ECOLOGICAL SUCCESSION & CLIMAX

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Learning outcomes

- Understand the basic concepts, causes , stages , types of succession and theories of Climax and its types

- Convey the significance of Ecological Knowledge needed for applying in field

- Intended to highlight the importance of disturbances (natural and man made) & its consequences in ecosystem and its future course

Overview of Presentation

- Learning outcomes
- Concept of Ecological Succession
- Importance, Types, Process & Examples
- Concept of Climax & Theories ,Types of Climax
- Applied aspects

Time to Think/Guess

What would have happened after?

- Glacial retreat of Glacier Bay, Alaska?
- Eruption of Mt.Helena Volcano?
- Flooding in a National Park
- **What the above have in common on their action on ecosystem?**

IMPORTANCE TO HAVE CORRECT ECOLOGICAL KNOWLEDGE

- Will the logged forest recover to become similar old-growth forest in the future?
- What is the time frame for this recovery?
- Why it is important to know about forest succession?
- HOW RECOVERY CAN BE ACHIEVED?
- HOW LONG IT WILL TAKE?

Plant Succession

- The gradual replacement of one type of plant community by the other in the development of vegetation towards a climax which is the culmination stage for a given environment is referred to as *Plant Succession*.

- E.P. Odum,- "Plant succession is an orderly process of community change in an unit area."

- Salisbury -

"Plant succession is a competitive drift in which at each phase, until the climax, the constituent species render the habitat more favourable to their successors than to themselves"

- Succession is a complex universal process which begins, develops, and finally stabilize at the climax stage.
- The climax is the final mature, stable self-maintaining and self-reproducing stage of vegetational development in a climate unit.

Succession and Climax Concept

- The whole sequence of communities that replaces one another in a given area is called the "Sere".
- Its various intermediate stages are called the *seral stage*
- Communities representing these stage are called the *seral communities.*
- Though the seral communities are not clearly distinct, yet they are recognized because of some dominant plant species growing in them.

- The relatively transitory communities are variously called development stages or **pioneer** stages,

- While the terminal stabilized system is known as **climax**.

- Species replacement in the sere occurs because populations tends to modify the physical environment, making conditions favourable for other populations until an **equilibrium** between **biotic** and **abiotic** is achieved.

- Plant succession is not a series of steps or stages but is continuous and very slowly changing complex.
- The replacement of vegetation takes place individual by individual. There is no jump from one dominant community to other.
- Dominant spp. of one community will persist along with some new migrants for several generations in a given area and bring about several changes in the habitat by their deeper shades and leaf litter.

- When the habitat becomes extremely non-tolerable for the existing plants then the plants of next community, that are well suited to that habitat, will come and become dominant.

- After several such changes, a stage may come when the habitat becomes occupied by most tolerant species that can reproduce and perpetuate well.

- Thus, the process leads to establishment of climax community; a mature, dominant, self-maintaining and slow changing plant community.

- Climax dominants are the species best adjusted to habitat and are able to take possession of the habitat and hold it against the new invading species.

- In the climax stage the stabilized ecosystem in which maximum biomass and symbiotic function between organisms are maintained per unit of available energy flow.

Causes of Succession

- The main causes of succession are :

  a) Climatic causes

  b) Topographic *causes like erosion*

  c) Biotic causes *like grazing, cultivation*

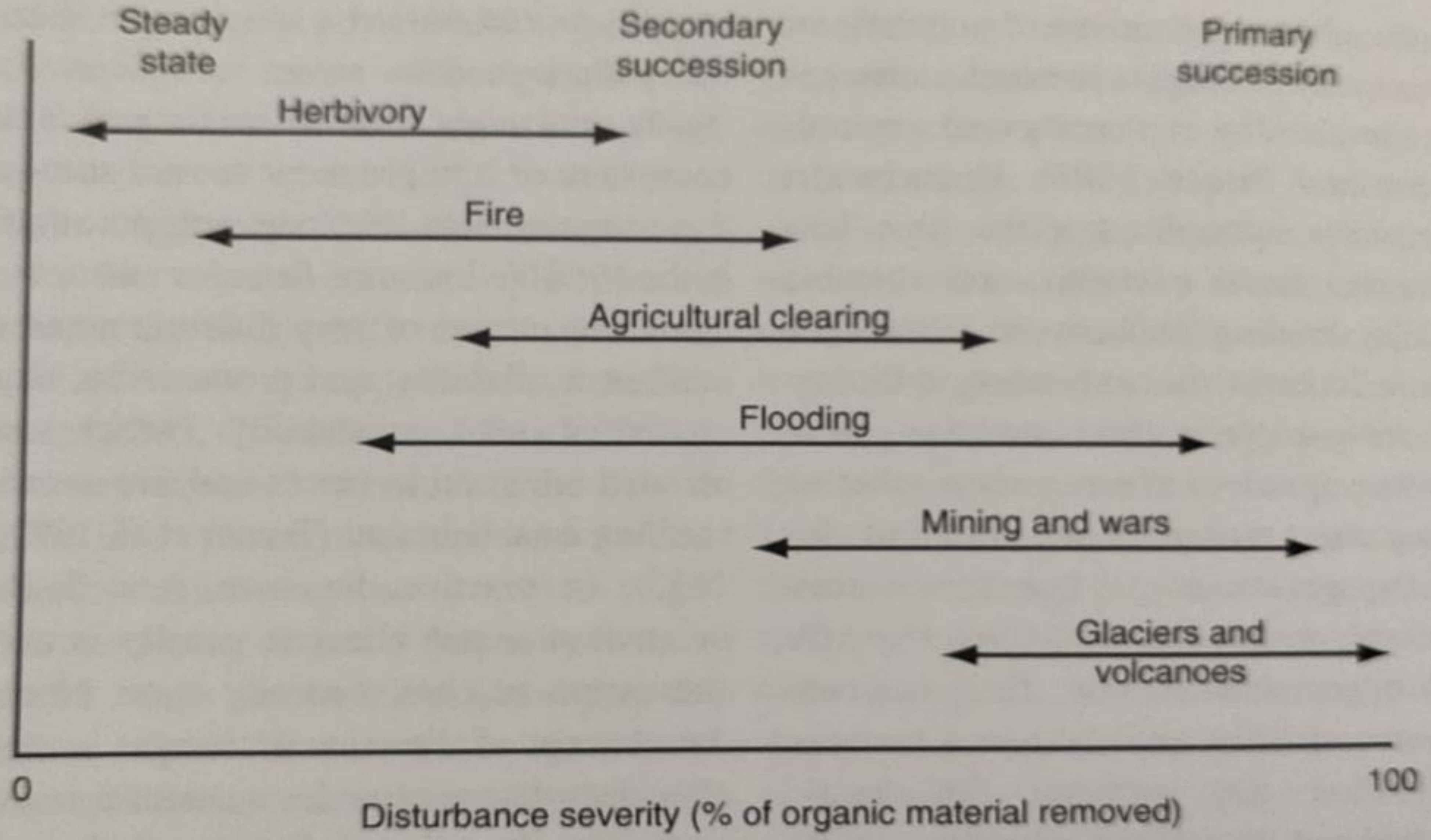


Fig. 12.7 Spectrum of disturbance severity associated with major types of disturbance, ranging from normal steady-state functioning of ecosystems to primary succession

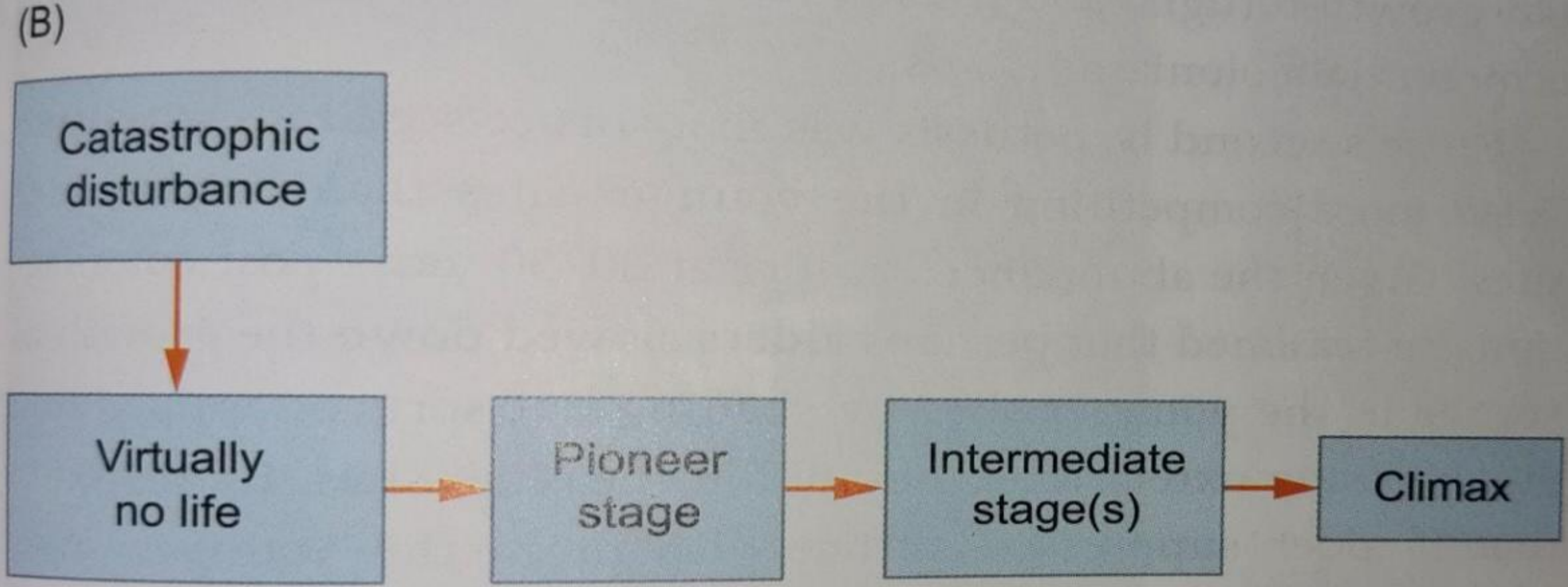


Figure 21.2. *(cont.)*

- Depending upon the nature of bare area on which it develops, the succession may be of two kinds: *Primary and Secondary.*

Primary succession: When the succession starts on the extreme bare area on which there was no previous existence of vegetation it is called *Primary succession or autogenic succession.*

- A forest rock surface expose by landslide
- A new lake formed by construction of a dam

Figure 21.2. A. Successional stages at Glacier Bay. Pioneer stage (left). Willow–alder stage (middle). Spruce stage (right). B. Simple conceptual model of primary succession showing catastrophic disturbance leading to a predictable series of developmental stages.

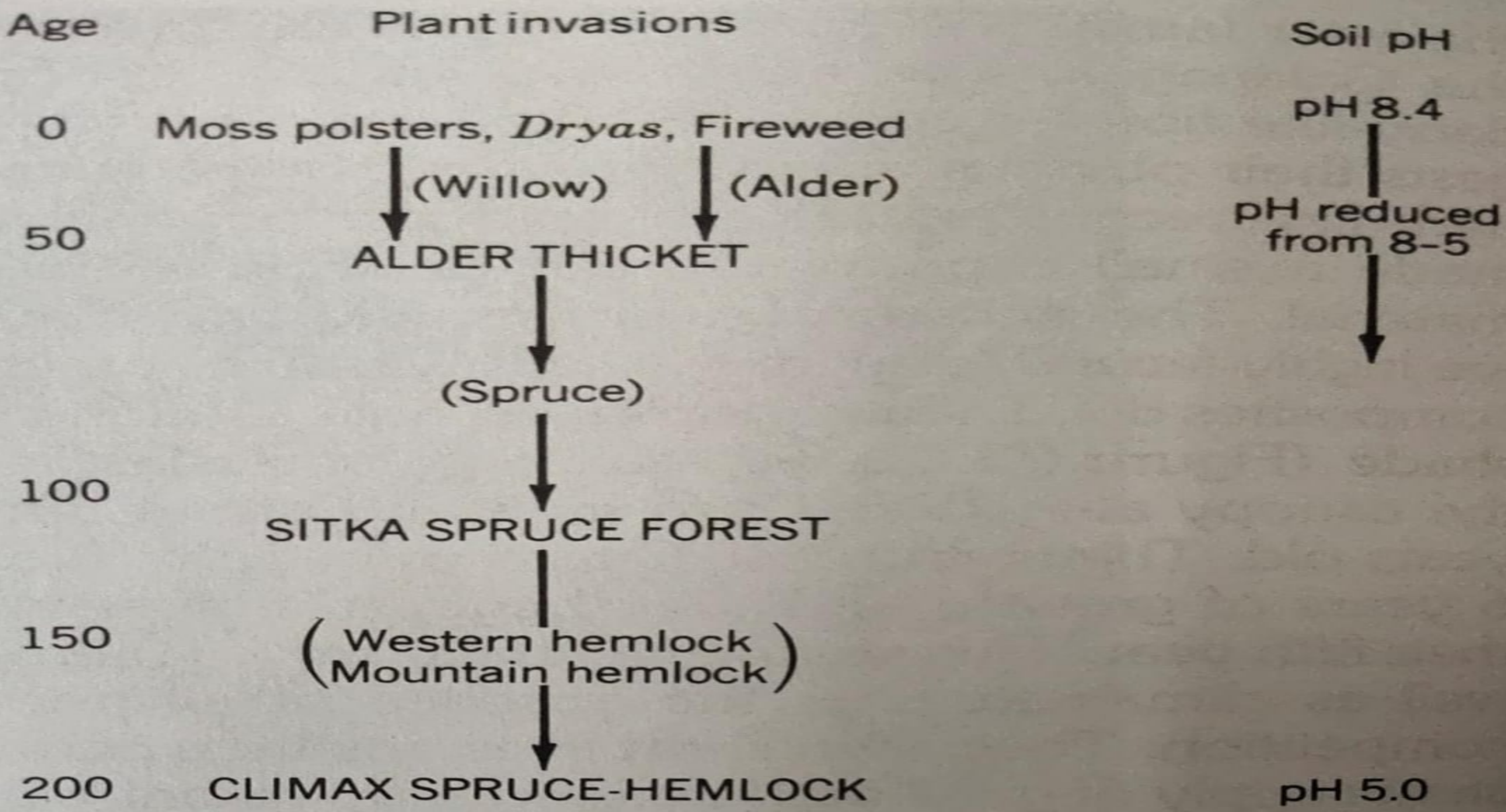


Figure 23.10 Primary successions at Glacier Bay on well-drained sites. (Age in years, data of Crocker and Major, 1955.)

