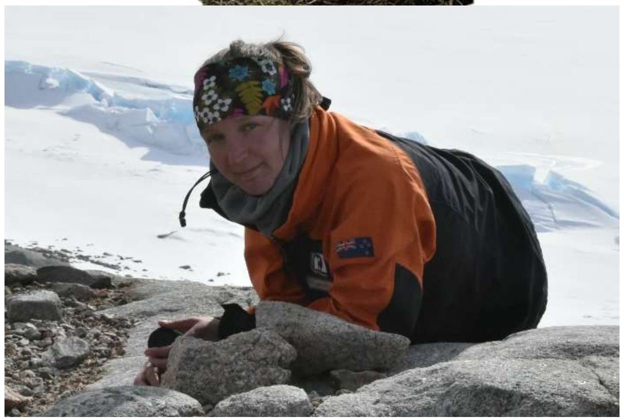
Experimental design

And Scientific decision making



Claudia Colesie

- adaptation/acclimation processes in lichens and mosses from polar ecosystems
- Gas exchange of photosynthesis and respiration

This week: Doing science

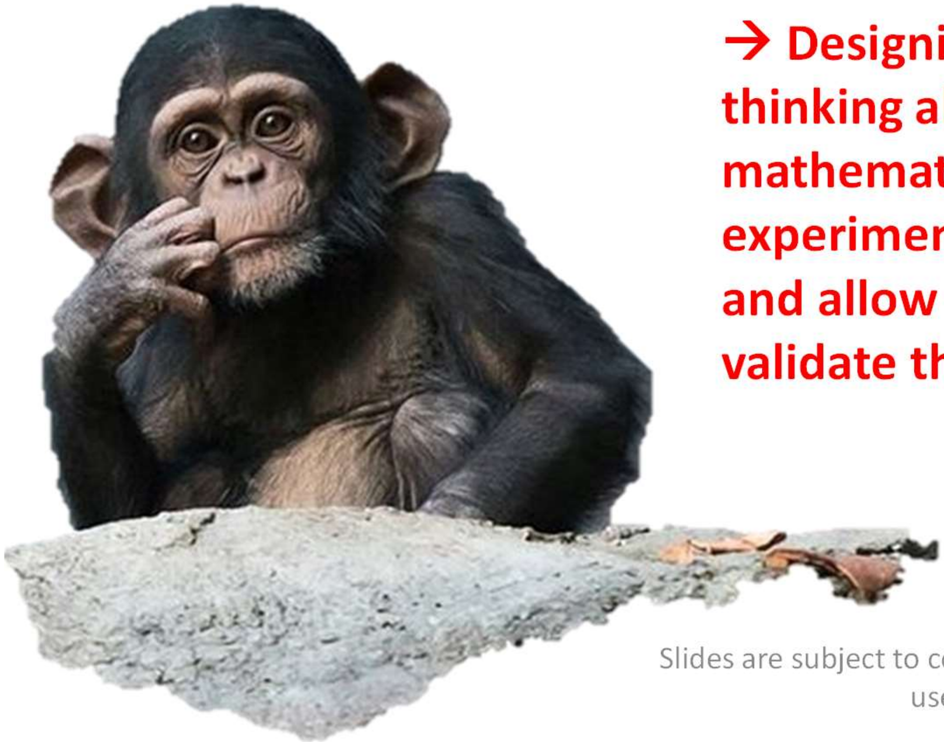
As Scientists we need to be able to…

- Design a good study (and spot bad ones)
- Organise our data so that it's easily usable (not just for yourself)
- Understand why we need statistics (& spot misinterpretation)
- Carry out statistical tests to analyse our data
- Write a research plan

Why should you care about design?

~~‘It does not matter how you collect your data, there will always be a statistical ‘fix’ that will allow you to analyse it’~~

~~‘If you collect lots of data something interesting will come out, and you’ll be able to detect even very subtle effects’~~



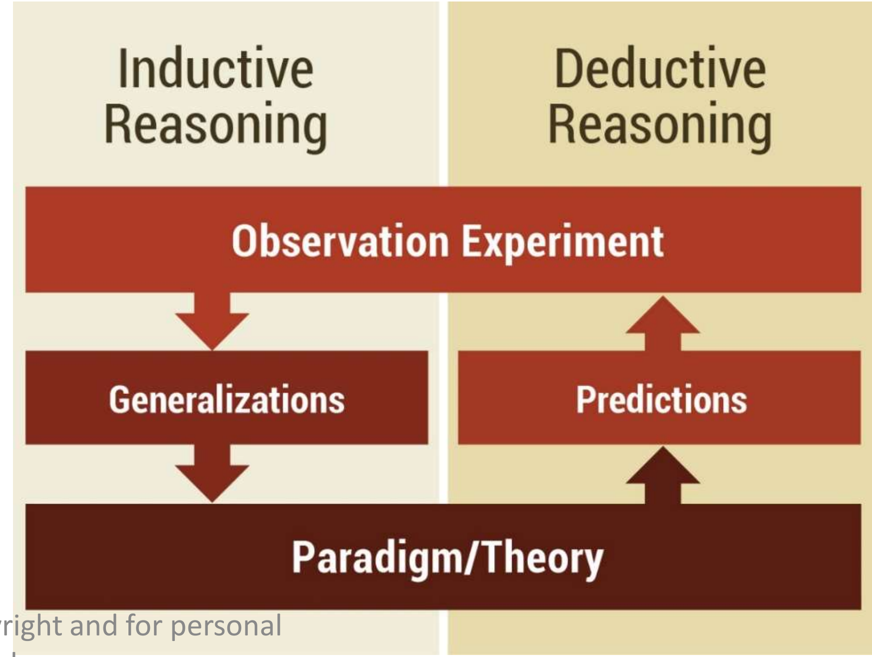
→ Designing effective experiments needs thinking about biology more than it does mathematical calculations. Careful experimental design at the outset can safe time and allow the use of powerful statistics to validate the results.

Science is different to all other systems of thought … because you don’t need faith in it, you can check if it works. - Brian Cox

Philosophy of science

- Deductive reasoning
  - Hold a theory, make predictions, test to see if it is correct

- Inductive reasoning
  - Make observations, discern pattern, make generalisation, infer a theory



Philosophy of science

Deductive Thinking

All trees are plants.

↓

A larch is a kind of tree.

↓

Therefore, a larch is a plant.

Inductive Thinking

Therefore, all trees are plants.

↑

A larch is a kind of tree.

↑

A larch is a plant.

Experimental design starts with a well-designed hypothesis

Black grouse example

Research question: Why do males have higher parasite loads than females?

Hypothesis: The stress associated with competition for mates reduces males' ability to mount defences against parasites

Prediction: Parasite loads are positively correlated with levels of circulating stress hormones, and males show higher levels of those than females

Null hypothesis: parasite loads are unrelated to stress

Null hypothesis prediction: There is no relationship across individuals between parasite load and level of circulating stress hormones

Experimental design starts with a well-designed hypothesis

Whelks example

Research question: Why do whelks group?

Hypothesis: Whelks group in protection from wave action

Hypothesis: Whelks group though feeding

Prediction: Whelks are more likely to be found in groups in areas with low wave action

Prediction: Whelks are more likely to be found in groups in areas with higher food density

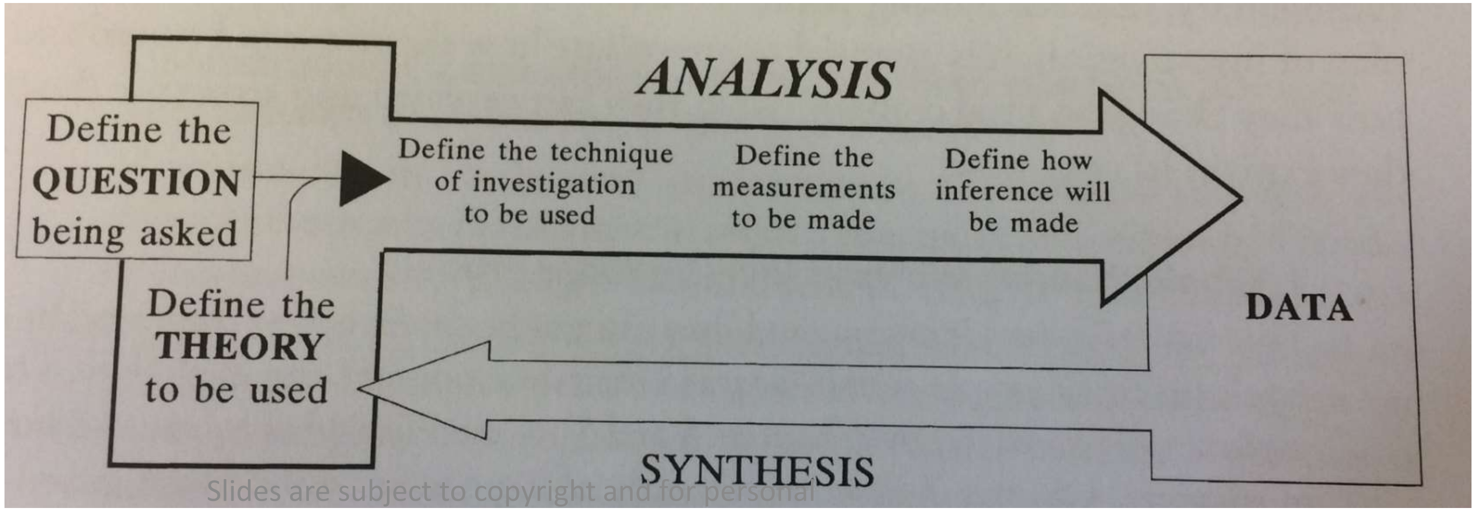
Null hypothesis: grouping is unrelated to wave action

Null hypothesis: grouping is unrelated to food density

Biological systems are complex, so it is common in life sciences to find that several hypothesis need to be combined to fully explain a set of observations

The three states of knowledge

1. Axiom
   A. Things already known (form assumptions in our study)
2. Postulate
   A. Questions that can be investigated and answered yes or no or probability
3. Data statement
   A. Define data and methods needed to classify postulate as true or false or acceptable to certain degree of probability.



Ford (2000) Scientific method for ecological research

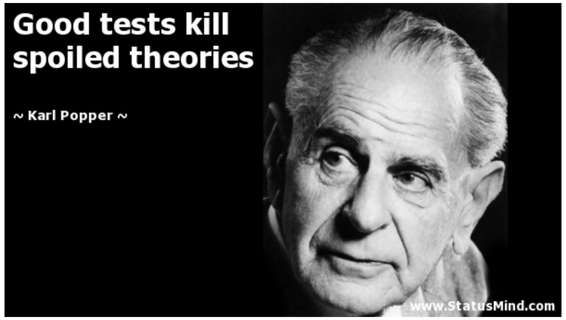
Hypothesis

Hypothesis: A clearly stated postulated description of how an experimental system works

The Hypothetico-Deductive Model, Falsifiable Hypotheses and Popperian Thinking

- ***You can never prove anything true as there are always unexplored alternative explanations.***

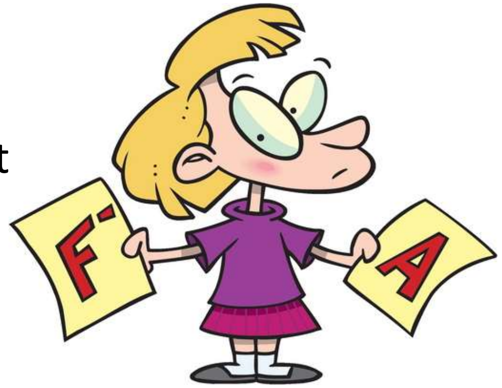
- ***But, you can prove something to be false!***



How do I produce strong evidence to challenge a hypothesis?

→ Avoid **indirect measure** or only use it if you have to. Interpret the results with care!

An indirect measure is a measure taken on a variable that we are not primarily interested in but which can be used as an indicator of the state of another variable that is difficult or impossible to measure.



→ Consider **every possible outcome** of your experiment and know how you would interpret it, before you decide to do the experiment.

→ If there is a weakness in your argument the **devils advocate** will find it. However, they can be made to believe you, but only when they have no reasonable alternative.

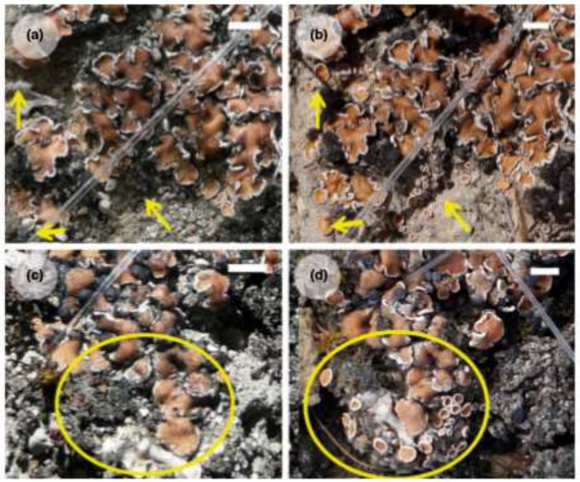
Controls

Control: A reference against which the result of an experiment manipulation can be compared to

There are three different types of controls in experimental design:

- Negative controls – a group to which a manipulation is applied that is expected to have no effect
- Positive controls – a group to which a manipulation is applied that is expected to have an effect
- Historical controls

Only very rarely situation occur where a control is not required. A clearly stated hypothesis will help you spot such cases.



Lichen transplant experiment

Pilot studies and preliminary data

A pilot study will allow you to become well acquainted with the system that you will be working on.

→ Try to gain information that will help you to better design your experiments
→ Make sure you ask sensible questions
→ Check if your techniques are working
→ Practise all your data collection techniques in a realistic setting before you need to use them in real.

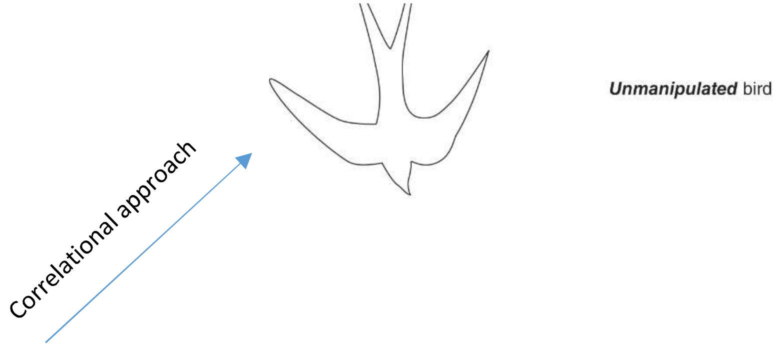
Example research task: Observe whether flock size in wild geese grazing on agricultural land varies with species and land use

- Can I find a good number of geese flocks?
- How close can I get before disturbing the animals?
- How well can I identify geese under field conditions?
- How well can I estimate the flock size?
- Can I take photographs?
- How well can I identify geese on a photograph?
- Are there enough sites from where I can take good photographs?
- How can I categorise the land use?

