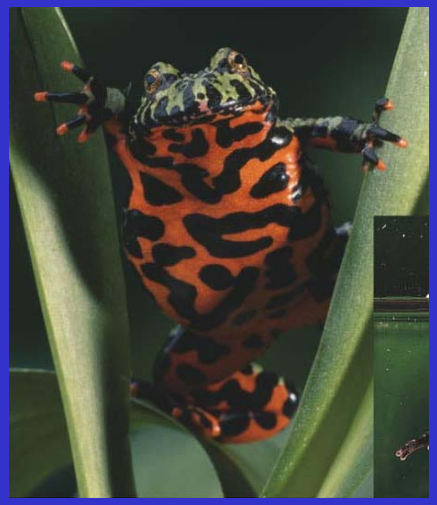


Species

Species are different “kinds” of organisms.

Species are the product of divergence of genetic lineages.

When one genetic lineage becomes two each lineage can have an independent evolutionary future.

The difference between species can be slight or dramatic.

Biologists differ in their concept of species. The difference in concepts used can depend on the group of organisms studied or on the goal of the researcher who studies them.

TABLE 15.1 *Some species concepts*

Biological species concept Species are groups of actually or potentially interbreeding natural populations that are reproductively isolated from other such groups (Mayr 1942).

Evolutionary species concept A species is a single lineage (an ancestor-descendant sequence) of populations or organisms that maintains an identity separate from other such lineages and which has its own evolutionary tendencies and historical fate (Wiley 1978).

Phylogenetic species concepts (1) A phylogenetic species is an irreducible (basal) cluster of organisms that is diagnosably distinct from other such clusters, and within which there is a parental pattern of ancestry and descent (Cracraft 1989). (2) A species is the smallest monophyletic group of common ancestry (de Queiroz and Donoghue 1990).

Genealogical species concept Species are "exclusive" groups of organisms, where an exclusive group is one whose members are all more closely related to one another than to any organism outside the group (Baum and Shaw 1995).

Recognition species concept A species is the most inclusive population of individual biparental organisms that share a common fertilization system (Paterson 1985).

Cohesion species concept A species is the most inclusive population of individuals having the potential for phenotypic cohesion through intrinsic cohesion mechanisms (Templeton 1989).

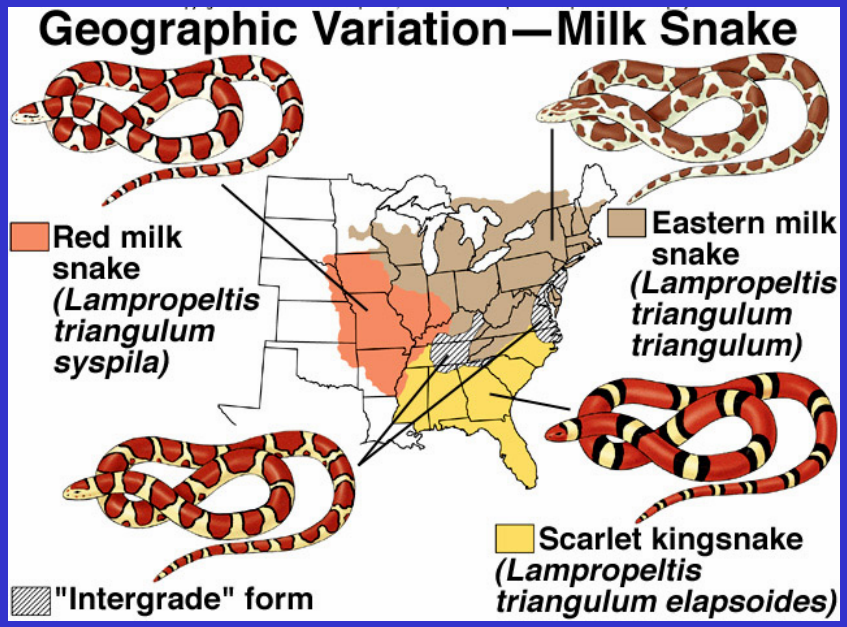
Ultimately, the idea of a species is a human construct that allows us to communicate about different forms of life.

The “biological species concept” is the idea of species that is most often used by evolutionary biologists.

