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The Species Problem

Selected Definitions
(Presented in Chronological Order)

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John Ray. 1704. "*Nulla certior occurit quam distincta propagations ex semine*." (Nothing is more certain to distinguish species than the criterion that true species faithfully reproduce their kind by seed.) "Plants which derive their origin from the same seed, and again propagate themselves in sowing, we may consider as belonging to a single species...Thus as to plants of specific conformity: there is certainty that they came from the seed of the same plant, whether as species or individual. For those which differ as species preserve their species in perpetuity, and one does not arise from the seed of the other, or vice versa." (*Historia Plantarum*. Chapt XXI).

Linnaeus, C. 1731. "All species number their origin first from the hand of the Omnipotent Creator: for species having been created, the Author of Nature has imposed the eternal law of generation and multiplication within the species itself...there is never a metamorphosis from one species into another." (*Critica Botanica* Sect. 271). "There are as many species as there were originally created diverse forms." (*Classes Plantarum* 1738). "That species of plants were created by God at the beginning of the world and do not change into other species, and are therefore natural, and that they remain unchanged to the present day no sane person will doubt; the confusion which would arise from the change of one species into another, to the detriment of mankind, would not be allowed by the most provident Maker." (Ortega's 1792 edition of Linneaus, *Philosophia Botanica*. 410).

John Lindley. 1832. "A species is an assemblage of individuals agreeing with each other in all essential characters of vegetation and fructification, capable of reproducing perfect seed from which progeny can be reared." In J. Heslop-Harrison, 1960. *New Concepts in Flowering Plant Taxonomy*, Harvard Univ. Press. p. 4).

Charles Darwin. 1859. "Nor shall I here discuss the various definitions which have been given of the term species. No one definition has satisfied all naturalistists; yet every naturalist knows vaguely what

he means when he speaks of a species." Also, "In determining whether a form should be ranked as a species or as a variety, the opinion of naturalists having sound judgment and wide experience seems the only guide to follow." (*Origin of Species,* London).

George Bentham. 1874. "It would seem, therefore, that at this stage of our progress .....the systematic botanist could already look towards that summit, upon reaching which his labours in aid of the general advance of the science might come to a close. But there was a rock ahead which had been looming in the distance, and which on a nearer approach posed a formidable obstacle, to most minds apparently insurmountable. What is a species? and what is the meaning of those natural affinities according to which species are to be classed? were questions which in 1859 it was generally thought vain to discuss.... We were taught, and some may still believe, that every species...was an original creation, perpetuated through every generation within fixed limits which never have been and never will be transgressed." (On the Recent Progress and Present State of Systematic Botany. *Report of the British A.A.Sc.*).

Asa Gray. 1887. "Each individual owes its existence to a parent, and produces similar individuals in its turn. So each individual is a link of a chain; and to this chain the natural-historian applies the name of Species. All the descendants from the same stock therefore compose one species. And it was from our observing that the several sorts of plants or animals steadily reproduce themselves, or, in other words, keep up a succession of similar individuals, that the idea of species originated. There are few species, however, in which man has actually observed the succession for many generations. It could seldom be proved that all the white pine trees or white oaks of any forest came from the same stock. But observation having familiarized us with the general fact that individuals proceeding from the same stock are essentially alike, we infer from their close resemblance that these similar individuals belong to the same species. That is, we infer it when the individuals are as much like each other as those are which we know, or confidently suppose, to have sprung from the same stock." Again, "Species are the units in classification. Varieties, although of utmost importance in cultivation and of considerable consequence in the flora of any country, are of less botanical significance. For they are apt to be indefinite and to shade off one form into another. But species, the botanist expects to be distinct. Indeed, the practical difference to the botanist between species and varieties is the definite limitation of the one and the indefiniteness of the other. The botanist's determination is partly a matter of observation, partly of judgment." (*The Elements of Botany*, Am. Book Co., NY).

R.V. Wettstein. 1901, "One may call species the totality of individuals which agree among each other and with their progeny in all characters which seem essential to the observer." (*Handbuch der Systematischen Botanik*, Wien. p. 13).