Selecting the broad design of your study

Experimental manipulation versus natural variation

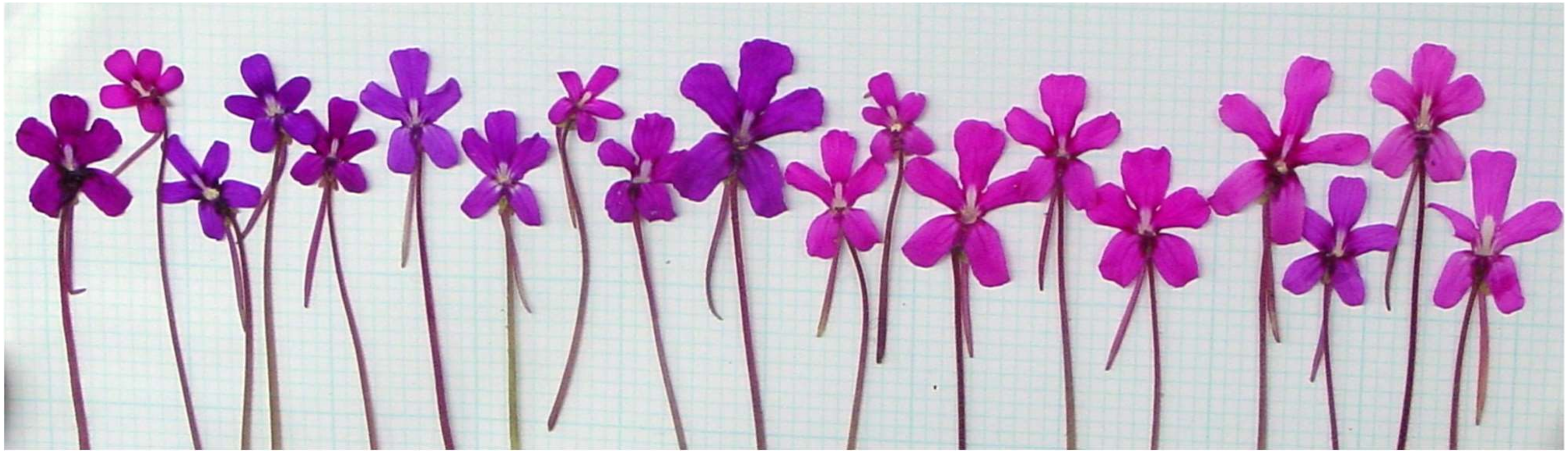
Correlational/observational studies:
Makes use of the naturally occurring variation, rather than artificially creating variation



Long tail streamers seen in many species of bird have evolved to make males more attractive to females

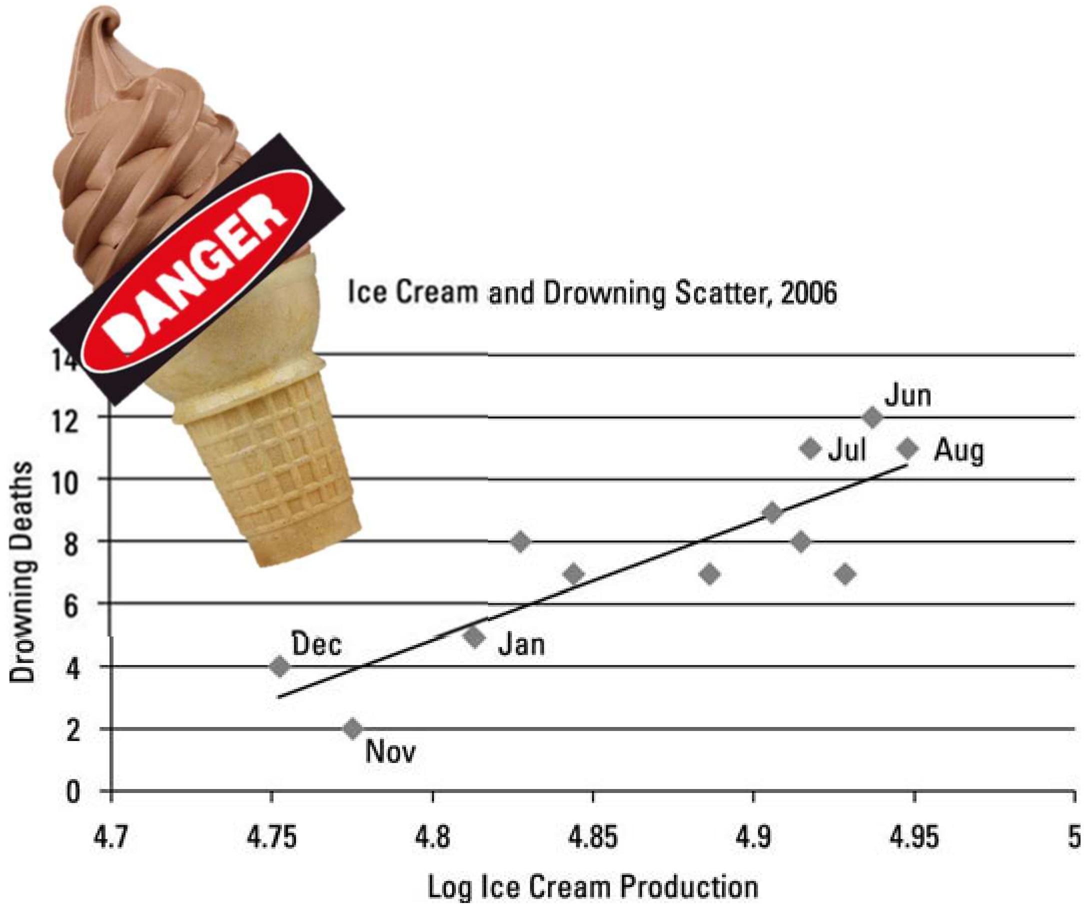
Correlational studies - Benefits

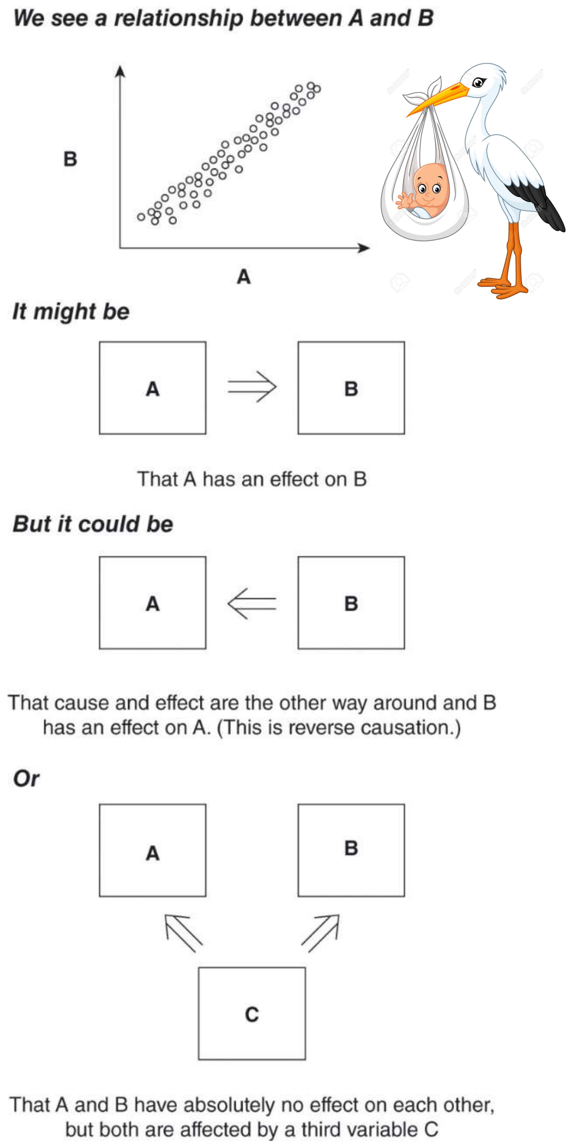
- Often involve less work
- Less time handling or confining organisms
- Problems with unintended side effects are less (example: cutting parts of the males tail might effect flying ability)
- **Deals with biologically relevant variation**



Correlational studies - Drawbacks

- **Correlational studies can suffer from third variables**
- **Reverse causation effects can occur**





Observational vs Experimental studies

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Example:

Research question:
Why do some sheep grow slower than others?

Hypothesis:
Worm burden is known to have detrimental effects on the gut walls and energy uptake. Therefore worm burden reduces the growth rates of Soay sheep.

Prediction:
Sheep with high worm burden have lower growth rates

Null hypothesis:
Growth rates are unrelated to worm burden

Formulate a clear research question

↓

Form a hypothesis that addresses the question

↓

Form predictions from the hypothesis

↓

Do the predictions follow logically from the hypothesis?

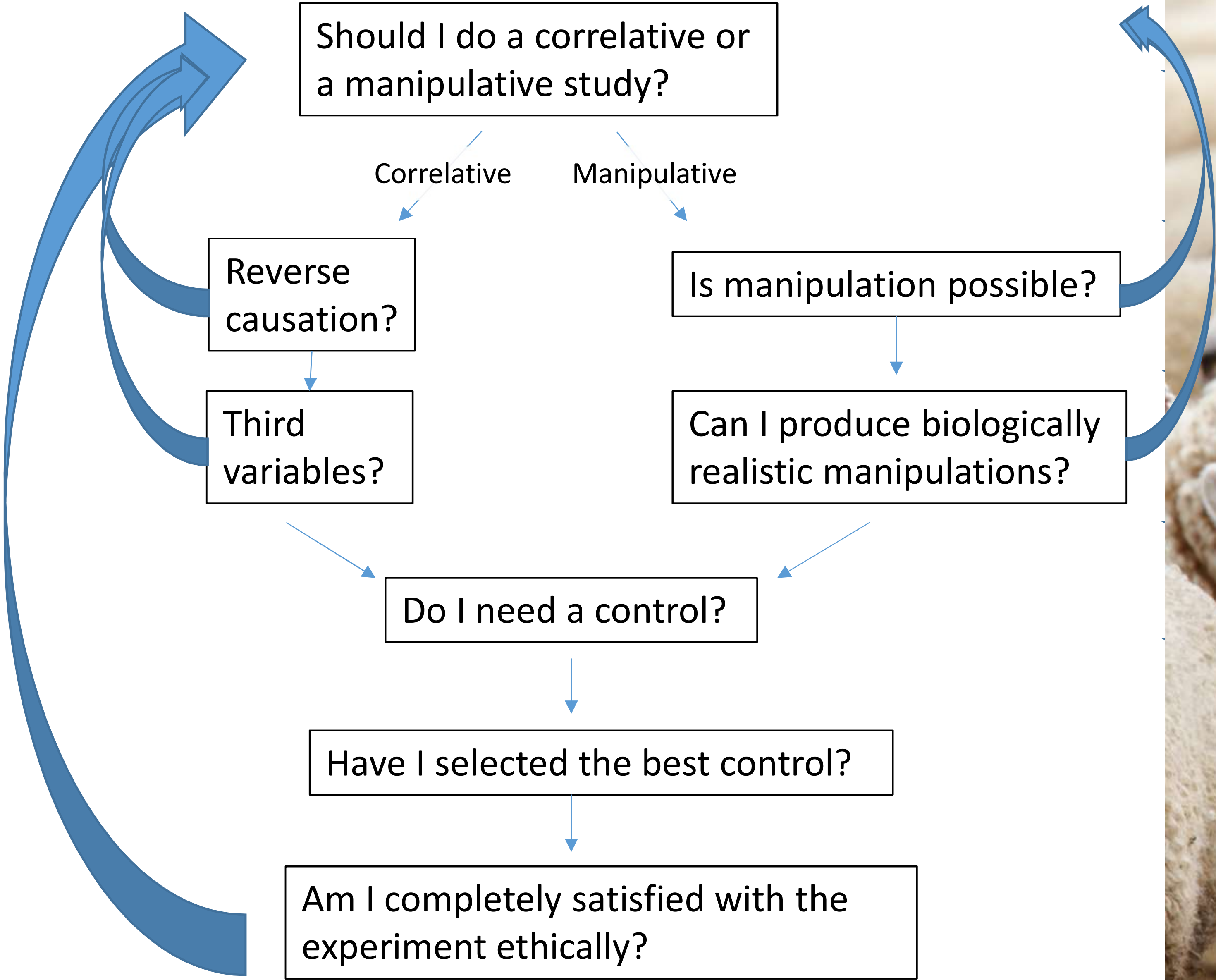
↓

Are the predictions testable?

↓

Form a null hypothesis

Structure of the experiment

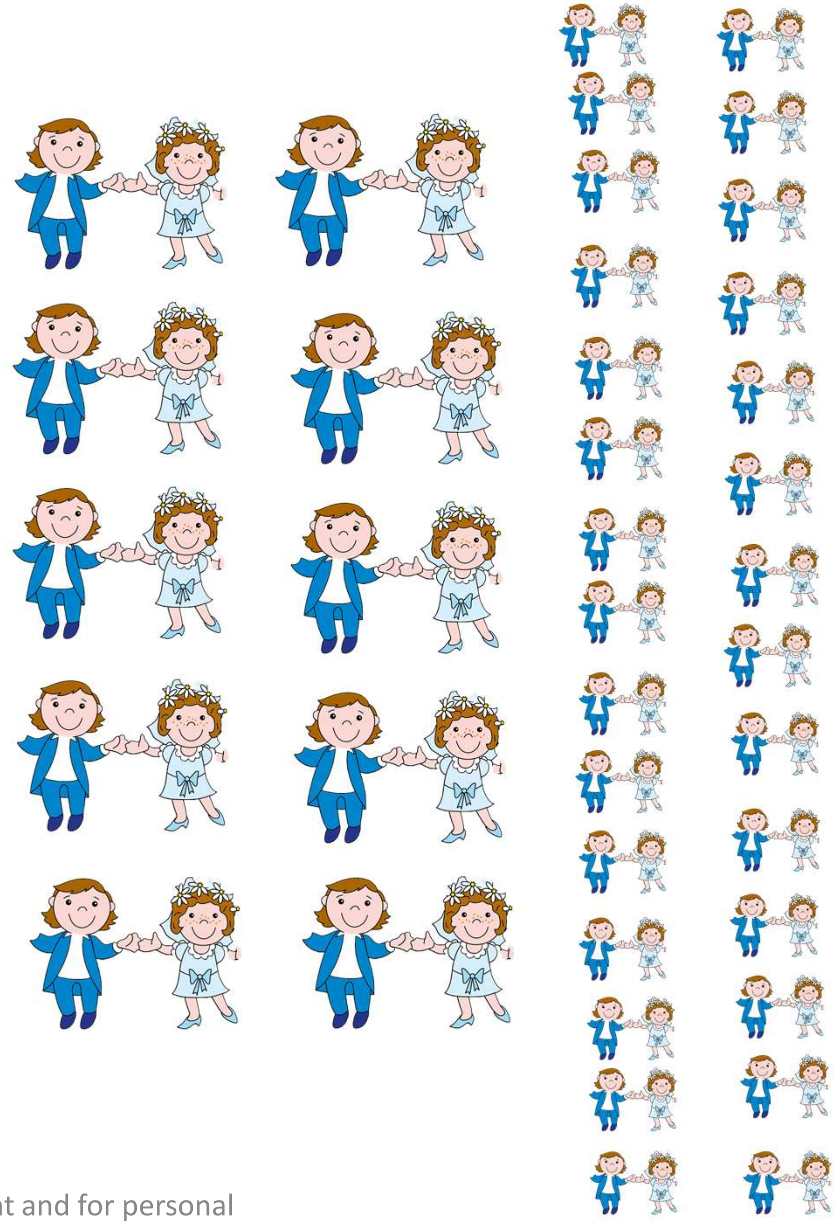


To control variation between subjects we need replication

Sex has an effect on human height

180 cm

185 cm



Sampling Units – Data points - replication

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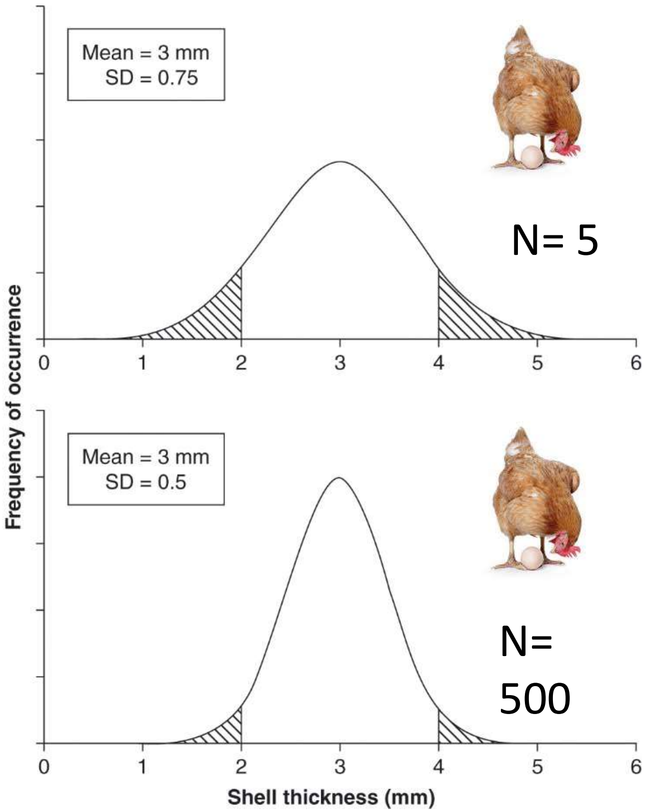
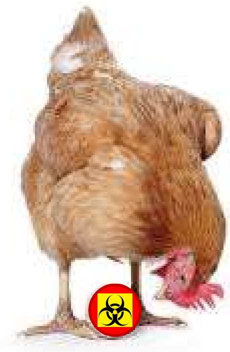
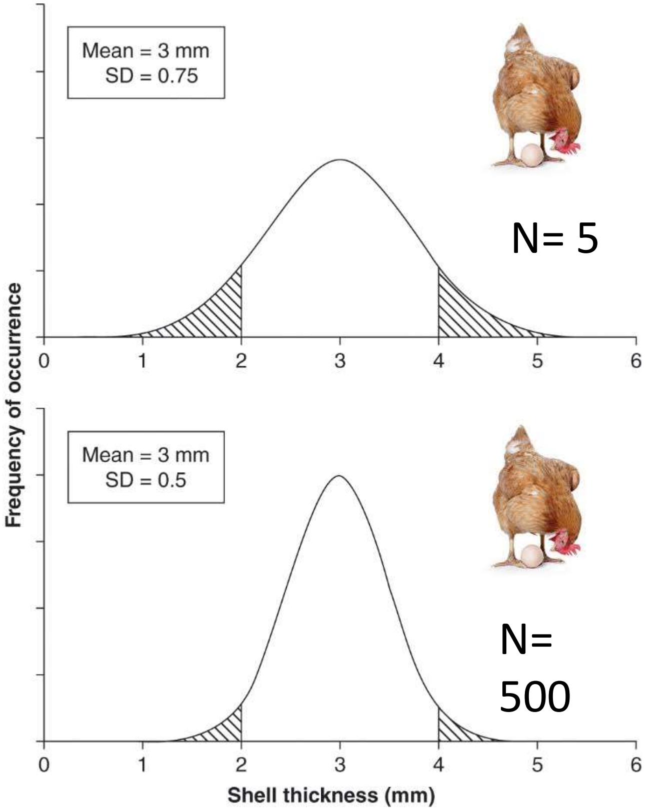
Replication - Exkurs

