

macroevolution. It is evident that present concepts of organic evolution have not and cannot account for the remarkable design and ability of the organs of vision from the light-sensitivity of the amoeba to the perfection of the eagle's eye.

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CRSQ—Creation Research Society Quarterly

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SYMPOSIUM ON VARIATION—I

POSSIBLE VARIABILITY IN LIVING ORGANISMS— A REVIEW OF CRSQ WRITINGS

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Abstract

A selected bibliography and brief discussion of creationist writings on limited variability in the biological world is presented.

Introduction

One of the major points of difference between the creationist and evolutionary models of science is that of the possible variation in the natural world. Generally an evolutionist believes in infinite variation that allows "nature" to start with "simple particles and molecules" and evolve upward to man. Whereas creationists in general believe in a limited variability. The Creator designed and quickly brought the various types into being. The only variation allowed, which is considerable but not unlimited, is within the gene pool of these original types.

These postulates affect the research and field work attempted by the two different groups of scientists. The evolutionist continually looks for links between living organisms, between living organisms and fossil remains and between various fossils. No lack of success will deter his search for the "chain" and similarities that connect all of the "evolved" creatures. Creationists will study both similarities and differences in organisms and will not overrate the former to the neglect of the latter. They generally view similarities as a solution to a common design "problem" and visualize the Creator repeating a pattern He has employed in His creative acts. The differences often are explained within a framework of different functions for various organisms or a different type of created kind.

Adaptation is viewed by the two opposing philosophies in different ways. Evolutionists feel that nature (natural selection) operates on an organism and it evolves a solution to an environmental problem and

survives in a particular niche of the natural world. A creationist believes that an organism present in a harsh natural environment is "preadapted" to survive. The omniscient Creator designed the particular creature to be successful in its intended niche. These few examples illustrate the repercussions of the different philosophies in the area of variation and fixity in nature.

In providing a recent creationist history for the concept of variability of living organisms, a review of *Creation Research Society Quarterly (CRSQ)* articles was attempted. The ideas developed by various creationist scientists can be studied in detail by reading their works. I offer these brief reviews as an introduction to this symposium. The references are collected according to author. I make no claim of completeness for I may have overlooked some contributions to the subject unintentionally.

Frank L. Marsh

Dr. Marsh probably has written more on the subject of variation than any other modern creationist. His writings likely have had a greater impact in this area than anyone else in recent years. He has done considerable research and writing on the kind concept and been very influential in its acceptance.

1. Marsh, F. L. 1964. The Genesis kinds in the modern world. *CRSQ* 1 (Annual):30-38. The author presented a history of the kind vs. species concept from both science and Scripture. He pointed out the confusion over kind and species in the literature. It is noted that there are limits to variation.

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2. _____ 1968. Fixity among living things. *CRSQ* 4:121-24. Historical discussion on how the early church handled the Genesis account of creation was developed. The development of theistic evolution in the fifteenth through seventeenth centuries was noted. The extreme fixity in created kinds in the seventeenth through nineteenth centuries and its implications were presented. Fixity is not at the species or individual level, but at the kind level which is taught in Scripture.

3. _____ 1969. The form and structure of living things. *CRSQ* 6:13-25. The observed discontinuity among both living and fossil forms constitutes evidence for the creation of basic kinds. Variation has never been known to accomplish more than the production of a new variety of a basic kind already in existence. Topics covered were origin of form and structure, resemblances and genetic kinds, common ancestor concept, homologous structures, convergence and adaptive radiation.

4. _____ 1973. The Genesis kinds and hybridization: has man ever crossed with any animal? *CRSQ* 10:31-37. The reported supposed crosses between plants and animals and man and beasts were examined. The importance of DNA studies was elucidated noting that basic types of animals have different DNA's. The uniformity of life principle since creation was presented. Adam and Eve are the parents of the human race.

