DISTRIBUTION AND STATUS OF THE PTERIDOPHYTES OF FAIAL ISLAND, AZORES (PORTUGAL)

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KEY WORDS: Azores, dot grid mapping, Faial, Macaronesia, pteridophytes

ABSTRACT
In 1999, a dot grid mapping project based on the UTM 1 km² grid, was carried out on Faial Island, Azores (Portugal). Distribution maps of the 52 species of pteridophytes and two hybrids found on the island are presented. *Diphasiastrum madeirenses*, *Asplenium x ticinense* and *Nephrolepis cordifolia* are reported from the island for the first time. The status of each taxon on Faial was determined by intensive study of habitat, general distribution and literature.

INTRODUCTION
Faial Island is the westernmost island of the central group of the Azores, an isolated archipelago of nine inhabited islands in the northern Atlantic Ocean between 36°55’ and 39°43’ northern latitude, and between 24°46’ and 31°16’ western longitude (Figure 1). The distance to the European continent is about 1600 km and to the American continent, almost 2000 km.

Figure 1. Map of the Azores.

The islands are of volcanic origin and located near the seafloor-spreading zone of the mid-Atlantic ridge. Faial Island is probably less than one million years old.
SCHÄFER: PTERIDOPHYTES OF FAIAL ISLAND (AZORES) 214

(Frias Martins, 1998). This island has an area of 173 km² and is dominated by a large central crater and a few secondary cones in the west, the highest point reaching 1043 m. The last volcanic eruption was in 1957/58 (Zbyszewski et al., 1959). The climate is dominated by a branch of the gulfstream and by a high-pressure zone, called the "Azores anticyclone". Annual precipitation ranges between 1000 mm in coastal areas to more than 3000 mm in the highest parts (Schäfer, 2000a). Mean temperatures reach 17 °C near the coast but can be less than 8 °C in the highest parts (Schäfer, 2000a).

Though famous for their landscape and "unspoiled nature", the Azorean Islands are one of the most intensively used regions in Western Europe. Dairy farming, raising of bulls and plantation of exotic trees like Cryptomeria japonica (Taxodiaceae) and Eucalyptus globulus (Myrtaceae) has destroyed large areas of indigenous vegetation, especially on Faial Island. Today, forests dominated by native species such as Laurus azorica, Ilex perado subsp. azorica and Juniperus brevifolia can be found only in a very few, inaccessible places like steep cliffs, mountains or craters. Even there, invasive neophytes, for example Hedychium gardneranum (Zingiberaceae), Pittosporum undulatum (Pittosporaceae) or the worst of all: Hydrangea macrophylla (Hydrangeaceae), are a serious threat (Schäfer 2000a). Several Azorean endemics are almost extinct and will most likely disappear during the next few years, as nothing is being done to prevent further spread of neophytes. In the dot grid mapping project of all species of higher plants on Faial Island, distribution maps of both rare endemics and invasive neophytes were created. These maps can be used for protection of rarities as well as control of neophytes. In this paper, only data for the pteridophytes are presented, less than ten percent of the total flora of Faial.

METHODS

Fieldwork for this study was carried out on Faial Island from May to November 1999, with a previous exploration trip in December 1998. The area of the island was divided into 1-km-squares, using the Universal Transverse Mercator-Projection (UTM). The 173 km² of Faial Island are divided into 210 UTM squares marked by the numbers 64 to 78 from the South to the North, and 40 to 61 from the West to the East. Each km² was visited at least once during the stay. Every day, one square was visited on foot, usually for a period of 11 to 13 hours, depending on day length. All species of higher plants that were discovered in the square were marked in species lists based on Hansen & Sunding (1993), together with a short note describing the habitat. In rain and fog, a dictating machine was used. Difficult of access areas, like the steep slopes of Caldeira and some cliffs, were visited on several days and scanned by telescope, to achieve species lists as complete as possible.

Doubtful and unknown plants were collected during the day and identified at night. Rare, or assumed rare, species were usually not collected, but documented by photograph or determined in the field. The locations of relevant species were determined, using the Global Positioning System (GPS) Garmin GPS 12. The abundance of each species was noted in the field.

