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MILOŠ DEYL:

Mikroevoluce krytosemenných rostlin

The Micro-evolution of the Angiosperms

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V poslední době i mezi geneticky zaměřenými biology a genetiky (na př. J. C. Willis, R. Goldschmidt, H. Nillson, W. Rotmahler a j.) se objevují vážné pochybnosti o možnosti vysvětlit vývoj na základě klasické genetiky. Rozhodně ani mutace, ani rekombinace nemohou vysvětliti evoluční progres. Je nápadný rozdíl v dědičnosti vlastností druhů a nižších taxonů na straně jedné a rodů a vyšších taxonů na straně druhé. Prvá dědičnost se řídí zákonitostmi klasické genetiky. Dědičnost rodů a vyšších taxonů se těmito zákonitostmi neřídí a předávají se vždy geneticky nezměněny. Je možno sice dosáhnouti různými šoky takové poruchy v metabolismu, že i znaky vyšších taxonů se podstatně změní. Vždy se však jedná o změnu fenotypickou a ne genotypickou ve smyslu taxonomického hodnocení. *Drosophila melanogaster* zůstane jako druh nezměněna i když má vytvořena 4 křídla místo dvou. Vznik pravidelných pelorických květů u *Digitalis purpurea, Consolida ajacis*, dvoučetné květy u *Galanthus nivalis* a j. nikdy nepřesahují taxonomický rámec druhů. Je proto třeba předpokládat, že materiální base dědičnosti nižších a vyšších taxonů je rozdílná. Taxonomický rozdíl znaků nespočívá na znaku samém, ale na jeho genetické hodnotě. Jeden a týž znak může být jednou znakem variety, jindy druhu po případě rodu a pod. Všechny znaky musí mít tedy podobný materiální základ odlišující se jen menší chemickou změnou. Klasická genetika přinesla dostatečné důkazy, že hmota ovládající znaky druhové a nižší je umístěna v chromosomech. Chromatinová hmota, snad především euchromatin či desoxyribonukleinová kyselina tvoří materiální basi dědičnosti. Je velmi pravděpodobné, že i vlastnosti vyšších taxonů musí mít podobný chemický základ, ale jeho chování při dělení buněk bude pravděpodobně odchylné. Kdyby podléhalo stejné dynamice jako chromosomy, musely by se nutně objevit i nepravidelnosti a ty by se pak projevily i fenotypicky. Je pravděpodobný předpoklad, že i znaky vyšších taxonů jsou ovládány chromatinovou hmotou a to pravděpodobně heterochromatinem či ribonukleinovou kyselinou a jsou nejpravděpodobněji uloženy v jadérku.

Na těchto základech jsem se pokusil vytvořit představy o různé dědičnosti znaků vyšších a nižších taxonů. Látky, které kontrolují dědičnost vyšších taxonů a tedy i nevariabilní základ dědičnosti byly nazvány organisátory. Látky, které kontrolují dědičnost nižších taxonů a tedy variabilní základ dědičnosti, byly nazvány determinátory. Mezi organisátory a determinátory je rovnovážný vztah, pravděpodobně s velmi složitou závislostí.

Představa o organisátorech a determinátorech nám pomáhá pochopit rozdíl mezi makroevolucí a mikroevolucí. V makro a mesoevoluci může docházet k základním změnám v organisátorech. Po jejich zablokování projevuje se proměnlivost pouze v determinátorech, které umožňují udržení plasticity ekologické i morfologické. Znaky vznikající v mikroevoluci nesou často známky účelnosti. O makroevoluci máme doklady nepřímé, ale zdá se, že v tomto období velká vývojová potence mohla paralysovat většinu změn, které byly nevýhodné vznikem odchylek v jiných znacích. Na př. složitost stavby květní u *Orchidaceae,* dlouhou dobou, po kterou jsou květy schopny opylení, speciálním morfologickým přizpůsobením při opylování a pod. Odchylky makroevoluční měly velkou diferenciační hodnotu a mohly tím vznikat základy pro nové vyšší taxony.

Daleko složitější poměry nacházíme v mikroevoluci. Jelikož mikroevoluční procesy u rostlin stále ještě probíhají, máme možnost dokonalého jejich poznání. Zvláště k tomu přispěla klasická genetika. V této práci byl učiněn pokus odůvodnit mikroevoluční procesy a vytvořit představu o materiální basi těchto procesů. Mikroevoluční proměnlivost má svoje příčiny ve vzniku mutací a v hybridisaci. Mutace vznikají jako následek materiálních a strukturálních změn chromatinové hmoty. Hybridisace umožňuje vznik nových kombinací, často jinak podprahových, společným působením chromatinových hmot geneticky příbuzných typů. Vznik nových odchylek je většinou chaotický, závisící na materiálním složení dědičných základů. Usměrnění těchto odchylek řídí procesy selekce a orthogenese, které vznikají působením vnějších podmínek na genetický systém. Z vnějšího prostředí je to teplo, některé chemické látky, hlavně obsah živin, vody, některých biologicky aktivních látek a pod. Rovněž vzájemné působení organismů a to jak živočichů na rostliny, tak rostlin na rostliny podporuje či potlačuje určité odchylky. Některé genetické systémy podporují variabilitu, na př. heterozygotnost, aneuploidie, trvalá heterozygotnost a pod. Jiné genetické systémy umožují rychlé ustalování úchylek, na př. nepohlavní rozmnožování, samoopylení a j.

Celkem můžeme rozlišit dva základní procesy stabilisace nových typů, a to selekci a orthogenesi.

Selekce je proces, při kterém z původně heterogenetické populace se vytvoří za určitých podmínek nový stálý typ. Procesy speciační, které při tom působí, jsou shodny s procesy objevenými Darwinem. Ovšem nedochází při tom k vytváření vyšších jednotek než byly mateřské, ale nanejvýše jednotek stejné výše. To znamená, že z druhu vznikne nanejvýše nový druh, ale nikoliv vyšší taxon. Celkový směr vývoje je tedy tříštění a zmenšování vývojové potence a ne její zvětšování. Vývojový směr postupuje od vlastností multifaktoriálních k monofaktoriálním, t. j. od smíšené populace druhu k čisté linii. Materiálně je to podloženo tím, že dochází při mutacích či během dělení buněk ke ztrátovým procesům v chromatinové hmotě, řidčeji k zmnožení některých částí. Nevznikají však nové, geneticky silně potentní látky, které by umožňovaly progres.

Orthogenese je poněkud odchylný způsob vznikání odchylek. Zatím, co při selekci vzniká jednoduché ustálení vlastností, vzhledem k určitému stanovišti, dochází u orthogenese k několikerému postupnému ustálení působením určitého extrémního činitele. Při každém ustálení se odpovídající účelné znaky stále více zesilují. Proces orthogenese je v celku podobný procesům, které objevil Lamarck. Ale jejich působení je omezeno jen na procesy mikroevoluční. Není jimi možno vykládat makroevoluci.

Lamarck, Darwin i De Vries snažili se svými představami vysvětlit různotvárnost a vývoj živých organismů. Jejich řešení byla opřena o důležité jevy přírodní. Zdálo se, že jedna představa vylučuje druhou a každá se hodí jen pro výklad některých jevů. Teprve podrobný výzkum, především genetický a evoluční vyhodnocení dědičnosti organismů umožnilo postupné proniknutí do tajemství evoluce. Zdá se mi, že mikroevoluční procesy, které dnes v přírodě pozorujeme je možno přiléhavě vyložit na základě ztráty nebo zesílení určitých chromatinových látek, které neustále mohou probíhat při nepravidelnostech meiose. Tím dochází většinou ke klesání vývojové potence. Toto zjednodušování dosáhne konečného stavu, když organismy nejsou již schopny samostatného života v přírodě. Všechny tři shora uvedené vývojové theorie je možno spojit v jedinou představu a vymezit každé určitý úkol v mikroevoluci organismů. Význam těchto tří teorií pro makroevoluci byl však přehodnocen. Podle různých úkazů je možno se domnívat, že makroevoluce se řídila docela jinými procesy, jak jsem se pokusil vyložit v předešlé práci.

Představy o zmenšující vývojové potenci musí mít přirozeně velký význam pro taxonomické hodnocení. Dosavadní představa o vzestupném vývoji a postupném vzniku stále vyšších taxonů zdá se být nepřijatelná, neboť nemohou se vyložit četné zjevy paleobotanické a fytogeografické. Většinu přírodních jevů je možno vysvětlit vývojem od vyšších k nižším taxonům. Není mi znám výklad vzniku různých kategorií taxonů pro každou kategorii specifických. Přece však tak nápadný zjev musí mít i svoje materiální příčiny. Předpokládám, že dědičnost druhů je ovládána jinými příčinami než dědičnost vyšších taxonů. Druhy vznikají jen modifikací základní stavby organismů a jsou ovládány chromatinovou hmotou v chromosomech. Rody však vznikají působením jiné dědičnosti, která nemůže být vázána na chromosomy, neboť jejich případnou ztrátou není ovlivňována. Domnívám se, že existenci rodů podmiňují rovněž látky podobné povahy jako chromatin chromosomů, které však organisují základní stavbu. Tyto se dnes již většinou nemění a jejich vývoj je ukončen. Nejpravděpodobněji jsou uloženy v jadérku, které má jak chemický, tak morfologický vztah ke chromatinu chromosomů. Rody vznikají právě při zablokování proměnlivosti této hmoty a další rozpad v druhy je způsoben interferencí chromosomů na tuto pevnou již dědičnost základní stavby.

Čeledi musely vzniknout zásahy ještě základnějšího rázu a sice obměnou dědičnosti základní stavby a tedy organisátorů, které dnes jsou však již také úplně stabilisovány.

V práci je učiněn i pokus o rozbor definice druhů. Systematikové poměrně bezpečně vymezují druhy, mají-li k disposici dostatečný materiál. Definice druhů, přesto, že jsou četné jsou málokteré přijatelné. Zdá se mi,

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že největší obtíže jsou působeny tím, že pro vymezování se používají znaky a vlastnosti druhů. To jsou však druhotné projevy pro definici nevhodné. Za jediný spolehlivý znak pokládám funkci, kterou má druh v přírodě. Za druhy pokládám skupiny příbuzných individuí, z kterých genetický, morfologický, fysiologický nebo prostorový isolační mechanismus vytvořil novou nejmenší samostatnou přírodní jednotku. Nejdůležitější z tohoto je funkce druhu jako nejmenší samostatné přírodní jednotky. Je to stadium, kdy klesání vývojové potence dostoupí kritického bodu. Další klesnutí má již za následek neschopnost udržet se v přírodě. Tohoto bodu je možno dosáhnout při různé vývojové potenci a na základě toho je možno rozlišit celou řadu druhů od linneonů až skoro po čisté linie. Isolační mechanismus pak působí možnost dalšího členění každého takového typu druhu.

Důležitý je i požadavek spontánní existence v přírodě. Proto není možno pokládat za druhy uměle vytvořené typy i když se od přirozených druhů mnoho neliší. Jen ten typ, který se v přírodě osvědčí je možno pokládat za druh. U každého druhu je nutno proto předpokládat většinou dlouhou historii a vytvoření určitého typu areálu. Vlastnosti morfologické, fysiologické, anatomické a genetické mohou sloužit jen za dokreslení druhové charakteristiky. Speciace je proces a jako takový je možno jej těžko definovat jen výsledky tohoto procesu, t. j. hotovými znaky a vlastnostmi. Speciační proces je však velmi komplikovaný a proto nemůžeme očekávat, že by i problém druhů mohl být jednoduchý.

Evoluce je proces složitý pro který máme většinou nepřímé důkazy. Proto bude jistě dlouho trvat, než se vytvoří naprosto uspokojující objasnění tohoto procesu. Je nutno stále hledat nová vysvětlení, která by přiléhavěji vysvětlovala všechny jevy, které se zdají být s evolucí spojeny.

INTRODUCTION

In my previous work I dealt with some conceptins of the evolution of the plants and chiefly of the processes of the macro-evolution. It was assumed that the cause of the evolution was a continuous complication of the matter on the basis of an affinity to combine of certain material wholes. Thus new and complicated individua are continually created. The course of this evolution is neither simple nor gradual. At the beginning, after the fusion, the greatest progress arises and the base of the greater part of the possible fundamental combinations is formed. In later evolution phases a refinement of the types follows, which resulted from the original progress. Gradually these types become more and more evolutionarily simplified and new possibilities get all the time more limited. Finally such a great simplicity can be reached, that individuals are not more capable to maintain themselves alive permanently.

However, there exist great differences in the quality of the evolutionary processes. After some fusions there come into being merely types of a limited importance, while others can initiate revolutionary consequences. These revolutions occured in the evolution of the plants but immensely rarely. On the contrary, fusions of a local and limited importance are common even today, and we can see an example in the origin of the hybrids of different morphological diversified lines. Here, after the fusion of the gametes, the formation of all fundamental evolutional possibilities takes place, potentially already in the first generation, and phenotypically in the second. In the next generation the new types decrease in number rapidly, although many of them are able to strenghten orthogenetically, as it will be shown further. Such ones exhibit a great vitality and therefore a considerable increase of the individua too. In a similar way we can imagine the whole phylogenetic evolution of the plants. Here also, very probably, the origin and fusion of two very complicated systems of matter took place and consequently also a revolutional origin of new forms. These new forms are successively formed into certain crystallized groups. Taxonomically these groups appear today to be the highest taxons. Paleobotanical and phytogeographical proofs testify that this evolution has undergone succesive phases. Individual phases differ from each other by the magnitude of evolutionary vigours which is manifested by the forming of variously high taxons. In the first phase, the macro-evolution, there arise bases of the highest taxons up to families. This evolutionary phase and the factors that probably governed them were dealt with in my previous paper. There examples of the evolution of the Monocotyledons were given as well.

With the diminishing evolutionary vigours, i. e. with the fixation of the evolutionary potency, the lower taxons too are successively formed. This phase, in which the bases for taxons lower than family are arising, forms the second evolutionary phase, the meso-evolution. Evolutionary centres come into being, first of all for genera, and further there appears also the start of the orthogenetic lines leading to a gradual purposive adaptation of some characters. Instead of the progress whereby higher taxons than parental ones arise, a specialization appears, in course of which there are arising taxons equally high or lower than the parental ones. These have, however, a more complicated morphological structure and are often purposively adapted to the external conditions.

These process of specialization and ortogenesis manifests itself still more intensively in the last evolutionary phase, i. e. the micro-evolution. Whilst in the macro-evolution we do not find many proofs of purposive adaptation, the micro-evolution is governed predominantly by purposive characters and properties. Here no more higher taxons come into being, but mostly new species only or taxons still lower. Here a kind of evolutionary simplification takes place, which may lead to such a small plasticity that the individuals cannot more adapt themselves to changing enviromental conditions and they become extinct or persist in highly specializied habitats only. The highest evolutionary simplification would be represented by the individua with all homozygous properties. But not even in case of cultivated plants this degree was reached, because such a substantial loss of vitality would occur that it would cause their death before they would have fully developed.

The evolution of plants proceeded thus in certain phases; it seems to be no direct way from the simple organisms to the complicated ones. Each group has its own independent progress which gets later fixed and diminishing. Progress arises always with more and more complicated representatives of individual phases. Thus a seemingly direct progressive line can be led from the simple to the more complicated organisms. In detail we observe, however, the origin of the group, its aging, and its renovation on a more complicated higher level. It appears to be a similar process as in the case of the ontogenesis of individua. In case of each new individual it mostly comes to an evolutionary cycle from the most simple one-celled types up to the final complicated types which mostly become extinct. There is not developed here a direct origin of perfectly complicated types, but a cyclic evolution being constantly repeated.

In the following chapters the importance of meso-evolution and micro-evolution will be dealt with as well as the agents governing these processes. Greatest stress is laid on the origin and the evolution of the species. Up till now the conception has been mostly accepted that the evolution leads from lower taxons to the higher ones. This supposition does not, however, correspond to many phenomena we observe on the plants. On the contrary, it seems that far more probably this process takes its course inversely, that is to say from the higher taxons to the lower ones. The hierarchy of taxons is probably caused by certain evolutionary knot points in which they could segregate in certain evolutionary phases during their fixation. It is just the equibalanced states which make possible the origin of a whole complex of similar individua. Their number and mutual dissimilarity mostly correspond to the evolutionary potency that was hidden in them in the time of their origin. Thus according to the magnitude of the changes and especially according to the quantity of taxons into which they got differentiated, we are even today often able to judge of the magnitude of the evolutionary potency of each taxon.

THE BEARERS OF THE HEREDITY

Discoveries in genetics have contributed and are still contributing more than any other discipline to the comprehension of micro-evolutionary processes. For the study of macro-evolution, however, their importance should not be exagerated and an application of genetic principles does not appear justified for the explanation of macro-evolution. Processes which governed the macro-evolution were, may be, phenotypically analogous to micro-evolutionary principles, but it is probable that they were of other quality than the processes we are studying today. It appears that it would represent an unjustified generalisation if we tried to explain the macro-evolutionary processes in the same way as the micro-evolutinary ones. We would commit thus the same error as if we tried, in the evaluation of the human being, to estimate the childhood in the same way as the old age, or if, in genetics, we would make no difference between the phenotype and the genotype, a. s. o.

From the evolutionary point of view genetic facts must be evaluated with a great precaution, in order not to overestimate them. Students of genetics seem to overrate the importance of their facts for the evolution, because they do not take into consideration the results of other branches of botany. Genetic facts must be in full accordance with discoveries in taxonomy, phytogeography, paleobotany, a. s. o. In this way only a correct evolutionary explanation of these facts can be secured and the danger of their overestimation avoided. Some of the genetic properties may be of real importance for the evolution, while the evolutionary importance of others might be only a seeming one. When studying the evolution, we often have to solve problems which had not yet been discussed in genetics. Our knowledge of such problems and of the method these problems should be dealt with, is not thorough enough to enable us to experimentalize with them. Therefore it may be necessary, now and then, to revise some of the genetic conceptions, even the general ones, concerning the evolution of plants.

In the present paper I use the former term "factor" as a symbol for the hereditary properties instead of "gene" in the sense of classical genetics. It seems to me that the conception of the gene be too materialized and that it represents the material locus of the propery and character. Such a conception, however, would not be in accordance with the reality, as each property and character most probably result from interaction of many loci, or one locus influences several properties and characters. Only in case of evolutionarily very simplified organismus such a great evolutionary isolation of different factors may happen, that these factors might seem to be governed by one locus only in chromosomes. This extreme, however, seems to be an exception in nature. As a rule characters are generated by interaction of several loci and the factors represent the result of their mutual interaction and not only the matter generating them. Thus the factor is not substance, but a result of the interference of several material bases.

The relation between the chromosome substance and the hereditarily transmitted properties has been much criticized, lately. In extreme cases some critics went as far as to a complete negation of this relation and to a proclamation that inheritance be a matter of the whole body and of each of its cells. According to this conception any existence of special units, in which the hereditary properties be located, is entirely denied. Such a conception, however, is in contradiction with our general experience in living nature in which, as a rule, any morphological differentiation is accompanied by a physiological and another differentiations. Different morphological characters acquire even special functions. That is just the causality of the morphological differentiation of the cell which indicates that physiological, genetic, and other differentiations must have happened there. Different organelles of the cell must have their different special determination, otherwise all this arrangement would be of no use. Nowadays many proofs have been collected demonstrating the most close relations between some of the properties and the chromatin of the nucleus. Students of genetics are right to consider this phenomenon as a difinitely prooved one.