5. _____ 1973. Book review. *CRSQ* 10:125-27. Marsh reviews "H. R. Siegler's book, *Evolution or Degeneration—Which?* and recommended it to those who wish to determine what living organisms can vary, hybridize, etc. Also a creationist classification system was developed in the book,

6. _____ 1974. Variation and fixity in nature. *CRSQ* 11:60-68. The amazing variation possible in living organisms was discussed and compared to the fixity of species in vogue during Darwin's time. Although there is diversity, there is discontinuity in variation. New variants are always within basic types and DNA in the genetic systems of living organisms leads to stability, not unlimited change. A review of a book with the same title written by Marsh is given in Armstrong (2). This book is distributed by CRS Books (outside back cover).

7. _____ 1978. Variation and fixity among living things: a new biological principle. *CRSQ* 15: 115-18. Two classes of variation were developed:

- a. nonhereditary (environmental, nongenetic)
- b. hereditary {
 - recombination of genes
 - mutations
 - chromosomal aberration

The principle was stated as follows: Processes of biological variation can go no farther than to produce new variants within basic kinds already in existence.

8. _____ 1979. Creationism and taxonomy. *CRSQ* 16:189-90. "Two recent *CRSQ* articles were discussed in relation to the possibility of identifying genus with kind.

9. _____ 1981. Have Genesis kinds ever crossed? *CRSQ* 18:164-67. The author answered no to the title and then discussed possible variations.

10. _____ 1982. Genetic variation, limitless or limited? *CRSQ* 19:204-206. The examination of

both living organisms and fossil remains proves the possibility of genetic variation within kinds (micro-evolution) and discontinuity between basic types.

Walter E. Lammerts

The founder of the Creation Research Society and world-famous rose breeder has determined first-hand many of the limits of variation in his extensive field work on plant hybridization, etc. Much of his studies have been published in the Quarterly. Synopses of some of his papers are given below.

1. Lammerts, W. E. 1964. Discoveries since 1859 which invalidate the evolution theory. *CRSQ* 1 (Annual):47-55. A brief section (pp. 48-49) in this paper concerns biological variation. Variation is limited, not unlimited as Darwin thought. Dr. Lammerts discussed the work of Darwin on the giraffe, Lamarck's concept of use and disuse and Mendel's crossing of various strains of peas.

2. _____ 1965. Planned induction of commercially desirable variation in roses by neutron radiation. *CRSQ* 2(1):39-43. The author developed the limits to variability in certain types of roses. He prefers a creative design or prepattern to explain variation.

3. _____ 1969. Does the science of genetic and molecular biology really give evidence for evolution? *CRSQ* 6:5-12, 26. Beans, corn and roses were used as examples to show that variation is limited. Other topics presented were the possibility of serial beneficial mutations, the resistance of certain bacteria to penicillin and the resistance of house flies to DDT. Translocation, inversions and polyploidy in the genetic systems of organisms was discussed as was chromosome doubling and recombination.

4. _____ and G. F. Howe. 1974. Plant succession studies in relation to micro-evolution. *CRSQ* 10:208-28. Extensive field studies were conducted on five California wildflower plant species populations—*Eschscholtzia californica* (California poppy), *Lupinus succulentus* (lupine), *Salvia carduacea* (thistle sage), *Orthocarpus purpurascens* (owl's clover) and *Viola pedunculata* (yellow pansy). In the years of the research program, there were variable temperatures, amounts of rainfall, etc. Some years were "lean" for plant variation whereas in the "good" years, plant variation was extensive. The authors concluded that natural selection restricted the amount of variation to bring populations back to a typical or normal form.

5. _____ 1974. Does nature really select selection? *CRSQ* 11:168-69. Several recent genetic experiments on living organisms were presented and the author suggested that many characteristics have no survival value. He believes that the Creator may have created certain species for the sake of variety to make the world interesting for man.