A species is a group or groups of actually or potentially interbreeding populations, which are reproductively isolated from other such groups.

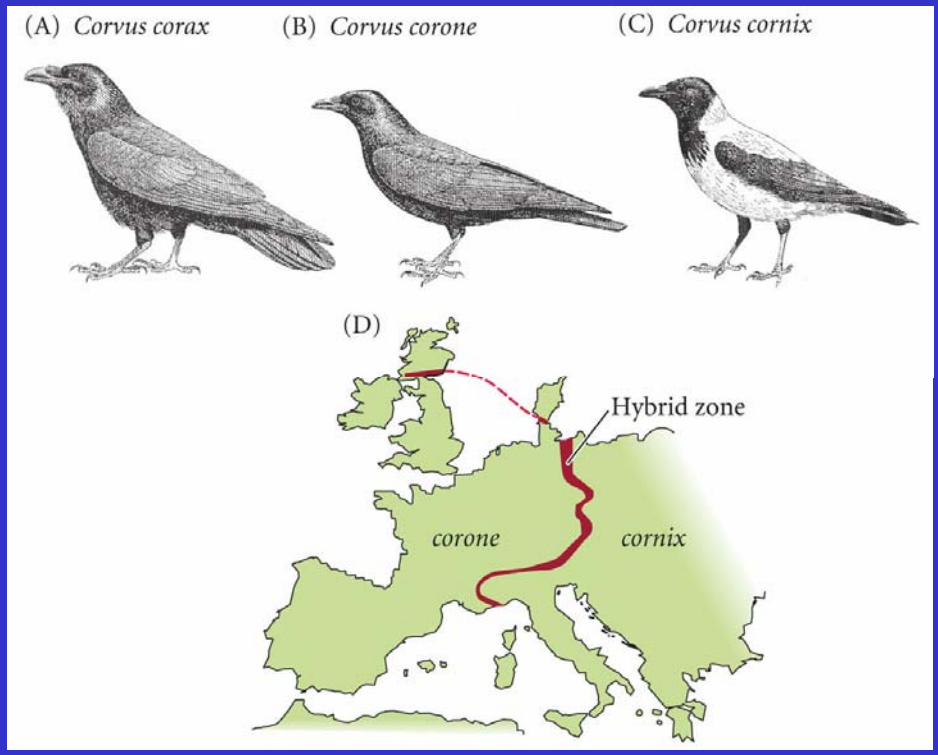
Reproductive isolation – the restriction of genetic exchange between groups even when those groups are sympatric (live in the same region). The restriction is often not absolute but sufficiently restrictive so that each group maintains a separate genetic identity.

A single species can have a range of forms but so long as the forms are not reproductively isolated, the forms are the same species.

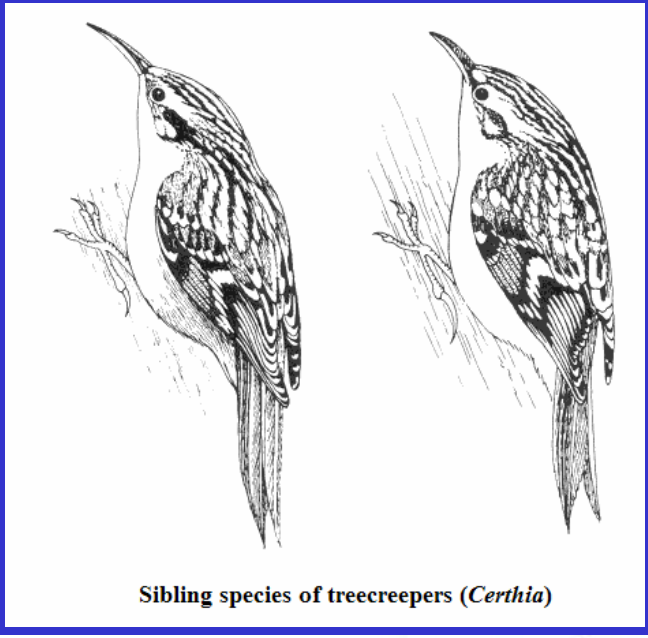


Members of one species often vary geographically. Intermediate forms often exist and show evidence of genetic exchange. Sometimes geographic variants of a species are called **subspecies**.

