Island biology

Allan Sørensen
Allan Timmermann,
Ana María Martín González
Camilla Hansen
Camille Kruch
Dorte Jensen
Eva Grøndahl,
Franziska Petra Popko,
Grete Fogtman Jensen,
Gudny Asgeirsdottir,
Hubertus Heinicke,
Jan Nikkelborg,
Janne Thirstrup,
Karin T. Clausen,
Karina Mikkelsen,
Katrine Meisner,
Kent Olsen,
Kristina Boros,
Linn Kathrin Øverland,
Lucia de la Guardia,
Marie S. Hoelgaard,
Melissa Wetter
Mikkel Sørensen,
Morten Ravn Knudsen,
Pedro Finamore,
Petr Klimes,
Rasmus Højjer Jensen,
Tenna Boye
Tine Biedenweg

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Larsen, Yoko L. Dupont & Jens M. Olesen
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Essay localities
The Faroe Islands

Kent Olsen

Introduction
The Faroe Islands is a treeless archipelago situated in the heart of the warm North Atlantic Current on the Wyville Thompson Ridge between 61°20’ and 62°24’ N and between 6°15’ and 7°41’ W. The nearest neighbours are the Shetland Islands, Iceland and Norway respectively some 345, 430 and 575km away. The islands was formed by volcanic activity during the Tertiary, about 50-60 million y. ago, and later by the Ice Age glaciers. The archipelago is composed of 18 islands covering 1400 sq km and the distance north-south is 113km and east-west 75km. There are 1100km of coastline and at no time is one more than 5km away from the ocean (Cornwallis et. al. 2001).

During the last Ice Age (Weichel), the Faroe Islands was covered with its own ice cap, distinct from the ice cap covering continental northern Europe. Possibly only the highest mountain peaks protruded from the ice, forming nunataks. These nunataks are thought to be refugia for some arctic plants, which were able to survive there. The majority of the present plant species invaded the islands after the ice disappeared about 10,000 y. ago through the action of wind, ocean currents, birds, and later, by man (Fosaa 2001). The long-distance transport and dispersal of flora and fauna to the North Atlantic Islands have been proposed to be assisted by icebergs, drift ice or even driftwood via the Transpolar Drift and East Greenland Current (Darwin 1859, Johansen and Hytteborn 2001).

The first settlers were Irish monks in the 6th century followed by the Scandinavian Vikings arrival in the 9th century. Along with the settlers and increasingly until present time came both alien flora and fauna (sheep, se below) (Cornwallis et. al. 2001).

The climate is highly oceanic with cool summers and mild winters. It is greatly influenced by the warm North Atlantic Current and by proximity to the common cyclone track in the North Atlantic region. Consequently, the climate is humid,
changeable, and windy. Precipitation reflects the topography of the islands. The coastal areas receive around 1,000mm per year increasing to more than 3,000mm in the central regions. The temperature in winter-time is very moderate considering the high latitude. Snowfall occurs, but is short-lived. The average temperature in the lowland ranges from 3°C in winter (min. – 10.4°C) to 11°C in the summer (max. 22.1°C) (Cornwallis *et. al.* 2001).

**Pollination landscapes**

Three significantly different altitudinal vegetation zones can be defined. From mean sea level there is a *temperate zone* with an upper limit at 200m AMSL followed by a *low alpine zone* at 200 – 400m AMSL and an *alpine zone* from above 400 AMSL (Fosaa *et. al.* 2004).

In terms of plant communities there are five significantly different communities. The *Alpine Vegetation* is found on flat mountaintops exposed to strong winds where the substrate freezes and thaws repeatedly. The *Heath Vegetation* is common throughout the Faroe Islands, but the *Grass Vegetation* is the predominant vegetation found from sea level up to the mountaintops. The *Mire Vegetation* dominates the moist areas and the *Fresh Water Vegetation* has a very limited distribution at the margin of natural lakes and small ponds. The *Coastal Vegetation* is found on more or less vertical cliffs, commonly up to several hundred metres (Fosaa 2001).

The highest mountain Slættaratindur has an altitude of 882m and is one of ten mountains in the Faroe Islands which rise to over 800m AMSL (*alpine zone*). The average height above mean sea level for the country is 300m (Cornwallis *et. al.* 2001).

On the archipelago some 250 native species of vascular plants are to be found (Davis *et. al.* 1996). Both the theory on island species diversity limited by ecological opportunities (habitat diversity) and the theory on isolation by distance are both in action when it comes to the Faroe Islands (Lack 1976). There are no woods, but plenty of grass. A mere 6% of the land is under cultivation while the rest is reserved
for the grazing of 70,000 sheep and some cattle and horses. The islands are heavily grazed, thus, “natural” vegetation is rare.

**Pollinators**

*Insects* – The world of insects is remarkably poorly represented (Nielsen 1908). Very few species are present in so great numbers of individuals that they can be of any importance to the pollination. Attention should be given to the pollination by means of thrips (*Thysanoptera*) which is widely distributed and probably valuable, e.g. in *Asteraceae*. In total 140 species of butterflies (*Lepidoptera*) have been recorded in the Faroe Islands (Jensen *et. al.* 2005). But none of them is known to be significant in plant pollination as most of them being scarce in numbers and most without annual occurrences. The occurrences of the honeybees – bumblebees (*Apidae*) are because of low numbers not of any importance for the pollination in contrast to relative nearby arctic areas outside the Faroe Islands (e.g. Greenland and Western Norway) where they play a major role. The only insects playing any quantitative role as pollinators are a few big flies (*Diptera*) where a list of the names of these is found in Nielsen (1908). The proportion of *Diptera* species of the total pollinator fauna increases in general with latitude (Olesen *pers. comm.*).

**Pollination Cases**

Numerically the vegetation is dominated by *Poaceae* (Grass Family), *Cyperaceae* (Sedge Family), and *Juncaceae* (Rush Family) (Hagerup 1951). Some of them are self-fertilizing (autogamous) but most are wind pollinated (anemophilous). The three *Umbelliferae* species *Angelica archangelica* (Garden Angelica), *A. silvestris* (Wild Angelica) and *Ligusticum scoticum* (Scots Lovage) are the Faroese species whose fly pollination is most easily observed with the inflorescences often covered in a dark layer of insects (*pers. obs.*). Fertilization of flowers by pollen from other flowers on the same plant (geitonogamy) is particularly conspicuous in *Umbelliferae*, where flies crawl from flower to flower all over the umbel. *Silene dioica* (Red Campion) has the corollas spread out flat so as to form a convenient landing-place for the visiting flies.
which easily strike against the projecting anthers or stigma. *Filipendula ulmaria* (Meadowsweet) is frequently visited by flies working about the inflorescences touching the anthers and shaking the light pollen out in all directions, where it hits the flower itself (autogamy) or the neighbouring flowers (geitonogamy). Furthermore the insects are powdered with pollen and may perform pollination (entomophily). Wind pollination is no doubt of the greatest importance for Meadowsweet (Hagerup 1951). In *Iris pseudacorus* (Yellow Iris) the pollination takes place when flies crawl down into the cleft between the style and the perianth. At the same time they enter a chamber quite suitable as a resting place particularly when the weather suddenly becomes unfavourable (strong winds, heavy clouds, etc.). The *Dactylorhiza maculata* ssp. *maculata* (Heath Spotted-orchid) is very abundant on the archipelago (*pers. obs.*). The orchid is visited and pollinated by the big and long-haired hoverfly *Eristalis intricarius* which strangely resembles a small dark bumblebee. This fly is perhaps the most important of all the pollinating insects on the Faroe Islands. It can easily pull out pollinia and carry them to the stigma of other flowers. The Faroese form of the orchid has so short a spur that its bottom can be reached by the proboscis of the fly (Hagerup 1951). *Thymus serpyllum* (Breckland Thyme) has plenty of nectar and *Eristalis intricarius* is seen crawling over the dense inflorescences leaving pollen on the purely female flowers. In the bisexual flowers the style grows up among the anthers and the stigma spread out so that autogamy may be obtained if insect pollination should fail (Warming 1908). A good number of flowers on the archipelago pollinate themselves either before, during or after flowering (Hagerup 1951). Many alpine – arctic flowering plant species have presumably evolved the ability to self-pollinate as a reproductive assurance mechanism under harsh abiotic environmental conditions that restrict insect flower visitation (Totland et. al. 2003). The method of pollination may be very different in different localities within the total area of distribution of the plant species as illustrated by *Calluna vulgaris* (Heather) in which the flowers may be pollinated by e.g. bees, butterflies, thrips, wind, and autogamy (Hagerup 1951). On the Faroe
Islands rain can also pollinate certain flowers as e.g. *Ranunculus sp.* and *Caltha palustris* (Marsh-marigold) (Hagerup 1951).

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Fróðskaparit Bd. 48: 41-54.


Shetland Islands
Janne Thistrup

Geography
Shetland islands are an archipelago consisting of 100 islands, islets and skerries stretching about 70 miles (113 km) from south to north. Only 14 of the islands are now inhabited, though a century ago it would have been twice that number. The Shetland’s have been inhabited for 5000 years. The island cluster is roughly equidistant from the north coast of Scotland, Norway and the Faeroes, extending from latitude $59^\circ 51'$ north and from longitude $0^\circ 45'$ west, which place them further north than Moscow, Stockholm and the southern tip of Greenland.

Geology
Some 400 million years ago what is now Britain and its islands lay on the Topic of Capricorn below the equator, an integral part of the super-continent which incorporated present-day Europe, North America, Scandinavia and Greenland. Aeons of continental drift gradually nudged this southern landmass north until it collided with the great northern continent of Laurentia. Thick sheets of ice covered Shetland many times over the past million years and glaciation has had a noticeable effect in the shaping of Shetlands. After the last Ice Age, about 10,000 years ago, the archipelago emerged more or less in its present pattern as the higher sea level caused by melt turned old mountain tops into a conglomeration of islands and skerries separated by sounds.

The islands have had a history of extinction and recolonization. On the islands there is an absence of trees but paleo-botanists have suggested from remains and fossil pollen grains found in peat that Shetland was once forested but estimate that the islands have been all but treeless for at least 10,000 years. The islands once supported scrubby vegetation of mainly birch, hazel and willow, but grazing and farming destroyed this and native trees survive only in inaccessible places.
**Climate**

Temperatures range from an average of around $15^\circ$ in summer to around $5^\circ$ in winter. Because of Shetland’s position on the globe the sun can shine up to 19 hours in June and in midwinter there is barely six hours of daylight. The warm water of the Gulf Stream means that the snow rarely lies around for more than a day or two. Rainfall averages a scant 1200 mm a year.

**Flora**

The Shetland can claim more than 800 species of flowering plants and ferns. All plants are protected by law in the British Isles, including more than 150 species which have a special protection. It is an offence to destroy or uproot any plant unless permission has been given. It is suggested that the most significant feature of Shetland’s flora is the proportion of arctic-alpine plants (those confined to mountains in central Europe, but occurring at lower levels in the northern Europe) and arctic-subarctic species (in Europe those restricted to northern Europe and the UK). Together, these account for almost 10% of the present-day native Shetland species.

**Insects**

The geographical isolation of the island group means that there are fewer species of insects, as well as plants, than in an area of equivalent size on the mainland. Not all species have been recorded and there are even gaps in the knowledge of the best known groups, Lepidoptera (butterflies and moths), Diptera (true flies) and Coleoptera (beetles). New species are listed each year. For example, there were over 40 species added to the list of Lepidoptera in 1996. Each year hundreds of butterflies and moths, as well as other insects, immigrate from the Continent. The Lepidoptera list currently stands at scant 300 more or less resident or immigrating species, 36 species of hoverflies (Diptera: Syrphidae) have been recorded and 29 species of Coleoptera are listed, these being the most numerous groups. In the
largest group, the Lepidoptera, only 14 are butterflies and it counts only one resident butterfly, the Large White (*Pieris brassicae*).

**Pollination**

The immigrating Lepidoptera have a peak in abundance in the summer months, from July to September, as are the period of flowering for the most common food plants. Some of the Lepidoptera visit several plant-species while others only visit one species. As well as some flowers are visited by several species of Lepidoptera while others are only visited by a single species. For instance is *Angelica sylvestris* (Wild Angelica) visited by *Phaulernis fulvigutella*, *Agonopterix heracliana* and *Agonopterix ciliella*, *Trifolium pratense* (Red Clover) is visited by *Nomophila noctuella* (Rush Veneer) and *Ematurga atomaria* (Common Heath), and *Cirsium* and *Carduus* (Thistles) are visited by *Agonopterix arenella* and *Vanessa cardui* (Painted Lady), while *Rhinanthus minor* (Yellow Rattle) is only visited by *Perizoma albulata* (Grass Rivulet). *Depressaria badiella* is visiting both *Hypochoèris radicata* (Cat’s-ear), *Sonchus arvensis* (Perennial Sow-thistle) and *Taraxacum* (Dandelions), while *Aglais urticae* (Small Tortoiseshell) and *Inachis io* (Peacock) are only visiting *Urtica dioica* (Nettle). I expect some of the plants to be pollinated while providing food for visiting insects.

Another family of native plants is *Orchidàceae*. The species representing this family is for instance *Dactylorhiza incarnata* (Early Marsh-orchid), *Orchis mascula* (early-purple orchid), *Dactylorhiza majalis*, subsp. *purpurella* (Northern March-orchid) and *Dactylorhiza masculata* (Heath Spotted-orchid). These are also pollinated by insects. Orchids are very specialised in attracting specific pollinators but can be pollinated by bees, flies, beetles, wasps or butterflies. The abovementioned orchids are all flowering in late May – June and are pollinated by bumblebees. There are only three species of common bumblebees in the Shetland’s: *Bombus muscorum* (“Shetland” Bumblebee), *Bombus magnus* (Northern White-tailed Bumblebee) and *Bombus*
*jonellus* (Small Heath Bumblebee). A subspecies of the latter, *vogti*, is restricted to Shetland.

Among plants endemic to Shetland is *Cerastium nigrescens* subsp. *nigrescens* (Shetland Mouse-ear). It is confined to the Unst serpentine fellfield and known nowhere else in the world. This is a generalist and is pollinated by different species of hoverflies and beetles.

*Literature*

References are not included in the text but the following books were used extensively:


*Moths and butterflies in Shetland, the Shetland Lepidoptera report for 1999*, compiled by Mike Pennington on behalf of the Shetland Entomological Group


In addition have I used the webside: www. Wildlife.shetland.co.uk.
Svalbard
Linn Kathrin Øverland

Introduction
Svalbard is a special part of Norway. The archipelago is among the most northern land areas in the world. The area has had little influence by humans and most of it is still virginal nature. Svalbard consists of many small and big islands and in total the area is about 61,000km². More than half of Svalbard is covered by glaciers. Spitsbergen is the main island of the Svalbard archipelago, and this is where the highest mountain is found. The Newton peak is 1713m (www.sysselmannen.svalbard.no). There are great climatic differences between the islands. The warmest and most moist climate is found on the west coast of Spitsbergen. The annual temperature is below zero, but Svalbard has a mild climate compared to other areas at the same latitude. This is because of the Gulf Stream which also creates huge differences in temperature and much wind. The annual rainfall on Svalbard varies from about 190mm to 525mm (www.met.no).

Pollination landscape
Tundra – The open landscape is dominated by a richly textured patchwork of perennial herbaceous plants, especially grasses, sedges, mosses and lichens. The woody vegetation of the tundra consists of dwarf willows and birches along with a variety of low-growing shrubs (Moles, 2002).

On the Svalbard archipelago, the tundra can be divided into two zones, described by their vegetation. There is also a third zone with scarce vegetation.

Middle arctic tundra zone – This area is found on mid-Spitsbergen and the southwestern parts of Svalbard. Circumneutral Cassiope tetragona communities within the alliance Kobresio-Dryadion make up the zonal vegetation of the middle arctic tundra zone.

Northern arctic tundra zone – This zone includes most of Spitsbergen, going from northwest to southeast. Luzulion arcticae is considered to be the zonal vegetation
of this zone. Kobresio–Dryadion is present, but is limited to the ridges and do not cover mesic habitats.

**Arctic polar desert zone** – This area is found on the northeastern parts of Svalbard. In this zone, the vegetation is very scarce and disrupted. The term “polar desert” has commonly been used about this extreme arctic zone, and this is due to the prevailing glaciation and the severe effects of cryoturbation\(^1\) resulting in endless stone and boulder fields. The two most serious factors limiting plant life have been regarded to be cryoturbation effects and water deficit. *Papaver* spp. are typical of these stony fields. These plants are very sensitive to competition, and occur widely scattered over the polar desert fields (Elvebakk, 1985).

**Pollinators**

Insects are not as diverse as in biomes farther south, but they are very abundant. There exists little literature on the insect – flower associations on the Svalbard. The class of insects consists of 29 orders, but only nine orders are represented on Svalbard. The archipelago has a low number of beetles and overwhelming preponderance of Diptera species when compared with temperate latitudes. For example, 55% of the insect species on Svalbard are Diptera while the Coleoptera (largest insect order on a global basis) form only 8% of the insect fauna (Coulson, 2000).

*Diptera (mosquitoes and flies)* – is present with 128 species. However, many of the families from Svalbard are poorly known (Coulson, 2000). Mosquito – *Aedes nigripes* is found on Svalbard. It is widespread in the circum polar arctic area. The population on Svalbard is stable. It is not certain whether the species has come naturally or if it is introduced. *A. nigripes* is believed to pollinate plants (http://miljo.npolar.no). In other arctic areas, *Aedes* spp. has been documented to be a common pollinator (Kevan, 1972).