J.P. Lotsy. 1916. "A species consists of the total of individuals of identical constitution unable to form more than one kind of gametes." (*Evolution by Means of Hybridization*, The Hague. p. 23).

Alexis Jordan. (*ex* Lotsy, 1916). "The Linnean species is no species."

G.E. Du Rietz. 1930. "Species are the smallest natural populations permanently separated from each

other by a distinct discontinuity in the series of biotypes". (The fundamental units of biological taxonomy, *Svensk. Bot. Tiolskr. 24:333-428*).

N.I. Vavilov. 1935. "The study of several hundered cultivated crops conducted by a large body of scientific workers has led us to a conception of the Linnaean species including the cultivated plants, as a definite *heterogeneous system*. As we interpret it, *the species represents a more or less distinct heterogeneous and variable morpho-physiological system, the origin of which is associated with a particular environment and area*." (The Origin, Variation, Immunity and Breeding of Cultivated Plants, Page 17, Translated by K. Starr Chester, In *Chronica Botanica 13(1): 1-366. 1951*.

Webster's Collegiate Dictionary. 1940. "*Biol.* A category of classifcation lower than a genus or subgenus and above a subspecies or variety, a group of animals or plants which possess in common one or more distinctive characters, and do or may interbreed and reproduce their characters in their offspring; a distinct kind or sort of animal or plant."

W.B. Turrill. 1940. "No single absolute test for a species is yet known, and it is debatable if such is ever likely to be found, but as a working hypothesis the following criteria should be considered: a species is morphologically definable in that it has a sum-total of characters, and every individual within it has constant resemblances with every other individual within it, and constant differences from every individual of other species, even when the individuals are grown under diverse conditions; species are isolated one from another, sometimes geographically, sometimes by habitat preferences, sometimes by having different flowering periods, usually by not crossing naturally to produce completely fertile offspring; species may show chromosomal differences. A species is an isolated group of individuals whose sum of characters tends to keep constant by natural inbreeding." (*Experimental and synthetic plant taxonomy*. In Huxley, J. ed. *The New Systematics*, Oxford Univ. Press. p. 62).

N.W. Timofeeff-Ressovsky. 1940. "A species is a group of individuals that are morphologically and physiologically similar (although comprising a number of groups of the lowest taxonomic category), which has reached an almost complete biological isolation from similar neighboring groups of individuals inhabiting the same or adjacent territories. Under biological isolation we understand the impossiblilty or non-occurrence of normal hybridization under natural conditions." (*Mutations and geographical variation*. In Huxley, J. ed. *The New Systematics*, Oxford University Press. pp. 91-92).

Mayr, E. 1942. "A species consists of a group of populations which replace each other geographically or ecologically, and of which the neighboring ones intergrade or interbreed wherever they are in contact or which are potentially capable of doing so (with one or more of the populations) in those cases where contact is prevented by geographical or ecological barriers." "Species are groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups." (*Systematics and the origin of species*, Columbia Univ. Press).

W.H. Camp and C.L. Gilly. 1943. "There are even some among us who have advocated that we discard the concept of a species altogether. Therefore, the question which the systematist should seek first to

answer is not: Upon what criteria should the concept of a species-unit be based? Rather, he must enquire: Does the species-unit deserve to be a fundamental philosophical concept? This, perhaps fortunately for his own peace of mind, has long ago been decided for him. The concept of species or kind, as a unit, has become so firmly entrenched in the mind of man--so much a part of his awareness, so necessary to his basic philosophy--that it remains only for the systematist to interpret this unit . . ." (The structure and origin of species, *Brittonia 4: 325-385*).

Alfred Emerson. l947. "A species is an evolved or evolving, genetically distinctive, reproductively isolated, natural population. All of these attributes are necessary, and no others would seem to be essential." (*Encycl. Brit.*).

M.L. Fernald. 1950. "The species is conceived as a series of individuals (usually numberless) occupying, until disturbed by man's activity, a natural geographic area and having essentially identical morphological characters of flower, fruit, or reproductive structure, somewhat exemplifying the biblical definition 'It is by their fruits ye shall know them', for most critical taxonomic study starts, when possible, with flower, fruit, seed or spore." (*Gray's Manual ed. 8*, p. vii).

