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Botany 465. Plant Geography R.M.Tryon,Jr. 1949-50

OUTLINE OF THE COURSE

I. Introduction (Sept. 29)

Introductory remarks
Plant Geography and its relationships
Common sources of error

II. The plant and its environment (Sept. 29, Oct. 6, Oct. 13)

The environment
The habitat
Adaptations
The causes of plant distribution

III. The history and classification of vegetation (Oct. 20, Oct. 27, Nov. 3)

Classification
Distribution
History

IV. The history and distribution of natural groups (Nov. 10, Nov. 17, Dec. 1)

History
Distribution

V. The history and distribution of floras (Dec. 8, Dec. 15, Jan. 5, Jan. 12)

History
Distribution

VI. A coherent theory (Jan. 19)

Field work (optional) in connection with parts II and III.

General References

> Texts: Good, Roland. The Geography of the Flowering Plants. Longmans, Green & Co. 1947.

> Oosting, H.J. The Study of Plant Communities. W.H.Freeman & Co. 1948.

Braun-Blanquet, J. Plant Sociology. English transl. Ed. Fuller & Conrad. McGraw-Hill Book Co. 1932.

>Cain, S.A. Foundations of Plant Geography. Harper & Bros. 1944.

Cooper, W.S. An Introduction to Plant Ecology. In press.

>Daubenmire, R.F. Plants and Environment. John Wiley & Sons. 1947.

Raup, H.M. Trends in the Development of Geographic Botany. Ann.Assoc. Amer. Geog. 32: 319-354. 1942.

Schimper, A.F.W. Plant Geography upon a physiological basis. English transl. Fisher. Oxford Press. 1903.

Tansley, A.G. and T.F.Chipp. Aims and Methods in the study of Vegetation. London.1926.

Warming, E. Ecology of plants. English transl. Groom & Balfour. Oxford Press. 1909.

Wulff, E.V. Introduction to the historical geography of plants. English transl. Brissenden. Chronica Botanica Co. 1943.

Kramer, P.J. Plant and Soil - Water relationships - McGraw Hill 1949

I. Introduction

1. Introductory remarks.

2. Plant Geography and its relationships.

PLANT ECOLOGY is the science which treats of the mutual relations of plants and their environment, including other organisms. Some phases, often considered in the realm of Ecology at the present time, are inseparable from Plant Geography and other phases are intimately related to it.

Autecology is the study of the individual. It deals with problems of "The plant and its environment". The field overlaps with Genetics in studies of inheritance of characters of adaptive significance. The two phases of it, to a considerable extent, seek causes of plant distribution, that is, causes of success or failure of migration, persistence and extinction. They will be considered from this point of view.

Morphological Ecology deals with the structural adaptations of plants to their environment. It is inseparable from some phases of Morphology and Anatomy, for example, studies of structure of xerophytes.

Physiological Ecology deals with the functional adaptations of plants to their environment. It is inseparable from some phases of Physiology, for example, studies of mineral deficiencies and studies of photoperiodism.

Synecology is the study of the units of vegetation. It deals with problems of "The history and classification of vegetation".

Static Synecology deals with the classification of vegetation and the distribution of the units. For example, the classification by life-form and the distribution of the various life-forms.

Dynamic Synecology deals with the history and nature of vegetational units. For example, a succession of associations toward a Climax. This field is closely related to Dynamic Floristics (see below). The history of the flora of an area and the history of the vegetation of that area are concerned, to a considerable extent, with the same problems.

PLANT GEOGRAPHY is the science which treats of the description and interpretation of the distribution of plants in relation to the earth's surface. It is closely related to Taxonomy and Evolution and, as indicated above, to much of Plant Ecology.

Phyletic Plant Geography is the study of groups with a common origin. It deals with problems of "The history and distribution of natural groups". For example, of a species, of a genus or of a family.

Static Phyletic Plant Geography deals with the delimitation of natural groups and mapping their distribution (essentially the same as Monographic Taxonomy) and the analysis and comparison of distributions.

Dynamic Phyletic Plant Geography deals with the history of the distributions of natural groups. It overlaps with the fields of Phylogeny, Evolution, and Genetics, particularly in relation to causes.

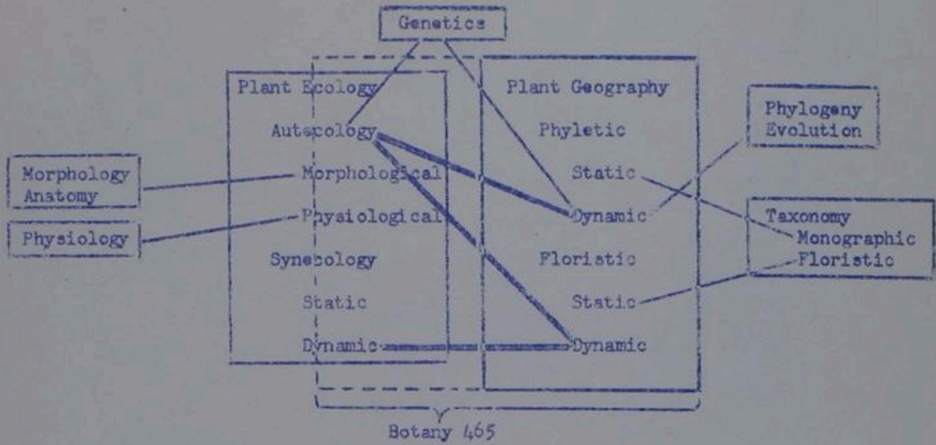
Floristic Plant Geography is the study of floras. It deals with problems of "The history and distribution of floras".

Static Floristic Plant Geography deals with the recording of the species of a flora and mapping their distribution (essentially the same as Floristic Taxonomy) and the analysis and comparison of the distributions.

Dynamic Floristic Plant Geography deals with the history of floras. It is related to Dynamic Synecology, as mentioned above, and to Autocology in relation to causes.

Most of the separate subjects listed above are so closely allied to some of the others that a classification of the subject matter of Plant Geography must, to a large extent, be quite artificial. There is utility, however, in bringing a degree of order out of a highly interlocking complex.

The following chart expresses the major areas in which fields overlap with one another. It does not express relationships of basic data. Research in any one phase of Plant Geography or Plant Ecology draws not only upon information furnished by other phases of those sciences but also upon factual material in other fields of Botany and in portions of the other Natural and Physical sciences.



Major areas in which phases of Ecology and of Plant Geography are contiguous and areas in which they are contigguous with other fields of Botany.

3. Common sources of error.

The literature of Plant Geography is descriptive and interpretative. Several causes have conspired to make not only the descriptive phase but especially the interpretative phase liable to considerable error. There is probably no other modern science in which the literature is often of such a dubious nature. In many cases the baldest types of assumption are treated as exact truth. The sources of error are usually those of incomplete or inaccurate date, of biased or of deductive reasoning. Some examples follow:

ERRORS OF DESCRIPTION.

Concerning maps of the distribution of species, genera, etc.

Identification of specimens.

Taxonomy of the group.

One entity mapped or more than one.

Variation within a species.

Different concepts of categories.

Degree of completeness.

Borders of range accurate?

Gaps within range significant?

Labels. (Standley, Science 65; 130-133, 1927 - concerning Bro. G. Arsène's collections).

Concerning the distribution of the kinds of vegetation.

(Largely the same as above.)

Concerning data obtained from experiments.

These are subject to many types of errors involving techniques, materials, measurements, etc.

ERRORS OF INTERPRETATION.

Bias.

Authors may write to vindicate an idea of hypothesis. Thus their work is biased although their data may be correct. This is most likely to occur in relation to an author's own ideas. It is difficult to defend one's ideas without becoming biased. "Perhaps its best antidote is to remember that truth may be stranger than fiction."--Woodson.

Deductive reasoning.

An assumption is made of relations among a circle of facts. For example, from observation of the correlation between plant distribution and environmental conditions one deduces that "there is a cause and effect relation between the environment and the plant". Once the assumption is made, facts are marshalled to its support. Soon authors using the assumption fail to mention that, no matter how reasonable, it is only an assumption. Finally, the assumption is stated as an exact truth. Explanations of causes are especially susceptible to this type of error. Few workers are content to deal with approximations, to deal with superstructures of research based on assumption. The tendency is to proceed to the exact and definite at all costs.

This course will not avoid many of the types of error listed above. It necessarily depends on literature which it is not practical to verify. It is important, therefore, to keep sources of error in mind and to determine how they may affect conclusions.

1. What is the environment?

The environment consists of all external conditions (factors) that are in contact with the plant. The environment is analysed, the individual factors recognized and measured.

<u>The major classes of environmental factors</u>.

- Climatic factors
  - Temperature
  - (Fire)
  - Light
    - Total light
    - Kinds of light
  - Water (atmospheric)
    - Rain
    - Snow
    - Hail
    - Fog
    - Humidity
  - Air
    - Chemistry
    - Movement
- Edaphic factors (soil or substrate)
  - Physical structure
  - Chemistry
    - Organic
    - Inorganic (including water and air)
    - pH
- Biotic factors
  - Plants
    - Epiphytes
    - Parasites (mostly fungi)
    - Symbionts
      - Root-nodule bacteria
  - Animals
    - Soil organisms
    - Galls, leaf-cutters, etc.
    - Browsers

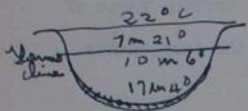
Listed above are only the main classes of factors. Within each may be recognized a large number of individual factors, each of which is part of the environment. "The intensity of most factors varies with the hour, day and season; and the rates of change, the duration of particular intensities, and the extreme values are all ecologically important aspects of the same environmental condition." "The problem of measuring those physical conditions that really govern plant behavior is much more difficult than commonly conceived. Actually only a thin shell of environment adjacent to the organism is of immediate causal significance, and the conditions in various parts of this shell differ materially from the conditions to which the instruments... may....be exposed."---Daubenmire.

<u>Habitat</u>

The habitat is the total environment as it occurs in relation to one plant or to one group of plants at a particular place. This cannot be expressed as simply the sum of the factors of the environment. All of the individual factors of each class must be correlated with each other and with all of those of all other classes, and not only at one time but over a period of time. An exact expression of habitat is an impossibility. We do not have the necessary measurements for even one habitat out of thousands and even if we did we have no way of expressing those measurements in their real interrelated complexity.

"Indeed, even if we knew the theoretical resultant, in the case of such complex resultants as cultural or vegetational features, a principle which attempted to state the sum total of all the relationships, each in its proper proportion, would be far too complicated for us to be able to use." "Even if one knew all the principles and had all the data, the solution would be involved in a mathematical equation so complicated that no finite mind could solve it."--Hartshorne, The Nature of Geography. Ann. Assoc. Amer. Geog. 1939.

Thermo-cline - point below surface of water where temperature drops too very rapidly - lowest part of a lake is deficient in O_2. The muck of the bottom contains anaerobic organisms.



At 7 m. below surface, very little light.
Above thermo cline, not a great deal of O_2, in spite of wave action, photosynthesis, etc.
Generally not as much CO_2 in H_2O as in atmosphere.

Characters of hydrophytes.
1. Weak supporting tissue.
2. Vascular tissue reduced.
3. No cutin on underwater parts.
4. Whole plant permeated w/ air spaces - not only intercellular. Air spaces serve as passages for O_2 + CO_2. These spaces closed - don't leak.
5. Functions of cutin on leaf surfaces exposed to air - prevents wetting of stomata. Gives better floating power.

Characters of xerophytes - have ability to endure prolonged drought.
1. Largely annual plants, utilizing the infrequent wet spells + laying over in form of seeds.
2. Protoplasm able to withstand wilting.
3. Various types of dormancy.
   Fouquieria splendens adjusted to rainfall as it occurs. When rain comes, quickly produces leaves - as soon as drought begins, drops leaves.
   Others where rainfall comes at regular intervals adapt themselves to these periods.
4. Reduction of leaves + branches, + stem is photosynthetic. Such as Ephedra.
5. Production of thorns thru reduct. of leaves + branches. Not as protection.
6. Reduction of surface area exposed.
7. Succulents + mucilage (pentosans, which unite w/ H_2O) chemically bound water.
8. Stomata opening only at night.

Epiphytes - special class of xerophytes, i.e. orchids, bromels, + ferns. In Orchids - velamen - outer layer of root spongy; good for H_2O absorption. In Bromels - production of scales.

2. In what ways is the plant adapted to its environment?

How does the plant become adapted to its environment?

Two meanings of adaptation: a condition, a process.

<u>The kinds of adaptations</u>. – Clausen, Keck, & Hiesey – Expt. Studies on the nature of Sp. I. Carn. Institut. Pub 520, 1940

1. Somatic adaptations are those that are the result of the environment affecting the plastic protoplasm. Such changes are not inheritable and may find different expression at different times in the same plant.

   <u>Structural</u>: root, stem, leaf, flower and fruit.

   Examples: Ludwigia sphaerocarpa
   Ranunculus flabellaris
   Polygonum amphibium
   Potentilla glandulosa

   <u>Functional</u>: Photosynthesis, respiration, transpiration, growth, germination, etc.

