**APPENDIX A**

List of previously described NPP morphotypes found on the eastern Andean flank and information on their ecological affinity.

*Amphirosellinia*-type (formally within Rosellinia): Classified by Ju et al. (2004). *Amphirosellinia* grow inside the bark of dicotyledonous trees (Gelorini et al., 2011; Ju et al., 2004).

*Anthostomella fuegiana* (HdV-4): Classified by van Geel et al. (1978). Ascospore occurs throughout a late Holocene peat bog in the Netherlands, attributed to Cyperaceae and Juncaceae host plants.

*Cercophora*-type 1 (HdV-112): Classified by van Geel et al. (1983, 1981) and van der Wiel (1982). *Cercophora* species are coprophilous or are associated with decaying wood, herbaceous stems and leaves (Lundqvist, 1972) and have been used as an indicator of animal dung at archaeological sites (Buurman et al., 1995; van Geel et al., 2003, 1983, 1981; van Geel and Aptroot, 2006). However, analysis by Cugny et al. (2010) was able to show no positive relationship between *Cercophora* and total grazing pressure and suggest presence is also linked to forested environments.

*Cercophora*-type 2 (HdV-1013): Classified by van Geel et al. (2011). Morphotype differs from HdV-112 based on variation in ascospore size and morphology. For ecology see *Cercophora*-type 1.

Conidiophores (HdV-96): Classified by van Geel (1976). Fungal remains of a heterogeneous group of dematiaceous genera (van Geel, 1976).

*Coniochaeta* cf. *ligniaria* (HdV-172): Classified by van Geel et al. (1983). *Coniochaeta* cf. *ligniaria* is a coprophilous or lignicolous fungus that has been found in Roman period soils from meadows near populated settlement sites (van Geel et al., 2003) and have been linked to fluctuations during long term changes in humidity (van Geel et al., 2011).

*Gaeumannomyces* sp. or *Clasteropspriom caricinum* (HdV-126): Classified by Pals et al. (1980). Hyphopodia of leaf parasites associated with Cyperaceae (Deacon, 1976; Walker, 1980; van Geel and Aptroot, 2006).

*Glomus* sp. (HdV-207): Classified by van Geel et al. (1989). *Glomus* is an arbuscular mycorrhizal fungus which occurs on a wide range of vascular plant. Increased presence of *Glomus* in lake sediments has been linked to soil instability and increased erosional processes (Anderson et al., 1984).

HdV-16A: Classified by van Geel et al. (1981). van Geel et al. (1981) indicate that Type HdV-16A occurs in mesotrophic conditions in peat during dry phases and decreases or is absent during moist oligotrophic phases.

HdV-123: Classified by Pals et al., (1980). Occurs commonly in bog or marsh type environments in the Netherlands associated with *Betula* and is considered to be an indicator of eutrophic to mesotrophic conditions (Bakker and van Smeerdijk, 1982; van Geel et al., 1981; Pals et al., 1980).

HdV-201: Classified by van Geel et al. (1989). Morphotype was recorded within drier microhabitats on standing culms of helophytes or on plant remains in temporary desiccated pools (van Geel et al., 1989).

HdV-495: Classified by van Smeerdijk (1989). A fungi associated with the epidermal remains of Poaceae in open and semi-open landscapes in Europe (Cugny et al., 2010; van Smeerdijk, 1989) and from the cloud forest and Páramo of the Venezuelan Andes (Montoya et al., 2010).

HdV-733: Classified by Bakker and Smeerdijk (1982). Morphotype was recorded from a mesotrophic helophyte marsh dominated by *Phragmites* sp.

HdV-1058: Classified by van Geel et al. (2011). Morphotype present throughout much of the late Pleistocene and Holocene of equatorial tropical east Africa, the highest concentration occurring during the climatically wet early Holocene.

IBB-16: Classified by Montoya et al. (2010). Ascospores found in modern samples from the Páramo of the Venezuelan Andes (Montoya et al., 2010).