In a few cases evidence has been found that some traits are transmitted through the cytoplasm. But even in this case it seems that, with the exception of viruses, such hereditary properties are primarily controlled by the chromosome substances. Its action, however, is very complex and the enviromental agencies (in this case also the cytoplasm is considered as an enviromental agency for the nucleus) can produce some properties, otherwise irreproducible. The potency is always the same, but the production of a definite character is possible only in presence of certain cytoplasmatic substances. Thus the cytoplasm produces a phenotype only, not a genotype, which is conditioned by the chromosome substance. This may be, to a certain degree, analogous to what can be observed on some properties controlled by the cytoplasm. In case of such a heredity we may assume that the appearance of the property in question may take place only in presence of certain cytoplasmatic substances.

As already mentioned, it seems that some conceptions of the students of genetics should be critically revaluated from the point of view of other disciplines. Thus, for instance, they start with the conception that most characters are controlled by chromosomes and that only an insignificant part may be controlled by other organelles in cells. There is no doubt that this assertion is valid for the majority of the genetic properties examined up to the present time. But are all the properties open today for the methods of genetic examination? This question must be answered in the negative. In genetics of today it is not possible to examine hereditary properties if they are not represented in at least two alleles. These are transmitted from one individual to its offspring unchanged. Most students are of the opinion that even monoallelic properties are controlled by factors lying in chromosomes. But they have lost potency to exist in several alleles. It seems, however, that the complicated processes which occur in the course of the division of the chromatin substance, especially during the actual duplication of the chromosome, should show certain irregularities even in these cases. Basing on these irregularities it should be possible to elucidate also the situation of the substance by which the inheritance in question is controlled. Some genetically orientated botanists e. g. Guppy H. B. (after Cain), Philipčenko 1927, Johansen, Willis J. C. (after Cain) and others already years ago emphasized the difference in quality between the characters of the species and the characters of higher taxons. The characters of the species and especially of the still lower taxons testify quite different types of inheritance than the characters of the genera and of the higher taxons. Most of the characters of the species are governed by laws which are in full concordance with the genetical studies of today. Although very complex dependences occur, yet most of them are controlled by chromosome substance. In case of wild plants the pleiotropism is usually normal, whereas the simple Mendelian ratios occur practically as a rare example of the transmission of hereditary characters. Quite different appears the inheritance of characters of higher taxomonic units. Here the characteristic properties of the genera and of higher taxons are transmitted always unchanged qualitatively and quantitatively. All the representatives of higher taxons have some characters which are qualitatively concordant, and it is just on the base of these concordant characters that the higher taxons are taxonomically classified. Without these characters a clear taxonomic order and hierarchy of taxons would be impossible. While the lower taxons testify a considerable variability of characters, it seems that in case of higher taxons some characters have their variability blocked. This blocking results probably from the phylogenetic evolution. We have to assume that something happened with the higher taxons which hinders them in their normal genetic variability. In some individuals, in exeptional cases, even differences from characteristic properties of higher taxons may be observed. For instance Monocotyledons have exceptionally dimerous flowers. This phenomenon may be thought either as resulting from properties stabilized in the course of phylogeny *(Paris, Anthurium, Majanthemum* and others) or as a simple phenotypic variability, caused mostly by a temporary evolutionary disturbance (as for instance dimerous flowers in *Gagea bohemica, Galanthus nivalis* and others).

It is difficult to imagine that anomalies of the characters of higher taxons would not be far more abundant if the latter were capable of independent assortment and segregation. But not even in the course of intergeneric hybridization fundamental anomalies of the characters of higher taxons may be observed. Sometimes changes occur which are not in accordance with the fundamental structure of the flowers, for instance in case of peloric flowers. But even in this case the origin of the actinomorphic flowers from the zygomorphic ones is not quite unusual and strangè for the higher taxons; this phenomenon may be explained rather by hidden tendencies of atavistic or even of progressive type, than by real changes of the characters of higher taxons. If indeed such a character occurs, it means, that it cannot be considered as valuable for the determination of higher taxons, but only of lower ones.

This different behaviour of the hereditary properties of higher taxons and of the lower ones proves that there must have been some difference in the phylogenetic evolution of the characters by which these taxons are determined. We know that no morphologic form is typical only for certain taxons. In different taxons different characters got fixed, which are then characteristic for all the descendants. Therefore, inevitably, most of the characters were variable in a certain phylogenetic phase. Dependent on the time of the evolutionary stopping, lower and higher taxons are determined. The species and lower taxons have preserved up to the present time their variability, and their properties are not yet blocked. Therefore new species with new properties can be developed.

This very different behaviour of certain properties and their importance for the descendants has not yet been satisfactorily solved in genetics. A generalization, presuming that all the hereditary properties be controlled by the same factors, is not proved by the facts. As soon as some character loses its polyallelomorphy, it gets beyond the scope of genetic investigation. After the transition of a property into a monoallelomorphic type, the property in question can be no more investigated with the help of genetic experiments. Such differences of characters might be very often observed when we are investigating the phylogenesis of taxons. Therefore, to explain these differences, theoretic conceptions, based at least partially on today's studies of cytology, biochemistry, and genetics, must be taken into consideration. It is, however, only in the future that it will be possible to either reject or correct the above conceptions. First of all it is clear that it must be taken into account that in the course of the phylogenesis taxonomic properties will have the possibility of transition from lower taxons into the higher ones and inversely. The ways of this evolution may be observed till now in certain cytological phenomena. If we denied the relations between the characters of higher and lower taxons, we would deny the possibility of evolution. The new conception must therefore be in accordance with this requirement and not in contradiction with cytological and biochemical discoveries. It is very probable that just like the genetic properties are based on certain cytological phenomena, so in the same way a certain cytological formation must be observable also in the properties of higher taxons. A further supposition, the new conception must comply with, is that there should be also an apparent transition from the bimorphy, manifesting itself in case of chromosomes, into the monomorphy which would in an additive way fuse without possibility of segregation. Multiplication and reproduction would take place rather by normal regenerative growing.

All the requirements are satisfied in a cell by only one organelle, namely by the nucleolus. About the function of this organelle very little is known up to this time, but its importance is probably very great. In Fortschritte der Botanik XVI, page 3—5, L. Geitler reports about the studies of Godward who investigated the relation between the nucleolus and the chromosomes of the genus *Spirogyra*. Here the nucleolar substance comes into close contact with the chromosomes. He is of the opinion that the ribose nucleic acid of the nucleolus can, in the prophase, turn into desoxyribose nucleic acid of the chromosomes. The discoveries of Heitz concerning the morphologic relations between nucleoli and Sat-chromosomes have been proved too. In case of *Gymnospermae* and *Angiospermae* two types in the formation of nucleolus have been detected. On the one hand nucleic substances rise to the surface of the chromosomes, unite, and in the formation of nucleoli Sat-zones go on first. On the other hand abundant granuli originate between the chromosomes, grow one after the other and unite on Sat-zones. Nucleic substances are not created, but condensed on the Sat-zones. Here a very close relation is manifested between the heterochromatic end of the chromosomes and the chromatin of the satellites and nucleoli.

These discoveries may be of extreme importance just for the comprehension of the difference between the characters of lower and higher taxons. The relations between nucleoli and chromosomes could easily explain also the different ways of transmission, into the offsprings, of characters which are bound to the organelles in question. While the chromosomes are always created twofold and separate independently during the division of the cells. nucleoli are always uniform. The functions of both organelles are distinct, and each is in action in another phase of the life of the cell.

I think that the opinion of some students of genetics who attribute too much importance to the fixed chromosomes, is not wellfounded. Chromosomes represent a wonderful event, formed to make possible the complicated division of chromatin substance. It is hardly probable that, in this fixed state, they could perform also the function of factors. All their action seems to be concentrated on the reproduction. Heredity, however, is caused by certain metabolic processes leading to the formation of certain constant characters of the plants. Therefore it can be hardly believed that in the course of the division chromosomes could perform also metabolic and morphogenic functions. Differentation of cells and morphogenic properties mostly make their appearance only beyond the meristematic zone, that is after the period of the prolongation in the interkinesis, when the chomosomes had dispersed into the "resting stage". Thus the phase in which normal cellular processes take place and one grown cell affects another grown cell, is likely to be far more important. No doubt it would help us immensely to explain some properties, if we could observe and determine the position of different chromatin granule in this phase. Unfortunately, this is methodically not yet possible. May be, we could understand certain properties caused by the position in the interkinesis. Even so we could explain, probably, differences, coused by the so called crossing over, that is by anomalies in the arrangement of single chromomeres into a spiral. In the arrangement of chromatin substance into chromosomes, no matter whether based on chemical or morphological relations, an exchange of similar substances can occur, causing an anomal arrangement. Also the independent assortment presumes the possibility of a perfect mixture of factors. It is very improbable that it would take place but in an already formed chromosome. It is more probable that it takes place in the phase of diffused chromatic substance. The number of changes from the normal state will be the larger, the greater will be the possibility of exchange of single chromomeres, i. e. the greater will be the material or the morphologic affinity of some chromomeres. In this way it would be possible to explain the statical value, appearing in crossing-over, and the possibility of reconstruction of normal relation in further generations. Origin but in already formed chromosomes is not excluded, but it would be probably very rare.

The conception of morphogenesis, occuring only in diffused stage, is supported by the different behaviour of nucleoli and chromosomes during the division of the cells. The differentiation of the cells takes place no sooner than in the period of the prolongation, i. e. in the interkinesis, when the chromatin substance of the chromosomes is already diffused. Thus the purpose of the diffusion could be the modification of the fundamental structure of the organism into certain forms. On the contrary the acitivity of the nucleoli appears to be most intense also in the period of their diffusion which coincides always with the period of the division of the cell. It is very probable that just at that time the most fundamental arrangement of the chromatin substance for the new cells takes place. The function of the nucleolus may therefore consist in the organization of the new cells, and especially of the chromatin substance, and thus in the preservation of a definitive order in the fundamental structure.

The differentiation of the functions of nucleoli and chromosomes would explain the difference in properties which are controlled by them. The fundamental structure is controlled by a substance which appears to be characteristic for the origin of higher taxons. This substance would be located mostly in the nucleolus. The fundamental structure, however, may be modified by certain substances which are characteristic for the formation of properties of lower taxons. The latter mentioned substances would lie in the chromosomes. Between both categories a chemical and morphological relation has been proved, leading from the euchromatic part to the heterochromatic part of the chromosomes and to the nucleolus, and morphologically from the chromosomes over satellites up to the nucleolus. Genetic factors lie chiefly in the euchromatic part of chromosomes, while in the heterochromatic part they cannot be ascertained, in most cases, by genetic experiments. If however the factors controlling the highest taxons were located in nucleoli, then the individual categories, eventually the different processes of condensation could answer the hierarchy of taxons. In this way the hierarchy of taxons and its characteristic features could be supported even from the material point of view.

The behaviour of the nucleolus during the division implies a quite different way of renovation. Here the fusion of the father's and mother's cells is not a simple mixture only, but a complete fusion of mother's and father's components. Therefore it is probable that the male and female components of the nucleolus are quite similar. The completion should take place by growth and consequent simple division. It is probable that even a small part has the faculty of completion and growth to necessary size. Therefore an accurate division of the substance is not inevitable, otherwise we had to observe, in nature, differences and anomalies on specimens with unequal distribution of the substance of the nucleolus. The growing can be controlled by the correlative potencies of the whole cell, which then determine the size of the nucleolus. This size may be materially predisposed for each organism. These conceptions are, no doubt, speculative only, but events observed up to this time do not exclude such a possibility.

Should these presumptions be correct, then it would be possible to justify the evolutionary difference which we observe in macro-evolution and micro-evolution. The evolutionary potency of the macro-evolution would then consist in the loosening of the fundamental plasticity, i. e. of the plasticity of the majority of properties which would then be controlled by the chromatic substances. The micro-evolution would be then characterized by blocking the major part of the changeable chromatic substance into unchangeable form; only a relatively small part of the changeable chromatic substance would have its variability preserved. The latter, however, consists rather in the combination of some fixed factors than in the faculty of forming quite new evolutionary possibilities. Nowadays, may be, only in the hybridization of the distantly related species a regrouping of the nucleolus and chromosomes substances could partially take place and make possible the formation of higher taxons. Investigation of the intergeneric hybridization could surely offer certain bases for the approval or the refusal of the above conceptions.

Practically the substances that control the hereditary transmission of characters to the offsprings could be divided into two groups. The first group would contain organizers which control the fundamental unchangeable building of the whole organism. The properties originating from the organizers cannot yet be governed by us, for the time being. They would lie, very probably, in the substance of the nucleoli. By the organizers the characteristic traits of the genera and higher taxons are determined. The second group would contain determinators which by forming certain genotype bring about changes of the fundamental building of the organism. Properties caused by the modificators are controllable, if genetic rules, by which they are controlled, are ascertained. These properties lie in the chromosomes and are open to genetic experiments. By these substances the properties of the species and lower taxons are determined.

Second conception to be examined is the opinion of the students of genetics concerning the origin of higher units and the direction in which the evolution develops. Up to the present time it was not possible to demonstrate by experiments any origin of higher taxons i. e. of genus at least. Some ideas only have been conceived how, by increasing small changes, such a difference could be formed, which could give rise to a new genus, and subsequently, may be, to a family. This opinion, however, could be maintained only if we supposed that the extent of the change indicates also the taxonomic level. Upon the higher taxons, however, we cannot look like this. Every individual must be judged by the evolutionary potency which is hidden in it, and not by morphological shapes. Unfortunately, for the present, this evolutionary potency cannot be measured otherwise than by the quantity and quality of the taxons, originating from it. Sometimes even higher taxons originate seemingly in conformity with the extent of the change, and not according to the quantity of taxons. This phenomenon might happen in case of isolated taxons which evidently have no related types. But it can be supposed that the related representatives became extinct, in past times. The opinion that such isolated types are of a very old age, is confirmed also by their area, which, as a rule, is very discontinuous. It can happen that, owing to unsuficient knowledge, two categories of taxons are associated: taxons, the potency of which can be measured by the quantity and quality of descendants, and taxons, which are morphologically and taxonomically isolated so that we do not know into which group they should be ranged. In such a category, therefore, there will be two types of taxons: on the one hand relic taxons with extinct representatives; that is why the nature of this type of taxons cannot be determined with accuracy; on the other hand taxons, created by gaps, which manifest, no doubt, great morphologic differences, but no evolutionary potency. As a matter of fact such taxons should be ranged among the lower ones. But as the experience of botanists confirms, large differences are mostly caused by isolation and extinction of related types: therefore the errors in evaluation are small. They can be corrected by geographical and paleobotanical research.

It is not likely that the absence of higher taxons in the researches of the students of genetics could be a mere chance. It is more probable that the higher taxons cannot appear there. If it is so, then other causes must be looked for and the phenomenon must be explained more correctly. Many genetic experiments have already been carried out but the evolutionary potency of the new types obtained was never great enough to justify a belief that a new genus had been created. Sometimes differences appear with characters proper to far higher taxons. But in most cases these differences represent only interesting anomalies which, however, do not pass over the taxonomic level of the species. So for instance choripetal difference on sympetal types, or inversely sympetal difference on choripetal types, or actinomorphic flowers on symetrical flowers, and so on.

Not even the selection in agricultural practice, lasting over thousands of years, can offer a single verified case of origin of types which could be taken for a realy new genus. We know the ancestors of the majority of cultivated plants, and they are of the same genus. In case of isolated types rather extinction of ancestors is taken for granted than origin of a new genus. In rare cases, as for instance in case of the *Zea mays* even a possibility of an origin as intergeneric hybrid is admitted. From the taxonomic point of view it is a very interesting case; it is not exluded, however, that even in this case we have to do with an ancient relic species.

If we consider all the genetic experiments from the taxonomical point of view, it gets more and more obvious that the evolutionary trend, leading to pure lines, leads rather to the evolutionary end than to the evolutionary progress. The pure line represents evolutionarily very simplified types. The pure line, characterized by high homozygosity, has, no doubt, the faculty of variability i. e. of forming sudden differences, but these differences are taxonomically of a very little value, although morphologically they may differ in a striking way from the parental types. However, the pure lines are specialized already to such an extent, that they are no more able to subsist in nature by their own forces. It means the evolutionary end. Thus the genetics, which tried to explain in this way the progress in nature, collects more and more facts proving that the evolution, observable in our times, represents, as a matter of fact, a disintergration of the species into small species and finally into pure lines. In spite of the unexpected result this cognition is of utmost importance for a correct evalutation of the evolution in nature.

In the same way, all the orthogenetic series represent an evolutionary trend leading to a high specialization, but the final types are, from the evolutionary point of view, far more simple than the original ones. In the end such a high adaptation to certain conditions can be developed, that beyond these conditions the types are uncapable of life. They get inelastic and die out. This phenomenon can be proved by many examples from the phylogenesis of extinct plants.

If we sum up the present genetic knowledge, we see that there exist no positive proof of the origin of higher taxons. On the contrary the majority of experiments demonstrate quite the reverse: a process leading from higher taxonomic units to lower ones and finally to pure lines. The pure lines represent such an evolutionary simplification which is no more able to maintain itself in nature by own forces. The genetics provides us with excellent proofs of micro-evolutionary processes. It is to genetics that we are obliged for our understanding of micro-evolutionary processes in nature.

The penetration into the complicated hereditary properties was made possible by the genial simplification of this problem by Mendel. Only thanks to the investigation of the heredity of one or two characters, laws by which this heredity is governed could be discovered. It was believed that each property was governed by a certain granule in the cell It was observed, however, that the same factor did not reproduce the same properties in all the individuals in which it occured. Sometimes it manifests itself in a certain percentage of the representatives only. The penetration of factors is sometimes increased or diminished by the presence of other factors. Such factors act as modifiers or suppressors. In the course of time, however, it was found that each property was the result of the interaction of many factors in the cell. The factors are not isolated, but one influences the other. Of course, certain particles are predominant, others have only a modifying influence. It is also possible that all of the factors are not transmitted by heredity; in the course of the complicated processes of the meiosis some subordinate physical particles may get lost. Hereby anomalies in the general function of the factors may be caused, giving rise to changed characters of the whole organism. This phenomenon is extremely important and explains the evolutionary processes of the organism. Especially the selection and the micro-evolutionary orthogenesis are controlled by these processes.

ORGANIZERS AND DETERMINATORS

Hereditary characters may be divided, from the point of view of the evolution, into two qualitatively different groups. Studying the phylogenetic evolution of the plants we see that some characters characterize the higher taxons, others the lower ones, as was already said. However, these characters cannot be taken for determined characters, from which the ones would represent a typical trait of lower taxons, the others a typical trait of higher taxons. One and the same character can represent, in one group, a trait of higher taxons, and in other group, a trait of lower taxons. Thus the function of each character can be very different, from the taxonomical and in consequence also from the evolutionary point of view. A question of fundamental importance, no doubt, is by what such difference of characters are caused. It seems that these differences are in close connection with the differences in the composition of the substance which they are bound to. This effects also the ease or the difficulty of the changes of characters bound to them. On the whole we could very roughly discern two types of substances that control the transmission of hereditary characters, as follows:

1. Organizers, which control the fundamental not changeable trait and characters of the whole organism;
2. Determinators, which cause the changes of the fundamental trait of the organism. These determinators can be taken for identic with the genetic factors.