Table 12.1 Successional changes in life-history traits after glacial retreat in Glacier Bay, Alaska[a]

Genus	Successional stage	Seed mass (g seed^{-1})	Maximum height (m)	Age at first reproduction (year)	Maximum longevity (year)
Epilobium	Pioneer	72	0.3	1	20
Dryas	*Dryas*	97	0.1	7	50
Alnus	Alder	494	4	8	100
Picea	Spruce	2,694	40	40	700

[a]Data from Chapin et al. (1994)

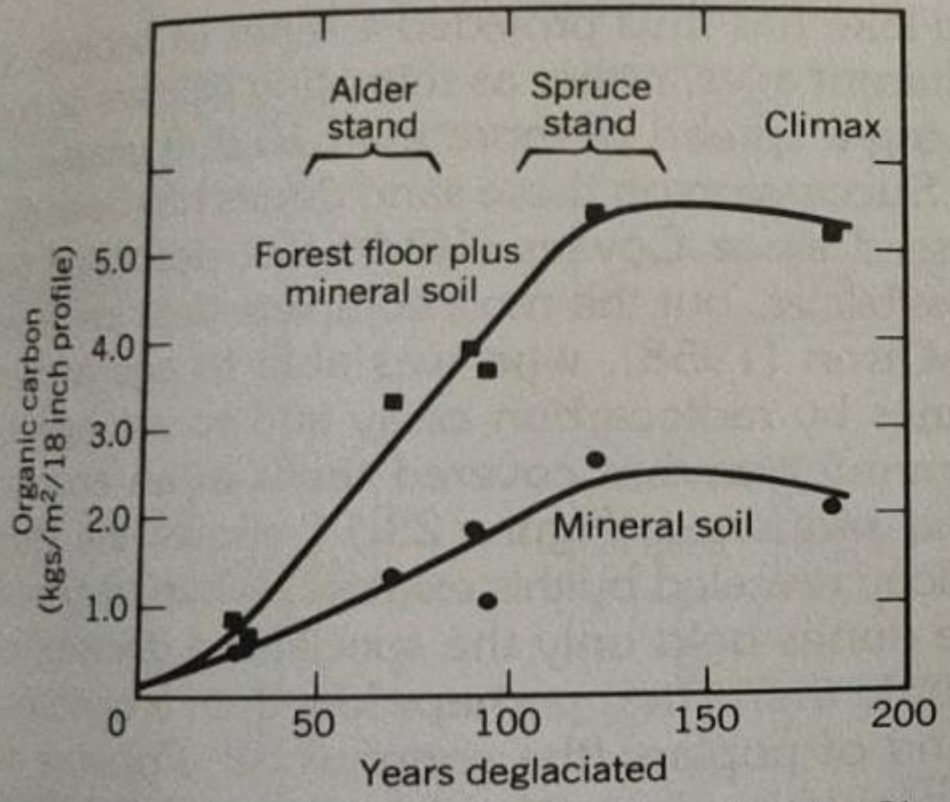


Figure 23.12 Accumulation of organic carbon in Glacier Bay succession.
Carbon continues to accumulate in the soil throughout the pioneer and alder stages before reaching what looks like a steady state under evergreen forest. (From Crocker and Major, 1955.)

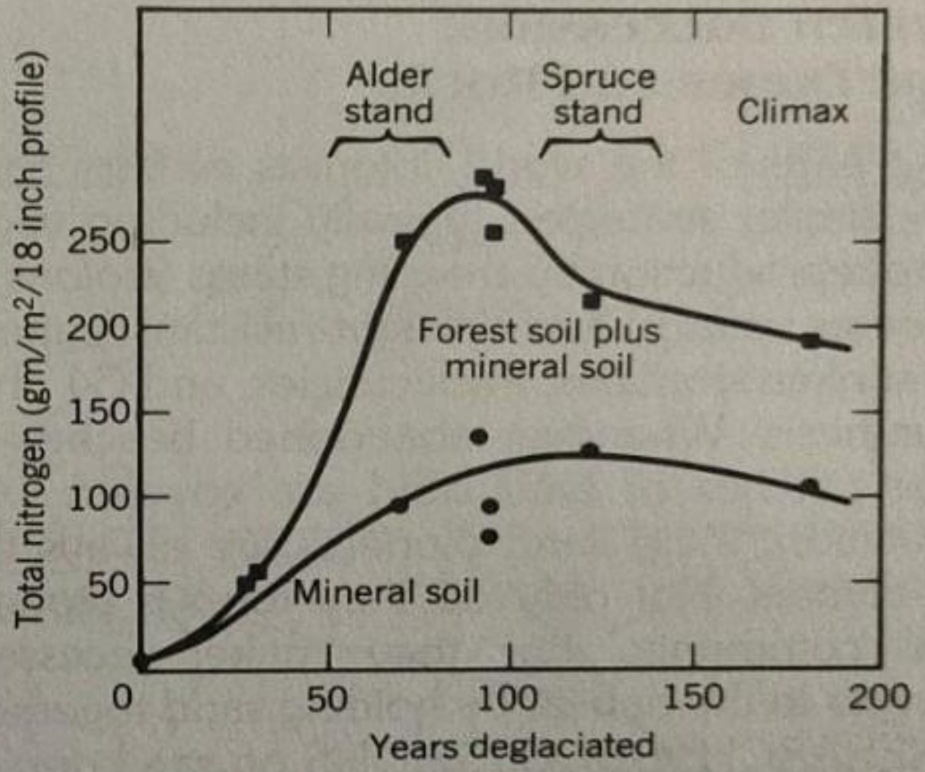


Figure 23.13 History of combined nitrogen in Glacier Bay succession.
Nitrogen is highest under the stands of alder before falling under evergreen forest. High inputs by nitrogen-fixing bacteria in alder root nodules explain this. (From Crocker and Major, 1955.)

Stage	Pioneer	*Dryas*	Alder	Spruce
Life history patterns	Dominance by light-seeded species	Dominance by rapidly growing species	Dominance by tall shrubs of intermediate longevity	Dominance by long-lived trees
Facilitative effects	↑ Survivorship	↑ N (weak) ↑ Growth (weak)	↑ SOM ↑ N ↑ Mycorrhizae ↑ Growth	↑ Germination
Inhibitory effects	↓ Germination (weak)	↓ Germination ↓ Survivorship ↑ Seed predation and mortality	↓ Germination ↓ Survivorship ↑ Seed predation and mortality Root competition Light competition	↓ Growth ↓ Survivorship ↑ Seed predation and mortality Root competition Light competition ↓ N
Impacts of herbivory	Minimal	Reduce growth of early successional species	Eliminate early successional species	Minimal

Fig. 12.9 Interaction of life-history traits, competition, facilitation, and herbivory in causing successional change after glacial retreat at Glacier Bay, Alaska. Life-history traits determine the pattern of dominance at each successional stage. The rate at which this dominance changes is determined by facilitative or inhibitory effects of the dominant species and by patterns of herbivory. In general, all four of these processes contribute simultaneously to successional change, with the most important processes being life-history traits in the pioneer stage, herbivory in mid-successional stages, facilitation in the alder stage, and competition in late succession. Modified from Chapin et al. (1994)

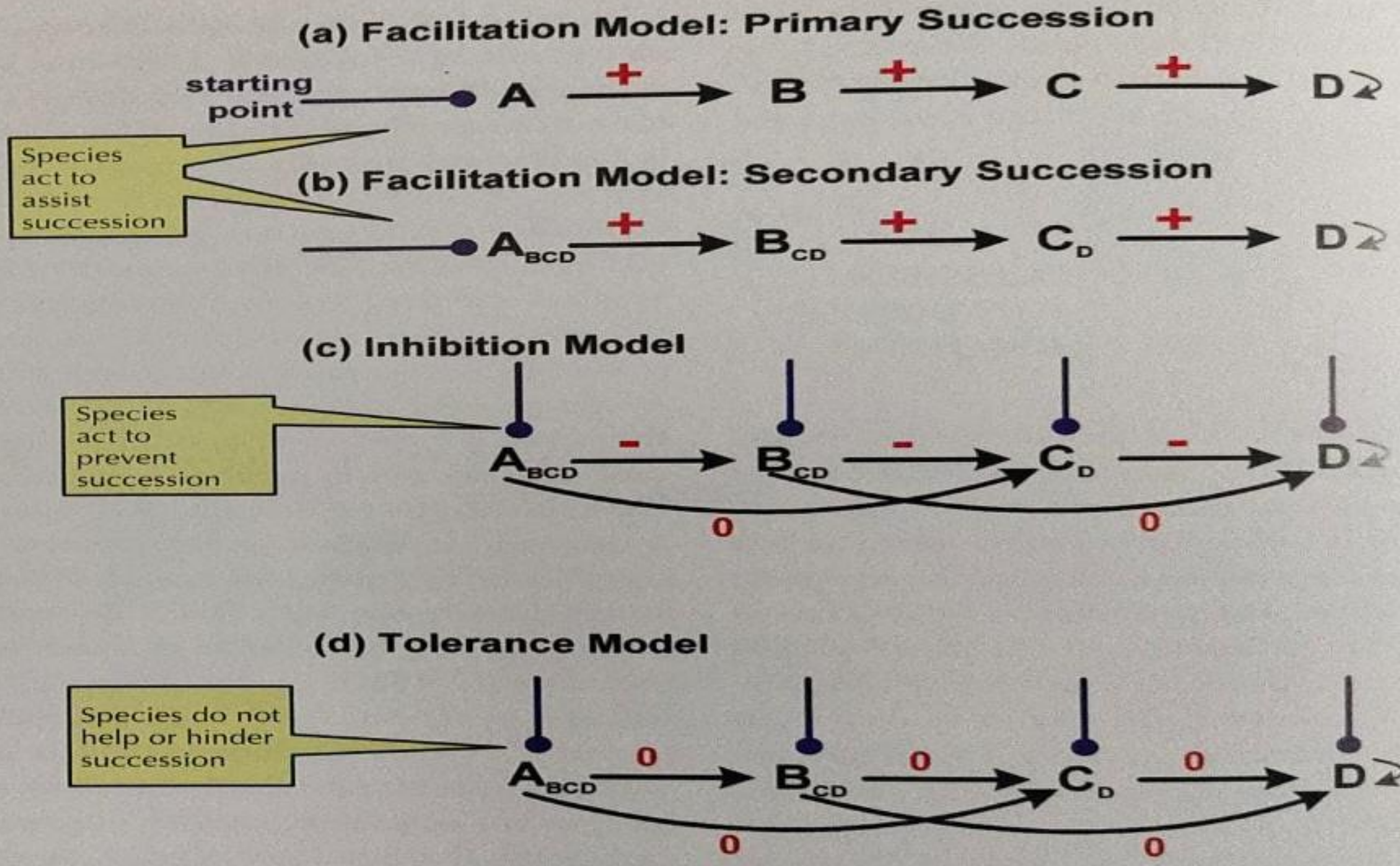


Figure 11.4 Conceptual models of succession. The capital letters A–D represent hypothetical vegetation types or dominant species; subscript letters indicate that species are present as minor components or as propagules. Black arrows represent vegetation sequences in time; blue lines represent alternative starting points for succession after disturbance. Circular arrows indicate that the species replaces itself. + = facilitation, – = inhibition, 0 = no effect. In these simplified sequences, species D would be the climax species. (Modified after Noble 1981.)

