CHAPTER 7

Identification

1. Introduction

Visual identification by light microscopy of airborne particles caught on a sticky surface is not easy (Allitt, 1979), but it still remains a good way of examining the whole air spora. Many pollen and spore atlases have good drawings or photographs but often many different magnifications are used. Gregory (1973) maintained that it was important to have all illustrations at the same magnification to enable easy comparison. The paintings in this book are all x1000 and give a selection of particles that can be found in the air. Identification to the level of species is often not possible. Many people looking at slides of particles deposited from air are often very specialized in a certain subject and therefore are not able to identify other kinds of particles present. Glancing through these plates will often give a hint of identification and it is then easier to look at different books or ask workers with expertise in that area. Small particles can be found as contaminants on many microscopic slide preparations for example a pollen grain or a fungal spore can be found on a histology preparation. The following plates could help such contaminants to be identified.

When trying to identify an object it is usually necessary to change focus constantly to look closely at its size, shape, density, colour, thickness and texture of its wall or edge, and its contents. Higher magnifications should be used to look at smaller particles but always be conscious of the size by checking with the calibration on the eyepiece graticule in the microscope. It is useful to build up a good collection of specimens for reference.

2. Particle types

Microscopic particles in the air can be of any constitution but this book is mainly concerned with biological particles. Small particles that are able to enter the lungs can cause problems to health for example asbestosis is caused by the inhalation of asbestos fibre. Examples of the diversity of particles in the air at any period of time can be seen in Plates 1-3 (chapter 6).

2.1. Pollen

Pollen grains tend to be spherical or nearly so, pale in colour and are the male gametophyte of seed plants. They are not very dense and contain a granular protoplasmic mass. The pollen wall, the exine, is multi-layered and often ornate with pores and fissures. The exine contains sporopollenin, which is resistant to decay, and hence pollen may last for thousands of years in the right conditions e.g. in peat. Pollen dispersed by wind tends to be smaller than those dispersed by insects, but sometimes have large air sacs (Pl. 7.1-3). Grass pollen is the most common type of pollen that is counted regularly, and typically has a single pore, which can be orientated in any aspect. The painting of *Phleum pratense* shows the pore in cross section whilst that of *Alopecurus myosuroides* shows it on the upper surface (Pl. 4.1 and 6).

2.2. Fungal Spores

Spores are classified by their mode of production. Fungal spores are very varied, single- to multiple-celled, hyaline with thin walls to dark with thick walls. Basidiospores are produced from a spore-bearing structure called a basidium, produced by all basidiomycetes such as rusts and smut fungi and the macro-fungi that produce mushrooms, toadstools and brackets. They have a scar of attachment and are mostly longer than broad and pale to dark, the wall is smooth or sometimes patterned (Pl. 9.1-50). Ascospores are produced in eights in an ascus and are released explosively by changes in water pressure by drying after rain. They have no scar of attachment, are elliptical to elongated, single or multi-celled, hyaline to dark (Pl. 8.1-46) and are often found in the air in groups of up to eight (Pl. 8.19 and 20). Many spores are produced asexually and are called conidia, they are single- to multi-celled, often coloured and may be quite large, the scar of attachment can usually be seen, and they are often released dry by the wind (Pl. 10.1-51, Pl. 11.1-27). Small spherical spores such as those of the genera *Aspergillus* and *Penicillium* are very difficult to identify to species level. Spores that are splashed tend to be hyaline with thin walls, e.g. *Rhynchosporium secalis* (Pl. 10.34).

2.3. Other plant material

Bacteria and actinomycete spores are very small and hyaline, more or less spherical and down to 1µm in diameter (Pl. 12.2-6). Lichens are composed of fungi and algae in symbiotic association as seen in the painting of the lichen soredium *Cladonia* (Pl. 11.38), the fungal constituent is often an Ascomycete e.g. *Xanthoria parietina* (Pl. 8.21). Algae grow in damp areas but can get airborne e.g. *Gloeocapsa* (Pl. 11.37). Diatoms are microscopic algae with delicately sculptured silicaceous cell walls which are very refractive (Pl. 11.34-36).