The mapping program FLOREIN 5.0 (Subal 1997), allowed production of provisional distribution maps and several kinds of synthetical maps throughout the mapping period. Much emphasis was put on the study of plant lists from former centuries. Following the method of other authors, e. g. Sjögren 1973b, the presence or absence of a species in these lists was used as an important factor in the decision as to whether a certain plant is an Azorean native or introduced. Voucher specimens of all
pteridophytes of Faial Island were deposited in the herbarium of the University of Regensburg (REG). In addition, some important specimens, e. g. *Diphasiastrum madeirense*, will be deposited in one of the best collection of Azorean plants at the Universidade dos Açores, Terceira (AZU).

**SPECIES AND THEIR DISTRIBUTION**

This list contains all the pteridophytes that were found to be well established and growing spontaneously on Faial Island. Cultivated ornamental plants and casuals were not included in this work. For each species, information about the ecology and distribution on Faial, distribution in the Azores and in general is given. In addition, the records in the literature concerning Faial Island are listed. The order of the families follows Tutin *et al.* (1993).

**Abbreviations**

- *: Endemic to the Azores and Madeira
- **: Endemic to the Azores only
- Col.: Collection number
- H: Habitat, distribution and altitudinal range on Faial Island
- JOR: São Jorge Island, Azores
- COR: Corvo Island, Azores
- CV: Cabo Verde
- D(A): Distribution in the Azores
- D(G): General distribution
- FAI: Faial Island, Azores
- FLO: Flores Island, Azores
- L: Records in literature of Faial Island
- MAR: Santa Maria Island, Azores
- PIC: Pico Island, Azores
- TER: Terceira Island, Azores
- 40-42: 40°00' to 42°00'
- 60-72: 60°00' to 72°00'

**Abundance and status on the distribution maps**

- indigenous, (very) rare
- introduced, (very) rare
- indigenous, rare - scattered
- introduced, rare - scattered
- indigenous, scattered - common
- introduced, scattered - common
- indigenous, (very) common
- introduced, (very) common

Contour lines are along 100 m isohypses (thin lines) and 200 m isohypses (strong lines). The grid system (1 x 1 km) is according to UTM (WGS-84): values of horizontal grid lines are from 4264 to 4278, and of vertical grid lines from 0340 to 0360.

**LYCOPODIACEAE**

- *Huperzia dentata* (Herter) Holub, Folia Geobot. Phytotax. 20: 72. 1985. *H. selago* (L.) Bernh. ex Schrank & Mart., Hort. Monac.: 3. 1829. subsp. *dentata* (Herter) Valentine, Feddes Repert. 69: 44. 1964. **Col.:** Az-F-639. **H:** Very rare; only two locations in the most humid region of the island, inside the caldera; one specimen growing epiphytic on *Juniperus brevifolia* [800-850 m]. **L:** Watson, 1844; Trelease, 1897; Palhinha, 1943, 1966; Franco, 1971; Sjögren, 1973b; Silva & Silva , 1974. **D(A):** All islands except MAR and GRA. **D(G):** Endemic to the Azores and Madeira. A record of *Lycopodium plumosum* L. by Forster (1787) might refer to this species.

- *Huperzia suberecta* (Lowe) Tardieu, Adansonia II, 10: 20. 1970. **Col.:** Az-F-1060. **H:** Very rare; only two locations in the most humid region of the island, inside the caldera; one specimen growing epiphytic on *Juniperus brevifolia* [800-850 m]. **L:** Watson, 1844; Drouet, 1866; Cunha & Sobrinho, 1938; Sjögren, 1973b. **D(A):** All islands except MAR, GRA and COR. **D(G):** Endemic to the Azores and Madeira.

