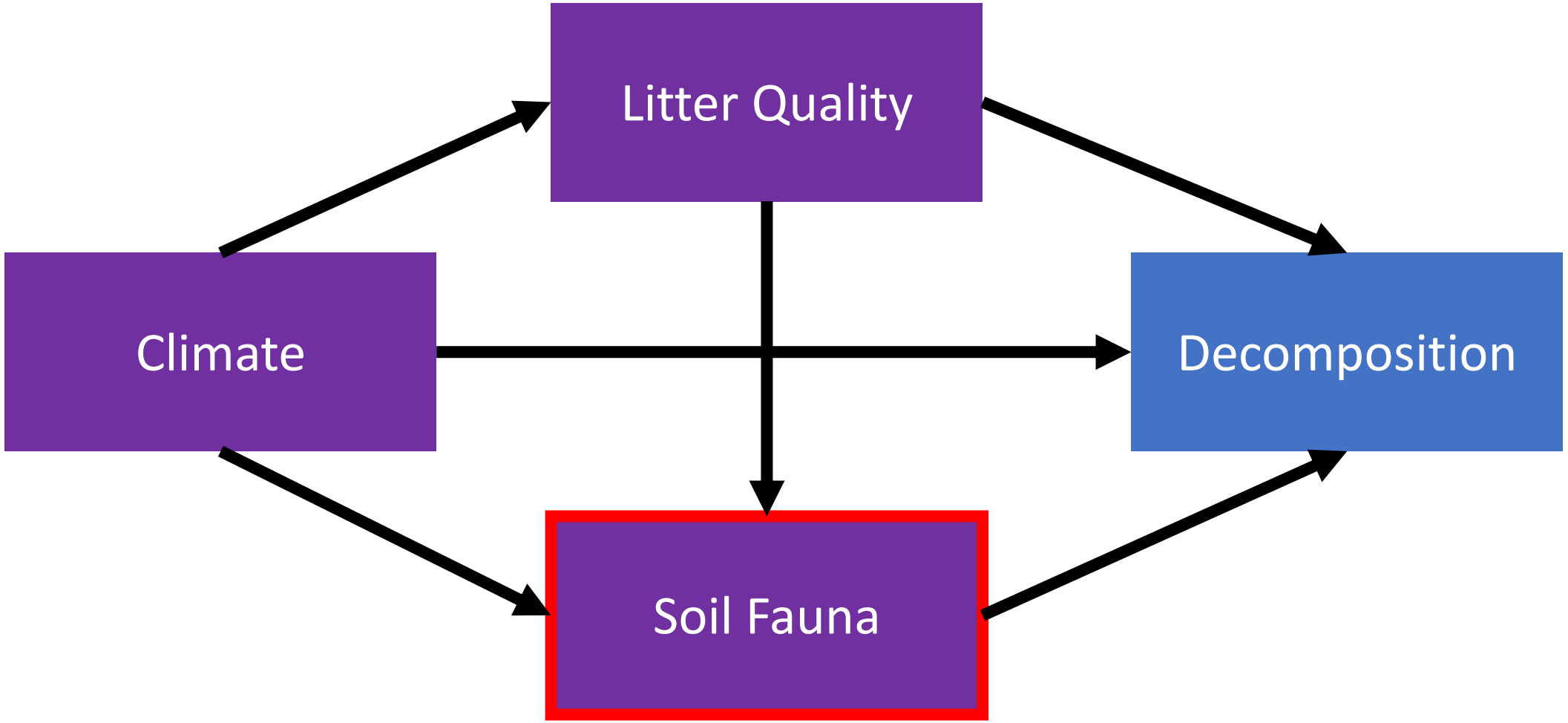






Zhang et al. 2008

Major controls of decomposition

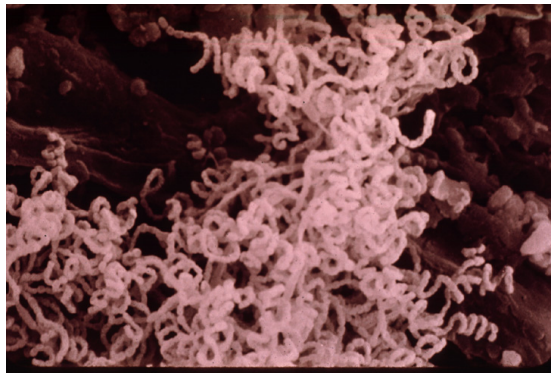


Soil organisms

- Breakdown organic material
  - Releases mineral nutrients
  - Stabilizes soil structure
  - Forms humus
- Inorganic transformations
  - Transforms N, P, S into plant available forms
- Nitrogen fixation
  - Fix N_2 from atmosphere

Microbial community characteristics determine litter decomposition

- Community composition
  - Who's there
- Enzyme activity – speed breakdown
- Most processes are mediated by enzymes secreted



Extra-cellular enzymes in soils involved in C and N transformations:

Enzymes involved in C transformations

-**glucosidase** → Microorganisms & plants (especially fungi & yeast)

(1st step in cellulose degradation)

-**cellulase** → Primarily fungi, some actinomycetes

(cellulose to glucose)

-**phenol oxidase** → Primarily fungi

(phenolic breakdown)

