ECOLOGY FOR EVERYONE

SCIENCES NEEDED TO TACKLE THE PROBLEMS OF HUMAN SURVIVAL: ECOLOGY OF BIOSYSTEMS AND HISTORICAL ECOLOGY

COMBINING THE CONCEPTS OF ECOLOGY OF BIOSYSTEMS AND HISTORICAL ECOLOGY IS THE BASIS FOR SOLVING PROBLEMS OF NATURE CONSERVATION AND RESTORATION

Using the current level of knowledge, the ECOLOGY of BIOSYSTEMS explains how biological objects (biosystems) live at different levels of organization:

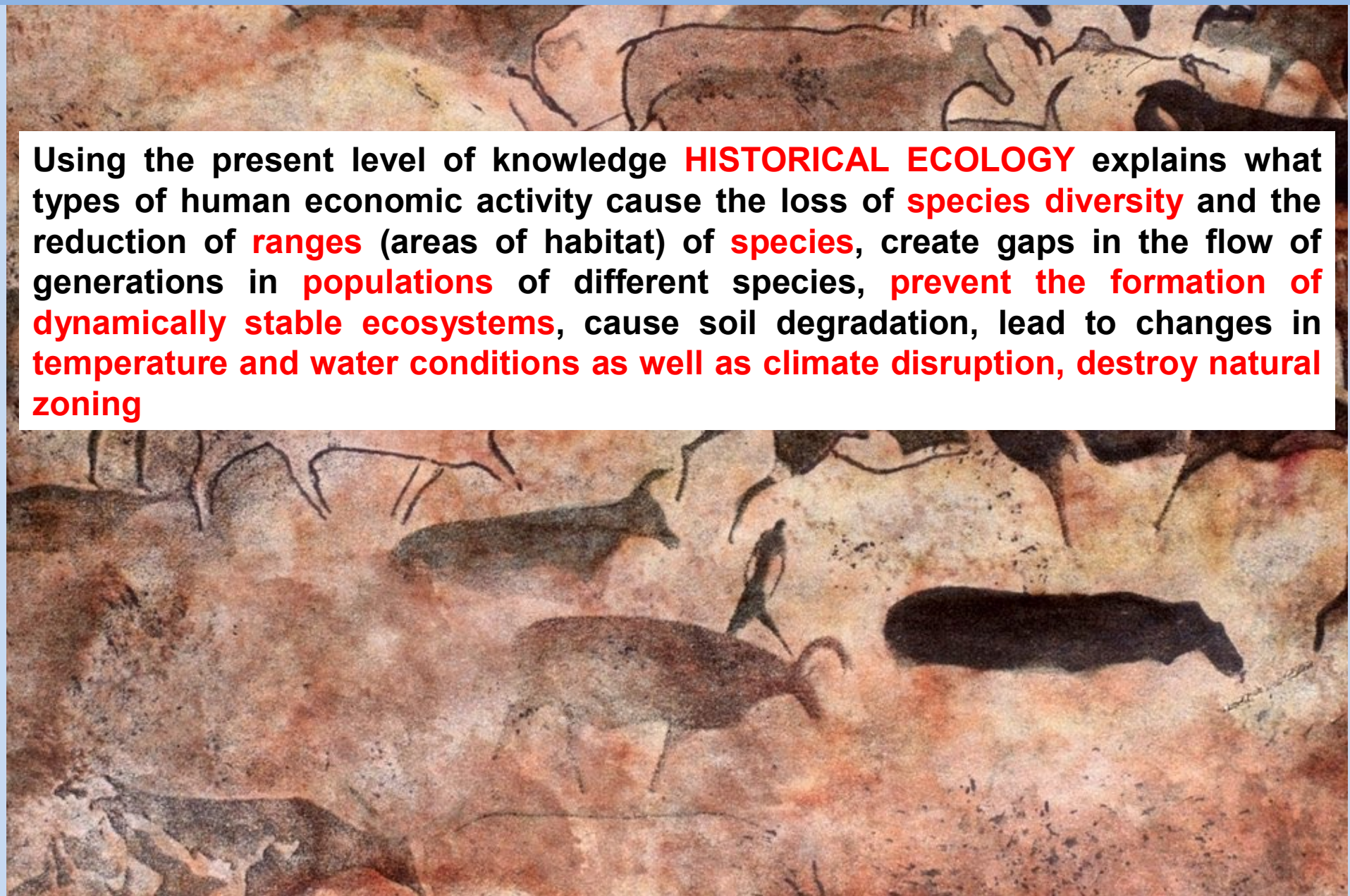
1. individuals (organisms) of each species in the process of ontogenesis, i. e. individual development from birth (appearance) to death

