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The Role of Animal Pollination in Plant Speciation: Integrating Ecology, Geography, and Genetics
Kay and Sargent

Supplemental Table 1. Documented or putative cases of floral isolation.[a]

Family	**Taxa**	**Life Form**	**Geographic region**	**Findings**	**Reference(s)**
Acanthaceae	*Aphelandra pulcherrima* complex	Shrubs	Tropical America	Divergent flowering times reduce pollen transfer by shared hermit hummingbird pollinators; at least two shifts to non-hermit pollination	McDade (1984), McDade (1992)
Acanthaceae	*Ruellia*	Herbs and shrubs	Tropical America	Multiple shifts among pollination by bees, hummingbirds, bats, moths, and butterflies; many sympatric species with divergent flowers	Tripp & Manos (2008)
Agavaceae	*Yucca*	Herbs	Temperate and tropical N. America	Obligate pollination mutualism with a genus of seed-parasitic moths has contributed to floral isolation and speciation	Leebens-Mack et al. (1998), Pellmyr (2003)
Amaryllidaceae	*Narcissus*	Herbs	Temperate Europe	Diversification of floral scent with changes in pollination syndromes, some hybridization due to incomplete ethological isolation; moth- and fly-pollination ecotypes across a geographic range	Dobson et al. (1997), Marques et al. (2007), Perez-Barrales et al. (2007)
Arecaceae	*Attalea allenii* and *Wettinia quinaria*	Palms	Tropical S. America	Divergent floral scents attract different species of beetle pollinators	Nunez et al. (2005)
Asphodelaceae	*Aloe*	Trees	Temperate S. Africa	Sympatric species partition the pollinating bird fauna; multiple shifts between bird and insect pollination	Botes et al. (2008), Hargreaves et al. (2008)
Berberidaceae	*Epimedium grandiflorum*, *E. sempervirens*, and *E. trifoliatobinatum*	Herbs	Temperate Asia	Nectar foraging bees show species fidelity (nectar spur length and proboscis length are correlated), pollen collecting bees are less discriminating	Suzuki (1984)

Family	**Taxa**	**Life Form**	**Geographic region**	**Findings**	**Reference(s)**
Campanulaceae	*Burmeistera*	Herbs	Tropical S. America	Floral character displacement among bat-pollinated species contributes to mechanical floral isolation; one shift to hummingbird pollination	Muchhala (2003), Muchhala & Potts (2007)
Campanulaceae	*Cyanea*	Herbs, shrubs, and trees	Tropical Pacific	Hypothesized partitioning of the bird pollinator fauna by flower size and elevation	Givnish et al. (2009)
Campanulaceae	*Lobelia cardinalis* and *L. siphilitica*	Herbs	Temperate N. America	Strong ethological isolation between sympatric hummingbird- and bee-pollinated species	Johnston (1991)
Caryophyllaceae	*Silene dioica* and *S. latifolia*	Herbs	Temperate Europe	Incomplete ethological isolation between bumblebee- and moth-pollinated species; floral scent contributes to pollinator specificity	Goulson & Jerrim (1997), Waelti et al. (2008)
Convolvulaceae	*Ipomoea*	Herbs	Temperate N. America (not native)	Herkogamy provides mechanical floral isolation in the face of heterospecific pollen flow; selection favors character displacement; strong ethological isolation among sympatric species with different pollination syndromes	Smith & Rausher (2007), Smith & Rausher (2008), Wolfe & Sowell (2006)
Costaceae	*Costus*	Herbs	Tropical America	Multiple shifts from bee to hummingbird pollination causing strong ethological isolation; mechanical floral isolation by shared pollinators	Kay (2006), Kay et al. (2005), Kay & Schemske (2003)
Euphorbiaceae	*Dalechampia*	Herbs	Tropical S. America	Multiple shifts in pollination system; evidence for character displacement in floral traits between sympatric species	Armbruster (1985), Armbruster (1993), Armbruster & Baldwin (1998)