IBB-25: Classified by Montoya et al. (2010). IBB-25 is found in surface samples from the cloud forest and Páramo of the Venezuelan and Colombian Andes (Hooghiemstra, 1984; Montoya et al., 2010).

IBB-259: Classified by López-Vila et al. (2014). Morphotype occurs in low abundance within a human disturbed montane/subalpine region of the Spanish Pyrenees.

IBB-262: Classified by López-Vila et al. (2014). Morphotype was identified in low abundance within a montane/subalpine fir forest (*Abies* sp.) of the Spanish Pyrenees.

*Kretzschmaria* (formerly *Ustulina*) *deusta* (HdV-44): Classified by van Geel (1978). A parasitic fungus of deciduous trees causing soft wood rot of stumps and dead roots (van Geel and Andersen, 1988; van Geel and Aptroot, 2006). Occurs on a variety of host trees in Europe and North America including taxa which occur within Andean montane forests, such as *Alnus* sp. and *Ilex* sp. (van Geel, 1978; van Geel and Andersen, 1988).

*Neurospora* spp. (syn. *Gelasinospora* spp. *see* García et al. (2004)) (HdV-1093 / HdV-1351): *Neurospora* spp. is suggested to be a carbonicolous, lignicolous or coprophilous fungi (Lundqvist, 1972; van Geel, 1978) with a life cycle adapted to respond to fire (Jacobson et al., 2006).

*Podospora*-type (HdV-368): Classified by van Geel et al. (1981). *Podospora*-type represents coprophilous fungi often found in relation to human activity and/or herbivorous fauna

(Almeida-Lenero et al., 2005; van Geel et al., 2008, 2003, 1981).

*Rosellinia*-type (UG-1174): Classified by Gelorini et al. (2011). *Rosellinia*-type is widespread throughout temperate and tropical regions and commonly found on decaying herbaceous stems and deciduous woods of dicotyledonous plants (Gelorini et al., 2011; Petrini, 2003).

*Savoryella curvispora*–type. Classified by Bakker and van Smeerdijk (1982). Morphotype is analogous to HdV-715 (Bakker and van Smeerdijk, 1982) from Europe and UG-1120 (Gelorini et al., 2011) from East Africa. Bakker and van Smeerdijk (1982) suggest a preference for eutrophic to mesotrophic helophyte marsh condition, while Ho et al. (1997) reported its presence on submerged wood in South-East Asia and South Africa.

*Sporormiella*-type (HdV-113): Classified by Ahmed and Cain (1972) and van Geel et al. (2003). *Sporormiella* are coprophilous fungi that are associated with herbivores (Comandini and Rinaldi, 2004; Davis, 1987) and have been used as a proxy to determine herbivore populations and extinctions (Baker et al., 2013; Burney et al., 2003; Gill et al., 2009; Raper and Bush, 2009).

*Sordaria*-type (HdV-55): Classified by van Geel (1976) and van Geel et al. (1981). *Sordaria* species are predominantly coprophilous (Lundqvist, 1972; Richardson, 2001; van Geel and Aptroot, 2006) but may include non-coprophilous species which occur in soil and on seeds (Guarro and von Arx, 1987).

Sordariales: Includes several morphotypes within this order but without genus identification (Bell, 2005; Lundqvist, 1972).

TM-211: Classified by Cugny et al. (2010). Morphotype identified as Coniochaeta B, from modern surface samples from a range of vegetation habitats within the French Pyrenees.

UG-1194: Classified by Gelorini et al. (2011). Morphotype present from lake sediment surface samples from western Uganda.

Xylariaceae-type: Morphotype may contain several species based on size variation belonging to the family Xylariaceae (Petrini, 2003; Whalley, 1993). Xylariaceae are cosmopolitan and occur as saprotrophic and coprophilous fungi and as endophytes on a variety of host plants (Whalley, 1993).