Ferns are distributed worldwide and usually grow in damp areas, e.g. valleys and tropical rainforests, spores are produced in sori which rupture to release them (Pl. 7.6-14). Mosses also grow in any damp places, their spores are produced in capsules and can be found in the air (Pl. 11.28-33). Plants become broken and pieces are blown around in

the air, plant hairs become detached and even structures such as pro-xylum (Pl. 12.10) can be found.

2.4. Animal material

Small insects, such as thrips, are often found in suction traps. They are removed before mounting the slide but often scales, hairs and other parts are left behind (Pl.12.17-21). House dust mite faecal pellets and parts are known to cause allergenic reactions in many people. (Pl. 12.15 and 16). Cysts of small animals can also be found in the air (Pl. 12.14 and 22).

2.5. Inorganic material

Outdoor air samples contain many non-biological(abiotic) particles from soil and products of combustion (Pl. 12.23-32). The paintings are only of small examples to preserve space on the plate.

3. Useful references

Early studies of airborne pollen grains as a background study of inhalant allergen enabled Hyde and Adams (1958) to publish their book *An Atlas of Airborne Pollen Grains*. This was not long after the Hirst Spore trap had been developed and is extremely helpful in providing photographs, good descriptions and a key for identifying fresh pollen grains of 92 plant species found in Great Britain. The book *Atlas of Airborne Pollen Grains and Spores in Northern Europe* (Nilsson *et al.*, 1977) contains light microscope photographs and scanning electron micrographs of 69 pollen types and of 5 fern spores, with short descriptions and distribution maps in Scandinavia. *Pollen Analysis* (Moore *et al.*, 1991) deals more with pollen that has already been deposited from the air in lakes and peat. However it has good diagrams of pollen shapes and aperture types, a key for identification, and illustrations of 450 pollen types. The light microscope photographs are mainly at a magnification of x1000 and scanning electron micrographs range from x1000 to x8000. *Airborne Pollen and Fungus Spores* (Tilak, 1989) is useful for a reference of tropical pollen and spores.

Atlas of Airborne Fungal spores (Nilsson, 1983) has a very good introductory section showing the terminology used and the lifecycles of different groups of fungi, and illustrations of 87 species. The species descriptions produced by CABI Biosciences (previously CMI or IMI) are very useful for identification at species level. The books, *Genera of Hyphomycetes* (Carmichael *et al.,* 1980) and *Illustrated Genera of Imperfect Fungi* (Barnet and Hunter, 1998), have many good line drawings.

Many detailed line drawings of fern spores in the book A *Manual of the Spores of New Zealand Pteridophyta* (Harris, 1955) give a good idea of the diversity of the group. *An Atlas of Recent European Bryophyte Spores* (Boros *et al*, 1993) gives light microscope photographs mainly at x1000 and some scanning electron photographs. Illustrations of dia-

toms can be found in *An Illustrated Catalogue of Airborne Microbiota from the Maritime Antarctic* (Chalmers *et al.*, 1996) There is increasing interest in health and safety in the work place; *Microorganisms in Home and Indoor Work Environments* (Flannigan *et al.*, 2001) gives illustrations of 87 fungi and 3 actinomycetes that might cause health problems through allergy, toxicosis or infection (Samson *et al.*, 2001). *Identification of Pathogenic Fungi* (Campbell *et al.*, 1996) gives good drawings of pathogenic fungi; the spores of some become airborne. Many papers giving illustrations of pollen, fungal spores and other airborne particles have been published in journals such as *Aerobiologia* and *Grana*.

