Ultra Summary: Bio 3DD3

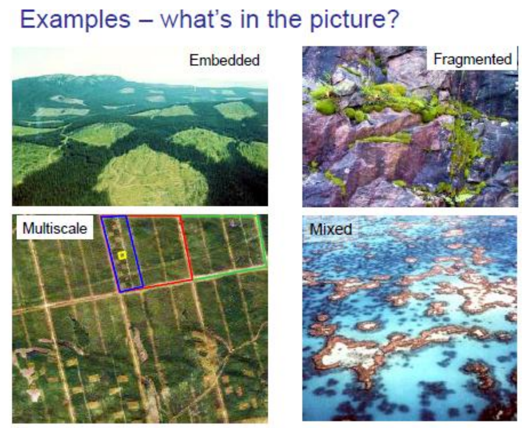
- **Ecological System:** Community or Ecosystem
- Ecological System (Community or Ecosystem) are made up of **fragments of local populations of species**, where the same taxonomic species **may exist elsewhere.** Thus, we can't just define community based on the number of species unless we look at **large scale: 'Scale' changes things**
- Membership of a species in a community ranges from almost **permanent** to almost **accidental**
- **Habitat** is hard to define because it changes depending on the **perception of the individual** spices (organism), and it usually forms a **multi-dimensional hierarchy**. **It is 'dynamic'.**
- **Community will have species**
  1) That are entirely living on it (usually in-case of **large-scale/extent)**
  2) Present in portion of that area
  3) Present because they are also present in surrounding environments (some birds for example)
  4) Present due to similarities of other far-away communities (**Ecological timeline**)- Very similar to their actual timeline
- Due to this **interactions between species** (as seen by three species on an island image) are **asymmetrical:** One species (a) may interact with species (b) completely, but b can interact with various other communities, so it is mostly free of pressure and completion from a, whereas a is fully covered by B: **In a given community one population might have an advantage over the other**
- In a given community, the **more abundant** species will occupy a **smaller range of space** and the **less abundant** species will occupy a **large area of space** (in comparison) because species that are restricted to small areas (can't migrate) can **specialize** and increase abundance whereas the non-restricted ones do not need to (based on **abundance (y) vs. space (x) graph)**
- **Local community** has species in which the **habitat is important, optional or occasional**
- Species can be **permanent or transient** (visitor)
- The ecological representation of a species (in terms of numbers) change (i.e. an ant in a local community vs. deer- there would be more ants for sure)
- Species from a 'community' might show **various integration** from its **sister communities** (or its own **broader population)**
- **How distinct/unique they are locally** depends on if they are **permanent or migratory** (i.e. ones that are not able to migrate might depend more on local reproduction, than migratory birds who can just reproduced in a different population if conditions are right)

- **Level Integration** of a species determine how important that community is to that species/ population of the species. For example migratory birds will be more flexible and less damaged when the community is damaged, because they are less integrated in the community
- **Transients:** General term for anything that does not depend on its local community (Wild-beast travels for grass). Linked mostly to the outside population, might have come by in accident, might not stay and reproduce in the future (accidental dispersal). **May CAUSE a significant impact on the local community**, but they do not depend on it
- Graph that shows colonization and extinction of bird species, the species with no extinction are very dependent on the community, whereas the ones that show extinction (not part of the community) are migratory (transient)
- **Broadly Ranging Species:** Another term, a species that has a broad extent (certain birds) and can occur in various local populations (transients fall into this)-the dynamics of these species are best understood in a large scale
- **Balance between various classes of members (permanent-optional)** may change depending on various factors (succession, community development, its stage etc.)
- **Same taxonomic species may change characteristics** depending on **environment** (protest examples and how they switch their trophy) : **populations** of the same species may have different characteristics
- **Species differ in 'traits': form gradients** (examples below)**:**
  1) **Reproductive gradient:** Species that differ in how many organisms they have
  2) **Gradient of Resource Utilization:** Species differing in resources
  3) **Gradient of Habitat Specialization**
  4) Example of butterflies specializing to each genera of flower
- **Niche:** Ecological characteristics of a species. Set of biotic and abiotic conditions a species can live under, usually viewed in 1-3 dimensions based on number of factors (biotic or abiotic like temperature or ph.)
- In two dimensions we compare two variables (pH and temperature) and it is like a box (simple to view)
- **Fundamental niche:** Areas where a certain can live under (due to the right factors), and **realised niche** (portion of the fundamental niche that is actually occupied by the species) because they are limited by other factors like competition
- **Relationships between species niche and it's habitat:**
  1) **Grenalian Niche:** Species present in suitable habitat
  2) **Hutchinsonian:** Species present mostly in suitable habitat, but some of the species are excluded from the suitable habitat due to **biotic interactions**
  3) **Source-Sink Dynamics:** Species exist outside their source (suitable habitat) in some numbers