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\(^1\) Cryoturbation (frost churning): freezing and thawing process, which displaces rock, sediments and soils present at high altitude area.

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Flies – Studies of insect-flower associations on Ellesmere Island (81°49’N), have shown a number of flies like Empididae and Syrphidae visiting flowers (Hocking, 1968). It is possible that these flies are responsible for pollination on Svalbard too.

**Lepidoptera (butterflies and moths)** – The Lepidoptera fauna consists of 11 species. It seems likely that the majority are wind blown migrants that do not breed on the island (Coulson, 2000). Therefore they are unlikely to be pollinators on Svalbard.

**Hymenoptera (Ants, bees and bumble bees)** – There are 26 species of Hymenoptera on Svalbard. Bumblebee species are present as pollinators in arctic regions, but no species have been observed on Svalbard (Coulson, 2000; Hocking, 1968).

**Cases**

*Saxifraga oppositifolia* – The genus *Saxifraga* (Saxifragaceae) comprises about 480 species. Most are perennial plants, but they can vary a lot in size, colour and shape. They are found throughout the greater part of the temperate and sub-arctic zones of the northern hemisphere with outposts in places such as Ethiopia, Mexico and the Arctic. Many are visited by bees, flies, mosquitoes and moths (Kevan, 1972). Thirteen species of *Saxifraga* occur on the archipelago of Svalbard (Elven & Elvebakk, 1996). *Saxifraga oppositifolia* is a circumpolar arctic and alpine perennial herb. The flowers are red–purple. Unlike many other saxifrages, *S. oppositifolia* is protogynous, i.e., the stigmas are receptive some time before the anthers dehisce (Ekstam, 1897 in: Stenstrøm & Molau, 1992). The sugar concentration varies between 21-51%, and the flowering period is 35 days (data from Ellesmere Island) (Hocking, 1968). Kevan (1972) found that *S. oppositifolia* on Ellesmere Island is dependent on insects for maximum seed – set. It is visited by bumblebees, flies (Syrphidae), but the mosquito *Smittia* spp. were the most frequent pollinator. It is therefore reasonable to assume that mosquitoes and flies are the most important pollinators on the Svalbard archipelago.

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www.met.no
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Greenland
Eva Grøndahl

Introduction
With an area of 2 166 086 km² Greenland is the largest island of the world. It is located at 72° N 40° W (centre), with a distance to the North-pole of only 740 kms. The southern tip is at the same latitude as is Oslo, Norway. Most of the island is covered with an icecap of a thickness of up to 3 km. The ice-free coastline makes up 410 449 km², and varies in breadth between a few km and 200 km. It is for the most part made up by a mountain landscape, cut through by deep fjords. Here the highest mountains of the arctic regions occur; in Eastern Greenland Gunnbjørns Fjeld rises to a height of 3 693 meters, whereas in the West the highest top Akuliarusseq have a height of 2 280 meters. Nearest land is Ellesmere Island, with a distance of only 30 km from the Northern tip of Greenland. (www.statgreen.gl). Greenland is a part of the North American Plate, from where it was »teared off« c. 90 mio. years ago (Brown & Lomolino, 1998). The first people arrived at Greenland c. 5000 years ago, coming from North America. Other arrivals occurred in 900 AD (inuit people and norsemen). Today, 80 percent of the island's people are Inuit; the rest are Danish (www.scantours.com). The present population number counts c. 57 000 people. (www.statgreen.gl)

Climate
There is no place in Greenland with a mean July temperature above 10° Celcius. Nevertheless the local temperature can vary very much, so that in valleys that are not exponated to wind, as well as on south-facing slopes, the temperature can be a lot higher. Furthermore, because of the height of the icecap, there is often a dry wind coming towards the coast. This wind can make the temperature rise several degrees in a very short time; examples have been seen of a temperature rise of 20° C within just one hour (Salomonsen, 1971).
The winters in Greenland are long, cold and dark. The summers are short and cool. There is less than 50 days a year with a mean temperature above 0° C. Furthermore the mean temperature never exceeds 10° C, which defines Greenland as an arctic area ( = above the tree-limit) (Salomonsen, 1971).

The precipitation in Greenland is low, generally less than 500 mm a year, (although in the South it can be up to 1 000 mm). In Thule (77° N) the precipitation is as low as 80 mm a year, which defines that area as an arctic desert (Salomonsen, 1971). The different degrees of oceanity are thought to have a great influence on the floral composition in different parts of Greenland (Böcher, 1971).

The flora of Greenland
There are 500 plant species in Greenland, whereas, to comparison, the Alaskan Northcoast comprises 600 species, and the Hudson Bay area has 650 species (Böcher, 1971). Nevertheless there is a big difference in the species composition of the north and the south of Greenland respectively, as well as there is a difference in species number between the two areas.

The main vegetation types of Greenland are:
1) Moor, bog, fen and march, 2) Herb-slopes and snow-beds, 3) Dwarf shrub heath, 4) Arctic steps, 5) Copse and 6) Fell-field, cliffs, beach and dunes (Böcher, 1957).

Many arctic plant-species have parabolic-shaped flowers. In addition many species have developed heliophily (for example *Dryas* and *Papaver* spp.), which means that the flowers or inflorescences follow the sun’s movements on the sky. By that mechanism the temperature within a flower can rise as much as 10° C at a surrounding temperature of 15.8° C. (Kevan, 1975). This mechanism of temperature rise within flowers actually attracts insects, which gain heat by sitting in the flowers, whereby they increase their metabolism and mobility by getting preheated for flight. On the other hand, the flowers themselves (*Dryas* at least) rely in part on the services of the basking insects for pollination, dispersal and colonization (Kevan, 1975).
Pollination

It was previously believed that arctic plants were independent of insects for pollination, mainly because of the tendency towards autogamy and apomixis in arctic plants (Kevan, 1972). It holds true that many high arctic species have developed advanced forms of gemmation, and that, in the arctic, asexual reproduction is very common (Lægaard, 1971). Nevertheless more recent studies have shown that dipteran species play an important role in arctic pollination, and that the proportion of dipteran species of the total pollinator fauna increases with latitude (Elberling and Olesen, 1999).

In a field study at Uummannaq Island (71°N, 52°W), Lundgren and Olesen (2005) found that 77% of all pollinator individuals and species were dipterans. Chironomidae was the most species-rich dipteran family and it was involved in 41% of all species interactions in the network. The pollinator taxon that visited most plant species was Chironomidae sp. (8 plant species). *Dryas integrifolia* was the most visited plant species (14 pollinator taxa). The strongest interaction measured in number of visitor individuals was *Saxifraga tricuspidata*—Chironomidae sp. with 45 of the 149 interactions.

Lundgreen and Olesen (2005) consider that one explanation for the dominance of Diptera as flower visitors is because of its dominance in general in the arctic insect fauna, as approximately half of all insect species in Greenland belongs to Diptera. Other, less dominating pollinators in Greenland are the two bumblebee-species *Alpinibombus hyperboreus* and *A. arcticus* (one of which parasitizes the other (Olesen, pers. comm.)). Also there are 52 species of Lepidoptera (41 native), and 50 species of Coleoptera, among other groups (Vibe, 1971).

Threats from introduced species?

Böcher (1971) stressed that the alien plant species that are occasionally introduced by humans, only occurs at harbours and in towns. It is nevertheless likely that the global warming may change the conditions in a way that the introduced species might gain advantage at the expense of the naturally occurring species. Also it might
be a threat that bee-keeping (Apis mellifera) is getting more common in the south of Greenland, as it has been argued that honeybees compete with native fauna for resources, are poor pollinators, and disturb the fitness of native plant species.

References
www.scantours.com/greenland_history__information.htm (2005-10-27)
Azores

Tenna Boye

Introduction
The Azores – an isolated group of islands 1500 km off the coast of Portugal in the North Atlantic Ocean and 850 km from the Madeira island. More precisely between 37°40´ North and 25°32´ West. These 9 volcanic islands have a relatively recent origin ranging from 8.12 Myr BP to 300.000 Yr BP (Ribeiro et al. 2005 ref. in Nunes 1999). The highest point, O’Pico, is on the island Pico at 2320 m. The fact that the islands are located mid-ocean results in a temperate oceanic climate with low variation in temperature throughout the year - mean ca.17°C. Human arrival was in mid 15th century and humans have since introduced a lot of flora and fauna to the Islands. Before their arrival, the nature on the Azores remained more or less undisturbed –also during the ice ages- due to the distance and isolated location of the islands (Morton and Britton, 2000).

Vegetation
The most common vegetation form is the Laurisilva forest with dominant trees and shrubs as Juniperus brevifolia, Erica azorica, Vaccinium cylindraceum, Ilex perado ssp. azorica, all endemic to the Azores and the native Laurus azorica. Also characteristic is a dense cover of moss and liverwort epiphytes (Ribiero et al. 2005). Height of this forest is about 5 m and the canopy is closed. As shown by Haggar (1988) forest composition depends on altitude. In the study done on Pico Laurus, Vaccinium and Ilex were most abundant at 600 m. Whereas Laurus was absent at 1250 m and Juniperus became more abundant and E. azorca most dominant. At areas below 500 m, the introduced Pittosporum undulatum has more or less taken over and the native Laurisilva remains at high altitude where the clouds cover the hillside. Eleven trees are native and eight of these are endemic to the Azores. All in all 56 taxonomic groups of the vascular flora are endemic to the Azores and after human arrival they have been amplified to 850 taxa (Haggar 1988 ref. in Sjögren 1984).
Annual rainfall lies between 1500 to 3000 mm increasing with altitude (Silva & Smith 2004), being at its highest in fall and early winter.

Pollinators
Nine species of mammals are recorded on the Azores and all of them, except for the bats *Myotis myotis* and *Nyctalus azoreum*, are introduced species (Mathias et al. 1998). Although some bats are known as pollinators in other parts of the world, the bats on the Azores are insectivorous and do not seem to play any role in the plant-pollinator food web neither do the other Azorean mammal species.

Bird pollination is not yet observed on the Azores (Olesen and Valido 2003), however lizard pollination is. *Teira dugesii*, an introduced lizard species, is an active pollinator of the flower *Azorina vidalii*, which is an endemic plant to the Azorean archipelago (Olesen 2003).

Mainly insects constitute the pollinators. In a research on generalism done by Olesen et al. (2002) all pollinators observed on the island, Flores, are insects. Here, species of flies, bees, butterflies, moths and ants pollinate the flowers. The endemic bees, *Halictus* sp., being the most generalist pollinator, contrary to the non-endemic and introduced species.

Case
The rare endemic bellflower, *Azorina vidalii*, is an evergreen plant which stands with white or pale pink flowers in June and July. It is a member of the Campanulaceae family which compromises 50 genera and 800 species world wide, but most species are to be found in temperate regions (Eddie et al. 2003). *Azorina vidalii* is monotypic, i.e. the only one to constitute the *Azorina* genus. There are around 20 populations distributed among 8 of the 9 islands (Olesen 2003) and these are pollinated by a wide variety of insects, among these the bees of the Halictidae family (Olesen et al. 2002), and by the previous mentioned lizard. In the pollinator food web, the *Azorina vidalii* can be considered a key species because it interacts with so many different pollinators. Its disappearance could have vital effects on certain
animal species. As shown in the research done by Olesen et al. 2002, the fly *Calliphora vomitoria* and the ant *Lasius niger* visit only this plant and they would therefore become excluded from the network if *Azorina vidalii* went extinct.

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St Helena
Pedro Finamore

Introduction
St Helena is situated in the southern mid-Atlantic (Lat. 15° 55’ S Long. 5° 45’ W.) about 1930 kilometers off the coast of Angola, and 1120 kilometers southeast of Ascension Island, which is the nearest land. The area of the island is 122 square km, with the highest point, Diana's Peak reaching 823 m above sea level. Its age is at least 14 million years. It is a volcanic island, rising from the sea floor at a depth of 4224 m. The Portuguese discovered St. Helena in 1502, the first permanent settlement was in 1659. It is now one of the UK's overseas territories and serves as the administrative center for Ascension Island and the Tristan da Cunha group. Many of the island's native plants are relicts of a primitive flora that was once widespread and that colonized the island as many as 10 million years ago (Cronk 1989). The island flora and fauna includes 10 endemic genera and 37 endemic species of flowering plants (Ashmole & Ashmole, 2000).

Main Vegetation Types
The scrubwood, the bastard gumwood, the gumwood, then the false gumwood and the black cabbage are thought to share an ancestor, and then adapted to different altitudes.

Tree fern thicket (700- 823 m) Endemic tree ferns, Dicksonia arborescens, dominate the highest elevations across the island's central ridge. The black cabbage tree, Melanodendron integrifolium also endemic, is another dominant species. This is the only vegetation type that can still be found to any great extent.

Cabbage tree woodland (600 - 750 m) Largely Composite species dominate here, also endemic.

Moist gumwood woodland (500 - 650 m) Another Composite, the gumwood, Commidendrum robustum, dominated this habitat (Cronk 1986).Today only fragments of this type of woodland remain.
Dry gumwood woodland (300-500 m) Dominated by the gumwood and the bastard gumwood, *Commidendrum rotundifolium*. This habitat has been completely destroyed, only a few gumwoods remain on cliffs and the bastard gumwood has become extinct in the wild.

Ebony - gumwood thicket (100-500 m) On the drier and more rocky parts of the island, the western side, ebony trees (*Trochetiopsis* spp.) and gumwoods are thought to have co-existed. The ebony, an endemic species to St Helena, covered a big area. Today only two individuals survive.

Scrubwood scrub (0-350 m) Near the shore in dry, windy and salty areas, the scrubwoods, *Commidendrum rugosum*, is dominant.

Saline semi-desert (0-250 m) In areas of saline soils the St Helena tea plant, *Frankenia portulacifolia* and the Samphire, *Suaeda fruticosa*, were the dominant species although the scrubwood was associated with this habitat. The halophytic Babies' Toes, *Hydrodea cryptantha*, is now spreading in large numbers over much of the outer parts of the island.

**Introduced Species**

St Helena is an unfortunate case of high influence of introduced species. Over half of the plants described in 1875 have disappeared. Many economically important plants were introduced, and now from 320 species, about 260 are naturalized. The fossil record indicates that St. Helena had at least four endemic land bird species when the first human settlers arrived (Stattersfield et al. 1998). Now, the only endemic bird remaining is the St. Helena plover or wirebird (*Charadrius sanctaehelenae*).

The invertebrate fauna of St. Helena has undergone some repetitive speciation and adaptive radiation, resulting in many endemic species (Ashmole and Ashmole 1997). There are 157 endemic beetles recorded. No mammals or reptiles occurred on St. Helena before introduction by humans, goats were released in 1533 and were one of the most destructive invasive species, probably extinguished more than 50 endemic plant species.
Commidendrum robustum  St Helena's National Tree.

In 1991 the gumwoods in the Peak Dale region were attacked by the Jacaranda bug (*Orthezia insignis*) and at least 25 percent of the 2,000 remaining trees had been killed. A black mould covers the branches attracted by the dew produced by the Jacaranda bugs. The ladybird (*Hyperaspis pantherina*) was then introduced from Kenya and controlled the *O. insignis* population.

The gumwood has also been heavily invaded by alien plant species such as *Phormium tenax*, *Olea africana*, *Cestrum laevigatum* and *Mellissia begoniifolia*. Unpublished work by Quentin Cronk suggests that the Peak Dale gumwoods are a relatively recent hybrid population. The variation between the trees in leaf form and color is clear to see. Seedlings from Peak Dale have been used in all the plantings across the island. It is likely that the trees at Deep Valley and Longwood are different from the Peak Dale trees.

**Interactions**

St Helena olive (*Nesiota elliptica*) – This extinct species (IUCN 2004) had numerous branches and black bark. The inflorescence was branched and did not rise above the leaves, it had pale pink flowers. The fruits were hard, woody capsules measuring 1 - 2 cm long, they split when mature. The flowering time was reported to be June to October. It is thought that pollination occurred through the endemic fly *Loveridgeana beattiei*, and that fruits take a year to mature (Cronk 2000). The tree is 99% self-incompatible.

Common flag (*Antholyza æthiopica*, Iridaceae) – “*Euplectes [Foudia] madagascariensis* (...) will sit perched on the long flower-stalk enjoying the honey, sucking it through an aperture which it bites at the bottom of each long tubular flower” (Meliss 1875). This description shows that it is probably a nectar robber.

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Falkland Islands
Kristina Boros

The Falkland Islands lie in the South West Atlantic approximately 450 kilometers north-east of Tierra del Fuego, between latitudes 51 and 53 degrees south, and longitudes 57 and 62 degrees west (McDowall, 1950). The archipelago is made up of two main islands, East and West Falkland, and over seven hundred smaller islands and islets, comprising a land area of just over 12,000 square kilometers (McDowall, 1950).

The Falklands has a cool, temperate, oceanic climate, dominated by westerly winds. Average monthly temperatures range from around 9 degrees Celsius during the austral summer (January/February) to about 2 degrees Celsius during the austral winter (June/July) (The Falkland Islands). Because of prevailing westerly winds, areas on the leeward side of the mountain ranges tend to have higher annual rainfall than those on the westerly windward side (The Falkland Islands).

Pollination Landscapes
Tussac grass – is a grass that dominates the coastal areas. It typically grows to a height of around 2 meters (although it can reach 3 or 4 meters), and features a tussock-like growth form around a fibrous pedestal (Warrah Issue 11). The leaves, which can grow up to 2 meters in length, bush out from the living crown, and provide valuable nesting cover for passerines and coastal birds.