4. Paintings - x1000

For illustrating and identifying particles, colour paintings are preferable to photographs, as more than one plane of focus can be shown on each specimen. It is also much easier to have a large number of paintings on one plate. The following nine plates contain paintings by one of the authors (Maureen Lacey) and give a personal impression of the particles as seen down a light microscope. Paintings used from *The Microbiology of the Atmosphere* (Gregory, 1973) were made by using a camera lucida on an old upright monocular microscope with an oil immersion x100 objective. All other paintings were made using a modern binocular microscope with a drawing tube attachment, this is easier to use and must be set up accurately, using a stage micrometer, to give the required magnification of x1500 (Lacey, M., 1997). The outline of the particle is painted and then the drawing tube closed whilst the rest is painted, the tube is switched back as required to add further details. The original paintings were traced onto plates with a mounted needle to give a clean edge. For publication the plates were reduced and printed at x1000 so that a ruler can easily be used to measure the painting, 1 cm on the plate is 10 µm on the specimen.

Pollen was painted from fresh specimens (s) collected by workers in many countries. The Monocotyledons and Dicotyledons are arranged in order as in Engler's classification (Willis, 1960). Fungal spores and other particles were painted from specimens (s), cultures (c) or impaction traps (t). The spores are arranged in groups using the 8th edition of the *Dictionary of Fungi* (Hawksworth *et al.*, 1995), but the large group of Mitosporic fungi is arranged as in the 5th edition of the *Fungi Imperfecti* (Ainsworth, 1961). Common names have been given where possible. When there is a perfect and imperfect state painted they are cross-referenced (-). Square brackets [-] indicate a possible disease in plants or animals.The paintings on the Miscellaneous plate (Pl. 12) are very varied but often only show very small particles of a type, enabling as many as possible to be shown.

Many planes of focus were used for each painting. The majority of paintings show the cross section but some, that appeared more solid, do not. The paintings of pollen of C*asuarina equisetifolia* and *C. cunninghamiana* (Pl. 4.15 and 18) illustrate this point. Generally only one painting of each type is given, this is the best representative on the mounted slide available.