*Diphasiastrum madeirense* (J.H.Wilce) Holub, Preslia 47: 108. 1975. *Diphasium madeirense* (J.H.Wilce) Rothm., Feddes Repert. 66: 235. 1962; *Lycopodium madeirense* J.H.Wilce, Nova Hedw. 3(1): 111. 1961. **Col.**: Az-F-500. **H**: Only one location inside the caldera, on steep slope in Juniperus forest at 800 m altitude, covering about two square metres. **L**: Previously not reported from FAI. **D(A)**: All islands except MAR and GRA. **D(G)**: Endemic to the Azores and Madeira. It was previously collected in probably the same location by Jermy *et al.* in 1994. A specimen was deposited in BM (Rumsey, in lit.).
**SELAGINELLACEAE**


**Col.**: Az-F-1061.  
**H**: Naturalized and very common from the coast up to Cabeço Gordo; in ravines, forests and hedges, on slopes, in coastal cliffs and waste places [10-1000 m].  
**L**: Watson, 1844, 1870; Drouet, 1866; Trelease, 1897; Tutin & Warburg, 1932; Cunha & Sobrinho, 1938; Palhinha, 1943, 1966; Franco, 1971; Sjögren, 1973b; Silva & Silva, 1974; Lüpnitz, 1975; Dias, 1996.  
**D(A)**: All islands.  
**D(G)**: Native to tropical and S Africa; introduced to the Canaries, Madeira and W Europe. Given in a list of *plants endémiques, ou à peu près* by Gandoger (1899).

**ISOETACEAE**

**Isoetes azorica** Durieu ex Milde, Fil. Eur. 278. 1867.  
**H**: Rare in shallow water of the small lake at Fundo da Caldeira [500 m].  
**L**: Watson, 1844; Franco, 1971; Sjögren, 1973b; Lüpnitz, 1975.  
**D(A)**: All islands except MIG, MAR and GRA.  
**D(G)**: Endemic to the Azores.

![Figure 4. Left: *Selaginella kraussiana* (Kunze) A.Braun; right: *Isoetes azorica* Durieu ex Milde.](image)

**EQUISETACEAE**

**H**: Scattered but locally common in the NW on slopes, in ravines and pastures close to springs; very common at Fundo da Caldeira; small, isolated population on a roadside in the S near Lombega [100-750 m].  
**L**: Watson, 1843, 1844; Seubert, 1844; Drouet, 1866; Watson, 1870; Trelease, 1897; Palhinha 1943, 1966; Franco, 1971; Sjögren, 1973b; Silva & Silva, 1974; Lüpnitz, 1975.  
**D(A)**: All islands except PIC, COR, and GRA.  
**D(G)**: Circumboreal: native to Macaronesia, Europe, Asia, NW Africa and N America.

**OPHIOGLOSSACEAE**

**Col.**: Az-F-1062.  
**H**: Single plants on wet ground along levada [500-650 m].  
**L**: Hansen & Sunding 1993.  
**D(A)**: MAR, FAL, FLO, and TER.  
**D(G)**: Native to the Azores, Madeira, W Europe (Iceland to Portugal), Corsica, Sardinia and C Europe.
Figure 5. Left: *Equisetum telmateia* Ehrh.; right: *Ophioglossum azoricum* C.Presl.


**OSMUNDACEAE**


Figure 6. Left: *Ophioglossum lusitanicum* L.; right: *Osmunda regalis* L.

**ADIANTACEAE**

Madeira. According to Caixinhas (1972), all Azorean records of *Pellaea calomelanos* (Sw.) Link refer to *P. viridis*.

**Anogramma leptophylla** (L.) Link, Fil. Spec.: 137. 1841. **Col.:** Az-F-1068. **H:** Common on slopes and shady walls at low altitudes especially along the N coast [20-250 m]. **L:** Seubert, 1844; Watson, 1844; Drouet, 1866; Trelease, 1897; Palhinha, 1943, 1966; Franco, 1971; Sjögren, 1973b; Lüpnitz, 1975. **D(A):** All islands. **D(G):** Native to Macaronesia, tropical Africa, Madagascar, C & S America, Australia and New Zealand.

**Onychium japonicum** (Thunb.) Kunze, Bot. Zeit. 6: 507. 1848. **Cryptogramma japonica** (Thunb.) Prantl, Bot. Jahrb. Syst. 3: 413. 1882. **Col.:** Az-F-1063. **H:** Naturalized in the Ribeira de Flamengos and on W exposed slopes near Ribeirinha and Salão [120-250 m]. **L:** Vasconcellos, 1968; Franco, 1971. **D(A):** FAI, PIC and MIG. **D(G):** Native to Japan, China, the Himalayas and Java; introduced to the Azores.