Tolerance or requirements for moist, salt-laden air allows tussac grass to become dominant around coastal regions, but more than about 300 meters from the coast, either lack of essential requirements, or competitive exclusion, prevents tussac growth (Warren Issue 11). Therefore, with the exception of small islands of less than about 600 meters diameter, tussac tends to form a strip behind the coastal zone. Grass Heath is dominated by rough grasses, usually whitegrass (*Cortaderia pilosa*), and covers the largest areas of the Falklands’ mainland. The name whitegrass reflects the fact that the growing point of the leaf is generally beneath a longer dead
leaf mass, giving the landscape a light buff appearance (Warrah Issue 12). On fairly well drained sites it can adopt a tussock growth form, and is often associated with pigvine (*Gunnera magellanica*), lawn lobelia (*Pratia repens*) and chickweeds (*Cerastium*). On poorly drained plains, such as much of Lafonia, it takes on a more lax, less tufted form, and tends to be associated with rushes, sedges, astelia (*Astelia pumila*) and oreob (*Oreobolus obtusangulus*) (Warrah Issue 12). Grass heath supports many flowering plants, invertebrates and a few birds.

**Pollinators**

There is a broad overlap between endemic birds and other fauna and flora, and it is emphasized that saving habitats for birds in these areas protects all wildlife. One of the main problems found on the island has been stemmed from the introduction of foreign animals and their grazing to the land. Therefore there have not been studies that emphasize the flora and fauna relationship specifically dealing with pollinators but rather to control the anthropogenic sources that are causing a depletion in the flora and fauna. There are many endemic plants to the island and the majority of them are located on the coastal region and generally found in the tussac grass. Some examples of these plants are Coastal Nassauvia (*Nassauvia gaudichaudii*), Felton’s Flower (*Calandrinia feltonii*) Snakeplant (*Nassauvia serpens*), Lady’s Slipper (*Calceolaria fothergillii*), Hairy Daisy (*Erigeron incertus*), Antarctic Cudweed (*Gamochaeta antarctica*) (Woods, Robin). Some of the endemic birds that can be found are the black-crowned heron (*Nycticorax nycticorax falklandicus*), the steamer duck (*Tachyeres brachypterus*), the kelp goose (*Choephaga hybrida malvinarum*), the black throat finch (*Melanodora melanodora*) and the black chinned siskin (*Carduelis barbata*) (McDowall, 50).

**Case Studies**

Although there has not been a specific study made to the pollinator and plant relationship it can be assumed that because of the endemic plants and birds that live in the coastal area that there is a relationship that exists between these species that
can only be found in the Falkland Islands coasts. For example, the Felton's Flower (*Calandrinia feltonii*) is a highly attractive magenta flower with a unique scent that is known to be extremely sweet. The seeds, which are small, shiny and black, usually germinate in late summer, and the plant over winters as a small seedling. In spring it grows rapidly and the flowers often appear by October, a time when little else is in bloom. The plant stems may reach up to 35 cm or more in length while the basal leaves can be up to 1 cm long.

Though it has not been discussed in this paper there are indeed insects that are also endemic to the Falkland Island. However, since the research down in Falkland Islands has been minimal there was not much detail about the dominating insects in the area and their role in pollination of the surrounding flora. Hopefully in the future there will be more case studies that will be taken on and more will be revealed about the Falkland Islands.

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Cape Verde

Allan Sørensen

Introduction
The Cape Verde archipelago is volcanic in origin and situated in the eastern Atlantic about 600 km from the African mainland and 1400 km from the Canaries. It consists of 10 main islands and 5 islets, divided into the windward (Barlavento) and leeward (Sotavento) groups. The Barlavento islands in the north are Santo Antão, São Vicente, Santa Luzia, São Nicolau, Sal and Boavista. The Sotavento to the south are Maio, Santiago, Fogo and Brava. There is a large difference in the age of the islands. The oldest being Sal, Boavista and Maio (26 million years) and the youngest Fago and Brava (only 100,000 years). Whereas the oldest islands are extremely flat caused by erosion, the youngest are mountainous. The highest peak is on Fogo and it reaches 2829 m. Total land area of the archipelago is 4564 km² (Irwin 1998)

Pollination landscapes
The Cape Verde Islands were discovered and colonized by the Portuguese in the 15th century. With them they brought domestic animals and plants which have changed the landscape dramatically. Once the Islands were covered by dry monsoon forests and savanna-like vegetation, but now most of it has been converted into agriculture. Native vegetation is severely fragmented and is restricted to areas where cultivation is not possible such as mountain peaks and steep slopes. (www.worldwildlife.) The vegetation landscape on the higher islands can be divided into four distinct regions according to Barbosa (1968).

Dry or sub desert mountain prairie – Found on plateaus above 1400 m. Here you mainly find species of the families Labiatae and Gramineae such as Lavandula dentate and Hyparrhenia hirta.

Humid or sub humid vegetation – Found on slopes exposed to NNE winds at medium altitudes (400 to 1000m). Here there is regular rainfall and the plants can benefit
from mist and condensation. These areas are the green zones of the islands. The dominant species are *Lantana camara* and *Furcraea foetida*.

**Sub arid savanna with some trees** – Typically found in slopes not exposed to NNE winds. *Hyparrhenia hirta*, *Heteropogon contortus*, *Eucalyptus* and *Acacia albida* are the dominating species. But almost all of these areas have been replaced by cultivation of maize and haricot beans.

**Arid grassy and shrubby pastures** – Sub desert formations of low altitudes facing SSW. Here you see *Aristida adscencionsis*, *A. cardosoi* and *Elyonurus royleanus* just to name some examples. (Barbosa 1968).

There are about 621 species of vascular plants on the islands of Cape Verde. More than 50% are introduced by man. So the native flora may thus contain as few as 224 species. Of those 85 are considered endemic to the archipelago. (Brochmann 1997).

**Possible pollinators of the Cape Verde islands**

Birds are well known as pollinators of flowering plants. Especially different species of hummingbirds and sunbirds are visiting flowers for nectar, pollen and insects. None of these species are found on the Cape Verde islands. But there are birds on Cape Verde that could be possible pollinators. For example have birds like the Spectacled Warbler (*Sylvia conspicillata*) and the blackcap (*S. atricapilla*) been observed eating nectar on the Canary Islands and Madeira (Olesen & Valido 2003). Both of these birds do live on Cape Verde so you could expect that the same thing is happening here, but I have not been able to find any literature on this. There might also be some passerine birds that have widened their niches. On the archipelago there are three species of passerine birds. (Bannerman 1968).

On the Islands there are found 19 reptiles for instance five *Mabuya* skinks and three *Tarentola* geckos. Species of these two genera are occasionally known to be nectar eaters - especially on islands.
The only native mammals include 5 small bat, which might also be nectar and pollen eaters and therefore classified as pollinators. However, they are most likely only insect-eaters.

Of course there are a lot of insects as well, including bees and butterflies. You definitely consider those being very important pollinators. (www.worldwildlife.)

**Hypotheses about interactions between plants and animals**

I have not found anything about the pollination biology of the plants on the archipelago in my literature. But it describes in some detail the morphological characteristics of the endemic plants so when I know the possible pollinators I can make some predictions about the interactions.

Natural selection favors plants that have been able to attract pollinators to disperse the pollen grains. A lot of different methods have evolved over time depending on which pollinators they rely on. Some plants mimic the females of a species so that the males try to copulate with the flower insuring lots of visits. This is the case with the orchid *Ophrys speculum* that looks like a female bee. Others have strong odours, colours or guidelines to the nectar, all depending on which pollinators they attract.

On the Islands of Cape Verde many plants have brightly colored petals that are blue or yellow and have guidelines to the nectar. These are likely to be pollinated by bees. Two examples could be the two endemics *Helianthemum gorgoneum* and *Lotus latifolius*. Flowers pollinated by butterflies are similar in many aspects to bee flowers. But normally the nectary of butterfly flowers is located at the base of a long, slender corolla tube, which is only accessible to the long sucking mouthparts of butterflies. A good example would be *Centaurium tenuiflorum* ssp. *viridense*.

Because there are 5 bat species on the islands you could expect some of them to be important pollinators. Bat pollinated flowers will produce copious nectar and have dull colours and strong odours. Mainly because bats use their sense of smell to find the flowers and they are active at night. Bat-pollinated plants on Cape Verde could be papaya and mangoes, which are found in cultivated areas on the big islands.
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www.worldwildlife.org/wildworld/profiles/terrestrial/at/at0201_full
Tristan da Cunha
Rasmus Høyer Jensen

Introduktion
Tristan da Cunha er en ø ud af 5 (37° 06' S, 12° 18' W) vulkanske øer, hvor Tristan da Cunha er den yngste på omkring 1 million år. Tristan da Cunha ligger cirka mellem Sydamerika og Afrika. Det nærmeste kontinent er Afrika 2800 km væk. Tristan da Cunha er 111 km² (103,2 if. andre referencer) og har en vulkan på 2062 meters højde. Vulkangen er ofte snedækket og har en kratersø. Øen har 5 naturlige vegetationszoner og kysten har op til 600 m høje klippesider (http://www.worldwildlife.org/wildworld/profiles/terrestrial/at/at0803_full.html)

Bestøvningslandskaber
Tuegræs, er blevet udryddet af græssædende dyr mange steder på øen. Det kan dog stadig findes på den østlige side af øen og i områder, hvor de græssende dyr ikke kan komme.

Bestøvere
Fugle ~ Der er 15 landfuglearter på øen, hvoraf 3 er endemiske (http://islands.unep.ch/INV.htm). Derudover yngler der forskellige havfugle på
Tristan da Cunha. De værlinger og forskellige drosler som findes på øen er måske med til at sprede stenfrugterne fra de *Nertera*-arter der findes (http://www.jncc.gov.uk/pdf/OT_TristandaC.pdf)

Invertebrater ~ Der er to sommerfuglearter på øen, hvilke arter det er, har desværre været umuligt at finde ud af, men man må gå ud fra, at disse to arter er med til at bestøve de forskellige urter, der gror på øen. I alt er der ca. 100 invertebrater og 24 parasitiske på Tristan da Cunha. Invertebraterne er desværre ikke blevet studeret særligt meget (http://www.jncc.gov.uk/pdf/OT_TristandaC.pdf), men man må gå ud fra, de er med til at bestøve planterne på øen.

Andre dyr ~ Der findes ikke nogle naturlige reptiler, amfibier eller terrestriske pattedyr på øen.

Cases


Heterostyli er en metode, der hjælper planten til at blive krydsbestøvet (Judd et al., 2002). Blomsterne i Rubiaceae er meget forskellige i farve og form. De kan blive bestøvet af mange forskellige dyr såsom sommerfugle, natsværmere, bier, fluer, fugle og flagermus. *Nertera* kan findes i bjergrige egne på New Zealand, Tasmanien, Mellem- og Sydamerika og på øerne, som Tristan er en del af. Der forefindes ikke nogle data om hvorledes arten *Nertera assurgens* blomster ser ud. Men *Nertera* har ofte hvidlige uanseelige blomster, der danner nektar som belønning til bestøverne. Planten danner i kontrast til blomsterne kødfulde farverige stenfrugter, som kan sidde på planten i

Da der hverken findes pattedyr eller reptiler på øen, må man gå ud fra at planten bruger fuglene (og måske mennesket) til at sprede sine frø. Da planten som førnævnt danner kødfulde farverige stenfrugter, er det højst sandsynligt, at fuglene spiser stenfrugterne og derved spreder frøene.

Referencer
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Corsica
Camilla Kruch

INTRODUCTION:
Corsica is the third biggest Mediterranean island. Its area is 8772 km², 183 km from north to south and 83 km from west to east (www.corsica.net). This island is characterized by the proximity of both mainland countries France (200 km) and Italy (150 km) and is very close to the Sardinia Island (only 40 km). Corsica became an island at the end of the Tertiary era. Before the huge glaciers melting from North Europe and the alpine valleys, it was linked to Sardinia and probably to Toscania since naturalists observe similarities between species from both regions (www.lepetitfute.com, complete reference in the bibliography)
The climate is called « mediterranean »: summers are hot and dry; winters mild. Because of the particular physical geography which presents high mountains (the highest is 2710 m high) there is also an alpine climate, which is colder. The main landscape type is the « maquis » composed of sparse bushes, small drought-resistant plants and small trees. Because of the grazing tradition that now is reduced, fires and urbanisation, Corsica is an interested island to study the vegetal progressive natural recolonization.

POLLINATION LANDSCAPE:
The maquis is the typical landscape of the island. The majority of the plants are small, with short aromatic leaves. There can be found, for example, different species of Genista, and Cistus, as well as Lavandula, the species Calluna vulgaris, the endemic species Mentha requieniensis. Big trees are rare in this particular landscape but species like Olea europaea, Arbutus unedo and fig-trees (Ficus carica) are adapted to the climate.
However, Corsica is also known for its high montane forests. Pines, oak and chestnut trees are the main species at higher altitude. The endemic species Pinus nigra subsp. laricio can become 50 meters high (www.corsica.net).
POLLINATORS:
Insects: Bees and bumblebees are the main pollinators on the island (www.eco-action, complete address in the bibliography). One subspecies is endemic, *Bombus terrestris xanthopus* (Chittka, 2004).
Vertebrates: Nothing was found about bird-pollination in Corsica.
One case of lizard-pollination of the scrub *Euphorbia dendroides* by *Podarcis lilfordi* was observed in the Balearic islands (Traverset, 1997). Though this plant species is common in all the Mediterranean bassin, nothing about reptile-pollination was found for the island Corsica.
A complicated interaction between the Dead Horse Arum (*Dracunculus muscivorus*) and *Podarcis lilfordi* is described by Perez-Mellado (2004, abstract). Although this case was observed in the Balearic Islands, the plant is also found in Corsica. The lizard is able to catch insects attracted by the plant, which has a special smell. So, at this step, lizards disturb pollination in this way. During the fruiting period, lizards base their diet almost only on the fruit of this *Arum*, and disperse the intact seeds, which experience enhanced germination in the lizard’s feces.

CASE:
The Dead Horse Arum (*Dracunculus or Helicodiceros muscivorus*, Araceae family) has a very particular red inflorescence which looks like an anal area of a dead mammal, with a hairy spathe and a ‘tail’ consisting of the hairy appendix of the spadix. Moreover, it has a strongly putrid scent that attract necrophilic insects (Seymour, 2003). Arcangeli studies (1883) show that the main pollinators are flies from the blowflies genera: *Calliphora and Lucilia*. Few hours after the sunrise, the plant starts to produce the rotting smell. Flies enter into the floral chamber and deliver pollen to the female florets. Then, they are trapped in the chamber because of the hairs which prevent them from escaping and spend the night in the flower. Early in the next morning, the male florets produce pollen which cover the insects. Then the hairs allow them to escape and find another inflorescence.
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http://eprints.unifi.it/archive/00000500/01/Corti.pdf


Some pictures of the Dead Horse Arum are available on the link

Cyprus
Tine Ann Kristin Biedenweg

Introduction
Cyprus is the third largest island in the Mediterranean. It is situated at the north-eastern end of the east Mediterranean basin at a distance of 75 km south of Turkey, 105 km west of Syria, 380 km north of Egypt and 800 km east of the nearest Greek mainland (www.mfa.gr).
Cyprus is an island of oceanic origin which has never been connected to the mainland. The minimum distance of Cyprus to the mainland during time would have been approximately 30 km caused by the Late Miocene Messinian Salinity Event about 5 million years ago, when more water evaporated than was being fed and the Mediterranean dried up (Schüle 1993).
Cyprus covers an area of 9251 km² and is broadly divided in four eastwest trending geologically defined regions: the Kyrenia mountain range, the Mesaoria plain, the igneous Troodos mountain (peak 1952m) and the surrounding sediments. The lowlands are dominated by intense agriculture and the lower mountain slopes are used for vine growing and extensive grazing. Due to overgrazing much of the mountain slopes and lowlands have shifted towards the typical Mediterranean garigue and maquis (bush) landscape. The higher parts are dominated by pine forest. (Gumbricht et al. 1996).

Oceanic islands
Islands of marine origin are barren of terrestrial life when they emerge. An island´s rate of colonization varies according to its size, its proximity to other land, climatic conditions, temperature and currents of the surrounding sea and the resources the island offers.
As a general rule, the number of species on islands of marine origin will increase with time and decrease in proportion to the islands´distance from the mainland or other islands.
The distance an animal is able to cross is determined by the velocity and kind of the transport and the animals’ ability to survive the loss of body heat and lack of food and water (Schüle 1993).

Plants are usually spread by oceanic drift, air flotation or dispersion by animals (mechanically attached, eaten/carried internally, embedded in mud on feet or attached to feathers by viscid substance) (Whittaker 1998)

**Orchids- an example of evolution**

One interesting group of plants to be found is the Orchid family. Darwin considered the great variety of orchid flowers as a result of the adaptation to their pollinators, i.e. insects. He found that no other plant family developed and perfected as many impressive differences in flower structure, while keeping a large degree of uniformity of the plants’ vegetative parts. The flowers are built to allow, favour or even require cross-fertilisation (Darwin 1862).