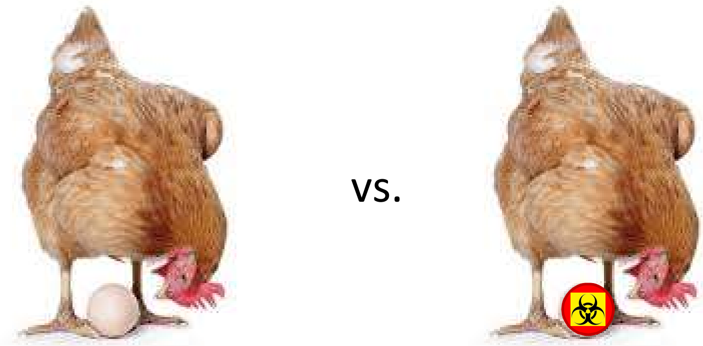


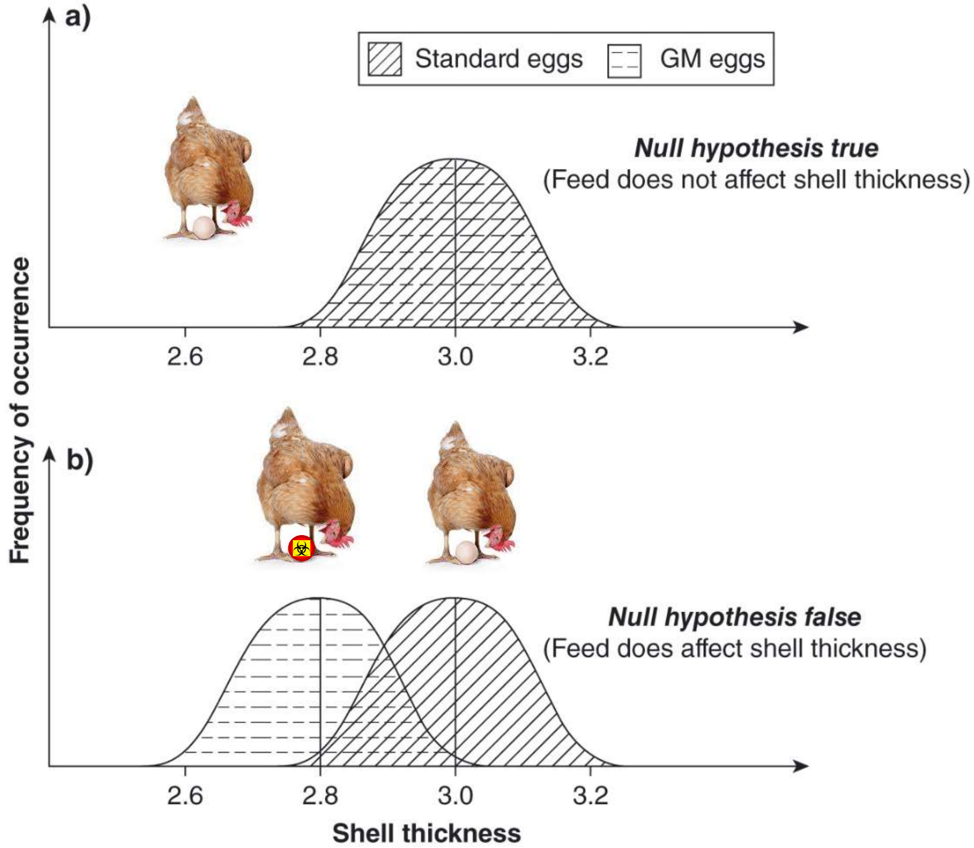
vs.



Replication - Exkurs

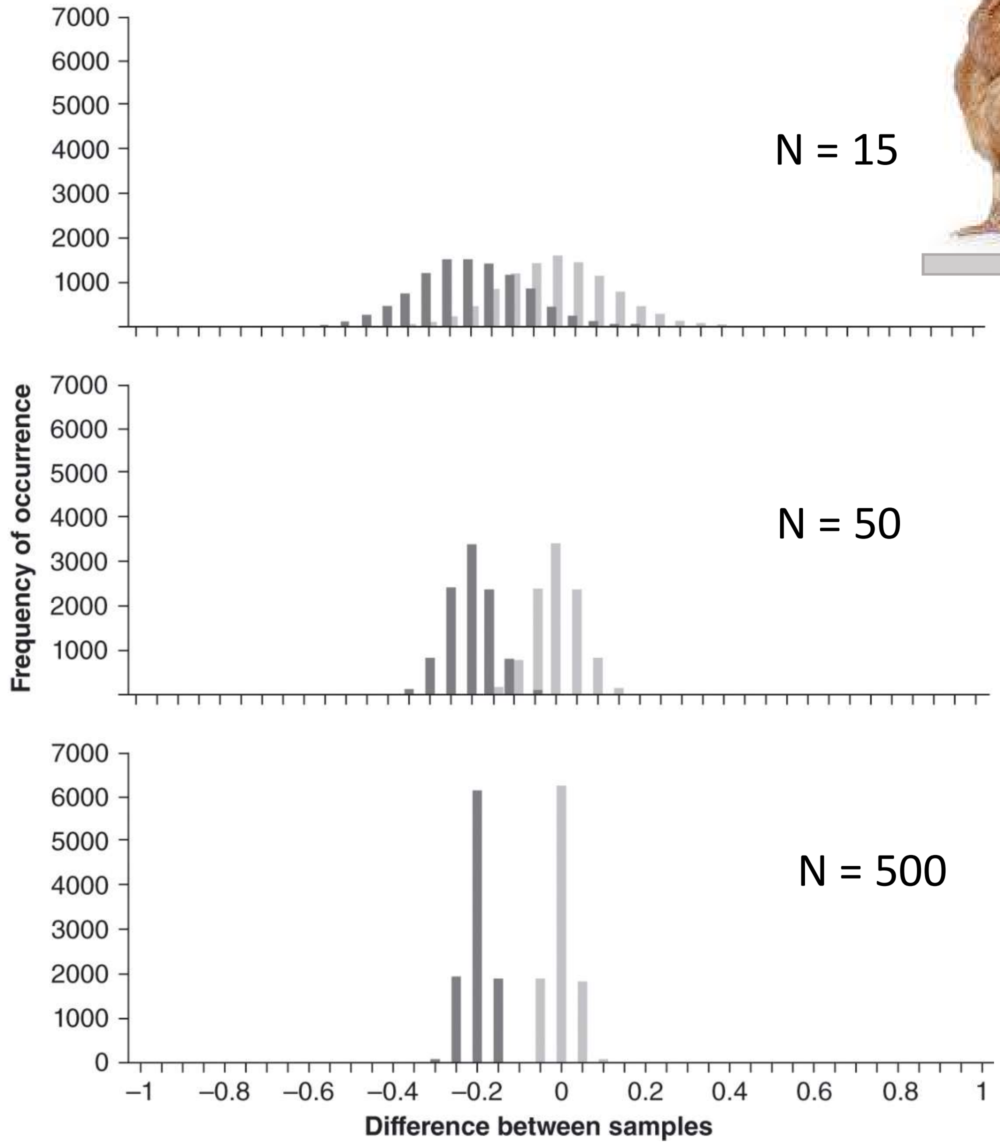






Mean thickness
Standard egg shells: 3 ± 0.2 mm
GM egg shells: 2.8 ± 0.2 mm

Replication - Exkurs



vs.

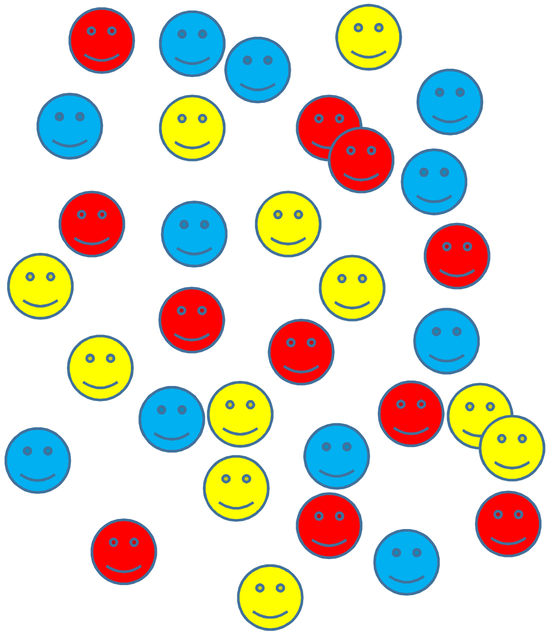
→Replication is a way of dealing with random variation. The more replicates, the greater the confidence that the difference between groups is due to factors that we are interested in.

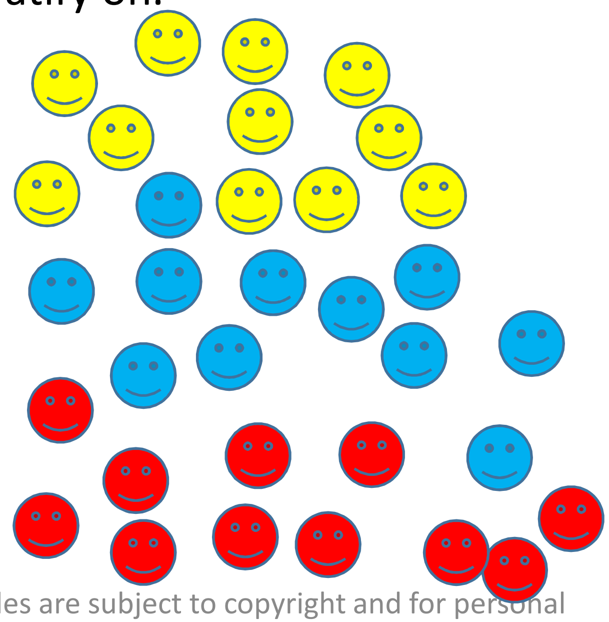
How to select a sample

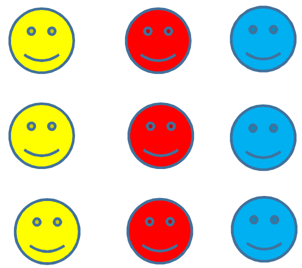
Sample selection methods

- Simple random selection: All members of the population are listed and a fixed number of samples is randomly selected. The samples should be representative

- Stratified sampling: Can be applied on any trait you can measure on subjects. Requires good information on the distribution of the variable that you want to stratify on.

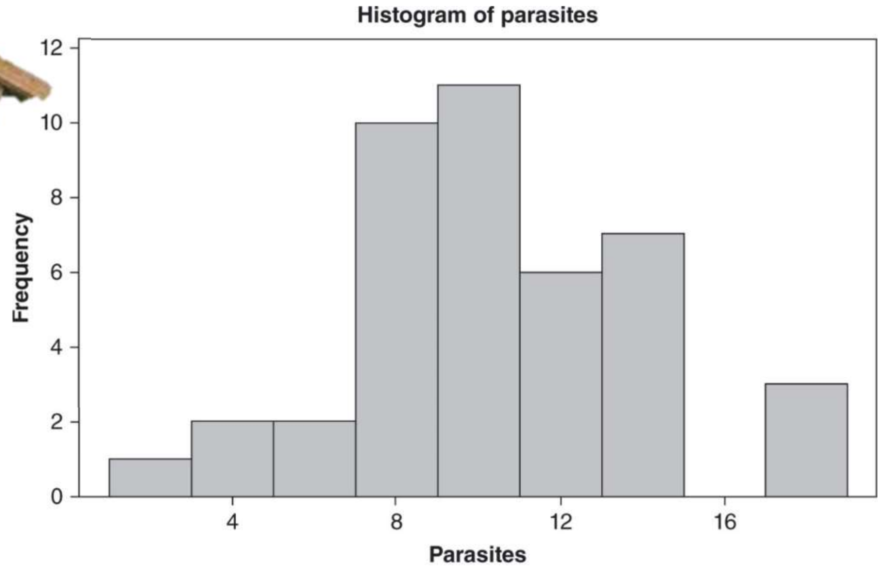






Pseudoreplication - Terminology and definitions

Sample independence



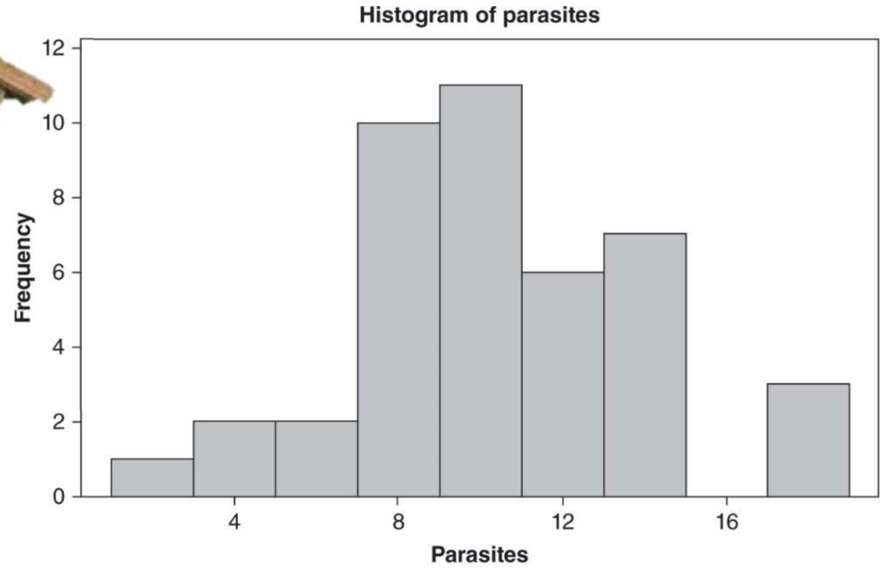
Any independent measurement is **just as likely** to have a positive deviation from the mean due to noise as it is to have a negative one.

→ The measurement made on one individual should not provide any useful information about that factor on another individual.

Non-independent replicates are called pseudoreplicates.

Pseudoreplication - Terminology and definitions

Sample independence



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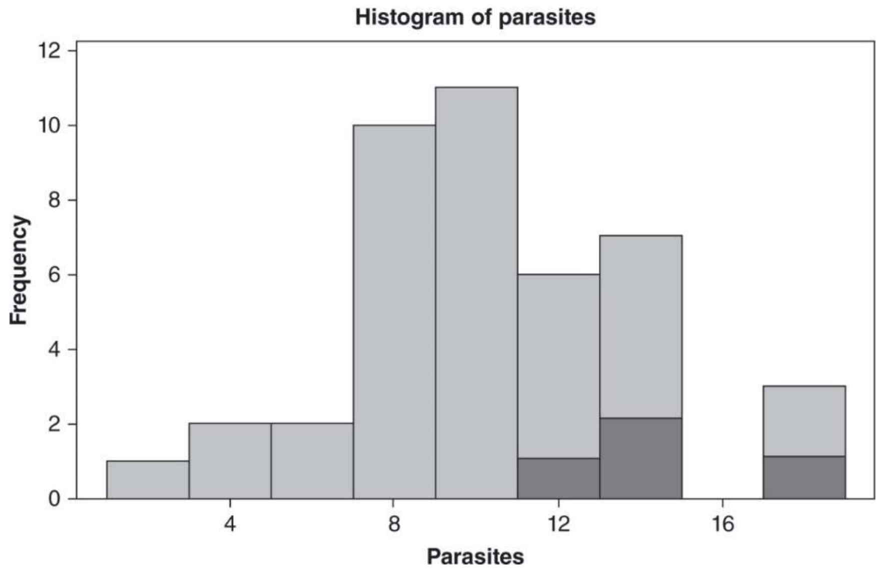
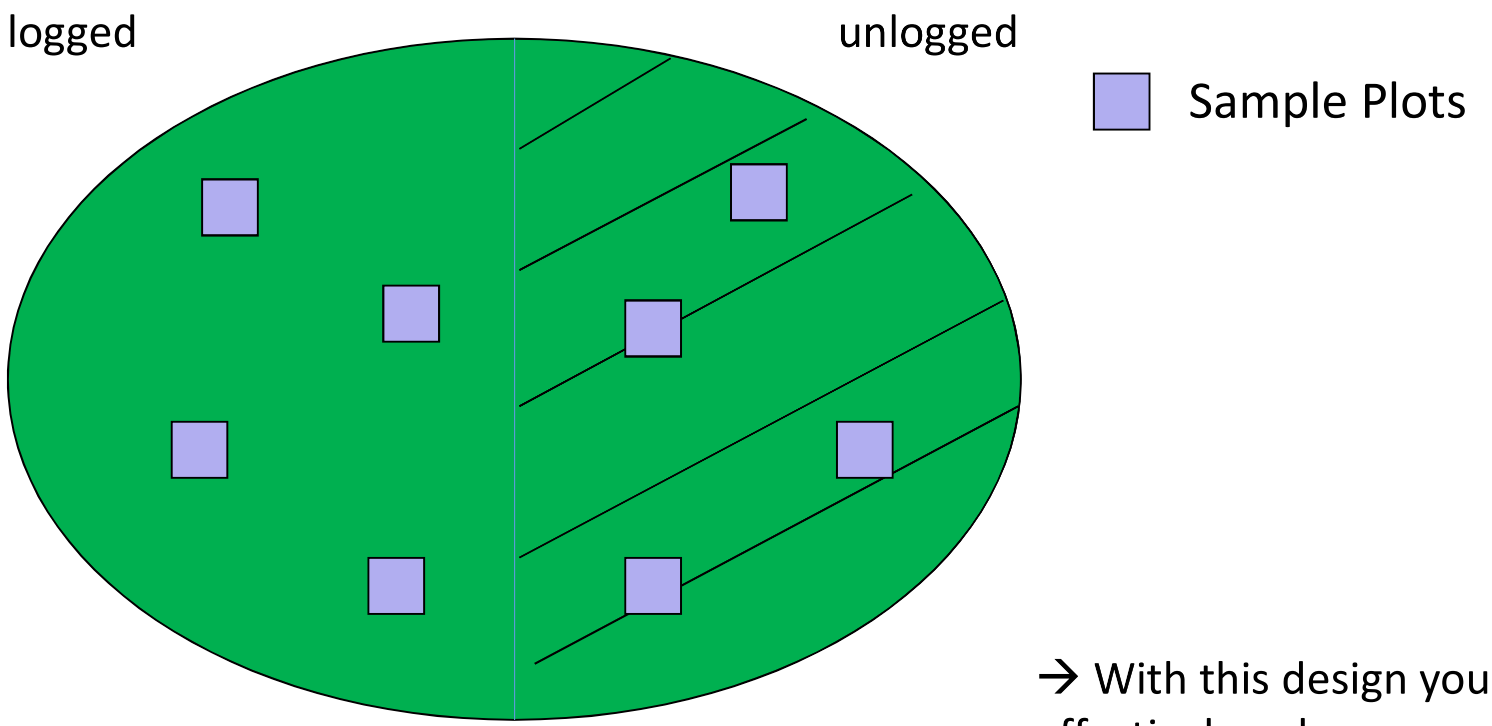