**Adiantum capillus-veneris** L., Sp. Pl. 2: 1096. 1753. **Col.:** Az-F-485, Az-F-592. **H:** Common around Horta (Monte Queimada, Ribeira de Flamengos) and sometimes elsewhere in coastal cliffs. Found also on old walls in villages and in cultivation [2-250 m]. **L:** Trelease, 1897; Palhinha, 1943, 1966; Vasconcellos, 1968; Franco, 1971;
SCHÄFER: PTERIDOPHYTES OF FAIAL ISLAND (AZORES) 220


FERN GAZ. 16(5): 213-237, 2001

FAI, TER, MIG and JOR. D(G): Native to W Canaries, CV, Mediterranean region, Old World tropics, Australia and Polynesia; introduced to the Azores, Madeira and S America.

Figure 10. Left: **Pteris incompleta** Cav.; right: **Pteris tremula** R.Br.

**HYMENOPHYLLACEAE**

*Hymenophyllum tunbrigense* (L.) Sm. in Sowerby. Engl. Bot. 3: 162. 1794. *Trichomanes tunbridgense* L., Sp. Pl. 2: 1098. 1733. **Col:** Az-F-629. **H:** Scattered on slopes, in ravines and shady forests above 400 m; usually epiphytic on old *Juniperus* and *Ilex*, most common inside the caldera; sometimes on wet rocks [350-880 m]. **L:** Watson 1843, 1844; Drouet, 1866; Watson, 1870; Trelease, 1897; Cunha & Sobrinho, 1938; Palhinha 1943, 1966; Sjögren, 1973b; Lüpnitz, 1975; Dias, 1996. **D(A):** All islands except COR and GRA; **D(G):** Native to Macaronesia, W Europe, N Italy, Luxembourg, E Germany (extinct); reported from N America and S Africa.

Figure 11. Left: **Pteris vittata** L.; right: **Hymenophyllum tunbrigense** (L.) Sm.

*Hymenophyllum wilsonii* Hook., Brit. Fl.: 450. 1830. *H. unilaterale* auct., non Bory, Willd. Spec. 5: 521. 1810. **Col:** Az-F-641, Az-F-1057. **H:** Local in ravines and inside the caldera; growing epiphytic on *Juniperus*, *Erica* and *Cryptomeria*, often together with *H. tunbrigense* [650-880 m]. **L:** Fernandes & Fernandes, 1980. **D(A):** All islands except JOR, MAR and GRA. **D(G):** Native to Macaronesia, N and W GB and France, Ireland, Faeroes, Iceland.

Juniperus forest and laurisilva remnants; sometimes even epiphytic and on rocks, but rarely fertile. Missing only in the W (except Furna Ruim) and along the coast [140-790 m]. L: Seubert, 1844; Watson, 1843, 1844; Drouet, 1866; Watson, 1870; Trelease, 1897; Cunha & Sobrinho, 1938; Palhinha 1943, 1966; Franco, 1971; Only in the central caldera (Sjögren, 1973b); Lüpnitz, 1975; Dias, 1996. D(A): All islands. D(G): Native to Macaronesia, GB, Ireland, W France, Spain and Portugal (Serra de Valongo). Gametophytes extending into C Europe (Rasbach et al., 1995). According to Fernandes & Fernandes (1983), all records of the pantropical Trichomanes radicans Sw. from the Azores are in error for this species.

Figure 12. Left: Hymenophyllum wilsonii Hook.; right: Trichomanes speciosum Willd.