G.L. Stebbins. 1950. "Species are separated from each other by gaps of genetic discontinuity in morphological and physiological characteristics which are maintained by the absence or rarity of gene interchange between members of different species." (p. 190). "In order... to make valid inferences as to the specific status of allopatric, as well as sympatric, population systems, one must determine not only whether they can cross and produce fertile hybrids under the optimum conditions of a cultivated garden plot but, in addition, whether they could coexist in the same territory and hybridize under natural conditions." Also, "The wisest course would seem to avoid defining species too precisely and to be tolerant of somewhat different species concepts held by other workers. The one principle which is unavoidable is that species are based on discontinuities in the genetic basis of the variation pattern rather than on the amount of difference in their external appearance between extreme or even 'typical' individual variants." Again, "If we accept this latitude in our species definitions, then we can recognize the existence as species-isolating mechanisms of purely spatial isolation, strictly ecological isolation of sympatric forms, or various combinations of these two isolating factors. And the latter are by far the most common in nature." (p. 204). (*Variation and Evolution in Plants,* Columbia University Press. Chapter IV: 189-250).

Henry A. Gleason. 1952. "A genus is a taxon of higher rank than a species. It ordinarily includes several or many species which resemble each other in important features of structure and which differ from other genera in equally important characters." (*Illustrated Flora of the Northeastern United States and Adjacent Canada*).

Andrewartha and Birch. 1954. "The species is the most inclusive Mendelian population; its chief characteristic is that its members do not (no matter how good may be the opportunity) interbreed with members of other Mendelian populations. Populations whose members do not interbreed because they are kept apart by geographic barriers may not be classed as species on this evidence alone; for example,

a number of Mendelian populations living on several widely separated oceanic islands may all belong to one species, even though there is virtually no chance of interbreeding in nature because of the distances separating the islands. On the other hand, if it were found, when they still did not interbreed, then they would be correctly classed as separate species."

Verne Grant. 1957. "...a community of cross fertilizing individuals linked together by bonds of mating and isolated reproductively from other species by barriers to mating." (*The plant species in theory and practice*. In E. Mayr (ed.), *The species problem: 39-80,* Amer. Assoc. Adv. Sci., Washington, D.C.).

D.H. Valentine and Askell Love. 1958. "The species of the biosystematist, for which it is convenient to use the term ecospecies, is defined in terms of gene- exchange. If two populations are capable of exchanging genes freely under either natural or artificial conditions, they belong to the same ecospecies; but if internal barriers to gene-exchange exist (e.g. in the form of incompatibility or hybrid infertility), then the populations are ecospecifically distinct. This definition is apparently simple, and it provides an objective criterion of a species, something which can be determined by experiment; and it also has a biological meaning in that it marks a certain stage in the process of evolutionary divergence." (Taxonomic and Biosystematic Categories. *Brittonia 10 (4): 153-166*).

Clausen and Hiesey. 1958. "Species are composed of genetically distinguishable ecological races and morphological subspecies, each of which is adjusted to its own kind of environment and controlled by interacting systems of genes loosely held together through genetic coherence." (*Carnegie Inst. of Washington Publ. Experimental Studies on the Nature of Species IV*).

V.H. Heywood. 1959. "It needs to be stressed that a fundamental tenet of taxonomy is that rules cannot be made about delimiting species: the most that can be done is to lay down general guiding principles. There must always be an element of judgment (involving experience and perhaps intuition) in any taxonomic decision. Non-taxonomists may deplore this, but it is unavoidable. For this reason no precise definition of the species is possible." (in *Fedde Repert. 63: 180*).

George Gaylord Simpson. 1961. "An evolutionary species is a lineage (an ancestral-descendant sequence of populations) evolving separately from others and with its own unitary evolutionary role and tendencies." (*Principles of Animal Taxonomy*, p. 153).

S.T. Cowan. 1962. ". . . just as no two observers see the same rainbow, so no two biologists conceive exactly the same species." (In G.C. Ainsworth & P.H.A. Sneath, ed., *Microbial Classification*, pp. 433-455).