Common sources of pseudoreplication

Common environment

Example: Effects of logging on soil properties



→ With this design you effectively only measure one replicate

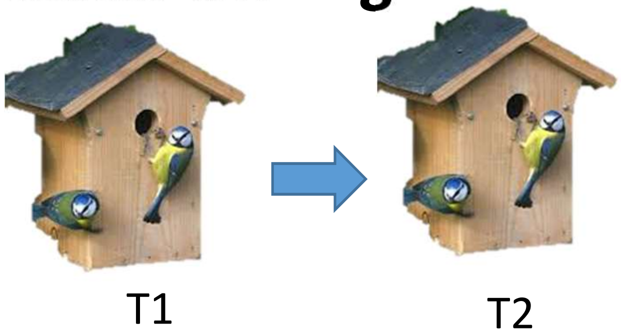
Common sources of pseudoreplication

Relatedness

The similarity due to genetics means that relatives are not independent data points when looking at effects of other treatments.

Measurements through time

Every experiment where multiple measurements are taken through time risks to produce pseudoreplicates. This depends critically on the biology of the system.



- → **Pseudoreplication is a problem that has to be addressed primarily by biologists and not by statisticians**
- → **You can almost always design your study to address non-independence. Any remaining can be handled by careful application of statistics**

Factors affecting the power of an experiment

- Effect size
- The amount of random variation
- The number of replicates

Relate to the biology of the system

In your control

These are the critical components of your experimental design!

Selecting the appropriate number of replicates

‘The more samples the better’?

→ The sample size should be big enough to give you confidence that you will be able to detect any biologically meaningful effects that exist, but not so big that some sampling was unnecessary.

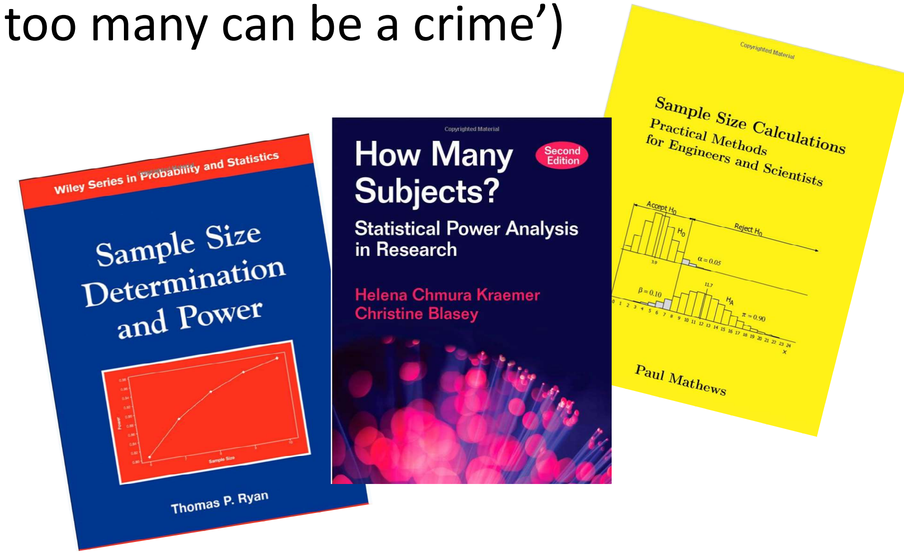
How to achieve this:

- Educated guesswork
- Formal power analysis

Statistical power is the probability that a particular experiment will detect an effect assuming that there is really an effect to be detected.

Factors affecting the power of an experiment

- The number of replicates ('too few replicates can be a disaster; too many can be a crime')



How do I know how many samples I need?

- Computer programs (Minitab)
- Equations in books
- Simulation methods (R)

In order to do that you need to know:

- The design of your study
- Which test you are going to use

AND decide:

- The effect size you want to reach
- The risk that an effect of this size is really there but your statistics will not detect it (→ Type II error)
- The risk that no effect exists, but your statistics mistakenly suggest there is one (→ Type I error)

Factors affecting the power of an experiment

- Effect size
- The amount of random variation
- The number of replicates

Relate to the biology of the system

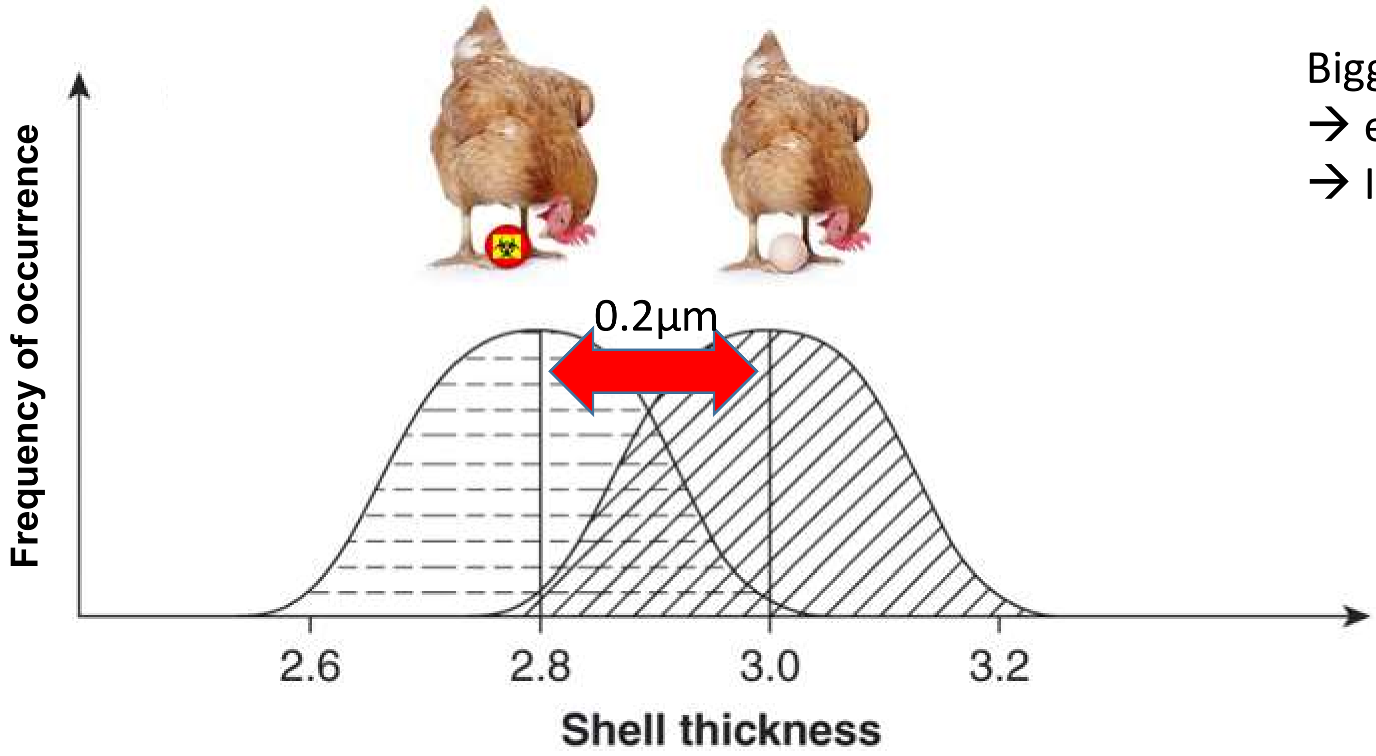
In your control

These are the critical components of your experimental design!

Factors affecting the power of an experiment

- Effect size

The effect size is the magnitude of the effect we are measuring. Effect sizes can include the difference between the means of two groups, or the slope of the relationship between two variables.



Bigger effect size
→ easier detection
→ Increased power

Factors affecting the power of an experiment

- Effect size

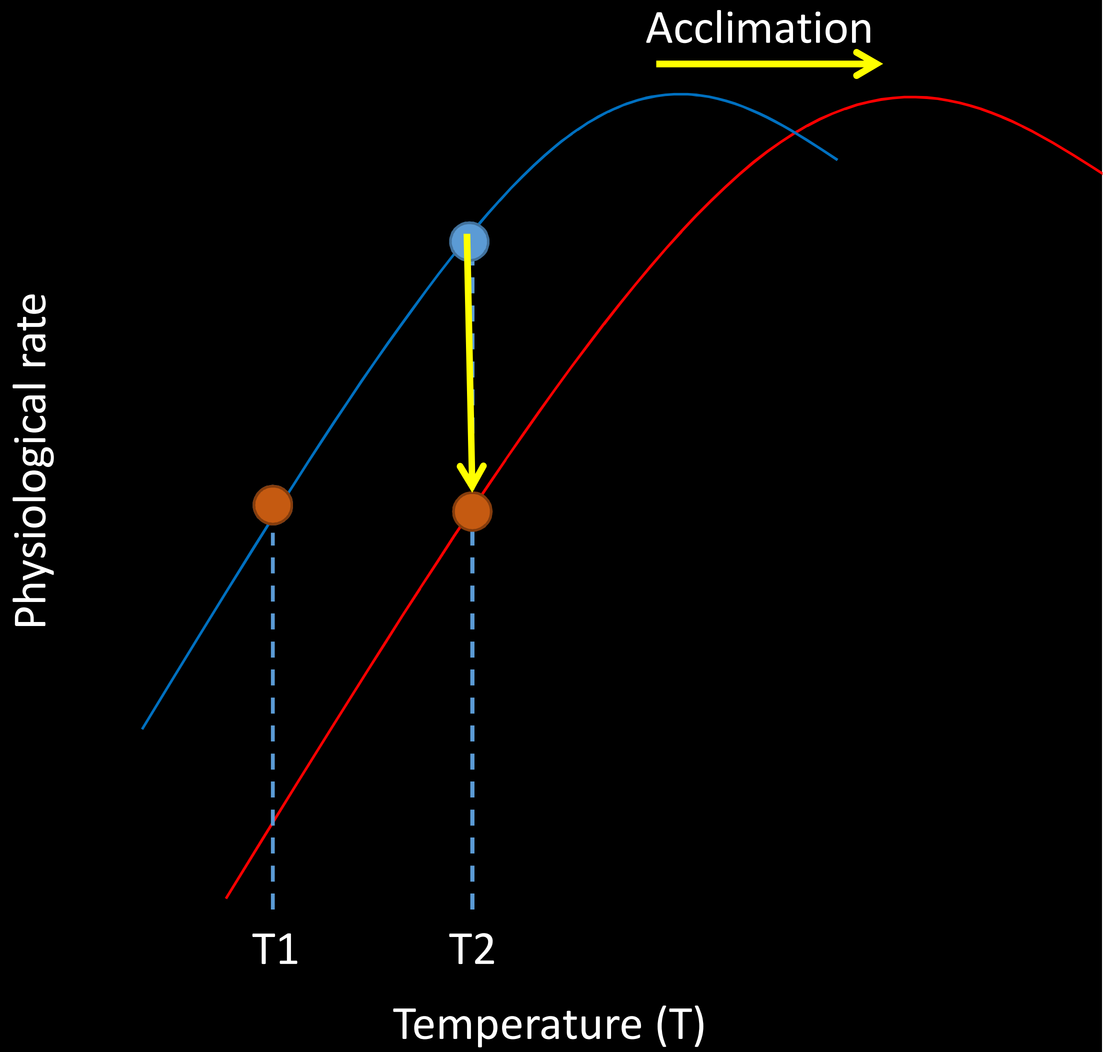
In some cases the there are ways to influence the effect size through the level of treatment.

Can Antarctic lichens acclimatise to changes in temperature?

What is thermal acclimation?

- A physiological, structural or biochemical adjustment by an individual in response to temperature changes.

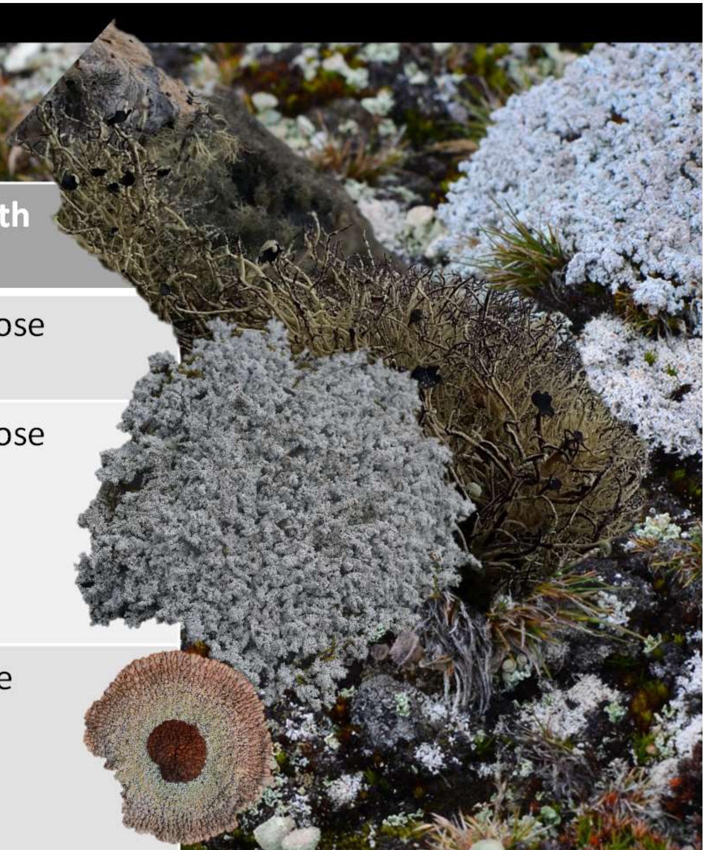
→ Organisms that acclimate can confer resilience to environmental change




SOUTHERN OCEAN
SOUTHERN OCEAN
SOUTHERN OCEAN
KONG HÅKON VII HAV
WEDDELL SEA
ANTARCTIC PENINSULA
BELLINGSHAUSEN SEA
AMUNDSEN SEA
ROSS SEA
RONNE ICE SHELF
ROSS ICE SHELF
DRONNING MAUD LAND
COATS LAND
ENDERBY LAND
KEMP LAND
MAC.ROBERTSON LAND
PRINCESS ELIZABETH LAND
WILHELM II LAND
QUEEN MARY LAND
WILKES LAND
TERRE ADÉLIE
GEORGE V LAND
EAST ANTARCTICA
WEST ANTARCTICA
ELLSWORTH LAND
MARIE BYRD LAND
Transantarctic Mountains
South Pole
Amundsen-Scott (USA)
McMurdo (USA)
Signy (UK)
Palmer (USA)
Rothera (UK)
Halley (UK)
90°W
90°E
180°
0 1000 2000
Km
0 200 400 600 800 1000
Miles