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Family	**Taxa**	**Life Form**	**Geographic region**	**Findings**	**Reference(s)**
Fabaceae	*Acacia*	Trees	Tropical Africa	Temporal displacement of pollen release throughout the day among ten sympatric species reduces interspecific pollen flow	Stone et al. (1998)
Fabaceae	*Cercidium floridum* and *C. microphyllum*	Trees	Temperate N. America	Shared bee pollinators show strong floral constancy at sympatric sites; flowers differ in ultraviolet color patterns	Jones (1978)
Fabaceae	*Erythrina*	Shrubs and trees	Pantropical	Multiple evolutionary shifts from passerine to hummingbird pollination	Bruneau (1997)
Fabaceae	*Hedysarum boreale* and *H. alpinum*	Herb	Temperate N. America	Strong floral constancy may facilitate overlapping flowering times	McGuire (1993)
Fabaceae	*Parkia*	Tree	Tropical S. America	One evolutionary shift from bee to bat pollination, with nocturnal bee pollination as a possible intermediate stage	Hopkins et al. (2000), Luckow & Hopkins (1995)
Geraniaceae	*Pelargonium*	Herbs	Temperate S. Africa	Multiple shifts in pollination system, often accompanied by shift in edaphic conditions; pollination shifts may evolve by reinforcement	Struck (1997), Van der Niet et al. (2006)
Gesneriaceae	*Achimenes*	Herbs	Tropical America	Multiple shifts in pollination syndrome (including hummingbird, butterfly, and bee); substantial sympatry among closely related species	Roalson et al. (2003)
Gesneriaceae	Tribe Sinningieae (*Paliavana*, *Sinningia*, and *Vanhouttea*)	Herbs and shrubs	Tropical S. America	Multiple shifts in pollination system, including bee, hummingbird, moth and bat syndromes; patterns consistent with allopatric divergence in floral characters	Perret et al. (2007), Perret et al. (2003), Perret et al. (2001)
Haemodoraceae	*Anigozanthos* and *A. humilis*	Herbs	Temperate Australia	Shared red wattlebird pollinators show strong floral constancy in sympatry	Hopper & Burbidge (1978)

Family	**Taxa**	**Life Form**	**Geographic region**	**Findings**	**Reference(s)**
Heliconiaceae	*Heliconia*	Herbs	Tropical America	Specialization on hermit versus non-hermit hummingbirds, mechanical isolation by segregation of pollen placement on shared pollinators, and attraction of different sexes of shared pollinators; many species occur in sympatry	Kress (1983), Stiles (1975), Stiles (1979), Temeles & Kress (2003)
Iridaceae	*Gladiolus*	Herbs	Temperate S. Africa	Multiple shifts in pollination system, often accompanied by shift in edaphic conditions; pollination shifts may evolve by reinforcement	Goldblatt & Manning (1998), Goldblatt & Manning (2001), Van der Niet et al. (2006)
Iridaceae	*Iris fulva* and *I. brevicaulis*	Herbs	Temperate N. America	Incomplete ethological isolation between partially sympatric melittophilous and ornithophilous species; major QTL contribute to floral differences	Arnold et al. (2004), Bouck et al. (2007)
Iridaceae	*Lapeirousia*	Herbs	Temperate S. Africa	Multiple shifts in pollination system, often accompanied by shift in edaphic conditions; pollination shifts may evolve by reinforcement	Goldblatt & Manning (1996), Goldblatt et al. (1995), Van der Niet et al. (2006)
Lamiaceae	*Monarda clinopodia* and *M. didyma*	Herbs	Temperate N. America	Incomplete ethological isolation by bumblebees and hummingbirds	Whitten (1981)
Lamiaceae	*Salvia apiana* and *S. mellifera*	Herbs	Temperate N. America	Mechanical and ethological isolation by different species of bees	Grant & Grant (1964)
Liliaceae	*Calochortus*	Herbs	Temperate N. America	Generalist insect pollination with individual pollinator species showing preferences for different plant species	Dilley et al. (2000)
Lythraceae	*Lythrum alatum* and *L. salicaria*	Herbs	Temperate N. America	Bees and butterflies contribute to assortative mating in sympatry through floral constancy	Levin (1970)

Family	**Taxa**	**Life Form**	**Geographic region**	**Findings**	**Reference(s)**
Moraceae	*Ficus*	Trees	Pantropical	Obligate pollination mutualism with a genus of seed-parasitic wasps has contributed to floral isolation and speciation	Herre et al. (1996), Machado et al. (2005), Ronsted et al. (2005), Yokoyama (2003)
Onagraceae	*Chamerion angustifolium* (diploids and tetraploids)	Herbs	Temperate N. America	Insect pollinators discriminate among plants of different ploidy levels growing in sympatry	Husband & Sabara (2004)
Onagraceae	*Clarkia breweri* and *C. concinna*	Herbs	Temperate N. America	Shift to moth pollination involving novel scent production, although species are allopatric	Raguso & Pichersky (1995)
Onagraceae	*Fuchsia encliandra* and *F. parviflora*	Shrub	Tropical Central America	Strong differentiation in floral traits and pollinator use in sympatry but not in allopatry, indicating character displacement	Breedlove (1969)
Onagraceae	*Oenothera brevipes* and *O. clavaeformis*	Herbs	Temperate N. America	Divergent timing of flower opening attracts different bee assemblages	Raven (1962)
Orchidaceae	*Angraecum compactum* and *Neobatheia grandidierana*	Herbs	Tropical Madagascar	Mechanical isolation of placement of pollen on hawkmoth pollinators	Nilsson et al. (1987)
Orchidaceae	*Ceratandra*	Herbs	Temperate S. Africa	Single shift in pollination system accompanied by shift in edaphic conditions; pollination shift may evolve by reinforcement	Linder & Kurzweil (1999), Van der Niet et al. (2006)
Orchidaceae	*Chiloglottis*	Herbs	Temperate Australia	Sexually deceptive orchids with species specific pollination; floral odors mimic female wasp sex pheromones	Mant et al. (2005a), Mant et al. (2005c)