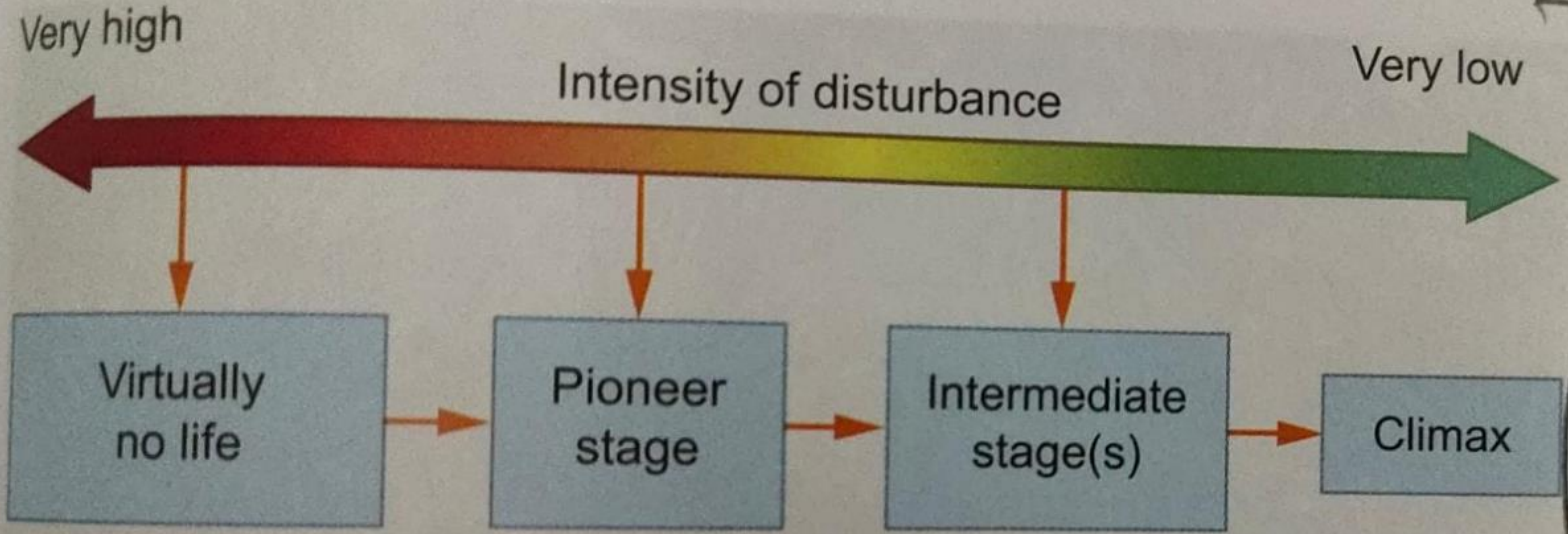


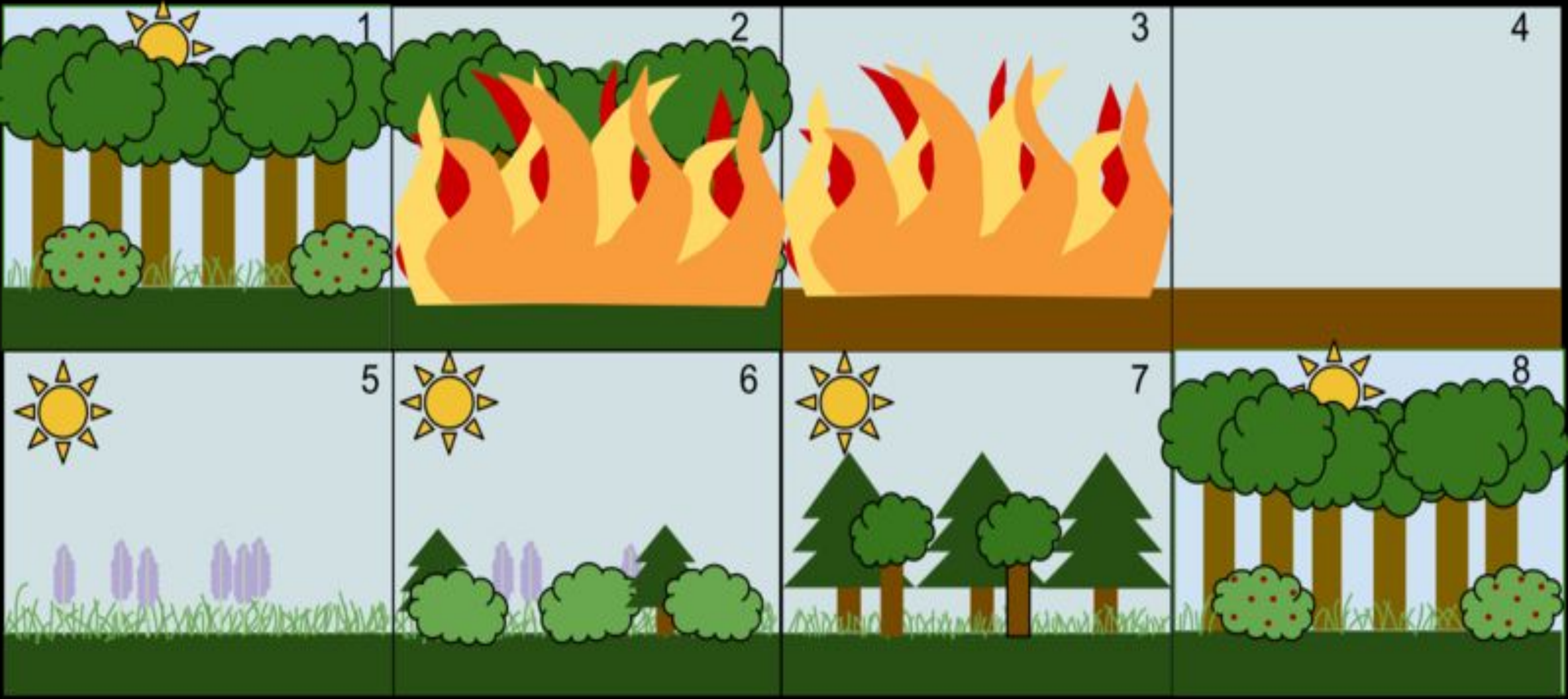
Figure 21.5 Model of primary and secondary succession showing the two processes as responses to a continuum of disturbance intensity

Secondary succession: This type of succession starts on the secondary bare area which was once occupied by original vegetation but later become completely devoid of vegetation by any process of denudation.

Secondary succession has fewer stages than the primary succession and the climax is reached very quickly in the secondary succession.

- Clear felled forest areas and abandoned agriculture field

Secondary succession



(G)

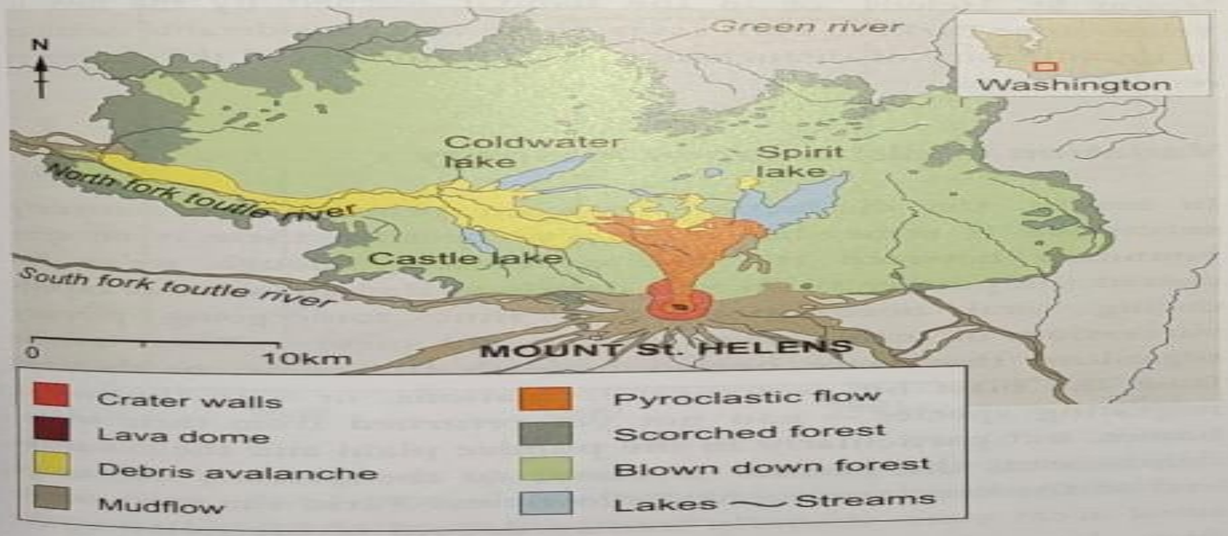


Figure 21.4 Disturbances resulting from eruption of Mount St. Helens. A. Debris-avalanche deposit. B. Tree removal zone. C. Blowdown zone. D. Scorch zone. E. Tephra fall zone. F. Mudflow. G. Map of disturbance zones.

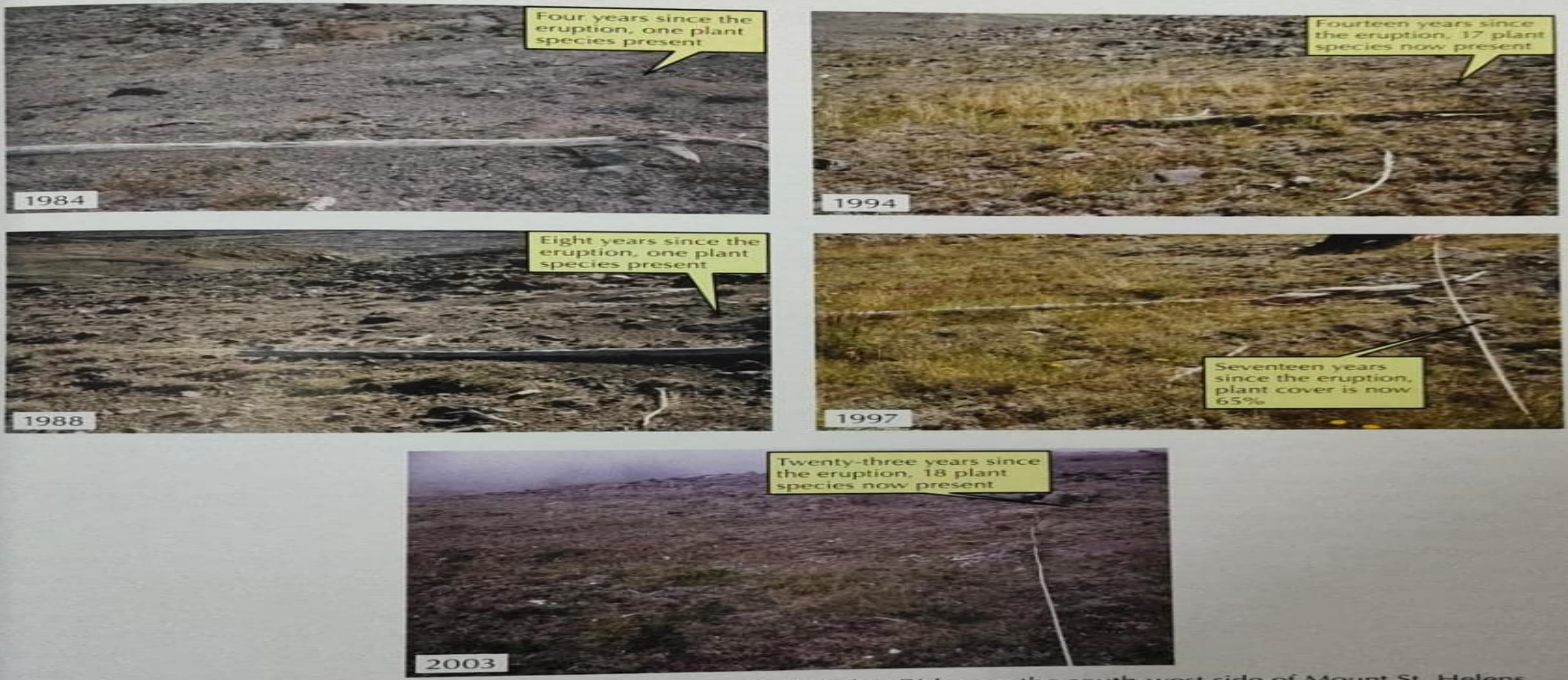


Figure 11.2 Primary succession on mudflow deposits on Studebaker Ridge on the south-west side of Mount St. Helens following the eruption of May 1980. Already in 1981 plants had colonized this devastated area and plant cover has been slowly increasing as the site undergoes primary succession. Figure 11.3 shows data from these plots. (Photos courtesy of Roger del Moral, 2004.)