POLYPODIACEAE


DICKSONIACEAE

**HYPOLEPIDACEAE**

*Cu lcita macrocarpa* C.Presl, Tent. Pterid.: 135. 1836. *Dicksonia culcita* L'Hér., Sert. Angl. 31. 1788; *Balantium culcita* (L'Hér.) Kaulf., Enum. 229. 1824. **Col.:** Az-F-1075. **H:** Common above 300 m in ravines, laurisilva, natural pastures and inside the caldera [350-980 m]. **L:** Seubert, 1844; Watson, 1843, 1844; Drouet, 1866; Trelease, 1897; Palhinha, 1943, 1966; Franco, 1971; Sjögren, 1973b; Lüpnitz, 1975. **D(A):** All islands except GRA. **D(G):** Native to Macaronesia, Spain (Algeciras, Galicia, Asturias) and Portugal (Serra de Valongo).

**THELYPTERIDACEAE**

Col.: Az-F-319. H: Common on slopes and in ravines at low altitudes and close to settlements [20-350 (-650) m]. L: Watson, 1844, 1870; Drouet, 1866; Trelease, 1897; Palhinha, 1943, 1966; Sjögren, 1973b; Franco, 1971. D(A): All islands except COR. D (G): Native to tropical & subtropical regions of the Old World; naturalized in several locations in America, the Azores and Madeira.

Figure 15. Left: Stegnogramma pozoi (Lag.) K.Iwats.; right: Christella dentata (Forsk.) Brownsey & Jermy.

ASPLENIACEAE

**Asplenium hemionitis** L., Sp. Pl. 2: 1078. 1753. *A. palmatum* Lam., Encycl. 2: 302. 1786. **Col.**: Az-F-1058. **H**: Usually found at altitudes lower than 400 m in ravines and hedges, on slopes and in N exposed walls. It is common in the N/NW parts of FAI, rare in the S [20-280 (-750) m]. Never seen in association with *Lactuca watsoniana*, *Frangula azorica*, and *Trichomanes speciosum* as reported by Sjögren (1973b) and Fernandes & Fernandes (1980). **L**: Seubert, 1844; Watson, 1844, 1870; Drouet, 1866; Trelease, 1897; Cunha & Sobrinho, 1938; Palhinha, 1943, 1966; Franco, 1971; Sjögren, 1973b; Lüpnitz, 1975. **D(A)**: All islands except GRA. **D(G)**: Native to Macaronesia (in CV very rare), W Portugal (Sintra, Mafra), N Africa.

**Asplenium marinum** L., Sp. Pl. 2: 1081. 1753. **Col.**: Az-F-1078. **H**: Scattered on coastal rocks around the island; single plants on seawind exposed slopes at higher altitudes, [0-150 (-500) m]. **L**: Forster, 1787, Watson, 1843, 1844; Drouet, 1866; Watson, 1870; Trelease, 1897; Cunha & Sobrinho, 1938; Palhinha, 1943, 1966; Sjögren, 1973b; Lüpnitz, 1975; Dias, 1996. **D(A)**: All islands. **D(G)**: Native to the coasts of Macaronesia and W Europe but presence on CV is doubtful (Lobin et al. 1998).

**Asplenium monanthes** L., Mant. Pl.: 130. 1767. **Col.**: Az-F-251. **H**: Scattered and usually in small populations in steep ravines and on wet rocks in shady ribeiras; rare in Myrica-Erica forest on young lava flows in the W [100-680 m]. **L**: Seubert, 1844; Watson, 1844, 1870; Trelease, 1897; Palhinha, 1943, 1966; Franco, 1971. **D(A)**: All
islands except MAR and GRA. D(G): Native to Macaronesia, Africa and C & N America.


WOODSIAICEAE
Diplazium caudatum (Cav.) Jermy, Brit. Fern Gaz. 9: 161. 1964. **Col.:** Az-F-1077. **H:** Common in shady ravines and *Pittosporum* forest [(30-) 150-600 (-800) m]. **L:** Franco, 1971; Sjögren, 1973b; Lüpnitz, 1975. **D(A):** All islands. **D(G):** Native to Macaronesia and SW Spain.