LIVINGSTON ISLAND
IOANNES PAULUS II PENINSULA

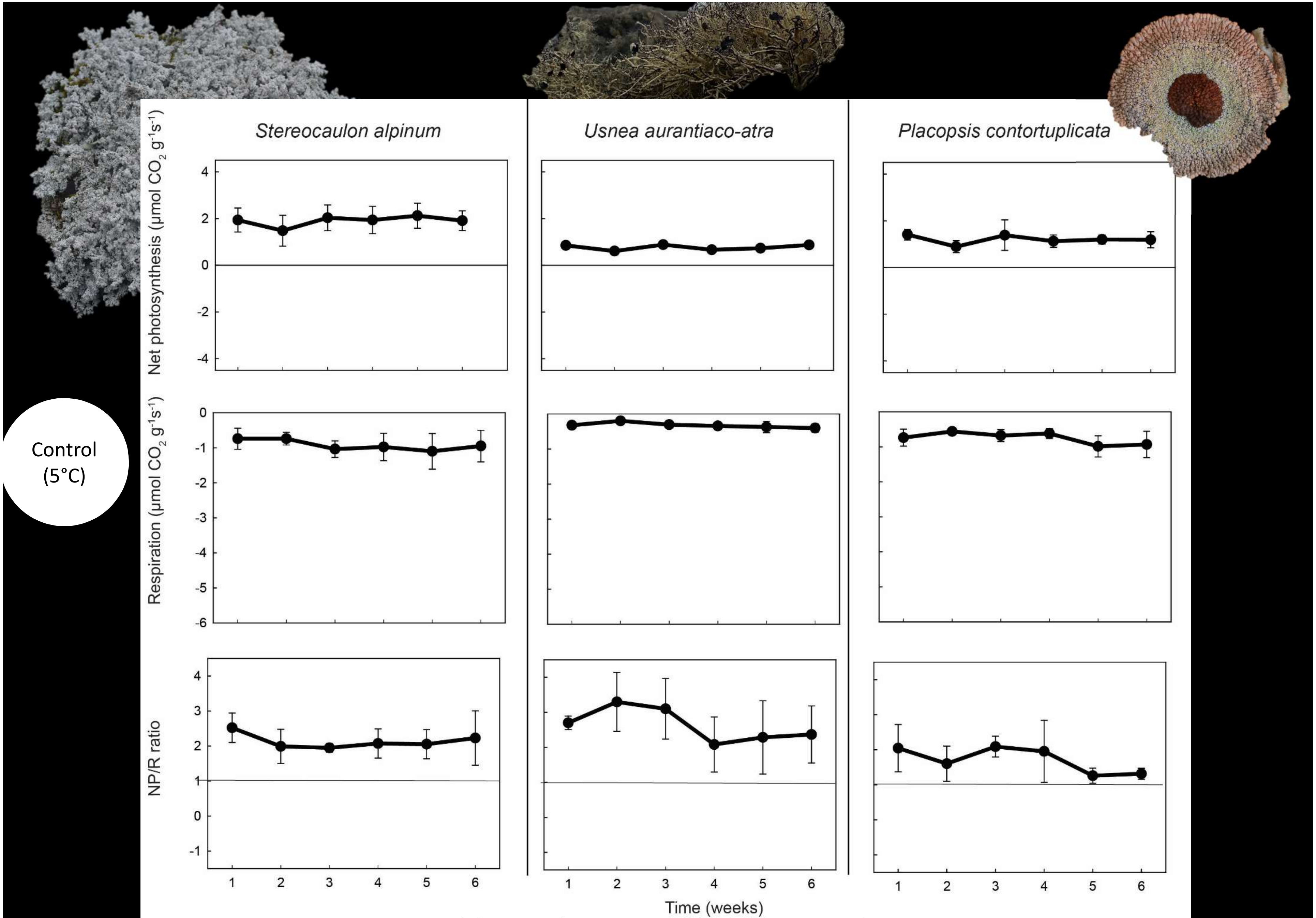
Species	Distribution	Photobiont	Growth form
Stereocaulon alpinum	Bipolar, high alpine	Green algae + cephalodia	fruticose
Usnea aurantiaco-atra	Southermost south America, South Georgia, South Shetlands, Antarctic Peninsula	Green algae	fruticose
Placopsis contortuplicata	Southermost south America, South Georgia, South Shetlands, Antarctic Peninsula	Green algae + cephalodia	foliose

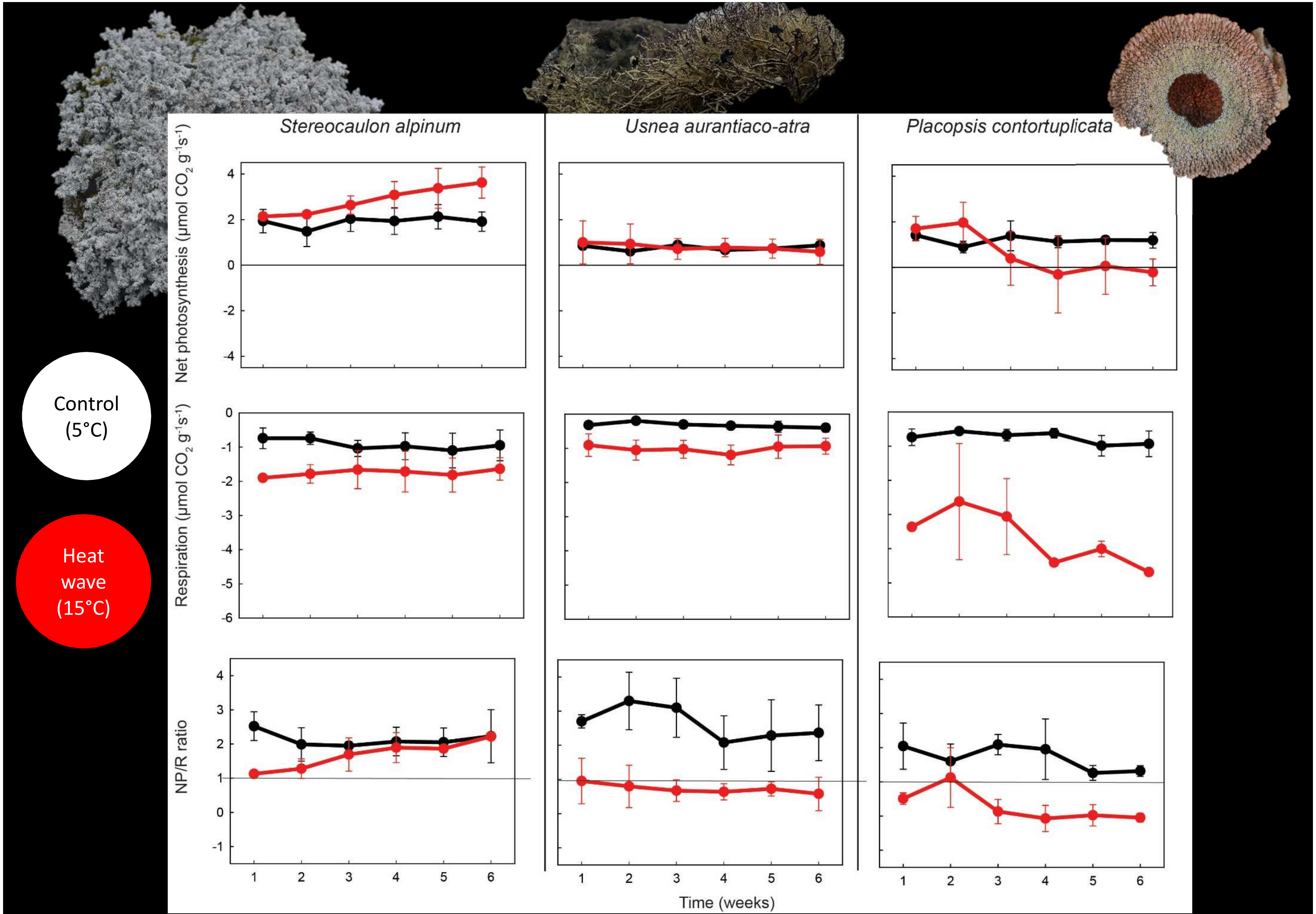


Control (5°C)

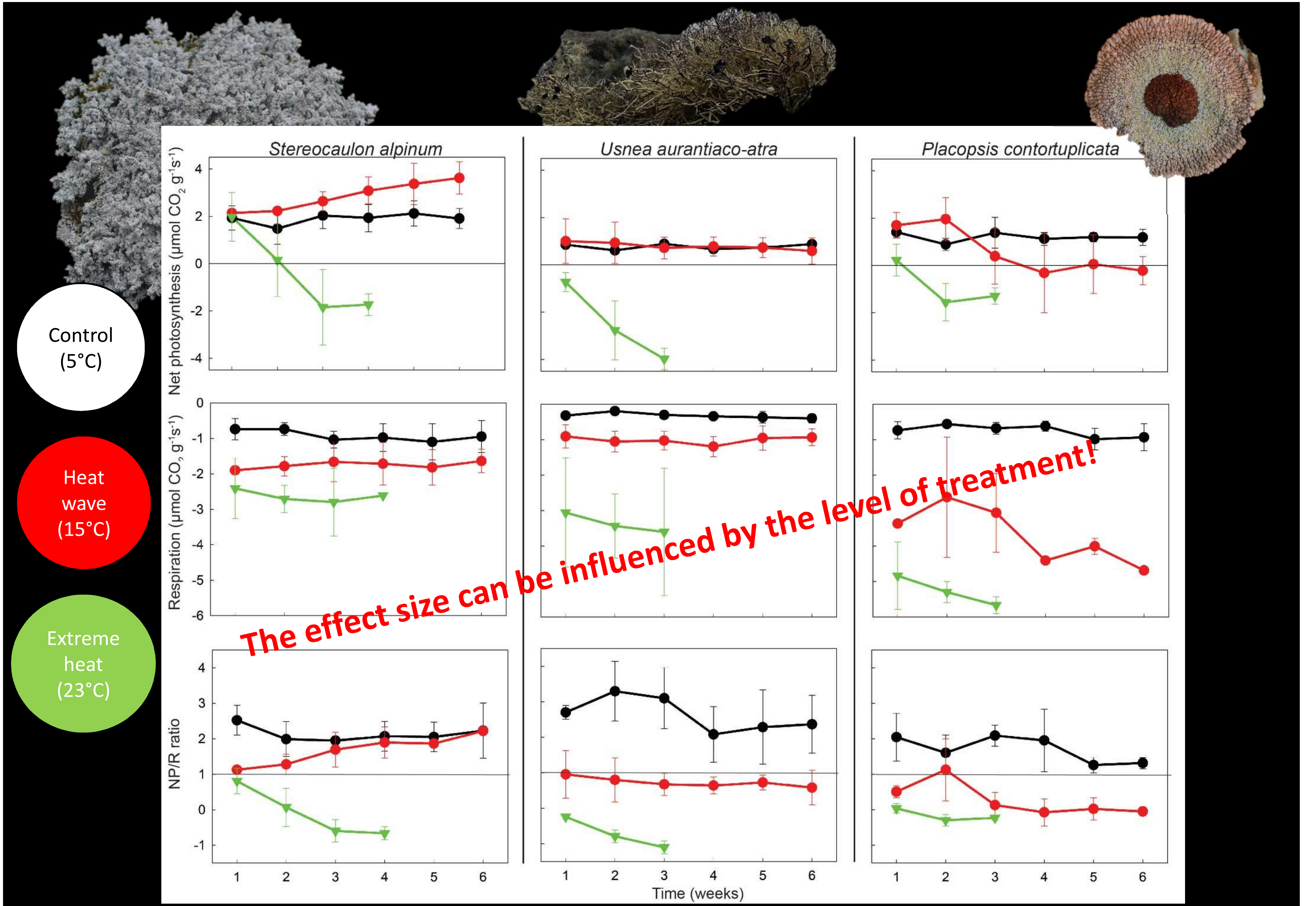
Heat wave (15°C)

Extreme heat (23°C)


Control
(5°C)
Stereocaulon alpinum
Usnea aurantiaco-atra
Placopsis contortuplicata
Net photosynthesis (µmol CO2 g-1s-1)
Respiration (µmol CO2 g-1s-1)
NP/R ratio
Time (weeks)



Stereocaulon alpinum
Usnea aurantiaco-atra
Placopsis contortuplicata
Net photosynthesis (µmol CO_2 $g^{-1}s^{-1}$)
Respiration (µmol CO_2 $g^{-1}s^{-1}$)
NP/R ratio
Time (weeks)
Control (5°C)
Heat wave (15°C)



Control
(5°C)
Heat
wave
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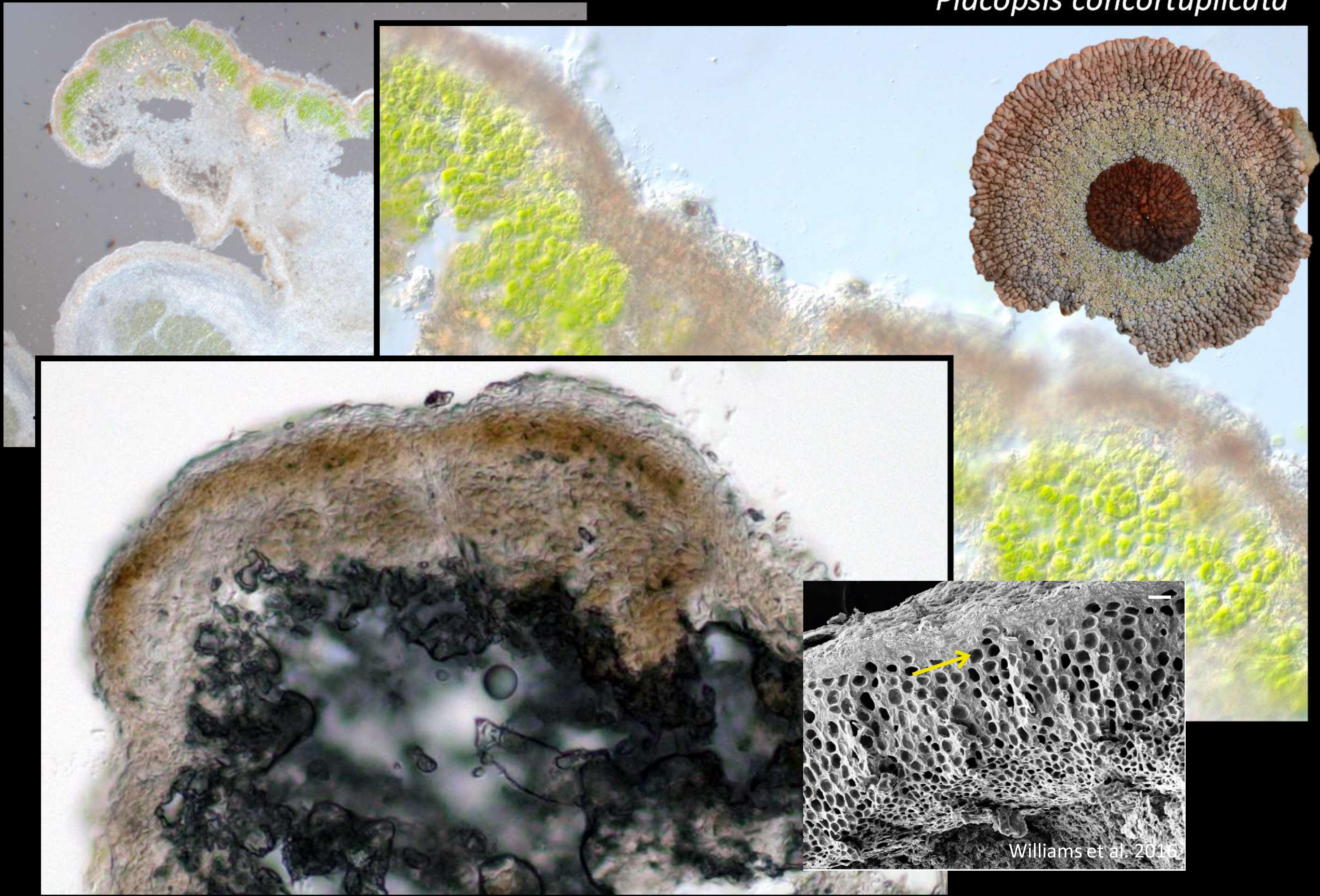
Stereocaulon alpinum
Usnea aurantiaco-atra
Placopsis contortuplicata
Net photosynthesis (µmol CO2 g-1s-1)
Respiration (µmol CO2 g-1s-1)
NP/R ratio
Time (weeks)
The effect size can be influenced by the level of treatment!

Placopsis concortuplicata



Factors affecting the power of an experiment

- Effect size
- The amount of random variation

Ways to reduce random variation:

- Improved experimental techniques
- More uniform experimental conditions
- More uniform experimental material

→ Anything you can do to reduce variation amongst your samples will increase the power of your study!

Experimental design in action

Randomization:
The allocation of experimental subjects to experimental groups has to be random. This is key to avoid confounding factors.

Randomizing study objects and other aspects of the study:
- How are the plants potted?
- Which pots are chosen for the treatment?
- How are the pots arranged in the greenhouse?
- When will the samples be taken?
- How will the samples be analysed?

Does plant feed affect the growth of tomato plants?

Aim to balance your experiments. A balanced experimental design has equal numbers of experimental units in each treatment group.

Experimental design in action

The completely randomised,

Does plant feed affect the growth of tomato plants?

vs.

Factor One-way	Absence	Presence
Levels Two levels	Control	Treatment

Experimental design in action

The completely randomised, single factor design

Does plant feed affect the growth of tomato plants?

A completely randomized one-factor design, with a factor that has **two levels**. The design is fully replicated and balanced.

Which is the appropriate statistical test?