The flowers of the European orchid genus *Ophrys* imitate sexual-releasing signals of hymenopteran females that stimulate the males to attempt copulation with these flowers (pseudocopulation). Several hundred chemical compounds are produced. Other important signals of the flower for allurement are optical (colour and patterns) and tactile (hairs). The allurement is usually highly species-specific so that one *Ophrys* species is only attractive to males of a single bee species and in some cases to one or several closely related species. *Ophrys* flowers never produce nectar and are exclusively pollinated by hymenopteran males (solitary bees, in some cases scoliids or sphecids)( Ayasse et al. 2000; Schiestl 2004). This pollination mechanism is probably not a consequence of co-evolution, but represents a complete one-sided evolution of the flower. *Ophrys* orchids are usually interfertile and the species-specific pollinator serves thereby as a pregamic isolating mechanism, preventing hybridization (Ayasse et al. 2000; Paulus & Gack 1990).

Loss of pollen is also prevented by being attractive to just one pollinator species. Most orchids pack their pollen in pollinia (clumps). Often they just have two pollen packages per flower, although each package may include more than one pollinium. It
is therefore important not to loose the packages to an inefficient pollinator. (Tremblay 1991)

The high specialization in *Ophrys* orchids to one or a few pollinators may be the most important reason for the observed low pollination frequency in studies. As an adaptation to this, flowers are relatively long-lived and pollinated flowers produce a high number of seeds. Such a low pollination frequency should lead to the evolution of strategies that increase the chances that males visit more than one flower in the patch. But visiting several flowers in the same inflorescence may increase the frequency of geitonogamy (pollination of the neighbouring flower) or autogamy (self-pollination) that may lead to inbreeding depression. (Ayasse et al. 2000)

Darwin compared the success of self- and cross-fertilisation under controlled experimental conditions.

The success of fertilisation can be measured as the number of produced ripe seed and as a number of different properties like size, weight or fertility of the progeny. The analysis of experimental data from over 50 plant species led Darwin to the conclusion that allogamy is more favourable in by far the most cases (Darwin 1876).

**Case study: Pollination of *Ophrys* (Orchidaceae) in Cyprus**

In 1988 a study by F. H. Paulus and C. Gack describes 12 *Ophrys* spp in Cyprus visited by 10 pollinators. Interestingly they found a lot of different biospecies in the *Ophrys* collection. Probably a result of genetic isolation due to varying pollinators and of differences in flower morphology.

The *Ophrys* spp occurring in Cyprus and their further distribution are as follows: One is a Cyprus endemic. All the other *Ophrys* spp are also found in Anatolia/ Middle East, while 50% of these also are distributed in E. Europe and 25 % in W. Europe (decreasing distribution probably due to increasing geographical distance).

It is very likely that the distribution of highly species-specific *Ophrys* is limited by its pollinators range. On Cyprus the *Ophrys* spp. are adapted to and pollinated by solitary bees, which are more likely to successfully colonize islands than social bees.
(Tremblay 1991). So when a species-specific pollinator spread to Cyprus, the matching *Ophrys* was able to establish itself.

**An example of convergence:**
The Cyprus endemic *Ophrys kotschyi* is found to be pollinated by the bee *Melecta tuberculata* as is *Ophrys cretica* distributed in Crete. *Ophrys kotschyi* and *Ophrys cretica* were considered as synonymous, but flower morphology and a statistical analysis indicates a convergence between these two *Ophrys* “forms”. If true, the similarity would be the consequence of identical selection pressures working independently and allopatrically through the same pollinator species *Melecta tuberculata*.

So even if some *Ophrys* species have a similar design and might be closely related, attention must be paid to the possibility of convergences as demonstrated in *O. kotschyi* and *O. cretica* (Paulus & Gack 1988).

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**Socotra**

Mikkel Sørensen

**Introduction**

Yemen's Socotra Island is the largest and most easterly island of this Indian Ocean archipelago, lying approximately 240 km east of the Horn of Africa and 480 km south of the Arabian Coast. The other main islands in the group are Abd al Kuri, Semhah, and Darsa. Abd al Kuri is the closest to the African mainland, only 90 km away.

Socotra is the largest island of the Land of Sheba, approximately 110 km long by 35 km wide and the area of is about 3625 km$^2$ (Varisco 1993). Its separation from Africa is believed to have occurred approximately six million years ago as a result many animals and plants that live today on the island are endemic species.

The rich and unique environment resulting from this period of social and biological isolation has led scientists to describe Socotra as “the Galapagos of the Indian Ocean.”

**History**

The ethnic origin of the people of Socotra is not quite established. But it is known that the people are a mix, and that they became isolated from the rest of Arabia, from where they must have most of their origin, between 1000 and 500 BCE. (Ref.1)

**Pollination landscape**

Socotra is characterized by the Hagghier Mountains, reaching 1525 m a.s.l., and located in the north-western part of the island, and an extensive plateau of Cretaceous limestone averaging 300 to 700 m in elevation. The eastern and central parts of the island receive some rain during fall and winter, while the western part of the island is arid.
The most widespread vegetation type is a distinctive species-rich open shrubland found on the coastal foothills and the limestone escarpments. Two endemics, *Croton socotranus* and *Jatropha unicostata*, are the main shrubs present and are the most abundant plants on Socotra. Succulent trees, such as *Euphorbia arbuscula* and *Adenium obesum*, and emergent trees, such as *Boswellia* spp. and *Commiphora* spp. are also present (Davis *et al.* 1994).

On the limestone plateau and upward to the middle slopes of the Hagghier Mountains there are areas of semi-deciduous thicket dominated by *Rhus thyrsiflora*, *Buxus hildebrandtii* and *Croton* spp. The higher slopes support a mosaic of dense thickets, dominated by *Rhus thyrsiflora* and *Allophylus rhoidiphyllus* with the emergent dragon's blood tree (*Dracaena cinnabari*), low *Hypericum* shrubland, and in many areas anthropogenic pastures. Open rocks are covered by lichens and low cushion plants, including an endemic monotypic genus of Umbelliferae (*Nirarathamnos asarifolius*) and several endemic species of *Helichrysum* (Ref.2)

**Flora and fauna**

**Plants**: Over 850 species of plant have been found on Socotra. The Dragon’s Blood Tree *Dracaena cinnabari* is the most famous of the 300 endemic species and dominates the skyline on many of the limestone foothills.

**Birds**: 182 species have been recorded on Socotra of which 41 breed, 85 are regular migrants and 56 rare visitors. Seven endemic species breed on Socotra: Jouanin's Petrel, Socotra Sunbird, Socotra Warbler, Socotra Cisticola, Socotra Starling, Socotra Sparrow and Socotra Bunting.

**Reptiles**: There are 24 species of reptiles on Socotra of which 21 are endemic - found nowhere else in the world but Socotra. (Alexander & Miller, 1996)

**Mammals**: There are only seven terrestrial mammals, most of which are introduced, although a bat *Rhinopoma* sp. and a shrew *Suncus* sp. are possibly endemic. Some of the species are livestock such as goat, sheep, camel and cattle. If the number of these animals will increase too much the removal of vegetation cover would result in
accelerated soil erosion and the loss of surface water through increased runoff rates. This would result in a dangerous, inestimable spiral for the island.

Pollinators
It does not seem like much pollination literature is available probably because the main issue on Socotra is the amount of endemic species. But for sure the most important pollinators are beetles and bees. But some bats and at least one endemic bird (Socotra Sunbird) are pollinators too. The Socotra Sunbird is a very small passerine bird which feeds largely on nectar, although they will also take insects, especially when feeding young. Flight is fast and direct on their short wings. Most species can take nectar by hovering like a hummingbird, but usually perch to feed most of the time. Compared to the mainland the interspecific competition is not very high i.e. because of extreme low migration from the mainland. The flora on Socotra is indeed special and the pollinators and the plants are perfectly adapted to each other.

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**Zanzibar**

Karina Mikkelsen

**Introduction**

Zanzibar is an archipelago, with the two largest islands being Unguja and Pemba, surrounded by a number of other smaller islands. The island of Zanzibar, Unguja, is the largest of the two, being 85 km long and 39 km wide and covering 1660 square kilometres. Pemba is only 67 km long and 23 km wide, thereby only covering 985 square kilometres (www.zanzinet.org1).

Both islands are separated from the mainland by Pemba channel in the north and Zanzibar channel in the south. Unguja is at the narrowest about 36 km from the mainland and Pemba is about 56 km off (www.zanzinet.org2). The islands are assumed to have been connected to the mainland, with Pemba separating during the Miocene (23-5 million years ago), many million years before Unguja, which separated in the Pleistocene (1,8-11000 years ago) (www.sunrisesafaris.com). Due to the time difference for the separation and the fact that the Pemba channel is about 800 metres deep at some places, Pemba is much more isolated than Unguja. Zanzibar channel is much shallower and interrupted by coral reefs and reef islands.

Unguja is generally flat, but run through by a ridge from north to south, with the highest point being about 120 m above sea level. Pemba is much more diverse in its topography with numerous ridges and hills and many inlets by the coast. The highest point on the island is about 100 metres (www.zanzinet.org1).

**Pollination landscapes**

Much of the natural forest on both Unguja and Pemba has been depleted, due to agriculture, primarily clove production. Most of them are now protected reserves. The main habitat types can be described as;
**Mangrove forests:** The forests along the costal line which cover approximately 20,000 hectares thereby covering about 12% of the island. The forest is important in preventing soil erosion along the coast. Canopy height is around 2-3 metres (www.africanmeccasafaris.com).

**Tropical moist forest:** Only a small amount of this natural forest is left and located in small patches around the islands. It consists primarily of large trees, reaching heights up to 20-35 metres depending on placement. The forest hosts also a number of bottom plants and climbers (Catry et al. 2000).

**Clove plantations and farmland:** Cloves were introduced from Mauritius in 1818, and with the strict order of planting two clove trees pr coconut palm it soon became the major component of agriculture on the islands. A major hurricane wiped away a large proportion of the plantations on Unguja, in 1872 but the production still dominates large areas of the two islands (www.allaboutzanzibar.com). Cloves are tall and slim trees, which reach a height of about 10 to 15 metres. The trees can get quite old, up to 150 years of age. Approximately 44% of the area on Pemba is covered by agriculture by which the main part is cloves (Catry et al, 2000). Also a large number of spices and fruit trees are present, like cinnamon, cardamom, nutmeg, coconut, banana, oranges, jackfruit and others (www.africanmeccasafaris.com).

**Pollinators**

Birds – The number of bird species on the two islands are rather limited, with only 153 on Zanzibar and 84 on Pemba (www.bsc.eoc.org). Due to the isolation factor of Pemba, the island has been declared an endemic bird area, with four endemic species and two subspecies of birds of prey, all of which are encountered frequently. The species are; Pemba African goshawk, Pemba green pigeon, Pemba scops owl, Pemba black-bellied starling, Pemba sunbird and Pemba white-eye. Other than this a great variety is found. Four of the endemic bird species rely on fruits or nectar as a primary food resource (Catry et al. 2000). Also Zanzibar has four endemic bird species.
Bees – Due to the large clove industry, an enormous amount of honeybees are present on Pemba island, housing perhaps 30 million bees (www.taa.org.uk). Many of the bees are kept in hives, but the decline in clove production has also resulted in some destruction of the hives, and therefore presumably an expansion in the bee distribution, with the bees going for other plants.
A large number of other insects are found on Zanzibar, including butterflies, beetles, ants, moths, and many more.

Mammals – Not many mammals are found on Unguja, and even less are found on Pemba. Only 54 terrestrial species are found, out of which, 23 are bat species. Bats are an important factor in the question of pollination and seed dispersing, since the bats are frugivorous. No large mammals are found on either Unguja or Pemba, but Unguja does host an endemic species of the Red Colobus Monkey (www.zanzinet.org3).

Cases.
As mentioned, both islands host a number of endemic species, such as birds and the Pemba flying fox and on Unguja, the Red Colobus Monkey. There have been some speculations on how the massive decline in the native forest will affect these endemic populations, by degrading their natural habitats. One might expect that the birds have preferred food resources and have made special adaptations over time. However, an investigation made by Catry et al. (2000) on habitat selection by all bird species on Pemba Island revealed that at least the first speculation is not the case. The endemics were not restricted to the native forest and overall the largest number of species, were found on farmland. This might be due to the type of farmland, with most of it being different types of fruit. The large clover plantations also support a number of species. All of this pointing towards that the threat against the species on the island is not as big as assumed.
The same pattern is found for the Pemba flying fox, which is supposed to be an important pollinator. Actually most of its diet is composed of cultivated fruit, with flowers and pollen of native plants as a less important source (Entwistle and Corp,
The investigation was restricted to a specific period of time, though, and they have no information on the diet the rest of the year. The concern which may arise from these investigations could be that the animals might have found more reliable and accessible food resources, thereby neglecting the native plants, leaving these without pollinators. Whether or not the small amount of pollinating insects and reptiles can do the work is yet to be investigated.

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The Maldives
Allan Timmermann

Introduction
There are approximately 1,192 Maldivian islands, spread over roughly 90,000 square kilometers and located in 26 atolls southwest of the Indian subcontinent in the Indian Ocean. Approx. 201 islands are inhabited and 991 are uninhabited. Geologically the islands are relatively new, and all together the Maldives covers a land area of 298 km². The atolls are situated in a north-south manner stretching from 7° N to the equator and between 72°-74° E, with a range in length of approx. 750 km and in width of approx. 120 km. The nearest mainland is India and Sri Lanka with the shortest distances being approx. 500 km and 700 km respectively. The islands vary in size, but all have flat terrain, with an average elevation of 1.2 m above sea level and the highest point a mere 2.5 m. The climate is Sub-tropical, with two monsoons, hot, humid and dry in northeast monsoon (winter) and rainy in southwest monsoon (summer). Annual rainfall varies from a minimum of around 1,800 mm, to a maximum of around 3,000 mm, and the mean temperature is 28 °c throughout the year.

Vegetation types
In general, most of the plants currently found in the Maldives, have been introduced from outside. Forests of *Pisonia grandis* are believed to have covered most of the land area before clearance occurred for settlement and agriculture. Wild stands of coconut (*Cocos nucifera*) do, however, exist on all the islands. Over all, 277 local and 450 introduced vascular plants species have been recorded in the Maldives. Five categories of vegetation are recognized, into which native plants of the islands have grouped themselves ecologically. They are beach pioneers, littoral hedge, sublittoral thicket, climax forest and mangrove and swamp forest. Beach pioneers include about twenty characteristic species and are the first plants on a natural beach. These are highly salt tolerant and tend to be low and herbaceous, the most
common species is *Launaea sarmentosa*. Littoral hedge includes about ten or so common species. These are usually scrubby with numerous branches. The most common species are *Scaevola taccada* and *Pemphis acidula*. Sublittoral thicket is described as a distinct community of small trees comprising of more salt sensitive species, existing behind the beaches in areas not completely dominated by coconut palms. These areas contain about twenty common species of mixed life form including shrubs, climbers and shade tolerant grasses; the prevalent trees being *Cordia subcordata*, *Guettarda speciosa*, *Hibiscus tiliaceus* and *Premna obtusifolia* and the climber *Passiflora suberosa*. Climax forest comprises mature trees from the “sublittoral thicket” in addition to *Hernandia nympheifolia* and *Terminalia catappa*. The mangroves comprise 13 species belonging to nine genera with the flora being dominated by *Bruguiera cylindrica*, *Ceriops tagal* and *Lumnitzera racemosa*.

**Pollinators**

More than 130 species of insects, including flies and ants, have been recorded in the Maldives. In addition, more than 67 butterfly and moth species have been identified, and other species including paper wasps have been observed throughout the archipelago.

The only native mammals living on the islands are two species of fruit bats, *Pteropus giganteus ariel* and *Pteropus hypomelanus maris*. Two gecko species and two agamid lizards, the common-garden lizard and the snake skink, comprise the reptile fauna.

The Maldives hold over 100 species of birds, but as in other oceanic islands, allmost all of them are sea birds. The otherwise dominant flower-visiting birds of the South Asia region, the sunbirds (Nectariniidae), are not present in the Maldives. Neither are other potentiel pollinators from the region, like White-eyes (Zosteropidae) and flowerpeckers (Dicaeidae). The only nectar-eating bird, and therefore potential pollinator mentioned in the literature, is the rose-ringned parakeet (*Psittacula krameri*), which is introduced.
Cases

Bats are vital for seed dispersal and pollination in tropical forests. Several flowers in the Maldives, such as *Barringtonia*, *Hernandia nymphaefolia* and *Cordia subcordata*, exhibit all the characteristics of bat pollination, being mainly white in colour and heavily perfumed, particularly at night.

The flowers of many of the dominant vegetation like *Scaevola taccada*, *Passiflora suberosa*, *Guettarda speciosa*, *Terminalia catappa* and *Pemphis acidula* resemble the characteristics associated with moth-pollinated flowers. They have a sweet scent, but not as heavily as the bat-flowers, they don’t produce nearly as much nectar, and they are white or pale in colour. All suggesting that moths are the primary pollinators, but other insects can also play a secondary role in pollination. The flowers of *Hibiscus tiliaceus* are yellow, a colour usually associated with bee-pollination.

Introduced plants and animals

The Maldives were first settled in the 5th century B.C. Human presence has dramatically changed the nature of the islands in several ways. Most native vegetation was cleared by the early 19th century and replaced by coconut plantations and other crops, such as mango (*Mangifera indica*), and many others. Introductions of domestic animals such as cat, goat, rabbit, house mouse, black rat, and Indian house shrew have also had a severe effect on native fauna.