   Examples: photosynthesis, Nasturtium
   light, Pinus taeda
   flowering, Potentilla glanulosa

2. Genetic adaptations are those that are inheritable. They may be modified but not greatly, by the environment.

   <u>Ecotypes</u>: Populations of species especially adapted to a particular habitat.

   <u>Two ecological classifications</u>.

   Adaptation to water.

   Hydrophytes are adjusted to a super-abundant water supply.

   Mesophytes are adjusted to an adequate water supply.

   Xerophytes are adjusted to a deficient water supply.
   Structure is xeromorphic, not xerophytic

   Examples, physiology and morphology.

prevents water loss.

9. New sets of roots in wet weather lost in dry.

Parasites & saprophytes - usually dry blacks - particularly in Scrophulariaceae.

Adaptation to nutrition.

Autotrophic

Parasitic: Cuscuta, Orobanchaceae, Loranthaceae, Rafflesia. Arceuthobium

Saprophytic: Monotropa, Conopholis

(Insectivorous): Sarracenia, Nepenthes, Drosera, Utricularia. Carnivorous plants by Lloyd, F.E. – Chronica Botanica, Waltham, Mass.

Examples, physiology and morphology

The process of adaptation.

The process of somatic adaptation is largely a matter of the effect of the environment, directly or indirectly, upon the germplasm or cytoplasm or both. The details lie in the realm of Genetics. Generally speaking, the protoplasm is plastic to various degrees and form and function may be modified within limits by the environment.

Genetic adaptation is again the province of Genetics. A simplified process might be as follows: Changes occur in the germplasm, variability is increased, under suitable conditions some variations have survival value, in a slowly changing environment and over many generations, the plant will be considerably different from its forebears and different, in part, in characters that are of adaptive significance.

3. What are the causes of plant distribution?

Is there a cause and effect relationship between the environment and the plant?

The causes of plant distribution are the causes of migration, establishment, persistence and extinction of the individual.

We have seen how the exact and complete analysis of the habitat is impossible. It remains to emphasize that no single factor or group of factors may be selected from the total habitat as causes. All of the factors are related and a change in one may result in changes in others. Instead of one factor limiting the range of a plant it is the whole habitat that is limiting.

Experimental Ecology, in seeking causes of plant behavior, is at the present time faced with two insurmountable difficulties. First, a species may be quite variable genetically in its physiological processes so that conclusions from an experiment may not be applicable beyond the plants that were actually a part of the experiment. Such physiologically distinct micro-races may not be identifiable by morphological characters. Second, the complexity of the habitat and the mutual relations of habitat factors render experimentation impossible. It is useless to experiment in the greenhouse or laboratory for the habitat there will be quite different from that in nature. Likewise, it is useless to experiment in the field for in order to experiment one must set up a control (the natural habitat) and the experiment proper which will be identical to the control except for one measurable difference. In changing the habitat in one way (by artificial shading, for example), it is necessarily changed in others (temperature, water, etc.).

The inductive method.

".....field ecologists attempting to explain plant behavior are often forced to confine themselves to inductive methods, seeking to establish concommitance between behavior and environment and realizing that the phenomena may never by capable of expression in any but broad generalities."—Daubenmire." Humboldt and his

Livingston + Shreve.

Methods

A Distribn. facts
(Vegetation + species.

1. Geog. range

2. Ecological distrib.

3. behavior at its limits

B Apparent climatic controls (correlation of as many factors as possible).

C. Actual climatic controls by experiment.

followers set themselves to describe the world of plants empirically, dealing with the relationships of plants to environment only on a comparative basis. They purposely refrained from plunging into problems of actual cause and effect, apparently because they had arrived logically at a strong presentiment that they could not solve such problems then, and probably never would. Ecological geographers, on the other hand, starting with the assumption of a causal relation between plant and environment, have built the entire structure of their science upon efforts to prove its significance and to interpret the distribution of plants on the basis of it. The initial reasoning, therefore, has not been by simple induction from a body of empirically and naively determined facts, but from a system of working hypotheses based upon assumptions of actual cause and effect."—Raup.

Livingston, B.E. & Forest Shreve. The distribution of vegetation in the United States, as related to climatic conditions. Carn. Instit. Wash. Publ. 284. 1921.

Objectives

Methods

Vegetation
Vegetation map of the United States
Species
Pinus ~~edulis~~ strobus - Plot distribution of a species from each vegetation region
Climate

Correlations

Vegetation
Northern mesophytic evergreen forest (east)
Species
Pinus edulis

Conclusions — no correlations found —

III. The history and classification of vegetation

How may vegetation be classified into useful and significant units?

1. The classification of vegetation
    - The primary types of units
        - Major world formations (grassland, forest)
            - Continental formations (coniferous forest, deciduous forest)
                - Major associations or communities (oak-hickory, beech-maple)
                    - Minor associations or communities (within oak-hickory)
                        - Alluvial forest, gravel bar, swamp, pond, glade, cove
                    - Micro-communities and sub-communities (strata, seasonal aspect, mosses on bark or leaf)
    - Descriptive terms used especially for formations and major association
        - Life-form
        - Physiognomy
        - Climate
        - Floristic composition
            - Basic objectives in description: relation of vegetation to climate
historical (succession)
pure description

(Example of life-form classification: Raunkier)

Phanerophytes, buds 25 or more cm. above ground
Chamaephytes, buds 0-25 cm.
Hemicryptophytes, buds on the ground and protected
Cryptophytes, buds beneath ground or water
Therophytes, annual plants

A life-form spectrum:

	Ph	Ch	H	Cr	Th
Death Valley	26	7	18	7	42%
Seychelles	61	6	12	5	16
High alps	0	25	68	4	3

Descriptive terms used especially for minor communities and micro-communities

1. Species list
2. Density: number of individuals
3. Frequency: number of quadrats in which a species occurs
4. Cover: area of crown
basal area
5. Sociability: degree to which plants of a species grow together
6. Vitality: size, flower and fruit production
7. Periodicity: season phases
8. Stratification: tree crown layer or strata, shrub layer, herb layer
9. Presence: regularity with which a species occurs in a series of stands
10. Constance: same as above but for quadrats
11. Fidelity: degree to which a species is confined to a kind of vegetation

Basic objectives in description: the same as those of the higher units, but descriptions in more precise terms so that they can be analyzed and compared

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10/20 - Hist + classification of vegetation

1. How classify vegetation?

a. Major world formations.

Continental "

Major associations or communities.

Minor " " "

Micro-communities or subcommunities.

Grassland or woodland (evergreen vs deciduous)

See Livingston + Shreve for continental formations.

(Mo. is in E. deciduous forest)

Beech-maple, oak-hickory as major associations

Alluvial forest within oak hickory association

or sand dunes (local communities)

or gravel bars

or prairie types

Within preceding types - stratification (heights of plants - 1st, 2nd, 3rd story) seasonal grouping - as in spring one type of plant is dominant for that region.

What terms to base classification of various groups.

1. Climate - necessary to classify world's climate first - Temp., rainfall, seasons.
2. Physiognomy - total aspect of plant - based on as many characters as possible - ligneous, herbaceous, etc.
3. Floristic - the dominant plants found in a region.

4. Morphological characters - ex leaf size + again the dominant form - broad-leaved

5. growth form, size of leaf = life-form - selecting 1, 2 or 3 characters only for determination.

Pl Geo 10/20/24 (cont)

Raunkiers life form classification

1. Phanerophytes – 25+ cm (bud level)

2. Chamaephytes – ground to 25 cm.

3. Hemicryptophytes – buds at surface, protected (ferns)

4. Cryptophytes – buds below ground or water level.

5. Therophytes – annuals

Raunkier considered bud position as vital, and that these positions would aid in classification.
An example of how these work

	1	2	3	4	5
Death valley	26	7	18	7	(42)
Sechelles	(61)	6	12	5	16
High alps	0	25	(68)	4	3

Nos = percentage of total species in area considered.
Bug in this is that high percentage might be relatively rare species.
Raunkier falsely assumed that introduced species would fit into the "normal" spectrum – many examples prove this wrong.

Present tendencies –
Based on physiognomy – a general aspect system w/o adaptive features being considered, but usually a combination of all methods.

10/20 – Classification of small units, as Missouri-an oak-hickory forest association.

1. Floristics is most important – in terms of species & plant associations – dominant species, or plant communities. For ex – sandbar would be the Salix association; glades – andropogon; woodland – stratification – tall trees, small trees, shrubs, herbs – or vitality in general – abundance of fl + fruit of species in this area. Distribution of individuals within the area (density or frequency).

2. See Oosting Chart on techniques – Type of things to be analyzed.
   1. Species list.
   2. Density – no. of individuals.
   3. Frequency – no. of quadrats in which species occurs. (100%, 50%, etc)
   4. Cover (1) crown area (how much ground area does crown of tree influence).
      (2) Basal area – how big is base of stem.
   5. Sociability – by itself, or mixed w/ others
   6. vitality.
   7. Stratification.
   8. Periodicity
   9. Presence – regularity of occurrence of a species
   10. Constance – quadrat method applied.
   11. Fidelity – degree to which a sp. is confined to that particular type of vegetation – if found only on glade, has high fidelity.

(9–11: important in comparing with other slopes, but not so hot for individuals.)

Importance of all this is for comparison with other similar situations in other localities.

2. The distribution of vegetation

The vegetation of the world (Map from Schimper)

- I. Luxuriant tropical rain forest and monsoon forest
- II. Less luxuriant tropical rain forest and particularly monsoon forest
- III. Xerophilous woodland of a tropical stamp, savannah forest and thorn forest
- IV. Temperate rain forest
- V. Sclerophyllous woodland
- VI. Summer forest
- VII. Grassland
- VIII. Grassland as a climatic formation, woodland as an edaphic formation, more or less abundant
- IX. Park-like landscape, meadow and forest in temperate zones with cold winter
- X. Desert
- XI. Alpine desert
- XII. Tundra
- XIII. Semi-desert

Discussion:

1. Tropical forest -
    - Central America
    - South America — Largest in Amazon valley
    - Africa
    - Malayasia
2. Temperate forest
    - North America
    - South America
    - Eurasia
    - Australia and New Zealand
3. Grassland and park-land
    - North America
    - South America
    - Africa
    - Eurasia
    - Australia
4. Deserts
    - North America
    - South America
    - Africa-Asia
    - Australia
5. The vegetation of North America

Characters of trees of tropical

1. No. of species usually high
2. No "pure" stands.
3. Trees large, w/ thin bark + smooth bole.
4. Freq. develop. of plank buttresses (partic. Sterculiaceae
5. Not greatly branched.
6. Leaves pretty much the same shape - ovate, glossy, thick.
7. Leaves + twigs completely pendent when young, they are essentially wilted (not turgid).
8. 2-3 stories of trees
9. Whole region taken up w/ plants - herbs, shrubs, trees, lianas, mosses,
10. epiphytes cover all branches - trees growing on trees, herbs, etc.
11. Aerial roots
12. Epiphytes more or less xeromorphic, depending on whether low or high.

10/27 – The rain forests of the Amazon valley are typified by an abundance of Bromels – none, or few in Asian + African rain forests. Epiphytic Cacti another character of American tropical rain forests. Araceae important in both Malaysian + American. Palms common but not abundant in rain forest.

African rainforest more of an open type – a vaulted appearance, not rich in no. of species. Not so much undergrowth. Greater no of individuals of a species growing together.

Malaysian I has many palms – particularly the climbers – Calamus + Raphia – Araceae, Piperaceae important. Ficus more impt. in Malaysia than American. Most sp. of Ficus start as epiphytes, later becoming ~~later~~ ground plants. Asclepiadaceae important as lianas. ~~Hymen~~ Epiphytes – Hymenophyllaceae important. Ericaceous shrubs as epiphytes.

Temperate frests – (summer forest of Schimper)

Characters

1. Few in epiphytes – Polypodium polypodides is farthest north extension of ~~true~~ epiphytes.
2. Essentially a pure forest.
3. Herbaceous + shrubby plants primarily a spring flora.
4. Leaf – shape variable.
5. Few lianas.
6. Cauliflory is rare, (does occur, but not extensively, exclusively in tropics) Cercis canadensis is an exception. Due to dormant buds
7. Well-developed bark –

In Eurasia – essentially same genera occurs as in N.A. both deciduous + conifers (mostly diff. spp.)

In S. American small temp forest w/ Fagus, Drymis (Winteraceae). Fairly moist w/ Hymenophyllaceae + Hepaticae

In Australia - temp forest of tree ferns + Eucalyptus (moist) pure Eucalyptus (dry).

New Zealand - largely tree ferns w/ some gymnosperms of enormous dimensions (ex. Dammara "Kauri", + Podocarpus is abundant). In dryer forests Fagus + Nothofagus are extensive.