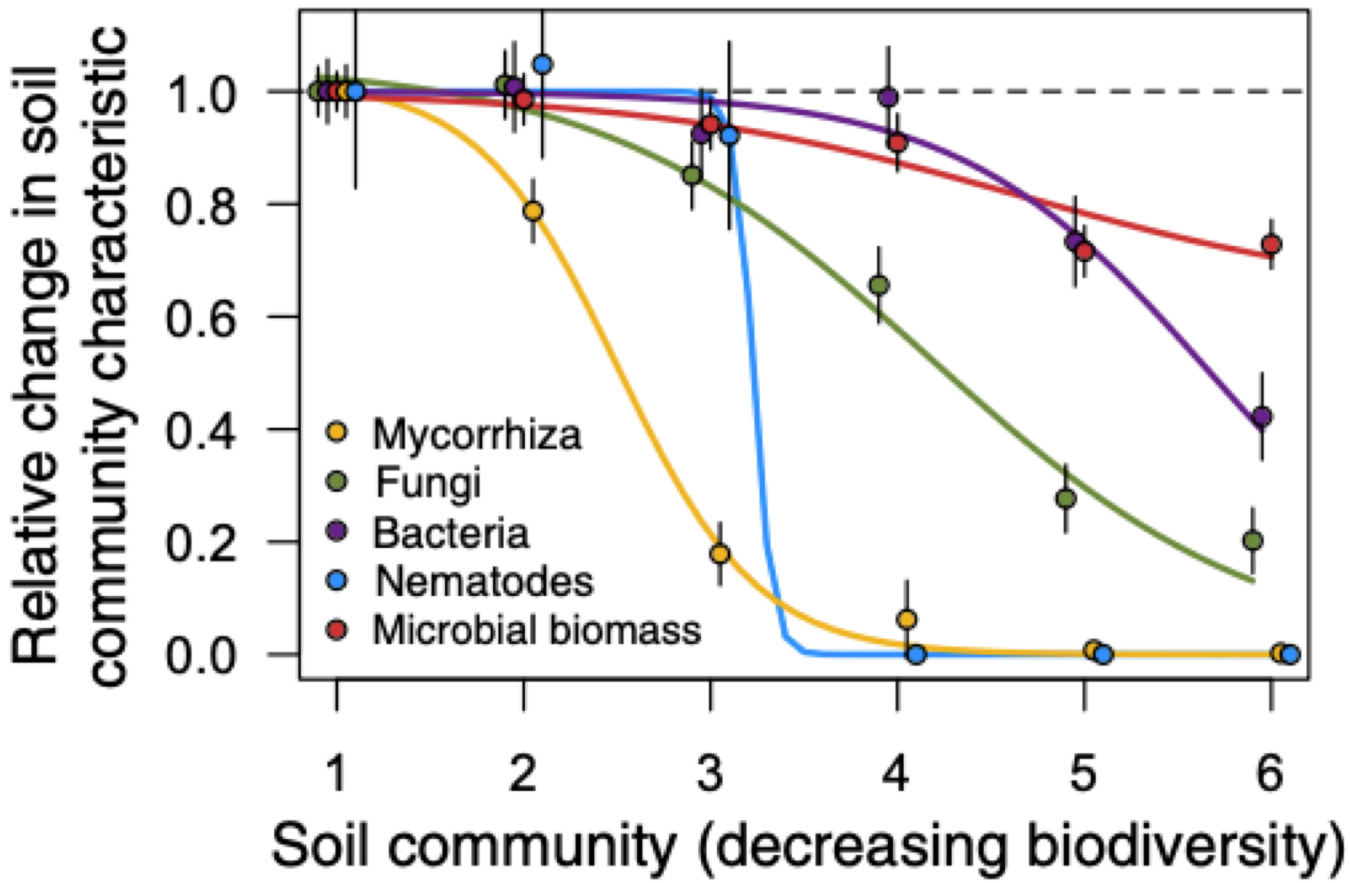
Enzymes involved in N transformations

-**protease** → Nearly all microorganisms