References


Krakatau
Camilla Hansen

Krakatau er en vulkan ø opstået de novo. I 1883 forsvandt 2/3 af den i et voldsomt udbrud, der efterlod sig en rest, der nu kaldes Rakata. Krakatau er en ø gruppe bestående af 3 øer: Setung (13 km², 182 m), Panjang (32 km², 142 m) og Rakata (17 km², 730 m). (Whittaker 1997). Området er fremdeles aktivt, og i 1930 så en fjerde ø dagens lys, Anak Krakatau. Øerne er beliggende i Sunda strædet mellem Java og Sumatra. Disse er hhv. 30 og 40 km væk. Nærmeste ø, Sebesi, ligger 12 km væk. Krakatau er speciel mht. at udbruddet i 1883 effektivt steriliserede de 3 øer og påvirkede øerne i nærheden. Dette skabte et unikt billede af, hvordan ø-samfund genetablerer sig selv. Øerne er uboet og har været fredet siden 1920. Området er domineret af en blandet tropisk regnskov. Rakata har en udbredt mos skov nær toppen og en kyststrandlinie domineret af typiske havspredte arter som kokos, Barringtonia, Terminalia, Casuarina. Arts sammensætningen for kyststrækningerne er typisk for området, medens det indre af øerne fremdeles er artsfattigt og atypisk set i forhold til det nærmeste fastland. Øerne er domineret af tidlige successionsarter med god frøsprednings evne, Neonauclea, Ficus. I højden er vegetationen domineret af Shefflera -buske. Tropiske regnskove er områder med verdens højeste biodiversitet. Så man ville kunne forvente komplekse pollinationsnetværk på Krakatau bestående af mange arter og links, selv om øer generelt er artsfattige i forhold til fastland. Der er på øen over 400 vaskulære planter, hvoraf der er ca. 54 arter orkidéer og 35 legumer (Whittaker 1997). Der er 54 sommerfugle, 40 landfugle, 9 reptiler (bog) og 2 rattus (Rawlinson)

Det er et problem for mange plante arter at kolonisere en ø. Ikke fordi de ikke kan komme frem, men fordi de kommer til at mangle en obligat pollinator, der enten er længere om at spredes eller ikke kan spredes ud på øen. Denne problematik skulle forventes for Krakataus figenpopulation. Da der er flere figenpopulationer på øen, tages det som indirekte bevis på, at i hvert fald hvepse var i stand til regelmæssigt at krydse havbarrieren til Krakataus i etableringsfasen. Figenarter menes at være en


Der er en stærk trafik mellem Sunda strædet, så introduktion af arter fra fiskere, turister og forskere vil være uundgåelig. Blandt sandsynlige introducerede arter er blandt andet visse krybdyr og rotten. 

Biota på øer er som regel disharmonisk. Pollinationsbiologien på en ø vil være afhængig af dens type, placering i forhold til nærmeste fastland samt dens størrelse. Landbro-øer vil gerne have et nested subset biota reflekterende mainland biota. Øer opstået de novo vil have en disharmonisk biota, med gode spredere og kolonisatorer overrepræsenteret i forhold til nærmeste fastland. Planter med lette frø, vindspredte som orkidéer og bregner, er godt repræsenteret på Krakatau. Placeringen i forhold til fastlandet vil afgøre hvor mange, der kan nå derud - øer tæt på land vil indeholde flere kolonisatorer. Efterhånden som afstanden til fastlandet stiger, vil antallet af endemier stige. Der er en hypotese om, at ø-økosystemer er rige på diöciske taxa. Dette er fordi, deres mekanisme for out-crossing vha små generalistinsektpollinatorer kan have en selektiv fordel i at kolonisere øer. Krakataus andel af diöciske træer og lianer ligger inden for det normale for en tropisk skov (Bush 1995).


Referencer


Bali and Lombok
Grete Fogtmann Jensen

**Introduction**

In the 18th century Sir Alfred R. Wallace, a contemporary of Charles Darwin and the so-called father of animal geography, spent nearly a decade cataloguing the plant and animal species, which inhabited the unique geographical area of the Malay Archipelago [1]. The Malay Archipelago refers to the vast group of islands located between mainland Southeast-Asia and Australia. Together with Australia, the Malay Archipelago marks the traditional boundary between the Pacific Ocean to the east and the Indian Ocean to the west and it includes Brunei, Indonesia, the Philippines, Papua New Guinea, East Timor, and Eastern Malaysia [1][5].

Sir Alfred R. Wallace not only formulated his ideas on evolution by natural selection while observing and collecting wildlife in the islands of Southeast Asia. His observations in the Malay Archipelago also led him to propose an imaginary line running between the region's islands. During his expedition in the Malay Archipelago between 1854 and 1862, he noticed a striking zoological difference between the animal and plant species of Asia and Australia. He was particularly impressed by the sudden difference in bird families he encountered when he sailed some 30 km east of the island of Bali and landed on Lombok. On Bali the birds were clearly related to those of the larger islands of Java, Sumatra and mainland Malaysia. On Lombok the birds were clearly related to those of New Guinea and Australia. Consequently, he marked the channel between Bali and Lombok as the divide between two great zoogeographic regions, the Oriental and Australian. In his honour this dividing line, which extends northward between Borneo and Sulawesi, is still referred to today as *Wallace's Line* [1][6].

**Geography**

Bali is a small fertile island midway along the string of islands, which makes up the Malay Archipelago. It is adjacent to Java and is the first in the chain of smaller islands comprising Nusa Tenggara [2][4]. A land corridor connected Bali to Java
during the quaternary glacial period (1.6 myo) [16]. Bali has an area of 5620 sq km, measures approximately 140 km by 80 km and is just 8° south of the equator. It is dramatically mountainous: the central mountain, which runs the whole length of the island, includes several peaks approaching over 2000 metres with Gunung Agung close to 3000 metres [4]. Bali is volcanically active and extravagantly fertile. The two go hand in hand because eruptions contribute to the land’s exceptional fertility and the high mountains provide the dependable rainfall [2].

Lombok is located about 30 km east of Bali and is one of two main islands of the province of West Nusa Tenggara. Lombok has an area of 4945 sq km and the volcanic mountain Gunung Rinjani in the north approaching 4000 metres dominates the island. Lombok stretches some 80 km east to west and about the same distance north to south [4].

Climate
Close as they are to the equator, Bali and Lombok have climates evenly tropical all year. The average temperature hovers around the high 20s°C year-round. There are distinct dry and wet seasons – dry from April to September and wet from October to March with a precipitation of more than 100 mm per month [2][4].

Flora
South and north of the central mountains are Bali’s agricultural lands and the main export crops – coffee, copra and rice – are grown here. The orderly rice terraces dominate the landscape of Bali, but there are also a variety of other landscapes – the dry scrub of the north-west and the primary monsoon forest, dense jungle, mangrove forest, savannah, palm tree groves and coral islands at the mountainous western side of the island. The extreme north-east and the southern peninsula; patches of dense jungle, forests of bamboo, barren and scrubby volcanic regions, and limestone areas with sandy and unfertile soil [2][3].

The flora of Bali includes many palm species, bamboo and flowering shrubs such as plumeria (*Plumeria rubra*), poinsettia (*Euphorbia pulcherrima*) and bougainvillea
(Bougainvillea glabra). Typical floras found in Bali also comprise several species of hibiscus, lotus flowers, orchids, trumpet flowers, magnolias, lilies and begonias. In addition, typical tree species of Bali include acacia, banyan tree (Ficus benghalensis), cendana (Santalum album), pulai (Alstonia scholaris), kepuh (Sterculia foetida) and trengguli (Cassia fistula) (also see supplement 1) [2][7][8].

Central Lombok is similar to central Bali, with alluvial plains and fields irrigated by water flowing from the mountains. Most of the agricultural land of Lombok is located here in a 25 km wide zone across the island and rice is the main crop. In addition, banana and coconut palms grow in profusion over most of the island [2]. Apart from the central part of the island, Lombok is noticeably different from Bali. North of the central agricultural zone it is mountainous and lush with tall trees and shrubs. Dense forests at the base of the mountains include big quantities of hardwood such as teak (Tectona grandis), mahogany (Swietenia Mahagoni) and Indian rosewood (Dalbergia latifolia) [2][4]. Other native trees include bintangur (Calophyllum inophylum), kesambi (Schleichera oleosa), bungur (Lagerstroemia speciosa) and fig (Ficus sp.)[14]. Orchids, edelweiss and anggrek are a feature of the grassy mountainous slopes [14]. In the south it is arid and covered by savannas. The land is dry and unfertile, with scrubby, barren hills resembling those in parts of Australia’s outback. This area gets little rain in comparison with the rest of the island, and often has droughts, which can last for months. Consequently, corn and sago are the staple foods instead of rice [2][4].

Fauna
At least 282 bird species have been recorded from Bali, of which about 150 are relatively common. Bar-winged Prinia (Prinia familiaris), Yellow-vented Bulbul (Pycnonotus goiavier) and the Indonesian Honeyeater (Lichmera limbata) are some of the most common bird species found on the island (also see supplement 1) [8][11]. The Honeyeaters are a very large family almost entirely restricted to Australasia. There are 11 species of Lichmera and five of them have spread to the Nusa Tenggara. Lichmera limbata is the only one that occurs west of Wallace's Line.
and thus honeyeaters have not invaded the Asian mainland [12][15]. The best-known bird species on Bali, the critically endangered Bali Starling (*Leucopsar rothschildi*), is endemic to the western dry monsoon forest [10]. Wild boar and different species of deer are the only large Asian mammals on the island [3]. Lizards are fairly common, but Bali is also habitat to a number of other faunas such as Ant-Eater (*Manis javanicus*), Porcupines (*Hystrix branchyora*), Leopard Cat (*Felis bengalencus*), Black Monkey (*Presbytis cristata*) and Giant Squirrel (*Ratufa bicolar*) (also see supplement 1) [4][8].

At least 250 bird species have been recorded from Lombok and only 50 % of these are shared with Bali. In contrary, Bali shares nearly all its bird species with Java (about 97 %) [2][16]. Yellow-bellied Sunbird (*Nectarinia jugularis*), Olive-backed Tailorbird (*Orthotomus sepium*) and Pied Bushchat (*Saxicola caprata*) are some of the most common bird species found on Lombok (see also supplement 2) [13][17]. Lombok is also home to the Australian sulphur-crested cockatoo, which is not found any further west of Lombok [14]. Large Asian mammals are absent and replaced instead by large numbers of marsupials, lizards, cockatoos and parrots (also see supplement 2) [2].

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New Guinea
Lucía de la Guardia

Introduction
New Guinea is a pacific tropical island situated in south-eastern Asia (geographic coordinates: 6.00°S, 147.00°E), just north of Australia. It is the second largest island in the world, after Greenland. The western half of the island consists of the province of Irian Jaya of Indonesia, and the eastern portion contains the bulk of the independent state of Papua New Guinea. As they are two different states, the information I found is just related to Papua New Guinea, which areal land is 452,860 sq km and it shares 820 km border with Irian Jaya. New Guinea is considered a mainland compared to the small islands that are around it, like Manus, New Britain, New Irland and Bougainville, all part of Papua New Guinea. The highest point is Mount Wilhelm 4,509 m. The terrain is mostly mountains with coastal lowlands and rolling foothills.

Pollination landscapes
Three quarters of Papua New Guinea is covered by tropical rainforests, and the remainder is made up of delta plains, flat grassland and mangrove swamps. The climate is typically monsoonal: hot, humid and wet year-round. There are defined wet (December to March) and dry (May to October) seasons, but both are subject to regional variation. Temperatures on the coast, in the low lands, are reasonably stable all year (oscillating between 25° and 30°C) but humidity and winds are changeable. Temperatures drop at higher altitudes, mountainous regions, and it can be very chilly in the highlands.
Annual rainfall totals nearly 5,080 millimetres in the Milne Bay region (at the extreme eastern end of Papua New Guinea) and about 5,840 millimetres at the mouth of the Fly River (Western Province, on the southern coast, bordering Irian Jaya). Port Moresby (on the southeast shore of New Guinea), which lies between these two points receives only about 1,145 millimetres of rain annually. The country is subject
to frequent and sometimes severe earthquakes, mudslides, tsunamis and active volcanism. Some destruction of areas rich in biodiversity is occurring because of the logging of forest each year. Open-pit mining is also causing serious problems

**Pollinators**
The animal life is as varied as the vegetation of the island. High mountains and wide lowlands provide favourable environments for many kinds of animals.

- 700 species of birds including 38 of the worlds' 43 species of the spectacular Bird of Paradise. There are more parrot, pigeon and kingfisher species than anywhere else in the world. Other notable birds are giant cassowaries, *kokomos* (hornbills) and cockatoos.
- Species richness of overall insectivores, terrestrial insectivores, ant followers, fig wasps (*Hymenoptera, Agaonidae*) as well as pycnonotids and biome-restricted species, were strongly or even very strongly positively correlated with overstory tree density and, in most cases, also with basal area. Pollination in lowland forests is dominated by highly social bees (mainly *Trigona* and *Apis* species), with beetles and other bees and flies. But the highlights of the insect kingdom are the world's largest butterfly, the Queen Alexandra Birdwing and scarab beetles.
- Fruit bats (family Pteropodidae): individuals of *Syconycteris australis, Dobsonia minor, Pteropus conspicillatus*, and *Nyctimene albiventer*, and *Paranyctimene raptor* were seen during feeding experiments.

**Cases**
Globally, Moraceae includes at least 1100 species, and more than two-thirds of these are figs (Rohwer 1993). The spectacular diversification of *Ficus* is often attributed to a coevolved, obligate mutualism between figs and pollinating fig wasps (*Hymenoptera, Agaoninae*) in which the plant relies on wasps for pollination and the wasps breed in figs (Janzen 1979; Weiblen 2002).
The family comprises five tribes that include monoecious, dioecious, androdioecious, and gynodioecious species with either unisexual or bisexual inflorescences (Datwyler
and Weiblen 2004). Both wind and insect pollination syndromes are indicated by the diverse inflorescences of the family. In particular, members of the tribe Moreae usually have explosive pollen release and are presumed to be wind pollinated (Bawa et al. 1985; Rohwer 1993; Williams and Adam 1993; Kinjo et al. 1998; Berg 2001) while some Artocarpeae and Castilleae are believed to be insect pollinated and provide brood sites for insect larvae (Bawa et al. 1985; Sakai et al. 2000; Berg 2001). Some members of the Dorstenieae with condensed staminate inflorescences might also provide insect breeding sites (Berg 2001). Sakai et al. (2000) demonstrated that pollination of Artocarpus integer (Artocarpeae) is mediated by gall midges feeding on the mycelia of fungi that grow on staminate inflorescences. Momose et al. (1998a) concluded that diverse insects pollinate A. integer and A. odoratissimus, while Artocarpus elasticus appears to be wind pollinated (Momose et al. 1998b). Sakai (2001) demonstrated that a species of thrips (Thysanoptera, Thripidae) pollinates the Neotropical, androdioecious Castilla elastica (Castilleae) and breeds in the staminate inflorescences. Thrips have also been observed on three other genera of Neotropical Castilleae (Sakai 2001; Datwyler and Weiblen 2004). The small sizes of most pollinators and the absence of direct human exploitation probably make pollination mutualisms less vulnerable to failure as a result of human impacts than dispersal mutualisms, but more subtle impacts, as a result of altered gene flows, are likely to be widespread.

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Solomon Islands
Karin T. Clausen

Introduction
The Solomon Islands are wet tropical oceanic islands in the South Pacific Ocean. The archipelago with its geographical form dates back to 5 mill. B.C. (Whitmore) and was created by coral reefs and volcanoes. There are about 992 islands including atolls, cays and larger islands and together their land area is 27,556 km$^2$ (L.P.) (The biggest islands are up to 181 km long and 56 km wide). The distance to Australia is 3168.15 km and to Papua New Guinea is 1341.86 km (www.map). The flora on the Islands is probably dispersed from New Guinea and nearby islands since it has never been attached to Australia and the wind blows mostly from north-west to south-east (Lewis & Cribb). The highest mountain is Mount Makarakomburu at 2.447 m. 80% of the Islands are covered with tropical rainforest (L.P.)

Pollination landscapes
Lowland forest (sea level up to 700 m) includes: Valley forest, Freshwater swamp forest, Mangrove forest, Beach forest, Forest on ancient limestone and recent volcanic surfaces, Seasonally dry forest and grassland (www.worldwild... Whitmore). Annual rainfall varies between 3120 and 6250 mm. The height of the forest is up to 45 m. The canopy is formed namely by: Calophyllum peekalii, Calophyllum pseudovitiense, Campnosperma brevipetiolatum, Dillenia salomonensis, Elaeocarpus sphaericus, Endospermum medullosum, Gmelina moluccana, Maranthes corymbosa, Parinari salomonensis, Pometia pinnata, Schizomeria serrata and Terminalia calamansanai (www.worldwild..., Whitmore). The only emergent being Terminalia calamansanai, which is a semi-deciduous tree. The trees are often covered with climbers and epiphytes - especially near the rivers. In between these trees there are many gaps covered with re-growth, i.e. plants which are up to 8 m tall (Bayliss-Smith...).

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2 Some sources believe these to be included in lowland forest; others that they should be looked upon separately.
Montane rain forest (above the lowland forest) - species of Myrtaceae (Acemena, Eugenia, Mearnsia, Metrosideros, Rhodamnia, Syzygium), Ericaceae (4 endemic epiphytic Rhododendrons) and Vaccinium (Whitmore), Ardisia, Psychotria, Schefflera, Ficus, Dacrydium, and Podocarpus pilgeri (www.worldwild...) have been collected in the mountains of the Solomons (Mueller-Dombois and Fosberg 1998). The maximum height of the forest is 20 m but the mountains are mostly full of smaller shrubs. Also there are plenty of bryophytes covering the ground to a height of 30 cm. The higher elevation conceives more water than the lowland probably up to 8000-9000 mm annual (L.P.).