**Appendix B**

Descriptions on new fungal morphotypes assigned with the prefix “OU-” (The Open University). Note: Three NPP morphotypes described here were not included elsewhere in the manuscript for two reasons: (i) OU-103 and OU-117 do not feature in any palynomorph graph as they occurred below the 2 % cut-off, and (ii) OU-114 is excluded from statistical analysis as it only occurred in a single sample. All descriptions and measurements are based on a minimum of five individuals.

OU-5 (Fig. 5, 1) – Ascospores, fusiform, 1-septate, slightly constricted at septum (20.3 – 23.1 µm x 5.9 – 6.8). Cells joined through the septa and roughly equal in size.

OU-18 (Fig. 5, 2) – Ascospores, fusiform, 1-septate, slightly constricted at septum (29.3 – 34.9 µm x 9.4 – 9.8 µm). Cells symmetrical, gently curving, light brown in colour, ends taper to a rounded point which is often crumpled.

OU-28 (Fig. 5, 3) – Fungal spores, narrowly fusiform, slightly curved, unequal and asymmetrical. Cell walls smooth, peach to light brown in colour. Three, five or seven septate, middle septum slightly constricted, distal cells tapering to a rounded end, walls at tips thinning. Subtypes have been defined for this morphotype according to the number of cells/septa as it follows: Form-A (4 cells; 75.0 – 85.1 µm x 8.0 – 10.5 µm), Form-B (6 cells; 79.9 – 97.1 µm x 8.8 – 9.6 µm), Form-C (8 cells; 93.4 – 103.8 µm x 9.3 – 11.4 µm).

OU-35 (Fig. 5, 4) – Ascospores, fusiform, 1-septate, strongly constricted at septum (20.7 – 24.8 µm x 9.4 – 11.8 µm). Cells brown, taper towards each aperture, apertures 1.1 – 1.9 µm wide.

OU-100 (Fig. 5, 5) – Ascospores, fusiform, 3-septate, slightly constricted at middle septum. Cells asymmetric, smooth walled (31.4 – 42.3 µm x 11.8 – 13.1 µm). Central cells brown (13.4 – 10.1 µm), distal cells tapered, light brown to occasionally subhyaline (8.0 – 5.3 µm).

OU-101 (Fig. 5, 6) – Fungal spores, 5 to 6-septate, slightly constricted at septa. Cells asymmetric, smooth walled (24.7 – 30.6 µm x 7.7 – 10.3 µm). Central cells brown becoming light brown to subhyaline at terminal cells. Proximal cell rounded with truncated end, distal cell hemispherical with apical pore (1.8 – 2.1 µm).

OU-102 (Fig. 5, 7) – Fungal spores, conidia, 3-septate (19.2 – 22.1 µm x 12.7 – 15.0 µm excluding proximal cell). Cells are dark brown and asymmetrical, distal cell subhayline and tapered with an apical pore. Proximal cell hyaline and often absent (3.1 – 4.9 µm).

OU-103 (Fig. 5, 8) – Fungal spores, slightly ellipsoid, 2-septate (30.6 – 40.6 µm x 10.6 – 14.8 µm). Cells dark brown, asymmetrical. Distal cell has aperture (< 1 µm).

OU-104 (Fig. 5, 9) – Fungal spores, conidia, 3-septate, slightly constricted at septum (26.2 - 32.1 µm x 12.4 - 14.7 µm). Distal cell brown, hemispherical, cells decreasing in size towards proximal cell. Proximal cell light brown, rounded, with apical pore. OU-104 is tentatively assigned to *Trichocladium* sp., which are often observed on submerged wood in fresh water environments (Goh and Hyde, 1999).

OU-105 (Fig. 5, 10) – Fungal spores, conidia, 2-septate (19.4 – 24.6 µm x 10.9 – 12.4 µm). Distal cell dark brown, hemispherical. Proximal cell rounded, light brown. This type is tentatively assigned to *Endophragmiella* sp.