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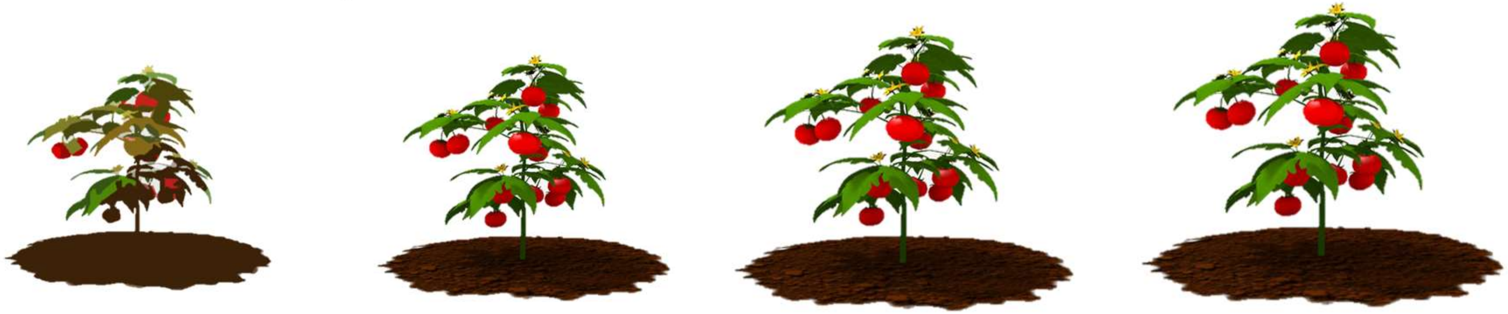
Experimental design in action

Do different feeding rates differ in their effect on the growth of tomato plants?

Experimental design in action

The completely randomised, single factor design



Factor One-way	Absence	Presence	Presence	Presence
Levels n levels	Control	Treatment	Treatment +1	Treatment +2

A completely randomized one-factor design, with a factor that has **four levels**. The design is fully replicated and balanced.

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Experimental design in action

Randomised designs with more than one factor

Do different feeding rates differ in their effect on the growth of tomato plants?

How does the application of insecticide affect the growth of tomato plants?

Experimental design in action

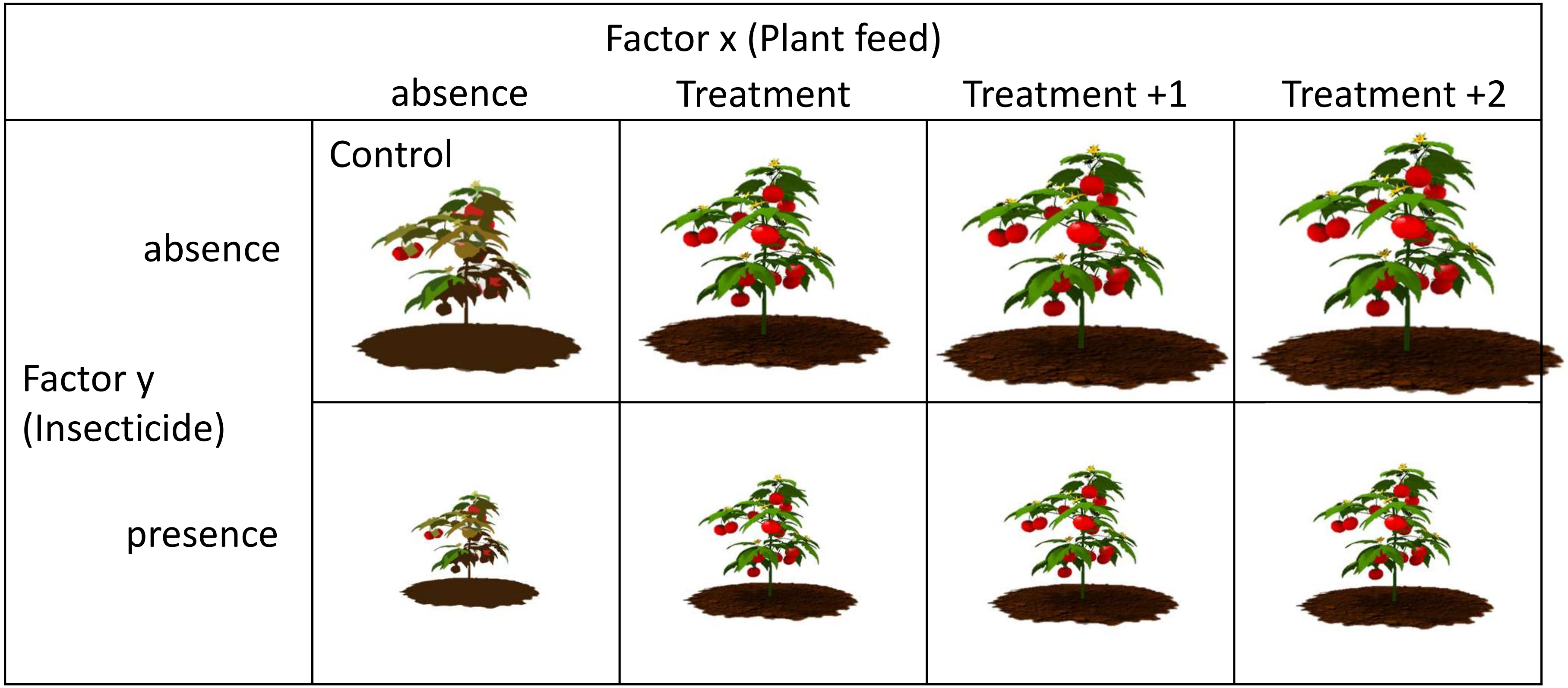
Randomised designs with more than one factor

		Factor x (Plant feed)		
	absence	Treatment	Treatment +1	Treatment +2
Factor y (Insecticide) absence				
Factor y (Insecticide) presence				

A fully crossed design means that all possible combinations of each treatment of the factors are implemented. Example Factor x has 4 levels, factor y has 2
→ 4 x 2 design. This involves 8 different treatment groups.

Experimental design in action

Randomised designs with more than one factor



A completely randomized two-factor design, with a factor x that has four levels and factor y that has two levels. The design is fully replicated, fully crossed and balanced.

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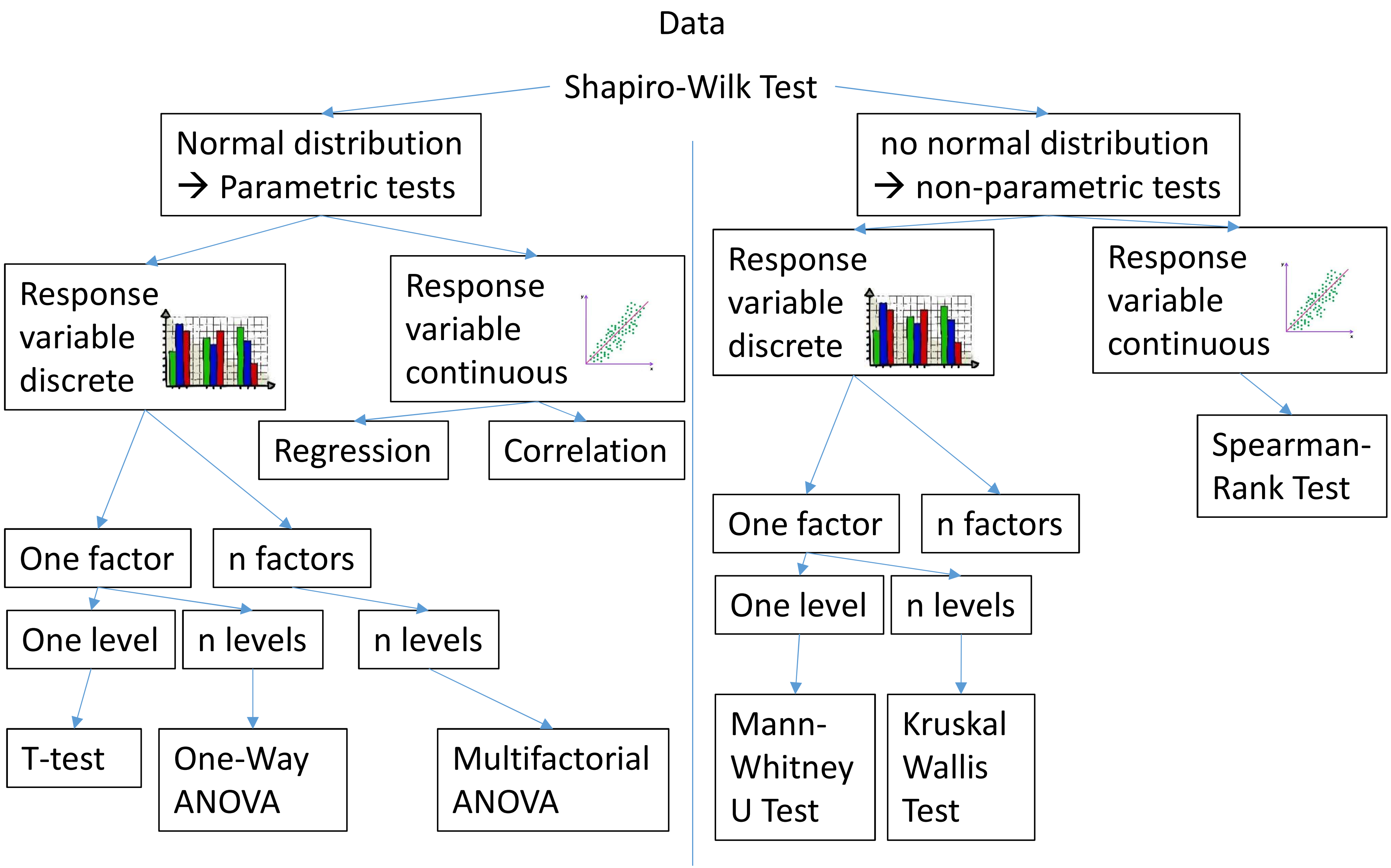
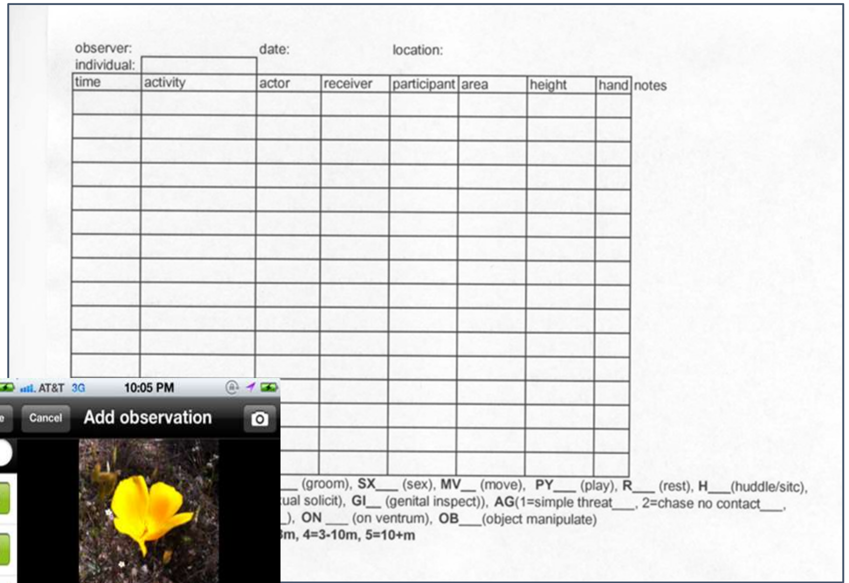
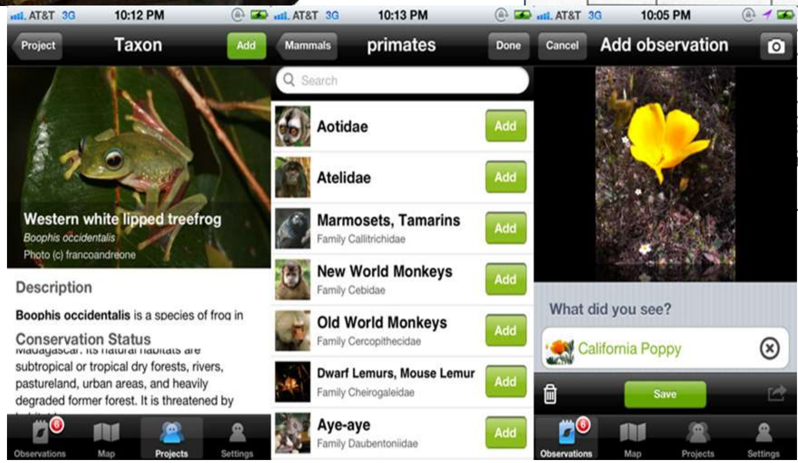
Students can go to TopHat.com or use our mobile apps and enter this join code to participate

Simplified guidelines to choose appropriate statistical tests



Data Collection methods





Design a data collection sheet

Why do we need data sheets?

A good data sheet should be composed of two components:

- Metadata

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A good data sheet should be composed of two components:

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- Essential for traceability and repeatability
- Short notes about each column
- At least list units!
- Problems and tasks sheets are also useful!
- You can keep this in a separate worksheet, but be wary of linking between worksheets

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- Data table

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A good data sheet should be composed of two components:

- Metadata
- Data table

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- Easy: 1,56 or 15.6 vs 1.56
- Insidious: 1.56 vs 1.65
- Inevitable: appear in large or multi-author datasets

Data Collection methods

- No matter how you collect the data, make sure it is backed up accurately and as frequently as possible.
- If the data are not collected in digital format, get them into digital format as quickly as possible.
- Email copies to yourself or use dropbox or similar software that archives data online. This can actually be better than back-up hard drives.
- Make photocopies of datasheets if entering data is not imminently possible.

Data entry and organisation

sort	plot	width	length	weight	Genus	SPCODE
1	1	0.1172	1.8326	0.2322	Diospyros	diospa
2	1	0.2520	3.2341	0.4062	Diospyros	diospa
3	1	0.7591	7.9552	0.3112	Diospyros	diospa
4	1	0.5539	5.5854	0.3223	Diospyros	diospa
5	1	0.6807	7.5155	1.0058	Diospyros	diospa
6	1	0.0420	0.4994	-0.4597	Diospyros	diospa
7	1	0.8634	8.9852	0.9038	Iriartea	iriade
8	1	0.4230	5.1943	0.4025	Iriartea	iriade
9	1	0.7147	7.5208	1.0420	Iriartea	iriade
10	1	0.9393	9.8935	2.9967	Iriartea	iriade
11	2	0.7774	8.6755	0.8864	Iriartea	iriade
12	2	0.7498	7.9637	0.6606	Iriartea	iriade
13	2	0.5333	6.0080	0.8104	Legume	legume
14	2	0.2024	2.6136	0.1005	Odontocary	odonto
15	2	0.8089	8.8193	1.0780	Oenocarpus	oenoba
16	2	0.6119	7.0687	0.3720	Trichila	tricpa
17	2	0.4226	5.0408	0.6187	Trichilia	tricpa
18	2	0.2815	3.3303	-0.0172	Trichilia	tricpa
19	2	0.0850	5.7539	0.2202	Trichilia	tricpa
20	2	0.1590	1.8429	-0.0892	Trichilia	tricpa
21	2	0.1521	1.7507	-0.2447	Trichilia	tricpa
22	2	0.2936	3.5089	-0.3402	Trichilia	tricpa
23	2	0.9205	9.3907	0.4160	Ziziphus	zizici
24	2	0.4036	5.0186	-0.1024	Ziziphus	zizici

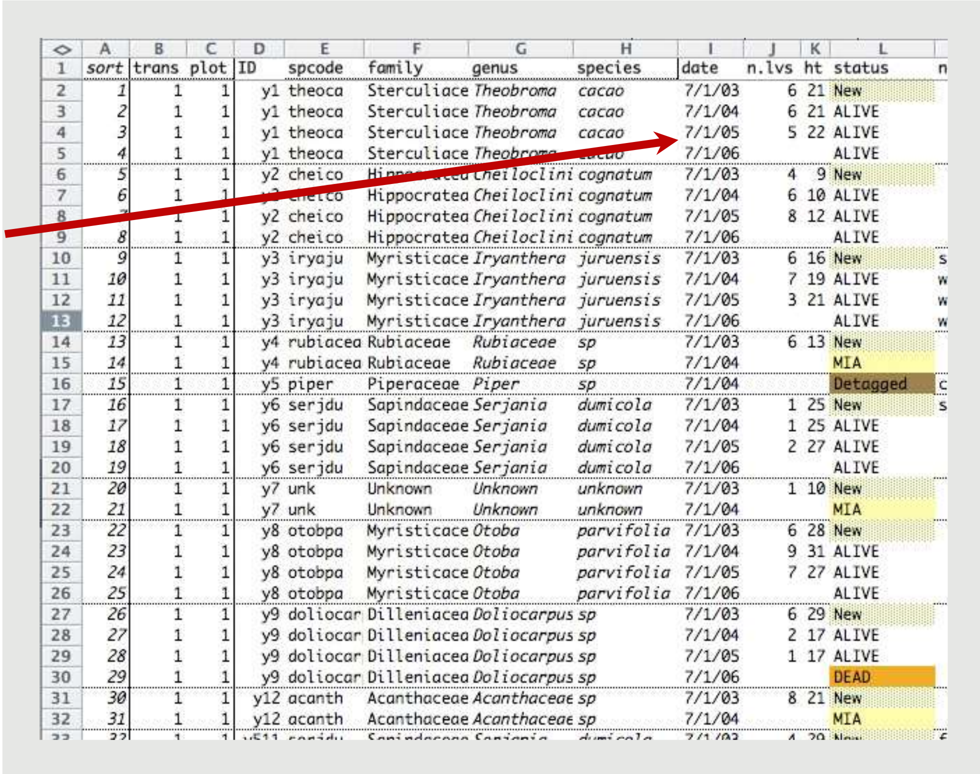
Ready

some data I collected on leaves once but I don't remember why			
plot	dimensions	length	weight
	Diospyros		
1	.1172, 1.8325	1.8326	0.2322
1	.2519, 3.2340	3.2341	0.4062
1	.7590, 7.9551	7.9552	0.3112
one	.5538, 5.5853	5.5854	0.3223
1	.6806, 7.5154	7.5155	1.0058
1	.0419, 0.4993	0.4994	-0.4597
	Irirtea		
1	.8634, 8.9852	8.9852	0.9038
one	.4230, 5.1942	5.1943	0.4025
one	.7146, 7.5208	7.5208	1.0420
one	.9393, 9.8935	9.8935	2.9967
two	.7774, 8.6755	8.6755	0.8864
2	.7497, 7.9637	7.9637	0.6606
	legume		
2	.5332, 6.0080	6.0080	0.8104
	Odontocarya		
2	.2024, 2.6135	2.6136	0.1005
	Oenocarpus		
2	.8089, 8.8192	8.8193	1.0780
	Trichilia		
2	.6118, 7.0686	7.0687	0.3720
two	.4225, 5.0407	5.0408	0.6187
two	.2815, 3.3303	3.3303	-0.0172
two	.0850, 5.7538	5.7539	0.2202
two	.1590, 1.8428	1.8429	-0.0892
2	.1521, 1.7507	1.7507	-0.2447
2	.2936, 3.5089	3.5089	-0.3402
	Ziziphus		
2	.9205, 9.3906	9.3907	0.4160
2	.4035, 5.0185	5.0186	-0.1024
	average length:	5.6251	