Early primary succession on volcanic substrates rarely produces plant densities sufficient to inhibit the colonization of new species. Neither space nor light is a limiting resource for plants in this environment. Nurse plants facilitate the establishment of other species. Lupines (*Lupinus lepidus*) have heavy seeds and are

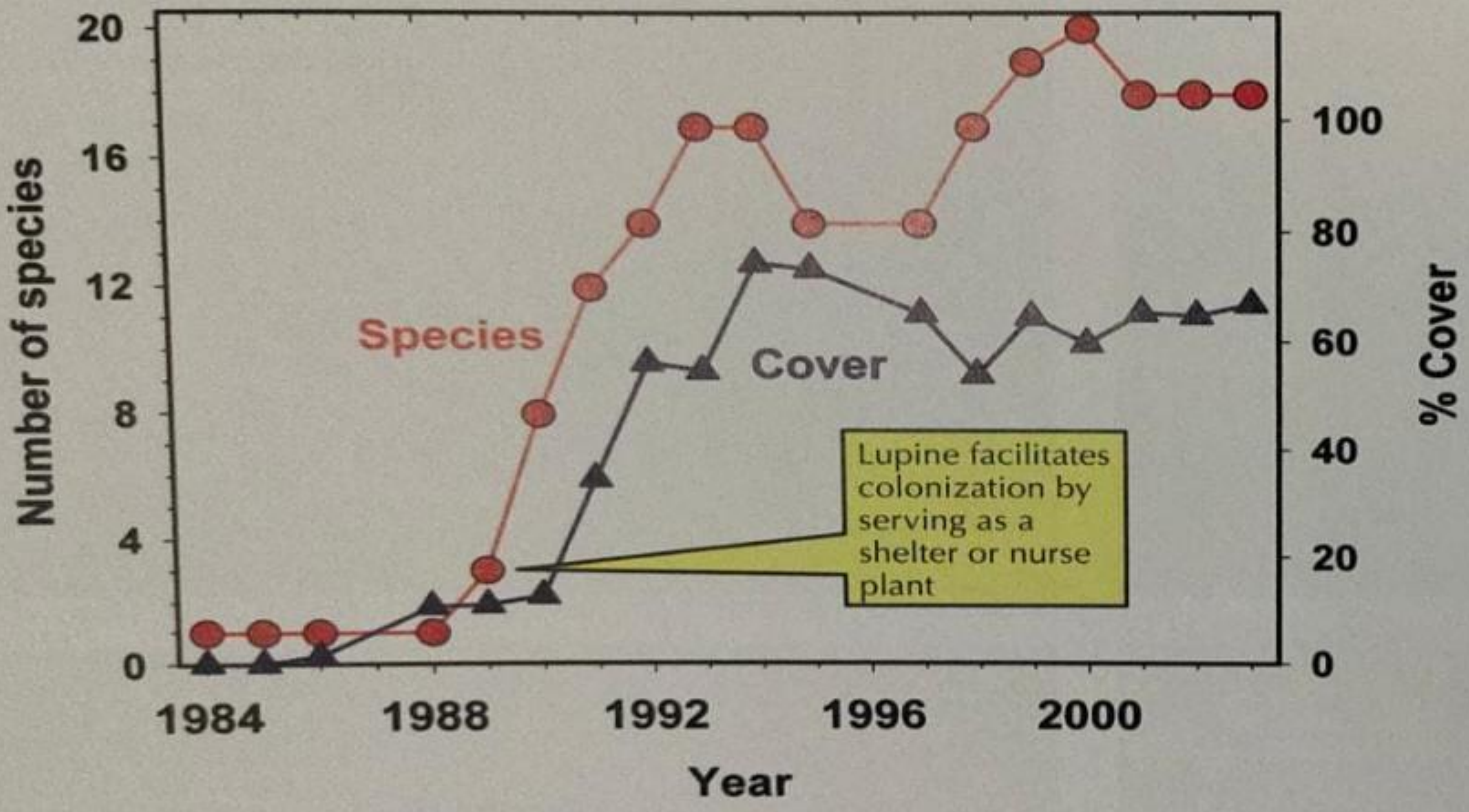


Figure 11.3 Number of species occurring in 1 m^2 quadrats in the Studebaker Ridge area on the south cone of Mount St. Helens, Washington. The number of species reached a plateau around 17–20 within 10 years of the irruption and the total plant cover on this area has increased only slowly because of the harsh conditions on these volcanic deposits. Photos of these plots are shown in Figure 11.2. (Data courtesy of R. del Moral, 2004, photo courtesy of Thayne Tuason.)

Table 21.1 Volcanic events associated with eruption of Mount St. Helens.

Event/zone	Area (km^2)	Deposit thickness (m)	Temperature (°C)	Organic matter
Pyroclastic flow/pumice plain	15	0.25–40	300–850	None
Debris avalanche	60	10–195	70–100	Rare
Blast/tree-removal	90	Variable	Variable	Common
Blast/blowdown	370	0.01–1.0	100–300	Common
Blast/scorch	110	0.01–0.1	50–250	Common
Blast/mudflow	50	0.1–10	30	Common
Tephra fall	1000	>0.05[a]	<50	Common

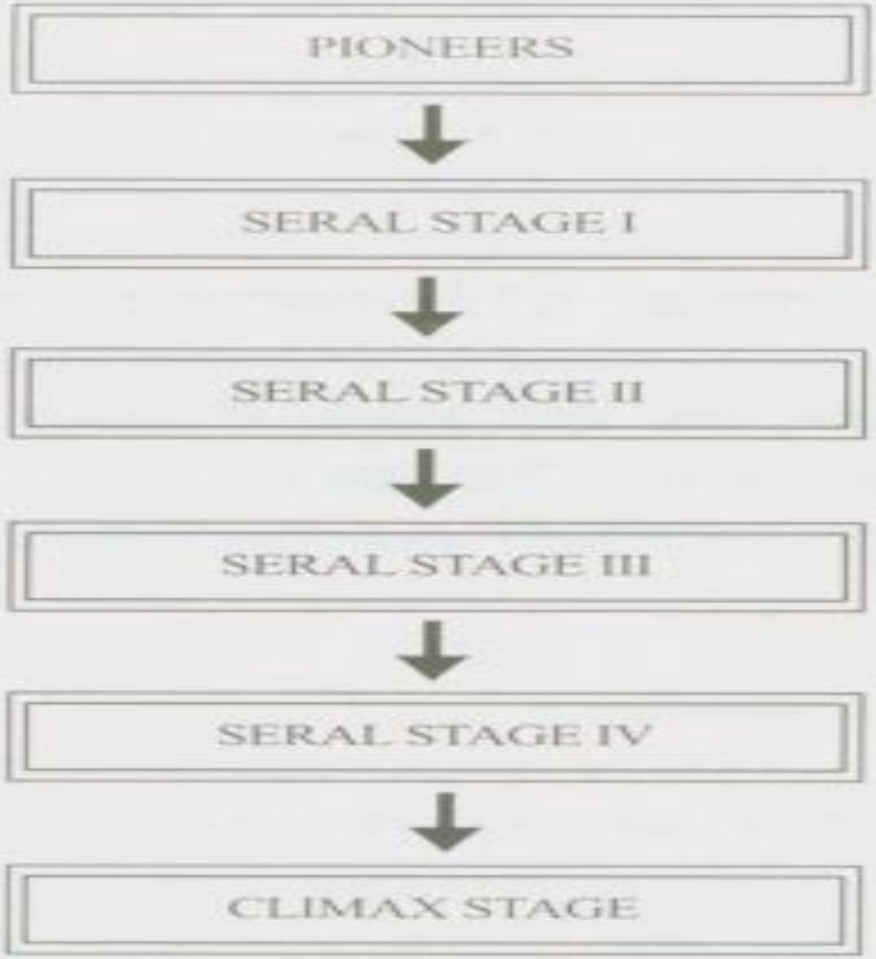
[a] There was a much greater area covered by a thin layer of tephra (<0.05 cm thick).

Table 11.1 Physiological and life history characteristics of early- and late-successional plants.

Characteristic	Early succession	Late succession
Photosynthesis		
Light-saturation intensity	high	low
Light-compensation point	high	low
Efficiency at low light	low	high
Photosynthetic rate	high	low
Respiration rate	high	low
Water-use efficiency		
Transpiration rate	high	low
Mesophyll resistance	low	high
Seeds		
Number	many	few
Size	small	large
Dispersal distance	large	small
Dispersal mechanism	wind, birds, bats	gravity, mammals
Viability	long	short
Induced dormancy	common	uncommon?
Resource-acquisition rate	high	low?
Recovery from nutrient stress	fast	slow
Root-to-shoot ratio	low	high
Mature size	small	large
Structural strength	low	high
Growth rate	rapid	slow
Maximum lifespan	short	long

Source: From Huston and Smith (1987).

Process of Ecological succession



Hypothetical representation of the process of ecological succession.

Roles of stand & landscape diversity in ecosystem after disturbance

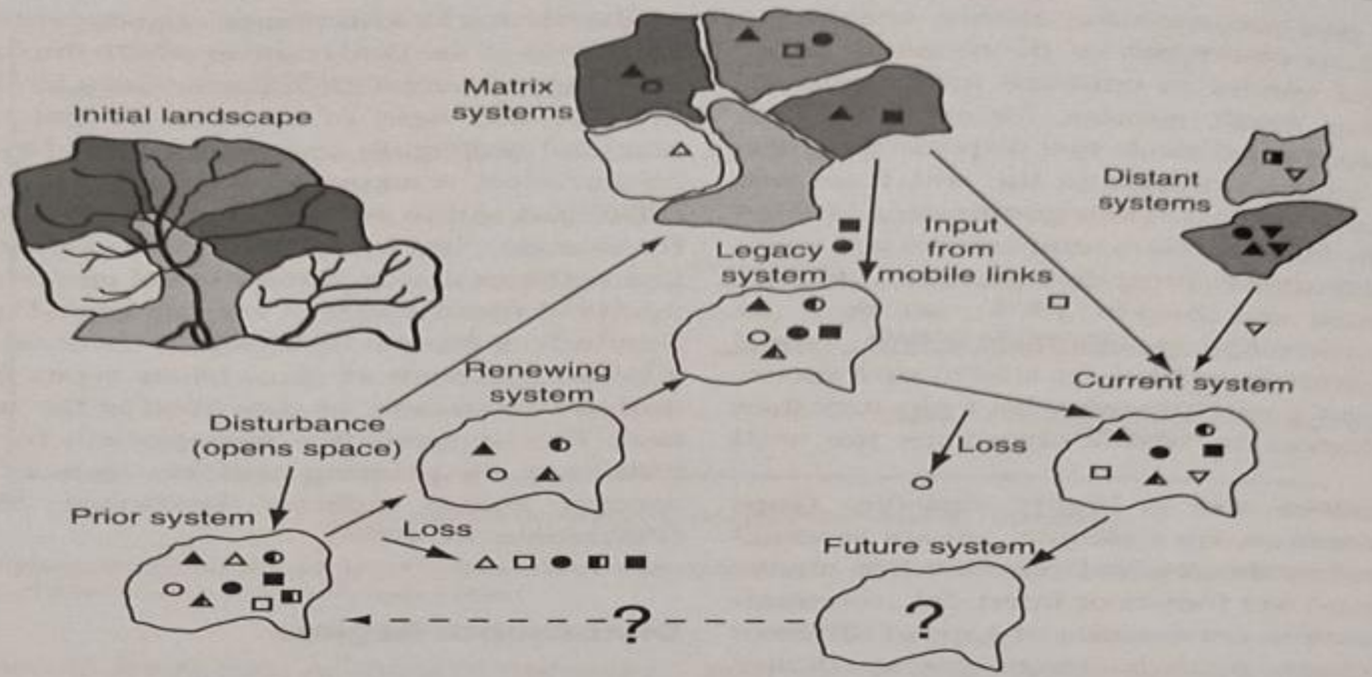
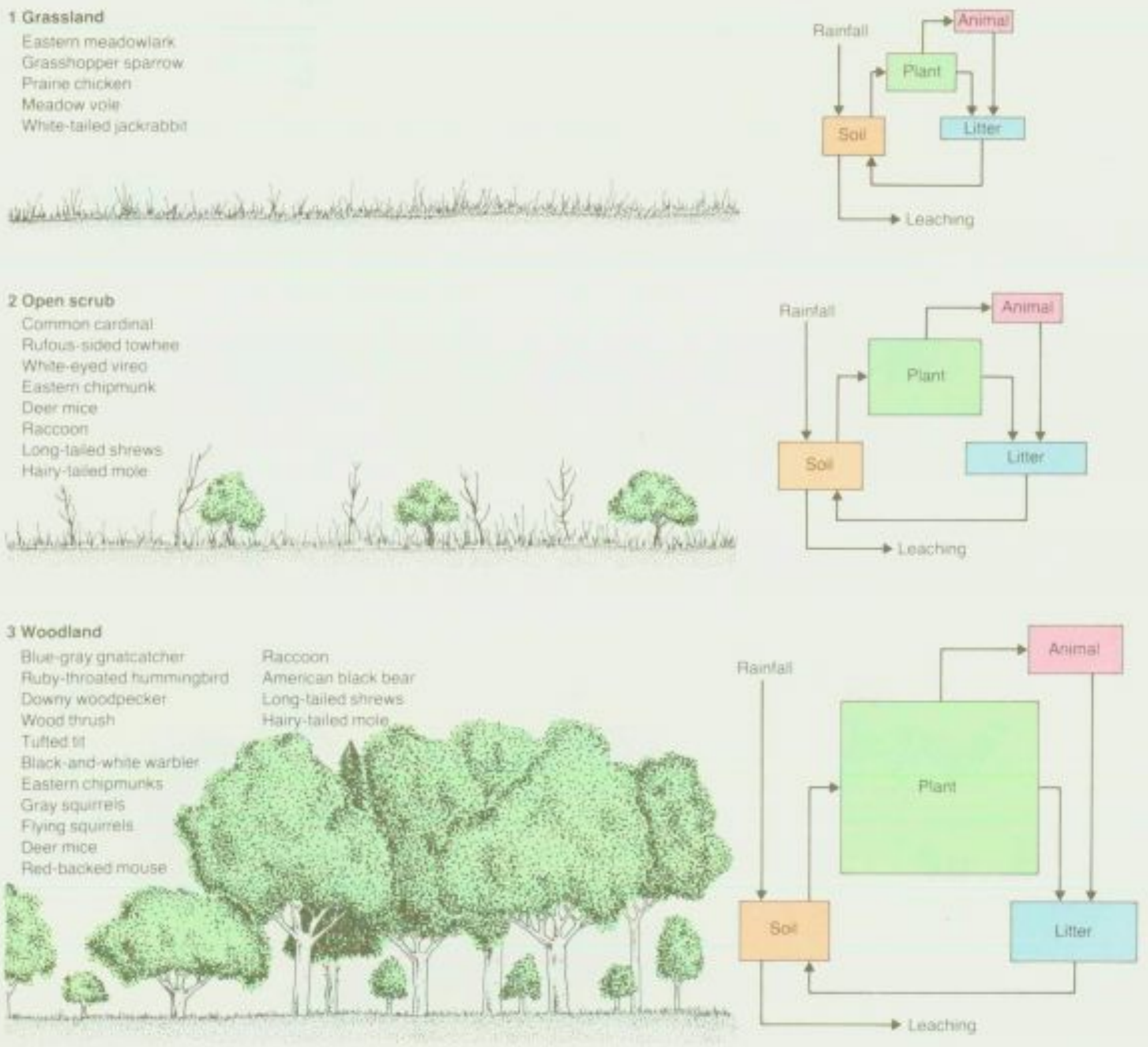