Grass-lands - (Schimper differentiates here savannah + step, the former is park-like w/ scattered trees + steppes all grass). Savannahs somewhat moister + stepp dry.
Characters.
1. Grass predominant. Savannah up to 6'. in Steppe, generally fewer & high.
2. Perenial herbs w/ bulbs, corms or rhizomes (underground storage organs).
3. Drier - open ground - not complete covering of soil.
4.

In S. America - Guiana - sedge predominate.
Southern - grasses, legumes + compositae predominant.
In Brazil, in savannahs, the Vochysiaceae form predominant trees.
In Argentina - pampas - Stipa + Melica important - developed into tufts. Plus shrubby compositae i.e. Baccharis. Tho shrun composites are undershrubs to the grasses.

African grass - savannahs - mostly of Paniceae, savannahs of Andropogoneae - Composites few, but many legumes, herbaceous + in savannahs Acacias predominate as trees. Adansonia (Baobab) is most important tree - (Bombacaceae) 27" diameter, but not very tall, not much branched. Rather scattered. Trunk is spongy - water storage.

EurAsian - Stipa impt. grass. Amaranthus, + Artemisia (composite) plus bulbous Lilliaceae)

Desert regions (generally unequally distr. damp season. Landscape (physiognomy) predominate

1. Characters of plants.
   1. Mostly annuals.
   2. Ephemeral leaves.
   3. Red. branchless stems, thorns present.
   4. Succulence of stem + leaf.
   5. Very large underground parts

Africa - 2 - N Afr. Family - Zygophyllaceae most impt.
A remarkable cucurbit is Citrullus colocynthis in dryest regions with an enormous root system - depends on subterranean water rather than ephemeral rainfall.
Tamarisc is important here.
Stapholea (Asclepiadaceae) looks like a cactus
S. Afr - strong development of bulbous monocots (Iridaceae + Amaryllidaceae) plus Aizoaceae such as Mesambryanthemum - "rock plants".
Welwitsia is found here.

In north Africa - Artemisia has a parasite of Orobanche - + in S. Africa - Euphorbia has " " " Hydnora.

Asian deserts similar to African - Chenopods developed as desert plants -

South American deserts developed on west coast.
Equadorian deserts driest in world - only a few annuals.
Farther south characteristic "fog" forest which frequently produces a forest in the middle of the desert.
The Argentine desert similar to those of our southwest.

North America - see Transeau for major regions.

Main types characterized as to common species (the original vegetation).

1. Tundra - primarily grasses + sedges, dwarf shrubs Salix + Ericaceae

2. Boreal (coniferous) forest - Picea glauca, Abies balsamea, Larix laricina, Picea mariana + Pinus banksiana.

3. Hemlock hardwood (N.E.) great mixture of species - Tsuga canadensis, Betula lutea + Acer saccharinum.

4. Deciduous forest - Fagus, Liriodendron, sugar maple. Quercus alba, Tilia, Castanea (chestnut); hickories + a no. of sp. of oak in the drier regions (i.e. Missouri).

5. S.E. Evergreen - primarily Pinus sp. - P. palustris, slash, pitch + loblolly - occurring as pure stands in dense forest or savannahs mostly on humus
In swamps - hardwoods - along streams - cypress, Fraxinus profunda, Acer rubrum + Nyssa aquatica.
In pine forest, + upland generally, fires + destruction by man - climax has been obscured.

6. Grassland - eastern 30"+ rainfall - tall grass - western - less rainfall, the short grass.
Eastern is richer in sp.
Western - Bouteloua, Buchlöe dactyloides + Aristida sp.
Eastern - Andropogon furcatus + scoparius, Sorghastrum nutans, Stipa spartea + Bouteloua curtipendula. Asters, Solidagos, Helianthus + other composites Leguminosae well developed.

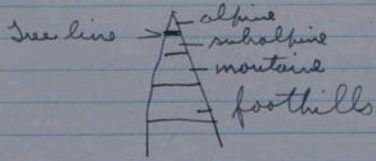
7. Desert - great basin area, exclusive of mountain ranges, sage-brush Artemesia tridentata - saline soils. Atriplex, Kochia + Salicornia present on salt flats. Mojave - creosote bush Larrea + Yucca brevifolia. Sonoran desert - Cacti + Carnegia gigantea - opuntias, mesquite, Prosopis

Geography 11/3/49

Read article in House Beautiful - ~~July~~ Oct. 1949 p. 146
"How to pick your private climate".

Vegetation of N. Am. cont.

Rocky Mt. Forests.
Zonation is a complication.



Sub-alpine characterized by Picea Engelmannii
Abies lasiocarpa
North → Tsuga mertensiana + Picea glauca

Montaine - Abies concolor, Pseudotsuga taxifolia +
Picea pungents
at lower elev. of this belt Pinus ponderosa, which
blends into foothills, with a Park-like aspect.

Foothills - no. of spp. of Pinus + Juniperus plus
Quercus + Cercocarpus at lower elevations of this zone.

Coastal forests - 2 regions - Sierra Nevada inland + coast proper.
Zonation as above evident, plus another complexity - the
west zone wetter than eastern side, with the zones
tilted

Subalpine - Red fir, Pinus contorta, lodgepole pine.

Montaine - Abies concolor, Pinus Lambertiana + Libocedrus
decurrens - farther north, Pseudotsuga comes in.
and Sequoia gigantea.

11/31 (cont)

Foothills - Pinus sabiniana + many spp. of oak.
this gradually going into plain, desert or scrub.

Pacific coastal belt most luxuriant of the two coastal belts, particularly thru Oregon & Washington.
The zonation not so extreme here.

Tsuga heterophylla
Thuja plicata
Abies grandis
Pseudotsuga

North from this region Picea sitchensis + Tsuga mertensiana + again Tsuga heterophylla.

Southern part (California) more complicated -

Sequoia sempervirens - in moister N. Calif.

Farther south (drier) - Broadleaved sclerophylls (trees) and chaparral (shrubs)

Quercus spp.
Castanopsis
Arbutus

Ceanothus arctostaphylos
Adenostoma fasciculata -

Chihuahuan desert —

What changes in vegetation have taken place in the past? Why? How?

3. The history of vegetation , 1. In terms of individual species

a. General considerations

Establishment

Growth

Extinction

Evolution 1- On a long time basis (impossible to study). 2- of macro races -

b. Intra-Areal changes– change within framework (ie. glade, creek-valley - occurring under relatively uniform habitat) - not affecting general type. Growth + death important here. Relative [illegible] of [illegible] stable. Growth (over

c. Inter-areal changes

Changes in plant associations (indirect change)

Succession

Changes in major vegetational units (direct change)

Gleason, H.A. The vegetational history of the Middle West. Ann. Assoc. Amer. Geog. 12: 39-85. 1923.

Distribution of vegetation during the Wisconsin

Early post-Wisconsin migrations

Development of the prairie

Forest migrations

Final prairie dominance

Final forest advance

increases crown spread of trees + increases size of colonial sp. Periodic seasonal fluctuation within a norm - over a 20 year period, same fluctuations generally occur. This is a relatively unimportant class as far as vegetational changes go.

c. Inter-aerial change - migration into an area of different type of vegetation.

2 Essential types - based on concept of a stable vegetation

1. Stable veget. developed by series of vegetations

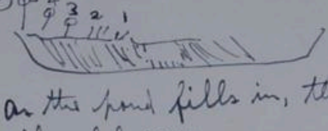
This is succession

(By stable vegetation is meant one that will remain the same as long as climatic conditions remain the same.)

Habitat is changed by the vegetation rather than by physiographic changes.

Ex. Development of a forest on a lake.

Developed first as floating + submerged aquatics.
By accumulation of detritus - reeds + cattails (stoloniferous)
Carex + sphagnum (in regions protected from wave action.
After sphagnum - shrubs - deposition of peat. (Floating mats)
Sphagnum starts only when pH is low.
$CaCO_3$ is deposited by plants (marl)
Zonation occurs -



As the pond fills in, the trees (Larix) will grow out over the whole area.

2. Stable vegetation changes directly into another type

Ex- sand dune changes

Secondary succession occurs after catastrophic forces -

Geography 11/10 –

Primary succession

"The new flora of the Volcanic Island of Krakatoa" by Ernst, A. Transl. Seward Cambridge 1908 (in Lib. 92).

History – Aug 26-27, 1883 – the whole island blew up with a sound heard 3000 miles away – fragments carried 750 miles, and fine dust circled the globe. About 4.4 cubic miles blew up. Waves after explosion noted in Atlantic –

By 25 years, a good flora developed – strand plants + grassland. In mountain, ferns + orchids developed. Higher vegetation came back much faster than expected. All plants appearing were wind, water or bird (dispersed) spread. The common species of neighboring lands were there.

Vegetational changes due to physiography or climate.

1. Physiographic changes more minor than climatic – i.e. – lowering of water table, silting in, building up of fore dunes, on a cliff, talus slopes. Post glacial swamping etc would be of major imp.

2. Climatic changes – of major importance – a tendency to variability from wet to dry for ex – occurring over a period of 500,000 years – Cause invasions of grassland into forest, forest into grassland or perhaps grass to desert.

1. Evolutionary change – fundamental over long time.

2. Climatic change – over long periods important.

3. Physiographic –

4. Successional change

5. [illegible]-areal change

Gleason - The Vegetational History of the Middle West -

1. Starting w/ maximum extent of Wisconsin ice .60,000 yrs ago
Six vegetational groups
1. Tundra
2. Coniferous "Boreal" forest - includes some of the hemlock + white pine
3. Prairie ~~of~~ or grassland.
4. Coastal plain - does not include tree species of present
5. Deciduous forest
   1. Alleghany } essentially same position as today
   2. Ozarkian } but then relatively close to the ice.
6. ~~Prairie - same~~ local.

Reasons for distribution based upon relic colonies of plants.
The tundra was a very narrow band, next to ice.

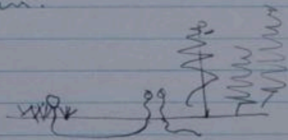
Climate at this time about the same as today, but drier.

30,000 BC marks appreciable retreat of ice - producing a drier + warmer period "Xerothermic Period": The tundra + coniferous forest increased, the prairie advancing both north + south (because of drought), decreasing the deciduous forest considerably.

Mechanics of movements -
1. Tundra - **next** to ice because of raw "soil", too wet. The tundra retreats with ice due to changed climate, drying up of soils, as the more southern plants advance.
2. Grasslands advance due to excess transpiration, particularly in winter - will kill off the trees, by hot, dry winds.

Attenuation - the plants didn't all advance at the same rate, causing a differentiation - the more the ice retreats, the lower the no. of species northward.

10000 BC - closed the Xerothermic period - not much change in temp, but increased precipitation, particularly increased in winter - this favors forest over grass. Increased water permits seeds of trees to grow in grass - in addition, sumacs or other shrubs with rhizomes could encroach upon the grass land, and after shrubs, trees could come in.



The deciduous Allegheny forest migrated westward, rather than the Ozarkian forest, since the Ozark forest was separated by a wide band of prairie.

Movement of E. coast strand plants westward occured during time when there were extensive lakes in the regions recently covered with ice.

Diff. in relics between Illinois + Indiana conifers + that of Ohio -

(1) Bog species - Thuja,

(2) Upland species - Abies balsamea

Relics of Ohio are both types, but only upland relics in Illinois + ~~Ohio~~ Indiana.

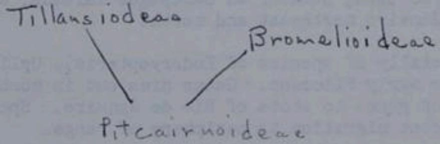
IV. The History and Distribution of Natural Groups

1. Tryon, R. M. Jr. Dynamic Phytogeography of Doryopteris. Amer. Journ. Bot. 31: 470-473. 1944.

   a. Phylogeny.
      Section Lytoneuron (free veins, unspecialized scales) is primitive,
      Section Eudoryopteris (areolate veins, specialized scales) is advanced.
      D. triphylla is the most primitive species.
   b. Place of origin of the genus.
      Ranges of primitive and most highly advanced species are mutually exclusive. Origin within or near present range of D. triphylla. Southern tip of Brazilian Highlands chosen because of age. Time: Early Miocene.
   c. Migration routes.
      Determined by adding species ranges to that of D. triphylla in phyletic sequence. Migration across northern Argentina to Andes, north to Colombia, east to Venezuela and British Guiana; a slower migration northeast toward Rio de Janeiro. Final migrations: Colombia to Mexico, northern South America through lesser Antilles to Cuba, Ecuador to Galapagos Islands, e. Brazil to Ihla Trinidade, Rio de Janeiro northeast and north.
   d. History.
      Initial migration (especially of species of Eudoryopteris). Uplift of the Andes in late Miocene or early Pliocene. Genus dies out in north central Andean region. Spread of genus to state of Rio de Janeiro. Speciation in section Lytoneuron. Recent migration to periphery of range.