This assumed division of characters, controlled by organizers and determinators, is supported by the investigation of the whole numbers of factors in chromosomes. In spite of the hypothetical value of the calculation the results are very interesting. Judging by the number of chromomeres in haploid sets of chromosomes the number of genes is estimated to be equal to 2.000—2.500 for the *Lilium pardalium,* and to 5.000—6.000 for the *Drosophila.* As the chromomeres are not bound to have only one factor, the above mentioned numbers are a little smaller than in reality. The calculation, based on the number of mutations, encountered in the genetically most thoroughly examined *Drosophila* and *Zea mays*, leads to the same result. The size of the factors, computed from the X-ray bombardment and divided by the whole volume of the chromosomes, is of the same order. In case of the human being, who, in this respect, is the best examined object, an assumption is accepted, based on natural mutations, that there are 30.000 to 40.000 factors in haploid chromosomes.

All these numbers seem to be too small to be able to seize all the characters of such a complicated object as a living organism. If we take into consideration that each shape and each property may be controlled by a great number of factors, which come into action in the course of the ontogenesis, we see that in the case of the above mentioned number only the factors modifying the fundamental trait can be concerned. The conception, supposing that each property be controlled by a relatively very simple material basis, does not appear to be justifiable. A number of properties must be controlled in some more complicated way. Basing on this assumption it must be admitted that a relatively small material basis should control an immense quantity of characters in accordance which a uniform, centrally governned principle. Otherwise the coincidence of all factors and the harmony of the organism could not be imagined. Just these fundamental factors must be distinguished from the subordinate ones, which are the cause of small changes. Both types of factors are hereditary, yet the latter change but in an insignificant way the fundamental trait of the organism. The theory of the mutations explains in an excellent way the modifying effect of the fundamental trait.

If we take some plastic genus of the cultivated plants, for instance *Cyclamen, Brassica* or other, and estimate the types grown by the man, no systematist, after having investigated the whole evolutionary process, will be in doubt about the genus of the types in question. Often, however, changes occur, the type of which is modified to such an extent, that it does not answer the type established in wild plants. Sometimes also the characters of the families get changed. But in spite of the extent of the variability the fundamental trait remains constantly intact; the changes encountered here do not correspond to veritable changes presupposed for higher taxonomical units. Their taxonomical level is only apparent and due first of all to the lack of our knowledge. It is probable that what is common to all the representatives of a certain genus is governed by other laws than what is changeable. The genetics of today cannot explain all the properties that in the course of the ontogenesis of each organism govern all biochemical processes and morphological shapes. Unexplained remain lots of functions, which enter into action always in just time and on just place.

Students of genetics suppose that all the characters, and in consequence also the characters of higher taxons, are controlled by genes. If it were so, it would be very difficult to explain why for instance in the phylogenic progress reduction of the number and of the size of chromosomes can occur. Examples of this phenomenon are known from the classical study of E. B. Babbcock of the genus *Crepis*. More primitive related genera have throughout X equal to 8 or to 9. In case of the genus Crepis most primitive have proved the species with X equal to 6, and the evolution of this genus has developed in the direction of the reduction of this number as far as X equal to 3. It is possible to assort the species in rows from X equal to 6 up to X equal to 3, it means in accordance with the decrease of the number of chromosomes. Moreover, in each row the species can be grouped in accordance with the decreasing total length of the chromosomes. If we take the extreme cases and if we value for instance the maximum total length of the chromosomes of the group X equal to 6 (occuring in the *Crepis kashmirica*) by 100 points, than the minimum length of the chromosomes in this group (occurring in *Crepis mungierii*) corresponds to the value of 46. The largest relative length in the group X equal to 3 *(Crepis capillaris)* corresponds to the value of 38, the smallest *(Crepis fuliginosa)* to the value 22. Thus within one and the same genus a great diminution of the substance of the chromosomes took place, the volume of the substance falling down to nearly one fifth of the original volume. This diminution of volume was not accompanied by a diminution of vitality. Some subordinate characters only have changed. The reduction of chromosomes was observed by Sinnott also in the case of 25 other genera of the Angiosperms. Thus the reductions of chromosomes cannot be considered as an isolated phenomenon in nature. If we adjudged to the substance of the chromosomes a quite determining influence on the formation of all characters, than it would be unthinkable, that such a reduction, even if we admitted that a part of the substance of the chromosomes could have been formed by heterochromatin, devoid of known gene loci and the functions of which are mysterious up to the present time, could have remained without essential influence on the organism. The taxonomic changes of the latter should have been far more substantial than the existing ones, remaining within the limits of the species. If we adjudged such an importance to the substance of the chromosomes, then there could be no individuals with homozygous deficiency, capable of existence. If we admit, however, that the fundamental characters are controlled also by the other substances than the chromosomes, all these phenomena are easy to be understood.

Nor can the aneuploids, known in many genera of the Angiosperms, give evidence for the great importance of the substance of the chromosomes for the extent of taxonomic changes of different caryotypes. It is true, that mostly it is the question of superfluous chromosomes in diploid or polyploid complement, but their influence is remarkably small. Owing to unregular distribution of the substance of the chromosomes often a considerable polymorphy of the genus takes place, but the resulting changes never exceed the level of small species. Variability of the aneuploids can be found in the following genera: *Erophila, Brassica, Viola, Nicotiana, Stipa,* *Veronica, Carex, Poa, Scirpus, Eleocharis, Iris, Crocus,* and others. All these species often puzzle the systematists.

In case of aneuploids there are not great taxomic changes if the equilibrium is broken. If the chromosomes controlled also the higher taxonomic characters, then some changes should have taken place in these characters too. This, however, is not the case even with different nullisomics, discovered in the *Triticum aestivum,* and with which Sears gradually obtained 17 of the 21 possible nullisomics. In polyploids, of course, the function of a missing chromosome can be substituted by a corresponding chromosome of another set. It should have been expected, however, that by this substitution there would take place in some combination, a diminution or a formation of a new taxonomically atavistic character. But all the nullisomics, if they are capable of life, remain within the limits and do not go beyond the level of the species. Thus even in the case of aneuploids it is demonstrated that higher taxonomic characters must not necessarily be controlled by the chromosomes.

A nice example of the modifiyng influence of the chromosomes is manifested by the sexual dimorphy of some organisms. Now and then considerarable morphologic differences might occur, but their taxonomic value is insignificant. Most known examples can be found in the zoology indeed, but also among the plants sexual dimorphic types can be cited as for instance the *Restionacae* or the numerous *Amentiferae,* the genus *Begonia* and the like. Here also it is often the question of the pleiotropic effect of the sexual chromosome; now and then differences are created not only in the sex organs but also in the vegetative ones. Most reputed differences in the habit or in the shape of the leaves can be found in the case of the *Juniperus communis, Populus nigra, Populus tremula, Cannabis sativa* etc. The sexual dimorphs and still more the gynandromorphs present an example of an extreme modifying action, controlled by the chromosomes. Here clearly the same ground is often very considerably morphologically changed by the action of chromosomes. In case of other examples of changes, controlled by chromosomes, the same kind of heredity can take place with the difference, however, that here independent taxons had been formed. Thus again it can be the question of mere modifications of the fundamental scheme of plants, determined by some material constitution. These foundations are determined by the phylogenetic evolution and for each evolutionary level they are more and more complicated.

However, we must not forget that the organizers and the determinators form one indivisible whole. Their differentiation serves only for the understanding of mutual evolutionary dependance and does not characterize some isolated categories. All the conception of organizers and modificators is merely a working hypothesis. But certain phenomena indicate that this conception may have some real basis.

Letal factors could bear witness against the conception of organizers, because with them often an insignificant homozygous character is connected with the death of the bearers. This need not be always an insignificant morphological character. Sometimes it can be a signal of a bad function of the organizers during the construction of cells in the organism.

It is possible that the loss of chromomeres is due more to the organizers than to the determinators, which probably are not able to cause such a change.

Of course it is unthinkable that the organizers could work without any anomaly. Just these anomalies are very important and enable us to penetrate into some phenomena of the heredity, unexplained up to the present times. Thus all the anomalies in the irregular division of the chromosomic substance are changes rather caused by organizers than by determinators. It is clear that simultaneously, in second place of course, also the function of determinators gets distinguished, making thus possible its experimental control. In the same way the existence of some letal factors, the formative value of which is usually insignificant, reveals chiefly an organization trouble; the morphological change can be considered rather as a signal of this trouble than as an independent change of the shape. The distinction between organizers and determinators could perhaps bring more precision into genetic explanations. Even if, however, it could be proved by experiments that organizers and determinators really work as supposed in the theory, then it would not yet solve the problem of causality in living organisms. A more detailed knowledge only would be acquired. It is evident that there must be something that controls the organizers. The hierarchy of processes controlling not only the evolution but also all the metabolic and morphogenous events in the organisms, must be build up gradually. All these events must be ranged into a system, dependently on their importance. According to the today's insight into these problems, all the above processes are caused by properties of matter and are the results of mutual interaction of differently complicated material particles of one whole.

It seems that the heredity of characters is not only an affair of heredity connected with the chromosomes, as it is most frequently explained. It is very probable that there exists another kind of heredity, which is governed by substances located extrachromosomally. It is, however, not the question of the cytoplasmatic inheritance, but of the heredity, by which the fundamental building of the offsprings is transmitted. This heredity is not governed according to the Mendelian inheritance, because it is transmitted to the offsprings always unchanged. The extrachromosomal heredity seems to govern the processes, which organize the fundamental building of the organism and consequently governs also the chromosomal heredity. Thus the extrachromosomal heredity is superior to the Mendelian inheritance, the function of which is restricted to smaller modifications of the fundamental building. The system of extrachromosomal heredity has got the denomination „organizers“ and the system of chromosomal heredity „determinators“. The extrachromosomal heredity, however, is not identic with the cytoplasmatic inheritance, which, in my opinion, is also determined by the genotype.

ASCENDENT OR DESCENDENT EVOLUTION

As mentioned in the introduction, the most frequently accepted conception is that the evolution develops from the lowest taxons to the highest. This conception followed from the observation of changes in nature and from their evaluation. It is assumed, for instance, that the *forma* can change into *varietas*, *varietas* into species, eventually into genus or higher taxons. According to this conception the evolution could be symbolically represented by a tree of life. The stronger fundamental branches should represent the higher taxons, whilst the smaller final branches should represent the lower taxons. At the same time it is assumed that each individual can have the same evolutionary potency. Similarly as from a cutting of tree a whole tree can grow up, each individual can give rise even to the highest taxons. These conceptions are supported by the experience that each species can under suitable conditions give rise to a new species, different from the original one. Also the *varietas* can in the course of time, develop even into an independent species, and so on. But further considerations, that such a species could by further evolution give rise to a new genus or eventually to higher taxons, are not justified by present experience. For the origin of a new genus from some species of another genus there exists so far no indisputable proof. Mostly it is a question of only an overestimate of morphological characters. To explain the lack of proof of the origin of higher taxons, we presume a successive long lasting evolution of the latter. As by a quick glance at an hour-hand we cannot ascertain, whether the wach goes or has stopped, so it is assumed that we cannot observe the change of species into genus, because such a change wants centuries for its accomplishment.

Anyway these opinions must be revised; all the phenomena which served for the demonstration of the progressivity of the evolution, must be submitted to a new investigation and evaluation.

It is remarkable that there exist more taxons of the value of *phylum* among primitive plants than among advanced ones. If a progressive evolution really existed, it could be expected that, in the course of time, the number of evolutionary lines would gradually increase. But even at a hasty glance at the phylogenesis of *Cormophytae,* which had been most thoroughly investigated from the paleobotanical point of view, we see that this is not the case. Already in the period of Paleophyticum, exception made of the Angiosperms, all the fundamental trends occur. New discoveries give evidence, that most probably even the Angiosperms had some of their representatives already in this period. Hereby the conception, that the evolution develops in the direction of constant progress, is deeply affected. Since the Carboniferous age indeed nothing substantially new has been discovered on Earth. Only some groups get more and more differentiated and put on taxons, other groups get more and more simple, and then their taxons diminish or die out. Is seems that in the Paleophyticum there existed far more fundamental evolutionary groups than today. No doubt, it is a very remarkable fact, if we take into consideration, how little it was preserved from the flora of those times. In spite of all this, the Paleophyticum appears as a period in which all the evolutionary trends has been allready accomplished. From that age, in a course of time far longer than the Paleophyticum itself, only differentiation of some groups took place. Types which have come into appearance later, have always closely related groups in the Paleophyticum; if such related groups were not traced in the Paleophyticum, we can still suppose that they existed there, but have been not yet discovered, or that they were not preserved. If the evolution were progressive, the number of new phyla should have increased rather in the geometrical progression than in the arithmetical one. But such a reproduction was never observed. Fundamental evolutionary lines make their appearance suddenly in a certain geological period; later their number rather diminishes than increases.

A similar phenomenon can be observed not only at a general look at the phylogenesis of *Cormophytae,* but also at the investigation of the evolution of Angiosperms during the last geological periods. This is neither a period of revolutionary geological activity nor a period of quietness. Under the influence of continuous coolness an immense migration of the plants on the northern hemisphere took place. By progressive cooling the species of the arctic and moderate zones were driven to the south and during warmer periods they were driven back to the north. During the migration the plants had to cover distances over thousands of kilometres long; they got into different climatic regions and into different soils. According to the existing evolutionary theories they had a unique opportunity for the formation of not only new species but also of higher taxonomic units. But neither the species that were originally arctic, neither the species coming from mountaineous regions of temperate zones, which in those times formed immense areas, differ much from each other; at most they formed very closely related species often on very distant places. In the case of new small species, which spread on vast spaces, their migration was made possible probably by their greater vitality for certain places, by their greater ability to migrate and the like. Thus this is a process of specialization and not a raise of evolutionary plasticity, leading to higher and higher taxons.

All the experiments undertaken up till now show that never a higher taxon than a species has been created, although sometimes morphological changes were developed, which seemingly reminded of higher taxons. Thus for instance the change *Drosophila melanogaster,* known as *tetraptera,* remains within the limits of this species, although this character in other types gave rise to higher taxons. The evolutionary potency of both types is, however, quite different, and it can serve rather as an example of the difference between the macro-evolution and the micro-evolution. Likewise there exist no proofs that domestic plants, which have been cultivated since many thousands of years, would have formed a new genus in the course of all this long time. Exstinct and isolated types can rather be explained by the extinction of wild parental plants.

Excellent proofs of the often very small variability of species are given by paleogeography. Many species, the areas of which had been broken up tens of millions of years ago, were preserved nearly identic on the separated parts of their original area. Not even the influence of the environment, which considerably changed in the course of the times, was able to bring about a differentiation. This is the case, for instance, of the *Sesleria insularis,* obviously formed in the Miocene, which remains the same on all the broken-up parts. But many other species are known, which are far more ancient than the above mentioned, and which did not change since the times, in which Angiosperms made their first appearance. For instance *Ginkgo* and *Psilotum,* the evolution of which brought no changes since those times.

From many facts it must be concluded that the evolution of plants did not and does not evolve in a simple progression. It is true that some lower groups of plants made their appearance very early and that afterwards plants appeared, which were more and more complicated. The latter are living side by side with the evolutionarily simpler plants but their importance with regard to the whole vegetable kingdom is diminishing. Not every group is in constant progressive evolution. The evolution of many groups stopped, and other groups gradually died out. On the whole, however, the vitality was perfect and thus the possibility was given for the plants to hold out throughout whole geological ages.

When studying the present and the extinct plants we must note an interesting phenomenon, namely that every taxon presented its best evolutionary possibilities at its origin and then gradually only lower and lower taxons came into being. The evolution of every taxon of our times is developing so, that the most changeable conditions are to be found at the origin, when the largest row of changes and new types make their appearance. Gradually the evolution gets stabilized and new types come into existence very rarely only.

Thus many proofs give evidence of a decreasing evolution. It appears as if after a sudden origin of the highest taxons a gradual quieting of the evolution followed, accompanied by the production of lower and lower taxons. For this trend far more and better proofs can be furnished than for the reverse, i. e. for the increasing evolution, in the course of which there should be successively created from the lowest taxons the highest.

AGENTS OF THE MICRO-EVOLUTION

Whilst of the agents of the macro-evolution we possess only indirect proofs, most of the agents of the micro-evolution are today well recognizable. The micro-evolutionary processes can be investigated with the help of well elaborated genetic methods, which make also possible more exact conclusions, that can be demonstrated by experiments. In the preceding chapters hypothethical conceptions about the macro- and micro-evolution have been explained. In the present part a treatise will be given about the agents of the micro-evolution, which can cause differentiation of plants within the limits of lower taxons.

It is a well known phenomenon, that the transmission of hereditary characters can be caused by different ways. Hereby the importance of each accomplished property or character can be very different also from the point of view of genetics and taxonomical valuation. Even a different qualitative and quantitative manifestation of the heredity can take place. This phenomenon has a great influence upon the value of individuals in nature and forms a material basis of the taxonomy of the organism.

Material causes, on which the taxonomy of plants is based, have not yet been satisfactorily solved. Only some indications have been made and attempts of this solution have been undertaken in the explanation of the importance of genetics for the evolution. It appears, however, that the importance of the micro-evolutionary processes is usually overestimated. The problem of higher taxons with respect to the genetic properties has not yet been satisfactorily solved and their hierarchy justified. These problems should be studied by a special branch of genetics, which would submit the quantitative value of hereditary properties to a systematic research. But some results of the genetic researches of today call for an evaluation of these notions to elucidate the taxons. Many attempts have already been made and still more attemps will be so to give such an explanation, before a satisfactory solution will be found. As this problem represents the very fundamental problem of the evolution, everybody who is interested in the evolution, should make known his opinion about these questions and support it by known phenomena. Even if these were only work hypotheses, as in my case, I consider them important for gradual and more precise specification and solution of these questions by other authors.

In nature we know only very few elementary processes which can cause a variability of the traits of single organs of the plants. In consequence the morphological variations, controlled by these processes, are not numerous. Only the combination possibilities are more abundant, and that is what gives rise, in the first line, to the variability of plants in nature. But the shapes, brought about by different causes, are of a very different value. As it has been already explained in my previous work, a change, which from the morphological point of view is quite identic, can have quite different importance for the plants. In case of some plants this change may represent only an inconstant modification as character lower than a species, and in case of other plants it can characterize the highest taxons. Thus not the shape, but its evolutionary value, i. e. its potency to originate different taxons, is of importance. Just this potency of each change represents the criterion for the evaluation. Nowadays we can learn about it but indirectly by the cognition of phenomena, which accompany and distinguish each change in nature. First of all, these phenomena are the following: the number of taxons, characterized by common shapes, and their function in nature.

Transmission of the properties from parents to the offsprings can explain, there is no doubt about it, some evolutionary processes, although, as we know today, the latter do not appear to contribute directly to the evolution. Heredity is a conservative power which keeps in nature the general constancy of types; it is rather a contra-evolutionary system. Different constancy of the hereditary properties is reflected very intensely in the taxonomy. The conservative power of the heredity is manifested with most energy in case of the fundamental properties, on which the taxonomy builds up the higher taxons.

The following three fundamental categories of phenomena are studied by the genetics:

1. Transmission of properties from parents to offsprings, i. e. the proper heredity.
2. Changes of hereditary properties, i. e. the variation.
3. Importance of the heredity and variation for the origin of new organisms, i. e. the evolution.

Heredity and variation stand in mutual antithesis. Hereditary transmission of a new property can make appearance only as a result of the predominance of the mutation factors over the conservative ones. To understand, eventually to govern the above processes, it is necessary to study each process independently, and to find the causes, by which it had been governed. Only then it will be possible to try the mutual relations between the processes and to explain the probable origin of new organisms.