Fig. 12.8 Roles of stand and landscape diversity in ecosystem renewal after disturbance. A disturbance such as a fire, hurricane, volcanic eruption, or war opens space in an ecosystem. In this diagram, each shape represents a different functional group such as algal-grazing herbivores in a coral reef, and the different patterns of shading represent species within a functional group. After disturbance, some species are lost, but an on-site legacy of surviving species serves as the starting point for ecosystem renewal. For example, after boreal fire, about half of the vascular plant species are lost (Bernhardt et al. 2011). The larger the *species diversity* of the pre-disturbance ecosystem, the more species and functional groups are likely to survive the disturbance; the more severe the disturbance the larger the proportion of species lost. (In this figure, all functional groups except "squares" survived the disturbance.) *Landscape diversity* of the matrix surrounding the patch is also important to ecosystem renewal because it provides a reservoir of diversity that can recolonize the disturbed patch. In this figure, the "square" function was renewed by colonization from the matrix surrounding the ecosystem. Through time, some additional species may be gained or lost, and new functional groups (inverted triangles in this diagram) may invade from a distance. Reprinted from Chapin et al. (2009)

Main stages from Grassland to Woodland



▶ **Inhabitants of European deciduous woodland.** ABOVE Common dormouse (*Muscardinus avellanarius*), which prefers secondary growth areas where the trees have edible seeds, eg hazel and beech. BELOW Blue tit (*Parus caeruleus*), which often nests in oak woodlands where it mainly feeds its nestlings on the immense caterpillar populations of oak trees.

◀ **Increasing structural complexity and changing diversity** with time — a diagram illustrating the main stages of succession from grassland to woodland in North America and the changing species diversity and pattern of nutrient cycle. The important points to note are that as the ecosystem becomes structurally more complex the fauna and flora becomes more diverse and the reservoir of nutrients moves from the soil (in grassland) to living things (mainly plants) in woodland.

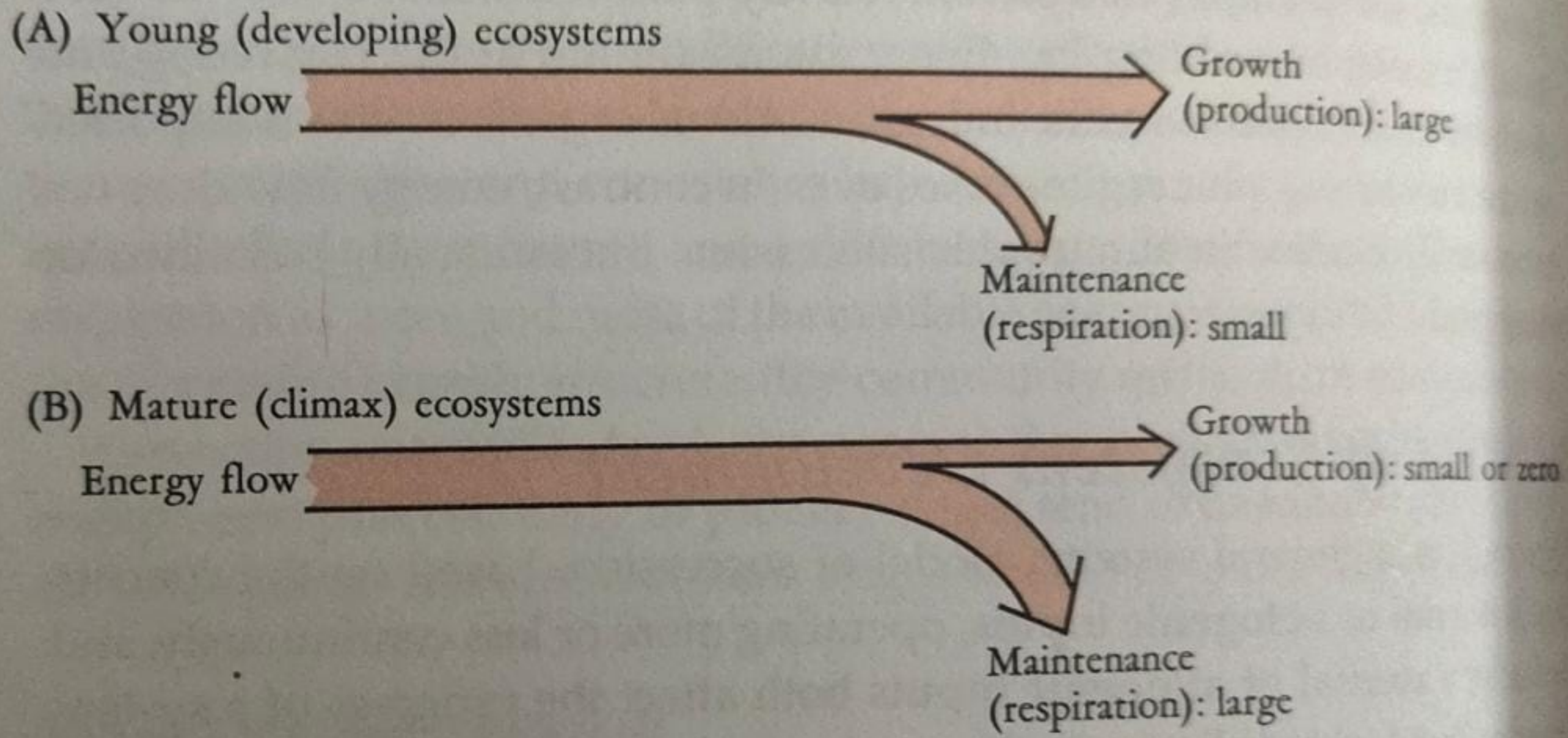
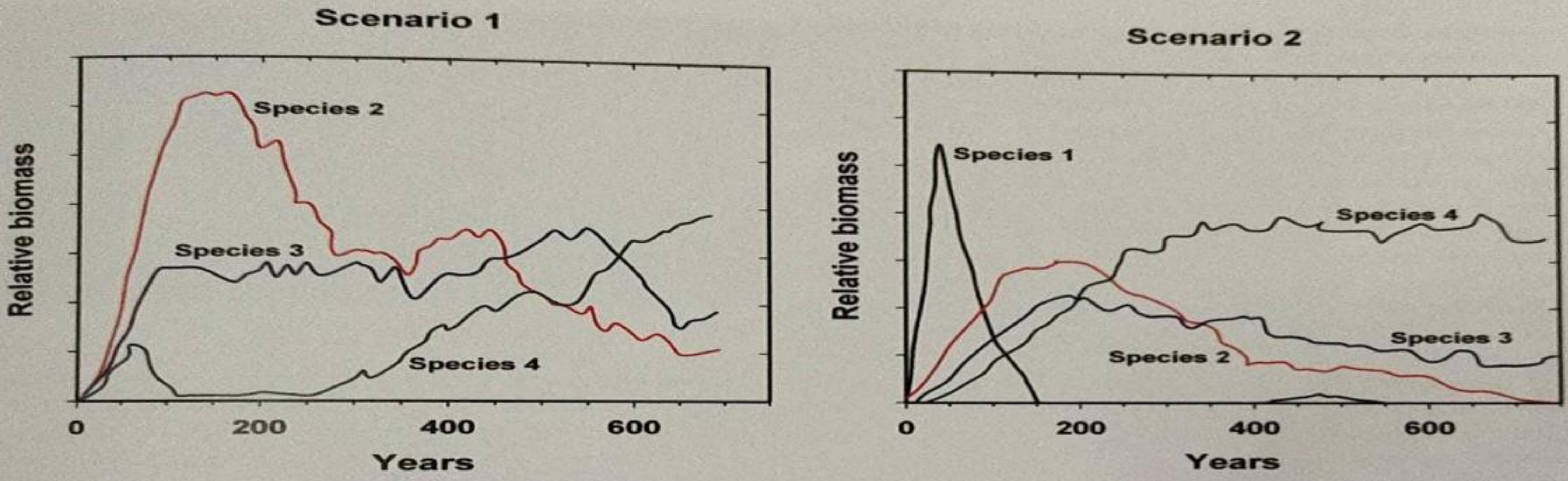
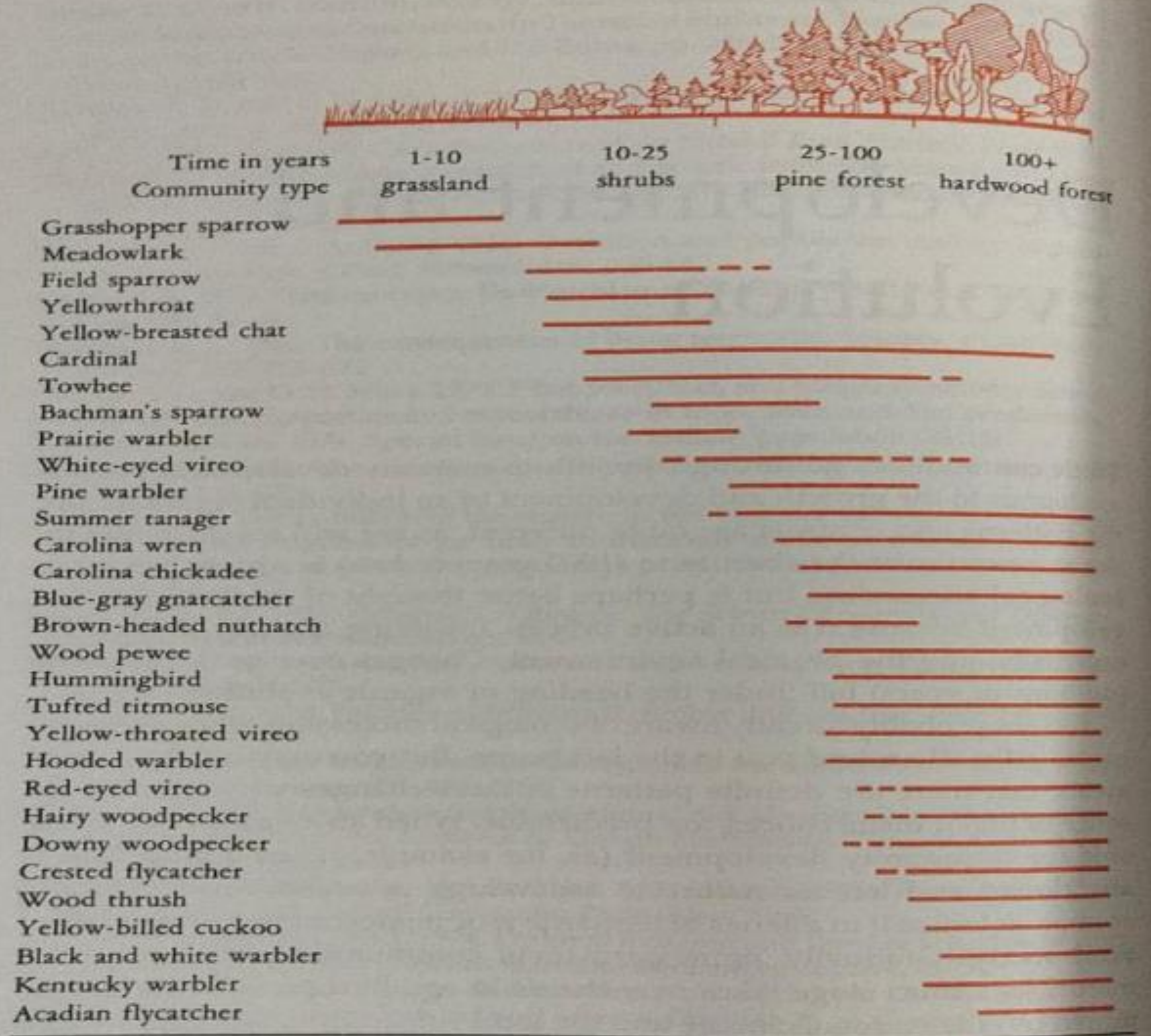


FIGURE 3. An energy flow model of ecological succession, contrasting energy partitioning between (A) developing systems and (B) mature systems.