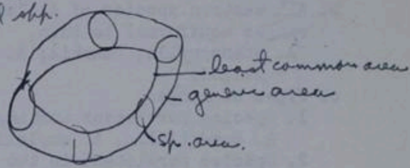
2. Woodson, R. E., Jr. Notes on the "Historical Factor" in Plant Geography. Contrib. Gray Herb. 165: 12-25. 1947.

   a. Areas in eastern North America continuously available for habitation by plants; Ozarkia, Appalachia, (Driftless Area) and Orange Island. The first three since the Paleozoic, the last since the Eocene or perhaps earlier.
   b. All eastern species of Asclepias can be referred to one of these refugia by ranges equiformal to them.
      A. stenophylla, Ozarkia; A. phytolaccoides, Appalachia; A. lanceolata, Orange Island.
   c. Types of ranges.
      1. Species persistent unchanged in two or more refugia:
         A. quadrifolia, A. amplexicaulis, A. purpurascens.
      2. Species persistent in two or more refugia but evolved into subspecies:
         A. tuberosa tuberosa, interior, Rolfsii
         A. incarnata incarnata, pulchra.
      3. Ancestral species persistent in two or more refugia but evolved into 2 vicarious species:
         A. perennis-texana, Appalachia-Ozarkia.
         A. hirtella-longifolia, Ozarkia-Orange Island.
         A. Meadii-obovata, " " "
         A. viridis-connivens, " " "
      4. Species endemic to one area.
         Vicarious but pair unidentifiable?
         Old species never occured elsewhere?
         Old species, extinct in other refugia?
         A. stenophylla, phytolaccoides, Nuttalliana, lanceolata, rubra.
      5. History.
         Species restricted in range by Cretaceous submergence, 70 million years ago. Orange Island remains isolated until the Pliocene, then species



Cohesion ratio -

Least (smallest) common area (to all spp.)
must include as small an area as possible with a little of all spp.



The cohesion ratio is the comparison of least common area to generic area.

may spread from it. Ozarkia and Appalachia ranges are not restricted to the north until Pleistocene glaciation. Meanwhile, after post-Cretaceous emergence species may spread south, east and west. Xerothermic period restricts ranges to the north and west. Various amounts of migration since then. Species may spread at any time land is available but new habitats and vegetations may act as barriers.
    Example: A. amplexicaulis.

3. Woodson, R. E., Jr. Some Dynamics of leaf variation in Asclepias tuberosa. Ann. Mo. Bot. Gard. 34: 353-432. 1947.
    History of the species, Cretaceous to Pleistocene, as above.
    Pleistocene to present: introgression of the three subspecies.
        crests of variability
        spread of leaf character of angle B.
    Future history: evolution of the subspecies, increase in variability.
4. Smith, L. B. Geographical evidence on the line of evolution in the Bromeliaceae. Bot. Jahrb. 66: 446-468. 1934.
    a. The subfamilies.
        Capsular series:
            Pitcairnioideae: appendaged seeds, unspecialized scales. – terrestrial
            Tillandsioideae: appendaged seeds, specialized scales. – epiphytes
        Baccate series:
            Bromelioideae: unappendaged seeds, specialized scales, epiphytes
    b. Capsular series.
        Which subfamily is primitive? Pitcairn. have genera with small ranges, Tillands. have genera with large ranges. According to Age and Area the Tillandsioideae would be primitive. But epiphytic habit and better means of migration may explain larger ranges. Evidence from cohesion ratio:
            The least common area.
            Tillandsioideae genera show little cohesion, Pitcairnioideae genera show much cohesion, hence it is primitive.
    c. Bromelioideae
        Derivation and migrations.

5. Smith, A. C. and M. F. Koch, Espeletia, a study in phylogenetic taxonomy. Brittonia I: 479-530. 1935.

Genus distributed in northern and northwestern South America.

Ecology: confined to paramos, i.e. alpine meadows above timberline, except E. nereifolia.

Adaptive morphology: woody caudex, mostly below ground, xeromorphic leaves.

Pollination: pollen with spines, insect pollinated.

Phylogeny: 5 groups of species, one species, E. nereifolia is primitive in morphology and in ecology. It is close to Polymnia and grows at lower elevations.

Distribution of the species-groups: On one paramo there are 17 species and all 5 species-groups. All other paramos have no more than 4 species and all of the same species-group.

History of the genus: Start with 5 species, each a basic one for future species-groups. Time: post-eocene because distributions show no correlation to Eocene submergence in northern South America. If genus existed then the effects of the submergence have been lost.

Evidence from E. nereifolia and its present habitat is that species migrated to paramos and changed as they did. They became isolated in the change from continuous lowland to isolated alpine habitats. This would relate speciation to the uplift of the Andes and to Pleistocene glaciation.

Uplift of the Andes (late Miocene-early Pliocene): Range of basic species are disrupted. Pleistocene glaciation: isolated habitats but at lower elevation than now. Post-Pleistocene: spread of species to present elevations.

Evolution in one species-group: The basic species consisted of many biotypes, these more abundant in some areas than in others. As the range was dissected, these biotypes were isolated. A single isolated biotype would evolve into a single isolated species. Several biotypes in one area would evolve into as many species by biological isolation. (insect pollination, no pappus etc.).

General conclusions: This type of evolution, splitting up of a few basic species into many local ones is common when small areas become isolated. Later spread of the local species, or their derivatives, may give rise to several very similar species of doubtful phylogeny. The earlier history of such species is easily obscured by recent migrations.

6. Constance, L. and R. H. Shan, The genus Osmorhiza (Umbelliferae). Univ. Cal. Publ. Bot. 23: 111-156. 1948.

Illustration of three basic types of disrupted ranges: bipolar, eastern North America and eastern Asia, eastern and western North America.

V. The history and distribution of Floras.

A flora is all of the species of plants that grow in a given area. For practical purposes discussion is confined to the higher plants. It is not necessarily a natural homogeneous unit but rather is usually a mixture of natural units, the floristic elements.

1. The floristic elements of eastern North America.

Arctic and alpine

Boreal (Canadian Forest)

Appalachian and Ozarkian

Coastal Plain

Prairie

Strand and sea grasses

Weeds

A floristic element is a natural unit only if it is defined so that the species have had a common history of route and time of migration into the Flora area. The above floristic elements are major types, each having several natural units within them. The natural units are usually more theoretical than real because of the difficulty of accumulating sufficient evidence of their history. Although the entire flora may theoretically be organized by floristic elements, actually many species will not clearly fall into any of the elements and many will be placed in different elements by different persons.

2. History of the flora of eastern North America during the Quaternary.

a. Pre-Pleistocene flora and the general effects of Pleistocene glaciation.

Flora a mixture of many of present floristic elements; undifferentiated. Four major advances of the ice results in a differentiation of the flora into elements of similar habitat requirements and similar variability.

Species that migrate north and south with the advances and retreats of the ice have many biotypes and are plastic. They are variable in genetics, physiology and morphology. Species that become almost extinct in the glacial periods have very few biotypes and are rigid. They are rather uniform in genetics, physiology and morphology.

In post-Wisconsin time those species with similar habitat requirements and similar behavior migrate as a group and represent a differentiated floristic element. Arctic and Alpine and Boreal elements have particularly had this history. The northern parts of the Appalachian-Ozarkian element have also. The Coastal Plain, Strand and Prairie were probably differentiated more by broad climatic and habitat differences than by the glacial periods.

b. The Coastal Plain floristic element.

Fernald, M. L., Specific segregations and identities in some floras of eastern North America and the Old World. Rhodora 33: 25-62. 1931.

Fernald, M. L., A century of additions to the flora of Virginia. Rhodora 42: 355-404 (maps); 503-521. 1940.

McLaughlin, W. T., Atlantic Coastal Plain plants in the sand barrens of northwestern Wisconsin. Ecol. Monog. 2: 335-383. 1932.

Peattie, D. C., The Atlantic Coastal Plain element in the flora of the Great Lakes. Rhodora 24: 57-70, 80-88. 1922.

Species are primarily of Austral affinities and often are of old or primitive groups.

I. Species with stations in the Appalachian and/or Ozarkian uplands.

Existed on those areas during the Cretaceous when they were low. As the peneplain rose they migrated to the emerging Coastal Plain, leaving relict colonies in suitable localities.

II. Species centering on Orange 'Island'.

Orange 'Island was a series of small islands, emergent and submergent at various times from the Eocene (or earlier) to the Pliocene. At that time the area was permanently emergent and became united to the mainland. Flora contained species from Ozarkia, Applachia and probably from the West Indies. In post-Pliocene times these have spread onto the Coastal Plain proper.

III. Species exclusively or predominantly in tropical Florida.
Mostly wide-spread West Indian species. Relatively recent arrivals by water or hurricane.

IV. Species on the northern Coastal Plain with extensions to Nova Scotia and Newfoundland.
Coastal Plain from Long Island to Newfoundland was submerged post-Miocene or probably post-Pliocene. Species spread north when it was emergent, spread to the present coast and persisted during the Pleistocene. (?)

V. Species with extensions into the glaciated Midwest.
Some species migrated in early post-Wisconsin time from the Coastal Plain up glacial rivers (now the Hudson and Mohawk) and along the shores of the large post-glacial Great Lakes as far as the Indiana Dunes, central and northwestern Wisconsin and east-central Minnesota. Others migrated northward along the Mississippi and Ohio river systems from the Mississippi Embayment.

c. The Strand floristic element.
History similar to V (above) but many species probably entered the Great Lakes system through the Gulf of St. Lawrence after that was free of ice.

d. The Arctic-Alpine and Boreal floristic elements with special reference to persistence in glaciated regions.

Fernald, M. L., Persistence of plants in unglaciated areas of boreal America. Mem. Amer. Acad. A & S 15: 239-342. 1925.
Fernald, M. L., Critical plants of the upper Great Lakes region of Ontario and Michigan. Rhodora 37: 197-222. 1941.
Hulten, E., Outline of the history of the arctic and boreal biota during the Quaternary period. Stockholm, 1937.
Raup, H. M., Botanical problems in boreal America. Bot. Rev. 7: 147-248. 1941.
Wynne-Edwards, V. C., Isolated arctic-alpine floras in eastern North America. Trans. Roy. Soc. Canada, Sect. V, ser. 3, 31: 1-26. 1937.

I. Fernald: Collected in Newfoundland and Gaspe, found many very rare or endemic species. These were of two types: a) with Cordilleran affinities; b) with Arctic affinities. Species generally found growing together in limited areas at high elevations.

Proposed that species were widespread prior to the last glaciation, that the ice exterminated the species except south or north of glaciation and on nunataks within the glaciated area. Some geologists agree with the unglaciated nature of the areas.

After the ice had disappeared most of the species did not spread at all or did not spread for from the refugia because they were senescent and conservative.

II. Wynne-Edwards: Possibility of survival on nunataks; arctic species could, but not mesomorphic Cordilleran species. A number of these do not grow very far north today in the West. Geological evidence: Sound in some cases. But relicts also occur on hills at Bic and on Mingan and Anticosti Islands. Bic was either completely glaciated or had an extremely small nunatak. Both islands were completely glaciated and Anticosti (probably Mingan also) was submerged by the post-Wisconsin Champlain Sea.

Proposes: Relicts are actually species with special habitat requirements. They grow on basic rocks. They do not grow on acid rocks, even in a nunatak area (Tabletop Mt., Shickshock Mts.). Species spread north after glaciation and have occupied suitable habitats. They have not had time to occupy all of the suitable habitats.

III. Hulten: First sees the fact that species have similar ranges. Assumes that those with similar ranges have had a similar history, i.e., similar route, source and time of migration. Formulates theory of Equiformal Progressive Areas: "When a number of species spread from a common source, their areas assume a concentricity around the place from which they radiated. Those plants which have equiformal areas of different size have radiated from the same centre, and this centre can be found if the area of as many species as possible belonging to the group are compared."

Maps world ranges of all species occuring in Beringia; sorts these into groups with similar ranges. Gets Equiformal Progressive Areas. Notes the positions of the centra of the groups. Finds a correlation with the known facts of glaciation. Each centrum contained a refugium.

Flora of Beringia was originally widespread, cut into segments by each advance of the ice, spread back into glaciated regions during each interglacial. Species that have not spread much are rigid (uniform population.) Species that have spread widely are plastic (variable populations).

Geography 11/17
Floristic elements.
Spp of similar ranges w/a similar history.
How long similar?
Nearly always correlated w/general climatic & physiographic areas.
Historical factors - the previous distribution of spp is important
i.e. - an old isolated land-mass spp. - later joined to other area - the original spp. will spread to the new area reflecting the shape of ancient land mass.

Distribution & history of natural groups -
1. Doryopteris - American Journ. Bot. 31: 470-473, 1944.

12/1 - Historical factor - tendency for seedling to become established near the parent plant. Does not relate to physiographic or geologic history. Interpreted from standpoint of biology of plant itself.
Environment not the only factor of pl. distrib.
Plants do not migrate over great distances.
Spp. do not invade a mature vegetation.
Spp migrate slower than means of dispersal allow.
Important thing is the ecological matter of dispersal and growth in that region - meeting the competition of established vegetation.
Most sp. have ranges not expected if methods of dispersal were great.
Plants w/light seeds or spores travel great dif distances, but distri. patterns are very similar to those w/heavy seeds.