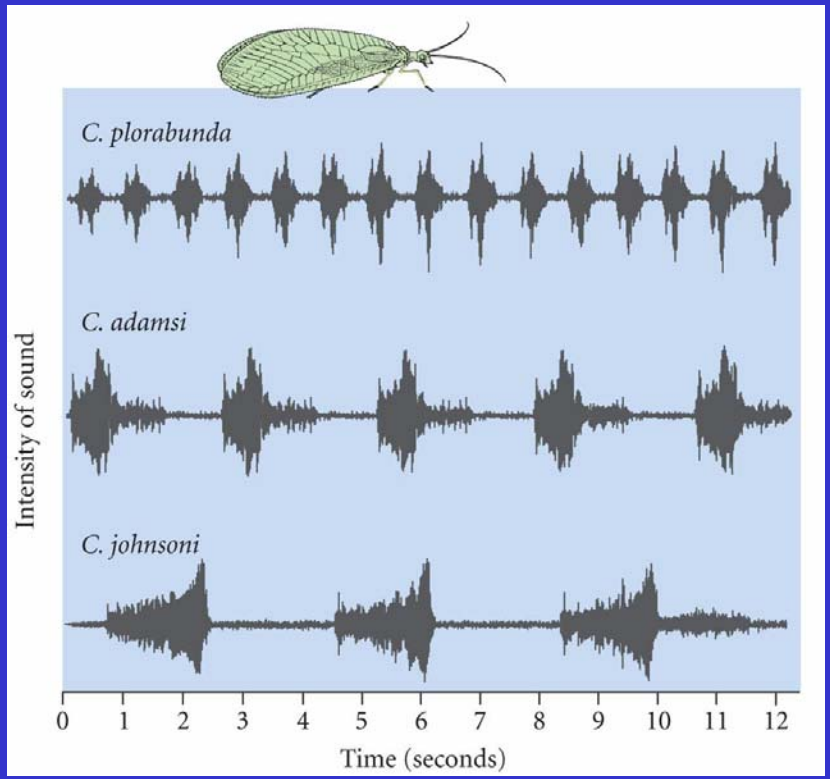
Often, species are very similar and arguably the same species. The divergence of lineages can be gradual and their genetic separation may not become complete. This can result in hybrid zones. If those zones are narrow, they may be called different species.



Some species, that are reproductively isolated, are difficult to distinguish using external and easily observable features.



Sibling species of treecreepers (*Certhia*)

