SANATAN DHARM COLLEGE MUZAFFARNAGAR
(Affiliated to Maa Shakumbhari University, Saharanpur)

Topics

Survivorship Curves, r- & k-selected species and Species Equilibrium Theory

For

Subject Zoology

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B.Sc. VI Sem

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<u>Survivorship curves</u>

1. Survivorship is defined as **the probability of surviving** to a **particular age**. It is measured as the percentage of the population that survives to a particular age.
2. The **fertility function (m_x)** graphs the **number of offspring** as a **function of age (x)**. It typically uses information from **females only**, because **paternity is difficult to trace**.
3. The probability of a female living to **age x** is **l_x**, and the average number of female offspring produced at age x is **m_x.** By multiplying the survival probability by the corresponding average number of offspring, we get **$l_x m_x$,** which is the **expected number** of **female offspring** for a female of age x.
4. Then, by summing all these products over all values of x (i.e.,$\sum_{x=0}^{\infty}$ **lxmx**), we obtain the net reproductive rate, which is the **expected number of females** offspring left by **each female** durin**g her lifetime.**
5. There are 3 general types of survivorship curves-highly convex curve, highly concave curve and diagonal curve.

   Highly convex curve-
   - This curve shows the population mortality rate is low until near the end of the lifespan. Such species tend to live throughout their lifespan, with low mortality rate e.g. many species of large animals as deer, mountain sheep and human etc. show convex curve.

   Highly concave curve-
   - In this type of curve, mortality rate was observed high during young stages e.g. oysters, other shell fish, oak trees etc.

   Diagonal curve-
   - If curve approaches a diagonal straight line that this shows the age-specific survival is more nearly constant. It also shows the constant proportion of organisms dying per unit time. In real world, no species population does not show the constant age-specific survival rate throughout their lifespan.
   - If curve show a slightly concave or sigmoid curve that means mortality rate is high in young ones but lower or more nearly constant in adult or older age e.g. many birds, mice, rabbits etc.
   - If a curve appears like a "stair steptype of survivorship curve" that means the mortality rate was changed throughout their lifespan and observed as zigzag type e.g. holometabolous insects such as butterflies (*Kalima papilo*), houseflies, mosquitoes, moths, bees, beetles, wasp ants etc.
6. A convex curve is shown by some large mammals particularly primates and humans.
7. Rodents and birds show the approximately diagonal curves.
8. And many plants and insects tend to show the concave curves.
9. Termite curve is rather different from other curves at it show the survivorship curve of whole colonies rather than of individual in a population.
10. Survivorship curves may vary in same species in different environment.
11. Convex curves are more probable in fairly constant climate such as in sea shore and moist tropics.
12. Tropical populations seem to have enhanced survivorship compared with their temperate relatives, tropical birds live longer than temperate ones.
13. Cottontail rabbits in tropics shoe lower rates of survival than those in temperate zone.
14. Figure of Survivorship curves-

Semelparous organism	**Iteroparous organism**
One clutch per lifetime	Several clutches per lifetime
e.g. annual plant	e.g. Human

r-selected species	**k-selected species**
In optimum environment	In threatened environment
Colonization in **new environment**, this species evolved with **low quality** due to **absence of competition.**	In **competitive environment,** this species evolved with **high quality** due **complex adaptation**
Population **far below carrying capacity**	Population **at carrying capacity**
Early sexual maturity	**Maturity** attains at **later stage**
Larger clutches size	**Smaller clutches** size
Smaller body sized of offspring	**larger body sized** of offspring
Age of **1st reproduction is most influential factor**.	Not at all.