**Pollinators**

Bats - fruit bats include the Bougainville monkey-faced bat (Pteralopex ancep), Guadalcanal monkey-faced bat (Pteralopex atrata), montane monkey-faced bat (Pteralopex pulchra), which are endangered, (www.worldwide...) and the flying fox Torresian tube-nosed bat. The flying fox is a specialist fruit-eater and it is known to disperse the seeds of rainforest canopy trees (www.epa...).

Birds - The archipelago has got more than seven endemic genera, a total of 199 bird species and many of these are plant pollinators (www.worldwide...). One of these birds is the green-naped lory, which eats fruit, seeds, buds, nectar, unripe grain and pollen. Another one is the grand Eclectus parrot which feeds on the same. Also the Rainbow Lorikeet, a brightly coloured strongly gregarious parrot, feeds primarily on nectar and pollen. In general all the different kinds of lory and lorikeet are nectarivorous birds feeding mainly on pollen, nectar and fruit juice (www.seaworld...). - Including the endemic species Cardinal lory, Yellow-bibbed lory, Meek’s lorikeet and Duchess lorikeet (www.worldwide...).

Butterflies - there are 130 species including the bird-wing butterflies (www.wfw...).

Wasp - fruit wasp

Lizards - members of the families Gekkonidae and Scincidae.

**Cases**
*Paphiopedilum* - The genus *Paphiopedilum* (Lady’s slippers) belongs to the family Orchidaceae and comprises approximately 77 species native to Asia and the South Pacific. They have robust shoots with several leaves, which can be either short and round or long and narrow. The flower itself is often mottled and it can only flower when it is fully grown. The roots are thick and fleshy so that they can retain a lot of water. The species thrive in moderate to high humidity (50-70 %), in temperatures which vary from 15 to 35°C and in dim light. Their flowers have an unusual formed labellum which makes them look like a lady’s slipper and they are therefore easy to recognize. Most of the *Paphiopedilum* are terrestrial and grow in humus layers on the forest floor but some of them are epiphytes or lithophytes. They are pollinated by insects which are trapped inside the pouch while trying to get nectar from the flower. On their way in and out of “the slippers” they touch the stamens and either collect or deposit pollinia.

In the archipelago the most abundant *Paphiopedilums* are: *Paphiopedilum bougainvilleanum* var. *bougainvilleanum*, *Paphiopedilum bougainvilleanum* var. *saskianum*, *Paphiopedilum wentworthianum* ([http://encyclopedia.](http://encyclopedia.)). The *Paphiopedilum bougainvilleanum* is often light green, green and white and flowers during summer and fall.

Beetle-pollinated flowers are typically white or dull in colour and have got strong odours, usually fruity or spicy. Flowers with sweeter odours are pollinated by bees, moths and butterflies. Bee-pollinated flowers have often got brightly coloured petals such as blue or yellow and distinctive markings – nectar guidelines. Both male and female bees drink the nectar but it is only the female that collects the pollen. Some orchids have developed complex passageways or traps (such as “the Lady’s slippers”) that force the bees to visit the flower in a special way. This ensures that the bee touches the stigma and the anther in a specific way, which results in pollination of the flower and ensures that the pollen can be dispersed to other flowers. Butterfly- and diurnal moth-pollinated flowers are similar in sight and smell to the bee-pollinated ones. Moth-pollinated flowers are typically white or pale in colour and emit a sweet odour after sunset. Both moths and butterflies use their
long sucking mouthparts to get the nectar from the floral tube (Raven). When one knows the different insect-pollination types it seems obvious to conclude that the genus *Paphiopedilum* must be pollinated by bees - especially by female bees. Because of the unusual shaped labellum only a few animals are suitable as pollinators and this makes the flower a specialist. On islands animals often adapt to the environment and utilize other resources than they would on the mainland. The *Paphiopedilums* could be pollinated by animals such as lizards that have developed a method for getting into the flower to consume the nectar or the pollen but the most important pollinator seems to be bees.

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New Caledonia
Franziska Petra Popko

Introduction
New Caledonia is a tropical country in the Pacific Ocean consisting of the island Grande Terre (area 16890 km$^2$; 390 km long, 50 km wide), the Loyalty Islands (area 1970 km$^2$), which are located 200 km northeast of Grande Terre, and several small isolated islands and reefs (5). The total area is about 19170 km$^2$ (1). It is located 1200 km east of Queensland/Australia and 1500 km northeast of New Zealand (5). New Caledonia was separated from Australia 65 to 80 million years ago. There is a high endemicity (84% of all species of seed plants), species diversity (about 3200 species of seed plants) and an abundance of archaic plant taxa, concentrated on Grande Terre due to the geological history of the island (3). Abundant plant families are for example Winteraceae, Amborellaceae, Strasburgeriaceae and Annonaceae (5). Grande Terre has coastal plains with interior mountains; the highest mountain is Mont Panie (1628 m); (6). One third of Grande Terre is wooded area but mainly secondary growth due to progressive deforestation (5; 6). The natural vegetation comprises three major types (see below; 5).

Pollination landscapes
Rainforest occurs in the east and central parts of Grande Terre (300 km$^2$ coverage). The canopy is closed and its height is up to 20 m at lower elevations, 3-8 m at higher altitudes (5). Mean annual precipitation is 2500 – 3000 mm (1).
Sclerophyllous woodland rises on sedimentary substrates from sea-level to 300 m. It occurs in the drier west of Grande Terre (coverage 100 km$^2$ undisturbed plus 250 km$^2$ very fragmented); (5). The forest is made up of semi-deciduous trees of 10-12 m height. It is surrounded by shrub vegetation dominated by Acacia spirorbis (2).
‘Maquis’ vegetation is a highly endemic, evergreen, sclerophyllous shrub-like heath formation, restricted to ultrabasic substrates at various altitudes (4500 km$^2$ coverage on Grande Terre); (5).
Pollinators
The New Caledonian fauna is depauperate due to forest fragmentation. Insect pollination is most common. Many rainforest flowers are dish-formed with pale colors; single flowers are small and are pollinated by small insects but they are aggregated in large inflorescences in order to attract pollinators (1).

There are 3 families of bees which comprise 28 species all together: Colletidae, Halictidae and Megachilidae. These solitary, short-tongued small bees were abundant pollinators before the introduction of the long-tongued, social honeybee (*Apis mellifera*, Apidae), which now visits plants much more often than the native bees. It occurs in all types of vegetation at every altitude and threatens interactions of the native bees with the local flora (3).

Moths are playing a big role among other members of the Lepidoptera (see case). They pollinate typically tubular or elongated flowers but also nontubular ones, such as *Nepenthes* sp. (Nepenthaceae) or *Exocarpus* sp. (Santalaceae); (3).

Only a few native bird species are likely to be pollinators of mostly red or orange, tubular or brush-shaped, robust flowers which are odorless and produce nectar (1).

Honeyeaters are dominant in pollination. At least two species (*Lichmera incana incana*, *Guadalcanaria undulata*) have been observed pollinating for example the endemic *Strasburgeria* sp. (3).

Bats have been observed being active pollinators, but rather of minor importance (3).

Wind-pollination is widespread probably due to its little energy requirement, which may be profitable on the wide occurring infertile soil of New Caledonia (1).

Case study
*Phyllanthus*, subgenus *Gomphidion* (Euphorbiaceae) is a cosmopolitan genus with over 800 tree- or herb species. 115 species are native in New Caledonia.

*Phyllanthus* is exclusively pollinated by gracillariid *Epicepha* moths. The pollination is accompanied by oviposition in some but not all flowers. The larvae destroy all seeds
in the flower; only pollinated flowers, which do not contain eggs will survive. Moths are specific to a single *Phyllanthus* host. In New Caledonia, *Phyllanthus bourgeoisi* and *P. aeneus* have no other flower visitors than *Epicephala* moths (4).

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Samoa

Morten Ravn Knudsen

INTRODUCTION
The Samoa archipelago is located by the longitude 172˚ west and latitude 14˚ south of the equator – just east of the International Date Line in the South Pacific Ocean. The archipelago consists of 9 inhabited islands and is divided into two political areas: The independent Samoa (former “Western Samoa” and from 1997 simply “Samoa”) and American Samoa (www.odci.gov). The islands of American Samoa are located 100 km south-east of Samoa. Distance to Fiji (Suva), New Zealand (Auckland) and Australia (Brisbane) are 900 km, 2800 km and 3700 km, respectively (www.encarta.msn.com). The two largest islands Upolu and Savaii have a total land area of 2934 km² and both belong to Samoa (www.odci.gov).

GEOLOGY, CLIMATE AND VEGETATION
The 2 main islands of Samoa, Savaii and Upolu, are app. 1 mill. years older than the island of Tutuila (American Samoa) which was formed 1.5 mill. y.a., and the chain of islands becomes younger as one move to the east. The islands are made by oceanic volcanoes, which still are considered active – in geological time scale. In fact, the latest major eruption in Samoa was in 1905 (Craig, 2002). The highest peak is on Savaii (Mauga Silisili, 1,857 m) and since the islands are volcanic, the terrain on Samoa becomes rockier as one move towards the island centre.

The tropical climate results in a rainy season from November to April. The islands are covered with tropical vegetation except at costal or marshy areas (www.odci.gov). Although the loss of Lowland Rain Forest is estimated to be 80% during the past 3000 years of human habitation, this vegetation type is still the most extensive (www.worldwildlife.org). The dominant trees are different species of Diospyros (ivory), Pometia, Syzygium and Planchonella. Furthermore, 2 other major vegetation types are present: the more wet and cool Montane Forest (above 500 m) and the more open Cloud Forest (above 650 m) with trees from the genera Dysoxylum,
*Omalanthus* and *Reynoldsia* as dominant species. Rainfall is about 5000 mm at these heights. Other minor vegetation types are also present, and much of the understory consists of different ferns (www.thewoodexplorer.com).

**POLLINATORS**

84 different land- and seabird species are found on Samoa. 11 are endemic to the islands and 5 species are introduced (www.bsc-eoc.org). Not all birds can be regarded as pollinators and/or seed dispersers, but there are important species for these tasks such as the Pacific pigeon and other pigeons, some honey eaters and finally starlings (Craig, 2002). The rather large number of endemics indicates some sort of barrier for further dispersion. The physical barrier of distance to mainland or other archipelagos is probably not the primary obstacle – poor competition skills in other habitats or simply lack of similar and suitable habitats might be more likely explanations.

Other important pollinators are the bats or flying foxes. Banack (1998) found that 79% of all canopy-forming trees on Samoa and American Samoa were used as foraging sites (i.e. fruit or flower resource) by *Pteropus samoensis* (Samoan fruit bat) and *P. tonganus* (White-naped fruit bat). 22 plant species were used by both bats and none of them seemed to prefer a particular set of core plant species. The bats are therefor regarded as generalists and keystone pollinators on the Samoan archipelago. The only other bat found on American Samoa and Samoa is the insect eating *Emballonura semicaudata* (Sheath-tailed bat), and these 3 bats are the only native mammals on the islands (marine mammals not included) (Craig, 2002).

11 native skinks and geckos are found on American Samoa (and probably also on Samoa). Pollination and/or seed dispersal by some of these lizards probably occur, as these phenomena are known to happen from studies on other islands, fx. on New Zealand and Tasmania. The reason for this is that lizards can density compensate when a niche or resource is not fully occupied by the expected animals (i.e the
animals that normally would use this type of resource on the mainland) and if there is shortage of arthropod food and/or predation risk is low (Olesen and Valido, 2003). Since the only native mammals on the islands are frugivorous and insectivorous bats, the predation risk for the island lizards have probably been lower compared to that of the mainland lizards – at least until the arrival of man. Also, if the insect fauna is limited in number and abundance then flowers might lack insect pollinators. This could have been the case in the natural history of Samoa, since the islands only have 11 native bee species (Cockereil 1924, Perkins & Cheeseman 1928, Bryan 1930 cited in Elmqvist et al., 1992).

As mentioned earlier, flying foxes are believed to be extremely important pollinators on the islands. Elmqvist et al. (1992) investigated the pollination of kapok, *Ceiba pentandra*, on Samoa. The reproductive structures of the tree were often badly damaged by the bats (up to 50% of the initiated fruits were destroyed). Nevertheless, *P. tonganus* is the only pollinator of *C. pentandra* on Savaii, although these trees are visited by several different pollinators in continental areas. The Samoan form of the tree was found to be self-fertile, but no fruit set were observed in the absence of pollinators.

Islands – and remote islands in particular – seem to have a small number of pollinating species compared to the mainland, but one must keep in mind that the species set of pollinators also differs from that on the mainland. Bats, birds – and to some extent lizards – generally play a larger role in pollination biology on islands than they do in continental areas.

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Tasmania
Jan Nikkelborg

Tasmanien strækker sig 296 km fra nord til syd, imens der er 315 km fra øst til vest. Samlet opnås et areal på 68,049 km² hvis dens mindre øer medberegnes³.

Selvom dens højeste bjerg – Mt. Ossa – kun er 1617m høj, er mange af de indre områder relativt ujævne. Denne mangel på flade områder har f.eks. resulteret i, at de to største byer Hobart og Launceston befinder sig nær yderst stejle bakker.
Det eneste relativt flade areal er den brede, bakkede slette, der strækker sig syd fra Launceston imod Hobart.
Størstedelen af den vestlige halvdel af Tasmanien er en labyrint af bjergområder og højdedrag, der bærer tegn på nylig gletscherdannelse. Her er klimaet ugæstfrit og den årlige nedbør er nedslående 3 m eller mere. Dette kan f.eks. ses i forhold til, at de østlige dele kun modtager ca. 1 m nedbør.

Sæsonmæssigt er forholdene modsat dem på den nordlige hemisfære, det sker dog, at storme bringer vinterlige tilstande året rundt.
Tasmanien befinder sig på "the Roaring Forties" bane – en berygtet vind der omringer verden og producerer meget foranderligt vejr. Af denne grund er den almindelige luftstrøm vestlig, derfor er det ikke overraskende, at de vestlige og sydvestlige områder er genstand for stærke vinde og stor nedbør. Ikke desto mindre findes der et maritimt klima, sikkert fordi Tasmanien er en ø og relativ lille. Dette betyder, at det sjældent er ekstremt koldt eller varmt.

³ Kilde: Go Atlas, s37
Tasmanien er Australiens mindste stat og et område, hvor der findes store kontraster af wilde oceane strande, grove bjergområder og sarte alpine højmoser. Idag er Tasmanien verdenskendt for dens specielle vildnis og en af grundene til denne udvikling må tilskrives, at Tasmanien for mellem 12,000 og 10,000 år siden blev adskilt fra Australien, da den sidste istid hævede vandstanden⁴.

Den diverse flora, der findes på Tasmanien, strækker sig fra de tørre skovområder i øst igennem den alpine højmose i centrum, til regnskovene i vest. Mange arter i den tasmanske flora eksisterede, da de sydlige kontinenter var samlet som Gondwanaland. Nogle vil muligvis referere til de tasmanske skove som ”levende museer”, da de f.eks. indeholder de høje Swarmp Gum ”Eucalyptus regnans” og Huon Pine ”Lagarostrobus Franklinii” der kan leve i tusinder af år⁵.


⁴ Kilde: Lonely Planet – Tasmania ”2nd Edition”, s. 28
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Fiji
Melissa Wetter

Introduction
Fiji is a group of 300 tropical marine islands in the South Pacific Ocean that are scattered in an area of about 3,000,000 km$^2$ around the Koro Sea. The islands are thought to have been formed from 5 to 33 million years ago but the island of Taveuni emerged 2,000 years ago. The total land area is approximately 18,200 km$^2$ and it lies 2,100 km north of Auckland, New Zealand. The islands vary in size from the largest, Viti Levu, being 10,400 km$^2$ and the smallest being just a few meters. The highest mountain lies on the large island of Viti Levu and peaks at 1323 m. The landscape consists primarily of mountains of tropical forest; however, dry grasslands can be found on the western sides of the larger islands, and mangrove forests can be found along the coasts (Derrick, 1965).

Pollination Landscapes
Lowland rainforest – Lowland rainforest is located on the southern and eastern sides of the larger islands. It consists of large hardwoods which include sandalwood and Buabua. The coconut palm is a dominant tree in the lowland rainforest near the coasts (Derrick, 1965)

Montane rainforest – The Fijian montane forest is on the southern and eastern sides of the larger islands. At the top of the montane forest is cloud montane forest which may receive as much as 500 to 1,000 cm of rain per year. The dense foliage of the montane forest contains the most native species of flora and fauna including the rare Tagimaucia flower and Fijian long-legged warbler Trichocichla rufa (Derrick, 1965)

Mangroves – Mangrove forests are found along the coasts in varying amounts but average about 20,000 hectares. The trees are able to tolerate salty, muddy water that have high oxygen levels. Mangrove trees and Dabi trees are some the familiar vegetation of mangrove forests (Derrick, 1965).

Pollinators
Birds – The birds of Fiji can be found at all altitudes specifically the honeyeater. Honeyeaters are restricted to Australasia. There are said to be about 30 species that have spread to the Fiji islands. The honeyeaters have a close mutual association with the flora in this region and are important pollinators of many Australasian trees and bushes (e.g., Eucalyptus, Banksia,
Callistemon, Correa, Epacris, etc). They have a brush-tipped tongue used to forage on a variety of flowering plants (Roberson 2005). Some other species include the parrots and lorikeets.