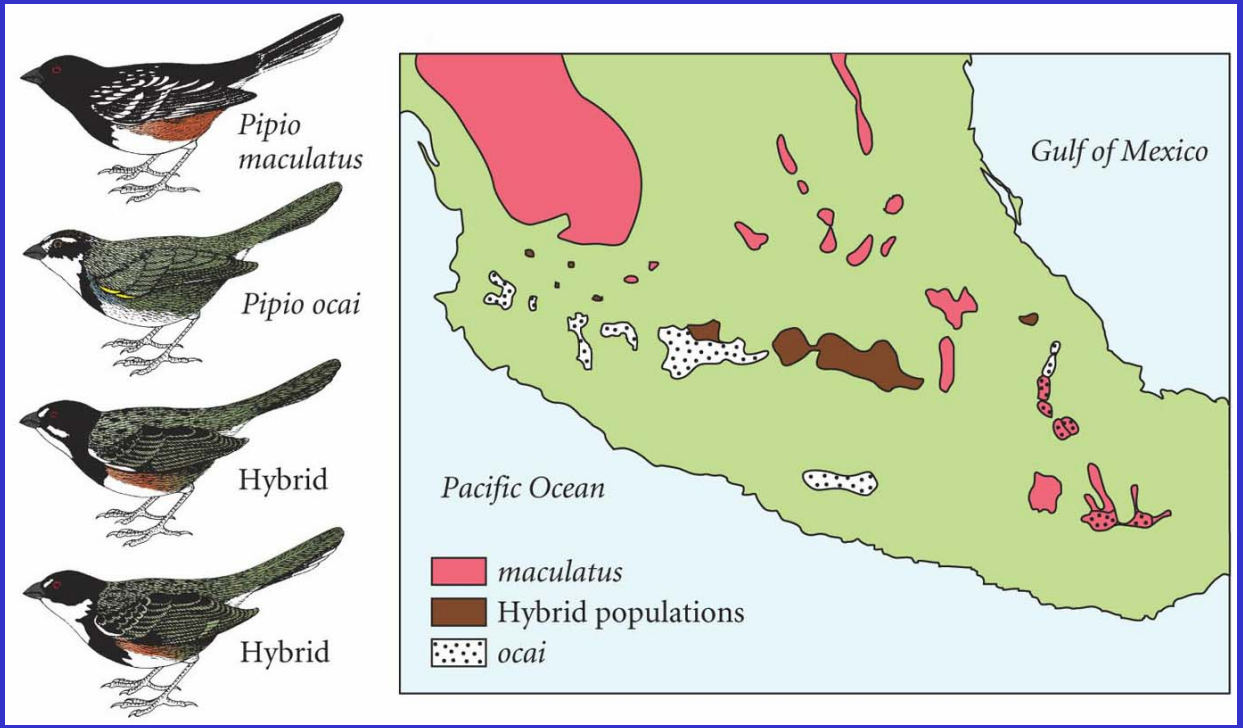


Such cases are called "sibling species."

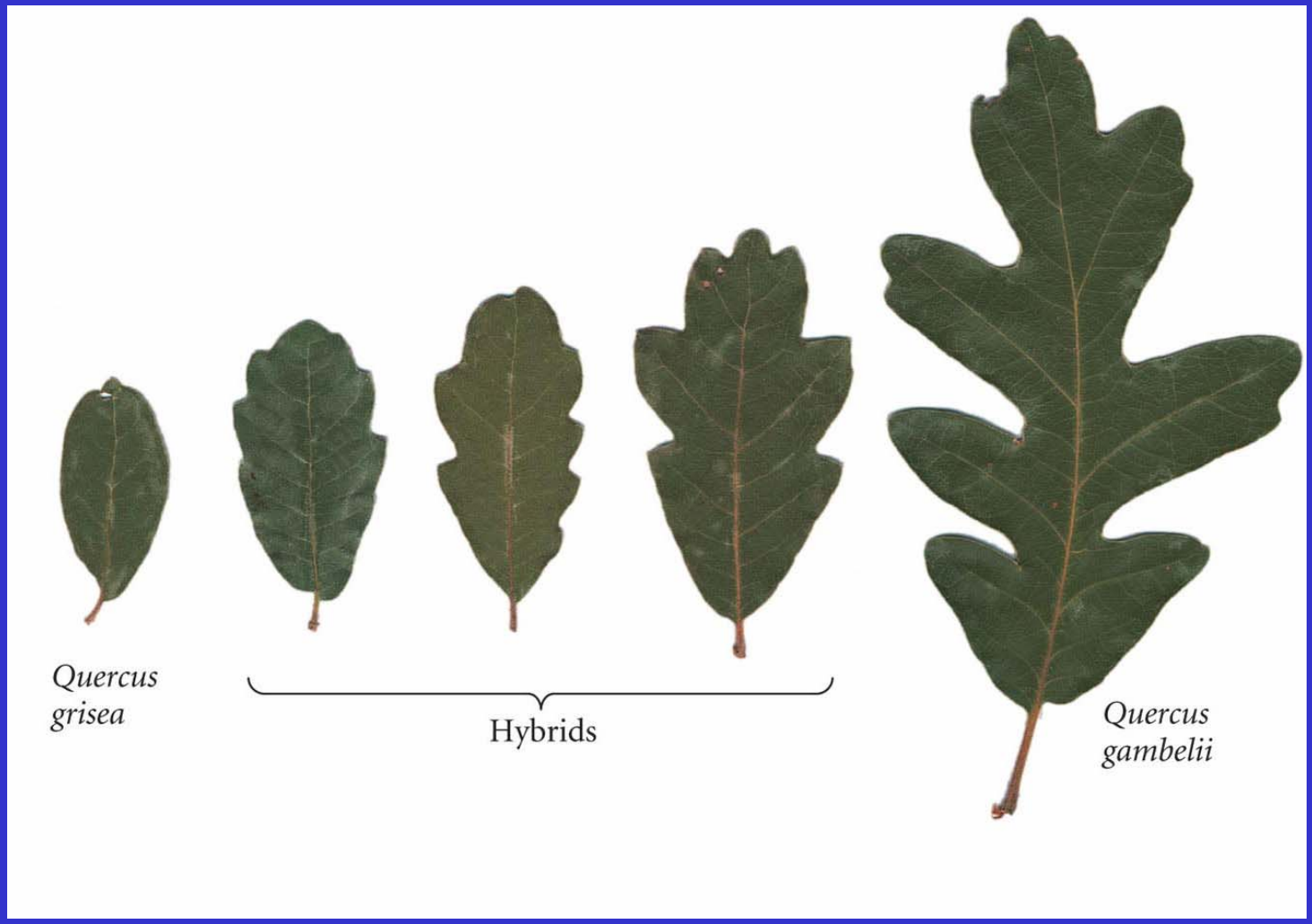
Sibling species show that appearance is not the critical criterion for different species.