Lyman Benson. 1962. "Definition of the term species is an ellusive goal only if an attempt to limit the category is included. Leaving out criteria for distinguishing species from each other, the problem narrows down to the question of what kind of entity is being classified. A working definition must take into account the following elements: 1) The species discussed in this book are composed of living organisms. 2) A species is able to reproduce itself. 3) A species is ordinarily a natural population or

system of populations, rarely an individual. 4) The individuals composing a species are genetically closely related." Also, "A living natural species is a reproducing population or system of populations of genetically closely related individuals." (*Plant Taxonomy.*, The Ronald Press Company, N.Y. pp. 289-290).

P.H. Davis and V.H. Heywood. 1963. "Many evolutionary taxonomists believe that species are formed as a result of the evolutionary processes. It is an act of faith for both Linnaean and evolutionary taxonomists that their task is to go out into nature and find these creations. The *concepts* covering these and other groups called species are, however, constructions of the human mind and cannot be defined. (P.89). And, on another page "...we may regard species as morphologically definable units, made up of groups of individuals (populations), which it is assumed are usually interbreeding, the containers and expression of one or more gene pools." (P. 98). (*Principles of Angiosperm Taxonomy*, D. Van Nostrand Company, Inc. N.Y.).

Carl L. Wilson and Walter E. Loomis. 1967. "Many difficulties are involved in the study of species and of their origin. Some species are sharply defined. but others grade into related species through intermediate forms. Some of these intermediate forms may represent incipient species, for species are arising today as in the past. Most evolutionary changes take place so slowly, however, that they do not become evident within any easily recorded period of time and so the problem is attacked indirectly. By growing plants in experimental gardens, by studying their mutations and their chromosomes, by collecting them and studying their distribution, it is frequently possible to make reasonable inferences concerning their evolutionary history. Although there is no general agreement on the definition of a species, it may be defined ideally as a group of individuals that are morphologically distinguishable from related kinds, and that will not cross or that cross with difficulty with related species. All existing species have come from pre-existing species, but so complex are environmental factors and living organisms that species are believed to have arisen in different ways; there is no one solution to the problem of their origin. The chief principles involved in the formation of new plant species may, according to modern views, be grouped under two main heads: (1) reproductive isolation and (2) species hybridization." (*Botany, 4th Ed.*, Holt, Rinehart and Winston, NY).

Arthur Cronquist. 1968. "An exact definition of the species is impossible, and the more precise one attempts to be, the larger number of species which do not fit the definition. Still, the basic concept is simple enough. A species is the smallest population which is permanently (in terms of human time) distinct and distinguishable from all others. It is the smallest unit which simply cannot be ignored in the scheme of classification. It is the primary taxonomic unit, and it may also be thought of as the basic evolutionary unit." And, "The line between strong varieties and weak species is necessarily an arbitrary one, involving subjective taxonomic judgment. The weak species of one taxonomist may be the strong varieties (or subspecies) of another." (*The Evolution and Classification of Flowering Plants*," Houghton Mifflin Co., Boston. P. 29).

George H.M. Lawrence. 1970. "The species (i.e., the ecospecies), as conceived by the biosystematist, is a group of interbreeding or potentially interbreeding individuals reproductively isolated from other groups of individiuals. It is a unit delimited primarily by genetical criteria and secondarily by criteria

derived from ecological and morphological evidence." (*Taxonomy of Vascular Plants*, the MacMillan Co., NY. p. 182).

Oswald Tippo and William L. Stern. 1977. "1. A species is a kind of plant (or animal). White oak (*Quercus alba*, Figure 3.11), red maple (*Acer rubrum*, Figure 3.15), white pine (*Pinus strobus*, Figures 16.9 and 16.10), coconut palm *Cocos nucifera*, Figure 11.12), tobacco (*Nicotiana tabacum*), are species or kinds of plants. 2. Each individual of a species is related to other individuals of the same species because they have common ancestors; they have evolved from the same sources. 3. Individuals of the same species are similar in structure, more so to each other than to other kinds of plants. 4. Species maintain themselves in nature; they do not change appreciably from generation to generation over short periods of time. 5. Individuals of a species interbreed and produce fertile offspring." (*Humanistic Botany*, W.W. Norton & Co., NY).

