EFFECTS OF THE 1997-98 EL NIÑO EVENT ON THE VEGETATION OF GALÁPAGOS

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INTRODUCTION

During the last large El Niño event, in 1982–83, heavy rain fell on Galápagos for nine months, forming rivers and eroding channels in many places, including normally arid areas. The vegetational changes that took place during that El Niño event are summarized by Hamann (1985).

Similar changes occurred during the most recent El Niño, which began in early 1997 with a heavier-than-normal rainy season and continued to the end of the wet season in 1998. During 1997, there was no garúa season, merely a drier period about September–October, and the vegetation did not dry up as in normal years. In some areas with friable soils, such as southern Santa Cruz Island and Alcedo Volcano on Isabela Island, the heavy rains produced powerful temporary watercourses, which eroded deep channels and removed all surface vegetation, including large trees.

EFFECTS ON THE VEGETATION OF THE SEMI-ARID ZONES

Herbaceous vegetation

In the Littoral, Arid, and Transition zones of the larger islands and throughout the lower islands, the general appearance during July–December 1997 was much greener than is usual for this normally dry part of the year. The herbaceous understorey layer, dominated by grasses, annual herbs, and creepers, was unusually dense. Among herbaceous species, *Mentzelia aspera* and *Cassia tora* became extremely common, each in places forming dense monospecific stands of height about 1–1.5 m. In many places, creepers (both native and introduced species) covered the bushes and trees in a dense carpet. Among the native species of creeper, *Passiflora foetida* did particularly well. *Rhynchosia minima* also became very abundant, apparently throughout the archipelago (including Genovesa, Santiago, San Cristóbal, Santa Cruz, and Isabela islands, among others), as in 1982–83 (Hamann 1985). Of the introduced species, *Momordica charantia* and *Cucumis dipsaceus* became much more widely distributed than in normal years. On Floreana Island, *Cucumis* was found covering huge areas of shrubland and woodland in the Arid and Transition zones. It has since died back, and it is unclear whether El Niño has allowed it to extend its distribution or whether it was already widely distributed but was formerly, in normal years, much less conspicuous. *Cucumis* was first recorded on Española Island during the 1982–83 El Niño. It became very common again on that island during the recent event. *Momordica* became a very obvious component of the Arid Zone vegetation on several islands. In all of these cases, it is hard to know whether this apparent change represents a real extension of distribution, or just a temporary increase in abundance in areas where the plants were already present.

Cactaceae

The Cactaceae both benefitted and suffered from the effects of El Niño. Their rate of growth and flower production were greater, this being especially obvious in species of *Opuntia*, but they absorbed so much water that many larger *Opuntia* trees fell over under their own weight, as happened in the previous El Niño (Hamann 1985, Luong and Toro 1985). The plants have a relatively weak and shallow root system, which is not capable of supporting such a weight increase, combined with the stronger winds that are experienced during El Niño. Despite this mortality of adults, in many places, regeneration of young plants both by seed and vegetatively, was great during the Niño period. Large numbers of young cacti were seen in many places in the months following El Niño. These include not only individuals growing from seed that germinated during El Niño, but, judging from their size, there are also many young plants that had germinated in preceding years. These may have experienced a sudden growth spurt, having been "waiting" for the favourable conditions for growth that were provided by El Niño. In contrast to the reports for the 1982–83 El Niño (Hamann 1985), the *Opuntia* flowered well twice: at the beginning of the event in 1997, and again at the beginning of the rainy season following El Niño, in early 1999.