6. _____ 1975. Acceptance of evolution theory can result in costly errors in basic breeding emphasis. *CRSQ* 12:68-69. The experiments on dwarf varieties of wheat were outlined. The induced mutation technique can lead to false data. Increasing mutations by radiation will not improve a species.

7. _____ 1975. Concerning the natural vs. supernatural: a reply to Henry M. Morris. *CRSQ* 12:75-77. Lammerts explained his theory of super-

natural changes in organisms since creation. In answer to this theory, see Akers, Jr. H. 1976. On allelic differences and sizes of population *CRSQ* 12:218-19.

8. _____ 1976. A note on speciation in *Ceanothus* and *Adenostoma* *CRSQ* 12:190-91. Variation within these two plants was elucidated and the creationist implications were offered.

9. _____ 1984. Plant succession studies in relation to micro-evolution and the extinction of species. *CRSQ* 21:104-108. Summary of previous Lammerts and Howe (4) work plus suggestions for further research was offered.

Arthur J. Jones

This British zoologist wrote a series of articles for the Quarterly in which he developed a creationist classification system for living organisms that deserves serious study by creationist taxonomists.

1. Jones, A. J. 1972. A general analysis of the Biblical "kind" *min*. *CRSQ* 9:53-57. Dr. Jones examined the term *min* with regard to its etymology, form and usage. He used Hebrew words within the clean and unclean concept to form a general classification system of beasts, land swimmers, water swimmers, winged fliers and man.

2. _____ 1972. Boundaries of the *rein*: an analysis of the Mosaic lists of clean and unclean animals. *CRSQ* 9:114-23. Detailed and exhaustive lists of the genera covered by each Hebrew name were given.

3. _____ 1973. How many animals in the ark? *CRSQ* 10:102-108. Using his classification system, Jones reached the conclusion that the number of animals in the ark did not exceed 2000. Rapid speciation occurred after the animals left the ark.

4. _____ 1973. Reply to Mr. Abraham *CRSQ* 10:182 and Abraham, E. W. 1973. Food laws. *CRSQ* 10:182. Exchange of letters about whether ducks, geese and swans are considered clean or unclean.

5. _____ 1982. The genetic integrity of the "kinds" (baramins); a working hypothesis. *CRSQ* 19:13-18. The author discussed a creationist model of genes and heredity as well as created patterns and speed of variation in living organisms. Original genetic potential was outlined.

6. _____ 1982. A creationist critique of homology. *CRSQ* 19:156-75. This treatise contains detailed discussion of how evolutionary arguments for homology misuse the evidence. Jones explained the evidence within a creationist model developing the limitations on variability. Convergence and parallelism were handled nicely. Creationist patterns were optimal from the start.

7. _____ 1983. Corrections and clarifications. *CRSQ* 20:122. Further comments were offered on the preceding paper (6).

Hilbert R. Siegler

H. R. Siegler, former Chief of Game Management and Research, Fish and Game Department, State of New Hampshire, brought his vast experience together for a series of articles on a creationist taxonomy. Likewise he authored a book (see Marsh [5]) which should be studied.

1. Siegler, H. R. 1974. The magnificence of kinds as demonstrated by canids. *CRSQ* 11:94-97. There are

118 different breeds of domestic dogs, seven true wild dogs, four different species of jackals, five different species of wolves (gray wolves and coyotes are known to occur in a large variety of races) and 13 different species of foxes. All four major categories of canids have been known to crossbreed. Siegler felt that these varieties have developed from superior created canids but within the boundaries of *min* (kind).

2. _____ 1976. Fleming Jenkin's critique of Darwin's *Origin of Species*. *CRSQ* 13:111-14. Jenkin noted that selective breeding first demonstrated considerable variability. However the rate of variation in a given direction constantly diminishes, tending toward a limit. No single case for macro-evolution exists.

3. _____ 1977. A creationist' taxonomy. *CRSQ* 15:36-38, 11. A creationist taxonomy was developed using swans, ducks and geese as an example. Since crossbreeding has been reported, the kind would be above the family level.