Clive A. Stace. 1980. "There have been many attempts to define a species, none totally successful. This difficulty has led to the cynical definition of a species as a group of individuals sufficiently distinct from other groups to be considered by taxonomists to merit specific rank. The crux of the question does of course, lie in the term 'sufficiently distinct', since, from what has been said above, there is no magic formula to decide the issue. Most taxonomists use one or more of four main criteria. 1. The individuals should bear a close resemblance to one another such that they are always readily recognizable as members of that group. 2. There are gaps between the spectra of variation exhibited by related species; if there are no such gaps then there is a case for amalgamating the taxa as a single species. 3. Each species occupies a definable geographical area (wide or narrow) and is demonstrably suited to the environmental conditions which it encounters. 4. In sexual taxa, the individuals should be capable of interbreeding with little or no loss of fertility and there should be some reduction in the level or success (measured in terms of hybrid fertility) of crossing with other species. As discussed elsewhere in this book. none of these criteria is absolute and frequently it is left to the taxonomist to apply his judgement. Often he does this by attempting to recognize as species units that are of comparable significance in whatever terms are being applied." (*Plant Taxonomy and Biosystematics*, Edward Arnold, London).

Webster's New World Dictionary (2nd Concise Edition). 1982. Species (-shez, -sez) *n., pl.* -cies [L., appearance, shape, kind, etc.] 1. a distinctive kind; sort; variety; class 2. *Biol.* a group of highly similar plants or animals that is part of a genus and that can reproduce fertile offspring only among themselves 3. *Logic* a class of things with distinctive attributes, grouped with similar classes in a genus.

Warren H. Wagner, Jr. 1984. ". . . a convenient taxonomic category that defines a unit of organismic diversity in a given time frame and composed of individual organisms that resemble one another in all or most of their structural and functional characters, that reproduce true by any means, sexual or asexual, and constitute a distinct phylogenetic line that differs consistently and persistently from populations of other species in gaps in character state combinations including geographical, ecological, physiological, morphological, anatomical, cytological, chemical, and genetic, the character states of a number and kind ordinarily used for species discrimination in the same and related genera, and if partially or wholly sympatric and coexistent with related species in the same habitats, unable to cross or, if able to cross,

able to maintain the special distinction." (A Comparison of Taxonomic Methods in Biosystematics, In *Plant Biosystematics*, ed. W.F. Grant, pp. 643-54, Academic Press, Canada).

H. Crum. 1985. "A species cannot be fully defined, nor can it be intuitively sensed. Although subjectivity is involved in decision making, a species is only as good as the knowledge and insights used in its delimitation. Certain methodologies help. So do good sense and good judgement based on meaningful experiences, and the more the better." (Traditional make-do taxonomy, *Bryologist* 88: 221).

Peter H. Raven and George B. Johnson. 1986. "In Chapter 21 we reviewed the nature of species and saw that there are no absolute criteria that can be applied to the definition of this category. Individuals that belong to a given species, for example, dogs (Figure 22-5), may look very unlike one another. Nevertheless, they are generally capable of hybridizing with one another, and the different forms can appear in the progeny of a single mated pair. On the other hand, the members of a given species often cannot hybridize with those of a second species. For example, dogs are not capable of interbreeding with foxes, which, although they are generally similar to dogs, are members of another, completely distinct, group of mammals. In contrast, dogs can and do form fully or partly fertile hybrids with related species such as wolves and coyotes, which are also members of the genus *Canis*. The transfer of characteristics between these species has, in some areas, changed the characteristics of both of the interbreeding units. About the only points that can be made about species generally are that they differ from one another in at least one characteristic and that they generally do not interbreed freely where their ranges overlap in nature. In some groups of organisms, including bacteria and many eukaryotes, asexual reproduction predominates and classification systems clearly do not have a genetic basis. Biologists agree, in general, on the kinds of units that they classify as species, but these units share no biological characteristics uniformly. Species differ from one another in at least one characteristic and generally do not interbreed freely with one another where their ranges overlap in nature." (*Biology*, Times Mirror/Mosby College Publishing, St. Louis).

Author and date unknown: "A species is what a good taxonomist calls a species."

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