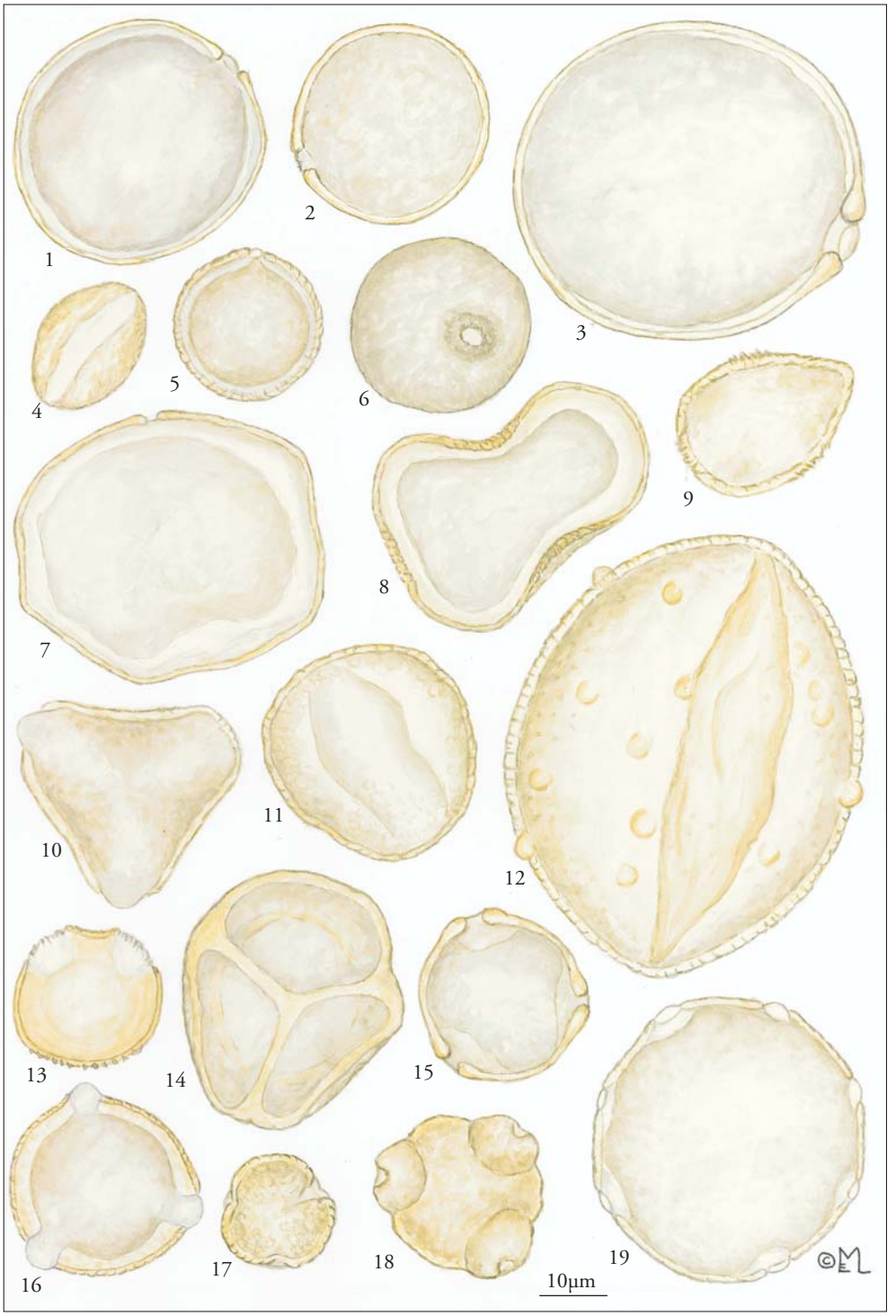

Plate 4
Pollen,
Monocotyledons and
Dicotyledons

Plate 4. Pollen - Monocotyledons and Dicotyledons

1 *Phleum pratense*, Timothy Grass, Gramineae, UK, s
2 *Paspalum dilatum*, Gramineae, Australia, s
3 *Triticum sativum*, Wheat, Gramineae, UK, s
4 *Phoenix sylvestris*, Date Palm, Palmae, India, s
5 *Sparganium erectum*, Bur reed, Sparganiaceae, UK, s
6 *Alopecurus myosuroides*, Black Grass, Gramineae, UK,
7 *Cocos nucifera*, Coconut Palm, Palmae, India, s
8 *Carex nigra*, sedge, Cyperaceae, Sweden, s
9 *Kyllingia* sp., Cyperaceae, Malaysia, s
10 *Elaeis guineensis,* Oil Palm, Palmae, Singapore. s
11 *Areca catechu*, Betel Nut, Palmae, India, s
12 *Borassus flavellifer*, Palmae, India, s
13 *Trachycarpus fortunei*, palm, Palmae, USA, s
14 *Luzula campestris*, Field Woodrush, Juncaceae, UK, s
15 *Casuarina equisetifolia*, Casuarinaceae, Singapore, s
16 *Garrya elliptica*, Garrya, Garryaceae, UK, s
17 *Salix caprea*, Goat Willow, Salicaceae, UK, s
18 *Casuarina cunninghamiana*, Casuarinaceae, Spain, s
19 *Juglans regia*, Walnut, Juglandaceae, UK, s