The biological species concept can only be applied to organisms that are sexual and outcrossing. Asexual forms may be called different species, but a different criterion must be used. For asexuals a two forms are called different species if they differ is some consistent way.

Species may be genetically isolated in one locality but not in others.



Some plants, classified as different species broadly hybridize.



In spite of difficulties, the biological species concept is broadly applicable. Many closely related species are reproductively isolated. There are many barriers to gene flow that result in reproductive isolation. Barriers are classified as premating or postmating.

TABLE 15.2 ***A classification of isolating barriers*** (Part 1)

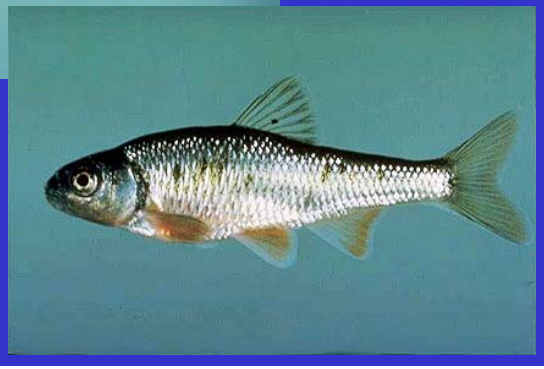
I. *Premating barriers:* Features that impede transfer of gametes to members of other species

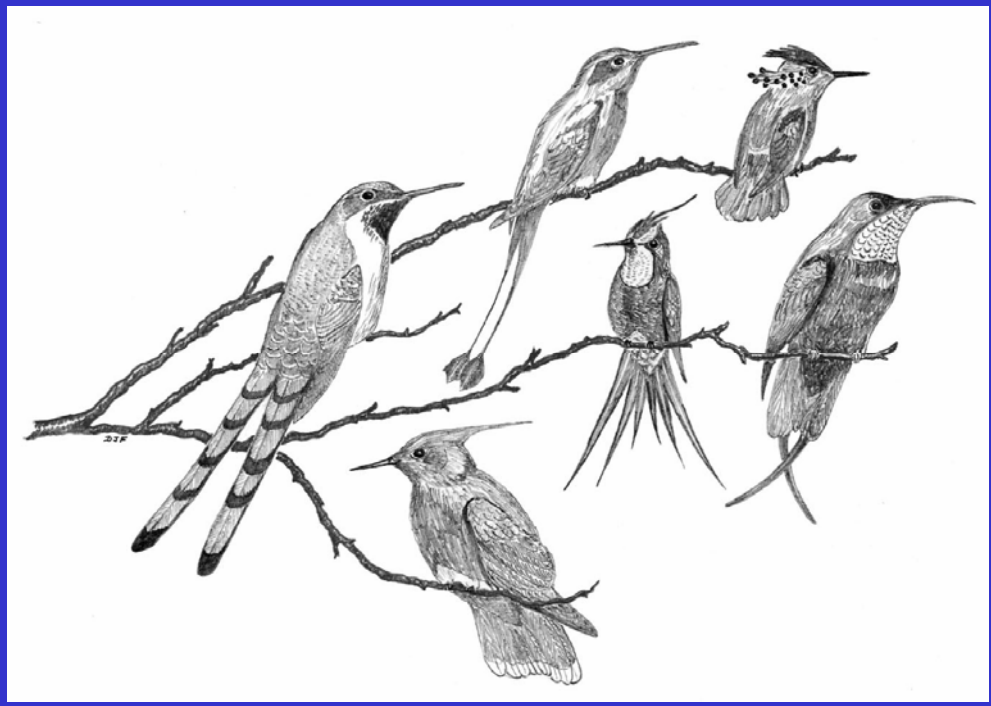
A. Ecological isolation: Potential mates (although sympatric) do not meet