Deparia petersenii (Kunze) M.Kato, Bot. Mag., Tokyo 90: 37. 1977. *Diplazium allorgei* Tardieu, Notul. Syst. 7: 150. 1938; *Lunathyrium petersenii* (Kunze) H.Ohba, Sci. Rep. Yokosuka Mus. 11: 53. 1965. **Col.:** Az-F-642. **H:** Naturalized and very common on slopes, in ravines, forests and tree plantations [30-900 m]. **L:** Gonçalves, 1962 (Sjögren, 1973b); Vasconcellos, 1968; Franco, 1971; Silva & Silva, 1974. **D(A):** All islands. **D(G):** Native to tropical and subtropical Asia; naturalized in the Azores and Madeira. *Deparia* was first collected in the Azores by B. Carreiro on MIG (Christ, 1906). It was misidentified for many years and even described as a new endemic species by Tardieu-Blot (1937). Sledge (1975, 1977) was the first botanist who could determine this interesting species correctly, more than 70 years after its introduction to the islands!


**Dryopteridaceae**


**Cyrtomium falcatum** (L.f.) C.Presl, Tent. Pterid.: 86. 1836. *Polystichum falcatum* (L.f) Diels, Nat. Pfl. 1: 194. 1899; P. acrostichoides auct., non (Michx.) Schott, Gen. Fil.: 9. 1834. Col.: Az-F-1059. H: Naturalized and very common in coastal areas; in rock crevices, walls and on slopes. Common in shady ravines up to 500 m, scattered along roads and on walls up to 1000 m. Above 500 m, this species is restricted to man made habitats [0-600 (-1000) m]. L: Tutin & Warburg, 1932; Palhinha, 1943, 1966; Vasconcellos, 1968; Sjögren, 1973b; Silva & Silva, 1974; Lüpnitz, 1975. DA: All islands. DG: Native to Asia (Japan, Taiwan, Korea, China, India), S Africa and Polynesia; introduced to Macaronesia (Acores, Madeira, Selvagens, Canaries).

**Dryopteris aemula** (Aiton) O.Kuntze, Rev. Gen. Pl. 2: 812. 1891. Col.: Az-F-1070. H: Common, but usually above 500 m; on steep slopes, in hedges, ravines, Cryptomeria plantations, Juniperus forest, laurisilva and natural pastures [(300-) 500-1000 m]. L: Seubert, 1844; Watson, 1844, 1870; Drouet, 1866; Trelease, 1897; Palhinha, 1943, 1966; Franco, 1971; Sjögren, 1973b; Silva & Silva, 1974; Lüpnitz, 1975; Fraser-Jenkins, 1982; Dias, 1996. DA: all islands. DG: Native to
Macaronesia (Gomera, Madeira, Azores), GB, NW France, Spain, Turkey and the Caucasus; records from CV were erroneous (Fraser-Jenkins 1982).


Col.: Az-F-254, Az-F-1051. H: Scattered, but locally common in old Cryptomeria plantations, on slopes and in ravines, especially in the SE [(250-) 350-780 m]. L: Described in 1977, previously collected by Gonçalves in 1963, 1971, 1973 (Gibby et al., 1977). D(A): FAI, FLO and PIC; (reports from MIG probably in error for Dryopteris azorica (Christ) Alston (Fraser-Jenkins 1982)). D(G): Endemic to the Azores. This species is tetraploid and probably derived from *D. aemula* and *D. azorica* (Gibby et al., 1977).

LOMARIOPSIDACEAE

*Elaphoglossum semicylindricum* (T.E.Bowdich) Benl, Botanica Macaronésia 6: 59. 1980. Elaphoglossum hirtum auct., non (Sw.) C.Chr., Ind. Fil.: 308. 1906. Col.: Az-F-626, Az-F-1056. H: Rare, often very small populations and restricted to single trees; usually in deep, shady ravines above 600 m and inside the caldera; growing epiphytically on *Ilex*, *Laurus*, *Juniperus*, *Vaccinium* and rarely on steep slopes [580-880 m]. L: Seubert, 1844; Watson, 1844, 1870; Drouet, 1866; Trelease, 1897; Cunha & Sobrinho, 1938; Palhinha, 1943, 1966; Franco, 1971; Sjögren, 1973b; Lüpnitz, 1975; Dias, 1996. D(A): All islands except COR, MAR, GRA. D(G): Endemic to the Azores and Madeira.