Species	Characteristics	Relative growth rate	Relative seed production	Diameter (cm)	Height (m)	Maximum age (years)	Shade tolerance
1	Fast growth, short life	2.17	5	50	15	50	intolerant
2	Moderate growth, longer life	1.43	1	100	30	300	tolerant
3	Slow growth, longer life	1.09	1	100	35	400	tolerant
4	Very slow growth, very long life	1.00	1	150	35	650	tolerant

Figure 11.5 A simple model of succession for trees. Species biomass dynamics and community biomass for hypothetical successional sequences with three and four idealized species in which competition for light is the driving variable. In scenario 1, all three species are shade-tolerant and thus have late-successional characteristics, but differ sufficiently in relative competitive abilities (growth rate) to produce a 'typical' successional replacement. In scenario 2, an early-successional species with a rapid growth rate and shade-intolerance is added to the three species in scenario 1. (Modified from Huston and Smith 1987.)



Number of common species[a]	2	8	15	19
Density (pairs per 100 acres)	27	123	113	233

[a]A common species is arbitrarily designated as one with a density of 5 pairs per 100 acres or greater in one or more of the 4 community types.

◀ FIGURE 1. The general pattern of ecological succession on abandoned farmland in the southeastern United States. The diagram shows four stages in the life form of the vegetation (grassland, shrubs, pines, and hardwoods); the bar graph shows changes in the songbird population that accompany the changes in autotrophs. A similar pattern will be found in any area where a forest is climax, but the species of plants and animals that take part in the development series vary according to the climate or topography of the area. (After Johnston and Odum 1956.)

TABLE 1. A tabular model of ecological succession: trends to be expected in the development of ecosystems. (After Odum's *Table 1*, 1969)

Ecosystem attributes	Developmental stages	Mature stages
Community energetics		
1. Gross production/community respiration (P/R ratio)	Greater or less than 1	Approaches 1
2. Gross production/standing crop biomass (P/B ratio)	High	Low
3. Biomass supported/unit energy flow (B/E ratio)	Low	High
4. Net community production (yield)	High	Low
5. Food chains	Linear, predominantly grazing	Weblike, predominantly detritus
Community structure		
6. Total organic matter	Small	Large
7. Inorganic nutrients	Extrabiotic	Intrabiotric
8. Species diversity — variety component	Low	High
9. Species diversity — equitability component	Low	High
10. Biochemical diversity	Low	High
11. Stratification and spatial heterogeneity (pattern diversity)	Poorly organized	Well organized
Life history		
12. Niche specialization	Broad	Narrow
13. Size of organism	Small	Large
14. Life cycles	Short, simple	Long, complex
Nutrient cycling		
15. Mineral cycles	Open	Closed
16. Nutrient exchange rate, between organisms and equitability component	Rapid	Slow
17. Role of detritus in nutrient regeneration	Unimportant	Important
Selection pressure		
18. Growth form	For rapid growth ("r-selection")	For feedback control ("K-selection")
19. Production	Quantity	Quality
Overall homeostasis		
20. Internal symbiosis	Undeveloped	Developed
21. Nutrient conservation	Poor	Good
22. Stability (resistance to external perturbations)	Poor	Good
23. Entropy	High	Low
24. Information	Low	High

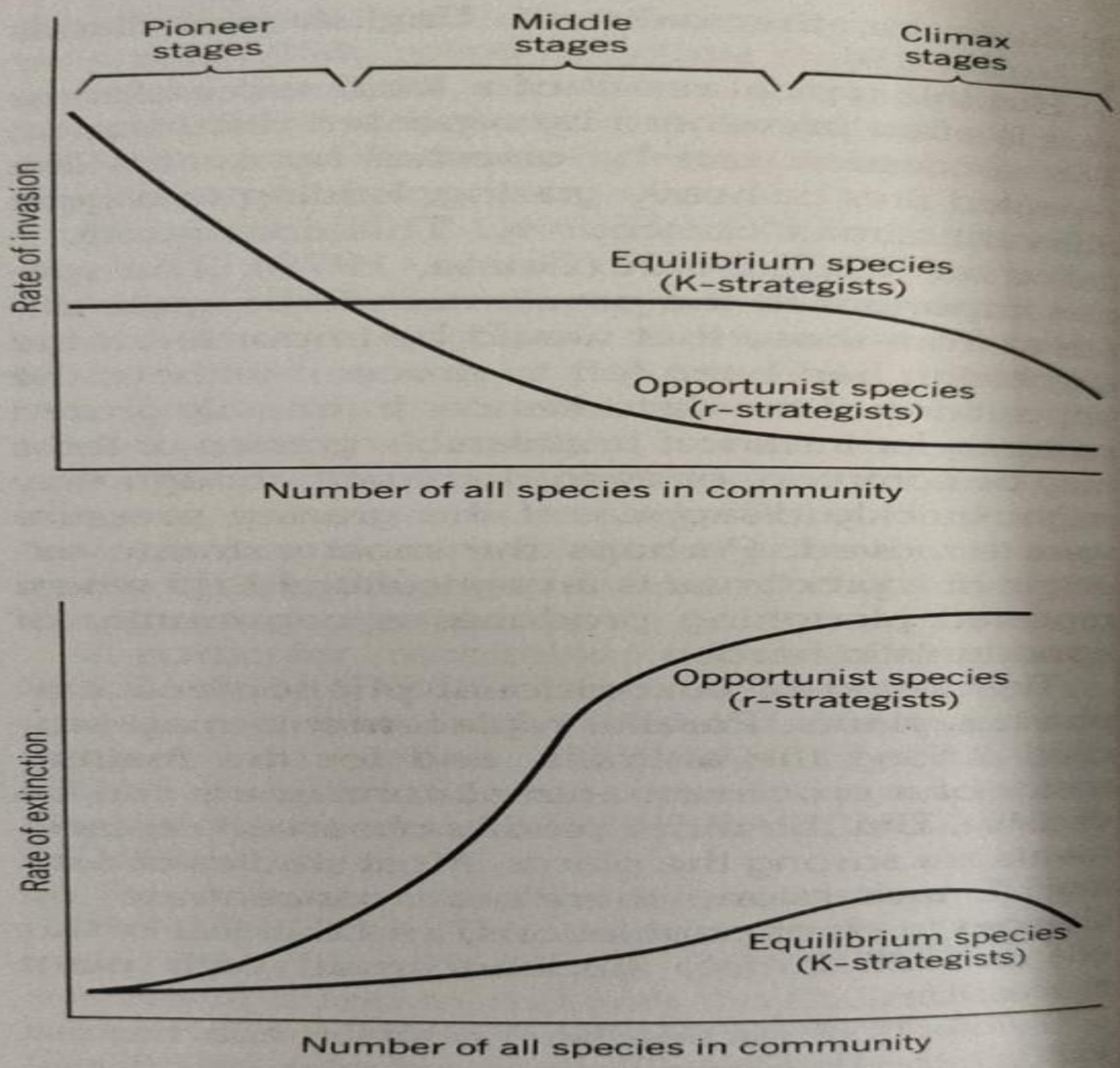


Figure 23.4 Model of succession as a function of rate of invasion.
Opportunist species invade early and rapidly *(top)* but their extinction by competition is also early and rapid *(bottom)*. The final number of species at climax will depend on the rate of continued invasion (which may proceed for thousands of years) and the rate of local extinction, which eventually should be very slow.

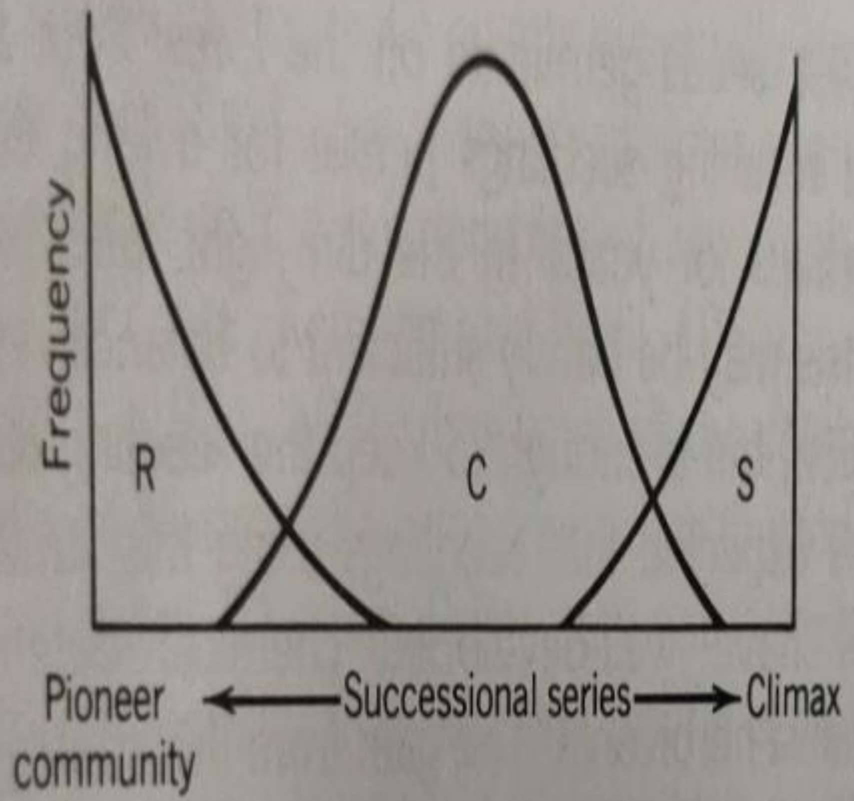


Figure 23.5 Three-strategy model of succession. Ruderals (R) are pioneer herbs that are replaced by competitors (C). At the climax stress-tolerators (S) invade. For details see text. (From Grime, 1979.)

Origin and development of communities

Stage 1. **Nudation** – exposure of new surface.

Stage2. **Migration** – arrival of seed/ propogules to area from neighbouring.

Stage 3. **Germination** of seed/propogules. When optimum condition exists.

Stage 4. **Ecesis** – only few germinated seeds/ propogules establishes successfully.

The successful establishment is called Ecesis.

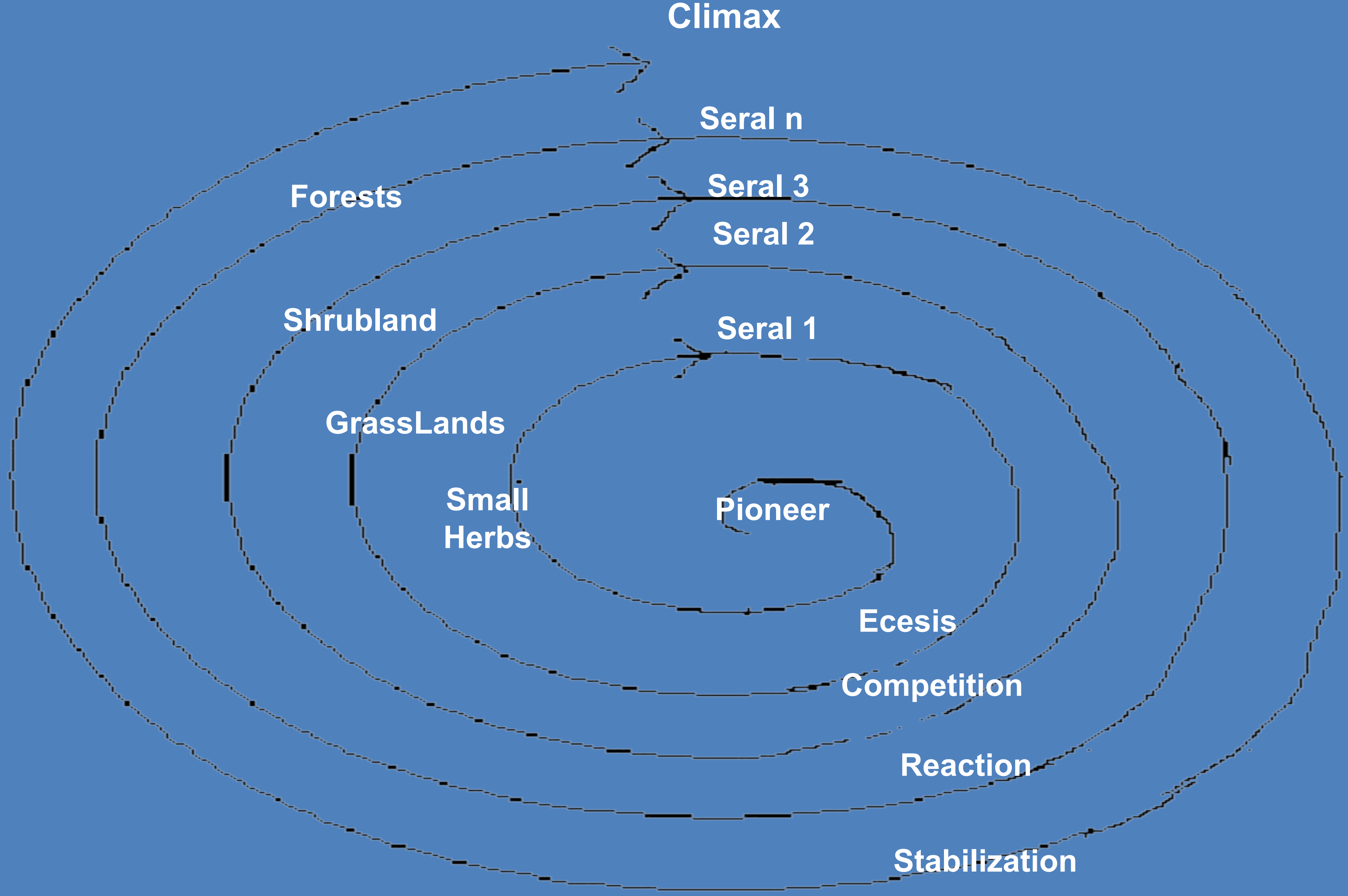
Stage 5. **Aggregation** – number of individual and species increases. This process is aggregation.