4) **Dispersal Dynamics:** Some species do not occur in the suitable area (on random) due to dispersal, kind of like hutchinsonian but hutchinsonian has a whole new oval that blocks out species presence.

- **Niche** can overlap in various ways, when they overlap things like **competition, symbiotic relationship** might take place. The more they overlap the stronger these relationships are or competition is. Below are the scenarios in a species can overlap:
  1) **Co-existence:** Both species have the same niche, same resource gradient (strong relationships and interactions)
  2) **Included:** One species occur in greater numbers, but fall within the range of another, more damage done to this species because the other species has a bigger resource gradient, and can go there when completion occurs
  3) **Reciprocal:** Occur in similar numbers, but an equal portion of them interact
  4) **Asymmetric:** One species has more space than the other, less pressure on that species
  5) **Non overlaps:** Abutting: Connected, but not overlapped, and Disjunction: completely no overlaps
- **Tolerance:** How tolerant a species is to the community factors, but **unlike niche it is inherent, has to do with genetics, and physiology** (does not depend on habitat or location). **One dimension response curve** (an ideal curve is bell shaped or Gaussian curve. For example a graph showing tolerance in temperature, will measure how species will perform in temperature (varying). In most cases, best performance in the middle, and poor in both extremes. It is based on **standard deviation** or how spread out the stuff are
- **Ecological Range:** Species not present not because it cannot tolerate (opposite), but this Is more about chance and how a particular species perform in a given community- how well organisms perform by chance, mating, due to dispersal etc. (a same species can tolerate rock pools with similar conditions, but due to chance, and performance a species might be present in one rock pool but not the other (even though they can tolerate both)
- **Habitat:** Definition depends on the species, is multidimensional (various factors competition, available resources) could limit and change perspective of what 'habitat' is based on a species (examples plants that specialized due to herbivore)
- **Habitat Structure:** Resolution increases as we get closer down the hierarchy. As scale increases, resolution decreases
- **Multidimensional Volume:** We can use infinite variables to define a habitat + **Hierarchy** (changing based on scale) =**Habitat**
- **Algae and mushroom (Lichen:** at finer resolutions we can distinguish individual habitats and own set of characteristics

- **Spatial configuration of patches of habitats: Can be Fragmented** (isolated fragments of similar habitats)**, Embedded** (one habitat embedded in patches within another)**, or Continuous and Compact** (a habitat that flows together- one large habitat with no disruption). Regardless in which way they are subdivided, the general **multidimensional model applies similarly to all** (all have finer habitats within general habitats)
- Is the depiction of hypothetical species' habitats true for one location or the whole range where species occurs? No it changes in space because conditions change in space



- Narrow range species (down the hierarchy) are **habitat specialists**
- Broad range species (up the hierarchy) are **habitat generalists**
- Intermediate range species: In the middle, medium resolution
- **Highest resolution on bottom--→ increases towards top**
- **Ecologists now consider wider scales**
- Community's species are really more or less isolated populations, with unequal contributions to the life of community and unequal needs and sensitivities
- Habitat is a multidimensional set of factors affecting species
- Habitat is hierarchical and can conveniently be mapped
- Habitat hierarchy emerges when investigator (or a species) uses different resolution of detail (changes scale)
- Scale change is also important in research. This is because:
- Processes and patterns change depending on our scale
- Spatial and temporal scales are positively related, with large entities exhibiting slow dynamics; and small entities changing fast
- This has implications for interactions

Chapter 2: How is Scientific Method Used in Community and Ecosystem Ecology?