Lowland Scalesia *species*

Effects on the lowland species of *Scalesia* were mixed. Although no formal monitoring was carried out, these species are so conspicuous that effects on them are comparatively easy to judge. In addition, two projects begun during El Niño allowed us to collect some data on their populations. One project is to monitor selected rare species for growth and reproduction, and the other intends to bring up to date our knowledge of the status and distribution of endemic plant

species of Galapagos. Both include *Scalesia* species among their subjects. These observations revealed that during El Niño many adult plants of lowland zone *Scalesia* species died, perhaps because of root rot or temporary flooding. One or both of these probably caused the death of plants of *Scalesia helleri* in the demonstration gardens at CDRS, where nearly all of the plants that had been cultivated over the previous three years died. Mortality was also observed in adults of this species in wild populations on southern Santa Cruz, as was the case among older adults of *Scalesia crockeri* (northern Santa Cruz), *S. incisa*, and *S. divisa* (both of San Cristobal). On the other hand, all of these species showed dramatically increased regeneration, with virtually every adult of *S. helleri*, *S. incisa*, and *S. divisa* surrounded by a circle of young plants. In the case of *S. crockeri*, the population on the south coast of Baltra Island increased enormously, spreading from a few isolated patches, to a more or less continuous fringe along the coastal cliff. Similarly, the growth of *Scalesia helleri* on Santa Fe Island has been impressive, as in 1982–83 (Hamann 1985). It is hard to generalize from one group of plants to another, but it seems likely that many plants that share habitat requirements and growth characteristics with the lowland *Scalesia* species would have been similarly affected.

Effects on the rarest plant of Galápagos, *Scalesia atractyloides*, were unclear. The species was believed extinct until, in 1995, a population of *S. a. darwinii* was discovered, consisting of five adult plants growing on the vertical wall of a crater. Two of the five died in early 1997 from unknown causes; they might simply have been old, or heavy rain might have affected them adversely. The crater was enclosed by a fence in December 1997, but the other three adults died at some time during mid-1998. During 1997, several seedlings were found below the adult plants. Although most of these disappeared (probably eaten by goats) during the year, a few survived until the fence was constructed. Unfortunately, two goats entered the crater through a gap in the fence (now closed) and most of the seedlings disappeared. To date, two remain. A drought due to La Niña might reduce the chance of more plants growing from seed during 1999. In November 1998, the other variety of the species, *S. a. atractyloides*, was rediscovered, after having not been seen since the 1980s, at a site on the west coast of Santiago. Only two adults are still alive at the site, and no seedlings have been seen. Again, although the site has now been fenced (in December 1998), regeneration from seed could be delayed by a Niña drought.

Growth and phenology

Many species developed leaves much larger than in normal years, in some cases to such an extent that they appeared to be a different species. This was true of many species of shrub and tree of the Arid and Transition zones, including *Cordia lutea*, *Bursera graveolens*, *Piscidia carthagenensis*, *Croton scouleri*, and *Cryptocarpus pyriformis*. In some cases, flowers and inflorescences were also larger than normal. Many bushes grew higher than normal, including especially *Cryptocarpus*. There was also a greater rate of growth in height and trunk diameter of many shrub and tree species (see data from Alcedo in Aldaz and Tye, this issue). *Bursera graveolens*, which is normally leafless for most of the year, retained its leaves for longer, and individual trees lost their usual synchrony in the timing of leaf production and leaf fall.

New records

Few new records of introductions to islands were made during the 1997–98 El Niño, although it is probable that some have so far gone unnoticed. The new island records that were reported are unlikely to have been the result of spread facilitated by El Niño itself.

EFFECTS ON THE VEGETATION OF THE HUMID ZONES

Vegetation communities

In the higher parts of the larger islands, the ferns, herbs, grasses, and creepers grew tremendously, forming dense, impenetrable masses. Both native and introduced species flourished. Certain introduced species, including *Rubus niveus*, *Lantana camara*, and *Ricinus communis*, spread noticeably during the extended wet period.