Equiformal areas - described by a slow migrating sp. - cf - must change pattern of distrib. overnight - makes slow, and similar distributional development.
As a sp. will show a certain type of distribution, a group of similar spp. will show a similar dispersal area.

An essential feature of equiformal area requires that the species exist at center of area, in addition to its dispersed area.

12/8 - A C Smith - Study of Espeletia - High Andean genus (growing in páramos) w/exception of 1 sp. Genus allied to Polymnia. Very heavy, hairy indument, resinous. See Smith + Koch - Espeletia; a study in phytogenetic taxonomy in Brittonia 1:479-530, 1935.

Constance, L + Shan, R.H. The genus Osmorhiza - (Umbelliferae) U of Cal. Bot. Publ. 23: 111-156, 1948.

12/15 - Study of Floras -

1. Flora - plants that grow in a region.

2. Floristic element - species with a common history.
Elements of E. N. America -
1. Appalachian - Ozarkian
2. Strand
3. Artic + alpine - very widespread thruout (little endemism)
4. Boreal (Canadian).
5. Plains or prairie
6. Coastal plain.
7. Weeds

1/5/50 History of floral elements of E. N. America.

1. The Coastal plain.

Pre-pleistocene distribution.
As ice advanced, progressive climatic belts -, only species that could migrate prevented from extinction. The most aggressive plants survived.
There were at least 4 ice advances + probably other minor ones.
These advances produced 2 kinds of species.
1. Rigid - relatively homogeneous genetically, with little migratory ability.
2. Plastic - relatively heterogeneous, capable of

migration, & varied genetically.

Artic & alpine genera - very poorly defined species, & rigid species wiped out.

Boreal vegetation - relatively few species with very broad ranges, the categories (sp. & genus) poorly defined.

Appalachian - Ozarkian flora, on the other hand, which was never glaciated, characterized by narrow endemics, rigid species which haven't had to migrate.

In the 1st two, species of similar physiological character would tend to move together.

Other regions, i.e. prairie, were little affected by glaciation. The strand & coastal plain probably existed far in the past.

The coastal plain & strand regions.

Three groups of plants.

1. Coastal plain proper -
2. Coast wise beaches (strand plants)
3. Between these 2 are land-locked bays, with brackish or partially fresh water, with plants that aren't strand plants, nor yet coastal plain.

~~[illegible]~~

1/12/50 - The Boreal & Arctic Floras

Hooker - Flora receded & advanced w/ the ice, and also up the mountains.

None (or very few) of the plants now found in N. Canada are endemics of narrow range, mostly wide ranging.

Fernald worked on endemics of Gaspe peninsula & Newfoundland - collected large no of endemics & rare species. In 1925 expounded his "Nunatak Theory".

Found localized species in the Gulf of St Lawrence region commonly have wide Western range

Divided plants into 2 groups –
1. Arctic alpine ✓

2. Cordilleran

If plants have had this ~~theory~~ history, why haven't they spread since glaciation.
~~Cole~~ Fernald called these species "senescent" and "conservative". The aggressive species spread from the ice-free refugia since they had not lost their ability to reproduce.

Wynn Edwards – proposed criticisms of persistency.
1. Possibility of survival on nunataks – nunatak isolated for 1000s of years during glaciation, and several of these areas were not on border of ice sheet but were some hundreds of miles from edge, so plants could not have existed under these terrific conditions. Some of the arctic species might have resisted the rigors of the climate he admits, but some of the Cordilleran species definitely do not have the structures to withstand such climate.

2. Geological evidence – 3 areas which he thought were not nunataks at all. these were: the Bic, Anacosta + Mingan. If these were not covered w/ ice, then probably were submerged. Since these areas weren't available, then there are no such relic species.

3. Theory he proposed is essentially same as Hooker's i.e. all existed S. of glaciation + have spread back. Notes that many sp are (calciphilous) – halophytes or grow only on serpentine, and thinks ∴ that it is a matter of habitat selection, because of narrow requirements. Don't occur on all suitable habitats because they haven't had time, or have had too much competition.

1

There are no Appalachian species which grow in the nunatak regions – This throws some doubt on the Fernald theory. Why didn't some of these species remain in this region.

References for + against Nunatak theory –

Raup – Botanical problems in Boreal America
Bot. Review Nos 3 + 4, 1941.

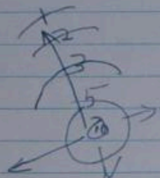
Wynne-Edwards – Isolated Artic-Alpine floras in eastern North America
Trans. Roy. Soc. Canada 3rd Series, Sec V 31; 1-26, 1937

Fernald. Persistence of Plants in glaciated areas of Boreal America – Mem. ~~Acad~~ Amer. Acad. A+S 15 No. 3, 1925.

" Critical plants of the Upper Great Lakes Region of Ontario and Michigan – Rhodora, 37: 197 et seq. 1935.

Hulten – Outline of the history of arctic and boreal Biota during the Quaternary Period. 1937. Stockholm.

Treatment based on equiformal progressive areas of present species.
Given a cleared area, w/ plants in center
1. All will migrate radially.
2. There will be different rates of migration of the different species.
3. All will finally fill the area.



If a series of species with similar ranges is built up, the areas will be equiformal. This will be progressive because species migrate from a center

He plotted ranges of 2000 species in Kamchatka + Bering sea islands.
Corelates centers of areas w/ known facts of glaciation.

Where all 8 species occur is the "centrum".
Each centrum contains within it a refugium where flo existed during last glaciation.

Uses Sewal Wright theory that species which were depauperated of biotypes and reduced in genetic variability by increased glaciation would not spread back as an interglacial species.

From centras are derived elementary areas, from which the species spread.

1/18/50 -
Hulten - species move slowly from refugia, at a rate of not more than a mile a year.

Insular floras w/ particular reference to the Hawaiian Is.

Characters of island flora.
1. Flora is poor
2. Each genus represented by few spp. (1-2).
3. Not hardly more than 2x as many sp as genera.
4. Relationship of species dependent on
   1. Nearness of continents - more sp near, less far.
   2. Larger the island the more sp.
   3. The higher the " " " " .
   These last related to habitats available i.e. coral only, few, but w/ other.
   Also relationship to age of island - problem here of dating the island.

These facts suggest spread of continental plants over ocean to the islands. The higher outlived islands will "catch" more wind dispersed spp. i.e. orchids + ferns than spp. spread by water or birds. Seeds w/ dispersal methods methodically spread over ocean routes.
Some sp. only irregularly present, and these w/o special dispersal mech. but occasionally show up - no method of explaining (perhaps on a log).

Evident that many migrules do not grow, even tho regularly dispersed from continent. This dependent on:

1. Proper habitat
2. Competition w/ existing vegetation.

Low islands w/ few habitats quickly covered w/ vegetation, excluding further invasion. A volcanic island, particularly w/ an active volcano will constantly open new habitats on cliffs + old lava flows as are available. This true in case of Hawaiian Islands.

Summary of Hawaiian flora:

1. Fosberg, F.R. - Derivation of the Flora of the Hawaiian Islands - in Zimmerman, E.C, Insects of Hawaii 1:107-119, 1948. - The flora not well known, further exploration necessary.

Lists 1897 sp. + var.
253 genera
93 families

These figures for vascular plants only. Represents a small flora for a tropical island.

	Endemics estimated	Ferns	Seed Plants
Species + varieties	94 %	65	95
Genera	12 %	8	13
Families	0		

These figures depends on specific + generic concepts - could be larger.

~~Endemism Ferns~~

Ferns have less endemism since more easily dispersed from continents -

1. Isolation ~~of~~ by geographic distribution cut down -

2. Time - not sufficient time to produce endemics.

There has been an invasion of at least 253 generic immigrants, unless some of the endemic genera have evolved into 2.

Fosberg says 407 immigrants to the island, figuring that each genus evolved into at least 12 closely related species - so that 407 is the base figure for species invading the island. Not all of the present species came in.

Fosberg estimates age of islands as between 5-10 million years. This allows 1 immigration every 20-30,000 years (i.e. this amt of time for 407 original immigrants to come in, one every ~~5-10~~ 20-30,000 years). His point is that there has been ample time to supply these immigrants & allow evolution - One hurricane of sufficient force to provide the present distribution.

Indo-Pacific 41%

Uncertain 10%
These so distinct there is no evidence for relation.

Austral (Pacific) 15%

American 17%

Boreal 3% 2000 miles (closest).

Pan Tropics } cosmopolitan } 14%

Name David G Rogers

Address

Subject Bty 465

Grade

Date 1/29/50

8

SOLD BY

Washington University

QUAD SHOP

Brookings Hall

2. Phylogeny in plant geography illustrated by Doryopteris.

Due to the absence of information concerning the present distribution of the American species of Doryopteris, their continuous ranges, it is necessary to examine the primitive and advanced morphological characters of the group to provide an adequate theory for its distribution.

The species group within Doryopteris which has the most primitive characters assumed oldest, and their distribution is considered to be the center of origin of the genus. Among other characters, open venation seems to be primitive, while closed venation is advanced.

The distribution of the oldest species group is centered in SE South America, and the oldest land mass in this vicinity was in the southern part of Brazil. Previous to the Miocene uplift

(2 Cont.) of the Andies, the whole of western South America (outside the Amazon basin) was available for distribution of the species. The genus migrated along this line, until at least part of the genus had reached the northwestern parts of South America, with extensions eastward into present day Columbia and/or Venezuela. With the uplift of the Andies, the western part of S. America became unsuitable as a habitat for Doryopteris, and consequently all representatives of the group died out, leaving the disjunction between southern and northern species.

Consequently, the regions of available habitat were extensions similar to the older ones, i.e. eastern Brazil for the older, more primitive southern stocks, southern Mexico, Central America, and the Antilles for the advanced northern members of the genus.

As the species of Doryopteris migrated, they became differentiated morphologically, but those species which remained in the area of the refugia in southern Brazil retained their old characters. By the time the species group of Doryopteris had reached the northern part of S. America, they had ~~been~~ evolved into an advanced type, and have remained so until today.

4. The characters of the family Bromeliaceae ~~had~~ divided the family into two distinct subfamilies, the ~~Pitca~~ capsular or baccate nature of the fruit being the major morphological distinction. Since the capsular fruits without any particular specialization would, according to the theory of age and area, make it ~~the~~ more advanced than the baccate group, it ~~is~~ necessary to provide a more compact and natural theory

of its present condition. S. Smith provided the "cohesion theory" of ~~primitive and~~ geographic ~~advanced character~~ distribution which is essentially as follows: those members of a group whose ranges were small, and a minimum line needed to connect all of their ~~the~~ ranges is essentially the same as the total range of the group, is ~~primitive~~ ~~older~~ primitive. This is true since the species within the group have become widely separated and differentiated, and this is indicative of age.

On the other hand, the species group which requires a much ~~as~~ smaller area to include ~~all of the~~ a portion of all of the species ranges than the total range of the group is considered to be advanced, since the species have not become sufficiently distinct and separated. This is indicative of youth.

This reasoning correlated much better with the morphological characters which are either primitive or advanced. In this connection, the terrestrial group of species in the Bromeliaceae, the Pitcairnoideae are the more primitive, and the epiphytic, baccate group, the Bromelioideae are the more advanced.

4. Since the present distribution of Espeletia ~~[illegible]~~ (in the northern part of S. America, mostly on páramos) does not coincide, or cannot be explained by the Cretaceous submergence of the region, a new theory must be provided. The present distribution of the 17 species is rather disjunct, with all of the species but one, confined to high alpine meadows or páramos. Most of the five species groups are represented on only one of the páramos, whereas the other páramos contain only one, two

or perhaps three species groups. Only one species is found off the páramos, and this species is most closely related to the allied genus Polymnia (?)

The apparent reason for this distribution is as follows: prior to the Andean uplift, the genus was represented by a group of primitive species with many biotypes. As the Andes became uplifted, these biotypes became widely separated, not in distance, but in habitat requirements. Since they became separated, the biotypes have become sufficiently distinct to be species, but they remain more closely allied to the species of the same páramo than to those of other páramos. The primitive area, or center of distribution is then considered to be the one páramo which contains more representatives of the species groups than any off the others.

6. Fernald's description of the nunatak flora shows that the areas which could maintain plants during the periods of glaciation, and the areas described have been agreed to by several geologists. In these areas, one of the pieces of physical evidence in his favor (according to Fernald) is the presence of tallus slopes which are aggregates + scraps of loose boulders of rough outline. Regions that were glaciated have been ground to smooth boulders by ice action. Plant evidence comes from the occurence in these nunataks of rare or endemic species, usually with large distributions in the unglaciated portion of the western U.S + S.W. Canada. According to this theory, the species previous to glaciation were widespread, but have not spread thru greater areas since that time due to "species senescence" or in other words, biotype depauperization.

Fernald divides the ~~groups of~~ endemics into two groups: Artic alpine + Cordilleran, depending on their present closest affinity.