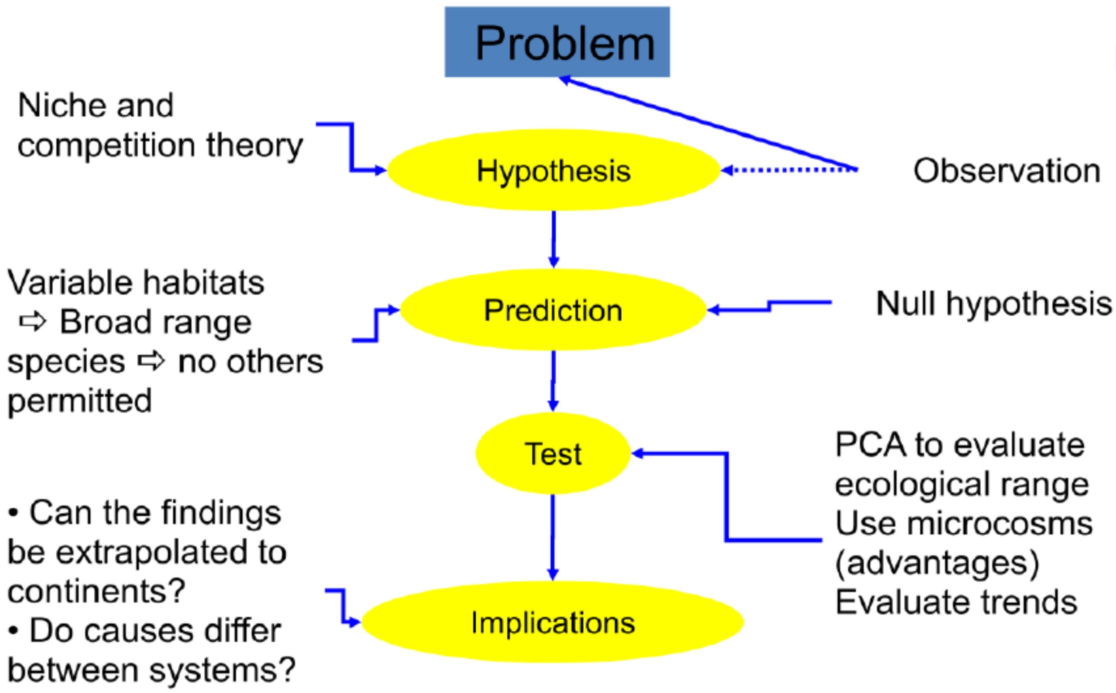
- To answer many questions in Ecology related to Ecological systems you must **develop and test a hypothesis**
- Hypothesis is based on **ecological theories , and scientifically accepted facts**
- **Testing of hypothesis: Experiments + Comparative studies (Both depend on using Statistical methods)**