From the evolutionary point of view the most striking phenomenon is the difference between the most frequent heredity of wild plants and domestic plants. This difference is, it is true, only a quantitative one, but a very important one for the understanding of the evolution. On the whole the hereditary conditions of wild plants are far more complicated than those of cultivated plants. Whilst in most wild plants the multiple factor or polygenes and pleiotropism are predominant, in cultivated plants most frequently only simple Mendelian ratios are observed. The consequence of this phenomenon is the relatively great variability of cultivated plants compared with the hereditary conservatism of wild plants. The variability of cultivated plants and of some wild plants is, from the taxonomic and in consequence also from the evolutionary point of view, of a very small importance. Most of the new shapes do not hold out for long in nature, although, from the morphological point of view, they may manifest themselves very considerably. On the contrary, rare hereditary changes of wild plants give more easily rise to new independent species, and thus to the origin of new taxons, laying on the same level as the parental taxon.

From the evolutionary point of view the valuation of the pure line is very important. The pure line can in no case be taken for an evolutionary progress. The origin of a pure line represent in fact the removal of a great quantity of original combination possibilities and the stabilization of evolutionary simple ratios. Hence it represents a pauperization of the evolution. If a strong influence of the external environment on the formation of new properties existed in nature, as it is sometimes affirmed, then it would not be difficult to preserve the pure lines. But the influence of the artificial selection is far more powerful than that of the external environment. The conservative powers, which preserve the constancy of properties transmitted by heredity, are far mightier than the external environment which causes the changes. The pure lines can therefore be cultivated under very different external conditions, even geographically very distant one from another; it changes very slowly and most frequently only, because it is not quite pure in all its characters.

The relationship between the genetical properties and the variability and evolutionary progress is also very important. The question is, whether the variability be the cause and origin of evolutionary progress. The relationship between variability and progress is not a direct one. If we observe variable genera, we see that they represent rather a stabilized type with irregular heredity than an inconstancy leading to progress. It is a blind play of evolutionary paths and their evolutionary value is only apparent. They represent only special cases of fixed irregularity of the genetic system, which furthers the permanent variability. It is caused for instance by the fitness of hybridization of otherwise constant types, aneuploids, apogamy, polyploidy, great mutability, structural changes of the chromosomes, irregular distribution of chromosomes (balanced heterogamy).

Apogamy has been found in the following genera: *Rubus, Hieracium, Taraxacum, Poa, Crepis, Potentilla.*
Aneuploids in the genera: *Crepis, Nicotiana, Brassica, Erophila, Carex, Viola, Iris.*
Hybridization: in the genera *Quercus, Viola, Iris, Aquilegia.*
Structural changes of chromosomes: in the genus *Oenothera.*
Polyploidy: in the genera *Rosa, Rubus, Salix, Viola.*
Balanced heterogamy: in the genus *Rosa.*

If the variation were a basis for a new progress, then the same variability could not be found in the species of lower and higher phyla. But we observe similar plastic species and the same taxonomical chaos among bacteria, fungi as among the Angiosperms. From what was said it must be concluded that it is a general phenomenon, which consists in the stabilization of certain genetical principles making possible this variability.

Polymorphic genera are most frequently explained as an example of the origin of new taxons and are often used as a base, from which evolutionary principles are deduced. It has been explained already that we have to do here rather with a hereditarily stabilized variability, which exactly so as for instance the mutation (which too is more or less hereditarily fixed) cannot lead to the evolutionary progress. It represents only a possibility to combine existing variable agents and not to increase the evolutionary potency, i. e. the ability to create higher taxons than parental ones. The variability is as a matter of fact fixed just in the same way as the simple characters, submitted to hereditary transmission. The only difference consists in the fact, that once a whole complex of variable characters had been stabilized, another time a simple character only had been fixed. Apogamy, capability of hybridization, balanced heterogamy, polyploidy are the same hereditary traits as the shape of leaves, colour of flowers, etc. Only their function in nature is different and leads also to quite different results. Often a taxonomical chaos arises which it is difficult to master. It is true that new shapes emerge, but the new offsprings never have a higher taxonomical value, than the parents; at the best they are able to form new taxons of the same level as the parental ones. Just this phenomenon is typical for the micro-evolution and forms the base for the majority of more complicated micro-evolutionary processes. By the influence of apomictic processes, as it will be shown later, now and then morphologically very distinct types may be created. From the evolutionary point of view, however, most of these types are simplified and often highly specialized, and that means the final possibilities of evolution. Of course for the evolutionary progress the variability and its cognition are not without importance. On the contrary, we realize that even such types could have existed in former days of great evolutionary vigour of types. In this way it is possible to explain why some taxons, for instance families, are so richly differentiated, whilst others remain isolated.

To explain the relationship between the properties of the different taxons, it seems that it will be necessary to change the conceptions concerning the simplicity and similar causes of the heredity, supported by classical genetics. Perhaps each taxonomical category is submitted to its own kind of heredity. That is probably just the diversity of fixed genetic system that the taxonomical hierarchy is based upon. The conception of organizers and determinators, explained before, should help to elucidate this question. It is certain that such conceptions are still far more complicated in reality. Nevertheless the laws of the hierarchy of taxons must be explained somehow already now. Our present knowledge permits us to make only such a little advance; if in the course of time this first step will turn out to be true then it will be surely possible to rectify and improve this conception. The hierarchy of taxons is solved in accordance with the conceptions of macro-evolution, meso-evolution and micro-evolutin.

Agents which are the cause of micro-evolution may be assorted into two categories. Firstly agents which give rise to the variability of the plants and thus to the origin of mutation. Secondly agents which make possible the fixation of variability and thus the conservation of different individuals in nature. As to the cause of their origin both categories are manifold and hence the taxons originated hereby must have different value.

The micro-evolutionary variability of plants can be brought about by two fundamental types of causes of the origin. First by the mutation. The mutation consists mostly in material or structural changes of the fundamental building unit, i. e. of the cell. Secondly by the hybridization, i. e. by the ability to form a new individual from two different basses. Both types have their material causes which then bring about the manifoldness of the micro-evolutionary variability. Of course the differences originated in this way are at first mostly incapable of independent life. The variability represents only the material basis for the micro-evolution. For the conservation of the difference in nature a further proces is necessary, in the course of which the difference gets independent, i. e. selection and orthogenesis make their appearance.

MUTATION

One of the most important causes of the micro-evolutionary variability of plants are the mutations or the processes leading to their origin. Mostly they are set up on material or structural changes of the chromosome substances, the chromosomal aberrations, deficiencies, duplications, translocatoins, inversions or their combinations, which give rise to new changes.

In some cases these causes can result in an origin of complicated genetic systems, by which the variability of plants is increased. Examples of such system are for instance apogamy, interspecific hybridization, balanced heterogamy, etc. which will be dealt with in the next chapter.

Mutations can be assorted in two categories dependently on causes, by which they had been effected. Firstly the proper factorial mutations caused by point alternations in the hereditary materials. Secondly the chromosomal alternations in which some or all of the factors may be lost, present in excess or may change their relative positions. Into this category belong the polyploidy, haploidy, heteroploidy, a position effect caused by the duplication, deficiency, translocation or inversion of the sections of chromosomes.

For some time past the mutations are taken for very important evolutionary agents. It is supposed that merely mutations are able to bring something new that had never been in the organism before. As there exist no proofs of sudden origin of a substantially new organism, a conception has been constituted, that with the help of mutations it is possible to create gradually lower and higher taxons. But there are no proofs to support this conception. All the examples of mutations known up to the present time have but small taxonomical value. At the best, only the origin of a small species may be demonstrated in this way.

Nevertheless the mutations are very important for the explanation of the micro-evolution, and that for the origin of new species or rather of their *varietates* or *formae*. Especially the first category of mutations, i. e. the "point mutations" of classical genetics, is considered as able to form the majority of the morphological and physiological differences. Their material nature, however, is not known, but it is supposed, that they exist on a submicroscopic level. They may actually consist of a whole assemblage of different physical and chemical changes (after Stebbins). Characters caused by these changes do not differ much from the following category and it seems that here too we have to do with combinations of fundamental substances and not with an origin of a quite new substance, which could have a potent effect on the alternation of the variability. These last changes may be supposed only in case of the macro-evolution and the meso-evolution.

The second category of mutation, i. e. alternations of the number and gross structure of the chromosomes, are taken rather for agents, from which are built up many of the isolating mechanisms separating plant species. Therefore macro-evolutionary processes do not spring up in this way, and the gross structural changes again appear to be the base of the micro-evolutionary processes only.

It appears that many evolutionarily new forms were not brought about by the mutations and that the latter make their appearance as a rule as hereditary properties only, the frequency of which may be altered by external environment. We so far never succeded to create experimentally some surely purposive mutations by influence of certain agents. For instance at low temperatures not only individual with a corresponding resistance against coolness spring up, but also such ones which cannot resist. The mutability is always nearly the same: the only difference is that the not adapted individua perish whilst the resistent ones thrive. Not even artificial mutations can be considered as new; they can be found also in nature, of course with far smaller frequency. Thus the external environment can only liberate the given constitutional mutability; therefore the external environment cannot be considered as a direct cause of the evolution.

As it has been already explained mutations in themselves have but small evolutionary value. Their chief property consists in the disturbance of the stabilized genetic balance of factors. The magnitude of a change caused by mutation cannot be judged by the magnitude only of the difference from the normal. Far more important is to what extent the original genetic balance has been disturbed and how numerous and constant changes can be brought about hereby. Mutations represent a complex system, in which the changes and the original genetic basis are influenced by each other and finally get again balanced in a harmonious whole which, however, is different from the original one. They are caused by internal material agents of each organism. The external environment can rectify the originally chaotic mutations into gradually increasing purposive characters. That is just for this function that the mutations are of immense importance in the micro-evolution, forming the basis on which the micro-evolution is built upon. The mutations are the chief cause of the striking purposiveness of some organisms in nature. Similar effect is manifested by the orthogenetical processes which consist in restricting and guiding the mutations in a certain direction. Hereby a succesional increasing of certain purposive properties may be brought about.

Mutation and its behaviour can help us to penetrate even into some complicated relations of the heredity. The possibility of reverse mutations in case of the crossing over and other phenomena may be based on the manner in which the chromosomes are being built. Up till now it is supposed that not even in the interkinesis a whole disintegration of chromosomes takes place. Reverse mutations and independent assortment, however, appear to give evidence that there are rather the chromomeres, which disintegrate and rearrange according to their material affinity. In the same time corresponding chromomeres of different genomes may possess the ability of mutual exchange. As they may exist some distant chromomeres with mutually similar affinity, irregular arrangement of diffused chromomeres can take place. Hereby not only a pure exchange of chromomere can take place but sometimes also a successional arrangement, corresponding to the exchanged chromomere, i. e. a crossing over. The probability of a crossing over is just as great as the affinity of two chromomeres for mutual exchange. That is why the crossing over has a firm value that can be statically ascertained. In the course of a new meiosis the original arrangement can take place, so that there will be a return to the original combination. It is probable that this activity does not take place in already formed chromosomes, but during the arrangement of chromomeres. The properties of the organism are more probably governed by the diffused chromatin substances (karyotine) than by the formed chromosomes, as generally supposed. In the diffused state the chromomeres are likely to obey to some legitimate arrangement which, however, need not be the same as in the differenciated chromosomes. May be that certain genetic laws could be very well explained just by the mutual relationship of the chromomeres in this diffused state. However, it is not excluded that in rare cases also a veritable crossing over could take place.

Mutations are the principal cause of the origin of the manifoldness of the plant kingdom and of its disintegration into an abundance of species and their deviations.

From the gross structural changes of chromosomes the attention of the evolucionists has been turned to the polyploidy. Recently considerable progress has been made in the research of polyploids. Many examples of the origin of new species have been given by this way. Mostly, however, only small species come into consideration. The inclination for polyploidization is not a general phenomenon in nature, and does not manifest itself in all species. Hence it cannot be taken for an important agent in phylogenesis. If the inclination for polyploidization were an important agent, then all the ancient types should have been high polyploids. It is true that polyploids are frequently found in the old types preserved up to these days. But it appears rather as if these species used this way to gain more ecological plasticity to prolong their existence in the world; the polyploidy is not likely to be a necessary mark of ancient types. Anyway the differences in higher taxons are not built upon the polyploidization of derivative taxons. All of them begin with on the whole a low number of chromosomes. Only in the course of the micro-evolutionary aging of taxons they appear more frequently and with the regeneration of the potency of the variability they hold out here and there even better than the diploids. Therefore in derivative floras they can be found most frequently. Thus polyploidization too is a micro-evolutionary process only.

Taxonomical value of the polyploidy is very different, just like that of other taxonomically useful agents, e. g. of the hybridization and of the another mutations. The polyploidy, however, may be often overestimated, especially if we do not simultaneously rate the taxonomical value of differences caused in this way. Of course the polyploidy is able to give rise to new independent species, just like the hybridization or other mutations. Numerous examples are known, in which really a perfect segregation and fixation of polyploids from diploids took place. Simultaneously with this process new advantageous properties of these types made their appearance. These new properties often enabled the new types to migrate into vast regions, which were entirely inaccessible for the old diploid type. In spite of the fact that these polyploids came into existence very long ago, they hold out and keep their newly stabilized morphological and ecological character.

Polyploids have not definite properties, specific only for themselves. Formerly they were believed to have more hardness, etc. Now we know that polyploidization gives rise only to a larger plasticity of many characters and properties. That is just for this property that polyploids are of considerable importance in micro-evolution. A stabilized genetic system becomes in this way instable and many new properties which formerly did not manifest themselves phenotypically can make their appearance. In the diploid state they were at most subliminal and only by the rise of genomes they could manifest themselves also phenotypically.

Nowadays many plants are known which in small districts developed a lot of different karyotypes, such as for instance: *Poa alpina, Erophila verna,* or whole genera such as: *Iris, Scirpus, Carex, Stipa, Brassica, Viola, Veronica,* and so on. Many from among the aneuploids or polyploids can in no case be taken for different species. Rather it appears as if some types, owing to a small stability of genome, inclined to form different karyotypes. Here, however, we have to do with the stabilization of hereditary instability, which need not lead to new types. In this way temporal differences only may come into existence, make their appearance for a certain time and then disappear. Another time transitory apomictic types may appear which, however, may spread as clones over vast areas. Always the most stabilized karyotype gives rise to other transitory karyotypes.

But not a single case is known, in which polyploidization or aneuploidization would have given rise to a taxon in the value of a new species. Sooner it appears that most families and perhaps even genera have diploid first parents and that the polyploidy characterizes rather derived taxons.

Recently proofs have been accumulated of the transmutation of higher polyploids into lower polyploids or even into normal diploids. It appears that this phenomenon is on the whole exceptional and that here we have to do with vital types descending from cells with haploid number of chromosomes. Already in a number of diploid species vital perfectly formed haploids have been known as for instance in the genera *Datura* and *Solanum.* Similar phenomenon may occur so much the sooner in polyploid types. Although it is not a frequent phenomenon, it is a very important one for the estimation of the value of polyploid types, which otherwise could be very easily overestimated from the evolutionary point of view, and in consequence overvaluated from the taxonomic point of view.

As early as 1910 B. Němec discovered the possibility of alternation of the number of chromosomes in the endosperm of the Angiosperms from 3 n in 2 n. Winkler H. described the reduction of the number of chromosomes in bud sports. A reduced number of genomes was discovered for instance in the genus *Parthenium,* where vital haploids with 36 chromosomes descended from types with 72 chromosomes.

All these examples, the number of which will surely increase in the course of time, compel us to look critically at the problem of the polyploidization. The possibility of a back reception of the diploid number is not excluded. Therefore the polyploidy like the other properties may be, but need not be a character of great taxonomical value. Different karyotypes may be of unlike importance within the different species and types for the evolutionary evaluation of polyploids.

On the whole it is obvious that the point mutation as well as the alternation of the number and gross structure of the chromosomes are mostly the starting points leading to pure line and not to the raising of evolutionary potency. That is just the constant diminishing of the evolutional variation, which appears to be the fundamental tendency of the micro-evolutionary trend. The diminishing of the evolutionary variability, however, slackens the repeated increasing or combining of some characters by complicated genetic systems. In our times this activity leads already only to a renovation of the variability within the species and not to an origin of higher taxons. This is the cause of the immense manifoldness of the micro-evolution. It is especially remarkable that neither the assumed chemical changes of the chromatin substance nor the point mutations are of any importance. They do not give rise to substances different to such an extent, that a new burst of evolutionary potency would be possible. If the above mentioned chemical changes and the point mutations were efficient this would have been manifested by at least periodic substantial bursts of the evolutionary potency even in our days. It seems that even in geological ages such substantial bursts were very rare too. Hence it is probable that mutations are caused only by a small chemico-physical stability of some factors; this lack of stability may be caused by some matter produced by the plants.

HYBRIDIZATION

Hybridization is very important for the origin of individuals with which different new combinations of properties and characters make their appearance. But not even these can be taken for essential evolutionary agents. In this way new species come into being, but very rarely on the whole. In these species there is mostly nothing essentially new; new are only some combinations and often a greater manifoldness of the new organisms. In this way the highest taxon created up till now by experiments, the so called good species may rise. Many species, even the Linneons ones, came into being in this way, sometimes, however, in combination with the polyploidization. In this manner, may be, even an essential progress could take place. Such a possibility is not excluded, but was not yet demonstrated. Well known bursts of evolutionary production are not yet satisfactorily explained, but it is not excluded, that they could be brought about by the fusion of two individuals of different evolutionary branches. It is however a very conditional supposition which, it must be said, is not supported by known examples. In the course of normal hybridization, as far as we know an independent assortment takes place. It can lead to factorial combinations only, although phenotypically individuals can be often created, that do not ressemble to either of the parents. But even in this case it must be supposed that the base be a genotypical one, that is to say from parents, in which these properties were not phenotypically manifested. We have to do here always with a mutual influence of different factors during the formation of characters. Something really new could have come into being only by the fusion of two chromatin bases and by the formation of a quite new substance, which would then be cause of quite new properties governable by this new substance. In today's genetical experiments such a phenomenon never occured. In the formation of characters only mutual influence of chromatin substances was observed. It is probable that new combinations only take place of given, but in no case of quite new substances.

A very important function of hybrids lies in the possibility of formation of new species. By hybridization the balance of the factors may sometimes be brought into instability. This is just the condition necessary for the creation of new species, in which a new balance of factors with new properties and characters gets stabilized. By this enrichment of the variability often more purposive types than the parental come into existence. Frequently also introgression of properties under the influence of hybridization may be encountered. From the evolutionary point of view in this case only infraspecific taxons can make their appearance. In spite of all that the latter may be more successful than the parents in certain habitats; but anyway it is allways the matter of combination of factors already given. In the majority of cases introgression leads to the rise of variability.

Examples are known, however, in which the loss of a free hybridization is the cause of increased reproduction of new Jordanons as for instance in case of genus and species, in which apomixis or even more or less strong autogamy occur. Here easily some changes may keep pure, because they are not excluded from the population by the free hybridization of all related types, and their isolation and thus also their segregation are easy. Also the loss of allogamy can lead to a rise of the micro-evolutionary variability. Autogamy therefore in many cases can present better prospect for the origin of changes.

According to the present knowledge hybridization has but a small importance for the macro-evolution, i. e. for the origin of higher taxons. If we take into consideration the genetic isolation of the genera of present times, we see that it is very little probable that by hybridization higher taxons could be formed. Of course in the period of high evolutionary plasticity hybridization could have had a great importance for the origin of new types. In a certain degree this conception is supported by the genetical system stabilized today in certain genera of the family *Orchidaceae*. Thus hybridization in first line forms the base of the micro-evolutionary variability. This is accompanied by a very close relationship between the complexity of the genetic system and the taxonomical complexity in individuals, in which such a system occurs. The troublesome species have always a very complicated genetic system and the irregular transmission of properties to the offsprings is the cause of many mutations and of the possibility of segregation of a great number of species. Especially mutations, which affect the genetic system, lead to frequent differences. Thus apomixis, heterokaryosis, self-sterilization, polyploidy, aneuploidy, and others are often accompained by a great variability of types, with which these complicated systems occur.