2. populations, i. e. groups of individuals of each species at different stages of ontogenesis living on territories sufficient to maintain a stable flow of their generations;

3. ecosystems, i. e. the set of populations of different species that coexist on a territory sufficient to maintain stable flows of generations of all its constituent species, and actively transform this territory in the process of life and death of individuals;

4. ecosystem complexes that exist within territories identified according to the division of landscapes (watersheds, river valleys, mountain slopes, etc.) and actively transform them. The composition of ecosystems within complexes is determined by the features of landscapes.

COMBINING THE CONCEPTS OF BIOSYSTEM ECOLOGY AND HISTORICAL ECOLOGY CREATES THE BASIS FOR SOLVING PROBLEMS OF NATURE CONSERVATION AND RESTORATION



Using the present level of knowledge HISTORICAL ECOLOGY explains what types of human economic activity cause the loss of species diversity and the reduction of ranges (areas of habitat) of species, create gaps in the flow of generations in populations of different species, prevent the formation of dynamically stable ecosystems, cause soil degradation, lead to changes in temperature and water conditions as well as climate disruption, destroy natural zoning

MODERN CONCEPTS OF ECOLOGY OF BIOSYSTEMS IS THE BASIS FOR MODEL RECONSTRUCTIONS AND RESTORATION OF NATURAL COVER

n the ecology of biosystems, complementary concepts have been formed that make it possible to assess the current state of biosystems (individuals, populations, ecosystems) and restore their natural state based on field data and experiments in Nature. The reconstructions are based on the concept of potencies and positions of systems. The potentials of a system are its properties, which are fully manifested in spontaneous (endogenously determined) development under optimal conditions. If such development is disturbed by external (exogenous in relation to the system) influences and / or the system develops in non-optimal conditions, then only part of its properties are manifested, which is its position in this particular case (Smirnova, Toropova, 2008),

CONCEPTS IN THE ECOLOGY OF BIOSYSTEMS:

1) discrete description of ontogenesis and viability of individuals: dividing the process of individual development from birth to death into stages (states) similar for multicellular plants and animals; identification of groups of individuals of different viability at each stage (Rabotnov, 1950; Uranov, 1975; Gatsuk et al. 1980);

2) types of strategies: ways to occupy and preserve the habitat (Ramenskiy, 1938; Greim, 1974)

3) natural disturbances: changes in the habitat during the life and death of individuals of any species (Falinsky, 1978; Ecology of natural disturbances, 1985; Evstigneev O.I., Korotkov, 2016)

4) mosaic-cyclical organization of ecosystems - the formation of breaks in the forest canopy due to the death of large trees and their small groups by old age (Watt, 1947; McCarthy, 2001); the relief of the pit and mound (due to the overturning of the earth embankment by a falling tree) and complexes for throwing the wind (due to trees falling without overturning the earth); or selective damage to vegetation: the formation of clearings in the forest, areas of open substratum in areas where animals stop, their burrows and other structures (Remmert, 1991);

5) key species - changes in the habitat using powerful environmental modifiers (ecosystem engineers), which are responsible for the stable existence of subordinate species (Braun-Blauquet, Pavillard, 1925; Crain et al., 2006; Hastings et al., 2007).

6) Climax of an ecosystem is a dynamically stable set of populations of key and subordinate species that are potentially able to inhabit the analyzed territory and interact in the process of active transformation of the environment (Smirnova, Toropova, 2016).