Family	**Taxa**	**Life Form**	**Geographic region**	**Findings**	**Reference(s)**
Orchidaceae	*Disa*	Herbs	Temperate S. Africa	Multiple shifts among diverse pollination systems, including butterfly, carpenter bee, long-tongued fly and moth pollination; possible reinforcement of pollination shifts	Johnson et al. (1998), Van der Niet et al. (2006)
Orchidaceae	*Disperis*	Herbs	Temperate S. Africa	Pollinator isolation via pollinator specificity and pollen placement described for several sympatric species.	Manning & Linder (1992)
Orchidaceae	*Gymnadenia conopsea* and *G. odoratissima*	Herbs	Temperate Europe	Divergent floral scents attract different pollinator assemblages to food deceptive orchids	Huber et al. (2005)
Orchidaceae	*Ophrys*	Herbs	Temperate Europe	Sexually deceptive orchids with species specific pollination and strong, but incomplete, premating isolation	Cozzolino & Widmer (2005), Mant et al. (2005b), Scopece et al. (2007), Soliva & Widmer (2003)
Orchidaceae	*Platanthera bifolia* and *P. chlorantha*	Herbs	Temperate Europe	Shift from tongue-attachment to eye-attachment of pollinia on shared moth pollinators	Maad & Nilsson (2004)
Orchidaceae	*Satyrium*	Herbs	Temperate S. Africa	Multiple shifts in pollination system, often accompanied by shift in edaphic conditions; incomplete ethological isolation	Ellis & Johnson (1999), Johnson & Kurzweil (1998), Van der Niet et al. (2006)
Orchidaceae	*Satyrium hallackii*	Herbs	Temperate S. Africa	Pollination ecotypes adapted to either bees or hawkmoths and long-tongued flies	Johnson (1997)
Orchidaceae	*Stanhopea tricornis* and *S. bucephalus*	Herbs	Tropical S. America	Differences in floral morphology and scent contribute to ethological isolation by different species of orchid bees in sympatry	Dodson & Frymire (1961)

Family	**Taxa**	**Life Form**	**Geographic region**	**Findings**	**Reference(s)**
Orobanchaceae	*Castilleja*	Herbs	Temperate N. America	Presence of hybrids leads to reduced pollinator constancy, possibly causing the breakdown of floral isolation	Hersch & Roy (2007)
Orobanchaceae	*Pedicularis groenlandica* and *P. attolens*	Herbs	Temperate N. America	Mechanical isolation by differing sites of pollen placement on the shared bumblebee pollinators	Grant (1994), Macior (1977), Sprague (1962)
Orobanchaceae	*Pedicularis rhinanthoides* and *P. longiflora*	Herbs	Temperate Asia	Mechanical isolation and floral constancy by the shared bumblebee pollinators	Yang et al. (2007)
Orobanchaceae	*Rhinanthus minor* and *R. serotinus*	Herbs	Temperate Europe	Incomplete ethological and mechanical isolation by bumblebee pollinators	Kwak (1978)
Papaveraceae	*Papaver rhoeas*, *P. dubium* and three other species	Herbs	Temperate Europe	Floral constancy by shared honeybee pollinators	McNaughton & Harper (1960)
Phrymaceae	*Mimulus* section *Diplacus*	Shrubs	Temperate N. America	Limited gene flow between yellow and red-flowered ecotypes and species	Grant (1993), Streisfeld & Kohn (2005)
Phrymaceae	*Mimulus* section *Erythranthe*	Herbs	Temperate N. America	Two shifts from bee to hummingbird pollination; nearly complete ethological isolation between partially sympatric hummingbird- and bee-pollinated species; major QTL contribute to floral isolation	Beardsley et al. (2003), Bradshaw et al. (1998), Hiesey et al. (1971), Ramsey et al. (2003)
Phyllanthaceae	Tribe Phyllantheae (*Glochidion*, *Breynia*, *Phyllanthus*, and *Gomphidium*)	Herbs, shrubs, and trees	Tropical Asia and Australia	Obligate pollination mutualism with a genus of seed-parasitic moths has evolved multiple times and contributed to speciation	Kato et al. (2003), Kawakita & Kato (2006), Kawakita & Kato (2009), Okamoto et al. (2007)
Plantaginaceae	*Penstemon*	Herbs	Temperate N. America	Multiple shifts from bee to hummingbird pollination causing ethological isolation	Wilson et al. (2004), Wilson et al. (2007)