Nowhere near ready

Data Entry and Organisation

- One value per cell



	sort	trans	plot	ID	spcode	family	genus	species	date	n.lvs	ht	status	n
2	1	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/03	6	21	New	
3	2	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/04	6	21	ALIVE	
4	3	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/05	5	22	ALIVE	
5	4	1	1	y1	theoca	Sterculiace	*Theobroma*	[illegible]	7/1/06			ALIVE	
6	5	1	1	y2	cheico	[illegible]	*Cheiloclini*	*cognatum*	7/1/03	4	9	New	
7	6	1	1	[illegible]	[illegible]	Hippocratea	*Cheiloclini*	*cognatum*	7/1/04	6	10	ALIVE	
8	[illegible]	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	7/1/05	8	12	ALIVE	
9	8	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	7/1/06			ALIVE	
10	9	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/03	6	16	New	s
11	10	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/04	7	19	ALIVE	w
12	11	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/05	3	21	ALIVE	w
13	12	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/06			ALIVE	w
14	13	1	1	y4	rubiacea	Rubiaceae	*Rubiaceae*	*sp*	7/1/03	6	13	New	
15	14	1	1	y4	rubiacea	Rubiaceae	*Rubiaceae*	*sp*	7/1/04			MIA	
16	15	1	1	y5	piper	Piperaceae	*Piper*	*sp*	7/1/04			Detagged	c
17	16	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/03	1	25	New	s
18	17	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/04	1	25	ALIVE	
19	18	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/05	2	27	ALIVE	
20	19	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/06			ALIVE	
21	20	1	1	y7	unk	Unknown	*Unknown*	*unknown*	7/1/03	1	10	New	
22	21	1	1	y7	unk	Unknown	*Unknown*	*unknown*	7/1/04			MIA	
23	22	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/03	6	28	New	
24	23	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/04	9	31	ALIVE	
25	24	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/05	7	27	ALIVE	
26	25	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/06			ALIVE	
27	26	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/03	6	29	New	
28	27	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/04	2	17	ALIVE	
29	28	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/05	1	17	ALIVE	
30	29	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/06			DEAD	
31	30	1	1	y12	acanth	Acanthaceae	*Acanthaceae*	*sp*	7/1/03	8	21	New	
32	31	1	1	y12	acanth	Acanthaceae	*Acanthaceae*	*sp*	7/1/04			MIA	

Data Entry and Organisation

- One value per cell
- One variable per column

	A	B	C	D	E	F	G	H	I	J	K	L	
1	sort	trans	plot	ID	spcode	family	genus	species	date	n.lvs	ht	status	n
2	1	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/03	6	21	New	
3	2	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/04	6	21	ALIVE	
4	3	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/05	5	22	ALIVE	
5	4	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/06			ALIVE	
6	5	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/03	4	9	New	
7	6	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/04	6	10	ALIVE	
8	7	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/05	8	12	ALIVE	
9	8	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/06			ALIVE	
10	9	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/03	6	16	New	s
11	10	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/04	7	19	ALIVE	w
12	11	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/05	3	21	ALIVE	w
13	12	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/06			ALIVE	w
14	13	1	1	y4	rubiacea	Rubiaceae	Rubiaceae	sp	7/1/03	6	13	New	
15	14	1	1	y4	rubiacea	Rubiaceae	Rubiaceae	sp	7/1/04			MIA	
16	15	1	1	y5	piper	Piperaceae	Piper	sp	7/1/04			Detagged	c
17	16	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/03	1	25	New	s
18	17	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/04	1	25	ALIVE	
19	18	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/05	2	27	ALIVE	
20	19	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/06			ALIVE	
21	20	1	1	y7	unk	Unknown	Unknown	unknown	7/1/03	1	10	New	
22	21	1	1	y7	unk	Unknown	Unknown	unknown	7/1/04			MIA	
23	22	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/03	6	28	New	
24	23	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/04	9	31	ALIVE	
25	24	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/05	7	27	ALIVE	
26	25	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/06			ALIVE	
27	26	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/03	6	29	New	
28	27	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/04	2	17	ALIVE	
29	28	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/05	1	17	ALIVE	
30	29	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/06			DEAD	
31	30	1	1	y12	acanth	Acanthaceae	Acanthaceae	sp	7/1/03	8	21	New	
32	31	1	1	y12	acanth	Acanthaceae	Acanthaceae	sp	7/1/04			MIA	

Data Entry and Organisation

- One value per cell
- One variable per column
- **Sort column**

◇	A	B	C	D	E	F	G	H	I	J	K	L	
1	*sort*	trans	plot	ID	spcode	family	genus	species	date	n.lvs	ht	status	n
2	*1*	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/03	6	21	New	
3	*2*	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/04	6	21	ALIVE	
4	*3*	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/05	5	22	ALIVE	
5	*4*	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/06			ALIVE	
6	*5*	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	7/1/03	4	9	New	
7	*6*	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	7/1/04	6	10	ALIVE	
8	*7*	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	7/1/05	8	12	ALIVE	
9	*8*	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	7/1/06			ALIVE	
10	*9*	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/03	6	16	New	s
11	*10*	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/04	7	19	ALIVE	w
12	*11*	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/05	3	21	ALIVE	w
13	*12*	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/06			ALIVE	w
14	*13*	1	1	y4	rubiacea	Rubiaceae	*Rubiaceae*	*sp*	7/1/03	6	13	New	
15	*14*	1	1	y4	rubiacea	Rubiaceae	*Rubiaceae*	*sp*	7/1/04			MIA	
16	*15*	1	1	y5	piper	Piperaceae	*Piper*	*sp*	7/1/04			Detagged	c
17	*16*	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/03	1	25	New	s
18	*17*	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/04	1	25	ALIVE	
19	*18*	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/05	2	27	ALIVE	
20	*19*	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/06			ALIVE	
21	*20*	1	1	y7	unk	Unknown	*Unknown*	*unknown*	7/1/03	1	10	New	
22	*21*	1	1	y7	unk	Unknown	*Unknown*	*unknown*	7/1/04			MIA	
23	*22*	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/03	6	28	New	
24	*23*	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/04	9	31	ALIVE	
25	*24*	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/05	7	27	ALIVE	
26	*25*	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/06			ALIVE	
27	*26*	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/03	6	29	New	
28	*27*	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/04	2	17	ALIVE	
29	*28*	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/05	1	17	ALIVE	
30	*29*	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/06			DEAD	
31	*30*	1	1	y12	acanth	Acanthaceae	*Acanthaceae*	*sp*	7/1/03	8	21	New	
32	*31*	1	1	y12	acanth	Acanthaceae	*Acanthaceae*	*sp*	7/1/04			MIA	

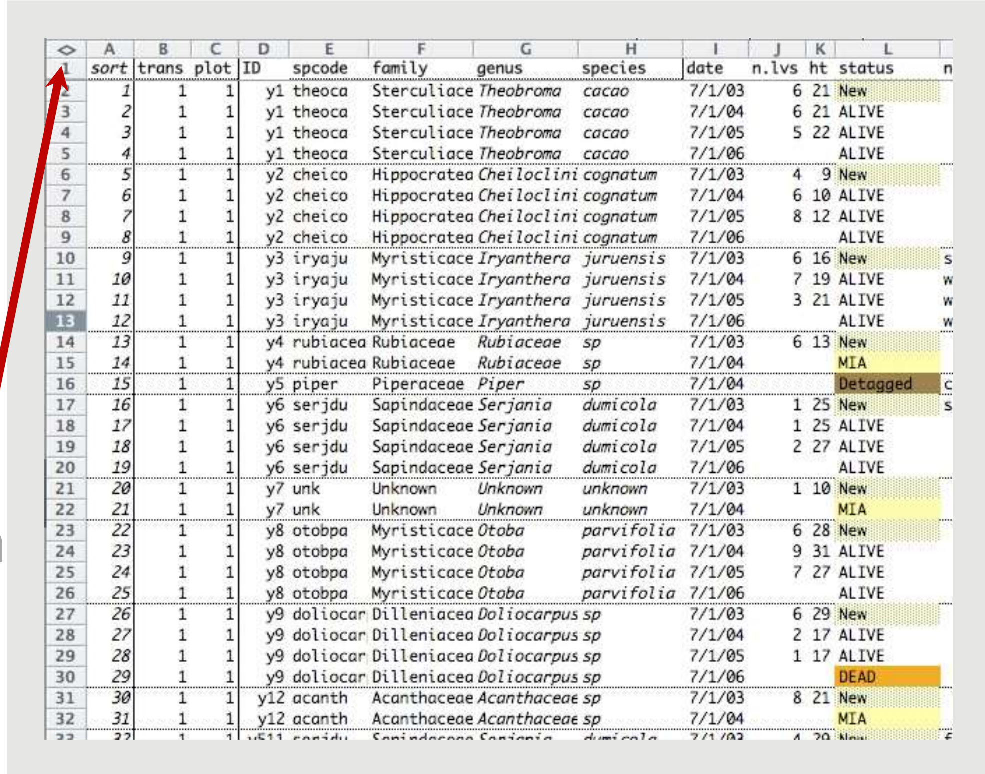
Data Entry and Organisation

- One value per cell
- One variable per column
- Sort column
- Descriptors on left, data on right

◇	A	B	C	D	E	F	G	H	I	J	K	L	
1	*sort*	trans	plot	ID	spcode	family	genus	species	date	n.lvs	ht	status	n
2	*1*	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/03	6	21	New	
3	*2*	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/04	6	21	ALIVE	
4	*3*	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/05	5	22	ALIVE	
5	*4*	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/06			ALIVE	
6	*5*	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	7/1/03	4	9	New	
7	*6*	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	7/1/04	6	10	ALIVE	
8	*7*	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	7/1/05	8	12	ALIVE	
9	*8*	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	[illegible]			ALIVE	
10	*9*	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/03	6	16	New	s
11	*10*	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/04	7	19	ALIVE	w
12	*11*	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/05	3	21	ALIVE	w
13	*12*	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/06			ALIVE	w
14	*13*	1	1	y4	rubiacea	Rubiaceae	*Rubiaceae*	*sp*	7/1/03	6	13	New	
15	*14*	1	1	y4	rubiacea	Rubiaceae	*Rubiaceae*	*sp*	7/1/04			MIA	
16	*15*	1	1	y5	piper	Piperaceae	*Piper*	*sp*	7/1/04			Detagged	c
17	*16*	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/03	1	25	New	s
18	*17*	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/04	1	25	ALIVE	
19	*18*	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/05	2	27	ALIVE	
20	*19*	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/06			ALIVE	
21	*20*	1	1	y7	unk	Unknown	*Unknown*	*unknown*	7/1/03	1	10	New	
22	*21*	1	1	y7	unk	Unknown	*Unknown*	*unknown*	7/1/04			MIA	
23	*22*	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/03	6	28	New	
24	*23*	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/04	9	31	ALIVE	
25	*24*	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/05	7	27	ALIVE	
26	*25*	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/06			ALIVE	
27	*26*	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/03	6	29	New	
28	*27*	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/04	2	17	ALIVE	
29	*28*	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/05	1	17	ALIVE	
30	*29*	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/06			DEAD	
31	*30*	1	1	y12	acanth	Acanthaceae	*Acanthaceae*	*sp*	7/1/03	8	21	New	
32	*31*	1	1	y12	acanth	Acanthaceae	*Acanthaceae*	*sp*	7/1/04			MIA	

Data Entry and Organisation

- One value per cell
- One variable per column
- Sort column
- Descriptors on left, data on right
- Single line for column headers



◇	A	B	C	D	E	F	G	H	I	J	K	L	
1	sort	trans	plot	ID	spcode	family	genus	species	date	n.lvs	ht	status	n
2	1	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/03	6	21	New	
3	2	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/04	6	21	ALIVE	
4	3	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/05	5	22	ALIVE	
5	4	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/06			ALIVE	
6	5	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/03	4	9	New	
7	6	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/04	6	10	ALIVE	
8	7	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/05	8	12	ALIVE	
9	8	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/06			ALIVE	
10	9	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/03	6	16	New	s
11	10	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/04	7	19	ALIVE	w
12	11	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/05	3	21	ALIVE	w
13	12	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/06			ALIVE	w
14	13	1	1	y4	rubiacea	Rubiaceae	Rubiaceae	sp	7/1/03	6	13	New	
15	14	1	1	y4	rubiacea	Rubiaceae	Rubiaceae	sp	7/1/04			MIA	
16	15	1	1	y5	piper	Piperaceae	Piper	sp	7/1/04			Detagged	c
17	16	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/03	1	25	New	s
18	17	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/04	1	25	ALIVE	
19	18	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/05	2	27	ALIVE	
20	19	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/06			ALIVE	
21	20	1	1	y7	unk	Unknown	Unknown	unknown	7/1/03	1	10	New	
22	21	1	1	y7	unk	Unknown	Unknown	unknown	7/1/04			MIA	
23	22	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/03	6	28	New	
24	23	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/04	9	31	ALIVE	
25	24	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/05	7	27	ALIVE	
26	25	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/06			ALIVE	
27	26	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/03	6	29	New	
28	27	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/04	2	17	ALIVE	
29	28	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/05	1	17	ALIVE	
30	29	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/06			DEAD	
31	30	1	1	y12	acanth	Acanthaceae	Acanthaceae	sp	7/1/03	8	21	New	
32	31	1	1	y12	acanth	Acanthaceae	Acanthaceae	sp	7/1/04			MIA	

Data Entry and Organisation

- No empty rows or columns

◇	A	B	C	D	E	F	G	H	I	J	K	L	
1	sort	trans	plot	ID	spcode	family	genus	species	date	n.lvs	ht	status	n
2	1	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/03	6	21	New	
3	2	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/04	6	21	ALIVE	
4	3	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/05	5	22	ALIVE	
5	4	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/06			ALIVE	
6	5	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/03	4	9	New	
7	6	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/04	6	10	ALIVE	
8	7	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/05	8	12	ALIVE	
9	8	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/06			ALIVE	
10	9	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/03	6	16	New	s
11	10	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/04	7	19	ALIVE	w
12	11	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/05	3	21	ALIVE	w
13	12	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/06			ALIVE	w
14	13	1	1	y4	rubiacea	Rubiaceae	Rubiaceae	sp	7/1/03	6	13	New	
15	14	1	1	y4	rubiacea	Rubiaceae	Rubiaceae	sp	7/1/04			MIA	
16	15	1	1	y5	piper	Piperaceae	Piper	sp	7/1/04			Detagged	c
17	16	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/03	1	25	New	s
18	17	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/04	1	25	ALIVE	
19	18	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/05	2	27	ALIVE	
20	19	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/06			ALIVE	
21	20	1	1	y7	unk	Unknown	Unknown	unknown	7/1/03	1	10	New	
22	21	1	1	y7	unk	Unknown	Unknown	unknown	7/1/04			MIA	
23	22	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/03	6	28	New	
24	23	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/04	9	31	ALIVE	
25	24	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/05	7	27	ALIVE	
26	25	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/06			ALIVE	
27	26	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/03	6	29	New	
28	27	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/04	2	17	ALIVE	
29	28	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/05	1	17	ALIVE	
30	29	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/06			DEAD	
31	30	1	1	y12	acanth	Acanthaceae	Acanthaceae	sp	7/1/03	8	21	New	
32	31	1	1	y12	acanth	Acanthaceae	Acanthaceae	sp	7/1/04			MIA	