**Bees** - Bees play an important role in the pollination especially of the coconut tree. Other insects have been observed in helping the cross-pollination of the coconut but as significant as the role of the honey bee.

**Bats** – Bats of the genus *Pteropodidae* are generalists who are important pollinators and seed dispersers in Pacific oceanic ecosystems. They help maintain diversity of dominant forest trees by affecting the regeneration and genetic flow (Banack 1998).

### Cases

**Cocos nucifera and honey bees** – The coconut palm (*Cocos nucifera*) is found in tropical environments around the world including. It is an important tree to the Fijians by supplying food, drink, house-building supplies and much more (Derrick, 1965). The tree is a branchless trunk and a top that has 20 to 30 feather-shaped leaves. When a new inflorescence is formed it later can produce 1 to 20 nuts (Woodruff 1970). Flowering occurs throughout the year. The flowers remain open only 1 day primarily between 6 a.m. and noon. It is only a few millimeters in size and has three cream-colored petals and six stamens. Pollinators include bees, ants, and flies. However, according to Whitehead and an unknown author, both of whom have studied coconut pollination, the honey bees are the biggest pollinators. Whitehead noticed 103 visits by honey bees in a 30 minute period (Scholdt and Whitehead 1969). An anonymous author noticed that the flowering coconut trees in Fiji that were freely visited by honey bees produced a higher yield of nuts (1916). Thus, honey bees seem to function as pollinators for the coconut palm tree.

**Pteropus samoensis** - The bat species *Pteropus samoensis* are an endemic species to Fiji. They inhabit different altitudes and were found to forage on fruit and flower resources throughout the year. Through studies, Banack noticed the bats feeding on 32 different plant species for fruit or flowers. The bats seem to use the flowers for both the pollen and nectar. However, they only visited the flowering plants in the months when the fruit yields were some of the lowest. The most common trees that the bats were seen visiting for flower use were *Syzygium inophyloides, Freycinetia reinecki*, and *Palaquium steinhii*. Even though the bats were seen taking nectar from the flowers they also use them for the pollen and may help the pollination of the plants (Banack 1998).

### References


New Zealand

Marie Hoelgaard

Introduction

New Zealand is situated in the South Pacific Ocean, between latitude 34°S and 47°S. It lies about 2.012 km southeast of Australia. New Zealand consists of two main islands and a number of smaller outlying islands so scattered that they range from the subtropics to the antarctic. The area is about 269,000 km². New Zealand's two main components are the North Island and the South Island, separated by Cook Strait. The North Island (116,000 km²) is 829 km long and volcanic in its south-central part. The climate is subtropical whereas the climate on the South Island is temperate. The South Island (153,000 km²) has the Southern Alps along its west coast, with Mount Cook (3,754 m) as the highest point.

New Zealand's separation from other landmasses about 100 million years ago allowed many ancient plants and animals to survive and evolve in isolation. The result is many unique plants and animals.

New Zealand is one of the most recently settled major land masses. Polynesian settlers arrived some time between 800 - 600 years ago to establish the indigenous Māori culture (www.seafriends.org.nz).

Flora and Landscapes

About 80 per cent of the New Zealand flora only occurs in New Zealand, including more than 40 endemic genera. The main two types of forest have been dominated by podocarps including the giant kauri and southern beech. The remaining vegetation types in New Zealand are grassland of grass and tussock, usually associated with the subalpine areas, and the low shrublands between grasslands and forests. There are 3954 species of angiosperms, 1546 of these are endemic and 2077 are exotic. Additionally there are 51 species of gymnosperms (www.landcareresearch.co.nz).
New Zealand flowers are characterized by being small in size and simple in structure. When contrasted with other floras, they have a high proportion of white flowers, this is particularly striking in genera that are mostly brightly coloured elsewhere (Webb and Kelly 1993).

**Fauna**

Until the arrival of the first humans, 80% of the land was forested and besides two species of bat, there were no non-marine mammals at all. Instead New Zealand's forests were inhabited by a diverse range of birds including the flightless Moa which is now extinct, the Kiwi and many more which are all endangered due to human actions. Reptiles presented in New Zealand include skinks and geckos and the Tuatara. There are no snakes but there are many species of insects.

About 100 species of native, terrestrial vertebrates live in New Zealand. 3 species of frog, 30 species of reptile (all lizards but one – the tuatara), around 65 land birds and 2 species of mammal (bats). Furthermore there are many marine species of bird and mammals. Since Europeans arrived there has been introduced around 70 species of terrestrial vertebrates. Because New Zealand has been isolated for so long these introduced species is a great threat to the native wildlife and many native species is already extinct. Especially all the species of flightless birds that evolved as a result of the lack of mammalian predators is very vulnerable (Kuschel 1975).

**Pollinators**

Pollination has not been studied well in New Zealand, but there is a tendency towards very primitive pollination systems and no evidence of coevolution between plants and pollinators. New Zealand plants rely on a higher proportion of unspecialised insect pollination than do plants in most other parts of the world (Newstrom and Robertson 2005).

Bees – there is a complete lack of large social bees. There are 40 species of bees in New Zealand, all are small, solitary and most function as generalist pollinators.
**Butterflies** – there is a very low diversity of butterflies. Only 30 species are known. No specialised butterfly pollination systems has been reported.

**Moths** – more than 1800 species are known but little research is conducted on their pollination.

**Flies** – the abundance and diversity of *Diptera* is very high in New Zealand. Many of the families are important pollinators in New Zealand.

**Beetles** – there are evidence of beetle pollination but they do not play an important role.

**Birds** – there is a very low diversity of bird pollinators compared to other parts of the world. Only 51 species of bird-visited plants are known. The pollinating birds are generalists.

**Bats** – one of the two endemic bats are known to pollinate a few plant species. It is not a nectar feeding specialist but has a broad omnivorous diet.

**Lizards** – few observations has been documented. There are no adaptations of the plants to lizard pollinators. Lizard pollination is most common on minor islands (Newstrom and Robertson 2005).

**Flora and fauna invasions**

New Zealand has suffered from many invasions of exotic plants and animals. These invasions often results in extinctions of native wildlife and changes in the food web. The influence however on the plant-pollinator systems seems to be minimal. This may be because there are no specialised pollination systems. If a pollinator is lost others can take over since there are no evidence of coevolution between plants and their pollinators and most pollinators are generalists (Newstrom and Robertson 2005).

**References**


Pitcairn Islands
Katrine Meisner

Introduction
The Pitcairn Island group is one of the most remote groups of islands in the South Pacific, it is situated about halfway between New Zealand and Peru (25°4’ S, 130°06’W); the nearest larger landmass is New Zealand which is 4800 km away, no major landmass is within a 5,000 km radius. The Pitcairn group comprises four islands: the volcanic Pitcairn Island, Henderson, an atoll uplifted by eruption of Pitcairn, and two atolls Oeno and Ducie. In addition to the isolation of the group the distances within it are also large: Henderson lays 200 km E-N-E of Pitcairn, 200 km east of Oeno and 360 km west of Ducie which is 600 km from Pitcairn (Brooke et al. WWW). The age of Pitcairn Island is less than 1 million years and Henderson, Oeno and Ducie are c. 16, 13 and 8 million years old, respectively (Kingston and Waldren, 2005). Pitcairn Island is the only one of the four islands inhabited by humans, in 1789 the mutineers of Bounty settled there, the island had previously been settled by Polynesian travellers. In 2003 there were 38 permanent residents. On Henderson Island there is evidence of Polynesian presence from 1250 to 1425 AD. The island is now a UNESCO World Heritage Site. Much of the information available on the Pitcairn group is from Henderson since this is the most researched of the islands. The climate is tropical mean annual rainfall on Pitcairn Island is 1716 mm, mean summer temperature is 17-28°C and mean winter temperature is 13-23 °C (Florence, 1995)

<table>
<thead>
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<th></th>
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<th>Ducie</th>
<th>Pitcairn</th>
<th>Henderson</th>
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<td>0</td>
<td>9</td>
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After J. Florence et al., 1995
Flora and landscapes

Due to the different origin of the four islands they have different landscapes. Being occupied by humans Pitcairn Island is the most disturbed of the islands but has more vegetation communities than the others, partly because of its greater altitude. The landscapes on Pitcairn include: *Metrosideros collina* woodland, *Homalium taypau* woodland, *Syzygium jambos* woodland, mixed woodland, weedy scrub and coastal scrub communities (Kingston *et al*., 2003).

Ducie is frequently overflooded by seawater; there are only two species of vascular plants on Ducie *Tournefortia* sp. and *Pemphis acidula* (Florence, 1995).

The landscapes of Oeno and Henderson include low stature scrub communities (up to 3 m) dominated by *Argusia argentea*, beach-front communities with herbaceous and shrubby species: *Scaevola taccada*, *Heliotropium candidum*, *Suriana maritima*, *Pemphis acidula* and *Argusia argentea*, closed and embayment forests up to 12 m high, taller tree species include *Guettarda speciosa* and *Pandanus tectorius*; smaller trees include *Celtis pacifica* and *Pisonia grandis*, *Cordia subcordata*, *Thespesia populnea*. Open limestone scrub: *Timonius polygamus*, *Eugenia reinwardtiana*. Cliff communities: *Heliotropium anomalum*, *Eugenia reinwardtiana*, *Chamaesyce sparrmannii*. Plateau forest communities dominated by *Pisonia grandis* but other species include *Nesoluma st-johnianum*, *Celtis pacifica*, *Xylosma suaveolens*, *Pandanus tectorius*. (Brooke *et al*. WWW) One native species of orchid is present on Henderson, *Taeniophyllum fasciola* (Florence and Waldren, 1995).

Pollinators

Birds: The islands are breeding ground for numerous species of sea birds but very few land birds inhabit the islands. Pitcairn Island has one endemic species of land bird: the Pitcairn Reed Warbler (*Acrocephalus vaughani*). Henderson Island holds four endemic species of land-birds: the Henderson Island Rail, *Porzana atra*, Henderson Island Fruit-Dove, *Ptilinopus insularis*, an endemic subspecies of the Pitcairn Reed
Warbler (Acrocephalus vaughani taiti), and Stephen's Lorikeet, Vini stepheni, which feeds on nectar. (Brooke et al. WWW)

Lizards: One species of gecko (Lepidodactylus lugubris) and three species of skink (Cryptoblepharus poecilopleurus, Emoia cyanura, Lipinia noctua) have been recorded from Henderson (Gill 1993). All are most likely Polynesian introductions; none of these are known to be pollinators.

Mammals: Domestic cats, Felis domestica and Polynesian rats, Rattus exulans, have been introduced to Pitcairn Island, also mice, wasps, ants and fruit flies (Kingston and Waldren, 2005). The only mammal on Henderson is the Polynesian rat; no mammals are present on Ducie and Oeno.

Insects: The honey bee, Apis mellifera has been introduced to Pitcairn Island. Not much is known about the insect fauna of the islands but 26 species of Lepidoptera are recorded for the islands, including one species of butterfly recorded on Henderson: Hypolimnas bolina (Holloway, 1990).

Threats to native interactions

The main conservation problems of the Pitcairn group concern Pitcairn Island; 250 species of plants and animals have been introduced to the island by humans. The Rose apple tree, Syzygium jambos, is a major problem on Pitcairn as it invades the native communities; it is pollinated by the introduced honey bees. S. jambos along with Lantana camara and Lablab purpureus pose a threat to an endemic species of land snail (Kingston and Waldren, 1995).

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Juan Fernandez Islands
Gudny Asgeirsdottr

Introduction
Juan Fernandez is a subtropical archipelago that was encountered in 1574 by Juan Fernandez. It is composed of three islands, the volcanic islands of Robinson Crusoe (also known as Más a tierra), tiny, mostly insignificant Santa Clara and Alejandro Selkirk (also known as Más Afuera). These islands are located 667 km west of Chile at latitude 33˚ 36′–33˚ 47′S and longitude 78˚ 47′–80˚ 47′W and have an area of 100.2 km². Santa Clara is thought to be the oldest of the islands, about 5.8 million years old, and Alexander Selkirk has the highest peak, Los Innocentes at 1319 meters. The Juan Fernandez archipelago is one of the few regions of the world where there were no permanent human settlements before 16th century, the European maritime expansion.

Pollination landscapes
Each island has its own somewhat distinct vegetation types. On Robinson Crusoe Island the zones are grasslands, introduced shrubs, tall forests, lower montane forests, tree fern forests, and high brushwood on exposed cliffs. Santa Clara Island has been denuded of shrubby vegetation and consists largely of grassy slopes throughout. On Alejandro Selkirk Island the zones are grassland slopes and deep ravines ("quebradas"), lower montane forests, upper montane forests, high brushwood, and an "alpine zone".

In general terms, the vegetation on Juan Fernandez archipelago is composed roughly of upper and lower montane forests of endemics as well as grassland, dry land with mostly aliens, cultivated areas, and two types of shrubland. The temperatures range in the archipelago throughout the year from 3-34°C, with an annual mean of 15.4°C. Average annual rainfall is 1081 mm, ranging yearly from 3118 to 1698 mm.
Pollinators

The native flora of the archipelago is small in number, only 156 flowering plant species. The level of endemic vascular plants is however high (~63%) including 11 genera and one family, Lactoridaceae. The endemic species density in the Juan Fernandez archipelago is higher than any other oceanic island: 2.08 species/km². At least one of the endemic species has gone extinct during historical times, the native sandalwood, and several others are on the verge of disappearing.

There are few floral visitors overall and the total insect activity on flowers is very low. Native insect pollinators are virtually absent and detected visits are very few and then mostly to species with white flowers. Flies are the most common visitors, followed by moths and beetles. Hummingbirds are essential, effective pollinators. Both sexes of two hummingbird species, which are the only two known hummingbirds on oceanic islands in the Pacific, one native (Sephanoides sephaniodes) and one endemic (S. fernandensis) have been observed actively taking nectar from several species. The plant species from which they extract nectar have long tubular flowers with red, orange, violet, or purple corollas and are self-compatible, except for Cuminia eriantha whose compatibility is unknown.

Cases

Two plant taxa, Escallonia callcottiae and Dendroseris litoralis are facultative selfers and produce nectar as reward. They are frequently visited by hummingbirds, which likely transfer the pollen. In addition, a few fly and moth visits have also been recorded but no visitors other than hummingbirds have ever been observed on the flowers of plants in situ. The position of the globular stigma (very close to the anthers), its large size, and the fact that it is very humid and sticky, promote self-pollen deposition as soon as the flower opens. Dendroseris litoralis may accomplish self-pollination when the stigmatic branches recurve back and touch residual pollen, if not removed in previous visits by hummingbirds.
Nicotiana cordifolia and Rhaphithamnus venustus are not facultative selfers and are also both frequently visited by hummingbirds seeking the abundant nectar in the flowers.\(^\text{a}\)

One of three species with unknown compatibility is thought to be pollinated by hummingbird. The rare gyno-monoecious Cuminia eriantha has tubular pink flowers that produce abundant nectar. Flowers are frequently visited by hummingbirds and therefore thought to be bird pollinated.\(^\text{a}\)

Most of the flowering plant species of the archipelago is thought to be wind pollinated (60%) or hummingbird pollinated (20%), a smaller number are purely autogamous (8%). The remaining percentage is still unknown, but is though probably also wind pollinated.\(^\text{a}\)

References


Hawaiian Islands
Petr Klimeš

Introduction
The Hawaiian archipelago, with a total land area of 16 710 km², is the most isolated group of higher islands on the Earth. They extend about 2400 km across the north-central Pacific Ocean (154°-160°W and 20°-22°N). They are about 3 800 km west of North America and a similar distance from the nearest neighbouring high islands the Marquesas in French Polynesia (Howarth and Mull 1992:9). The Hawaiian islands consist of the tops of ocean volcanoes and have never been connected to any body of land. So all of the native plants and animals in Hawaii are descended from organisms that made their way there through the air or across the water from the surrounding distant continents and islands. An adaptive radiation has led to a fast dramatic diversification of the organisms and thus most native Hawaiian species are endemic (Olson 2004). The Hawaiian archipelago is located near the center of the Pacific Plate, which is moving toward the northwest. Therefore the islands moved away from the hotspot to the northwest and thus the northwest islands are more eroded and older than the southeast islands (Olson 2004). The southernmost Hawai’i is the youngest (less than 700 000 years old) and largest (10 458 km²) main island with the highest volcano Mauna Kea with altitude 4 205 m above sea level contrary to the northwest main island Kaua’i, which is about 5.5 mil. years old and rises only 1600 meters above the sea (Howarth and Mull 1992:9).