- Mostly studied in **small spatial and temporal scales** (why easier to accesses because it is a smaller area, and faster time is better because we want results fast)
- Then, using **special methodologies,** we can take the 'small scale' studies and apply it to general 'larger scales' (**most of these methods are in early stages of development)**
- The first step is **Scientific Theory :** Primary guide in which hypothesis, methods etc. are derived from: **Logical web of well-founded assumptions, observations, and expectations**
- **Ecology does not have a unifying (common theory),** but number of theories (assumptions, observations or expectations) can be used to generate hypothesis
- **Hypothesis:** If testable usually has the 'if' and 'then' (**it specifies conditions and 'predicts' the consequences':** If salt dissolves (condition), then it will dissolve in water (consequence)
- **The consequence (prediction) MUST BE UNIQUE:** Only when predictions are unique, we can distinguish them from other patterns etc.
- **Null hypothesis:** Explains the **outcome in-case hypothesis (if-then) is NOT true** (Usually saying if 'consequence' is not true, then the cause is not present: If salt does not dissolve in water, then salt is not soluble in water
- **SCALE:** Is an important risk factor, when testing hypothesis, we need to address and specify the scale of study!
- **Hypothesis Testing:** Numerous steps ranging from data collection all the way to statically analysis **, particularly ECOLOGY RELIES ON STATISTICAL METHODS**
- **Statistical testing is best** suited to extract responses of interest from inherent internal and external sources of variability as well as various systematic but uncontrolled factors.
- **Ecologists can use models, observations, experiments**
- **Ecologists MUST specify the scale of study**
- **Example** (recall species diversity decreasing with latitude- go back and check book if needed): Average niche breadth increases with increasing habitat variability northwards (increase niche breadth= more overlap of niche= greater competition = reduction of species)
- **This REDUCTION OF SPECIES was due to COMPETTITIVE EXLCUSION (Niche Theory Premise)**
- Even if our new hypothesis, requires logic from old ones (like we already know that species drop as we go north), we still need **to prove all the hypothesis sets and formulate ours** (we can't just use other 'known' hypothesis just because they are general)
- Steven supported the old concepts by showing data of mammals that show a steady increase in geological range depending on degrees of latitude (this explains why niche

breadth increases northwards), and now we can actually formulate the own hypothesis and test it

- **Example 2: Rock pool model system**: Each rock pool is a small ecosystem (contains community of invertebrates +others). They were testing the hypothesis that 'decrease in species variability' is due to 'competition' (not the same as last one where they were saying before)
- **Four main factors measure (Oxygen, Temperature, PH, and Salinity) in 49 rock pools over the years:** Length of bar= 2 standard deviation around mean**, the longer the bars are the more variable they are. Short bars are less variable**
- We have multiple variables (different ones)→ we need a way to put all the variables together into one **SYNTHETIC VARIABLE (overall variable)** (so we can get a clear picture of the overall variability of the environment)→ **requires the use of statistics**
- **Synthesis Variables are made use PCA (Factor or Principal Component Analysis):** This processes looks for **similarities (correlations) among variables, and group the similar variables into sub-groups:** Thus correlated variables may be grouped into PCA1 and PCA2 for example.
- They used PCA groups to check variance in the entire pool system and PCA 1 actually showed the most variance (not PCA 2- so these group of correlated variables did not have much effect): Used to determine species **ecological niche (a species occurring in similar PCA 1 values all over has a narrow niche, but the one that occurs in varying PCA 1 values has a broad niche- able to cope with varying things better)**
- After gathering the PCA values → Standard deviation (STATISTICS) was used to determine relationships
- So we know that only broad-range species can exist in variable environments, but we still need to determine if variability actually causes a reduction in niche
- This can be accomplished by plotting **species richness vs. habitat variability**
- The graph shows that habitats variability increases lead to drop in richness (loss of niche)
- **We need to make sure the result is SIGNIFICANT!**
- **We still need more evidence to show that competition affects continent-scale gradient of species diversity** (scale is bigger now from rock pool to continent, and also we need to show evidence of competition, so far we just showed that variables cause decrease in richness)
- **Third step: Check weather habitat variability increase when broader niche species are present** (we know that broader niche species can survive in variable habitats)→ **mean ecological range of all species in pool vs. habitat variability → as range increases variability increases:** More variable habits are home to broader niches (result from this graph)

- **This small scale TREND corresponds with the large scale trend,** but this does not necessarily show COMPETITION!
- Thus, we can conclude that the gradient is not produced by broad range species outcompeting other species from locations they occur. Rather, it is differential extinction of narrow range species from variable pools that creates the gradient.