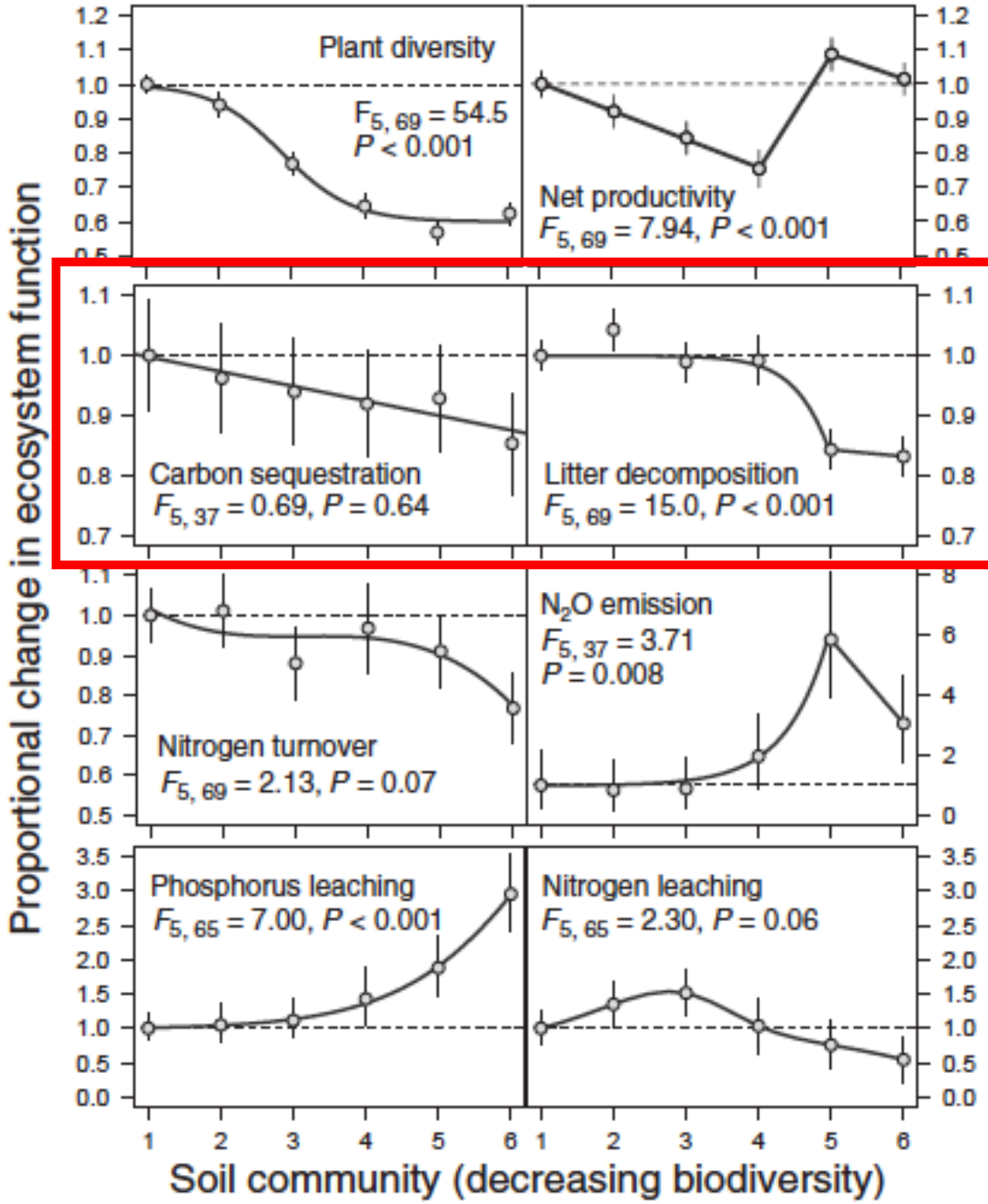
(proteins to polypeptides to amino acids)

-**urease** → Microorganisms & plants

(urea to ammonia)