Genetic experiments clearly demonstrate the ways of the micro-evolution and make possible observation of the origin of new taxons. Irregularity, caused by mutation, in the constitution of factors of an individual or eventually two different, but related sets of factors get into population by means of hybridization. There they cause a greater or smaller disturbance of the existing balance of factors. The selection which then follows introduces a new order, and a new balance between the factors is established. Finally in consequence of all these processes new taxons may be created. All these processes can be observed, nowadays, only within the limits of equal or related species. Therefore they must be taken for micro-evolutionary processes.

Hybridization is important chiefly for the origin of new possibilities of properties already given and for the penetration of new mutations into populations. Without hybridization, mutations would have be confined to individuals only and they would generally perish with the dead of these individuals. Thus hybridization is a process leading to the manifoldness of the micro-evolution and with the help of the selection it stabilizes and creates new taxons.

It may be, however, supposed that analogical processes occured also in the period of increased evolutionary potency, i. e. also in the meso-evolution and the macro-evolution. It should have resulted in the creation of different higher taxons, genera, families. The diminishing of the variability is the cause of the fact, that the evolutionary processes of present times are not strong enough to form new families and genera.

Hybridization has played a major rôle in the origin of the new types of cultivated plants. It is the most efficient agent making possible new combinations of asked properties. It is especially important for ornamental and orchard crops, in case of which the reproduction of a single convenient individual may continue to reproduce itself vegetatively.

ISOLATING AND STABILIZING MECHANISMS

Mutations and hybridization would inevitably lead to a chaotic occurence of changes, if there were not agents, which bring order into these actions. These agents are the selection and the orthogenesis, which make possible creation of new, permanent types and often even of good taxons, mostly, however, within the limits of species or at best of genus only (origin of the new species).

Isolation and stabilization of new characters are resulting from the influence of external agents upon the genetic system. External agents that exert their influence are very numerous and very different from the point of view of quality; the genetic systems too may be of very different nature. In consequence even the isolation and the stabilization of characters in the population is extremly manifold. Often the same results may be obtained by different methods or same methods under different external conditions may give rise to different results.

As to the external environment, causing the isolation and the stabilization of certain phenotypes, we should cite in the first place the temperature and some chemical substances, especially the content of water, nutriments and some biologically active substances. But also the organisms can interact one upon the other and can guide the evolution in a certain direction; the stabilizing types can support each other, or another time they can restrict incompatible changes. In this way, insects influence the pollination, different animals the migration or the reproduction of plants, etc. Mutual competition between different species of plants represents of course a strong stabilizing mechanism.

Another fundamental agent which exerts a strong influence upon the stabilization and orthogenesis of certain types is the genetic system. Genetic systems generally assist the manifoldness and hamper the quick stabilization and pauperization of the genotype, as for instance in case of heterozygoty, aneuploidy, structural hybridity, permanent heterozygoty, etc. Some genetic systems, however, intensively aid the selection of types and the quick stabilization. In this way also assexual reproduction, self-fertilization, and the like exert their influence.

The activity of isolation and stabilization mechanisms leads in micro-evolution towards the specialization of plants and in consequence to the origin of purposive types. On the whole specialization may be divided into two fundamental processes:

1. Selection, which gives rise to new stable organisms. Fundamental evolutionary principles agree in case of selection considerably with the Darvinian hypothesis. The explanation, however, is based on genetic laws and not on external agents.
2. Orthogenesis, which gives rise to more and more specialized organisms by increasing certain adaptive properties. The evolutionary principles of the orthogenesis are very similar to the Lamarckian evolutionary hypothesis. Orthogenesis cannot be explained by the inheritance of acquired characters, but by changes of genotype.

Selection and orthogenesis are very similar processes giving rise to specialization. The differences consist in the fact, that selection ends with the origin of a certain stabilized purposive type, whilst the orthogenesis gives rise to a great number of successive and often stabilized types, some purposive characters of which continue to increase.

SELECTION

Material basis of the selection depends on the natural variability of the properties of organisms and on the influence of external environment, by which the genetic system is being stabilized. The interaction of these factors is very complicated, and the best success of the genetics consists thus in penetrating into this mystery, and in explaining the activity of most different internal and external agents in the course of the creation and genetic stabilization of types. Selection is a process of stabilization of certains genetic systems from heterogenetic population or of heterozygotes, caused by mutations or hybridization. In the number of direct selectionary agents external environment should be cited in the first place; for instance: temperature, radiation, chemical substances, content of water and nutrition, man, and so on. These condition exert a selection pressure upon the population, composed from individuals with different properties. Of course the selection pressure is supported by individuals, for which the selection agents are advantageous, and hampered by individuals with disadvantageous and sometimes also only indifferent characters. The activity of the selection comes to an end when a new genetic balance is acquired, in which adaptive properties in further generations get stabilized. Thus a new type, different from original parents, comes into existence. Hence selection represents a stabilization of a new balance coming from heterogenetic population. As normally very numerous agents participate in this process, it usually does not happen that the same selection agents could exert a reaction upon the new set. Every stabilization of balance is purposive in a certain environment and therefore in such an environment such a population is stable. Different environment of course may bring about another new selection even from the newly created taxon. These processes are the cause of the origin of new types, morphotypes, etc. and often even of new species. In rare cases, however, the new type may be submitted to the action of the same agents, which influenced its origin, and then gradually in the same ecological sense increasing changes can make their appearance. But this process makes already part of the orthogenesis, which will be treated in the next chapter.

In selection the multiformations is considerable. Most different genetic systems can result in the support and the stabilization of very different characters. Thus for instance the normal sexual reproduction has other effects than the apomixis, genetic sterility, self-fertilization, introgression, etc. Normal diploid condition acts in another way than the polyploid, aneuploid or permanent heterozygoty. Changes by defficiency differ from those by duplication, translocation, inversion, and the like. Different selection effects are caused also by isolation, migration, competition, and the like. Extreme influences of temperature, content of nutritions, salts, water in soil, different radiation, chemical substances, and the like influence in very different ways the selection of individuals of heterozygous populations. By all this the whole process of selection becomes extremely complicated, but thanks to the progress in genetics we are able to answer in a satisfactory way many of the questions. All these problems are elaborated in an excellent manner in the classical work of G. L. Stebbins, which I am referring to.

From the evolutionary point of view the origin of new balance may be valuated either as a process of recombination only or as an influence of structural changes. As far as we know, this way has never given rise to something essentially new or to a burst of evolutionary potency. Therefore it appears that in the micro-evolution no burst of formative power can occur, and that all changes develop on the intraspecific level only.

Very often it is declared that the selection of the abler individuals be the most important agent of the whole evolution. If this opinion were true, an evolutionary pressure should arise, which would create organisms more and more adapted to the environment in which they live. This conception appeared to be supported by the fact that the higher organism from the taxonomical point of view, the more purposive its properties. We see, however, that even the most primitive organisms are provided with excellent purposive characters, and that the difference consists only in the fact, that the more advanced the organism is, the more complicated are its purposive characters. Purposive changes do not lead to the increasing of taxonomical value, but to the overmultiplication of individuals in nature.

The selection in itself influences only the formation of the difference among the populations and eventually the formation of specific barriers. Properties advantageous for the life are of great importance for the relative quantity of such individuals in nature, but not for the macro-evolution, the ways of development of which are different. In micro-evolution, however, it is one of the most important agents for the origin of the manifoldness in nature.

Often the influence of many agents is a very relative one and it may happen that under different conditions quite the reverse is obtained by the influence of one and the same agent. For instance, in the isolation the following axiom is current: the smaller the colony of the organism, the easier the eventual changes may take root in their heredity. In the majority of cases the influence of this agent is exerted in that sense, but not always. We know plants, the area of which has been torn often into very small colonies since the Miocene age and even earlier, and in spite of all that, selection did not manifest itself in the broken-away parts, thought the latter got into very various environment and in unusually large colonies. Also other agents played here their rôle, especially the internal constitution of the plant. In case of changeable types disintergration into different small groups is possible, in case of unchangeable types, it is not possible. Therefore each process ascertained either theoretically or experimentally must be checked, to be sure whether it really occurs in nature.

ORTHOGENESIS

Orthogenesis is one of the most important processes which enable us to explain many phenomena in the micro-evolution of plants. As it is not open to direct observation, because it takes a long time before it becomes apparent, we are generally compelled to make use of indirect investigation. Hypothetical explanation, however, need not be in contradiction with the knowledge nowadays at our disposal, especially with our notions in genetics. Students of genetics unfortunately pay very little attention to the orthogenesis, although the results of genetic research present the best possibility for the explanation of the orthogenesis in a pure material manner, and for proving it by exact experiments. It was not yet possible to master the whole problem experimentally because it lasts very long time; best it could be observed by the paleonthologists. But many genetic processes show us how it would be possible to explain the origin of some orthogenetic branches, which are open for investigation not only in nature, but also in cultivated crops.

The first, who met with the orthogenic lines, was Lamarck and his study is the first attempt to explain the evolution of organisms. As at that time the material causes of the changes of the organism were not known, he helped himself by the so called heredity of the acquired character. Heredity of characters acquired by the organism in the course of its life, was not yet proved. All the cases cited to support this conception may be easily explained by the function of normal hereditary properties, i. e. by genotype. The appearance of the acquired characters in the offsprings may be more easily explained by the constitutionally established hereditary factors, than by their appearance as late as in the course of the excercise of the parents, and by their transmission to the offsprings. There exists none undubitable example of the heredity of some properties created by a corresponding reaction to the pressure of the external environment. Of course the existence of a heredity of acquired characters is not excluded, but it has not yet been demonstrated for certain. If a frequent orthogenesis of certain characters occured in nature, then it would be a striking phenomenon, open to demonstration. The understanding of the evolution would then be far more simple than it is now, when so many causes and relations interfere.

The students of genetics lay little emphasis on the importance of the orthogenesis for the evolution. Many phenomena, however, may be cited which could explain orthogenesis also from the genetic point of view. So for instance the orthogenesis may be expained by pleiotropism, multifactoriality, definiency and some other well known factors like selection, isolation, hybridization, mutation, and so on.

Recent genetic researches furnish more and more evidence that pleiotropism and multifactoriality are far more frequent phenomena, as supposed up to this time. They seem to be the general line of the activity of genetic factors. On the contrary, one-to-one relation between a character and a gene is an exception. Most frequently it occurs in case of cultivated plants, where a considerable evolutionary pauperization takes place, as it will be explained later. There exists a whole complex of genetic factors, which influence each other in most different ways and which are the cause of different changes. Heredity is by no means a simple propriety. It is very difficult to penetrate into this complex, and it took a long time before fundamental simple principle were discovered by Mendel, mostly of domesticated plants. Nowadays researches made such a progress that it is possible to investigate some genetic processes in their whole complexity. As in every discovery, the detection of fundamental principles is made possible by a genial simplification of the problems; later, on eventual exeptions, disadvantages of this simplification are found out and a solution of the problem in all its complexity may be undertaken. Up till now such a progress has been made, that it is possible to ascertain factors, which influence many characters and on the other hand to ascertain characters, caused by the influence of many factors. That is just this phenomenon, which makes possible the explanation of the orthogenesis.

Another very important phenomenon for the explanation of the orthogenesis is the ascertainment that owing to the irregularities of the mitotic and meiotic division of the cells factors can disappear or on the contrary increase. This phenomenon has been proved not only by genetic tests but also by direct observation of changes in chromosomes. Thus if individual hereditary characters result from whole sets of factors, then the loss or duplication of certain factors can cause certain changes in corresponding characters. These changes mostly manifest themselves in the number of characters, because according to the multiple factor hypothesis a series of factors comes here into consideration, the effect of which is cumulative.

We must realize that every property and character is submitted to the influence of factors, from which some improve them, others suppress their full manifestation. It can happen that only favourable factors will be present and the disfavourable ones will be removed or vice versa. Herewith the maximum possibility in the formation of such a character is attained; in this direction the change of the organism cannot be increased any more. In this manner the evolutionary end is established, conditioned by the material possibilities of such types.

By the deficiency or duplication of chromatin substance an advantageous change, adapted to certain environment, may be supported. In such a case, of course, an evolutionary pressure must make its appearance, facilitating an easier survival of the individuals with such changes, in comparison with the original ones. In micro-evolution therefore the Darwinian theory is fully justified. Naturally if the situation explained just now is accompanied by a loss of further factors, which normally could hamper the perfect evolution of the adaptive character, then the result will be a still better improvement of the mentioned adaptive character and hence greater prospects of the survival of these types. In such a case an extreme environment may act as selection agents. This phenomenon, however, occurs very seldom in nature, where so many causes and consequences alternate, that such an onesided production of some character must be extremely rare. Notwithstanding it really happens, that extreme environment enables some types with hidden potency to form extreme characters. Most perfect examples are presented by the plants by the so called mimicry. Here in different evolutionary branches, under the influence of extreme environment, very similarly looking plants are created. Best examples are given by the succulent plants from *Cactaceae, Euphorbiaceae,* and others; further the alpin types, salt plants, water plants, etc. Materialistically such cases are very difficult to explain, although there can be no doubt that this phenomenon exists in nature.

With such orthogenetic branches theoretically two different evolutionary ends are possible. Firstly, an irreversible evolution in case of characters effected by the loss of limitating factors. The latter cannot be substituted and hence the way backwards is impossible. Secondly an evolution with possible reversibility in case of characters effected by duplication of favourable factors. Naturally the latter may gradually disappear, and a return to original state may be assumed. Both ways are possible and some phenomena bear witness that they really exist. For the most part, however, most different transitions of both directions as well as an establishment of complicated balances with new conditions may be found.

Thus the base of the orthogenesis is formed by a favourable mutation, caused by loss or duplication of chromosome substance and by consequent selection, ameliorating gradually favourable characters. By hybridization and isolation this process may be considerably accelerated, but sometimes also slackened. For the origin of orthogenical branches dominance or recessivity of some characters may be often advantageous. Dominance and recessivity are caused by a number of factors and therefore they manifest themselves in the form of a quantitative feature. In many cases a perfect selection has been already attained, so that in some plants the dominance and recessivity got a character of a nearly qualitative feature. In different complexes of factors the dominance and recessivity may be different; on the whole they represent a cumulative quantum property, increased by some factors, decreased by the others. Therefore also in case of this trait, when the balance of factors is disorganized, the orthogenesis may set forth in a certain direction. The dominance and the recessivity may overcome certain delicate evolutionary stages in the course of the orthogenesis and the selection, because a not adaptive property may be suppressed only temporarily as a recessive one, and conversely an adaptive property may be temporarily supported as a dominant one. In this manner this phenomenon may become very important for the speed of the orthogenesis, because the orthogenesis may temporarily find its way even in types with recessive or dominant properties.

With the help of orthogenesis we are able to elucidate very complicated phenomena in nature, the knowledge of which would remain ortherwise vague only. So for instance the origin of many quantitative characters, which seemingly look like a progress, can be more easily explained by an evolutionary regressive orthogenesis. All characters of plants must have a material basis. In many cases, however, complicated correlative relations of different chemical substances or their physical shapes, which influence each other, come into consideration. Thus the material base of the properties of plants must have its definite limits. But owing to the correlative action of the other properties of each organism, which too have their material bases, these limits cannot be reached, just because of hampering influence of other properties and their material bases; hence a property cannot exhibit its perfect condition. In nature we find most frequently types, in which the orthogenesis did not lead to a total evolutionary pauperization, but in which the balance of properties is in equilibrium. Such types therefore have a relatively high evolutionary vitality without onesided specialization by orthogenesis. Thus most properties are of a restricted use. Such a stage is very favourable for these types, because it gives them a greater vitality and helps them to overcome different troubles of life.

Extreme conditions of life make the life possible only for individuals with well developed extreme properties, adapted for the environment in question. But to make the development of such a property possible, factors must be removed or their action restricted, which hamper a full evolution of certain traits, or conversely other must be accumulated, which effect continually greater and greater extreme characters in the individual. This can be reached by purely passive selection of types, which for certain reason lost factors restricting the formation of characters, or increased factors favourable to that formation. Therefore from all the favourably develeped phenotypes there are gradually selected and increased such types, in which these characters are developed also genotypically. Naturally in the course of such deficiencies all individuals are eliminated, in which simultaneously with the loss of the limitating factor also factors inevitable for the conservation of necessary vitality are lost. Such individuals are not capable of continous life. Elimination of unfavourable factors during the formation of favourable ones lasts probably very long, and therefore the orthogenesis may be relatively short, but it may last also throughout the whole geological periods.

In nature the orthogenetic evolution does not proceed as far as its end but as a rule it stops far earlier. Often at the very beginning of the orthogenic branch, in consequence of some alternation of the environment, it turns into another direction. Therefore among wild plants we seldon find perfectly specialized types; such types would had small vitality, and a little alternation of the environment would have made them die out. Therefore only such properties may get lost, which are not inevitable for life. Surely, every vital species has plenty of such properties.

A fine example of a perfect orthogenesis is given, as mentioned before, by the genus *Euphorbia* and by the family *Cactaceae*. In the case of the *Euphorbia* this process did not exceed the limits of the genus, and therefore it is a case of a micro-evolutionary orthogenesis. In the case of *Cactaceae* the process took place within the limits of the family, and so it is a meso-evolutionary process the origin of which dates from the period of higher evolutionary plasticity. In these cases a remarkable adaptation of some types to desert climate and formation of perfectly similar succulents took place. In both cases we have to do with the same orthogenesis, but in different evolutionary branches.

For similar cases of remarkably spezialized types in nature of course only a hypothetic explanation is possible, supported by phenomena which would be able to assist such an evolution. It is impossible to reproduce a whole orthogenesis, because it would last too long.

Another more instructive and more easily explainable example is given by domesticated plants. Here the main evolutionary pressure was not caused by passive influence of the natural environment, but by the active selection of the breeders; mostly this selection has been conscious, but formerly it used to be unconscious or more or less subconscious. Origin of properties favourable for the man in cultivated crops represents only seemingly a progressive evolution of new properties. Far more comprehensible explanation is given by the conception of orthogenetic evolution. Certain phenotypic property may be caused either by material factors, or by the lack of some polygenic factor, and therefore a definite perfect character cannot be created. Especially in case of higly spezialized characters, as encountered in cultivaded crops, it often appears that advantageous changes can be created only by advantageous grouping of all factors influencing this character. It means that even all the correlative factors must be made full use of to obtain for instance a large savoury fruit or a high content of sugar in a sugar-beet, and so on. This must be attained by elimination of all factors, which correlatively diminish these properties, and by accumulation of all favourable factors, which increase them. By selecting for futher cultivation phenotypes with most favourable properties the breeder chooses simultaneously those phenotypes, which had lost more or less permanently this or that limitating factor not absolutely necessary for the plant. By centuries of constant selection more and more genotypes got accumulated and modifications lost their importance. So gradually there made its appearance a seemingly new or improved, but in reality formerly only suppressed character, advantageous for the breeder. Thus mostly it is question of a desirable selection only, and not of an origin of a new property. This orthogenesis, howerer, differs substantially from the orthogenesis caused by natural environment. In nature the whole evolution is considerably restricted by the fact, that vitally weakened individua must sooner or later perish. Therefore in nature the orthogenesis is not so extreme and rapid. By action of the breeder individuals may be kept alive, which without his help would not be able of independent life. In this way a far higher specialization in the formation of properties may be reached, and whole orthogenesis may develop more rapidly.