- Steps and connections involved in the formulation and partial solution to a scientific problem posed by the example. The problem was a question motivated by observation. It necessitated a tentative answer – the hypothesis. The hypothesis allowed formulating a testable prediction which was contrasted against the null hypothesis. The answer may lead to further questions or problems for the cycle to be repeated with new contents.
- **Two types of hypothesis:**
  1) **Qualitative:** Really good when s. methods are not available, but even s. methods are used to test a qualitative hypothesis (although it is not meant to be used). Example variable habitats= home to broader niche species (is qualitative , but we used stats to test it)
  2) **Statistical (most preferred type):** Statistical hypotheses are assertions or conjectures about *the parameter* or parameters of a set of measurements or counts. These parameters most often include the mean and the variance of values that were measured empirically (in the field or lab).

- It is one thing to have an idea, but it's another to form once with little promise: So it is good to eliminate those unpromising ideas beforehand (don't make stupid hypothesis!)- For example once phosphorous was shown to cause eutrophication, we know that testing if carbon does anything would lead to low promise, so it's better to abandon those studies
- **Types of statistical tests:**
  Testing for mean of group of values and seeing if they are similar, different (what is different from each variable) in several groups of values simultaneously: **T-TEST** (mean group), and **Annova** (simultaneous)
  Regression Analysis: When one set of values change, does the other set change? For most comparisons results are from **bar graphs**, and for regression results are represented using **trend lines**
- **Null Hypothesis:** Denoted by H0, it states that there is **no difference** between observation sets (no increase or decrease in mean values)
- **Statistical testing is about REJECTING the NULL HYPOTHESIS and proving that there is ACTUALLY A DIFFERENCE**
- **Alternative Hypothesis:** HN, accepted when null hypothesis is rejected (it is not tested directly, but it is the **actual hypothesis that they want to test for)**
- **Qualitative Hypothesis:** A hypothesis that **makes predictions** when **one or more conditions are true** (links via logic)
- Scientific hypotheses are derived from theory; their tests involve predictions and statistical evaluation of obtained data
- Current tools in ecological studies are **statistics, experimental design, long-term observations, and comparative studies**
- **Out of these 'EXPIREMENT' is the most effective tool in ecology**
- **Experiments:** Usually require tools (so small scale is appropriate), you can change variables and experiment (either controlling all variables except the one of interest, or controlling the one of interest, and changing all the variables) through processes like **randomization**
- Some experiments can manipulate **more than one variable (involve factorial designs)**
- **Four basic design principles:**
  1) **Replicate:** Repetition of basic experimental unit (a lake being studied for example). Studying repeatedly, can correct experimental error, reduces the effect of random error, sample mean is more precise
  2) **Randomize:** Minimizes biases
  3) **Avoid Psudo-Replication**
  4) **Use of Controls:** must be used in any manipulative experiments

- **Observational Studies (Natural Experiments):** Often used for **large scale comparative studies** where observation is better (it is hard to manipulate large scales in a small environment), **no control over experiment design. Example: wildfires**
- **SCALE PROBLEMS:** Large and long-temporal scales are hard to study, so now they study **multiple-scales simultaneously (Stratified Sampling Protocol):**
- **Space and Time are correlated scales : Fast-Small, Large-Long**
- Problems with variables in multiple scales: **discontinuity** (will be present in one scale, but not the other), they are not continuous
- **How do we deal with multiple * large scale processes?**
  1) **Substitute space for time:** moving in space to find a faster occurrence of similar phenomena
  2) **Redefine the variable** of interest as scales change: **frequency distribution** – a different variable than the one that it was derived from but measures the same thing at increasing levels of scales
  3) **Scaling functions**- describes systematic changes in a parameter of interest as a function of the system change