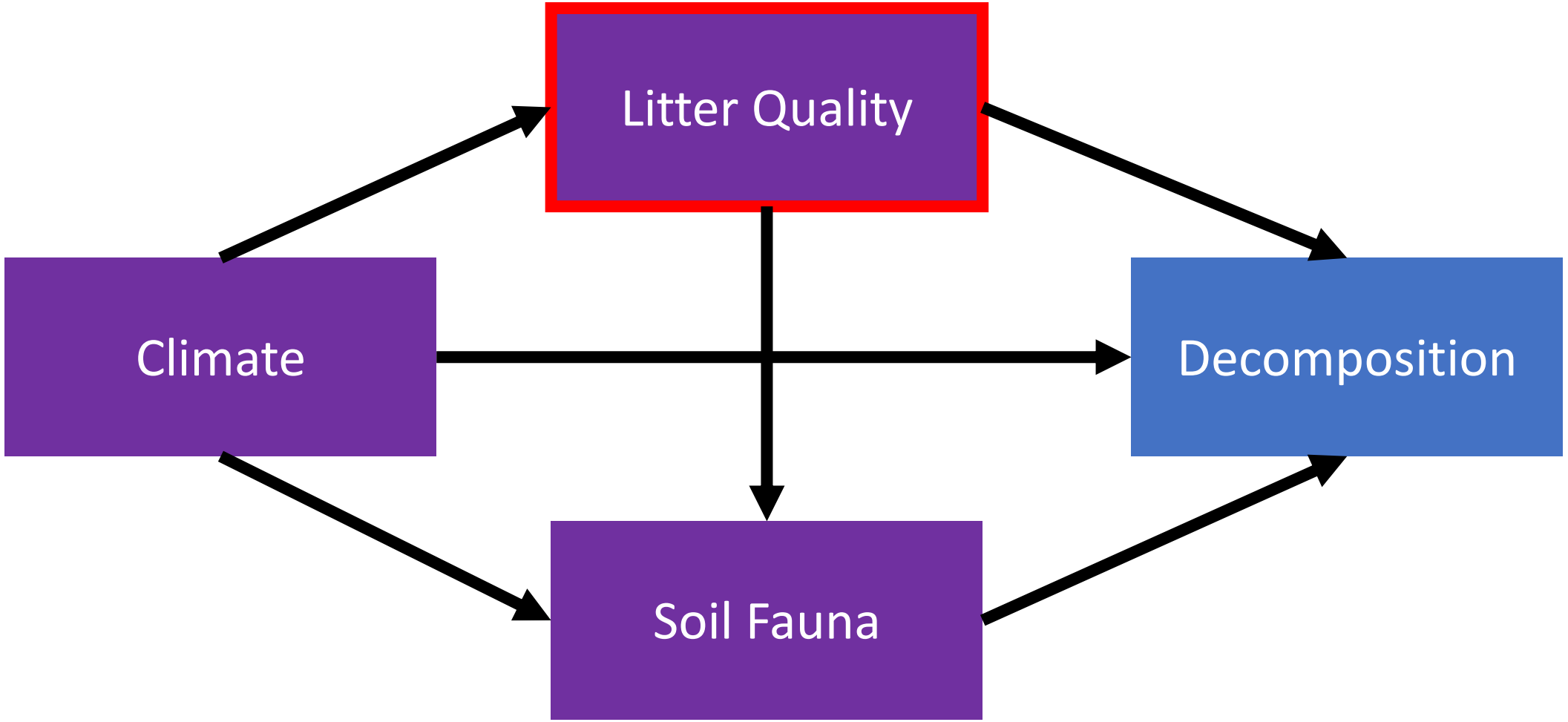


Wagg et al. 2014

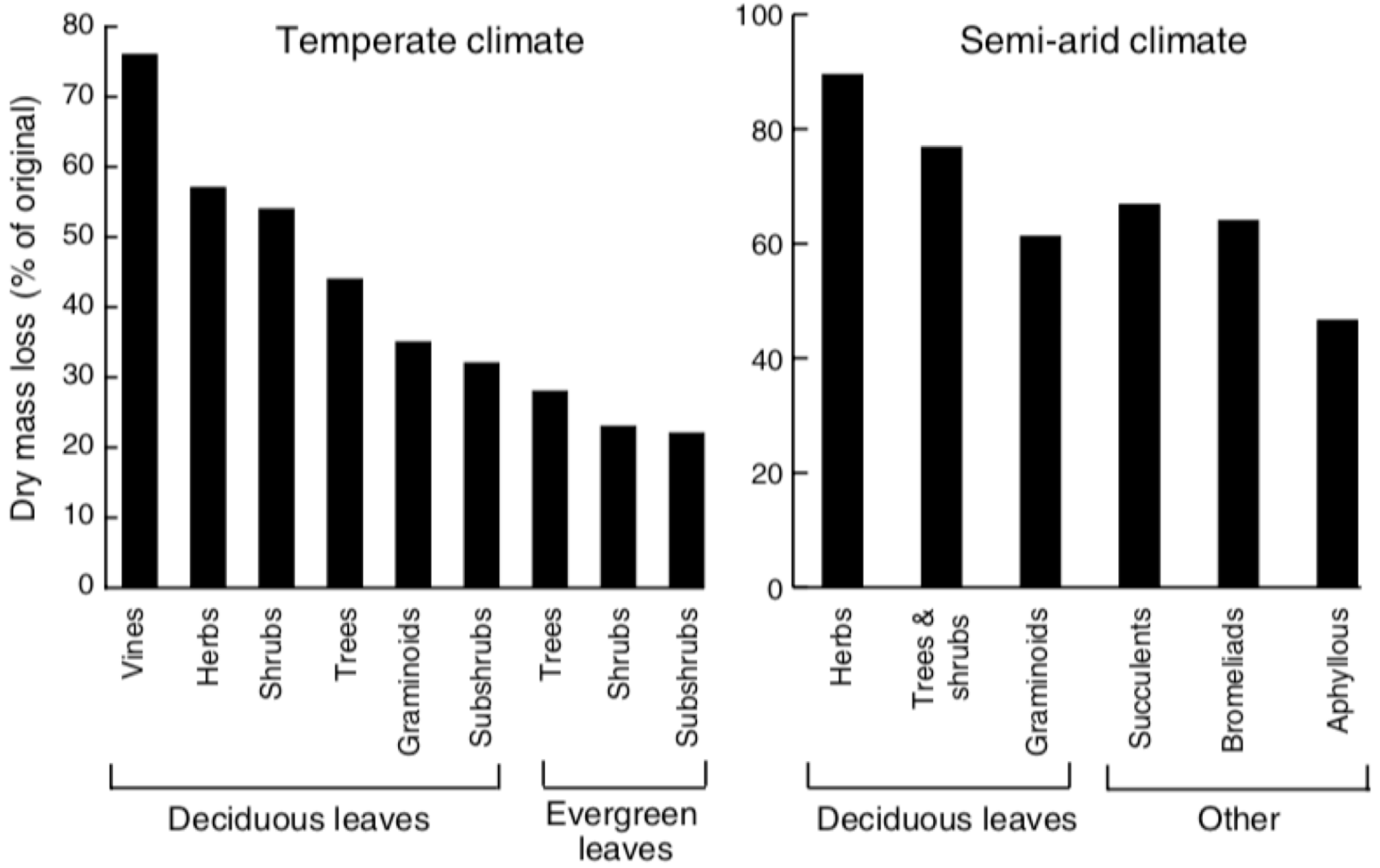


Wagg et al. 2014