1. Temporal isolation (populations breed at different seasons or times of day)
2. Habitat isolation (populations have propensities to breed in different habitats in the same general area, and so are spatially segregated)

B. Potential mates meet but do not mate

1. Behavioral (sexual or ethological) isolation (in animals, differences prevent populations from mating)
2. Pollinator isolation (in plants, populations transfer pollen by different animal species or on different body parts of a single pollinator; may also be classified as ecological isolation)





Postmating barriers occur after mating and can act before the zygote is formed (prezygotic) or after (postzygotic).

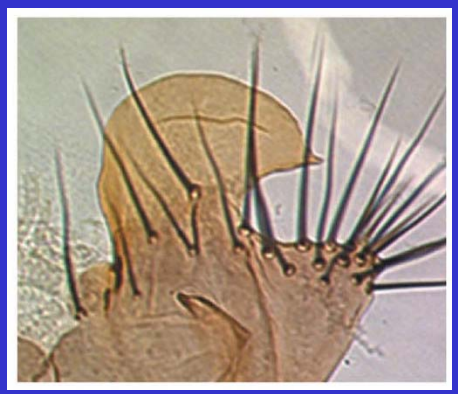
TABLE 15.2 ***A classification of isolating barriers*** (Part 2)

II. *Postmating, prezygotic barriers:* Mating or gamete transfer occurs, but zygotes are not formed

A. Mechanical isolation (copulation occurs, but no transfer of male gametes takes place because of failure of mechanical fit of reproductive structures)

B. Copulatory behavioral isolation (failure of fertilization because of behavior during copulation or because genitalia fail to stimulate properly)

C. Gametic isolation [failure of proper transfer of gametes or of fertilization, either due to intrinsic incompatibility or to competition between conspecific and heterospecific gametes (conspecific sperm precedence or pollen tube precedence)]



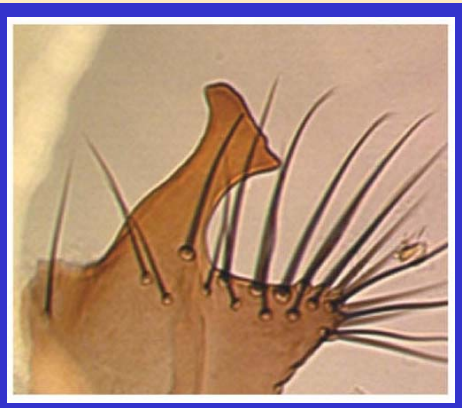


TABLE 15.2 ***A classification of isolating barriers*** (Part 3)

III. *Postzygotic barriers:* Hybrid zygotes are formed but have reduced fitness

A. Extrinsic (hybrid fitness depends on context)

1. Ecological inviability (hybrids do not have ecological niche in which they are competitively equal to parent species)
2. Behavioral sterility (hybrids are less successful than parent species in obtaining mates)