Family	**Taxa**	**Life Form**	**Geographic region**	**Findings**	**Reference(s)**
Plantaginaceae	*Penstemon spectabilis* and *P. centranthifolius*	Herbs	Temperate N. America	Incomplete ethological and mechanical isolation between partially sympatric ornithophilous and hymenopterophilous species	Chari & Wilson (2001)
Polemoniaceae	*Ipomopsis aggregata* and *I. arizonica*	Herbs	Temperate N. America	Poor pollen transfer by the shared hummingbird pollinator at sympatric sites	Grant (1993), Wolf et al. (2001)
Polemoniaceae	*Ipomopsis aggregata* and *I. tenuituba*	Herbs	Temperate N. America	Incomplete ethological isolation between partially sympatric ornithophilous and sphingophilous species	Aldridge & Campbell (2007), Campbell et al. (1998), Grant (1993), Melendez-Ackerman & Campbell (1998)
Polemoniaceae	*Phlox*	Herbs	Temperate N. America	Selection for a red (vs. pink) color morph of *Phlox drummondii* is stronger for populations sympatric with the pink-flowered congener *P. cuspidata*, suggesting character displacement and floral isolation.	Levin (1985)
Polemoniaceae	*Polemonium viscosum*	Herbs	Temperate N. America	Divergent floral morphology with elevational differences in pollinator assemblage	Galen (1996)
Polygalaceae	*Polygala vauthieri* and *P. monticola*	Herbs	Tropical S. America	Divergent placement of pollen on the pollinator promotes conspecific pollen transfer in areas of sympatry	Brantjes (1982)
Ranunculaceae	*Aquilegia*	Herbs	Temperate N. America	Multiple shifts among bee, hummingbird, ar moth pollination syndromes; incomplete ethological isolation between partially sympatric ornithophilous and sphingophilou species	Chase & Raven (1975), Fulton & Hodges (1999), Grant (1993), Grant (1994), Whittall & Hodges (2007)

Family	**Taxa**	**Life Form**	**Geographic region**	**Findings**	**Reference(s)**
Saxifragaceae	*Heuchera grossularifolia* (diploids and tetraploids)	Herbs	Temperate N. America	Insect pollinators discriminate among plants of different ploidy levels growing in sympatry	Segraves & Thompson (1999), Thompson & Merg (2008)
Solanaceae	*Iochroma*	Shrubs	Tropical S. America	Extensive floral divergence associated with partial divergence in pollinator assemblage	Smith et al. (2008a), Smith et al. (2008b)
Solanaceae	*Nicotiana alata* and *N. forgetiana*	Herbs	Tropical S. America	Strong ethological isolation between partially sympatric hummingbird- and hawkmoth-pollinated species	Ippolito et al. (2004)
Solanaceae	*Nicotiana glauca*	Shrubs	Temperate S. America	Geographic variation in hummingbird pollinator assemblage corresponds to variation in floral traits	Nattero & Cocucci (2007)
Solanaceae	*Petunia axillaris* and *P. integrifolia*	Herbs	Tropical S. America	Ethological isolation between sympatric hawkmoth- and bee-pollinated species; genetic dissection of floral traits	Ando et al. (2001), Hoballah et al. (2007), Quattrocchio et al. (1999), Stuurman et al. (2004)
Solanaceae	*Solanum grayi* and *S. lumholtzianum*	Herbs	Tropical N. America	Character displacement in floral morphology in sympatric but not allopatric populations	Whalen (1978)
Stylidiaceae	*Stylidium*	Herbs	Temperate Australia	Comparison with a null model suggests that overdispersion in pollen placement among sympatric species is driven by character displacement.	Armbruster et al. (1994)

[a]We identified cases of floral isolation by performing a Web of Science (Thompson Reuters) search with the following search string Topic=(pollinat* OR floral) AND (isolat* OR speciat* OR diversif*) and Timespan=1990-2008. We included additional references found therein and in Grant (1981).

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