4. _____ 1980. Equating species with kind. *CRSQ* 16:231. Species cannot be equated with kind.

5. _____ 1983. Some thoughts on kinds. *CRSQ* 20:122-23. The author issued a challenge for continuing work on a creationist taxonomy.

Colin Brown

This British creationist has contributed several smaller selections on the subject of the limits to variation.

1. Brown, C. 1982. The monotremes. *CRSQ* 18:187-89. The monotremes are not links between mammals and reptiles. They offer no support for evolutionary theory.

2. _____ 1982. Variation and the fourth law of creation. *CRSQ* 19:100-103. Limited variation within kinds was discussed.

3. _____ 1982. The first seven basic biological laws of creation. *CRSQ* 19:187-88. The author proposed seven "laws" of creation in which the fourth and fifth deal with variation limits in living organisms.

4. _____ 1983. Further remarks on the fourth law. *CRSQ* 20:62-63. Possible genetic changes were elucidated.

George F. Howe

As a botanist, Dr. Howe, has contributed invaluable insights in the development of the modern creationist model of science. Some examples are given below.

1. Howe, G. F. 1964. Paleobotanical evidences for a philosophy of creationism. *CRSQ* 1 (Annual):24-29. The author noted that "modern" forms are frequently identical to "remote" fossil specimens implying the lack of infinite variation. Specifically changes in non-vascular plants (e.g. fungi and algae) throughout the geologic strata have been only slight. Frequently extant algae are quite similar to the fossil types. Extant forms of mosses and liverworts are similar to the fossil entities. The genus *Lycopodites* of the Paleozoic is like the *Lycopodium* or "ground pine" of today. Plants with fan-shaped foliage like the modern ginkgos have been found from the Upper Devonian to the present.

2. _____ and W. E. Lammerts. 1980 Biogeography from a creationist perspective: II. The origin and distribution of cultivated plants. *CRSQ* 17:4-18. A creationist model of possible variation was developed

for the origin and distribution of cultivated plants from the standpoint of a rapid creation, the Fall, the Flood and a post-Flood dispersion from the area of Asia Minor using corn, wheat, roses, strawberries and apples as examples.

3. _____.1982. Postfire strategies of two chaparral shrubs (chamise and *Ceanothus*) cast light on origins. *CRSQ* 19:3-10. Variation possibilities within two California shrubs using fire as a natural selector was discussed.

William J. Tinkle

Dr. Tinkle contributed some very pointed shorter selections to the Quarterly in relation to variation.

1. Tinkle, W. J. 1976. Selection: artificial and natural. *CRSQ* 13:131-33. Actual variations in living organisms were discussed. Changes because of environmental effects (acquired characteristics), presence or absence of certain genes and mutations were brought to bear on natural and artificial selection. The author claimed that Darwin misapplied and misunderstood heredity factors for change.

2. _____. 1977. Genetics favors creation. *CRSQ* 14:155-56. Using acquired characteristics, latent genes, groups of diverse genes and mutations, Tinkle discussed the limits on variation using fruit flies and sugar beets as examples.

3. _____.1981. Let us reason together. *CRSQ* 18:25-26. The thesis of this note was that changes in nature are rare.

Various Authors

1. Armstrong, H. L. 1973. Rapid variation within the kind. *CRSQ* 10:69-70. Rapid variation in aphids was presented. Millions of years were not needed to accomplish the changes and yet the organisms were still aphids after the changes.

2. _____. 1977. Book review of *Variation and Fixity in Nature* by Frank L. Marsh (*CRSQ* 13:222) is given in its entirety. This book is available from Creation Research Society Books (see p. 160).

In the world of living things, there are two complementary aspects: *continuity*, in that, for instance within one kind of animal, such as dogs, many varieties are to be found; and *separation*, in that there is a gap, which anyone can recognize, between dogs and cats. Indeed, much the same could be said of dead things; the evolutionist makes much of the alleged continuity of the fossil record; but for all of that the gaps are still there to his perpetual embarrassment.