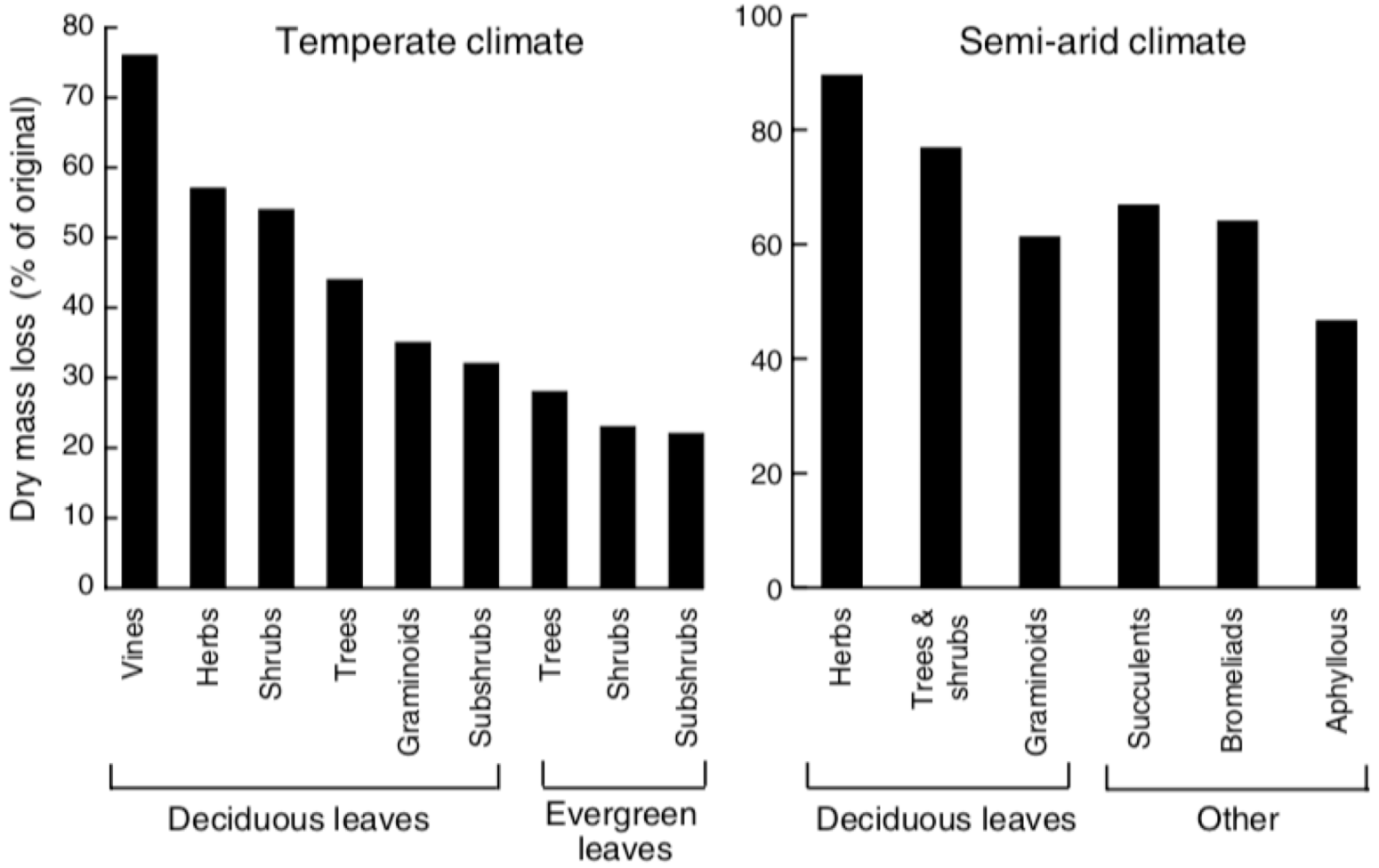
Major controls of decomposition



Litter quality varies with plant type

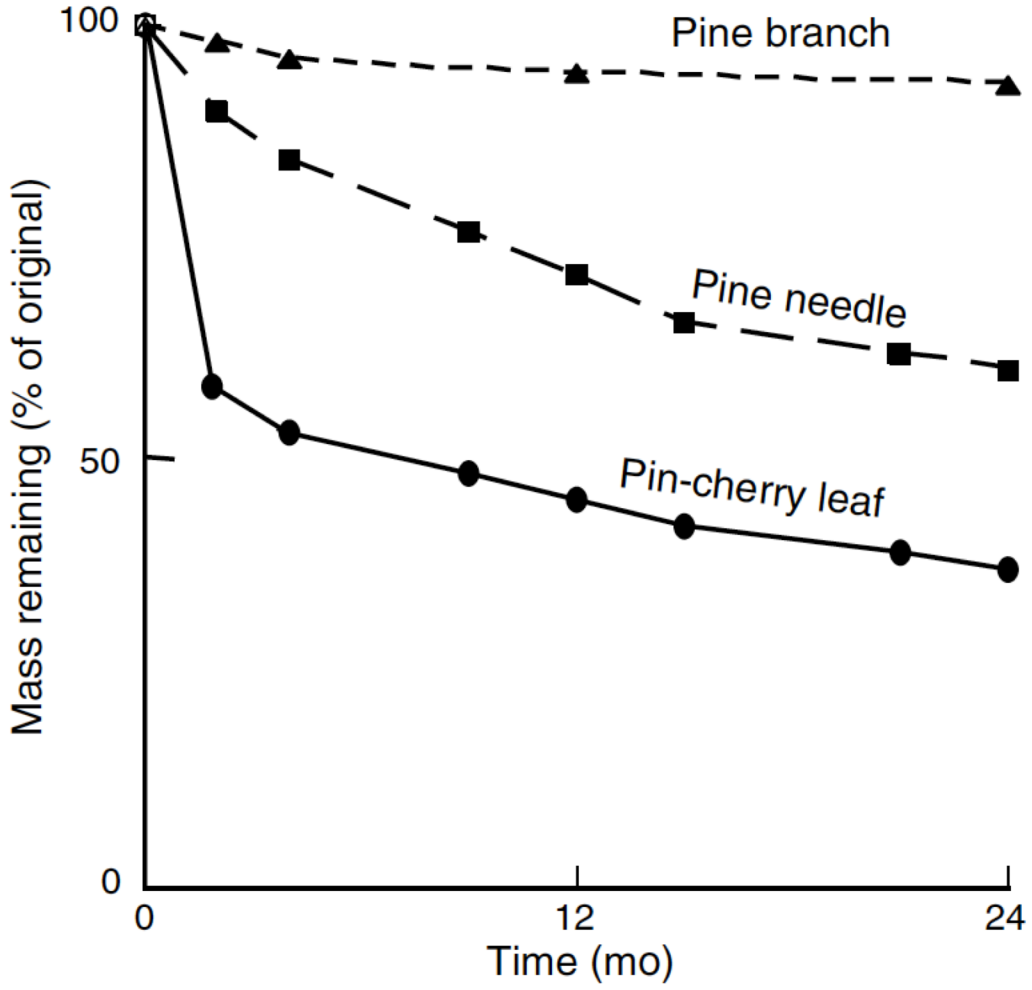