Data Entry and Organisation

- No empty rows or columns
- Fill empty cells with NA

◇	A	B	C	D	E	F	G	H	I	J	K	L	
1	sort	trans	plot	ID	spcode	family	genus	species	date	n.lvs	ht	status	n
2	1	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/03	6	21	New	
3	2	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/04	6	21	ALIVE	
4	3	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/05	5	22	ALIVE	
5	4	1	1	y1	theoca	Sterculiace	*Theobroma*	*cacao*	7/1/06			ALIVE	
6	5	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	7/1/03	4	9	New	
7	6	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	7/1/04	6	10	ALIVE	
8	7	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	7/1/05	8	12	ALIVE	
9	8	1	1	y2	cheico	Hippocratea	*Cheiloclini*	*cognatum*	7/1/06			ALIVE	
10	9	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/03	6	16	New	s
11	10	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/04	7	19	ALIVE	w
12	11	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/05	3	21	ALIVE	w
13	12	1	1	y3	iryaju	Myristicace	*Iryanthera*	*juruensis*	7/1/06			ALIVE	w
14	13	1	1	y4	rubiacea	Rubiaceae	*Rubiaceae*	*sp*	7/1/03	6	13	New	
15	14	1	1	y4	rubiacea	Rubiaceae	*Rubiaceae*	*sp*	7/1/04			MIA	
16	15	1	1	y5	piper	Piperaceae	*Piper*	*sp*	7/1/04			Detagged	c
17	16	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/03	1	25	New	s
18	17	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/04	1	25	ALIVE	
19	18	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/05	2	27	ALIVE	
20	19	1	1	y6	serjdu	Sapindaceae	*Serjania*	*dumicola*	7/1/06			ALIVE	
21	20	1	1	y7	unk	Unknown	*Unknown*	*unknown*	7/1/03	1	10	New	
22	21	1	1	y7	unk	Unknown	*Unknown*	*unknown*	7/1/04			MIA	
23	22	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/03	6	28	New	
24	23	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/04	9	31	ALIVE	
25	24	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/05	7	27	ALIVE	
26	25	1	1	y8	otobpa	Myristicace	*Otoba*	*parvifolia*	7/1/06			ALIVE	
27	26	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/03	6	29	New	
28	27	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/04	2	17	ALIVE	
29	28	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/05	1	17	ALIVE	
30	29	1	1	y9	doliocar	Dilleniacea	*Doliocarpus*	*sp*	7/1/06			DEAD	
31	30	1	1	y12	acanth	Acanthaceae	*Acanthaceae*	*sp*	7/1/03	8	21	New	
32	31	1	1	y12	acanth	Acanthaceae	*Acanthaceae*	*sp*	7/1/04			MIA	

Data Entry and Organisation

- No empty rows or columns
- Fill empty cells with NA
- Comments column with ‘free text’
- No special characters, including accents

◇	A	B	C	D	E	F	G	H	I	J	K	L	
1	sort	trans	plot	ID	spcode	family	genus	species	date	n.lvs	ht	status	n
2	1	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/03	6	21	New	
3	2	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/04	6	21	ALIVE	
4	3	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/05	5	22	ALIVE	
5	4	1	1	y1	theoca	Sterculiace	Theobroma	cacao	7/1/06			ALIVE	
6	5	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/03	4	9	New	
7	6	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/04	6	10	ALIVE	
8	7	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/05	8	12	ALIVE	
9	8	1	1	y2	cheico	Hippocratea	Cheiloclini	cognatum	7/1/06			ALIVE	
10	9	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/03	6	16	New	s
11	10	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/04	7	19	ALIVE	w
12	11	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/05	3	21	ALIVE	w
13	12	1	1	y3	iryaju	Myristicace	Iryanthera	juruensis	7/1/06			ALIVE	w
14	13	1	1	y4	rubiacea	Rubiaceae	Rubiaceae	sp	7/1/03	6	13	New	
15	14	1	1	y4	rubiacea	Rubiaceae	Rubiaceae	sp	7/1/04			MIA	
16	15	1	1	y5	piper	Piperaceae	Piper	sp	7/1/04			Detagged	c
17	16	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/03	1	25	New	s
18	17	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/04	1	25	ALIVE	
19	18	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/05	2	27	ALIVE	
20	19	1	1	y6	serjdu	Sapindaceae	Serjania	dumicola	7/1/06			ALIVE	
21	20	1	1	y7	unk	Unknown	Unknown	unknown	7/1/03	1	10	New	
22	21	1	1	y7	unk	Unknown	Unknown	unknown	7/1/04			MIA	
23	22	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/03	6	28	New	
24	23	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/04	9	31	ALIVE	
25	24	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/05	7	27	ALIVE	
26	25	1	1	y8	otobpa	Myristicace	Otoba	parvifolia	7/1/06			ALIVE	
27	26	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/03	6	29	New	
28	27	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/04	2	17	ALIVE	
29	28	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/05	1	17	ALIVE	
30	29	1	1	y9	doliocar	Dilleniacea	Doliocarpus	sp	7/1/06			DEAD	
31	30	1	1	y12	acanth	Acanthaceae	Acanthaceae	sp	7/1/03	8	21	New	
32	31	1	1	y12	acanth	Acanthaceae	Acanthaceae	sp	7/1/04			MIA	

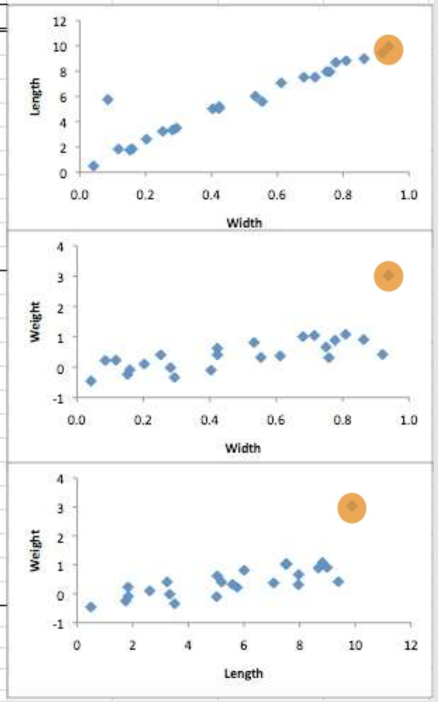
Finding errors: Sorting

- Good for easy errors, not insidious ones
- Beware not sorting all columns
  - Can cause fatal errors
  - Best to select all first

sort	plot	width	1000width	width	Genus	Genus	SPCODE
1	2	0.1172	2936	0.2936	Trichilia	Trichilia	tricpa
2	2	0.2520	850	0.0850	Trichila	Trichila	tricpa
3	2	0.7591	4230	0.4230	Iriartea	Iriartea	iriade
4	2	0.5539	5333	0.5333	Legume	Legume	legume
5	2	0.6807	7774	0.7774	Iriartea	Iriartea	iriade
6	2	0.0420	4036	0.4036	Ziziphus	Ziziphus	zizici
7	2	0..8634	1172	0.1172	Diospyros	Diospyros	diospa
8	2	0.4230	8089	0.8089	Oenocarpus	Oenocarpus	oenoba
9	2	0.7147	9393	0.9393	Iriartea	Iriartea	iriade
10	2	0.9393	5539	0.5539	Diospyros	Diospyros	diospa
11	2	0.7774	8634	0.8634	Iriartea	Iriartea	iriade
12	2	0.7498	7147	0.7147	Iriartea	Iriartea	iriade
13	2	0.5333	2024	0.2024	Odontocarya	Odontocarya	odonto
14	2	0.2024	1590	0.1590	Trichilia	Trichilia	tricpa
15	1	0.8089	420	0.0420	Diospyros	Diospyros	diospa
16	1	0.6119	7498	0.7498	Iriartea	Iriartea	iriade
17	1	0.4226	6119	0.6119	Trichilia	Trichilia	tricpa
18	1	2.8150	7591	0.7591	Diospyros	Diospyros	diospa
19	1	0.0850	9205	0.9205	Ziziphus	Ziziphus	zizici
20	1	0.1590	1521	0.1521	Trichilia	Trichilia	tricpa
21	1	0,1521	2520	0.2520	Diospyros	Diospyros	diospa
22	1	0.2936	2815	0.2815	Trichilia	Trichilia	tricpa
23	1	0.9205	6807	0.6807	Diospyros	Diospyros	diospa
24	1	0.4036	4226	0.4226	Trichilia	Trichilia	tricpa

Finding errors: Graphs

sort	plot	width	length	weight	Genus	Genus	SPCODE
1	1	0.1172	1.8326	0.2322	Diospyros	Diospyros	diospa
2	1	0.2520	3.2341	0.4062	Diospyros	Diospyros	diospa
3	1	0.7591	7.9552	0.3112	Diospyros	Diospyros	diospa
4	1	0.5539	5.5854	0.3223	Diospyros	Diospyros	diospa
5	1	0.6807	7.5155	1.0058	Diospyros	Diospyros	diospa
6	1	0.0420	0.4994	-0.4597	Diospyros	Diospyros	diospa
7	1	0.8634	8.9852	0.9038	Iriartea	Iriartea	iriade
8	1	0.4230	5.1943	0.4025	Iriartea	Iriartea	iriade
9	1	0.7147	7.5208	1.0420	Iriartea	Iriartea	iriade
10	1	0.9393	9.8935	2.9967	Iriartea	Iriartea	iriade
11	2	0.7774	8.6755	0.8864	Iriartea	Iriartea	iriade
12	2	0.7498	7.9637	0.6606	Iriartea	Iriartea	iriade
13	2	0.5333	6.0080	0.8104	Legume	Legume	legume
14	2	0.2024	2.6136	0.1005	Odontocary	Odontocarya	odonto
15	2	0.8089	8.8193	1.0780	Oenocarpus	Oenocarpus	oenoba
16	2	0.6119	7.0687	0.3720	Trichila	Trichila	tricpa
17	2	0.4226	5.0408	0.6187	Trichilia	Trichilia	tricpa
18	2	0.2815	3.3303	-0.0172	Trichilia	Trichilia	tricpa
19	2	0.0850	5.7539	0.2202	Trichilia	Trichilia	tricpa
20	2	0.1590	1.8429	-0.0892	Trichilia	Trichilia	tricpa
21	2	0.1521	1.7507	-0.2447	Trichilia	Trichilia	tricpa
22	2	0.2936	3.5089	-0.3402	Trichilia	Trichilia	tricpa
23	2	0.9205	9.3907	0.4160	Ziziphus	Ziziphus	zizici
24	2	0.4036	5.0186	-0.1024	Ziziphus	Ziziphus	zizici

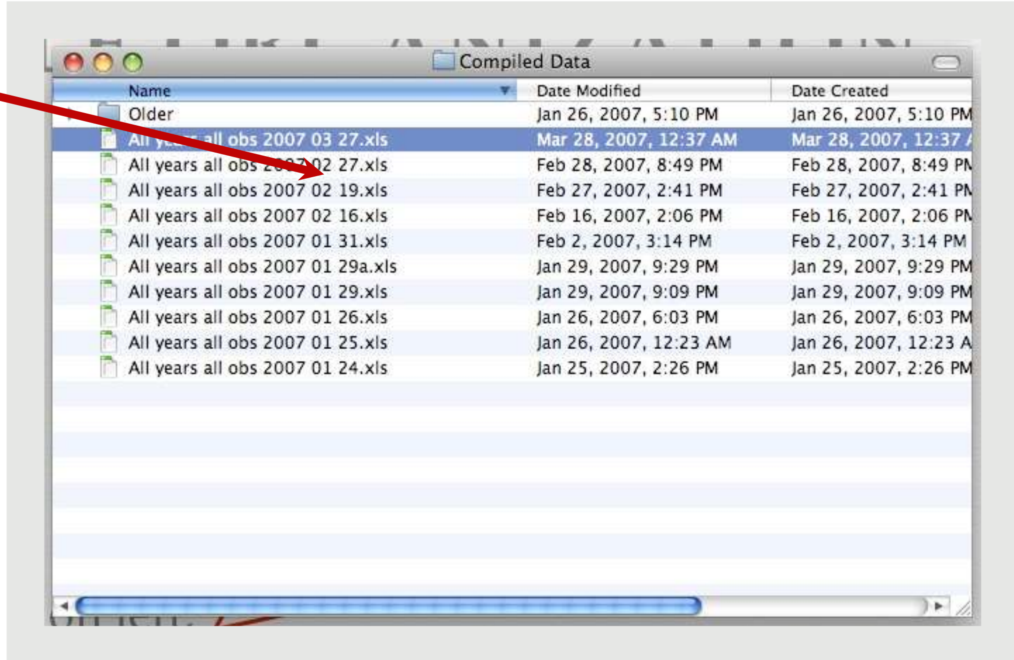


Insidious, plausible errors are hard to zap!

Where is it? Ribbon > Charts

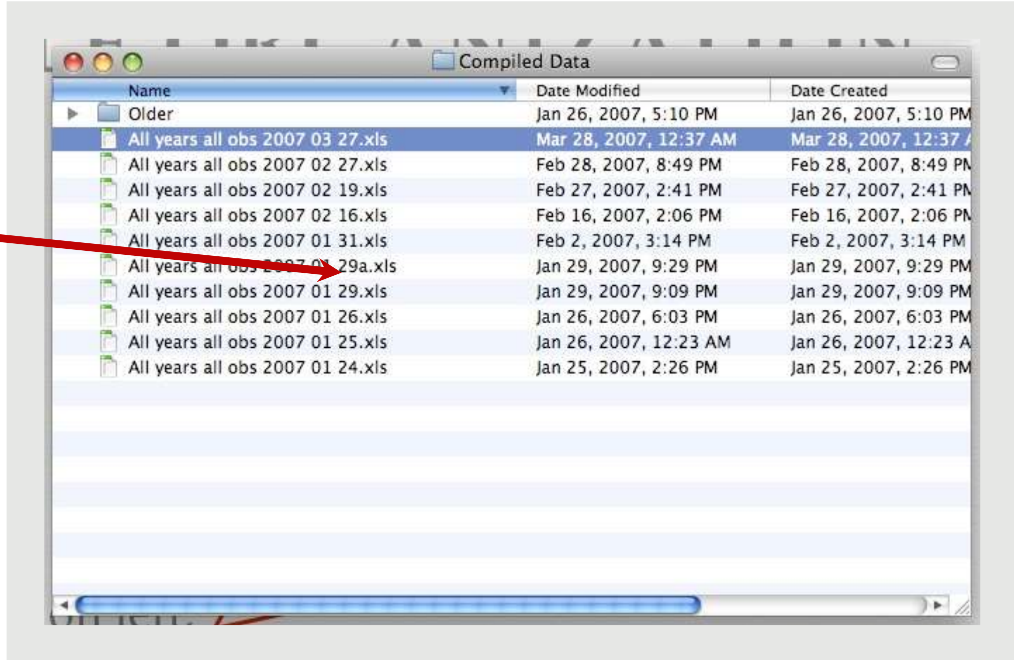
File Organization

- New file name every day



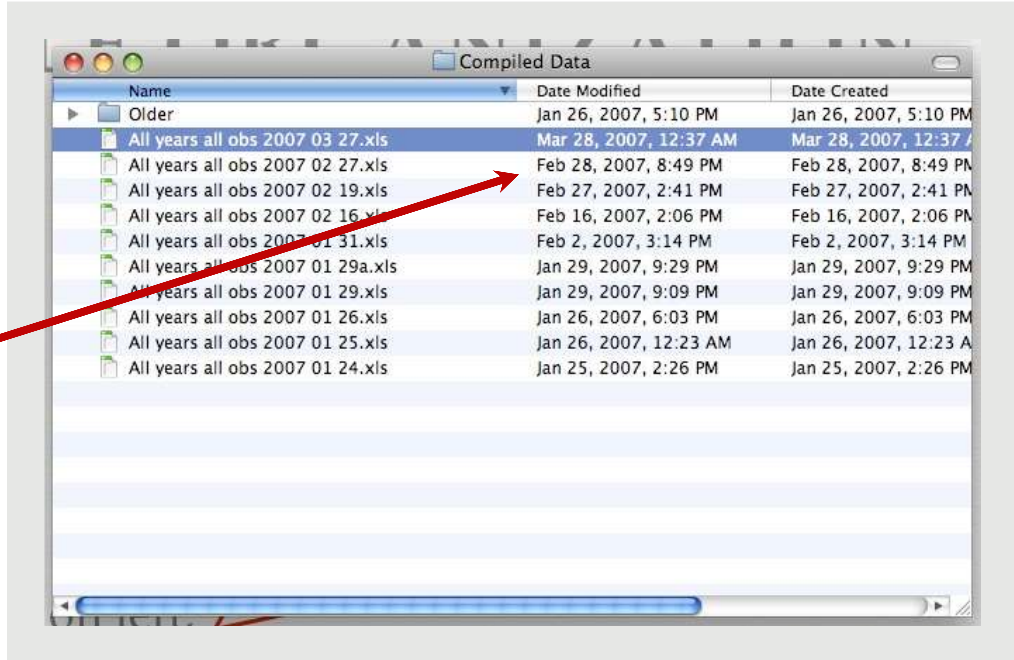
File Organization

- New file name every day
- a, b, c… if within-day saves



File Organization

- New file name every day
- a, b, c… if within-day saves
- Format date for easy sorting



Applications

Dissertation project
And then…

Writing a research plan

What's the purpose of a research plan?
- demonstrate your intellectual vision and aspiration

- Choose an important subject
- Be specific
- Keep it short and focus on the major themes
- Have asolid, well-considered, realistic plan
- Include preliminary data
- Demonstrate independence