BASIC CONCEPTS OF ECOLOGY OF BIOSYSTEMS

ONTOGENESIS IS A PROCESS OF INDIVIDUAL DEVELOPMENT COMMON TO ALL MULTICELLULAR ORGANISMS FROM BIRTH TO DEATH

Comments: an individual is born, develops, reaches the period of maturity and reproduction, ages and dies, constantly transforming the environment.

Two ways of dividing ontogenesis:

1. into time periods (minutes, days, years, etc.) specific to each species.
2. into stages of development (formation of the embryo, childhood, youth, maturity, aging and death). Level of detail of ontogenesis division of individuals into stages differs in different species and depending on the problem being tackled (Cenopopulations of plants, 1976, 1988).

ONTOGENESIS OF TREES (Diagnoses and clues ..., 1989)

Both methods of ontogenesis division are most fully studied in trees of moderate climate, since they form annual layers in the wood, which allows to determine the duration of each stage of development in years.

1. Latent - dormant seeds or vegetative primordia.
2. Pre-generative: from seed germination (or the development of a vegetative primordium) to the beginning of seed propagation; states: plantlets (pl), juvenile (j), early (im1) and late (im2) immature, early (v1) and late (v2) virginal plants
3. Generative: from the first seed production to the termination of seed formation due to aging; states: young generative (g1), middle-aged generative (g2), old generative plants (g3).
4. Postgenerative (senile): from loss of ability to seed to death of old age; senile plants (s).

At the same stage of development, individuals differ in power (level of vitality).

LEVELS OF TREE VITALITY

Class one *(**normal vitality**):* during ontogenesis, an individual develops without delay, its size and weight constantly increase to the old generative state, the development of vegetative organs *(shoots, leaves, and roots)* is positively correlated with the intensity of fruit and seed formation.

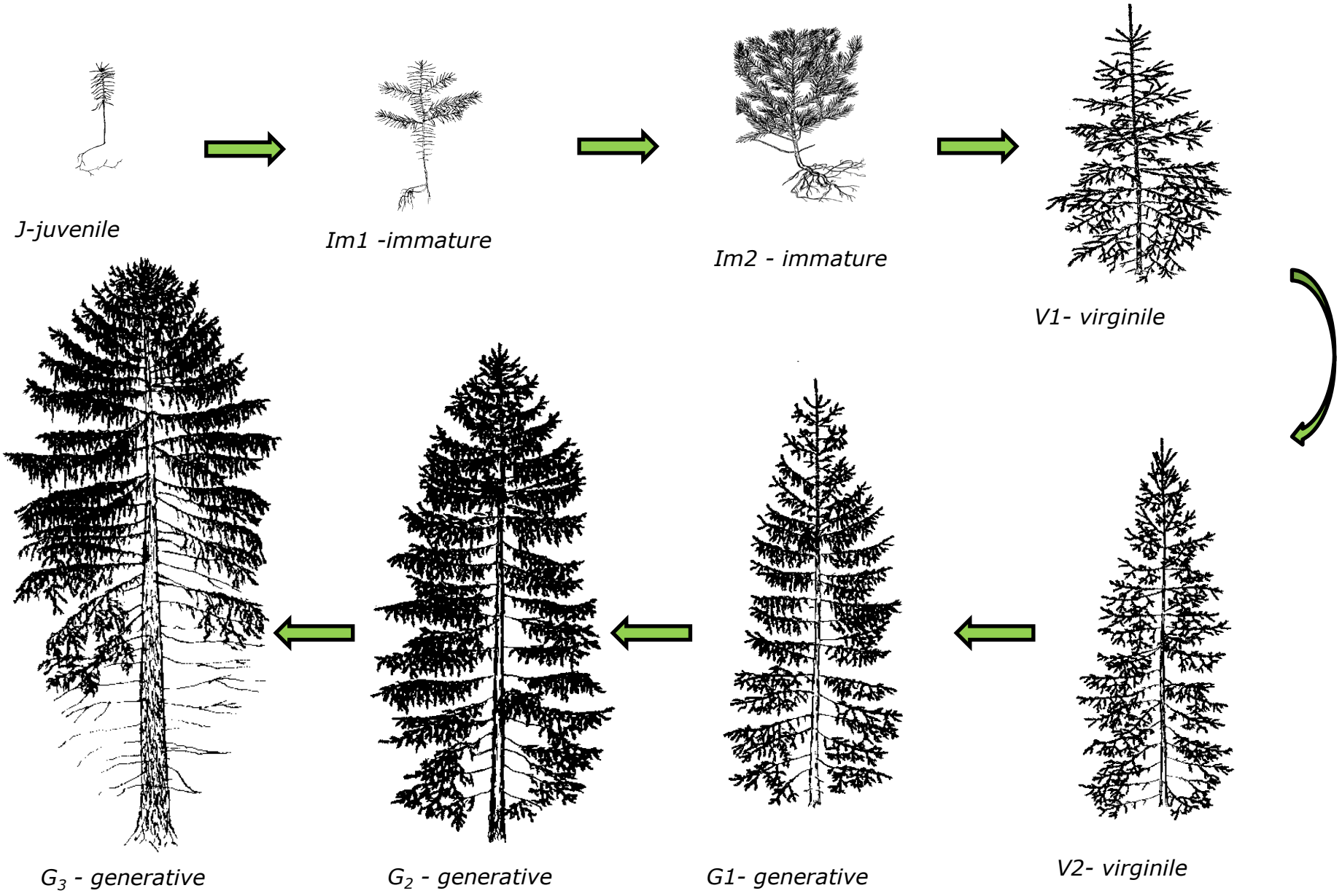
Class two *(**reduced vitality**):* during ontogenesis, the development of an individual slows down both in the pre-generative and generative periods; the size and biomass of such individuals is smaller, and the absolute age in years is greater than in individuals of the first class of vitality, there are no positive correlations between the parameters of vegetative and generative organs.