1. A population in which each female produces **a single, large clutch very early in life** is **r-selected**.
2. **K-selected organisms** generally have **larger bodies**; **smaller clutches**; **more reproductive events** during their **lifetime**; and **longer lifespan** than r-selected organisms.
3. A **starling** is more **r-selected** than an **eagle**; a **bear** is more **k-selected** than a **coyote**. A **cactus** is more **k-selected** than a **desert annual**. A **human** is more **k-selected** than a **dog**.
4. **Early colonists of succession** are more **r-selected organisms** than late colonists. Early plant colonists begin life as **tiny seeds**, have **rapid development**, produce **large "clutches"** and have **large niches**.
5. **r-selection-**

- This selection is found in places where environment is not saturated with individuals and they have plenty of facilities to increase and spread.
- This selection is directed to increase the fertility and to maintain or acquire adaptedness to the external environment.

6. **k-selection-**

- When environment is more or less saturated with individuals, this selection is known as k-selection. Its effect is to increase the viability and the ability of ecological intraspecific competition.

Turnover of plant species during a secondary succession

1. Secondary succession is the **redevelopment of a climax community** after a disturbance, such as **fire, avalanche, or farm**, has eliminated the existing community.
2. A turnover of species occurs during succession largely because the first plant species to colonize the area have traits that promote such early colonization; they produce **many tiny, wind-blown seeds, are tolerant of a broad range of conditions**, and **develop rapidly**. These **good colonists, or r-selected species**, **are not good competitors** and are **gradually outcompeted and eliminated from the area** by a series of better competitors, **each more k-selected than the previous ones**.
3. **K-selected species** produce **fewer, larger, animal-dispersed seeds** and so are **slower to colonize** than r-selected species, but **once established they are better equipped to compete-to monopolize light, water and nutrients**.
4. A disturbed forest undergoes a turnover of plant species from **small annual herbs** to **larger perennial herbs** and **grasses**, to **shrubs** and then to **the trees typical** of the area.
5. The presence of **one set of plant species** in the succession often **improves conditions** for the **next generation of plant species**, a process known as ***facilitation***.
6. By covering the bare soil with vegetation, for example, **early colonists help the soil retain moisture**, which makes it possible for other species, with greater water requirements, to become established and **replace the earlier species**.
7. The succession reaches **its climax** when there are **no further replacements**, at which time the community is appropriate for the climatic and soil conditions of the region and usually has the same set of species that existed prior to the disturbances.

Species Equilibrium Theory

1. This theory predicts the **number of species on an island**.
2. It was presented in **1967** by **R. H. MacArthur**, of **Princeton University**, and **E. O. Wilson**, of **Harvard University**.
3. It proposed that the observed **set of species in an area**, **specifically an island**, is the result of two processes: **colonization** and **extinction**.
4. When the **rate at which new species colonize the island is equal to the rate at which resident species become extinct**, a **dynamic equilibrium** is reached and the observed number of species reflects this equilibrium. (**Colonization rate = extinction rate where a dynamic equilibrium in number of species is reached**).
5. According to basic theory, at first the colonization rate will be high, because of all the species that could possibly reach the island, i.e., the **species pool**.
6. As species from the species pool colonize the island, the rate of colonization necessarily decreases because the list of potential colonizers become shorter as some species become actual colonizers.
7. The rate of colonization declines until it reaches **zero** when **all the species** in the pool have colonized the island.
8. At the onset, the extinction rate is zero since no species have yet colonized the island and rises to a maximum when all the species in the initial pool have colonized and all have gone extinct.
9. While colonization curve declines and the extinction curve rises. The shapes of curve vary as a function of taxonomic group and environmental conditions.

10. The equilibrium number of species is reached when the rate of colonization equals to the rate of extinction.
11. **MacArthur** and **Wilson** extended the basic theory to incorporate differences in island size and distance from the mainland, where the species pool is located.
12. **A small island** has same colonization rate as a larger one, but **its extinction curve rises more rapidly**; in comparison with populations on a large island, and so, also, the **fewer the species** of island will have at **equilibrium**, the relatively smaller populations on smaller islands have probabilities of extinction for a given number of species on the island.
13. The equilibrium number of species is lower for a small island than for a large island.
14. **Distance from the mainland** influences the **rate of colonization** rather than the rate of extinction: the **farther an island is from its species pool, slower the rate of colonization** and so, also, the **fewer the species** of island will have at **equilibrium**.