The same dichotomy exists as things are followed through time. There is variation: many breeds of horse have been developed. But there is also fixity: no breed of horse has ever looked like cows.

The author investigates these complementary aspects of living beings. Subjects considered include the physical basis of heredity, which could be called the basis of stability or fixity; and the causes of variation, since variation within limits from generation to generation undoubtedly occurs. But the key words are: "within limits." There is no evidence for limitless variation.

As for the fossil record, Marsh shows that it is evidence, not for continuous change, but rather for great stability (as is shown especially by the persistence of the so-called living fossils) along with limited variability.

The author has been well known for his investigations into the nature and extent of the Genesis kinds. So it is not surprising to find some space devoted to the question: "What were the original created kinds?" Scripture rarely deals with such details. The conclusion is that, for the most part, the kinds are recognized by "the true instinct of mankind," as Aristotle wrote.

Experiments in breeding may throw light onto doubtful cases. If different animals, such as the bison and the cow, can cross, they belong to the same original kind. But if not, that does not prove that they belong to different kinds. For there are varieties of *Drosophila* which are mutually sterile.

Incidentally, it is shown that hybridization, and related phenomena, could not have anything to do with alleged macro-evolution. For such processes are merely a re-shuffling of existing characteristics; and result in nothing really new. As a matter of fact, many reports of unlikely crosses have to be received with great caution. For the whole matter is full of hoaxes and errors. As for mankind, all of the evidence goes to show that man never has crossed and cannot cross with any other creature.

The book concludes with a chapter, "Thoughts to Ponder," in which the author summarizes the conclusions reached. Marsh concludes that the doctrine of limited variability inside of created kinds, which is the scriptural one, is in best accord with the facts. There is also a very useful glossary. Many references to the literature are given.

In summary, this book gives a very readable account of the scriptural doctrine of creation according to kinds, and shows the doctrine to be a reasonable one.

1. Klotz, J. W. 1972. Flora and fauna of Galapagos Islands. *CRSQ* 9:14-22. The adaptive potential of finches, mockingbirds, tortoises, cacti and iguanas was developed. Created organisms have considerable potential for variation but macroevolution was not proven. Klotz noted that Darwin's belief in fixity of species misled him.

2. _____.1986. Book review of *The Natural Limits to Biological Change* by Lane P. Lester and Raymond G. Bohlin (*CRSQ* 22:201) is given in its entirety. The book is available from Zondervan Publishing House.

This book is one of the most significant contributions to the creation/evolution controversy that has appeared in recent years. It is a thoroughly objective review of Neo-Darwinism and punctuated equilibrium together with the suggestion that there is "another alternative"—creationism with its suggestion that there are limits to the amount of biological change.

The authors avoid emotional pleading. They freely admit that their approach is conditioned by what the Scriptures say but do not argue in sup-

port of their point of view from the Scriptures; rather they present scientific evidence to support their position.

It is very clear that living things change. The idea of a static creation is a straw man that those who oppose creationism set up, a caricature of what creationists hold. The authors recognize that there is a grain of truth in what evolutionists have built their theories on—that there is variety, that there is change, and that there is adaptation to the environment. These are certainly recognized today by all creationists.

It is the main thesis of the book that Neo-Darwinism and punctuated equilibrium fail because genetics, which must supply the mechanism for the changes which these theories demand, does not do so. In both evolutionary theories the conclusion must be so far as a mechanism is concerned “no evidence.” Indeed as the authors point out the very opposite is true; the evidence from a study of possible mechanisms is entirely negative.

The authors also discuss the reasons why punctuated equilibrium has become so popular—the obvious failure of Neo-Darwinism to explain how the wide variety of living things has developed. At the same time they make it quite clear that those who support Neo-Darwinism and punctuated equilibrium are still committed evolutionists. Their attack on these theories has not led them to a repudiation of evolution.