Stage 6. **Colonization** – the plant that initially colonize and aggregate are called **pioneers**.

Stage 7. **Competition**

Stage 8. **Invasion** – newer and more aggressive species

Stage 9. **Stabilization** – leading to **climax vegetation**.


Climax
Seral n
Seral 3
Seral 2
Seral 1
Forests
Shrubland
GrassLands
Small
Herbs
Pioneer
Ecesis
Competition
Reaction
Stabilization

Monoclimax and Polyclimax Theories

- Regarding the number of climax in a given habitat or climatic region there are two different theories:

- **Monoclimax theory:** According to Clementsian, *there develops only one true climatic climax in a particular climatic region*. This concept is generalized as monoclimax theory.
- As per FE Clements, in a given reason, all lands are faces, eventually tend to be occupied by a single kind of community which is a climax.
- The factors determining climax is **regional climate**. If regional climate is stable, climax community will maintain stability indefinitely.

Monoclimax Theory

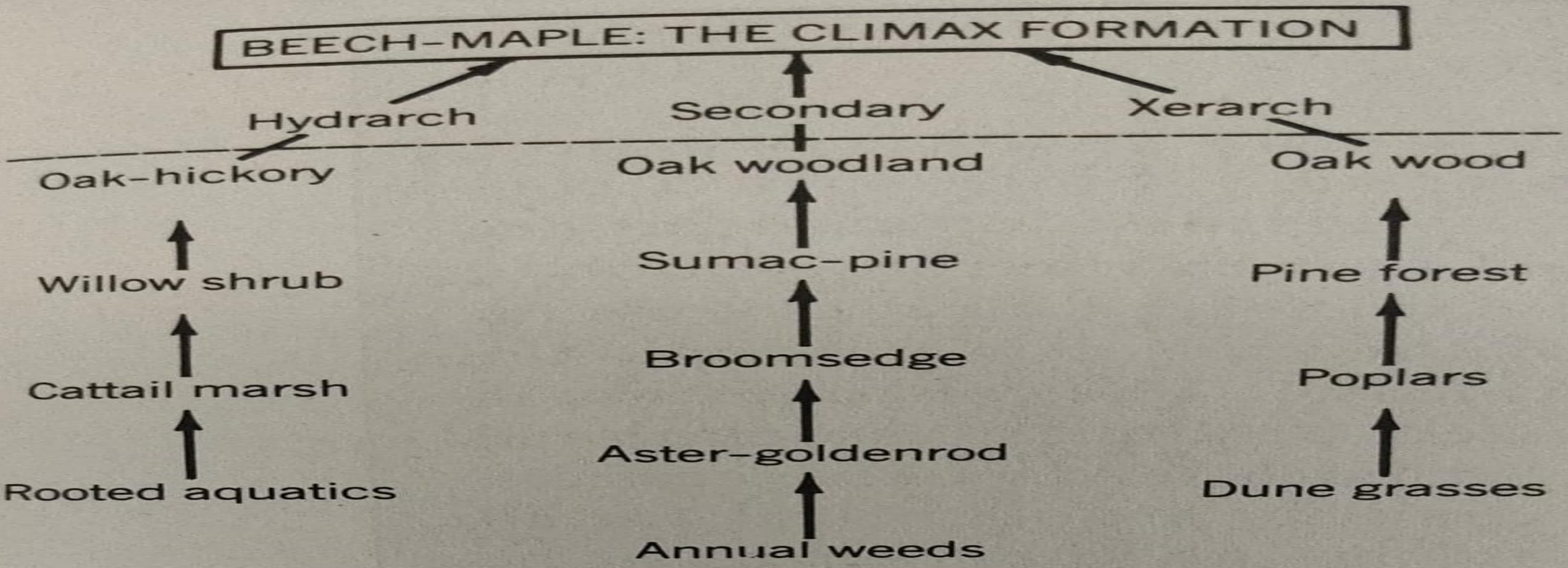


Figure 23.25 The kind of community taxonomy proposed by Clements.
All associations are supposed to be related to the climax formations by their roles as seral stages in successions.

Poly climax Theory

- **Polyclimax theory: it** holds the view which is opposite to monoclimax concept. *It defines climaxes as the stabilized and self-maintaining plant communities and considers that a numbers of climaxes may exist in a given area.*

- In Poly climax hypothesis, different climax communities are possible on different sites.

- As per RH Whittaker, there is only **one big climax community** that varies according to soil, slope and other habitat factor.

Codominanace of two climax tree species

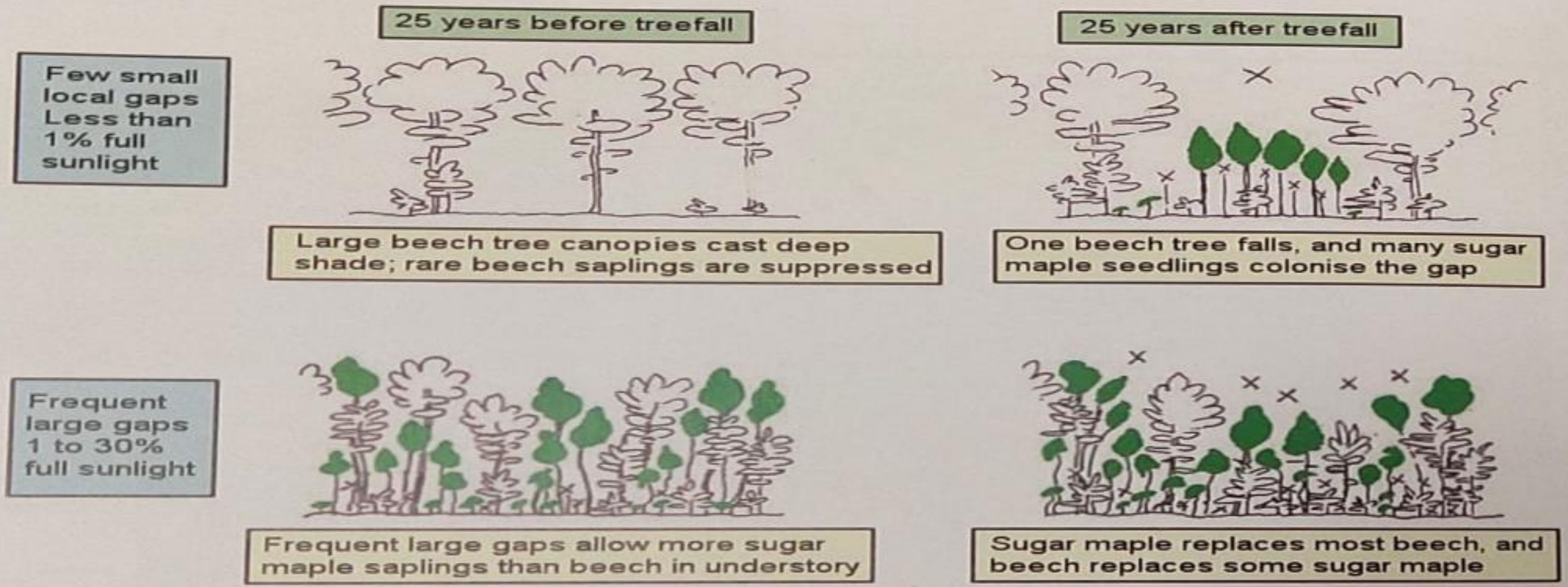


Figure 11.12 Conceptual model of how the American beech–sugar maple forests of Michigan maintain codominance of two climax tree species instead of succeeding to a single dominant climax species. The left column is before tree-fall; the right column is after tree-fall. Infrequent falls of large beech trees every 100+ years (top panel) favor sugar maple (green tree silhouettes) while frequent gaps every 10–40 years (bottom panel) favor a mixture of sugar maple and beech (open tree silhouettes). X marks the former positions of the crowns of fallen trees in the right column. Maples from the understory were suppressed on average 20 years before being released to grow in a gap, while beech trees from the understory were suppressed 121 years on average. Intermediate conditions between these two extreme scenarios will often favor beech over sugar maple. This type of succession mechanism will maintain a climax forest containing both beech and sugar maple. (Modified from Poulson and Platt 1996.)

Different types of climax

- Climatic climax – due to climate
- Sub climax – due to interference
- Edaphic climax – soil factors
- Pyral climax – due to fire

Climatic climax – sal

- Tropical wet evergreen
- Tropical moist deciduous
- Moist shiwalik   and himalayan forests

Edaphic climax

- The climatic climax is achieved where physical conditions of the substratum are not so extreme as to modify the effects of prevailing regional climates.
- Climatic climax is term used for general climax.
- Sometimes the climax is greatly modified by the physical conditions of soil such as its topography and water content. Such a climax is known as *edaphic climax*.
- Sal forests from a pioneer plant association of Acacia catechu and Dalbergia sissoo in the Gangetic alluvium of Uttar Pradesh is a typical example of plant succession.
- Sal
- Heavy clay area – aegle (bael and terminalia)

Edaphic climax

1. Northern Trop. Wet evergreen - Cane brakes
2. Southern Trop. Wet. evergreen -Bamboo brakes
3. Northern Moist Deciduous- T. Tomentosa
4. Temperate Dry Deciduous- Anogeissus pendula
5. Temperate Dry Deciduous -Bosewellia serrata
6. Temperate Dry Deciduous–Babul
7. Temperate deciduous -Hardwickia

Pre climax

- In climatic zone, there may be sites which have relatively low, or high moisture supplies. The site with low moisture supplies carries a climax vegetation which is more xerophytic then general climax. This climax is called **pre –climax.**

- **Chir Pine forests** in exposed ridge in sub tropical broad leaved forests of oak is pre –climax.

- Moist teak adjoining evergreen forests in TN

Post climax

- A climax with more mesophytic vegetation on shelter sites, than the general climax is called **post climax.**
- More cool and moist area
- Damp sites of semi evergreen forests in sal zone converted into evergreen forests
- Chir pine converted into oak

Sub - Climax

- A vegetation which is not a climatic climax, but stable under continued influence of some biotic factor is called **sub-climax.**

- If biotic factor are removed or controlled, sub-climax will proceed towards general climax.

- **Teak and sal forests in moisture zones is sub-climax**.

- If these forests are not subjected to grazing and fire it will change into mesophytic vegetation of mixed species.

Retrogression

- Succession is a process of development and at early stages in succession, more developed plant communities are present, than the previous stages.
- The process of development of communities can be reversed by some adverse influences. These influences may be man made or natural.
- The plant communities may not be improved over previous stage but resemblances of what had existed in earlier stage. This is known as **Retrogression**.

- In Retrogression is marked by appearance of species which are lower in height and more xerophytic in character, than those they are replacing.
- Examples of retrogression :

(i) Profuse regeneration of Adina Cordifolia in Sal forests in South Raipur (MP)

(ii) Replacement of Oak (Quercus incana) in Himalaya by pure stand of Rhodoedendron.

Succession in some Shorea robusta forests of the U.P.

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Abstract : Succession studies in the dry and moist S. robusta (Sal) types indicate that there is evidence for both progression and regression. The dry types ultimately degrade into a dry grassy savanna, after passing through the mixed miscellaneous stages. The primary succession in the dry Sal type starts from a grassland association with species like Saccharum spontaneum and Erianthus munja, leading to the mixed miscellaneous stage. This may regress to deciduous forest, or to mixed forest with Sal and finally to dry savanna. In the moist Sal type, the primary succession starts from grasses and leads to mixed forests of Sal and Terminalia tomentosa, Syzygium cuminii etc., after passing through mixed miscellaneous seral stages. The moist Sal type may, however, degrade to a dry Sal type, then to mixed miscellaneous forest, and ultimately to dry savanna. In localities with a high water-table and under moist conditions, regression may proceed towards savanna with tall grasses. The tall-grass savanna may be more or less stabilized as a sort of post-climax association. [Cf. F.A. 22 No. 308. KEYWORDS: Araucaria cunninghamii \ plant ecology \ Shorea robusta \ vegetation types \ forests \ plant succession \ Synecology \ Syzygium cuminii \ Terminalia tomentosa

SUCCESSION AND CLIMAX

- Types of new sites (primary succession) in India
- Alluvial- riverian
- Estuarine
- Sand dunes
- Land slips
- Screes (dry/ cold area, mountainous areas)
- Colonization of the site
- Riverian
  - Water as main source- Shisham, Trewia,
  - Air borne spp.- Khair, populus, alnus

- **Landslips**
  - Seed by wind dispersal
  - Alnus, populus, Blue pine
- **Sand dunes**
  - Coastal – casuarina
  - Shifting land sand dunes – herbs, shrubs

- **Hydrarch succession – wet environment**
  - **Water, wet land, marshy land**
- Mesarch succession – moist environment mainly in deep and texture soils
- Mainly secondary succession

- Oligortrophic succession–**poor nutrient environment**

- **Mesotropic** succession–**balance nutrient environment**

- **Eutropic** succession–**fertile and rich environments**

- Allogenic succession–geological processes change the physical environment which in turn changes the biota

Hydrosere: The plant succession which start in the aquatic environment is called "hydrarch". A series of changes taking place in the vegetation of hydrarch is called hydrosere.