Class three (***low vitality***): at the early stages of ontogenesis, the development of an individual is delayed for a long time, the generative period is reduced or absent; an individual passes from the pre-generative into the postgenerative state; there is no correlation between the absolute age and the stage of development. Young individuals of this group often develop senile structures. Individuals of this group of vitality usually have small sizes and biomass as compared to individuals of normal and reduced vitality.

At the third level of vitality, the basic principle of sustainable development of individuals does not work, i. e. there is no predominance of the processes of growth and neogenesis over the processes of dying-off in the first half of ontogenesis. In individuals of low vitality, premature aging and death predominate

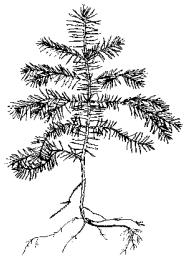
INDIVIDUALS OF REDUCED AND LOW VITALITY TOLERATE ADVERSE CONDITIONS (DROUGHTS, COLD SPELLS, FUNGAL DISEASES AND PEST DAMAGE) MUCH BETTER ; THEY FORM A RESERVE FOR THE SPECIES SURVIVAL IN THE EVENT OF MASS DEATH OF INDIVIDUALS OF NORMAL VITALITY (Cenopopulations of plants, 1976,1988; Diagnoses and keys ..., 1989).

ONTOGENESIS OF A EUROPEAN SPRUCE OF NORMAL VITALITY (Romanovsky, 2001)



ONTOGENESIS OF A EUROPEAN SPRUCE OF REDUCED VITALITY (Romanovsky, 2001)