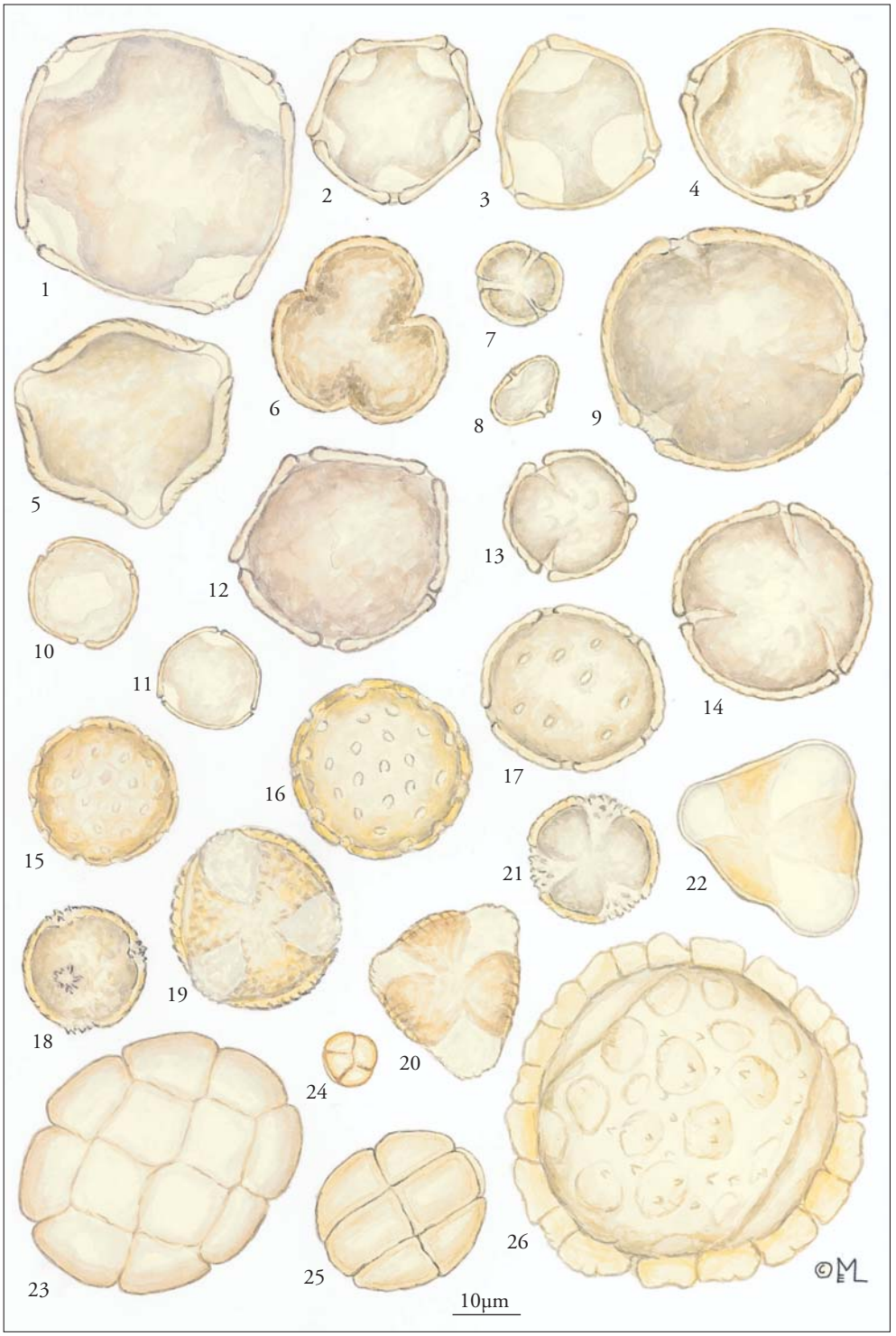

Plate 5
Pollen, Dicotyledons

Plate 5. Pollen - Dicotyledons

1 *Carpinus betulus*, Hornbeam, Corylaceae, Sweden, s
2 *Alnus glutinosa*, Alder, Betulaceae, Sweden, s
3 *Corylus avellana*, Hazel, Corylaceae, UK, s
4 *Betula verrucosa*, Silver Birch, Betulaceae, UK, s
5 *Quercus robur*, Common Oak, Fagaceae, UK, s
6 *Quercus suber*, Cork Oak, Fagaceae, Spain, s
7 *Castanea sativa*, Sweet Chestnut, Fagaceae, UK, s
8 *Cecropia* sp., Moraceae, Venezuela, s
9 *Fagus sylvatica*, Beech, Fagaceae, UK, s
10 *Parietaria diffusa*, Urticaceae, Spain, s
11 *Urtica dioica*, Nettle, Urticaceae, UK, s
12 *Ulmus glabra*, Elm, Ulmaceae, UK, s
13 *Rumex acetosa*, Sorrel, Polygonaceae, UK, s
14 *Rumex crispus*, Curled Dock, Polygonaceae, UK, s
15 *Atriplex canescens*, Salt Bush, Chenopodiaceae, USA, s
16 *Chenopodiun album*, Fat-hen, Chenopodiaceae, UK, s
17 *Amaranthus viridis*, Amaranthaceae, India, s
18 *Thalictrum* sp., Meadow Rue, Ranunculaceae ,UK, s
19 *Brassica napus*, Oilseed Rape, Cruciferae, UK, s
20 *Sorbus aucuparia*, Mountain Ash, Rosaceae, UK, s
21 *Platanus* sp., Plane, Platanaceae, UK, s
22 *Kalanchoe* sp., Crassulaceae, Venezuela, s
23 *Acacia auriculiformis*, Leguminosae, Singapore, s
24 *Mimosa pudica*, Leguminosae, Venezuela, s
25 *Mimosa arenosa*, Leguminosae, Venezuela, s
26 *Delonix regia,* Gulmohor, Leguminosese, India, s