Chapter 3: Dispersal

- Communities assemble when **an empty area is available, a certain species manages to send colonizers to that empty space (dispersal), and the arriving colonizers manage to establish and reproduce (AREA + ARRIVAL + ESTABLISHMENT)**
- The colonizers differ in their ability to REACH the site (some may take, some can fly through wind like spiders)
- **Colonization depends on: SCALE ISOLATION** (is it an island etc.), **dispersal distance** (how far away it is), and **site size** (how much of the new site can be occupied in the first place)
- **Colonization ALWAYS requires OUTSIDERS** (you can't say a species colonized the same area- it's already there!)
- **Empty habitats:** Arise from physical OR interaction between physical and biological processes
- **Krakatoa explosion→ Split into three islands→ Created Anak Krakatoa (subsequent small eruptions)**: Original life was TOTALLY destroyed during this extreme volcanic event (**the three initial islands HAD NO vegetation left over)**
- First thing seen was spider, followed by small patches of grass
- **Colonization** from surrounding areas, island of **Sebesi** (closest colonization fauna/animal source)

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- Animals sea dispersed or blown by wind were first to arrive, but not considered serious colonizers, most serious ones were **flora** and they were **sea-dispersed**
- **Strand-shore clippers (Ipomea)** were the **first-serious colonizers**
- **Ferns-** Successful early colonizers because they have spores that can be carried easily dispersed by wind well
- **Followed by grasslands – grew tall and hard to walk through**
- **Woodland species dominated the interior of the islands over time** (dispersed by wind and even bat-or bird dispersed)- **forests once they developed further changes** like for example they **diminished grasslands** (so now scientists had an easier access to the mountains)
- **Ferns and Orchids (Epiphytes) all depend on forest- so their # increased, while grass # decreased**
- Wind spread species – **occupied upper slopes of the volcanic island**

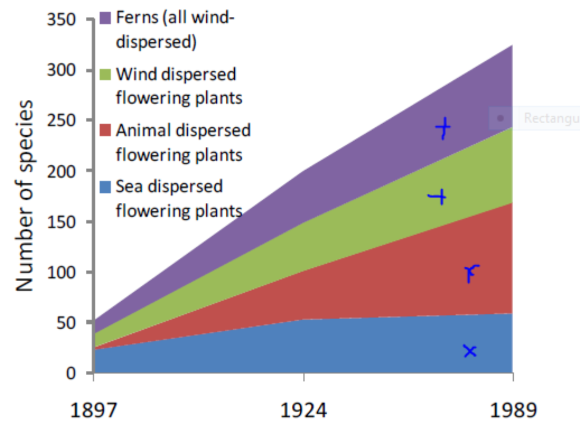

Fig. 3.4. Colonization trends on Krakatoa (Island of Rakata) among different plant categories. Animal dispersed plants arrive at higher rates after the initial wave of early colonizers.

- **Post colonization- during development- DISTRUBANCES** (interruptions in development) occurred: These disturbances for example would be **small volcanic explosions, that slowed things down**
- **Things to note in the image above:** Sea dispersed level off around 1924 (first 30 years) – probably because that mode of dispersal was un-necessary, pretty much all the species using it was there. **Animal dispersed flowering plants** had a slow growth, but their #s increase dramatically (biggest gap) mainly because there are more animals in the island itself to help with dispersal!
- **Other processes that create new habitats:**
  1) **Lava fields:** lava flow that covers a large area
  2) **Land slide**
  3) **Alluvial depositions:** Flood deposits new soils wiping out old soil (which may continue living organisms like fish- but it won't survive on land after the water retreats) so pretty much consider it as empty land
  4) **Volcanic Pyroclastic flows and ash deposits: pumice** (light rock with lots of air bubbles), and various sediments drop from ash, filling up old landscapes. **Cover ground by a thin layer**
  5) **Glacial moraines:** Stuff deposited by moving glaciers (common in cooler climates)