Other species of plants which have not been confined to the nunataks are considered to be widespread since glaciation due to the fact that they remained aggressive, and have not become depauperate.

One of the most convincing arguments against the nunatak theory is the fact that none of the species of the Appalachian highlands is represented in the nunatak examples. If these species had wide western extensions, why should not a few of them also have ranges in the unglaciated Appalachian mountain chains.

From the physical standpoint, Wynne Edwards points out that at least three of the

2.

Name Rogers

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Date

so-called refugia could not have been extant during the glacial periods since if they weren't covered by ice, then they were submerged completely during interglacial periods. On these nunataks which did remain above the ice and were not later submerged, the endemic species do not always grow at the tops of the nunataks, but near the base, which in all possibility, was covered by ice. Further, the talus slopes cannot be too critical evidence for remaining unglaciated since weathering could easily produce the type of fragments left in these regions within the period since the last ice advance.

From the aspect of the types of plants exhibited by Fernald, especially the Cordilleran mesophytic species, could not have possibly withstood the terrific climate which surrounded the region extends throughout the Appalachian south of New York into northern Georgia and westward thru the Ozarks.

4. SE coastal evergreen forest-
From New Jersey south to southern Florida (exclusive of the tip) + west to eastern Texas. Composed largely of sp. of Pines - particularly P. palustris, + in the swampy regions, Taxodium distichum.

5. Subtropical + tropical southern tip of Florida - generally a mixture of the coastal plain element w/ a West Indian element (Swietenia mahogany, Bursera, ~~etc~~ + occasionally Hippomane, w/ coastal swamps of Rhizophora.

Voluble - vines that climb by twisting rather than by tendrils.

Gentianaceae - all herbs as distinguished from Loganiaceae which are trees, shrubs, or very rarely herbs.

1. Calyx frequently gamosepalous to a marked extent.
2. Corolla w/ glandular pits called "fovea"
3. Sometimes saprophytes or mycorhizic
4. Stigma is broad + 2-lobed as dist. from Loganiaceae which has spindle-shaped stigmas.
5. Frequently infundibuliform (narrow tubular) corolla.
6. " somewhat pleated.
7. Fovea may be replaced by a fringed corona.

Gentianaceae prominent north temperate plants.

Gentiana usu. bluish

Sabatia - SE. coastal plain plant - usu. pink-flowered. Pleiomerany in this genus.

Swertia - large herbaceous genera. Includes segregate Frasera - largely SE Asia + America

Halenia - petals spurred looks like Aquilegia. largely tropical, but freq. in south temperate

Nymphoides - a little floating aquatic - flr. solitary on long pedicels - water-snow flake.

Menyanthes - "Bog bean" - palustris. leaves palmately divided. Fls. in branched racemes.

Leiphaimos - colorless saprophytes - tropical.

Apocynaceae - tends toward woodiness, but w/ a number of herbs.

1. Latex plants.
2. Ovaries free, but stigmas united.
3. Fruit consists of 2 separate carpels.
4. The internal appendages of the corolla may be interpreted as stipules.
5. Stamens connivent about the stigma.
6. Pollen in tetrads.
7. The lobes of the disc suggest carpellodes (from the vascular bundles)
8. Apocynaceae mostly w/o stipules, but frequently w/ large ones. used to separate from Loganiaceae.
9. Largely tropical. Apocynums get farthest north.
10. ~~Vinca~~ Periwinkle - Vinca rosea - an annual - the only one in family actually is genus Lochnera

Plumeria - fls. white, fragrant - sp. rubra most commonly
cultivated "frangi- pani". About 6 other sp. in
tropical America.
Alamanda - large vine. much cult.
Nerium alleander - from SE Asia. named from Leander.
Amsonia - blue fls - infrequent - "dog-bane".
Strophanthus -

Asclepiadaceae. no trees in family.
Periploca - S. Asian vine - sub family w/1 pair of pollinia.
the pollinia are funnels.
Stapelea - cactus like desert plants.

THE MENDELIAN SINGLE FACTOR DIFFERENCE

As yet, there is no single definition which will accurately describe and explain a Mendelian single factor difference. This is due to our small knowledge of the actions and structure of germ plasm. We have not reached the stage when we may examine the fundamental units of our living matter, and our best efforts up to the present have been those which assume the presence of a body, and procede to describe what this body produces. Today, for the sake of convenience, we call this "body", or Mendelian single factor a "gene", and the single factor difference a "gene mutation".

The geneticist, the physiologist, and any other scientist interested in the structure and action of the gene has his own interpretation of this piece of material, and by considering all of the studies made, we may get some notion of the nature of this "thing".

From the standpoint of what a Mendelian single factor difference produces, we look at the F_2 generation of a cross between a dominant and recessive character. A Mendelian single factor difference is one which produces a 3:1 ratio. This is the classical definition, but most factors do not show such simple ratios. Many instances of this single factor difference have been described in both plants and animals and any issue of the Journal of Genetics will have at least one, sometimes more. The effects of a gene mutation are, for the most part minor, but may be striking in character. The color of the skin of an animal, the shape of a leaf, the pigment of the corolla, etc. are sometimes single factor differences.

The only time that a single factor difference is known to be present is when a character different from the normal or "wild" type shows up. Many single factor differences may have such a small expression in the offspring that it passes unnoticed.

The action of a gene may be confined to a single expression, or may be seen in several organs of a plant or animal in successive stages of development.

From the standpoint of genetics, a single factor difference is produced when a locus on a chromosome has been altered in some way, either by crossing over, by a change in the gene itself, or due to its linkage with some other factor.

To a physiologist, a single factor difference is produced when the side chains of a complex nucleo-protein have been altered or rearranged in such a manner as to produce some visible effect.

The nature of a gene is best shown by its characteristics: (Goldschmidt, 1938):

1. It is a highly active substance and it is potent in very small quantities.
2. The substance of a gene is doubled before each cell division, and is, therefore, capable of assimilation and growth.
3. The gene is able to undergo a definite, sudden, and in many cases, reversible change, called mutations.
4. The mutated gene is perpetuated in the same way as the original gene, is as stable as the original one, up to the moment of another mutation.

From these characters we must say that the body involved must be of definite structure, with the same structure persisting over the period of countless generations. This brings up the question of where in a living cell can such structures be found. Progressing inward from the cell wall or outer membrane, it is in no way possible to imagine any such structure existing outside of the complex protein substances of the nucleus. The contents of the cytoplasm are much too variable to provide any such constancy as is required of a gene. By this reasoning, it has been necessary to say that hereditary units are carried at definite loci on the chromosomes. This is not to say that there is no influence of the cytoplasm on hereditary traits, but for the most part, the nucleus, chromosomes, and more exactly, the genes carry on the characters of the plant or animal thru countless generations.

What is a gene? From an analysis of the materials within a nucleus, we may assume that the genes are complex proteins, with certain nuclear acids attached. Of how many molecules a gene is composed is a question beyond answer at present, except to say that it is variable. The gene may be a mold, or a die, by which parts may be stamped out, or it may have no direct action itself, but by the production of an enzyme or hormone, direct the formation of certain structures. Whatever the nature of these bodies, it is difficult to imagine any independent action. Rather, any mature structure is the result of many genes all working in a directed sequence.

With such a sequence in mind, we find it hard to understand how anything could be altered in this sequence without some catastrophic effect to the organism as a whole. Andit is true that most changes of this sequence are harmful, with only a few changes being for the better. It is not hard to imagine, however, that color changes would be one of the few places where a change in a regulated sequence might not be of a lethal nature, or minor changes in the shape of a leaf, corolla segment or sepal. However, if the gene mutation affects some part of the essential reproductive organs, such as length of stamen or style, then we find that any such change from the wild type has more chance of being destructive than constructive.

Environment cannot be disregarded in consideration of the operation of a Mendelian single factor. The effect of temperature, altitude, light, water, and other natural physical phenomena may appear to give the same results as gene mutations. Such has been well shown in the work of Clausen, Keck and Heisey, where material from the same clone, grown under varying environments produces a number of striking differences. This work shows that the genetic material is capable of adaptation to immediate requirements of an organism without alteration of the germ plasm. To know exactly what effect the environment plays in this matter requires the examination of each factor of environment and each single factor or gene involved. Obviously, such work is an impossibility, but until we have done this, we may only make hypotheses for gene action.

The present and future of life forms are dependant to some extent on the Mendelian single factor difference. Although any one such factor might not have noticeable effect on the success or failure of a species, the cumulative effect of a number of such changes could easily be the reason for the increase or decrease of that species. The Mendelian single factor difference is but one of many phenomena which have helped to evolve our present day flora and fauna. I am not capable of evaluating the importance of any of the phenomena as relates to their importance in evolution, but I am of the opinion that a great deal too much emphasis has been placed on the study of such isolated facts as have been made concerning the color, shape, texture, etc. of a rabbit's fur, or a pansy's flower. Such problems as these should be left to the practical breeder, so that the Journal of Genetics and other publications may be kept free for studies of a more fundamental nature. I do think that the Mendelian single factor difference has been over-emphasized as a factor in evolution.

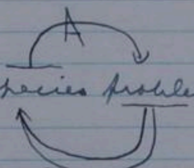
or the physiologist.

Back to the Facts. (but your paper is mostly theory)

1. Make study of hybrids of Odontoglossum
Miltonia
– iodasa

A. History of these hybrids
B. Morphology of the parents + hybrids.
C. Taxonomy – distribution

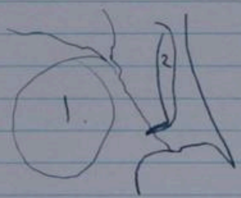
2. Microevolution
Methods of study
1. Data on the species problem



Andy's method

Differences between individuals = ?
" " species

Study of the Uvularia (sens. stric.) (Liliaceae)
sp. 1. grandiflora
2. perfoliata



Both spp. diploids, w/no difference in chromosomes.

dp dark pink
Lp light "
w white
b orange

y = yellow
Ly = light "

Rogers 3-18-50

Family 3 yellow (13) x white (15)

1. b
2. w
3. ~~w~~ Ly
4. b
5. w Ly
6. y
7. w
8. w
9. b
10. w
11. y
12. Lp
13. w
14. w
15. b
16. w
17. ~~b~~ w
18. ~~w~~ b
19. w
20. y
21. w
22.
23. w
24. w
25. ~~w~~ Ly
26. Lp
27. b
28. dp
29. w
30.
31. w
32. w
33. w
34. b
35. y
36. b
37. w
38. w
39. w
40. w
41. w
42. w
43. ~~w~~ Ly
44. w
45. w
46. w
47.
48. w
49. Ly
50. b
51. Ly
52. Ly
53. Y
54. Y
55. w
56. b
57. w
58. w
59. w
60.
61. Ly
62. Y
63. Ly
64. w
65. w
66. Lp
67. Ly
68. w
69. Lp
70. ~~Lp~~ b
71.
72. w
73. w
74. Lp
75. Ly
76. w
77. w
78. y
79. y
80.
81. w
82. w
83.
84. b
85. w
86. dp
87. Ly
88. Ly
89.
90. w
91. Lp
92. Ly
93. Ly
94. b
95. dp
96. dp
97. dp
98. y
99. y
100. y
101.
102. Ly
103. Ly
104. w
105. w

dp = dark pink
w = white

Lp = Light pink
b = bronze

Rogers 3-18-50

Family 2 white (201) x bronze (231)

1.
2. dp
3. w
4. dp
5. w
6. dp
7. Lp?
8. dp
9. w
10. Lp
11.
12. dp
13. dp
14.
15. b
16. Lp
17. w
18.
19. pink
20. w
21. w
22. dp
23. pink
24. Lp
25. dp
26.
27.
28. w
29. w
30. w
31.
32. Lp
33. Lp
34.
35.
36. Lp
37. Lp
38.
39. Lp
40. w
41. Lp
42. Lp
43.
44. w
45. w
46. w
47. dp
48. w
49. dp
50.
51.
52. dp
53
54. dp
55. w
56. dp
57.
58. w
59. w
60. Lp
61.
62.
63. dp
64.
65.
66. w
67. dp
68. w
69. Lp
70. dp
71.
72. dp
73. dp
74. Lp
75. dp
76.
77. w
78.
79. w
80. dp
81. w
82. w
83. w
84.
85.
86. w
87. w
88. dp
89. Lp
90. w
91. dp
92. w
93. w
94. Lp
95. w
96. Lp
97. w
98.
99.
100. dp
101. Lp
102.
103. w
104. Lp
105.

3/6 -

Sh. are two sorts of things
1. Concepts
2. Actual phenomena.

Snapdragon families:

1. White bronze

F1 Pink

F2 Bronze, yellow, white

Plants to be scored

3/13 -

Snapdragons from a cross of 2 different types
(1 a green-house + 2- an outdoor type)

white bronze

bright pink

white, pink, bronze, yellow

1 family

of these white yellow

1 family bronze 1 family

the whites are most difficult.

pick out 2 whites 1-white + 1 ivory white

Pink

Four main types

	anthocyanin	nonanthocyanin
nonyellow	pink	white - groundcolor ivory
suffusedyellow	bronze	yellow

at least 2 factors, maybe 3 as to anthocyanin or nonanthocyanin.