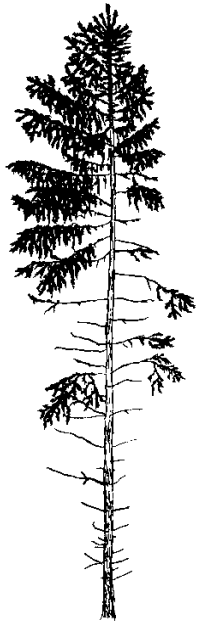
J-*juvenile*



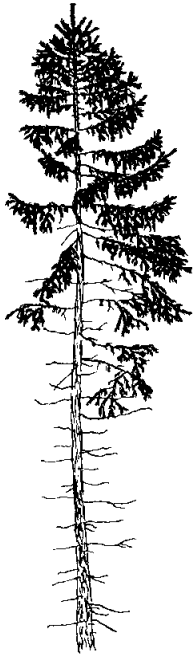
Im1 -*immature*

Im2-*immature*

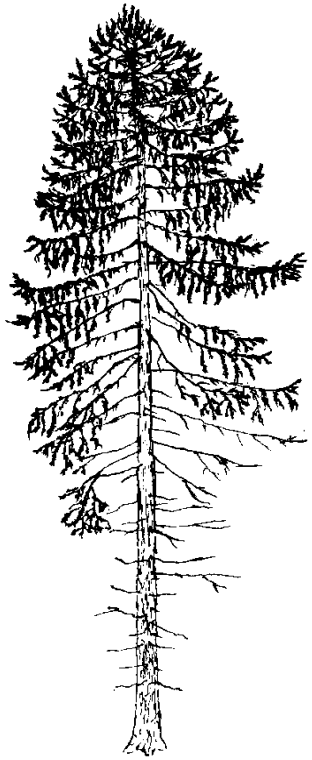
V1-*virginile*



V2- *virginile*

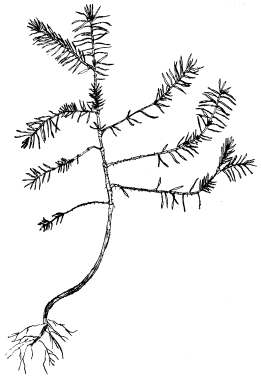


G1- *generative*

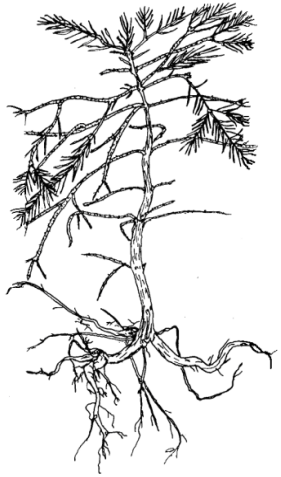


G_2 - *generative*

EARLY STAGES OF ONTOGENESIS OF A EUROPEAN SPRUCE OF LOW VITALITY (Romanovsky, 2001)



Im1 -*immature*



Im2- *immature*

V1- *virginile*

In nature, you will hardly find generative trees the vitality of which at the initial stages of ontogenesis was low. When the environment changes for the better, their growth and development improve and the tree's vitality gradually becomes normal. However, the entire history of its development can be "read" by the size of the annual rings at the base of the trunk.

ANNUAL RINGS AT THE BASE OF TRUNKS OF A SIBERIAN FIR V1 (photo A. Efimenko)

NORMAL VITALITY, 40 years

LOW VITALITY, 90 years

TREES OF LOW VITALITY IN GREEN MOSS-SMALL HERB FIR-SPRUCE FORESTS
(A.S. Efimenko)

The reason for low vitality is lack of light, which is necessary for normal development