OLEANDRACEAE

*Nephrolepis cordifolia* (L.) C. Presl, Tent. Pterid.: 79. 1836. Col.: Az-F-1082. H: Widely cultivated and locally naturalized on roadsides in *Myrica-Pittosporum* forest, in ravines, on walls and waste places close to settlements; sometimes epiphytic on *Populus* [10-480 m]. L: Previously not reported growing subsponaneously at FAI. D(A): FAI, MIG, MAR, GRA and FLO (Schäfer, unpubl.). D(G): Native to the tropics of Africa, Asia and America; locally naturalized in Macaronesia. *Nephrolepis* was first found growing subsponaneously in the Azores in 1987 at MIG (Hansen, 1992).

BLECHNACEAE

and MIG. **D(G)**: Native to Australia, New Zealand and Tasmania; naturalized in the Azores and Madeira.

**Figure 27.** Left: *Nephrolepis cordifolia* (L.) C. Presl; right: *Doodia caudata* (Cav.) R.Br.

*Blechnum spicant* (L.) Roth, Ann. Bot. 10: 56. 1794. **Col.**: Az-F-1071. **H**: Common on slopes, in forests and natural pastures [(5-) 200-1000 m]. **L**: Seubert, 1844; Watson, 1843, 1844; Drouet, 1866; Watson, 1870; Trelease, 1897; Cunha & Sobrinho, 1938; Palhinha, 1943, 1966; Franco, 1971; Sjögren, 1973b; Lüpnitz, 1975; Dias, 1996. **D(A)**: All islands except GRA. **D(G)**: Macaronesia (except CV), Europe, N Africa, Asia and N America.

**Woodwardia radicans** (L.) J.E.Sm., Mem. Acad. Sci. Turin 5: 412. 1793. **Col.**: Az-F-1076. **H**: Common in ravines, on slopes, in old *Pittosporum* forest, laurisilva and *Erica* shrub [60-950 m]. **L**: Watson, 1843, 1844; Seubert, 1844; Drouet, 1866; Watson, 1870; Trelease, 1897; Cunha & Sobrinho, 1938; Palhinha, 1943, 1966; Franco, 1971; Sjögren, 1973b; Lüpnitz, 1975; Dias, 1996. **D(A)**: All islands except GRA. **D(G)**: Native to Macaronesia (except CV), Spain, Portugal (Gerês, Sintra) S Italy, Sicily, Corsica, Crete, Himalayas, China, Japan, Philippines, Java, C America.

**Figure 28.** Left: *Blechnum spicant* (L.) Roth; right: *Woodwardia radicans* (L.) J.E.Sm.
Diversity maps
The distribution data of the pteridophytes of Faial Island was used to create three synthetical distribution maps, showing the $\alpha$-diversity, i.e. the number of taxa per km$^2$. In Figure 29, the diversity of pteridophytes in general is shown, using the distribution data of all 54 taxa found on the island. The maximum was found to be 29 taxa per km$^2$. There are three centres of diversity at low altitudes – in the SE (Flamengos region), the NW (Praia do Norte, Ribeira Funda) and in the NE (Salão) – and two at high altitudes: the caldera and the slopes in the N/NW. The surroundings of the capital Horta and the region of the Capelinhos Volcano in the W are extremely poor in pteridophytes.

Figure 29. Pteridophytes on Faial Island (taxa/km$^2$).

Figure 30. Indigenous pteridophytes on Faial Island (taxa/km$^2$).

In Figure 30, only the data of the 41 probably indigenous taxa were used. The maximum of indigenous pteridophytes on Faial Island is 23 per km$^2$. The number of indigenous pteridophytes increases at higher altitudes, reaching maximum values in the caldera and in the NW from 500 to 700 m a.s.l.
Finally, a synthetical distribution map of the 13 neophytes among the pteridophytes of Faial Island was created (Figure 31). The centres of neophyte diversity in pteridophytes are located in and around some coastal settlements, especially Flamengos, Castelo Branco, Praia do Norte and Salão. The number of introduced ferns is reduced above 500 m but a few are present even at the highest altitudes.