The new and quantitatively changed properties represent, however, because of the loss of some factors, an evolutionary pauperization of types, and not an increase of evolutionary potency. Theoretically every property, which from the evolutionary point of view is not yet at the end of its possibilities, corresponding to its material composition, is capable of an orthogenesis. By these processes the origin of highly productive cultivated crops, incapable of independent existence in nature, might be explained. Such crops need all the agrotechnical care to hold out. If cultivated crops were left only for a few generations without help, they would surely die out. The loss of properties in the course of the selection is usually permanent, and in certain highly specialized types a remedy would be impossible. That is why the protection of wild plants, related to cultivated ones, is so important, for in the wild plants an immense magazine of properties is preserved. By hybridization it is then possible to redress the loss of important properties, so easily wasted by selection, misled to undesirable side-lines.

By evolutionary simplification there may be also explained some otherwise incomprehensive phenomena from agricultural and genetic practice, first of all heterosis, renovation of the effectiveness of degenerating sorts, and properties of polyploids. The most striking heterosis arises from the hybridization of two more or less inbred and degenerating lines, as for instance *Zea mays*. Both parental lines have been selected by orthogenetic selection for the same purpose, i. e. for increasing the harvest. In the course of the selection, most probably, the limitating factors have been removed beyond optimal limits and the harvest were declining because of constant inbreeding. At this stage the degeneration already begins, because in the course of further selection such factors are removed too which keep up the hybrid vigour. Herewith a great simplification is brought into both evolutionary lines. As most probably in both lines the loss affected not the same, but different polygenic factors, it is possible that in each line even such factors, which are the cause of hybrid vigour, are still preserved, namely such ones which did not unfavourably influence the proprieties supporting the high harvests. In each line the factors, which cause the vitality, were beneath the normal. But by means of hybridization both lines completed not only the vitality supporting factors, but also the factors causing high harvest, to an unexpected level. The new hybrid displays then a supernormal production and viability. The more orthogenically selected types (i. e. with factors with high homozygozity difference but not hindering each other), the greater the heterosis. The high homozygozity, however, could unfavourably manifest itself in that sense that, as the types in question were geneticaly simple (with simple heredity), even insignificant losses of factors could cause rapid and severe falls, irreversible, however, in the offsprings of these hybrid types. By this far more important simplification than that encountered in normal selection, it is possible to explain even the high harvest, which surpasses by far the results obtainable by a normal selection. In case of heterosis the size of the effect depends on the extent of the evolutionary simplification in a certain direction. As all the cultivated sorts can be simplified in this manner, a larger or smaller hybrid effect can be expected in case of hybridization of suitably selected pairs of sorts.

On similar principles the well-known greater plasticity of polyploids with respect to diploids may be based. Here some properties have had their factors in subliminal quantity. By the multiplication of genomes in cells a number of factors was reached which was able to form even phenotypically a certain character. This increasing of the variability may concern not only the increasing of vitality and ecological plasticity, but also the morphological changes. Already a small improvement is capable of introducing the superiority of polyploids with regard to diploids in certain environments and on certain habitats. This is often the cause of a new migration of polyploids beyond the boundaries of the distribution of diploids. As with autopolyploids only small changes can occur, so soon a genetic stabilization sets in. Then polyploids get again stabilized just as the diploids. By orthogenesis, however, other characters may be maintened and increased with the polyploids than with the diploids.

The third example of a gradual loss of properties is the recently discovered method of regeneration of degenerating sorts of some crops. The successional decline of the effectiveness of old sorts may be explained by deficiencies. That is why in the course of time most sorts degenerate. As in different regions deficiencies produce the loss of different properties, it is possible to recover the efficiency of the sorts by crossing the sorts of different mutually distant habitats. It can be expected that in some individuals all original or nearly original properties will meet together again, and that in this way the old efficiency of the sorts will be obtained afresh.

In all the above described cases the evolution leads from complex evolutionary possibilities to an evolutionary simplification, often accompanied by high specialization for a certain environment. We must be always aware of this trend, although sometimes it might seem that we succeeded in obtaining quite new properties. The size and the quality of a seed or of a fruit need not therefore depend on a gain of some new property, but often on the loss of all the correlatively limitating factors, which are not inevitably necessary for the life of the plant, but which may in a correlative way restrict the perfect development of certain properties. Also the old not variable species may be considered as the types evolutionarily more or less simplified. Their stability, however, need not be potentionally absolute. Under certain external conditions not yet experienced by the plant in its evolution, a new orthogenetic evolution may start, often in different direction.

Orthogenesis need not be limited merely to the irregular division of the chromosome substance at the meiosis. Also the mitotic division or the mitosis-like division may lead to the mutability as in the case of the multiplication of the bacteria in cultures. In one single culture bacteria may reach the number of millions and even billions of individuals. Hereby a favourable orthogenesis is made possible of individuals with changes suitable for the acting environment. Now and then these changes may be apparent even on the cultures, by diferent shape of single sectors of the colonies. Winge found out that unfavourable mutation formed lens-shaped inclusions in the colony, favourable ones formed sectors with convex margins.

The most known example is that of the orthogenesis by successional increasing of the resistance of the bacteria against penicillin. This process has been investigated by Demerec (according to Stebbins) on the *Staphylococcus aureus.* Moderate concentration of penicillin increased successional mutations more and more resistant against penicillin. This successional increasing cannot be explained by normal selection, but only by orthogenesis by the appearing of constantly new increasing mutations, by the loss, or here, owing to the reversibility of this process, by the multiplication of favourable factors. Similar increasing of the resistance to drugs of the sulfonamide type hawe been investigated by Emerson and Cushing (according to Stebbins) on the Ascomycets *Neurospora.* The increasing of the resistance went so far that some strains specialized to such an extent, that their optimal growth occured only on a medium containing sulfanilamide. Also this case may be explained only by the orthogenetic increasing of certain properties. In microbiological literature many other examples may be found, such as for instance the origin of the resistance to the killing action of ultraviolet light and X rays, or the training of bacteria for certain media on which formerly they could not live, and so on.

Orthogenesis is a very important phenomenon, which on my opinion can explain many of the hitherto inexplicable problems in the life of the plants. It occurs frequently in nature; of course it is not the only principle conditioning the micro-evolution. By orthogenesis there may be explained in a uniform and harmonious way the evolutionary hypotheses of Lamarck, Darwin, and De Vries. Phenomena investigated by these authors meet just in orthogenesis, but their explanation is based on different material foundations. All the three hypotheses try to solve the problem of the evolution of plants, but their explanation is overestimated. Combination of the three theories into a uniform conception of orthogenesis, which should be based on genetic researches, will enable us to understand one of the fundamental principles of the micro-evolution.

Orthogenesis cannot be taken for an absolutely fatal tendency leading to the evolution of certain extremes. It is only an ability to start increased changes in a certain direction as soon as opportunity offers. The micro-evolutionary orthogenesis is caused chiefly by external conditions. In case of loss mutations orthogenesis is inevitably an irreversible evolution towards evolutionarily more and more pauperized types. In case of normal specialization, however, most of the changes may follow several directions, and these changes need not inevitably increase. Sometimes only, if they get into conditions favourable for the orthogenesis, they may gradually increase. This increasing need not be continued as far as the end; in nature far often only short increasings take place, and later the evolution continues in another direction. Such short orthogenetic changes are not isolated, on the contrary a great number of them can take place simultaneously, influencing one another. The orthogenesis is very important also for the understanding of the purposiveness in the evolution of plants. Adaptation to the environment is just in this case most striking. By orthogenesis it would be also possible to explain the rudimentation of disused organs. In this case the mutations, which would lead to their suppression, may fully develop, as they attack a character no longer necessary. Thus the whole orthogenetic line, leading to the suppression of such a disused organ, may make itself useful. The factors participating in the formation of an organ may simultaneously act as suppressors of an other necessary organ. If in the course of the phylogenesis some of these not needed factors get lost, then it must lead to the suppression of the not needed organ and to the improvement of then needed one. This conception, no doubt, is a very hypothetic one, but the present genetic knowledge does not exclude the possibility of this explanation.

Orthogenesis appears to be a typical micro-evolutionary process, in which an important rôle is played by the purposive selection and by the evolutionary pauperization. The phase of the macro-evolution levels up the obstacles of the environment by a powerful fundamental evolutionary potency with the help of which it overcomes the troubles of life. By orthogenesis a disorganization of the genetic balance in the organisms can be brought about. Conflicts resulting hereof between different parts and even cells give gradually rise to quantitative changes in different organs of the plant. If these changes did not affect the pleiotropic action of the factors, then lethal manifestations would make their appearance with the loss of factors necessary for the existence of some shapes. In case of multifactorial and pleiotropic characters, however, the loss of one partial factor may be balanced by an increased action of other factor. It must be, however, emphasized that every orthogenesis must be materially predisposed (limited). Therefore such an orthogenesis may be provoked only, for which there are material conditions. The arbitrary orthogenesis without materially predisposed basis are impossible.

Orthogenesis need not be limited to the micro-evolution. Similar phenomena could have occured also in the meso-evolution and perhaps in the macro-evolution. In the latter cases naturally, their importance could have been far more penetrating. The high evolutionary potency of those phases, however, made onesided evolution impossible; merely in stabilized lines their effect could have manifested itself more vigourously.

TAXONS AND THEIR EVOLUTIONARY VALUE

If the conception of the diminishing evolutionary potency in course of the phylogenesis of the plants is right, then its significance for the comprehension of individual taxons must be great. The evolution of the taxons proceeded from the highest to the lowest and not conversely.

Up to the present time a conception is predominating that the evolution takes its course with a nearly equal rate from the beginning of the apparition of the first living organism till today. Rarely only there appear serious objections against this conception. Much material, however, was collected witnessing against the conception of a harmoniously running and ever constantly progressing evolution. If there existed an evolution characterized by a constant progress of ever equal rate, then just the highest taxons, e. g. new phyla, would have to increase during geological periods. Nevertheless all the fundamental evolutionary branches made their appearence as early as the Paleozoicum. Even the pollen of the Angiosperms was found in the carboniferous period and one cannot exclude the possibility of finding at one time even older vestiges of the Angiosperms. It means that during the last 200 milion years nothing essentially new has appeared on Earth concerning the plants. This is in fundamental conflict with all evolutionary theories existing up till now. There are many proofs of the fact that the families of the Angiosperms were not arising by a gradual gathering of changes, but appeared almost suddenly, and that during the last 100 million years good families were probably not arising any more. Only new genera, and chiefly species were appearing, which abundantly arise even today.

These conceptions will not result in great alternations of the existing contents of taxons as far as the families, but their influence has surely to manifest itself in the definition of each taxon and but secondarily also in the contents of taxons, in the first place of the species. Each taxon is determined by the evolutionary potency which it possesses in the period of the formation of the basis of this taxon. This potency is, naturally, different with families, genera, and species. On the other hand all families had to exhibit a nearly equal evolutionarilly potency, and just in the same way also the genera had to be evolutionary nearly alike. After all even the species which form the lowest independent taxons had to have a mutually nearly the same evolutionary potency.

The evolutionary potency of families, genera, and species must be distinguished from each other by a certain qualitative leap, caused also by another material heredity basis of each of these categories of taxons. Individual categories of taxons must have a different value of their properties, which must be subject to a different modifiability. Limits between individual categories of taxons need not be sharply differentiated by morphological shapes. Owing to the little quantity of fundamental shapes formed by plants, some characters of different taxons may be phenotypically much alike and these may then look as transitional characters. Hence morphological characters may sometimes have but an apparent taxonomical value. Nevertheless there can exist transitional types, as with most phenomena in nature.

Somehow we can imagine the significance of individual categories of taxons by a comparison with categories of organic compouds. This comparison is not homologous, indeed, still there exists here some similarity. Chemistry distinguishes after all few types of fundamental organic compouds. Each of these fundamental groups possesses an immense potency, for it can constitute a great number of separate matters which in spite of a similar general composition can have different properties. Each of these subordinate groups has itself the potency to form a batch of fundamental modifications and this manifests itself by the formation of an enormous number of different substances according to the nature and position of different substituents. In the same way we can imagine also the value of individual taxonomical categories and their relationship with taxons we observe in nature. Just as in case of chemical bindings the same element may have a different value in accordance with its situation in the compounds, so also a different position and function of certain compounds in the genetic system can form morphological characters of different nature. In case of chemical compounds the nature of the binding is well known and man is able not only to classify them on this basis into fundamental processes and subordinate ones, but even to master and direct their origin. Of far more complicated substances governing the shapes of living organisms we know very little and our conceptions thereof are but very hypothetical ones. Yet we can suspect that the connection between categories of taxons and the different function of the shapes might be in principle similar to that of chemical compounds. This is, however, a most delicate question which cannot be verified in a simple way, and whose processes cannot be directed as it is the case of far simpler chemical compounds. In case of an organism one has to do with an exceptional and far more complicated relationship.

Up to this time the students of genetics have paid their attention merely to the changeable genetic properties and on the whole they have not taken any notice of the not changeable hereditary properties. The changeable properties are in the heredity after all the most subordinate ones and they cause mostly but changes of species. In any case they do not affect the fundamental building of the living matter which correlatively directs the whole development of individuals as well as the phylogenetical evolution. It seems that families must have their material basis in other more fundamental principles which have been allowing far greater and more fundamental changes than genera or even species. Taxons as far as genera are now so stabilized that today their change and hence an arising of new taxons is not possible any more. As the evolution proceeds irreversibly, it is not possible today to disturb this building in the finished individua without destroying their life. Research as applied by the chemistry cannot by applicated here. In order to facilitate at least a conception of the situation of substances governing different heredity, a hypothetic conception has been elaborated about organizers and determinators as well as about their function in the heredity.

The most complicated is the relation between the potency to form characters and properties and between the finished shapes. This is a principle of fundamental importance especially for the comprehension of the origin and evolution of taxons and thus even of species. This relation confronts us hitherto with many mysteries. In a most striking way this relation is evident in the case of the development of the organisms. In the phylogenetical evolution we may suppose a similar relationship. One can suspect it from different facts of the present relations of the evolution as it manifests itself in the plant-kingdom by the existence of evolutionarily differently complicated individuals.

In the ontogenesis it comes to very complicated circumstances between the formation of shapes and the potency to form them. After differentiation of a number of tissues or of the whole organs the potency for further development is for the most part temporarily exhausted. Permanent potency is restricted only to meristemes. As far as the formed differentiation exists, no new morphogennous potency shows itself in the environment of the finished organs. This potency it not lost absolutely, however, but its further manifestation is limited or suspended by the backward correlation of the finished organs. From the experimental morphology we know the reactions of the plant after a disturbance of such a correlation of finished traits and the manifestation of a fresh morphogennous potency. The differenciation of tissues and organs is a very complex system which always leads to the decay of the individual, sooner or later. In this system the potencies of the cell substances and the finished shapes of the vegetable body are in a continual conflict with each other. At last the shape becomes victorious and makes the manifestation of material potencies impossible, which leads finally to the dying down of the individual. But a timely separation of a part of the individual which is capable of an independent development makes possible the reestablishing of the original developmental potency and thus a cyclic repetition of the development. Each development is thus an irreversible process and gradually something gets always lost hereby. After the formation of some organs namely all the possibilities do not remain preserved, but only the subsequent ones which go on diminishing.

In case of phylogeny we observe somehow similar processes. Here also it comes to the formation of a shape, but this is not an index of the evolutionary potency of the organism. Similarly shaped organisms may have once a great evolutionary potency, another time their potency may be nearly exhausted. Also the blocking of the evolution of such organisms may be different. Mostly the finished forms prevent irreversibly a regressing evolution. An important difference is, however, that in case of the ontogenesis a cyclic renovation (regeneration) of the development occurs, whilst in case of the phylogeny it seems to occur but an aging of this process; a new recapitulation of the evolution from the lowest stages does not exist. Only two cases occur here. Firstly, it is the repetition of continually similar traits because of the stabilization of their genetic system, which to a certain extent corresponds to the action of meristemes in case of ontogenesis. Here also a constant balance is maintained on nearly the same level. Then it is a gradual change of the shapes under the influence of the evolutionary potency of each living cell. These changes show successively, however, a constantly diminishing evolutionary ability which at last decreases as far as to give rise to factorial combination of already existing factors. Phylogenesis is a unique process of which we do not know whether it shall not repeat, as in case of the ontogenesis, until it reaches final complicated shapes; these would necessarily lead to extinction if they would not eventually crumble into new most primitive organisms starting the evolutionary cycle from the beginning for the second time.

In the case of ontogenesis there occurs no exhausting of all possible shapes, but merely the arising of traits made possible by the environment. The traits of each individual are thus but one of many possible occurrences. At the same time each trait is irreversible and influences all further stages. The whole organism is, however, nearly always governed by a single type of heredity and hence the unity of the whole individual remains intact. In the case of phylogeny it looks somewhat different. Here likewise, indeed, the full manifestation of evolutionary potency does not sometimes occur, but such only that is made possible by the environment. This environment does not act as a main agent that could differently change the internal phylogenetic potency. As, however, the phylogeny proceeds in individualized parts, greater or lesser hereditary changes are possible, which may stabilize in their properties and so last a long time. These changes influence the further phylogeny in a similar irreversible manner as the morphological differenciation the further ontogenesis. Just by a different evolution there arise different substances in genetic systems and thus also great differences in the results, i. e. in taxons depending on them. By creation of each taxon something is lost from the original evolutionary potency and thus also in the case of phylogeny the evolutionary potency must gradually sink. Only exceptionally the formation of a material system may occur which would make possible a sudden increasing of the evolutionary potency. It seems, however, that such an essential evolutionary leap occured during the evolution of the plants but very rarely and that individual periods with progresses were separated in every instance by some hundreds of millions of years. The gradually diminishing evolutionary potency can account for why we have on the whole so few high taxons that are always very old. But nor do the lowest independent taxons, i. e. species, occur in such a number as it would correspond to the divergent evolution with a continually increasing evolutionary potency. In no case do the 150.000 species of Angiosperms correspond to an especially huge disintergration of the evolutionary potency into such an immense number as it would answer the enormous manifoldness of conditions acting in this process.

SPECIES

Problems of species as a fundamental taxonomical unit has of course at all times arisen the interest of many students. Although nearly every systematist recognizes and defines relatively well new species from fresh and exsiccated materials, the definition of species has made and will surely make many difficulties. Numerous definitions were elaborated, but none of them is perfect. Several only are rather acceptable and even these are either too extensive or too concise. None gives security and it could in some cases comprise either taxons lower than species, or higher ones.

In my opionion the cause of difficulties in the delimitation of the conception of species lies partly in the complexity of this problem, partly in its inaccurate evolutionary evaluating. A systematist recognizes species by their concrete characters which he compares with characters of the related species. Most definitions make therefore use of their characters and properties to define species. This seems to me to be just the cause of the difficulties, for characters and properties are only secondary manifestations of species which cannot be defined by them. In a great number of cases it is indeed possible to define roughly species in such way, but with every character and property there go so many exceptions that we cannot adopt a unique point of view, from which it would be possible to define the species precisely. As an only reliable character I consider the function which the species has in nature. Species is a group of hereditarily related individua which form a new smallest independent natural unit with assistance of the genetic, morphological, physiological or spatial isolating mechanism.

I suppose the most important thing in this conception of the species is that this shall be the smallest independent natural unit. Isolation mechanisms are then important for the origin of the species and its different types.