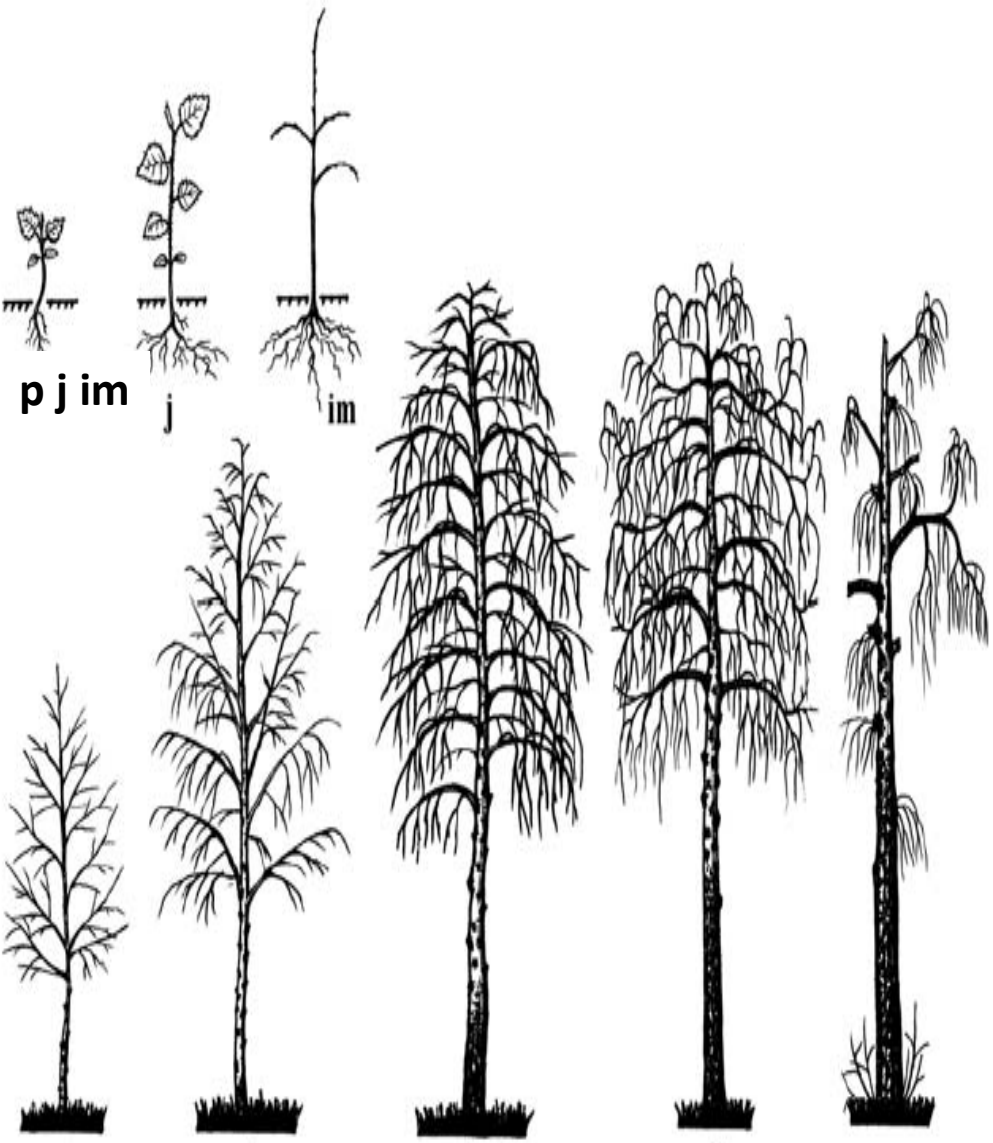
spruce im1

spruce v1

fir v1

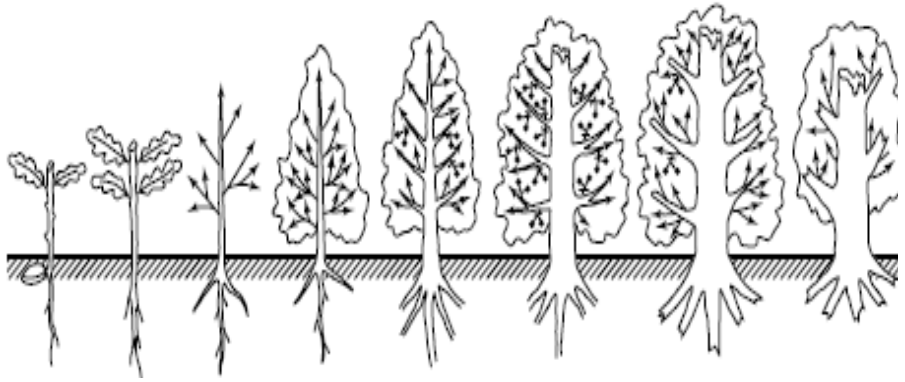
A fir trunk that has taken root

ONTOGENESIS OF A COMMON BIRCH OF NORMAL VITALITY (by A. I. Shirokov)