**DISCUSSION**

Seventy five percent of the pteridophytes of Faial Island are classified as indigenous species, five of them being endemic to the Azores, four of them endemic to Madeira and the Azores. The low rate of neophytes in pteridophytes is in contrast to rates of more than eighty percent of exotic species in the total flora of the island (Schäfer, 2000a). All the neophytic pteridophytes were introduced as ornamental plants, especially in the past 100 years, but soon spread from private gardens to natural habitats. Most of these taxa are restricted to lower altitudes and the surroundings of settlements either due to climatical reasons or, especially in slow spreading taxa, due to historical reasons. A similar decline in the number of neophytes at higher altitudes was found for the complete flora of Faial (Schäfer, 2000b). The percentage of pteridophytes in the flora in total increases at higher altitudes due to the rapidly decreasing number of spermatophyte taxa. By comparing the diversity maps with a precipitation map of Faial Island (Schäfer 2000a), the centers of diversity of the indigenous pteridophytes were found to be located in the most humid regions of the island. There is no correlation with different kinds of agriculture or the distribution of *Cryptomeria* plantations on Faial.

Four pteridophytes were found in more than eighty percent of all UTM squares: *Pteridium aquilinum*, the neophytes *Cyrtomium falcatum* and *Selaginella kraussiana* and the endemic *Polypodium azoricum*. These species are found especially in intensively cultivated areas, in pastures, on walls or in hedges between pastures. They have a very broad altitudinal range. On the other hand, the indigenous species *Huperzia suberecta*, *Ophioglossum azoricum*, *Lycopodiella cernua* and *Elaphoglossum semicylindricum* were found to be restricted to very few locations on the island. These species are in danger of extinction on Faial but are more common on other islands of the archipelago, especially on Flores.
Four pteridophytes, reported from Faial by Vasconcellos (1968) could not be found during this study: *Adiantum aneitense* Carruth., *Pteris multifida* Poir., *Pityrogramma calomelanos* (L.) Link var. *aureoflava* (Hook.) Weath. ex Bailey and *Pityrogramma chrysophylla* (Sw.) Link. These species were reported as escapes from cultivation and might have disappeared. Furthermore, *Pteris cretica* L. and *Oreopteris limbosperma* (All.) Holub reported by Sjögren (1973a) were not found in 1999. *Pteris cretica* is a neophyte in the Azores and was either overlooked or has disappeared outside private gardens. *Oreopteris limbosperma* might still exist somewhere inside the caldera. It is native to the Azores and a common fern of high altitudes e. g. on Flores. A single report of *Davallia canariensis* (L.) J.E.Sm. from the Caldera by Cunha & Sobrinho (1938) repeated in Cunha (1939) was in error for *Culcita macrocarpa*.

**CONCLUSIONS**

There is no dominance by exotic species in the fern flora of Faial Island. However, neophytic species like *Sphaeropteris cooperi* and *Deparia petersenii* spread in a very short period of time from coastal gardens to the most important reserves of the island including Caldeira Grande. Though less obvious, these species are, like *Hydrangea* and *Hedychium*, a threat to the endangered endemic flora of the Azores and their populations should be controlled with mechanical, biological and in a few places with chemical methods. In future, populations of any further garden escapes should be destroyed before they can become established.

**ACKNOWLEDGEMENTS**

Prof. Dr. P. Schönfelder, University of Regensburg, Germany gave constant advice during the project. Prof. Dr. E. Dias, Universidade dos Açores, Terceira, and Prof. Dr. E. Sjögren, University of Uppsala gave some advice in personal communication. H. Rasbach, Glottertal, Germany, checked several specimens of *Asplenium* including cytological examinations and gave advice about nomenclature and authors. Dr. H. Martins, Universidade dos Açores, Faial granted access to the library of DOP. J. Pereira and M. Ávila Gomez, Direcção Regional do Ambiente, Faial, showed me some interesting places on the island. M. Brum, Castelo Branco, Faial, provided logistic help during the stay on Faial. The author wants to thank J. Camus and Dr. F. Rumsey, British Museum London, for corrections and additions to the manuscript. The fieldwork of the author was enabled by grants from the Erich-Oberdorfer-Stiftung and the German National Merit Foundation. This financial support is gratefully acknowledged.

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