Regeneration of native species was good in areas of the highlands that are badly overgrazed by goats and other feral ungulates. On both Alcedo Volcano and Santiago Island, the areas of the highlands that have been converted in recent years to open pasture or bare ground were covered with denser growth of grasses. Among the grass, regeneration of shrub and tree species was excellent. There seem to have been two reasons for this. The goats and other animals had largely dispersed to the lower parts of the islands, where the green vegetation was unusually succulent. Combined with this, the heavy rains led to increased germination and growth of young plants or resprouts. In the highlands of Santiago, the grassy areas, which were formerly mixed *Scalesia pedunculata* – *Zanthoxylum fagara* – *Tournefortia rufosericea* forest, developed abundant regeneration, especially of *Tournefortia*. Unfortunately, as El Niño ended, the goats moved back to the highlands and have already, within months, destroyed much of this new growth. In some species, this

may have depleted a precious seedbank without contributing to the production of replacement seeds. Regeneration of *Scalesia pedunculata* on Santiago was mainly limited to the small patches with remaining adult trees, reflecting its relatively short-distance seed dispersal mechanism (Hamann 1979). Many young plants, up to 2.5 m height, were found in such patches. Unfortunately, as the goats moved back to the highlands, these saplings were their prime targets, and most were immediately killed by having their bark eaten.

Further observations from the humid zones of Alcedo are presented by Aldaz and Tye (this issue).

Miconia robinsoniana

Effects on certain vegetation communities were marked. *Miconia robinsoniana*, the dominant shrub of the Miconia Zone on Santa Cruz, grew very well during El Niño, with bushes reaching over 3 m in height. Regeneration was good in areas where the species had been rare in preceding years and which had been dominated recently by a fern-sedge community. Regeneration was similarly good in areas heavily invaded by *Cinchona succirubra*, where the *Cinchona* was cleared by the Galapagos National Park Service (GNPS), such as on the outer slopes of Media Luna. Unfortunately, the *Cinchona* also did well during El Niño, and the density of young plants is now very high, across the majority of the area of the Miconia and Fern-sedge zones.

Scalesia pedunculata

The forests of *Scalesia pedunculata* in the highlands of Santa Cruz suffered a mass dieback during and after El Niño of 1982–83. Causes were thought to be root rot and high winds during El Niño rains, combined with the succeeding La Niña drought (Hamann 1985). The dieback resulted in strikingly even-aged stands of the species, which date from the subsequent regeneration. This phenomenon has not been repeated during the current event. Some wind-throw of adult trees was experienced, but no mass die-off of entire stands. Wind-throw also affected other trees in the highlands, including *Cinchona succirubra*, where many adult trees were seen with branches torn off, although relatively few trees were blown over. It remains to be seen whether a Niña drought continuing through the rainy season of 1999 will contribute to increased mortality of the *Scalesia*, but so far the effects do not seem as severe as in 1982–83. Hamann (1985) suggested that the normal lifespan of *Scalesia pedunculata* is about 15 years. If that is true, then the majority of the trees in the highland forests, at least on Santa Cruz, are near the end of their lives, since they germinated about 1982–84. Mass dieback now might be facilitated by the poor resistance of such older trees to unfavorable environmental conditions such as drought. Species undergoing periodic dieback and regeneration cycles, such as *Scalesia pedunculata* are vulnerable to invasion by species with a more continuous growth and regeneration pattern. Invasive species such as *Cinchona succirubra* and *Pennisetum purpureum* have become much more common since the 1982–83 event. A worry now is that a mass dieback of *Scalesia pedunculata* could be followed by invasion of its habitat by aggressive alien species of plant, which could prevent the regeneration of the *Scalesia* forests and thereby replace them. It remains to be seen whether this will take place in the coming year.

LITERATURE CITED

Hamann, O. 1979. Dynamics of a stand of *Scalesia pedunculata* Hooker fil., Santa Cruz Island, Galápagos. Bot. J. Linn. Soc. 78: 67–84.

Hamann, O. 1985. The El Niño influence on the Galapagos vegetation. *In* G. Robinson and E. M. del Piño, eds., El Niño en las islas Galápagos: El evento de 1982–1983, pp. 299-330, Charles Darwin Foundation for the Galápagos Islands, Quito.

Luong, T.T. and B. Toro. 1985. Cambios en la vegetación de las Islas Galápagos durante "El Niño" 1982–1983. *In* G. Robinson and E. M. del Piño, eds., El Niño en las islas Galápagos: El evento de 1982–1983, pp. 331-342, Charles Darwin Foundation for the Galápagos Islands, Quito.

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