The authors suggest the use of the term “prototype” to substitute for the concept of “kinds” in Genesis. They feel that “kinds” is too general a term and they point out that “species” is not the equivalent of the “kinds” in Genesis. In a “Response” V. Elving Anderson expresses the opinion that this term probably will not catch on, and I am inclined to agree with him. This reviewer does not believe that it is possible to develop a better term than “kind” or that it should be equated with any of our present taxonomic categories.

The book is a careful objective evaluation of the two currently advocated theories of evolution, Neo-Darwinism and punctuated equilibrium. An unbiased reader will conclude that there is as much evidence for the other “alternative,” a limit to the amount of biological change, as there is for the two evolutionary theories.

1. Mehlert, A. W. 1988. A critique of the alleged reptile to mammal transition. *CRSQ* 25:7-15. This Australian creationist has contributed many excellent articles and book reviews to the Quarterly. He discussed the major problems involved in presenting cynodonts as transitional forms which they are not. Variation was shown to be definitely limited.

2. _____ 1988. Reptiles and taxonomy. *CRSQ* 25:99-100. The author suggested that reptiles be placed in the class Reptilia since they have no evolutionary relationship to other mammals.

1. Williams, E. L. 1976. A creation model for natural processes. *CRSQ* 13:34-37. A model for changes in nature based on the first two laws of thermodynamics was developed. As conservation (first law) processes and degeneration (second law) processes “vie with

each other” in nature, change is guaranteed to develop. Over a period of time the created order is eroded. Conservation processes, the stronger of the two, operate more effectively under favorable conditions. Struggle does not improve organisms and intelligence can aid conservation processes. This article is also a chapter in *Thermodynamics and the Development of Order* offered by Creation Research Society Books (see p. 160).

2. _____ 1986. A reevaluation of the English” peppered moth’s use as an example of evolution in progress (Osborne). *CRSQ* 23:27-28. This article was a review of an Institute for Creation Research Master’s thesis. The conclusion drawn is that the melanism in the English peppered moth is a very poor illustration of evolution. This thesis should be consulted by anyone interested in the use of this moth as an example of evolution in progress.

Custance, A. C. 1974. The Lebzelter principle: a generative idea. *CRSQ* 11:157-59. When man lives in large conglomerates, race tends to be stable while culture becomes diversified. When man lives in small isolated groups, culture is stable but diversified races evolve. Variability and inbreeding were discussed within the main thesis of the article. The human race is descended from a single pair and was scattered some time after the Flood are the postulates from which the arguments were developed.

Davidheiser, B. 1976. “Darwin’s mistake.” *CRSQ* 13:115-16. Variation is limited, a fact Darwin failed to comprehend.

Harper, G. H. 1979. Limited variability, an old idea. *CRSQ* 16:81-82. An history of the concept of limited variability was presented citing the writings of many British scientists. The steady state theory of species was discussed.

Heyes, G. B. 1985. Extrapolation’s implications. *CRSQ* 22:25-33. This article contains a section on variability and evolutionary extrapolation.

Lubenow, M. L. 1980. Significant fossil discoveries since 1958: creationism confirmed. *CRSQ* 17:148-60. A model for phylogenetic origins was offered. No transitional forms are found in the fossil record which illustrates the creationist postulate of limited variability in nature.

Moore, J. N. 1976. Documentation of the absence of transitional forms. *CRSQ* 13:110-11. Since there are no transitional forms, there is a definite limit to variation.

Moore, R. S. 1965. A study of moss and miniature roses. *CRSQ* 3(4):12-18. Successful development of everblooming moss roses after many years of painstaking work has afforded an excellent example of progress in rose breeding. Yet the result is not due to slow accumulations of minute differences which might be expected according to evolutionary theory. Evidently nothing new has been added, only changes in the DNA message that allow different expressions of already existing genetic material.