The species then represent the smallest independent natural units arising by successive diminishing of evolutionary potency in the phylogenesis, but often stabilized by increasing of certain properties by means of genetic systems and processes. Diminishing of potency reaches its critical point just in a stage when the evolutionary potency may go on sinking even further indeed, but when the new decrease results in an inability to maintain an independent existence in nature; or they are so small that they do not come into consideration for the origin of a new species and maintain themselves but in the value of a *varietas, forma* or pure line. Diminishing of the evolutionary potency may go as far as the stage when most properties are represented in homozygous state, i. e. as far as the pure line in the sense of classic genetics.

An important supposition for the species is its spontaneous existence in nature. All species have not got, however, an equally great evolutionary potency in the stage which they reached by phylogenetical evolution. Sometimes the present stage can be reached also with a higher evolutionary potency, another time the diminishing of the evolutionary potency can under favourable conditions pass on nearly to the pure line. Thus species are neither theoretically nor practically identical as to the evolutionary potency. This must lead, of course, to a number of different types of species. On this principle lies also the taxonomic classification of the species in polytypic species, Linneons, Jordanons, etc.

Each species, may it have whatever evolutionary value, must be judged also by the cause which led to its origin. According to the stabilization of the genetic system in question, the value of species can be very different. Constancy or mutability of species are directly dependent on the genetic system. Thus even their independency as a natural unit can be in each genetic system a different one. The genetic system may concern both hybridizations and mutatitons. Hybridization can give rise to types of very different taxonomic value. An ascendent row would be formed e. g. by sterile hybrid, hybrid swarm, introgressive hybrid, agamospecies, hybrid species. Likewise the types arising by mutation have a different taxonomic value. Structural changes of the chromosomes, polyploidy, aneuploidy, balanced heterogamy, and the like can be a basis for the origin of changes from forma till Linneons. At that individual genetic systems are important agents for the stabilization or variability of taxons arising by these processes. For the origin of new taxons there is of a great importance even the isolation mechanism and thus the ways by which taxons gain a greater or lesser independency. It has a great importance for the taxonomy as well, as it elucidates not only the function of individual taxons in nature, but also their quality. Isolation mechanism can be of very different nature. Also its results can have a very different taxonomic value, namely from varietas till species. Thus the ecological isolation gives rise to changes living under different ecological conditions. The spatial isolation furthers changes in case of migration into other geographical regions. The seasonal isolation asserts itself at the origin of changes having their individual evolutionary stages in different vegetative seasons, and obstructs thus their hybridization. The genetical isolation acts principally by constituting barriers in the hybrids. The morphological isolation acts by forming changes mainly in the construction of sexual organs which can hinder fertilization with related types.

A different taxonomic value of species resulted from different evolutionary potency, different causes of arisen species effected by different genetic systems, and at last different isolation ways dependent upon the difference of isolation mechanisms, make the problem of species a very complicated one; hardly is it possible to stow it into a simple definition. That will not do neither by reliance on causes, nor on isolation mechanisms, nor on shapes originated by these processes. Neither is it possible to start with a supposition that only one model of the species exists. On the basis of taxonomic value, causes of the origin, and routes of the isolation it is necessary to build a whole row of different models of species which will differ from each other by a different evolutionary potency, by genetic systems, and isolation mechanisms. It is natural that even such types will exist which it will be difficult to assort. These are in the first place the transitional types without sharp limits.

Very important is the supposition that the species should represent a natural unit. Such types cannot be regarded as good species as have been acquired artificially, even if they do not differ genetically from natural species. Each species needs a certain time to have its independency proved. In this time its specifical properties must manifest themselves and a specifical area must be created. Thus species covers the pragmatic moment as well. Without proving in nature there is no possibility to aknowledge any species. For this reason artificial species can be regarded merely as copies, but not natural species. Examples of morphologically and genetically well differentiated, but not independent types can be cited from the agriculture. E. g. the sorts of *Brassica oleracea* could indeed form an independent species by their genetical, morphological, and ecological properties, nevertheless they are not capable to maintain themselves in nature for a longer time, and therefore it is not possible to regard them as species. But even in culture each new sort must prove its pureness and it often lasts very long until it is selected. Just the same way, not every individual in nature which is different can be regarded a new species. As taxon it works out not until it proves in nature.

Another condition for the acknowledgement of species must be a close relationship. It is not possible to include into one species types which morpholotically look very like, but arise from different evolutionary branches. In these cases, however, division is not possible until the real relationship of such converegent types is proved.

If a species may be regarded as independent it is necessary that it should exist for a certain time in which its independency might manifest itself. Each species must therefore have its own history. It is not possible to regard as species types arisen very recently, even if they manifested perhaps great and good differences from their relatives. That is why I regard such types merely as taxons lower than species. Their importance and value must always be, however, minutely analysed.

Also the delimitation of the species upwards against the higher taxons is important. I myself do not regard as species taxons which contain more than one lowest independent unit. As for the elementary species, I comprehend it in a relatively narrower sense of the word. The greater part of subspecies, which properly speaking represent independent natural units, I regard as species. Collective species, however, are not elementary species. It seems to me that the only stage that could be ascertained with relative ease were just the transition between the independently functioning unit and the not independent one. This independent stage exists in all species, whilst in many species there are not formed small species, and the small ones are often lacking in the higher ones. Taxonomy distinguishes this by taxons lower than species. But even so there is left, in good species, a great number of differently valuated types.

For delimitation of species we use morphological, physiological, anatomical and genetic characters and properties. But all these properties do not warrant an accurate delimitation of species nor the control of our work. From of old and even today one most often uses morphological characters. Notwithstanding that in a much greater part of cases it is possible to find good distinctive characters in the gross morphology, their application in more complicated cases is difficult. Especially the homologous variability, introgression, and imperfect barriers give rise to similar characters in different evolutionary branches, they cause transmission of solitary characters into neighbouring population of other species, and effect a bad isolation of morphological characters, etc. Thus morphological characters are not by themselves able to delimit perfectly individual species.

Physiological properties are less utilized as good criteria for the separation of individual species, and this because of their frequent insignificancy.

Although they can give in some cases even very good results, still as general means they were not and cannot be made use of.

In recent time one uses the further the more anatomical and palynological characters. These methods are often very successful at the delimitation of higher taxons, but mostly within genera they are often remarkably uniform, so that they have no distinctive intraspecific ability, or after all only in exceptional cases.

Of late years a tendency has been coming up more and more to use for the typification of taxons the presence of certain chemical compounds. But not even this character is a general delimitating one. In different evolutionary branches there appear the same substances and on the other hand, chemical substances may essentially differ even within the same species. Therefore the chemical compounds can be applicated in the same way as the morphological, physiological, and other characters. Their identification is often rather difficult, and that is why this criterion is very rarely used, especially if we have the possibility to use for the valuation characters which can be verified more easily.

An excellent means for the delimitation of species are the genetic characters and properties. Especially the genetics has made possible a better penetration into the problems of species. Often it is very difficult, however, to value genetic properties from the point of view of taxonomy. It seems that we have not yet a suitable criterion for this valuation. A conflict arises also by the fact that we observe genetic processes only for a very short time, whilst speciation lasts even millions of years. Therefore they may be considerably different and merely seemingly alike. A correct evaluation is therefore difficult and some processes resemble each other only seemingly. In the speciation, the most important is the origin of the stabilization of genetic process which as a rule lasts a very long time. About this process we can only conjecture as for the most part it is not possible to repeat it. Therefore, e. g. an artificial creation of a species indicates rather a possibility of the origin than the real course of the origin of a species identical with another one already stabilized. Real differences can be insignificant, but for the life very important. Stabilization needs an immense number of little steps to remove all the difficulties which life lays in the way.

The interfertility of populations can be one of the possible properties, but never a unique and exclusive one. There are so many exceptions that the origin of hybrids cannot be used as a good character in the delimitation of species. There have been created indeed whole systems of taxons based upon the valuation of the interfertility, but after all it was soon recognized that their application formed considerably artificial groups, which often it was not possible to compare with the taxons of the systematists at all. Into such groups can be assorted but representatives of different genera, another time species, another time still taxons lower than species. Intergeneric and intrageneric hybridization, further inability of hybridization even between representatives of one species has effected a turn-away from the use of these properties as proof for the delimitation of species among the systematists. Investigation of interfertility may even today be important for the interpretation of many evolutionary phenomena, but not as property causing the origin of new species.

For all these reasons one cannot delimit species by single categories of characters only, but it is necessary to use all the categories of characters which can say us something about the fundamental properties of species. It is important, however, that never only certain qualities are in question, but the most different characters and properties can characterize a species and often in quite another sense with different species. Speciation is a process and as such one it can be but with difficulty defined by the results of this process, i. e. by adult characters which can have the most different causes. The value of this speciation process does not consist in morphological, anatomical, physiological or genetic characters or properties, but in the value and function that this process has in nature. And this is the origin and formation of species as the lowest independent natural unit.

A conception which considers the species as an independent natural unit coming from the diminishing of the evolutionary plasticity, does not suppress the troubles, which may be observed in nature. Even if a quite true picture of the species were found, the existing complexity of this problem would not be removed. A right conception of the species, however, would be of great use. Therefore it must be gradually formed and an appropriate picture of it should be sought for, corresponding better to the reality. A better understanding of the species should make possible a better explanation of facts and an inclusion of more and more exceptions into general conceptions. Always, however, there will be plenty of transitory cases impossible to scheme into simple conceptions. Real complexity cannot be removed by a simplification, but only by detailed knowledge of all causes of this complexity.

The definition of the conception of the species is difficult, although the causes of the species are, thanks to our genetical researches, quite comprehensible. Genetics succeeded in penetrating deeply into the problems of the species. Indirectly the genetics makes a cognition of the limits of these conceptions possible. On the exceptions it is then possible to determine fundamental and secondary agents influencing the speciation.

It would appear that not by the characters, but by the speciation as process the species may be typified. Not even this is true, because the speciation represents only the ways, in which the evolution is carried out, and the individuality of species as the natural units is maintained. The individuality of the species as the natural unit arises and may be considered as an equibalanced relation between the stabilization system and the system responsible for the variability in each population. The genetic stabilization system must predominate over the system causing variability. As a result of these processes a species comes into existence, which, however, can maintain itself only so long, until the genetic system causing variability, gets predominant. The interference of these two agents is one of the most interesting properties of the evolution. Now and then the predominance of the variability is caused by the interference of the external environment, by which the equibalanced relation of the genetic properties may be alternated.

On the other hand the genetic stabilization system arises mostly in consequence of the internal action, and the genetic factors in it are predominant.

The formation of the stabilization system is one of the most important agents, causing long lasting equibalance of genetic properties and persistance of certain combinations of the properties, by which the existence of every species is made possible. From genetics we know that the stabilization of the properties may be caused in most different manners, depending on which different changes may make their appearance, distinguished not only by evolutionary potency, but also by properties and their stability. The origin of homozygozity, autogamy, apogamy, loss of the mutability, origin of hereditarily purposive properties represent the genetic stabilization systems, which diminish the possibility of the origin of changes and are the cause of a persistent equibalance of the whole genetic system. On the other hand the structural changes of the chromosomes, polyploidy, aneuploidy, balanced heterogamy, easiness of hybridization represent the genetic systems, which facilitate great variability. The later makes possible the origin of new combinations or of new hereditary changes. In this way constantly new changes come into appearance, which after segregation may lead as far as the formation of new species.

A strong stabilization system as counterbalance of the variability may be formed on different levels of the evolutionary potency. Dependently on this level of the evolutionary potency the species with a higher or lower evolutionary potency may be formed.

Therefore a splitting up to pure lines need not occur in case of all the species. That is just the nature of the stabilization system which is decisive for the value of each taxon. Thus the species is created by the predominance of the stabilization system over the variability.

Between the species and genera characteristic transitional type of taxons may be found: the *species collectiva* (polytypic species). This group does not answer the conception of the species, as it is not the smallest natural unit. Likewise it cannot be taken for a genus, as it is obviously governed by the accommodableness of the chromosome substance and before all by the complexity of the genetic system. This characteristic taxon is formed by a group of closely related species, provided usually with a more elastic genetic system, which makes possible a splitting into a row of small species by action of most different isolation mechanisms. The more complicated the genetic system, the more numerous closely related species may be formed. Conversely a stabilized simple genetic system hinders the splitting into numerous small species.

On the same causes is based also the division of the species into Linneons and Jordanons. The Linneons are characterized by the stability of their genetic system, and therefore they do not form small species. On the contrary the genetic system of the Jordanons is usually elastic and causes a considerable variability. The variability brings about the origin of small species and the splitting often as far as the pure line. As, however, different genetic systems may have different quality, the division into Linneons and Jordanons is not a sharp one. Many intermediary types can be found, for which it is difficult to choose this or that category.

The causes of the origin of the species from the evolutionary point of view may be seen in the accomodableness of the fundamental building by the chromosome system, which tolerates constant hereditary changes. The fundamental building of every plant is governed by a system of hereditary not changeable and permanently transmitted properties, which may be considered as caused by the hypothetic organizers.

GENERA

Also the function of the genus in nature may be considered as an evolutionary stage caused by a certain genetic system. The conception of the genus was but little specified by the systematists, mostly only by definitions still more vague than in the case of the species. Most frequently the genera are defined by external resemblance only. It spite of the fact that the genus, no doubt, is the same reality in nature as the species, there exists, as far as I know, not one satisfactory genetic proof of it. It must be supposed, that the genera are caused by special genetic systems, which, however, are different from the specific genetic systems. It is very little probable that such a striking natural phenomenon as the genera be submitted to the same laws as are the species and that the only difference between these laws be a quantitative one. If the generic properties were located in the chromosome matter, then irregularities should have appeared in the division of karyotin substances in the course of meiosis in the same manner as it is observed in the case of the properties of the species. Loss of different chromosomes should have led to changes of the characters characteristic for the genera. Herewith a greater inconstancy of higher taxons should have been brought about and in consequence a chaos in the hierarchy of taxons. But there exist no signs that the generic characters would change genotypically. Here and there changes of generic properties occur, but these changes are seldom of a genotypic nature. And if any occur, then they are as a rule very small, most probably in the ontogenesis, without alternation of the taxonomical value. Thus for instance if the trimery is changed into dimery, as e. g. in the case of *Galanthus* or *Gagea,* etc., then not a base for a new genus but only a small modification has been brought about, which mostly does not even attain the value of a new species.

Not even in genera does a complete genetic separation take place. Many representatives of different genera may mutually hybridize and produce even fertile hybrid lines. That is the cause why the value of hybridization in taxonomy must not be overestimated. Thus the barriers of the sterility cannot be effective for the definition of the species, especially if it does not occur in genera. Obviously the loss of the hybridization is not an unchangeable property of the genera; genetic relationship may be possible even if single branches have been separated since a long time. Examples of intergeneric hybrids are not frequent, it is true, nevertheless they happened in many genera, for instance in the family *Gramineae,* in the genera *Festuca-Lolium, Zea-Euchlaena, Aegilops-Triticum, Elymus-Sitanion,* and others. Similar examples may be found in many other families. Genetic incompatibility therefore cannot be the property of genera.

Nor can the morphological characters be used to typify the genera safely. It is true, that the fundamental morphological building is preserved in the genera, but not absolutely. Moreover it is difficult to typify this morphological building, as it is known to us only from the statistical examination of every character in nature. Also its taxonomical value is rated accordingly. We find, however, many indeterminate cases or exceptions, which make the evaluation difficult. Thus it would be just as difficult to typify the genera by certain morphological characters as the species. In the genera and species the morphological differences are gradual only and not qualitative, and therefore they are not a safe criterion to be used for the delimitation of these taxons.

The stabilization of the genetic system, which forms the genera, is a very complicated process. Direct experiments with this genetic system are not yet practicable and therefore the solution of these problems is extremely difficult. Thus in the formation of conceptions concerning the material causes of the genera we are reduced to suppositions only. These of course must not be in conflict with the events we can see in nature. The following conceptions therefore represent a working hypothesis only, supported, however, by certain phenomena in nature. In accordance with the former conceptions the genus may be explained by the reaching of a certain critical point in the general diminishing evolutionary potency. This point is characterized by a certain genetic system. The genus forms a group of related types with one or more species. With this group the system of organizers has reached its complete stabilization in the general diminishing evolutionary potency. Modifications of this genetic system by the evolution of the genetic system of the determinators may be, no doubt, considerable, but essential mutations leading to higher taxons than the genus are not probable. Thus the genera are characterized by the modifiability, caused by the chromosme substance, in the course of which, however, the matter which organizes the formation of the chromosomes does not change.

Whilst the conceptions concerning the species are considerably concrete, thanks to genetic researches, conceptions dealing with the genera and higher taxons are very hypothetical. Neither the genetics nor the other branches of botany succeeded in solving satisfactorily the causes of the origin. Similarly the conceptions of the function of higher taxons in nature are very rare. The genus was mostly established as a natural category by morphologic taxonomical methods only. But the reality of this category is quite clear. It is very expressively marked by the quantitative jump existing as a rule between the properties of the species of a certain genus and other species of other genera. Although the genus is a clean crystallized natural category, still hardly anybody tried to explain this so striking phenomenon and to justify it with the help of known agents. Most frequently the genera are explained as a result of progressive differentiation of the divergent evolution. It, however, does not explain the mostly clear qualitative jump between genera and species and between genera and families. In case of a progressive differentiation the transition of all the taxons should have been more or less gradual. A jump caused secondarily by the extinction of a part of predecessors is very little probable. Only in rare cases it may be supposed that the separation set in by jump. Nevertheless we see the majority of genera is strictly separated not only from the higher, but also from the lower taxons. Only in case of monotypic genera the genus fuses with the species. This case is very rare and it occurs mostly with old and not with young genera as it could be expected in a progress proceeding from species to genera.

The cause of this curious phenomenon must decidedly depend on certain material bases, which phenotypically manifest themselves as genus. This problem, however, is not yet proved by any concrete event, which could be demonstrated experimentally. In case of species we are helped by the properties governed by the chromatin substance, which can be demonstrated by genetical experiments, because these properties are changeable. Generic properties, however, are not subject to genotypical changes and if they change, then generally phenotypical changes only come into consideration, which never manifest themselves by a production of a new genus.

Obviously there does not exists one model only, neither in case of species, nor in that of genera. With the species, thanks to genetic researches, we know the causes of the origin of many different models of species; with the genera we know nothing about the causes. By taxonomically morphological methods, however, different quality of genera has been safely proved. Here the difference of models is not so apparent as with the species, but still it is posible to distinguish a different quality by the content of different genera. Monotypic and polytypic genera surely represent different genetic systems, by which this phenomenon is caused. It is true, that the cause of this phenomenon lies in the diversity of the chromosome genetic system. This diversity is probably caused by the differences in the extrachromosomale heredity, by which the action of the chromosome heredity is organized. It appears to be self-evident, that there must exist some higher principle superior to the normal heredity and controlling the normal heredity.

FAMILIES

Just like the genera, so also the families appear to be a typical taxonomic category. Also here there exist sharp limits between different families, which proves that also this category must have certain material causes, to which this phenomenon is due. As between different genera of every family great differences exist, it appears that here far more important changes have had occurred than in the genera. I suppose, that families were created thanks to the modifiability of the fundamental building and that they were controlled by laws different from the genetic laws of today. Nowadays we do not observe any longer that the characters, by which we determine the families, would qualitatively change. As they are present in all the representatives of every family, we must suppose that these characters occurred in the oldest member of the family and in all its descendants. From the phytogeography we know that nearly all families are very old. From the paleobotany we know that many families, considered as derivated, existed already in the most remote times, fully crystallized. Thus the formation of the families must have taken its course in overwhelming majority already in the first phases of the progress of the Angiosperms. Since that time they have developed as independent evolutionary branches. If we admitted a constant progressive evolution, the number of the families should gradually grow and they should be most frequent in the stage of new-formation. The today's situation of the Angiosperms is far from confirming such a supposition.