Family 1 bronze x yellow – all bronze
Family 2. white x bronze

Pink	-33	45
White	-24	33
bronze	-1?	

Family 3 yellow x white

Pink	12	11	2
White	-47	44	8
Ivory	11	17	2
Yellow	10	11	2
bronze-	11	13	2

Two kinds of white
1. white – starting out greenish
2. ivory – " " creamish

Possible ratios 9:3:3:1 or 1:1:1:1
w/all but white from Fam 3. the latter is possible.
54/44 could be 1:1 or 9:7.

w/a 9:7 means AB 9
aB
Ab 7 - all white
ab

w/2 dominant factors - same color
w/1 " " only - all white.

3-27

Genus Narcissus - allowing for ploidy, all sp. will cross w/ each other.

If genus weren't pretty, no-one would know possibility of these crossings - brought from all Europe & Orient because.

Common narcissus - Narcissus pseudo narcissus,

1. yellow,
2. Early
3. narrow segments
4. long crown, short tube.
5. no anthocyanin
6. no sweet fragrance.

Artificial hybrid   backcross poets narcissus x common

lighter
later
broader
shorter crown

Crosses behave like a simple factor difference.

Cross a common x poet

e yellow crown recessive	E white crown, yellow edge dominant	3:1
i pale yellow (recessive)	I Intense yellow (dominant)	3:1
b one color	B Bicolor	3:1

, white flowered, yellow fringed, (Incomp.)   27/64

x

any yellow trumpet   1/64

↓

3:1 of white

Narcissus - centers in eastern end of Mediterranean regions -
Has been cultivated since classical times, and for this reason, species distribution patterns are not of any meaning.

N. jonquilla - nat. of S. France - leaves teret, onion-like.

N. Tazetta - paperwhites - distr. Med - Orient to Japan & China. widest distribution.

N. bulbocodium - littlest narcissus - all corona, little petal.

N. triandrus - Spain - angel's tears - very infa variant in the Channel Islands - a single clone -

Cyclamen flowered N.

Bulk of hybrids between
N. pseudo-narcissus x N. poetica.

Stillingia
width of aerial stem.
" " leaf.
no. of leaves at center of flush within x cm.
no. of bracts of inflorescence within x mm.
no. of fls. per bract
color of bract.

May 1, 1950 –

The problem of the individual.

1. What is an individual? – The only thing that exists in nature is the individual, but no water-tight definition of ind, as in Iris, where the rhizomes separate.
2. Apomixis – various kinds – in Malus theifera, no fertile pollen – not known exactly how mother tissue side-tracks reduction division, but the seedlings are exactly like parents. This species is a triploid. This phenomenon is common in grasses, Sorbus, Crataegus, Compositae & Legumes. Elymus (Gramineae) is example at Gray's Summit.

Blue-grass – not always apomictic, but mostly so. Chromosome complements mostly from 56 — 70, the range being from 28–90. All seem interfertile. Cross pollinate any of these & F1 will always look like the mother plant, since stimulus from a foreign plant, but if self-pollinated, mostly get a peculiar looking off spring.

This type of thing in higher plants allows the reproduction of individuals which are constant, but which will (by use of the sexual plants) produce plants if conditions change.

GENERA OF PALMS IMPORTANT IN NATIVE DOMESTIC ECONOMIES

SUBFAMILY
  TRIBE
    Subtribe
      Genus

(Systematic arrangement according to O. Drude, in Engler & Prantl, Natürlichen Pflanzenfamilien 2 (3) 28-90. 1889.)

CORYPHINAE	
PHOENICEAE	
Phoenix (Date)	N. Africa, Near East, S. Asia
SABALEAE	
Chamaerops (Dwarf Fan)	Mediterranean
Trachycarpus (Chusan)	China
Corypha (Talipot)	S. Asia
Nannorhops (Mazari)	SW. Asia
Livistona (Serdang)	SE. Asia, Indonesia
Pritchardia	W. Pacific Islands
Washingtonia (Desert)	SW. United States
Sabal	West Indies
Copernicia (Carnauba)	Brazil
BORASSINAE	
BORASSEAE	
Hyphaene (Doum)	Africa
Borassus (Palmyra)	Africa, S. Asia
Lodoicea (Sea Coconut)	Seychelles
LEPIDOCARYINAE	
MAURITIEAE	
Mauritia (Murití, Caraná)	Tropical America
METROXYLEAE	
Raphieae	
Raphia (Raffia, Jupatí)	Africa, Madagascar, S. America
Oncocalamus	Nigeria
Ancistrophyllum	Tropical Africa
Eremospatha	Tropical Africa
Calameae	
Metroxylon (Sago)	S. Asia, Indonesia
Coelococcus (Tahiti Nut)	Pacific Islands
Daemonorops (Dragon's Blood)	Indonesia
Calamus (Rattan)	Africa, S. Asia, Indonesia
CEROXYLINAE	
ARECINEAE	
Caryoteae	
Caryota (Fishtail)	S. Asia, Indonesia
Arenga (Sago)	S. Asia, Indonesia
Geonomeae	
Podococcus	Tropical Africa
Manicaria (Bussú)	Tropical America
Leopoldinia (Jará, Piassaba)	Brazil
Geonoma	Tropical America
Calyptrogyne (Coligallo)	Central America
Iriarteae	
Iriartea (Pachiuba, Maquenque)	Tropical America
Ceroxylon (Wax)	Andes
Morenieae	
Chamaedorea (Pacaya)	Central America

Psilopsida

Psilotaceae

Sporophyte – no differentiation into stem, leaf & root
axis w/ dichotomous branching
Sporangia cauline, massive, terminal 2-3 chambered
Homosporous, no tapetum, numerous spores.

Gametophyte – Prothallia monoecious, cylindrical, dichotomous, subterran., mycorhizal, no differentiation into veg + reprod. regions. Radial, elongate. Sex organs on all sides. Antheridia ♂, globose, projecting. Sperms ♂, multiciliate; Archegonia ♀; scattered, sunken, neck of 4-6 tiers projecting, deciduous

Lycopsida

Lycopodiaceae – herbs, perennial, w/ specialized habit; determinate branching, dichotomy; leaves small, simple, irreg., spiral or decussate, no ligule; protostele, exarch xylem, leaf trace small, simple, strobilus + (in some –) sporophylls leaf like, sporangia foliar (ventral) or axillary, homosporous. Tapetum of 1 layer; numerous spores. Prothallia ♂♀ tuberous; green or non-; on surface or subterran., radial; short. Sex organs on crown or upper side, antheridia ♂, sunken, sperms biciliate.

Lycopodium + Phylloglossum

Selaginellaceae – herbs, peren. or annual, determinate, dichotomous branching, leaves small, simple, spiral or 4 ranked. Ligule +. Protostele, exarch xylem, leaf trace small, simple, Strobilus +, sporophylls ± leaf-like; sporangia axillary or cauline, heterosporous, tapetum 1 layer, megaspores ♀, large; microspores ♂, minute. Prothallia dioecious, greatly red.; chlorophyll – Male wholly within spore wall, 1 veg. cell + 1 antheridium. Female largely within spore wall, protruding cushion, w/ rhizoids + archegonia. Sperms ♂, biciliate. +

2. The homologous theory assumes that the sporophyte + gametophyte are essentially alike in nature; that the sporophyte is not a new thing but a modified preexisting form; that the sporophyte and gametophyte are correlative phases in the life cycle of the plants which have arisen by modification of an original single phase which was sexual.

~~Lycopsida~~

Lycopodiaceae

Isoetaceae - herbs, perenial w/ highly specialized ("corm") habit, branching rare, dichotomous, leaves simple, spiral; ligule present; protostele, exarch xylem, anomalous secondary growth; leaf trace small, simple; strobilus present (?), every leaf a sporophyll. Sporangia foliar (ventral) semi-chambered, heterosporous. Tapetum of 1 layer. Megaspores 150-300, large; microspores ∞. Prothallia dioecious, greatly reduced, no chlorophyll. Male: wholly within spore wall; 1 vege. cell + 1 antheridium. Female within spore wall; cushion w/ rhizoids + archegonia. Sperms 4, multiciliate.

1 Genus.

Sphenopsida

Equisetaceae - perennial herbs w/ rhizomes. Branching free, whorled, alt. w/ leaves. Leaves small, simple, fused, whorled. Ligule –. Dissected siphonostele w/ nodal rings. Endarch xylem. Leaf trace small, simple, no gap. Strobilus +. Sporophylls of sporangiophores, the sporangia suspended on sporangiophores. Homosporous. Tapetum irregular, of several layers. Spores ∞, small, green, w/ elaters.
Prothallia monoecious, cushionlike, w/ erect photosynthetic lobes. Dorsiventral. Sex organs on upper side. Antheridia ∞, sunken. Sperms ∞, multiciliate. Archegonia ∞ at base of lobes, sunken,

The nature + origin of the sporophyte of vascular plants

Two theories

1. Antithetic - assumes that the sporophyte + gametophyte generations are essentially distinct, that the sporophyte is a new phase introduced into the life cycle of vascular plants in relation to life in the air; it assumes that the complex, independent, land-living sporophyte has evolved from the zygote of an ancestral algal form through a stage where it was merely a spore bearing ~~stage~~ structure wholly dependent upon the gametophyte.

(over)

F

Sterling Howard
Dept UC-4
1400 Monterey Ave
NY 57

35 mm Cine Exacta reflex w f 3.5
Carl Zeiss "T" coated Tessar.
134.50 w/o
144.50 w case post paid

1. In measurements, don't make any decimal divisions of millimeters except as averages. Ex – 2.8 – 7.1 mm wrong, rapid 2.5 – 7.0.

2. Locality – st w/ US

Introduction

Generic Relationships

Evol. tendencies + Intersp. Relationships

Economic Imp.

Vernacular Names.

General Morphology

~~Studies~~ Study material #

RR x Rr

	R	r
R	RR	Rr
R	RR	Rr

	R	r
R	RR	Rr
r	Rr	rr

Regular verbs.

1. Sagen = to say   Present tense

ich	sage	wir sagen
du	sagt	ihr sagt (Sie sagen)
er, sie, es	sagt	sie sagen

Auxiliary Verbs

Haben - to have | Present | sein - to be

ich habe	wir haben	ich bin	wir sind
du hast	ihr habt (Sie Haben)	du bist	ihr seid (Sie sind)
er, sie, es hat	sie haben	er ist	sie sind

Auxiliary Verbs (Cont).

✓ werden (i) – to become

Present

ich werde	wir werden
du wirst	ihr werdet
er wird	sie werden

Regular verbs

1. lachen - to laugh
2. hoffen - to hope
3. fragen - to ~~bo~~ ask
4. schreiben - to write
5. hören - to hear
6. verstehen - to understand
7. zeigen - to show
8. gehen - to go, walk.
9. beobachten - to observe, watch
10. berichten - to report
11. denken - to think
12. finden - to find
13. meinen - to think; say; mean
14. sitzen - to sit.
15. bleiben - to stay, remain
16. brauchen - to need; use
17. bringen - to bring; take
18. holen - to fetch; bring
19. legen - to lay, place
20. rechnen (an "e" inserted between stem + ending) - to figure
21. versuchen - to try, attempt
22. zahlen - to pay
23. atmen (an e inserted between stem + ending) - to breath

Present Indicative of atmen

ich atme	wir atmen
du atmest	ihr atmet
er/sie/es atmet	sie atmen

24. bekommen - to get, receive.
25. beweisen - to prove
26. gebrauchen - to use
27. glauben - believe
28. kommen - to come
29. kosten - to cost
30. reden - to talk, speak
31. warten - to wait
~~33. antworten (an. e~~
32. arbeiten - to work
33. beissen - to bite

34. erzählen ✓ | to relate, tell
35. kaufen ✓ | to ~~sel~~ buy
36. machen | to make, do
37. pflanzen ✓ | to plant
38. riechen | to smell
39. stehen | to stand, to be
40. verlieren ✓ | to lose
41. dauern ✓ | to last
42. kennen | to know (by acquaintance)
43. lernen | to learn
44. lieben | to love
45. liegen | to lie, be situated
46. spielen | to play
47. studieren | to study
48. verschwinden | to disappear
49. weinen | to weep, cry
50. behaupten | to affirm, assert
51. bezahlen | to pay for
52. erwarten | await, expect
53. scheinen | shine, seem
54. suchen | to seek
55. verdienen | to earn
56. verkaufen | to sell
57. wechseln | change
VII 58. blicken | to look, glance
59. fortsetzen | to continue
60. führen | lead, guide
61. grüsen | to greet
62. nennen | to name
63. reizen | to irritate; charm
64. schenken | to make a present of.
65. schieben | to shove, push
66. springen | to spring, jump
67. steigen | to climb
68. hindern | to hinder, prevent
VIII 69. binden | bind
70. heben | lift, raise
71. fliessen | flow, run
72. küssen | kiss
73. öffnen | open