Litter quality varies with plant type

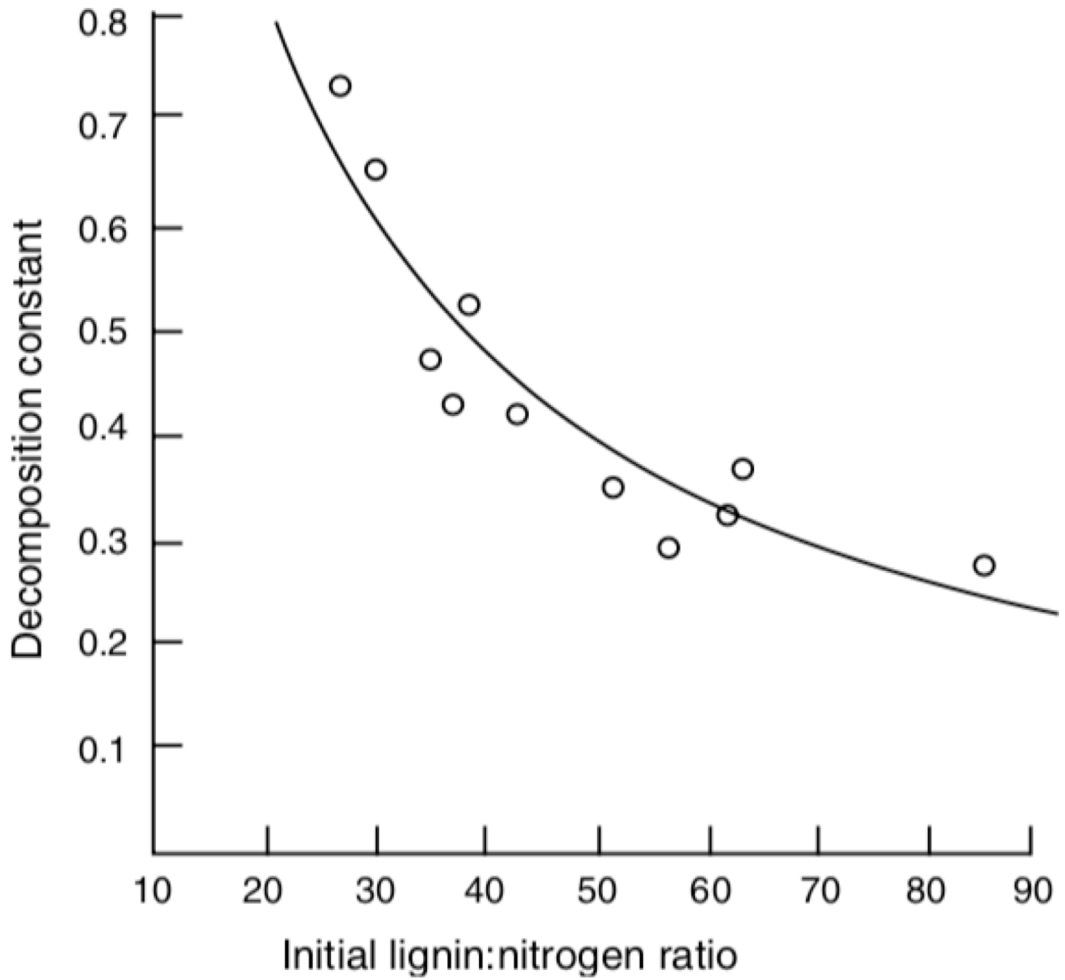


Why don't all decompose fast?