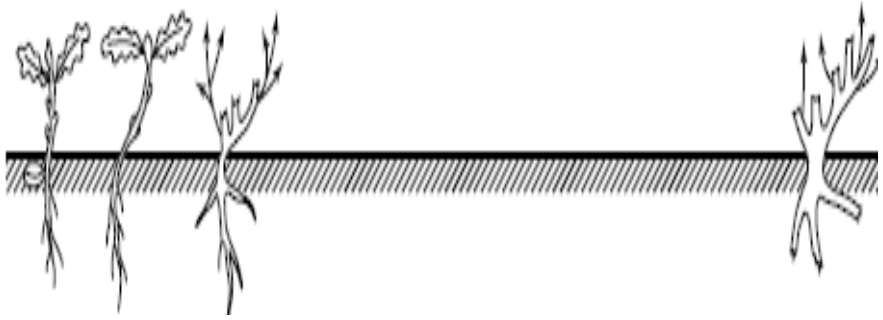
ONTOGENESIS OF A COMMON OAK OF NORMAL AND LOW VITALITY (*Evstigneev, 1988; 1991*)

normal vitality



p j im v g1 g2 g3 s

low vitality



p j im s

(Chistyakova A.A. 1989; Smirnova et al., 1984; East European Deciduous Forests, 1994)

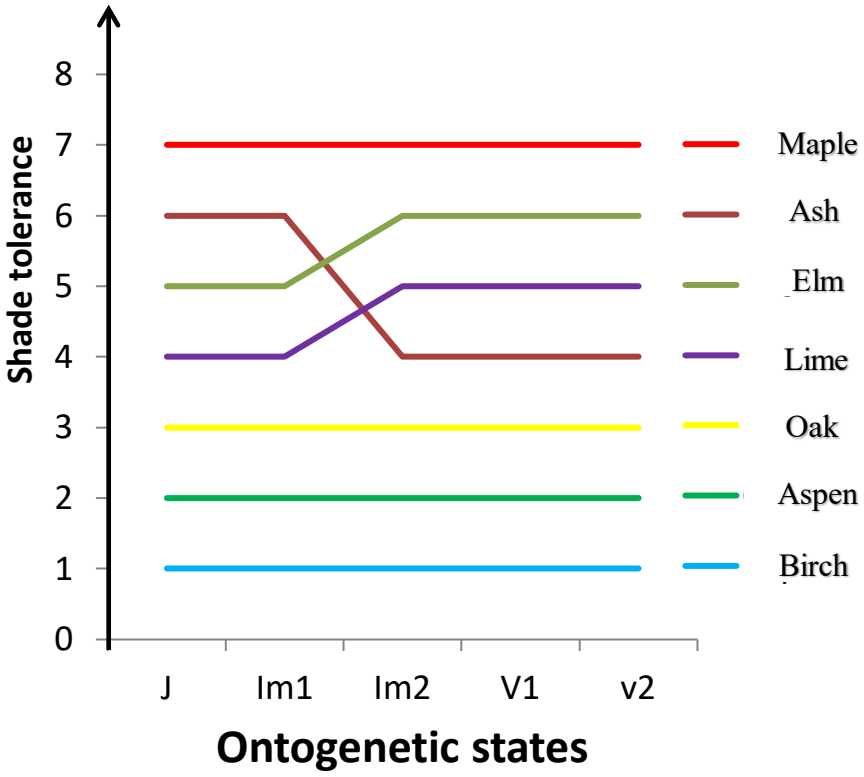
CHANGE IN LIGHT REQUIREMENTS OF TREES OF DIFFERENT SPECIES IN THE ONTOGENESIS

(***Evstigneev**, 1988; 1991*)