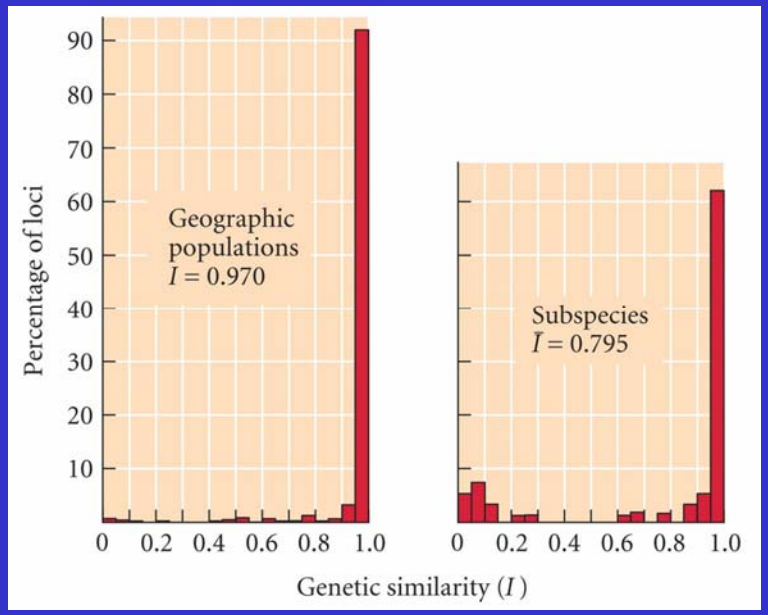
B. Intrinsic (hybrid fitness is low because of problems that are relatively independent of environmental context)

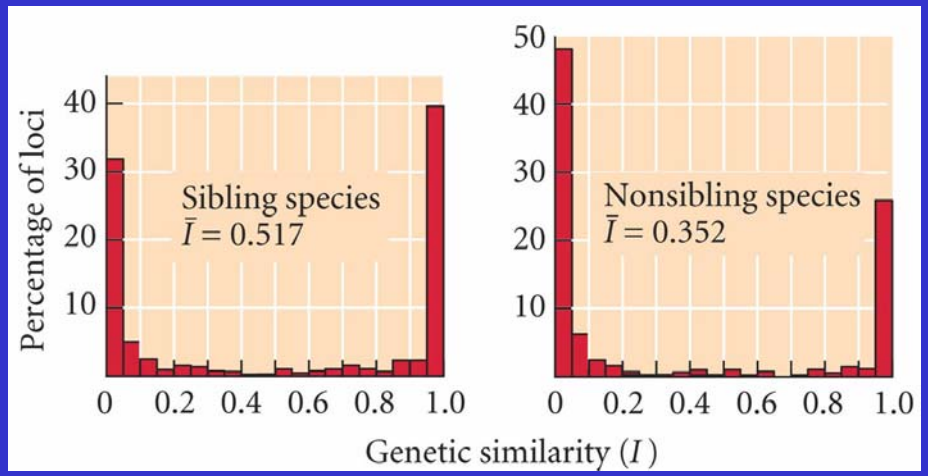
1. Hybrid inviability (developmental problems cause reduced survival)
2. Hybrid sterility (usually due to reduced ability to produce viable gametes; also "behavioral sterility," neurological incapacity to perform normal courtship)

Hybrid sterility is most often seen in the heterogametic sex – males in mammals and insects – females in birds and butterflies. This is called "Haldane's Rule."

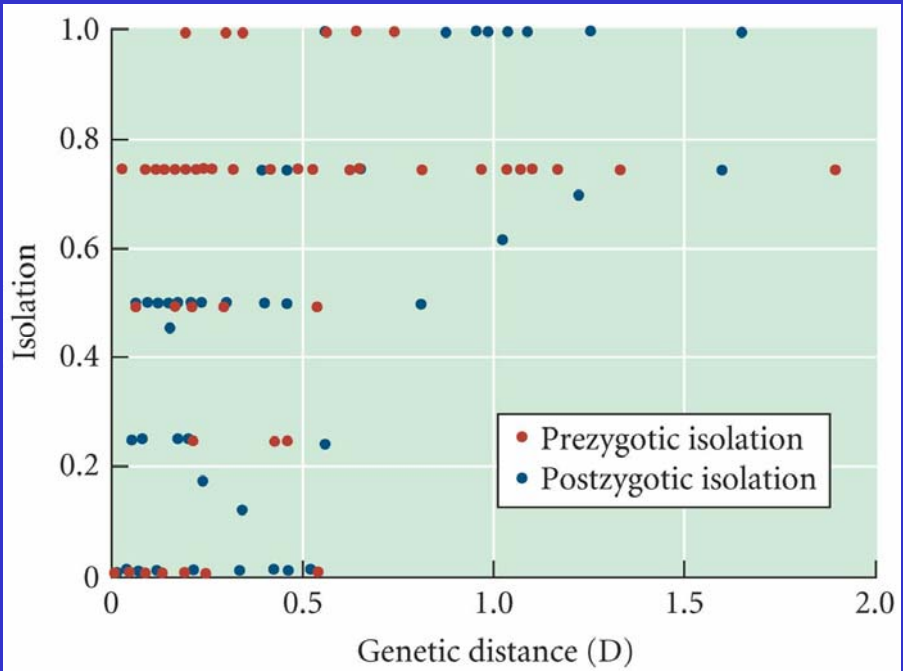
Hybrid problems may not develop in the F_1 offspring, but crosses among the F_1 and backcrosses to the parental species may produce inviable or sterile offspring . This is called "F_2 breakdown."