Rodabaugh, D. J. 1976. Probability and missing transitional forms. *CRSQ* 13:116-19. The author used statistics to demonstrate that evolution could not occur through micromutations if limited variation is assumed. The conclusion was that transitional forms could not exist.

Schopp, G. M. 1976. Dogs provide no evidence for evolution. *CRSQ* 12:220. Dogs provide no evidence for infinite variation.

Smith, E. N. 1985. The role of creation research in modern biology. *CRSQ* 22:105-107. The research needed to develop the kind concept was outlined.

von Fange, E. A. 1989. The Litopterna—a lesson in taxonomy: the strange story of the South American 'false' horses. *CRSQ* 25:184-90. A historical and scien-

tific review of the supposed evolution of the horse. A reader can detect the failure of the infinite variation postulate again.

Conclusion

Considerable creationist literature is available that illustrates the truth of limited variability in nature. Hopefully creationists will continue to do research on this topic and improve the creation model of science.

SYMPOSIUM ON VARIATION—II

WHAT IS A SPECIES?*

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Abstract

A number of examples are given to show that there is no definition of the term "species" applicable to resolve questionable cases. Taxonomists disagree among themselves and change their minds as to what is a species and how many there are in various genera. As an evidence of evolution, taxonomy has a problem with gaps similar to the problem in the fossil record. Hereditary changes within species may represent "natural selection" but not evolution. Since the term species cannot be adequately defined it is not proper to say that creationists believe each species was created separately.

Introduction

What is a species? Dr. James Fisher (1940) of the London Zoological Society said, "Two animals belong to the same species if such is the opinion of a competent taxonomist." But recognized taxonomists frequently disagree. Charles Darwin recognized the problem and wrote in his *Origin of Species*, "From these remarks it will be seen that I look at the term species as one arbitrarily given, for convenience. . . ." No definition of species can be applied to resolve questionable cases—it is a matter of opinion.

There is a popular misconception that if animals or plants can be crossed and produce fertile offspring they belong to the same species, otherwise not. This no longer is recognized as an adequate criterion by most scientists. Dr. Fisher (1940), for example, says,

Two animals do not necessarily belong to the same species if they interbreed in the wild. There are many examples of distinct species which have increased their range . . . so as to overlap. In this region of overlap they may interbreed, producing a mixed or hybrid population. Nevertheless this does not mean that they are the same species.

Professor Michael F. Guyer (1948) of the University of Wisconsin wrote,

Ordinarily individuals of the same species are entirely fertile when inbred, and individuals of different species cannot or will not reproduce with each other, but there are so many exceptions to this rule that it cannot be used as a satisfactory distinction.

Species Differences

Sometimes species are separated on the basis of trifling physical differences. Ernst Mayr (1942, pp. 272-73) tells of two species of European birds called brown creepers which differ in that one has a long, nearly straight claw on the hind toe while the other has a short, curved claw. They occur together but are said not to interbreed. He also mentions two species of flycatchers. One has a longer tail than the other, but the difference is so slight that the species cannot be told apart unless the birds are caught and the tails measured.

There are species that are distinguished by detailed internal anatomy. Dr. Carl Heinrich (1956) of the Smithsonian Institution says of moths of the family Phycitidae, "Anyone wishing to identify phycitids must resign himself to a tedium of dissection and slide making." According to Robert W. Pennach (1953) of the University of Colorado, there are some annelid worms in which:

. . . identification depends on internal details of the reproductive system, and though careful dissections are often adequate, it is frequently necessary to make stained serial sections of the segments containing the reproductive structures. Usually cross sections are sufficient, but some workers advocate longitudinal sections in addition.

Some species are identified physiologically. This is frequently the case in bacteria, where distinct morphological characteristics may be difficult to find. Two species of the single-celled green alga *Chlorella* are identified by measuring their average rates of respiration.

Another phenomenon which may cause trouble for the taxonomist is alternation of generations. In some animals each generation is very different from the one which preceded and like the one before that. The

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