6) **Fire:** Destroy organisms and burn organic matter down, but normally it is rare for a complete destruction (**fire is a partial distruster:** not all organisms die)! Damage depends on the intensity, and the area covered (various factors), so fire may strip down a habitat, or just modify the ecological system: **many organism have adaptation to fire**
7) **New under-water mountains:** volcano erupts, but does not reach ocean surface, so you get condensed underwater mountains- **so it produces a brand new empty land**
8) **Underwater shelf mudslides: produces new substrates** along a continental shelf (these are like landslides but underwater)
9) **New lakes or rivers:** arise in depression, due to glacial activity, natural damming of rivers cut lakes and form it (it's like what we do but natural!), rivers move lots of sediments in and around shifting their floor creating habitats, water level changes creates new habitats.
10) **Humans also create habitats (Anthropogenic habitats) –** dams etc., most happening and most diverse type, ponds created, mining generated stuff, walls etc. agriculture (example shows once abandoned, the field grew back similar to how it was before agriculture occurred)
11) **Can also be looked at in a small scale:** Pitcher plant that forms ponds attacking different organisms
12) **Desertification:** Climate change-natural or human- may lead to destruction of original communities (they can't survive no more because they can't survive in desserts!) : **long time temporal scale**

- **New habitats arise MORE and in higher frequency, and faster at SMALLER SCALES** (remember everything is fast when small)
- **Depending on if ANY thing was present in the new-site OR it was fully divided two terms can be studied: PRIMARY SUCESSION and SECONDARY SUCESSION**
- **Organisms that ARRIVE FIRST have SPECIAL ABILITIES (OR UNIQUE ADAPTATIONS)**
- **Dispersal Adaptation:** They must reach the new site first, two basic types of dispersal **passive and active.**
- **Passive:** Dispersal by wind and water: USE VECTORS TO GET SOMEWHERE = and they can **target desired habitats**
- **Active:** The actual organism moves or disperses using its own energy=**poor at targeting=end up wandering**
- **Both have adaptations to INCREASE success of dispersal**
- We can tell adaptations based on characteristics of an organism that makes them colonize and survive
- **Terrestrial Systems: First arrivers usually have one or several traits:**

1) **Small size**- arrive first, large seeds negatively correlated (large seeds=poor dispersal), unless dispersed by sea (in that case large seeds= good dispersal)
2) **Resistance to drying:** New **sites heat up and loose water** easily, so these things should have traits that lets them adapt to it (so initial organisms are well adapted to dry water-less conditions: Must be resistant to **high temperature, low humidity, and low water availability (initially),** in terms of **sea dispersal= resistant to salt**
3) **Germination:** How fast or how well they germinate: A initial blown seed has a good strategy if it waits for rain season and grows (will be more successful)- It should know when is the good time to germinate
4) **Capability:** Coping with long periods of scarcity (food for example)- because new habitats do not really have anything that these organisms can capture and use (reptiles better than mammals, birds can just fly to their source, plants can develop creeping stem, but they should be able to 'generate' food via photosynthesis- sun light is always plenty :D)
5) **Morphological adaptations to transport:** Hairs on seeds so they can FLY, fleshy sweet indigestible seed containing fruits, burs to attach to animals: **geared for attachment to animals, or for lift (via wind, water-** coconuts, mangrove root adaptation**)**
6) **High light requirement:** Plants require light, they need to be able to cope with high/low light requirement