It is very probable that already in the early periods of the evolution of the Angiosperms the lower taxons too made their appearance, though exceptionally. As for the species, decidedly, these exceptions must have been very rare. Only a few isolated species manifest old hiatuses in their distributions that characterize some ancient families. Thus it appears that some branches grew rapidly old and were in the position to form even species, which did not change or eventually changed only some of their less substantial characters. The evolution of the Angiosperm did not at all proceed with regularity, so that first only the highest and then gradually lower taxons would be formed. The irregular evolutionary aging was characteristic for all the periods, but the general trend of evolution from the highest to the lowest taxons is clearly apparent with the Angiosperms. Thus surely already in the first phases of the progress a heredity existed, controlled by chromosomal substance, and even an extrachromosomal heredity. But thanks to the great plasticity of the fundamental building and of some properties, controlled by the extrachromosomal heredity, the influence of the chromosomal heredity was considerably diminished.

Basing on the gradual diminution of the number of higher taxons in the course of the evolution we must suppose that the evolutionary potency was not always the same. In the oldest phases of the progress of the Angiosperms far more fundemental changes in their building seem to have been formed. Therefore in those times the plants must have been far more plastic than later, when obviously their plasticity decreased. This is manifested by the gradual decrease of the higher taxons. The differences in the evolutionary potency cannot be measured, of course, by the plants of our times; nor can they be valued by preserved paleophenotypes. Thus we are referred to an indirect observation of the gradual frequency and of the relationship between higher and lower taxons.

In order to understand at least a little the phenomena in question, we must presume that the heredity in the first phases of the evolution of the Angiosperms is different from the heredity of our times. Hereby probably not the laws of the heredity are concerned, but rather the evolutionary processes, which were gradually altered. The evolutionary process grew old and herewith some evolutionary possibilities got lost which existed in the period of the progress.

On the base of the before explained conceptions I am of the opinion that it was question of successional stabilization of the heredity, caused by extrachromosomal material bases of the cell, situated most probably in the nucleolus. In my opinion these bases are able to govern the formation of the fundamental building of the Angiosperms. Already from the origin of the Angiosperms the chromosomal heredity surely existed, but, as it has been already explained, its influence in the time of the formation of the fundamental building of the families was of smaller importance. It surely was suppressed by extrachromosomal heredity, open to far greater and far more fundamental changes, than that represented by the modification of the basis, caused by the chromosomal heredity. It seems that just in the period of the progress such a heredity could be changed and successively formed, which did not manifest a pair-nature basis as does the chromosomal heredity with its interference of the heredity of male and female gametes.

The changes of the hereditary basis, as observed in families, and the formation of extrachromosomal heredity are purely macro-evolutionary processes. On the contrary the micro-evolution is based on the formation and interference of the chromosomal heredity after a complete stabilization of the extrachromosomal heredity. As a result of these agents in the first place the species make their appearance. As both processes started already in the macro-evolutionary period, every family which was formed in those times may be typified by the extrachromosomal and chromosomal modifiability. By the blocking of the extrachromosomal variability families are stabilized and genera formed. But neither the family nor the genus can be safely typified by their characters, because there is no simple relation between these characters and the taxonomical level. These taxons, however, may be typified by the function of the genetic system which may probably do best justice to the position of every taxon.

Families are formed by a group of types with one or more genera; in the course of the diminishing evolutionary potency this group has been formed by the stabilization system of the extrachromosomal heredity. In case of the families a variability of the organizers may be supposed, in the same way as in case of the species the chief agents are represented by the variability of the determinators. The species are controlled by the chromosomal heredity, and the families by the system of the organizers. But even the formation of families belongs to the period of diminishing evolutionary potency, as many of the characters and properties have been blocked earlier, and in consequence characterize yet higher taxons as for instance orders, etc.

In the diminishing of the evolutionary potency certain cardinal points may be observed whose causes may be of great importance for the understanding of taxonomic categories. An attempt has been made to justify the hierarchy of taxons by the evolution of different genetic systems, of which each would be justified by its own complexity. Herewith there would be justified also the level of each category of taxons. That is, no doubt, a purely speculative conception, but I am of the opinion, that it is necessary as a working hypothesis, which may make possible more true and more accurate solution of these complicated problems, the investigation of which has been unsufficient up till now. Nowadays it is difficult to explain the causes of the phylogeny, when even the causes of the ontogeny, whose innumerable examples are passing under our eye, are hardly known to us.

SUMMARY

All that is living on Earth is forming one whole, disintegrated into a great number of individuals representing independent parts of this whole. New and new individuals are continuously arising from the old ones, which disappear one after the other, but all of them are constantly forming a lawful whole. One simple embryo may give rise even to the highest organized individuals. But if we have no experience, we cannot guess what will spring up from the embryo. Always, however, the embryo is tending towards its materially predisposed complexity. Similarly also the evolution of all that is living takes its course from onecelled forms to complicated ones, and probably it is predisposed in the same way as the evolution of an individual. The course of the phylogeny may, however, considerably differ from that of the ontogeny. Taxons originated from phylogeny cannot be foreseen with accuracy, because we have no experience as to the aim of the phylogenetic evolution. In case of ontogeny, however, this aim is mostly recognizible. In the course of time the course of phylogeny may be scattered in all directions, and therefore the ends of the evolutionary branches may be very different. Whilst the ontogeny manifests itself in a great number of examples, in phylogeny there exists only one course which is never repeated. To a certain extent it is the same as in the history, where each event can happen once only. All that is living is controlled by laws corresponding to the properties of the matter which it is composed from. In the development of single individuals the alternations are different from those encountered in the evolution of a whole phylum. But boths groups of alternations have many things in common. Development and evolution are analogical processes, but their possibilities are different.

In principle the phylogenetic evolution and the ontogenetic development are governed by two antithetic forces:

1. Conservatism of the present stage.
2. Changeability and origin of changes.

In ontogeny this influence is resulting in modifications, in phylogeny it is resulting in hereditary constant mutations.

Causes of changes in ontogeny are different from those in phylogeny. In ontogeny they are based on the intervention of external agents while internal agents do not change. In phylogeny changes are caused by the influence of internal agents, and the external changes cause the "to be or no to be" of the changes. Conservative forces can predominate af any time and interrupt the origin of certain changes. Herewith the precedent changes get stabilized and transmitted already without qualitative differences into further generations.

There is, up to the present time, a general belief that evolution is proceeding with the same rhythm since the appearance of the first living organism up till now. Rarely only serious objections against this conception make their appearance. A great number of proofs, however, has been collected against this conception of a fluently running and constantly progressing evolution. If the cited conception were true, then in the course of geological periods the number of the highest taxons, for instance of phyla, should increase. This is not the case, as already in the paleozoic period all the fundamental lines of plants have made their appearance. Even the pollen of the Angiosperms, which are taken for the most accomplished type, can be found already in the Carboniferous period and it is not excluded that still older tracks will be found. Thus it is very probable, that all the fundamental types made their appearance in a relatively short middle paleozoic period; hence it follows that during more than two hundred millions of years nothing substantially new has appeared on Earth. Such a conception would be in a fundamental conflict with all present evolutionary theories.

Paleobotany, however, offers other details too. Already in the beginning of the Cretaceous period most different families of the Angiosperms made their appearance, sometimes even such ones, which had been considerel as very derivated. This is confirmed also by the phytogeographical researches which bear witness that the majority of families migrated across regions which have been covered by sea since the very beginning of the Cretaceous period. Thus these families come from still older periods than from the Cretaceous one. Here in the first place areas of families come into consideration, which have been separated by the Pacific Ocean.

Families were not created by gradual accumulation of changes, but rather suddenly, and in the course of the following one hundred millions of years good families did not originate any more. Only new genera and especially species appeared, the formation of which takes place even nowadays. On the base of these and other events the course of the evolution must be valued in another manner than so far. First the representatives of highest taxons made their appearance, and gradually lower and lower taxons came into being. Thus the evolution of the plants does not proceed in the direction of more and more advanced types, but in phases. The gradual origin of types derived from primitives ones is improbable. After a revolutionary origin of representatives of the highest taxons the evolutionary potency diminishes and gradually lower and lower taxons are formed. This evolutionary trend seems to be general, and present even in the smallest changes, which can be observed nowadays within the species. From genetics we known, that the greatest variability and the fundamental mutations make their appearance already in the first generations and that later the new combinations get more and more lost and that the original manifoldness gets stabilized on a few types only. Thanks to these and some other events it is clear, that the evolutionary potency, i. e. the ability to form new types is not the same in the course of time. It is most powerful soon after the origin of the changes and then it gets gradually stabilized.

The evolution of plants is divided into three important phases: the macro-evolution, the meso-evolution and the micro-evolution. Each phase is of quite different consequence for the evolution. The macro-evolution represents the phase of the greatest evolutionary potency, in which the greatest changes are formed under the influence of unsteadiness of many properties and characters. It is supposed, that in that period taxons higher than families make their appearance and that also the bases for the families are formed. The meso-evolution is a phase, in which the evolutionary potency begins to get quiet. By favourable combinations many polymorphic organisms may be formed. It appears that in this period the families got definitely formed and that they built bases for the genera. The micro-evolution is a phase, in which the evolutionary potency begins to age. Only small alternations are being producted. The plasticity of species is rather seeming. It is caused on the one hand by the stabilization of irregular distribution of the chromosome substance in case of some types, on the other hand by the orthogenesis, caused rather by the loss of some properties than by an origin of new evolutionary properties.

Difference must be made between the evolution leading to the formation of higher taxons and the evolution leading to the origin of equal or lower taxons than the parental ones. The first phenomenon I call the progress, and the second the specialization.

The striking phenomena, which may be observed in the dynamics of the evolution of plants, must of course have their causes. Unfortunately, in this domain we have but suppositions. It is necessary, however, to back them by all the facts, which could support these conceptions. Recently among the students of biologically orientated genetics and of pure genetics (e. g. J. C. Willis, R. Goldschmidt, H. Nillson, W. Rotmahler, and others) serious scepticism arises as to the possibility of an explanation of the evolution on the base of classical genetics. Neither the mutations nor the recombinations are able to explain the evolutionary progress. There is a striking difference between the heredity of the properties of the species and lower taxons on the one hand, and of the genera and higher taxons on the other hand. The first mentioned heredity is governed by the laws of classical genetics. The heredity of genera and higher taxons is not controlled by these laws; from the genetic point of view they get transmitted unchanged. It is true that by different interferences such disturbances may be brought about in the metabolism, that even the characters of higher taxons may be changed. Always, however, this is a phenotypic and not a genotypic change from the point of view of taxonomic evaluation. *Drosophila melanogaster* as a species remains without change even if it got four wings instead of two. The origin of regular peloric flowers in case of *Digitalis purpurea, Consolida ajacis,* dimerous flowers in case of *Galanthus nivalis* and others, never exceed the taxonomical level of the species. Thus it must be supposed that the material basis of the heredity of lower and higher taxons is different. The taxonomical difference of the charac-does not consists in the character itself, but in its genetic value. One and the same character may be once a character of the *varietas*, another time of the species, eventually of the genus, etc. Thus all characters must have a similar material nature, differing by a small chemical change only. Classic genetics has safely proved that the matter, which governed the specific and infraspecific characters was located in chromosomes. The chromatin substance, perhaps in the first place the euchromatin or the desoxyribose nucleic acid, form the material basis of the heredity. It is very probable that the properties of higher taxons have a similar chemical nature; but the behaviour of the latter in the course of the cell divisions is likely to be different. If it were subject to the same dynamics as the chromosomes, it would surely result in irregularities, which would manifest themselves also phenotypically. It may be supposed that even the characters of higher taxons are controlled by chromatin substance, namely by the heterochromatin or ribose nucleic acid and that they are most probably located in the nucleolus.

That is on these principles I tried to form the conception of the difference of the heredity of characters of higher and lower taxons. Substances which control the heredity of higher taxons, and thus also the not changeable base of the heredity, were called the organizers. Substances which control the heredity of lower taxons, and in consequence also the variable base of the heredity, are called determinators. Between the organizers and the determinators there is a balanced relation with probably a very complex dependency. Action of the one may destroy or increase the function of the other.

The conception of the organizers and of the determinators helps us to understand the difference between the macro-evolution, the meso-evolution, and the micro-evolution. In the macro-evolution and the meso-evolution fundamental changes in the organizers can take place. After the latter had been blocked, the variability can manifest itself only in the determinators, which make possible the conservation of the ecological and morphological plasticity. Therefore the characters, formed in the micro-evolution, bear always the signs of purposiveness. As to the macro-evolution, our proofs are indirect only, but it seems that in this phase the great evolutionary potency could paralyse the majority of changes that were unfavourable by the arising of changes in other characters; for instance the complexity of the floral structure in the case of *Orchidaceae* by the length of the time, during which the flowers are capable of pollination, by special morphological adaptation during the pollination, etc. The differentiation value of macro-evolutionary changes was very considerable, and thus bases for new higher taxons could be formed.

Far more complicated relations may be found in the micro-evolution. As the micro-evolutionary processes are still proceeding in the plants, the possibility is given for their better investigation. Especially the contribution of classic genetics is of importance. In foregoing chapters an attempt has been made to explain the micro-evolutionary processes and to form a conception of the material basis of these processes. The micro-evolutionary variability of plants has its causes in the origin of mutations and in the hybridization. Mutations are resulting from material and structural changes of the chromatin substance. Hybridization makes possible the origin of new combinations, which sometimes were subliminal only, by compounding chromatin substances of genetically related types. The origin of new changes is generally chaotic and dependent on the material structure of hereditary bases. Adjustment of these changes is controlled by selection and orthogenesis, caused by influence of external conditions on the genetic system. As to the external environment the following conditions may be cited: temperature, some chemical compounds, content of nutriments, water, some biological active substances, and so on. Similarly the mutual action of organisms, namely not only of animals upon the plants, but also of plants upon the plants, may support or suppress certain changes. Some genetic systems assist the variability, as for instance the heterozygoty, aneuploidy, structural hybridity, permanent heterozygoty, etc. Other genetic systems make possible a rapid stabilization of changes, such as for instance the asexual reproduction, selffertilization, and so on.

On the whole two fundamental processes of the stabilization of new types may be distinguished: the selection and the orthogenesis.

Selections represents a process, in the course of with, from originally heterogenic populations under certain conditions, a new permanent type is formed. The specialization processes, which are acting here, are identic with those discovered by Darwin. Of course not higher taxons than the parental ones are formed, i. e. in the best case units of the same level may be producted. It means that from a species at best another species, but by no means a higher taxon can arise. The general trend of the evolution consists therefore in the scattering and diminishing of the evolutionary potency, and not in its increasing. The evolutionary trends proceed from multifactorial to monofactorial properties, i. e. from mixed population of the species to pure line. Materially this trend is based on the fact that in the course of mutations or during the cell divisions loss processes in the chromatin substance take part, more frequently than multiplication of some parts. There do not come into existence new, genetically powerful potent substances, which would make a progress possible.

Orthogenesis represents a little different kind of the origin of changes. Whilst in the selection simple stabilization of properties sets in with respect to certain habitats, in orthogenesis a multiple successional stabilization under the influence of some extreme agents takes place. During each stabilization the corresponding purposive characters get stronger and stronger. The orthogenetic processes are on the whole resembling the processes discovered by Lamarck. Their influence, however, is restricted to the micro-evolutionary processes only. They cannot be used for the explanation of the macro-evolution.

Lamarck, Darwin and De Vries tried to explain, by their conceptions, the multiformity and the evolution of living organisms. Their solutions were based on important natural phenomena. It appeared that one conception excluded the other and that each were convenient for the explanation of certain events only. But a detailed research, especially the genetic and the evolutionary evaluation of the inheritance of the organisms, made it possible to penetrate step by step into the mystery of the evolution. I am of the opinion that the micro-evolutionary processes we are observing in nature today, may be rightly explained by the loss or multiplication of certain chromatic substances, which constantly can take place, being given the irregularity of the meiosis. Thus mostly the diminishing of the evolutionary potency takes its course. This simplification finally reaches a stage, in which the organisms are no more capable of an independent life in nature. All the three above mentioned evolutionary theories may be combined into one conception, and each of them may get assigned a certain function in the micro-evolution of organisms. The importance of the three theories for the macro-evolution, however, was overestimated. According to certain events it may be believed that the macro-evolution was governed by quite different processes, as I have tried to explain in my former paper.

Conceptions of the diminishing evolutionary potency must be naturally of a great importance for the taxonomic evaluation. The up-to-date's conception of a progressing evolution and gradual origin of higher and higher taxons appears to be unacceptable, because it cannot explain many paleobotanical and phytogeographical phenomena. But the majority of natural events may be explained by an evolution from higher to lower taxons. I do not know any explanation of the origin of different taxons by different causes, specific for each taxon. Nevertheless such a striking phenomenon must have its material causes. I suppose, that the heredity of the species is governed by other causes than the heredity of higher taxons. The species are caused by the modification only of the fundamental building of the organisms and are governed by the chromatin substance in the chromosomes. Genera, however, are caused by the influence of other heredity, which cannot be bound to chromosomes, because it is not influenced by their eventual loss. It is my opinion that the existence of the genera is produced as well by substances of similar nature as the chromatin of the chromosomes, which is responsible for the organization of the fundamental building. Nowadays these substances generally do not change any more and their evolution is at its end. Most probably they are located in the nucleolus, between which and the chromatin of the chromosomes there exist chemical and morphological relations. The genera arise just with the blocking of the variability of this substance and the further disintegration into the species is caused by the interference of the chromosomes upon this already stable heredity of the fundamental building.

The families must have had arisen by an intervention of still more fundamental kind, namely by the change of the heredity of the fundamental building, and consequently of the organizers, which today are also fully stabilized.

In this paper an attempt has been made to analyse the definition of the species. Systematists reliably delimit the species, when they have sufficient material at their disposal. In spite of the fact that many definitions of the species have been elaborated, few only are acceptable. It seems to me that the greatest trouble consists in the fact, that for delimination the characters and the properties of the species are used. These, however, represent secondary manifestations which are not convenient for a definition. In my opinion the only sure character is the function that the species exerts in nature.

For species I take groups of related individuals, from which the genetical, morphological, physiological or spatial mechanism formed a new smallest independent natural unit. Most important is the function of the species as the smallest independent natural unit. It is a stage, in which the diminishing evolutionary potency reaches the critical point. Further diminishing results already in the incapability of existence in nature. This point may be reached with a different evolutionary potency. Accordingly a whole row of species may be distinguished from Linneons to nearly pure lines. The isolation mechanism offers a possibility of further division of such a type of species. Important is the claim of spontaneous existence in nature. Therefore artificially produced types cannot be taken for species, even if they do not differ much from the natural species. Only such a type which can preserve itself in nature may be taken for a species. With each species therefore mostly a long history must be presumed, as well as the formation of a certain type of area. The morphological, physiological, anatomical, and genetic properties may serve to the completion only of the characteristics of the species. Speciation, being a process, is difficult to be defined by the results of this process, i. e. by adult characters and properties. The process of the speciation is very complicated, and therefore we cannot expect that the problem of the species could be simple.

Evolution is a complicated process, for the investigation of which mostly but indirect proofs are at our disposal. It will still take a long time before a quite satisfactory explanation of this process will be possible. Constantly new explanations should be sought for, which could more truly explain all the phenomena connected with the evolution.

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