Populations, subspecies, and reproductively isolated species have gradations of genetic differences.





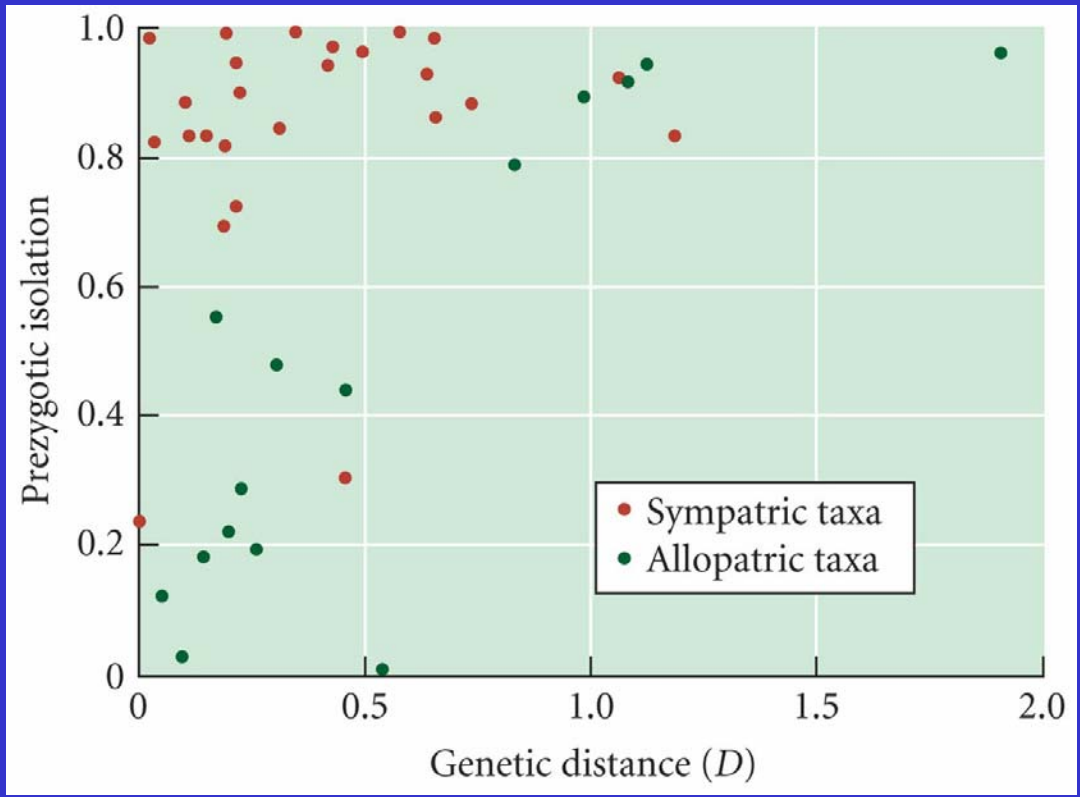
Coyne and Orr used genetic distance to estimate time of divergence of many species pairs of *Drosophila* and compared their degree of prezygotic isolation and postzygotic isolation with their divergence time.



The strength of isolation increases with time – for both types of barriers

Full reproductive isolation evolves with variable amounts of divergence (0.3 to 0.5) - ~1.5 to 3 million years

Among recently diverged forms the strength of prezygotic isolation is greater than the strength of postzygotic isolation.



Prezygotic isolation is stronger among sympatric forms than among allopatric forms.

There is some evidence that postzygotic isolation can select for prezygotic differences between species.