OU-106 (Fig. 5, 11) – Fungal spores, conidia, 2-septate (15.1 – 17.7 µm x 6.8 – 8.0 µm). Distal cell brown, hemispherical. Proximal cell subhyaline, rounded, with apical pore.

OU-107 (Fig. 5, 12) – Ascospores, fusiform, 1-septate, slightly constricted at the septum (34.1 – 39.9 µm x 8.7 – 10.6 µm). Dark brown, slightly curved, variable number of parallel longitudinal distal furrows.

OU-108 (Fig. 5, 13) – Ascospores, fusiform, 1-septate (37.4 – 44.0 µm x 11.9 – 16.1 µm). Cells often asymmetrical. Cells taper to rounded point, with small (<1 µm) inset apical pore.

OU-109 (Fig. 5, 14) – Fungal spores, elliptical, 1-septate (24.6 – 29.9 µm x 11.8 – 12.4 µm). Cells often asymmetrical.

OU-110 (Fig. 5, 15) – Ascospores, 4 individual brown curved fusiform cells (23.8 – 26.1 µm x 16.8 – 18.5 µm. Individual cells 5.5 – 6.0 µm wide.

OU-111 (Fig. 5, 16) – Ascospores, elliptical, single celled (21.5 – 28.2 µm x 19.1 – 22.3 µm x 16.7 – 20.0 µm). Spores bilaterally flattened, dark brown, single protruding apical pore. Flattened sides dark brown (i), light brown band around spore (ii).

OU-112 (Fig. 5, 17) – Fungal spores, fusiform to elliptical, often asymmetrical (31.2 – 37.1 µm x 15.8 – 19.3 µm). Spore dark brown, protruding apertures at either end (1.0 – 1.8 µm).

OU-113 (Fig. 5, 18) – Fungal spores, curved fusiform, single celled (45.0 – 50.1 µm x 7.0 – 7.6 µm). Germ split on inner curve (14.6 – 15.8 µm long).

OU-114 (Fig. 5, 19) – Ascospores, elliptical, single cell (22.8 – 28.8 µm x 11.4 – 17.7 µm). Spores light brown, with single apical pore, cell walls thicken around middle. Found in single sample in Lake Huila record. Tentatively assigned to the Sordariales.

OU-115 (Fig. 5, 20) – Fungal spores, elliptical, single celled (24.5 – 28.4 µm x 16.9 – 21.6 µm). Brown with equatorial dark band, single pore offset from apex, cell wall thickens around pore (2.2 – 3.0 µm).

OU-116 (Fig. 5, 21) – Fungal spores, flask shaped with flat base (triangular-shaped with rounded vertices), single celled (19.2 – 23.0 µm x 15.4 – 21.5 µm). Dark brown, single pore at apex (1.3 – 1.8 µm).

OU-117 (Fig. 5, 22) – Fungal spores, ellipsoidal, single celled (27.7 – 32.0 µm x 17.5 – 24.3 µm). Cell covered in small circular craters (1.7 x 2.9 µm in diameter and 1.1 x 2.4 µm apart). Single pore at apex with thickened wall.

OU-118 (Fig. 5, 23) – Ascospores, narrowly fusiform to elliptical, single cell (22.9 – 29.4 µm x 8.8 – 10.5 µm). Spore light brown, 4 parallel longitudinal furrows, slightly protruding apertures at either end.

OU-119 (Fig. 5, 24) – Fungal spores, inequilateral, single cell (19.4 – 25.1 µm x 10.9 – 11.5 µm). Cell, dark brown with one side straight. One end truncated (2.8 – 3.9 µm),other tapering to an angled protruding hyaline apex.

OU-120 (Fig. 5, 25) – Spherical fungal spores, smoothed, thick walled, dark brown (14.4 – 15.8 µm). Single pore (2.1 – 2.8 µm).

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