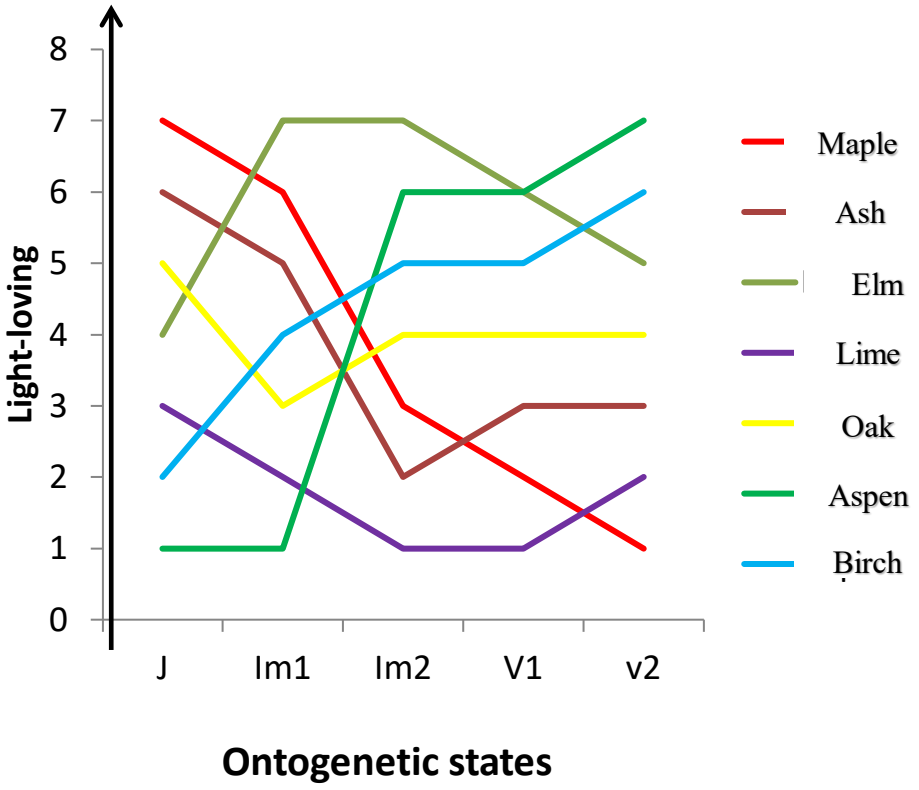
Each species at different stages of ontogenesis has different requirements to its habitat. The ranges of light requirements vary in ontogenesis of each species in different ways: one species may still be able to live in the shade, while the other needs a lot of light.

<u>This is why species with different light requirements can live together.</u>

Shade-tolerance scale



Light-loving scale



ONTOGENESIS IN THE ANIMAL WORLD

In the ontogenesis of invertebrates, there are three main ontogenetic states:

1. egg
2. juvenile individuals
3. mature individuals

A more fractional division of each ontogenetic state is different for different species. It depends on the total duration of ontogenesis, the habitat of a species at different stages of ontogenesis and may be different when solving different scientific tasks.

There is no information about the life of earthworms after losing their reproduction capability.

Stages of ontogenesis of an earthworm

Cocoons
(containing 1-3 eggs each)

Juvenile worms leaving the cocoon

Juvenile worm without a ring

Mature worm with a ring

Safari Ltd.

ONTOGENESIS IS A COMMON TO ALL MULTICELLULAR ORGANISMSPROCESS OF DEVELOPMENT OF AN INDIVIDUAL FROM BIRTH TO DEATH : CHILDHOOD → YOUTH → MATURITY → OLD AGE...

Capybaras

Elephants

Wolves

Wild boars

COMPARISON OF PLANT AND ANIMAL ONTOGENESIS IN NATURE AND IN AGRICULTURE

Ontogenesis in the Nature:

1) consistent passage of all developmental stages from birth to death is the basis for species preservation;

2) simultaneous existence of individuals of normal and low vitality creates a necessary reserve for preserving the species under adverse conditions (weather disasters, reproduction of pests, predation pressure, etc.);

3) different duration of ontogenesis in different species and individuals of different vitality, changes in vitality and environmental needs in individuals of the same species during ontogenesis is the basis for preserving the species in the Nature.

4) inclusion of dead individuals in the general cycle of matter and energy.

Ontogenesis in Agriculture:

1) ontogenesis of plants and animals is forcibly terminated when they achieve economic value;

2) individuals of reduced and low vitality are removed because of their low economic value;

3) the resulting products (of plants and animals) are removed from their habitats, which leads to depletion of the cycle of matter and energy;

4) producing new full-value products requires constant investment of effort and funds into their cultivation.

The purpose of the Nature is to prolong the existence of species under various conditions, including adverse ones, in order to leave offspring.

The purpose of Agriculture is to get as many necessary and standardized products as possible at a given time.

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