- **Differential Success:** Based on dispersal adaptations, some species are more likely to arrive to a location first. Certain **list based on traits of species arrive first (in order below)**
  1) **Transient:** Animals with a broad range, they explore habitats (spiders etc)
  2) **Seeds or Spores:** Allows them to be easily carried by **wind or water (seeds by wind or water arrive BEFORE seeds carried by animals)**
  3) **Plans with small seeds** (usually arrive before large seed plants come): More numerous, easier to be carried
  4) **Plants with seeds carried by animals:** Wind dispersal is usually initial but **depending on scale,** plant dispersal by animals would occur first (small scales where they could just walk by) vs. island (wind will be first, then animal vectors)
- Some species **CHANGE trait once arrived, to be successful and increase fitness in that environment**
- **Aquatic traits NOT THE SAME as TERRESTRIAL**
- **Phroteic dispersal:** Example of water mites, wind, then climb on other bugs that transports them to desired location
- **Parastic relationships:** A bug that depends on water as a larvae , parasitic to grasshoppers and other insects, does something to cause them to drown them-selves,

and larvae goes into the water (when the bug decides to lay eggs- it drowns other insects!)

- **Water fleas: Wind dispersed egg sacks (ephypia):** float, small so they attach to plants, dry
- **Anthropods are the most successful in terms of arrival**, followed by **snails,** then **amphibians,** then **mammals**
- **Increasing size= less animals bringing plants** (more wind and water)
- **What happens after arrival?**
  - The new environment is physically demanding- they need to adapt to this
  - Ability to survive birth (or germinate) – seeds after arrival should be able to grow
  - Ability to reach reproductive maturity (they shouldn't die before being able to reproduce)
  - High reproductive rates **(colonial nature)**: usually associated with **small seed plants**
  - Additionally should be able to cope with photosynthesis variance , water availability,
- Once a population emerges, it may further change depending on **environmental filtering:** Lactua murali- evolved to stop dispersal distance, so they don't have to waste time on sending more seeds and dispersing and rather focus on reproducing on that island (don't do what they typically did back home- which is try to disperse)
- Early colonizers often show **r-strategies (high reproductive rate) in order to increase N-population**
- Post colonization, problem is competition for resources with other organisms, the species that produce off-spring that cope with variables like predation will be more successful= this variables are only achievable when **population close to carrying capacity:** So species that have these adaptations to produce these off-springs are called **k-strategists**
- **Small site + small dispersal distance= Uniform colonization**
- **Large + small dispersal distance = Differential colonization** (most species will arrive to the border, and some will reach the centre- because still small distance but large site, so they can-not really reach like they did in uniform). **The most in-land species has the highest dispersal distance**
- Also area closer (short dispersal distance) is less extreme compared to centre, the **centre is occupied more by R-stragists** that can adapt and reproduce like crazy
- Patterns of colonization increase with new habitat size (increase heterogeneity=spatially diverse)= larger area= colonization Is greater
- **K strategists:** usually have large seeds, dispersed by animals, and occupy outer portions
- **Model of dispersal:** random walk: animal moves small step at a time and direction of step is random (as time increases, they will have more random steps, more dispersal)
- **Dispersal limitations:** All the factors mentioned above that limit dispersal

<u>**Direct and Indirect Interactions**</u>

- **BASIC distinction between multiple DIRECT interactions:**
- Indirect interactions come in greater variety, harder to understand (study) than direct species to species interaction
- **Indirect interactions increase as species diversity increases**
- **Queen of Tree-INTERSPECIFIC INTERACTION:** Ficus stree, has a **mutalaistic relationship with a fig wasp**
- **TriTrophic:** A predater consumes the preadtor of a host species (thus increasing the other species diversity)
- **Expliotative competition:** Can be direct or indirect, TWO PREADATORS ONE PREY (predators compete for same resource indirectly and decrease)
- **Habitat Facilitation:** ONE species improve another species habitat : A pradtor alters the habitat of a prey, causing other predator abudance to increase (occupies habitats the other preadtor can alsoacess the prey)
- **Apparent Predatin:** Preadtion of one species lead to decline of another
- **Indirect mutlaism: Two species** benefit on each other by acting on other species
- **Indirect commensalism:**
- Predation: Arrow pointing with a – sign
- Provision: Arrow pointing with a + sign (provides something)
- Interference/Resource Competition: Arrow also denoted by – sign
- Commensalism and mutualism: arrow pointing would have + sign (it benefits it)
-