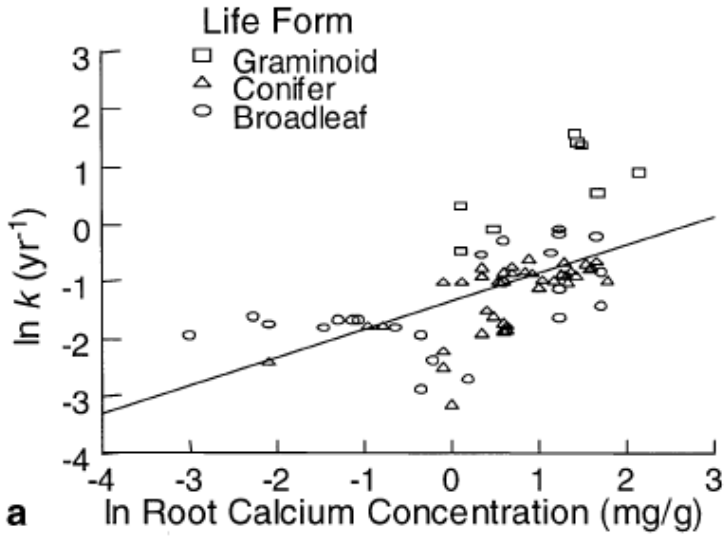
Leaves decompose faster than branches

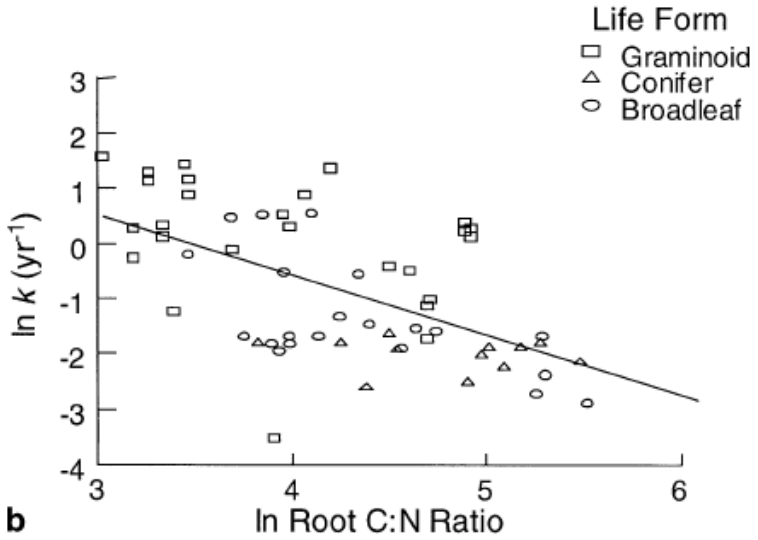


Higher nutrient litter decomposes faster



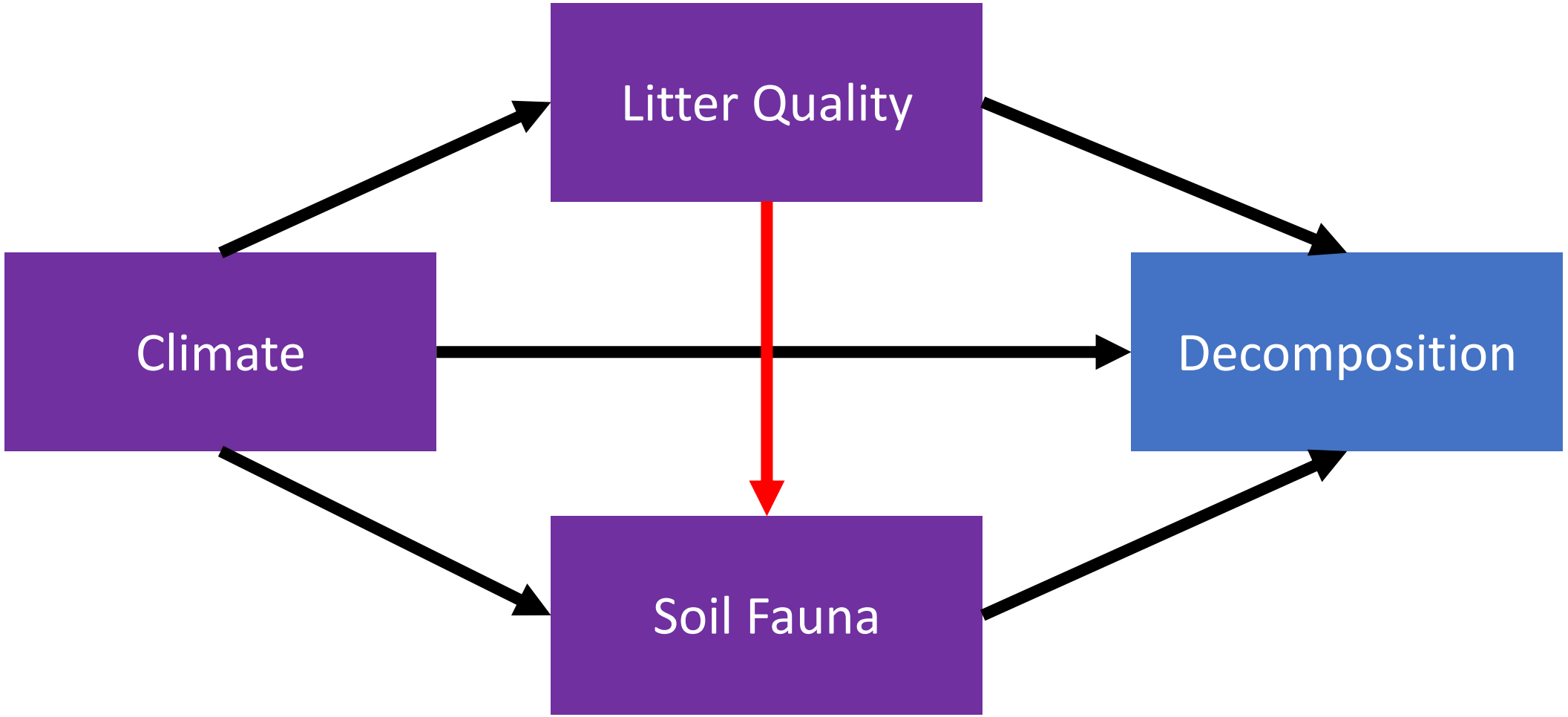
Higher nutrient litter decomposes faster