Halosere: It is special type of sere which begins on a salty soil or in saline water.

Xerosere: When the vegetational succession develops in xeric or dry habitat, it is called xerarch or xerosere. Xerosere may be of two types:

i) **Psammosere:** It refers to the vegetation succession that begins on the sandy habitat.

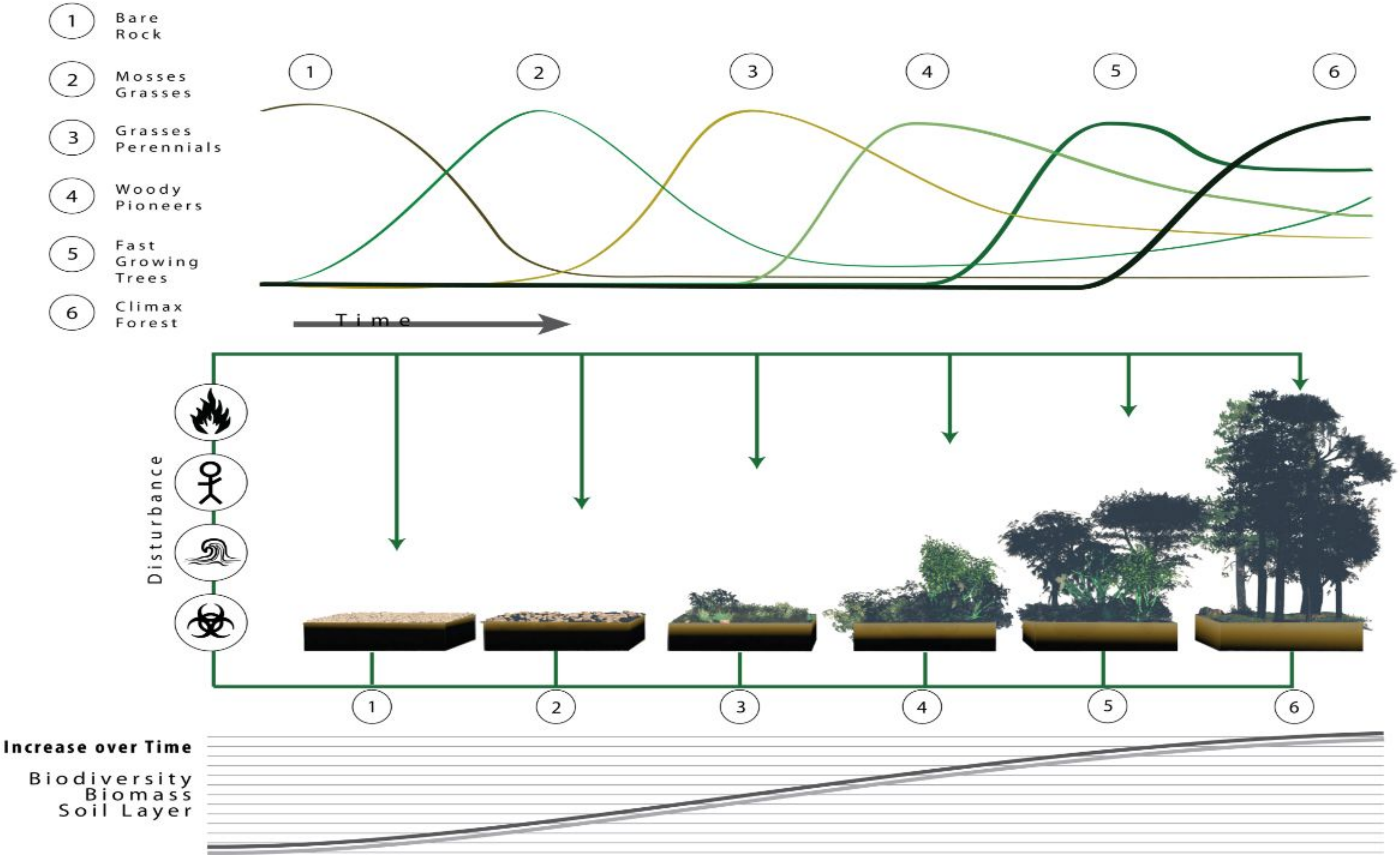
ii) **Lithosere:** It refers to succession that occurs on rock surface.

- Successions which depends upon the moisture condition of the place.

  Xerarch – **Dry condition such as bare rock, wind blown sand, rocky slopes**

- **Stage –I rocks, in hospitable environment**
- **Stage –II lichens, mosses- tolerating drought and production of organic matter**
- **Stage –III more shrubs**
- **Stage –IV tolerant trees**

Forest Succession Over Time In Six Stages



Example of Plant Succession

- Evolution of Sal forests from a pioneer plant association of Acacia catechu and Dalbergia Sissoo in gangetic alluvium of UP is an example of plant succession.
- The stages in succession of Sal are:-

(i) Acacia Catechu – Dalbergia Sissoo

ii) A. Catechu – Holoptelea - Adina – Albizzia

ii) Holoptelea – Adina – Lagestroemia parviflora – Salmalia – Terminalia belerica.

v) Adina – Lagerstroemia parviflora – Terminalia –Shorea

v) Shorea – Lagerstroemia –Terminalia –Adina.

Typical succession (Riverian)

1. Saccharaum Munja, Saccharaum Spontaneum, Tamarix
2. Khair (Acacia catechu)- shisham
3. Khair – Holeptelia – Adina – Albizia
4. Holeptelia – Adina – Lagerstromia – Salmaila – Terminalia Ballerica
5. (a) Adina – lagerstromia- Terminalia – Shorea (b)Adina – Trewia Toona (Moist)
6. Shorea – Lagerstromia- Terminalia– Adina and Jamun

Plant Succession in Himalayas in the altitudinal zone of 2400 – 2700m.

- Shrub association – blue pines – mixed forests of blue pine, deodar and spruce - mixed coniferous forests of deodar, spruce and fur.

- Succession (coniferous)

1. Shrub
2. Blue pine
3. Deodar, Spruce, Blue pine
4. Spruce, Fir, Deodar

Shifting sands in Spain

ow does a living community develop when an area of
ground is made available for colonization by plants and
nals? When, for instance, a glacier retreats leaving an
nse of crumbled rock and detritus, or sand builds up
nd a shore line as it is dried and moved by the wind, a
ess of gradual development is initiated which will
nately lead to mature, stable vegetation. The outcome of
process, which ecologists call *succession*, is predictable. Nor-
y, the development continues until as much vegetation is
ed as is possible within the limits of the resources of the
icular site. Often this means that the characteristic biome
he particular climatic zone will be attained; this is certainly
case if climate is the major limiting resource. There are
sions, however, when other factors limit the degree to

than that normally associated with that climatic zone. For example, in the temperate grasslands—that is, the steppes and prairies—the climatic factor which limits growth is summer

those which result from a piece of land coming into existence which has not formerly borne a vegetation cover, such as the new land formed by volcanic lava flow, or a newly-formed estu-

One of the best examples of a primary succession i
dune. Sand from the intertidal zone is dried by the s
tide. Some is then blown by the wind, accumulating

◄▼ **Animals of Coto Doñana** sand dunes, Spain. In mature Umbrella pine (D): (1) Spanish Imperial eagle (*Aquila heliaca adalberti*); (2) Azure-winged magpie (*Cyanopica cyana*). In invading Umbrella pine (C): (3) Short-toed eagle (*Circaetus gallicus*); (4) Red deer (*Cervus elaphus*); (5) Montpellier snake (*Malpolon monspessulanus*); (6) Great gray shrike (*Lanius excubitor*). In grass and sedge (B): (7) Crested lark (*Galerida cristata*); (8) Wild boar (*Sus scrofa*). Zone (A) is the advancing dune ridge. See box right for further details.

Shifting Sands in Spain

Some ecosystems experience a repeated and often predictable disturbance or catastrophe, such as fire or wind blow in forests, and this initiates the succession anew. One particularly striking example of this is known to occur in the dune systems of southwest Spain, in the Coto Doñana National Park. Here the dune ridges are never fully stabilized, and they move in advancing waves from the Atlantic coast inland, engulfing the developing vegetation. As each dune ridge advances (A), it leaves behind a bare area of flat, damp sand, which is rapidly invaded by grasses and sedges (B). The major tree species of the area is the Umbrella pine, and this soon arrives also (C), taking advantage of the buildup of organic matter in the damp

soil. Its winged fruits ar
carried by the wind, but
are also an important fo
source for animals and b
particularly the Azure-w
magpie (2), which haun
local pine woodlands, a
birds undoubtedly assist
spread of the fruits.
Within about 40 year
pine trees have formed a
mature strip of forest (D
is producing cones of its
well as supporting a bird
which includes the mag
forest also provides nest
for predatory birds such
Short-toed eagle (3) and
very rare Spanish race o
Imperial eagle (1). But i
about this stage that the
predictable disaster strik
the woodlands are buri
more by the next wave o
mobile dunes.
The Umbrella pine is
well attuned to this sequ
events since it can comp
life-cycle within the allo
years or so. Slower-mat
species such as juniper a
Cork oak fail to maintai
viable population under
conditions. There is also
evidence that this seque
persisted in the area for
time: fossil peat deposit
beneath the sands and c
in neighboring cliffs pro
evidence from the fossil
grains preserved within
that the same cyclic suc
has been going on for a
13,000 years.

Succession on a sand dune

One plant which can cope is the grass called the Sand couch. Although it grows to a height of only about 60cm (2ft), it extends by underground stems and binds the sand together. Its upright leaves are drought-resistant and are not desiccated by drying winds. Indeed, the very presence of the leaves causes eddies in the surface airflow, and this causes the driven sand suspended in the air to be deposited in the lee of the obstruction. Small dunes up to 1m (3ft) in height may develop as a result, thus raising the surface of the sand out of the reach of the tidal flow. This then permits the invasion of species of plants which are more sensitive to salinity. Among these is the Marram grass, a more robust and aggressive species than the Sand couch, which can grow to about 1.2m (4ft) in height and which has much more extensive rhizomes. Its dense growth has a profound effect upon the wind speed over the dune surface, and therefore upon the deposition of sand. Under the influence of the Marram grass the dunes grow very quickly and may attain heights of 100m (330ft) or more.

But the dense growth of the Marram grass has a further effect: it suppresses the growth of the Sand couch, which then disappears from the growing dune. The situation is rather ironic, for the Sand couch by its very growth and success in the habitat has created the conditions in which the newly-arrived species has an advantage over it. Merely by growing there the Sand couch has effectively signed its own death warrant!

But the story does not end there, for the continued growth of Marram grass and the buildup of dunes leads to further changes in the microclimate and wind-flow patterns of the entire habitat. While the dune is actively growing and unstable,

is the way in which the growth of the plants themselves modifies the habitat and thereby permits the entry of less specialized, but often more competitive, species. Organic matter is added to the soil, which gives it greater water-holding capacity and encourages the growth of microbes. These provide a faster and more efficient cycling of essential nutrient elements, which

▼▶ Succession on a sand dune—animals that colonized a sand dune at each stage of its development. (A) Drift line: (1) Sand hopper (*Gammarus locusta*). (B) Pioneer dune: (2) Common tern (*Sterna hirundo*), nesting site. (C) Mature dune: (3) Oystercatcher (*Haematopus ostralegus*), nesting site; (4) Banded hedge snail (*Cepaea nemoralis*); (5) Common kestrel (*Falco tinnunculus*) hunting; (6) Natterjack toad (*Bufo calamita*); (7) Field vole (*Microtus agrestis*); (8) Meadow grasshopper (*Chorthippus parallelus*); (9) European rabbit (*Oryctolagus cuniculus*). (D) Shrub phase: (10) Willow warbler (*Phylloscopus trochilus*); (11) Chaffinch (*Fringilla coelebs*).

will not spend time in the developing ecosystem until its vegetation has become attractive to them, as a source of physical shelter, as a means of hiding from predators or as a source of food. So a certain degree of complexity must be attained before animals are a significant factor in successions.

detritivore animals such as springtails (Collembola) and woo lice (Isopoda) can thrive. This humid carpet is also ideal f the germination of many plant species which, without su protection, could not survive as seedlings in the inhospitab and unstable sand.

As DFO the application & understanding of succession& climax is significant

- *Riverine succession and woody succession challenges for park managers*
- *Managemental decisions like river training, reintroduction/ Translocation of wild animals, controlled burning*
- *Silvicultural operations-Thinning operations ,Felling operations(Clear felling, Selective felling)*

Contd…

- *Threats like Grazing, Fire, Deforestation, Clearing for Shifting cultivation, fragmentation/Honey combing due to illegal encroachments, illegal tree felling*

- *Planting of tree species/fodder species*

- *Weed removal operations*

- ***Finally role in Restorative Ecology***

DISCUSSION