Verbs w/ vowel change in second & 3rd person singular
(The change indicated in parentheses)

fahren (ä)	to drive, ride, go
laufen (ä)	to run
lesen (ie)	to read
schlafen (ä)	to sleep
sehen (ie)	to see
~~so~~erfahren (ä)	to find out, learn
vergessen (i)	forget
~~erfahr~~	
wachsen (ä) ✓	to grow
werfen (i) ✓	to throw
geben (i)	to give
nehmen (nimmst, nimmt)	to take
essen (i)	to eat
~~gefallen (ä)~~	
halten (ä) (du hältst, er hält)	to hold
lassen (ä)	to let
sprechen (i)	to speak
tragen (ä)	to bear, carry; wear
treffen (i)	to hit; meet
stoßen (ö)	to push, thrust

Verbs taking the dative

antworten ✓	to answer
danken	to thank
gefallen (ä) ✓	to please
gehören	to belong to
helfen (i)	to help
begegnen	to meet, encounter
dienen	to serve

Irregular verbs

tun

wissen

treten (trittst, tritt)

to do

to know

to step, walk

Session Vocabulary

I	aber	but, however
	alle	all
	alles	everything
	alt	old
	auch	also, too; either; even
	auf	on, upon; up
	dann	then
	das	the; that
	ein	a, an
	einfach	simple, simply
	kein	no, not any
	mehr	more
	natürlich	naturally
	neben	next to, beside
	nicht	not
	nichts	nothing
	nun	now
	oder	or
	das Papier	the paper
	schön	beautiful, handsome, fine
	schwer	difficult; heavy
	so	so, thus
	das Stück	the piece
	und	and
	wer	who
	wieder	again
	das Wunder	the wonder
II	allein	alone; but
	an	on, at; near
	der Bleistift	the pencil
	das Buch	the book
	dicht	thick; close
	die Frau	the woman; wife
	Frau-	Mrs.
	für	for
	das Geld	the money
	das Glas	the glass
	gut	good; well
	das Haar	the hair
	hier	here

die Jugend	the youth
jung	young
lang (lange)	long
leise	softly, gentle, gently
man	one
die Mark	the mark (coin)
nach	to; toward; after
noch	still
nur	only
rot	red
schon	already
über	over; above; about
das Urteil	the judgement, opinion
viel	much
viele	many
wach	awake
warum	why
das Wasser	the water
die Zeitung	the newspaper
zufrieden	satisfied, contented
zurück	back
zwar	to be sure
III auswendig	learn or know by heart
bei	at or with
bekommen	to get, receive
bestimmt	definitely
das Bett	bed
beweisen	to prove
da	there
dünn	thin
~~erfahren~~ (a)	
fast	almost
die Gans	goose
~~gab~~	
heute	today
immer	always
interessant + dative	interesting
das Kleid	dress
leider	unfortunately

III neidisch	jealous, envious
neidisch auf	envious of
nein	no
ob	whether, if
der Preis	prize, price
reden	to talk, speak
der Schnee	the snow
spät	late
übrigens	by the way
um	at, around, about
~~vergessen~~	
die Wand	wall
was	what
weiss	white
wenn	when, whenever, if.
die Woche	the week
wohnen	to live, dwell.
zu	to, too
zwischen	between
IV der Abend	evening
also	therefore
der Apfel	apple
die Arbeit	the work
aus	out of, from, of.
ausserdem	moreover, besides
beissen	to bite
ehrlich	honest
die Erbse (pl. die Erbsen)	the pea (peas)
die Erde	the earth, ground.
das Feld	field
frisch	fresh
der Frühling	the spring
ganz	whole, entirely
~~geh~~	
gerade	straight, just
gern	gladly, willingly
das Geschäft	the business, deal, store.
die Geschichte	the story, history
gleich	like, same, immediately

der Herbst	autumn
der Hof	the court, farm
jemand	somebody, someone
die Kartoffel	potato
die Klasse	
der Krieg	war
kurz	short
mit	with, along
oft	often
ohne	without
~~recht~~	right
recht + dative	for, since
seit	since that time
seitdem	the share, part
der Teil	under, below
unter	of, from
von	before, in front of
vor	
V arm	~~poor~~
dass (conj.)	that
denn "	for
dieser	this
doch ✓	yet, however, but
die Ecke	the corner
eng	narrow
etwas ✓	something, somewhat
der Gefallen ✓	the favor
genug	enough
das Gesicht ✓	the face
glücklich	happy
das Haus	house
der Held	hero
hinter ✓	behind
hungrig	hungry
das Jahr	year ~~each, every~~
jeder	each, every
jener	that
kaum	scarcely
leicht	light, easy

mancher	many a
der Mann ✓	
nah	close, near by
das Pferd	horse
solcher	such
der Strumpf	stocking
der Student	
vielleicht	perhaps
der Wald	the forest
wann	when
der Weg	the way, road, path
welcher	which, what
wo	where
wohin	whither, to what place
die Zeit	time
VI als	than; when; as
die Art	the manner; sort
ausser	outside (of)
blau	blue
daher	therefore
der Erfolg	the success
das Fach	the subject; drawer
der Fall	the case
die Farbe	the color
der Feind	enemy
die Gefahr	danger
grün	green
heilig	holy
der Hut	hat
je -- desto	the -- the
das Kind	child
los	loose
-los	less
schlaflos	sleepless
die Lösung	solution
der Markt	market
der Mensch	the human being, person
möglich	possible
die Mutter	mother
nämlich	namely, you see

neu	new
die Not	need; distress
obgleich	although
die Schuld	the guilt, blame
schuld(ig)	guilty (to blame)
sondern	but
sonst	otherwise
die Strasse	street
der Tag	day
trotz	in spite of
der Trotz	obstinacy. the spite; haughtiness
während	while, during
weil	because
die Weise	manner, way
das Wort	word
das Wörterbuch	dictionary
die Zukunft	the future
VII ab	off; down
ander	other; different
anders	different
der Augenblick	the moment
die Bank	bench
besser	better
bis	to, up to, until
damit	so that
das Dorf	town, village
ehe	before
der Enkel	grandson
der Fisch	fish
früh	early
die Gegenwart	the presence; present time
der Hafen	harbor
hell	bright, light
jetzt	now
klein	small, little
das Land	land, country
das Meer	ocean, sea
morgen	tomorrow
der Morgen	the morning
der Name	name
der Platz	place

plotzlich	suddenly
richtig	correct, accurate
der Rock	the coat, skirt
schenken	to make a present of
schlank	slender
schnell	fast, quickly
schwarz	black
die Seite	the side, page
die Sonne	sun
weder — noch	neither — nor
weit	far, distant
der Wind	wind, breeze
VIII das Auge	eye
das Bild	picture
das Blut	the blood
der Boden	ground; bottom, floor
derselbe	the same
durch	through
einander	one another, each other
das Ende	end, close
ernst	serious, earnest
das Fenster	window
fern	far
die Hand	hand
hart	hard
heiss	hot
das Herz	heart
innen	within
der Kopf	the head
die Kraft	force, power, strength
die Macht	power, might
der Mond	moon
die Nacht	night
der Rucken	the back
selber	self
tief	deep
das Tuch	cloth; kerchief.
die Tur	door.
der Vater	father

IX	gegen	against, toward
	das Gegenteil	the opposite
	der Onkel	Uncle
	sogar	even
	die Tochter	daughter
	die Vergangenheit	the past
	vorbei	past, by; gone
	wirklich	real, really, genuine
X	böse	angry, bad
	einzig	only, sole; unique; single
	erst	first, at first, not until
	ewig	eternal
	fein	fine; excellent
	der Gott	God
	der Himmel	the sky, heaven
	irgend(ein)	any; some
	kalt	cold
	die Kirche	church
	die Krone	crown
	letzt	last
	der Löwe	lion
	das Mal	the time (instance)
	meist	most; usually
	der Mund	mouth
	der Mut	courage
	niemand	nobody, no one
	nötig	necessary
	das Schaf	the sheep
	sehr	very
	der Stein	stone, rock
	der Tisch	table
	die Vernunft	the reason (mind)
	warm	warm
	das Weib	the woman; wife
XI	der Arm	the arm
	der Arzt	the physician
	der Brunnen	well, fountain
	die Brust	breast, chest
	die Butter	butter
	deutlich	clear, plain
	[illegible]	[illegible]

der Donnerstag	Thursday
eigen	own
das Eis	ice
die Familie	the family
das Fass	the barrel, cask
fertig	ready; finished
fest	solid; firm, fast
froh	glad, happy; joyful
gewöhnlich	usual, customary
gross	great, large; tall
klar	clear, plain
der Kuchen	the cake
langsam	slow(ly)
laut	loud, noisy
der Meister	the master; champion
(der) Mittwoch	Wednesday
nie, niemals	never
die Pflicht	the duty
die Sache	the thing, affair
der Schmerz	the pain, grief
der Sieg	the victory
sogleich	immediately, at once
(der) Sonntag	Sunday
statt (anstatt)	instead of
die Stunde	the hour, lesson
der Wein	wine
wenig	few
ein wenig	a little
wild	wild
der Winter	winter

Idioms

denken an	to think of
nicht mehr	no longer
gar nichts	nothing at all
heute abend	this evening
noch nicht	not yet
recht haben	to be right
er hat recht	he is right
es ist mir ganz gleich	it is all the same to me
es ist mir recht	it is all right with me
glauben an	to believe in (w. acc.)
immer noch	still
noch immer	still
gern (plus verb)	to like to
ich esse gern	I like to eat
ich schlafe gern	" " " sleep
es geht mir gut	I am well
es geht ihm gut	he is "
nach Haus gehen, kommen	to go home, come home.
um zu	in order to
es gibt	there is, there are
immer wieder	again & again
ohne zu arbeiten	without working
ohne zu sagen	without saying
mit gutem Recht	rightly
auf Wiedersehen	good bye
noch einmal	again
Platz nehmen	to sit down
stehen bleiben	to stop
warten auf	to wait for.
am Ende	in the long run; after all
auf jeden Fall	at any rate
so etwas	something of the kind
[illegible]	[illegible] (tense) is concerned

wie steht es mit	how about
zum Beispiel	for example
bitten um	to ask for
fragen nach	to ask for
im Gegenteil	on the contrary
kennenlernen	to make the acquaintance of
nach und nach	little by little
zum ersten Mal	for the first time
danke schön	thank you
halten von	to think of
morgen früh	tomorrow morning
so geht es im Leben	such is life
zu Grunde legen } (zugrunde liegen)	be at the bottom of / be the basis

Modal auxiliaries

dürfen - to be allowed to, may

ich darf	wir dürfen
du darfst	ihr durft
er darf	sie dürfen

~~wir~~

können - to be able to, can

kann	können
kannst	könnt
kann	können

mögen - to desire to, like

mag	mögen
magst	mögt
mag	mögen

müssen - to be compelled to

muss	müssen
musst	müsst
muss	müssen

sollen - to be to, to be said to

soll	sollen
sollst	sollt
soll	sollen

wollen - to want, intend, claim to

will	wollen
willst	wollt
will	wollen

verbs taking dative

antworten	to answer
danken	to thank

Prepositions which require the dative

aus
ausser
bei
mit
nach
seit
von
zu
gegenüber opposite

Personal pronouns Singular

	1st	2nd	3rd
Nom	ich	du	er, sie, es
Dat	mir	dir	ihm, ihr, ihm
Acc	mich	dich	ihn, sie, es

	Nom	Dat	Acc.
1	ich	mir	mich
2	du	dir	dich
3	er, sie, es	ihm, ihr, ihm	ihn, sie, es

Plural

	nom	Dat	acc.
1	wir	uns	uns
2	ihr (Sie)	euch (Ihnen)	euch (Sie)
3	sie	ihnen	sie

Nouns

1. vorsitzende	president, chairman
2. Gesellschaft	society, association
3. Mitglieder	member, fellow
4. Masse	mass, volume, amount
5. Zunahme	increase, advance, growth
6. Bedürfnis	lack, want, need, requirement
7. Beantwortung	an answer to, reply to
8. wird	is becoming
9. Reihe	row, range, sequence, rank
10 betreffen	to concern, befall, catch
11. berühren	to touch, border on
12. vor allen Dingen	primarily, chiefly, above all else
13. Zusammenhänge	to cohere, communicate, be connected
14. Herkunst	arrival, origin, source, derivation
15. Wissen	knowledge, scholarship
wissenschaftlichen	scientific
16. Teildisziplin	component, theory (doctrine)
17. gelöst	dissolved, in solution
18. einleuchten	to be clear
19. im Folgenden	in (from) the following discussion
20. Rahmen	frame, structure, scope,
21. Zeitschrift	periodical, journal
22. Beitrag	contribution,
23. Stellungnahme	attitude
24. bereits	already, previously
25. Bekanntem	well known, noted
26. wechselnd	to change, alternate, vary
27. Bewertetem	
28. verzichten	to relinquish, waive, give up
29. möchte (mögen)	would like to
30. Einzelfunde	single discovery, -finding,
31.	