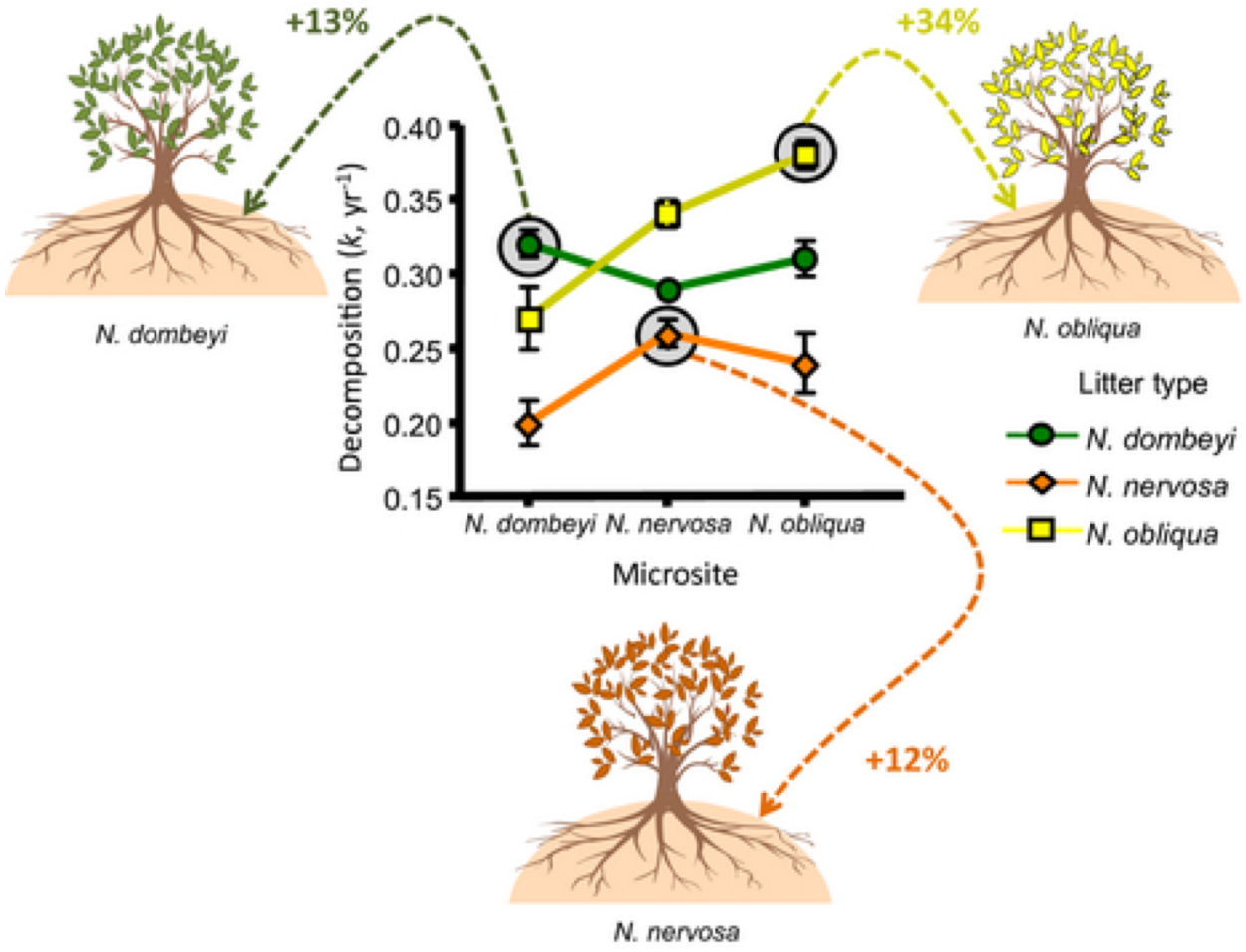
Silver & Miya 2001

Major controls of decomposition



Home Field Advantage

Do microbes decompose substrates that they've "seen" before better than naïve substrates?



Austin et al. 2014

Why is the ground brown?