Pollination landscapes
The Hawaiian Islands support a remarkable number of different habitats. The climate varies dramatically from arid tropical on the leeward seashores with less than 26 cm annual rainfall to the windwards peaks on Kaua’i with record annual rainfall 1 152 cm (Scott et al. 2001:1). More than 100 different native plant communities and 150 distinct natural ecosystems have been recognised since different climate, local topography, type of lava, age, altitude and degree of isolation between islands...
The approximately more than 1 000 species of native angiosperms plants are descended from about 300 separate founders that colonized the islands and 89 % of these species are endemic. The composition of the flora is moreover complicated by a large number of non-native species. There are about 900 introduced naturalized plants species today (Millen http:3). Botanists described several different vegetation zones in Hawaiian islands (Howarth and Mull 1992:9-11, Millen http:27). Strand salt zone is dominated by low shrubs on the windward side and low-growing perennial plants on the leeward side. There are more non-endemic species, probably because they are easily dispersed by floating or by birds. The other zone of coastal vegetation lies to 300 m and consists of arid areas on the leeward and mesic areas on the windward coast. Dryland forest dominated on the leeward side of the main islands to 900 m, but this area has been most influenced by agriculture, many of the native trees have become rare and now it is dominated by introduced grasses such as *Pennisetum setaceum*. The mezic forest occurs above 750 to 1250 meters. This zone has an open canopy with a mixture of trees and shrubs such as endemic species of the genera *Pelea, Cyanea, Acacia* and *Metrosideros* and this is common on the Moloka‘i and O‘ahu islands. The rain forest occurs to 1700 m on the windward side and is characterized by high rainfall 150 to 300 inches per year and by the highest diversity and number of endemics. Only on the highest mountains of the islands Hawai‘i and Maui at 1850 m and higher the subalpine zone occurs, which is dominated by native trees *Sophora* and *Myophorum* and above 2000 m is changing to the cool alpine scrub and the aeolian dry zone.

**Pollinators**

In Hawaiian Islands there are no native amphibians and reptiles and no native mammals with the exception of one species the American bat (Zimmerman 1970), which is insectivorous (Carpenter 1976). There live at present only 54 species of native birds and 35 of which are endemic (Scott et al. 2001: 1-14). About 95 % of the 5 565 described species of native terrestrial arthropods are insects, but they
represent only 15% of the known families of insects and they are descended from only 350-400 ancestral immigrants (Howarth and Mull 1992:18).

INSECTS- Among native insect fauna there are perhaps many species that visit flowers and are potential pollinators, but unfortunately little work has been done on pollination biology among Hawaiian plants and insects (Stone and Scott 1985:184). There is a significant lack of large odourous and bright-coloured native Hawaiian flowers, probably because there live only a few native butterfly species and no native social bees. Small beetles and flies are numerous and many native plants have small, greenish-white flowers which are beetle or small insect-pollinated (Millen 2005). The flowers of the Hawaiian genera *Clermontia* and *Cyanea* (Lobelioideae) are attractive to many species of the native drosophilid fauna (Spieth 1996). There live also 64 species of native yellow-faced bees (Colletidae), which are important pollinators of native plants (Howarth and Mull 1992:55).

BIRDS- 20 of 35 living native species of birds belongs to endemic subfamily Drepanidinae (Fringillidae) also called Honeycreepers (Scott et al. 2001). Many of the Drepanidids species are nectar feeders and are so important pollinators of many native plants, many of which have typical bird-pollinated large colourful red-purple twisted flowers (Millen 2005). Probably the most investigated nectarivorous species are Apapane (*Himatione sanguinea*) and l’iwi (*Vestiaria coccinea*). They breed mostly in wet forests, but also make movements to leeward dry and subalpine zone, following the availability of nectar of the tree *Sophora chrysophylla* in the period of low *Metrosideros* flower availability in wet forests (Scott et al. 2001:154). Spieth (1966) described the coadaptation between l’iwi and flowers of *Clermontia arborescens* (Lobelioideae). L’iwi has specially decurved long bill, which precisely fits into the decurved corolla of *Clermontia* flower and displays unique acrobatic posture, when it is eating. Probably because of dramatic decline of its previously favoured nectar source the lobelioids plants, l’iwi now consumes more nectar of the ohia trees *Metrosideros* (Myrtaceae). Smith et al. (1995) established the selection of l’iwi for the shorter bill, after the shift in diet from the long corolla lobelioid flowers to ohia flowers without corrolas. The native ohia three *Metrosideros collina*, the most
abundant species in the undisturbed forests today, is associated with Apapane and l’iwi. Flower colour of this tree varies from light yellow to deep red. It seems that yellow flowers are adapted for insect pollination, whereas the red-flowering trees occur more at higher elevation, where the honeycreeper live and are birth-pollinated (Carpenter 1976).

**Introduced species**

When the Polynesians came about 400 A.D., they introduced about 60 plants and animals and they started to alter the landscape by agricultural activities. After the arrival of captain James Cook in 1778, which discovered Hawaii for Europeans, the change of Hawaiian nature was accelerated (Olson 2004). Now there live in Hawaii about 3 260 alien arthropod species (Howarth and Mull 1992) and at least 140 species of 14 different orders of birds have been introduced (Scott et al. 2001:31). The impact of some alien species is devastating (Olson 2004). About 19 endemic birds have disappeared since the 18th century and almost all of the rest species are threatened (Scott et al. 2001). There are documented about 100 extinct species of plants (Millen http). The introduced wasp *Vespula germanica* and an aggressive ant *Pheidole megacephala* have decimated many native insects (Howarth and Mull 1992). The introduced bees *Apis mellifera* and *Xylocopa sonorina* rob nectar in flowers of native plants (Stone and Scott 1985:185). This all means an obvious danger to native pollinators and their plants, which are alive yet. Fortunately there are some efforts of scientists and volunteers to map and to rescue the rest of the native Hawaiian fauna (see HEAR project http://www.hear.org/).

**References**


Galápagos
Dorthe Jensen

INTRODUCTION:
The volcanic archipelago Galápagos Islands is placed in the Pacific Ocean just on the Equator ranging from 1°45´N to 13°S. The North Western islands have an age of 750,000 years and the South Eastern islands between 4-5 million years. The nearest mainland is towards east of the archipelago at a distance of 1000 km. The landmass of the archipelago covers 7882 sq km. Galápagos Islands consists of 13 major islands, 6 small islands and scores of islets. 97% of the Galápagos Islands has been National Park since 1959. The second largest major island is named Isla Santa Cruz which landmass covers 986 sq km. The highest point of the island is Cerro Crocker at 864m. 10 km north of Isla Santa Cruz are Daphne Islands found. These are two small islands covering a landmass of 1 sq km all together. The highest point is found on Dahne Major and reaches 120 m. Though the islands are characterised by steep, eroded and dry slopes (Rachowiecki & Palmerlee 2003). Isla Santa Cruz and Daphne Major are by Adsersen (1989) mentioned to be in the same insular unit. This unit will be the main geographic site in this essay.

FLORA AND FAUNA:
The colonization of the Galápagos Islands is described by a model to be initialised by colonization of the islands in the southeast, the oldest ones, and followed by colonization of islands to the north and northwest, the youngest ones (Harvey, 1994).

THE OPUNTIA GENUS AT THE ISLA SANTA CRUZ INSULAR UNIT:
On the Galápagos Islands there have been counted 604 species and subspecies of indigenous plants. Of those 144 are termed rare. Of the endemic plants consist a great part of rare species (31%) than the native plants (20%) (Adsersen, 1989).
Some of the endemic and according to the sources Adersen (1989 and Lawesson et al. (1987) rare species are members of the genus *Opuntia* (Cactaceae). The Galápagos Islands are home to 6 *Opuntia* species with 14 varieties in total. All cacti are endemic to the Galápagos Islands and pollinated by different animals – among these are birds (Hicks & Mauchamp 1996). The demographic characteristics of the *Opuntia* genus are slow growth and long life span (4.3 cm/year; 150 years) (Hamann 2001).

The subspecies *Opuntia echios* var. *gigantea* is endemic to the Isla Santa Cruz and it is found in the arid zone of zonobiom II (Siegmar 2002). The vegetation is ranging from dry season deciduous steppe forest to forest (Hamann 2001). The abundance of the *Opuntia echios* var. *gigantea* is highest in the lower elevations and opening with the higher altitude (Hicks & Mauchamp 2000). The flower of *Opuntia echios* var. *gigantea* is obligatory outcrossing. On Isla Daphne Major there is found a pollination relationship between the cactus *Opuntia echios* and the finch *Geospiza scandens* (Grant & Grant 1981).

THE OPUNTIA POLLINATING FINCH, *Geospiza scandens*:

The cactus finch, *Geospiza scandens*, is one of the 14 Darwin finches on the Galápagos Islands. Of those are six species ground finches. The *G. scandens* is a specialist and dependent on the presence of the *Opuntia* sp. The finch nests in these cactuses as well (Grant et al., 2004). The beak size and shape of Darwin´ s finches differ according to the birds’ food sources. The *G. scandens* uses its long and slender bill to extract the pulp from the *Opuntia echios* (Campbell, P.). The finch is common in the arid lowlands and hills of many of the larger islands of the archipelago, especially where the *Opuntia echios* grows (Lysinger, M). It is found that the breeding succes of the finch is correlated to the climate conditions. There is a positive correlation between breeding success and rainfall. This is very obvious during the El Niño years (Grant et al., 2000). The climate affects the plant survival and productivity. A dry season causes a lower food source availability to the *G.*
scandens. These conditions has been shown to be the explanation of an increasing inbreeding depression in G. scandens populations (Keller et al.)

THE PLANT AND POLLINATOR RELATION:
It is found that G. scandens not only pollinate O. echios. It also drinks nectar and eat the pollen grains and aril around the seeds. The aril consumption often leads to cracked and or occasionally dispersed seeds.

In the dry season when other food items might be scarce G. scandens opens the early flower buds to rub the pollen grains before flowering. This rubbery often includes snipping the style and destroying the stigma. If the stigma is destroyed the ovules do not get fertilized and as a consequence the flower does not produce seeds for the G. scandens to feed on later. This action limits the food source and obviously seems to be a disadvantage to the pollinator. Grant & Grant explain the disadvantageous pollen robbery with the short term benefit in gaining access to pollen in the dry season when the total seed access might be scarce on the Isla Santa Cruz insular unit. Further explanations say that the style snipping could be a method for the birds to mark the already visited flowers so that the foraging will be as economical effective as possible.

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THE WEB:

Cuba

Hubertus Heinicke

Introduction

Cuba, between the 19\textsuperscript{th} and 24\textsuperscript{th} degree of northern latitude 74\textsuperscript{th} and 85\textsuperscript{th} degree of western longitude, is the largest island from the Greater Antilles. The main island is 1200 km long and between 30 and 190 km wide. The area is about 110,860 km\textsuperscript{2}. The highest mountain is Pico Turquino and this mountain is 2005 m high.

Like Jamaica, Cuba was much closer to Central America after the last glaciation. Also the age of Cuba is similar to the other islands from the Greater Antilles and is approximate 24 million years.

On this island the climate is subtropical maritime with a high humidity (80-90\%). The rainy season is from May until October and the average rainfall is more than 1,600 mm. Seasonal variation of the mean temperature is from 21°C (February) to 33°C (July – August).

Pollination landscapes

Western Cuba is home to the wooded mountain slopes of the Sierra del Rosario with its tropical rainforests and mixed vegetation, and the Sierra de los Órganos, including the Viñales Valley, notable for its limestone landscape of sheer hills, many of which contain large caverns.

Flat, fertile land dominates central Cuba, ideal for breeding cattle and for growing tobacco, food crops and sugar cane. A few mountain formations also dot this landform, including the Sierra del Escambray.

The Oriente region in eastern Cuba produces a substantial amount of sugar cane, making the area indispensable to the national economy.

Pollinators

Bees – belong to the most important pollinators in Cuba. For example for the “Bambusa vulgaris” are the most common visitors the two Trigona biroi and Halictus
sp. Especially there are also a lot of *Euglossa* species, which are also found in Central America.

**Butterflies**- also the butterflies are really important pollinators, but there are not many species on the island. For example the species *Pachliopta hector* L. and *Catopsilia pyranthae* L. observed commonly at the *Catharanthus roseus* (L.)

**Birds** - Cuba has a remarkable avifauna, ranging from Bee Hummingbirds (Trochilidae), Cuba has 24 endemic species as well as many other Caribbean specialities.

**Lizards and geckos** – Reptiles have the highest number of species in Cuba (Number of total known species, 1992-2003: 153). Most of them are lizards and also a lot of them are important pollinators.

**Cases**

As I mentioned before Cuba is the biggest Island from the Greater Antilles and it is also very close to Mexico and Florida from the main country and to other big islands from the Greater Antilles Haiti and Jamaica. You will find in Cuba a high number of species. For the higher plants is the number of the total known species (1992-2002) 6,522. Some of them are newly imported agriculture plants like the Papaya (*Carica papaya*, Caricaceae), but also a lot of Passifloraceae species. Most of these Passifloraceae species are pollinated by bees, hummingbirds and some lizards. Also, I found out, that some species are bat pollinated. A common tropical ornamental plant, which also occurs in Cuba is the *Catharanthus roseus* (L.), which is pollinated by butterflies. The most important pollinators are the bees, butterflies and bats, because it seems that the lizards and the hummingbirds are just nectar robbers. Especially some lizards species, which stole the nectar and the pollen from the plant visiting bees.

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Dominica, Lesser Antilles
Ana Martín González

Introduction Dominica (15° 25N, 61° 20W) is an island of 751 km² of the Lesser Antilles. It is situated 43 km south of Guadaloupe and 39 km north of Martinique. The distance to Venezuela, nearest mainland, is 502 km (www.nationalgeographic.com). It is a true oceanic island of volcanic origin that was formed, along with its surrounding islands, in the Cretaceous (http://library.iem.ac.ru/j-petr). Dominica is very montaneous, Mt. Diablotin (1447 m) is the highest peak.

Pollination landscapes (based on Lack et al. 1997). The most widespread habitats, from low to high elevation, are as follows. There are also restricted areas of grasslands, swamps and fumaroles.

a. Littoral Vegetation Present in some coastal areas on the Atlantic side. This vegetation type suffers from constant strong winds and high rainfall. It is mainly formed by Tabebuia pallida, Chrysobalanus icaco and Terminalia catappa trees, as well as herbs from the Asteraceae family.

b. Dry Scrub Woodland Present in the lowland at the Caribbean side of the island. It is characterised by tall trees with showy flowers, mostly flowering at the end of the dry season when the majority are leafless, mainly Bignoniaceae and Fabaceae and Cordia sp. shrubs.

c. Cultivated and Disturbed Land Widespread from the lowland to mid-elevations all over the island. Primarily covered by fruit crop such as banana, citrus and mangoes and vegetable crops as dasheen and tannia, but also ornamental plants for commercial trade.

d. Rainforest From around 200 m to 800 m. The island has the best conserved rainforest of the Lesser Antilles. It is evergreen and reaches more than 40 m. Mainly Sloanea sp., Dacryodes excelsa and Amanoa caribia trees, with many climbers (Marcgravia sp., Hillia parasitica, etc.) and epiphytes.
**Montane Thicket & Elfin Forest** Just above the rainforest and up to the summits. Mainly *Clusia* sp., Melastomataceae and Rubiaceae species, the dominant palm *Prestoea acuminata*, tree ferns and mosses. Elfin woodland on the exposed ridges, where the plants become smaller and denser.

**Pollinators**

**a_Birds** In Dominica there are five pollinating birds: the bananquit (*Coereba flaveola*) common and widespread throughout the island, and four hummingbirds. From low to mid elevations we find the Green-throated Carib (*Sericotes holosericeus*) substituted by the Purple-throated Carib (*Eulampis jugularis*) from mid to high elevations, both with long curved bills. The other two hummingbirds are smaller with small and straight beaks, the Blue Headed Hummingbird (*Cyanophaia bicolor*), restricted to high elevations, and the Antillean Crested Hummingbird (*Orthorhyncus cristatus*), common all over the island though less frequent at high elevation and in the interior rainforest (Lack 1973; *Pers. obs.*).

**b_Bats** One species of nectarivorous bats, the Lesser Antillean endemic Long Tongue Bat (*Monophyllus plethodon*) restricted to montane forest and banana plantations (Evans & James 1997) was fairly active (*Pers. obs.*). Also, the Antillean cave bat (*Brachyphylla cavernarum*), that although frugivorous, might also take nectar. It lives in the rainforest (Evans & James 1997).

**c_Insects** 55 species of lepidopterans (Evans & James 1997), and numerous species of hymenopterans (bees e.g Honeybees and *Xylocopa* sp., wasps and ants) and dipterans (mainly Syrphidae and Muscidae), as well as some coleopterans (*Curculionidae*), hemipterans and thrips (*Pers. obs.*).

**Cases**

*Cordia globosa*. A highly generalised species of shrub from the Boraginaceae, common along the west coast. Flowering at the end of the dry season for about 2½ months. Many inflorescences with 3-4 small, white and fragile flowers. Nectar concentration between 20 to 50%, visited by many different species of butterflies,
bees, wasps, ants and birds. It is one of the most generalised plants in the Dry Scrub Woodland (Pers. obs.). Other Cordia species, C. martinicensis (North of Dominica) and C. lutea (Galápagos), are also highly generalised (T. Ingversen, pers. comm.; McMullen 1993; respectively).

Marcgravia sp. Marcgravia is a genus of lianas with 45 species distributed in South and Central America. 3 species (M. trinitatis, M. umbellata and M. lineolata) occur in the rain and montane forest of Dominica. They are all visited by hummingbirds, however, the Purple-throated Carib is the only one that pollinates. In addition, the first two species are also pollinated by the bat Monophyllus plethodon (Zusi & Hamas 2001). Even though this group has been hypothesised to be mainly ornitophilous, studies have shown that they might have evolved towards night-pollination, since some species (including M. trinitatis, M. umbellata in Dominica) have anthesis in the evening, the anthers are usually shed the next day at noon and are visited by nocturnal animals such as bats and opossums (Dressler pers. comm., Zusi & Hamas 2001).

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