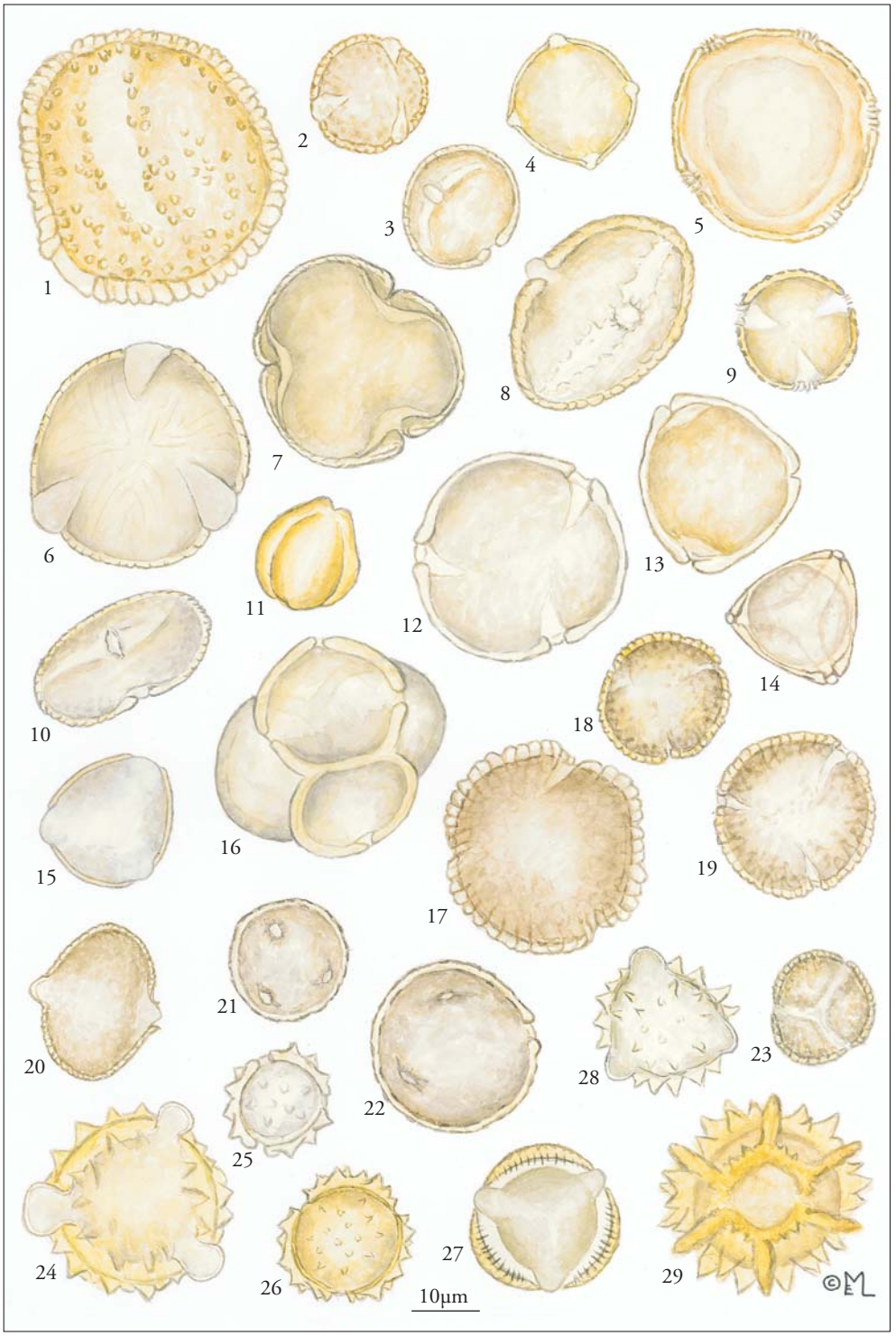

Plate 6
Pollen, Dicotyledons

Plate 6. Pollen - Didotyledons

1 *Azadirachta indica*, Neam, Meliaceae, India, s
2 *Euphorbia hirta*, Euphorbiaceae, India, s
3 *Phyllanthus virgatus*, Euphorbiaceae, India, s
4 *Acalypha* sp., Euphorbiaceae, Venezuela, s
5 *Pistacia lentiscus*, Mastic Tree, Anacardiaceae, Spain, s
6 *Acer pseudoplatanus*, Sycamore, Aceraceae, UK, s
7 *Tilia* sp., Lime, Tiliaceae, UK, s
8 *Heliocarpus americana*, Tiliaceae, Venezuela, s
9 *Tamarix pentandra*, Salt Cedar, Tamaricaceae, USA, s
10 *Anthiscus sylvestris*, Cow Parsley, Umbelliferae, UK, s
11 *Miconia* (*Tamonea*) sp., Melastomaceae, Venezuela, s
12 *Carica papaya*, Pawpaw, Caricaceae, India, s
13 *Eucalyptus* sp., Myrtaceae, Portugal, s
14 *Callistemon citrinus*, Bottle Brush, Myrtaceae, USA, s
15 *Lindenbergia indica*, Scrophulariaceae, India, s
16 *Calluna vulgaris*, Ling (Heather), Ericaceae, UK, s
17 *Ligustrum ovalifolium*, Privet, Oleaceae, Spain, s
18 *Olea europaea,* Olive, Oleaceae, Spain, s
19 *Fraxinus angustifolia*, Narrow Leaved Ash, Oleaceae, Spain, s
20 *Rungia pectinata*, Acanthaceae, India, s
21 *Plantago lanceolata*, Ribwort, Plantaginaceae, UK, s
22 *Plantago coronopus*, Buck's-horn Plantain, Plantaginaceae, Spain, s
23 *Sambucus nigra*, Elder, Caprifoliaceae, UK, s
24 *Senecio vulgaris*, Groundsel, Compositae, UK, s
25 *Parthenium hysterophorus*, Compositae, India s
26 *Solidago* sp., Golden Rod, Compositae, UK, s
27 *Artemisia vulgaris*, Mugwort, Compositae, UK, s
28 *Ambrosia deltoidea*, Triangle Leaf Bursage, Compositae, USA, s
29 *Taraxacum* sp., Dandelion, Compositae, UK, s

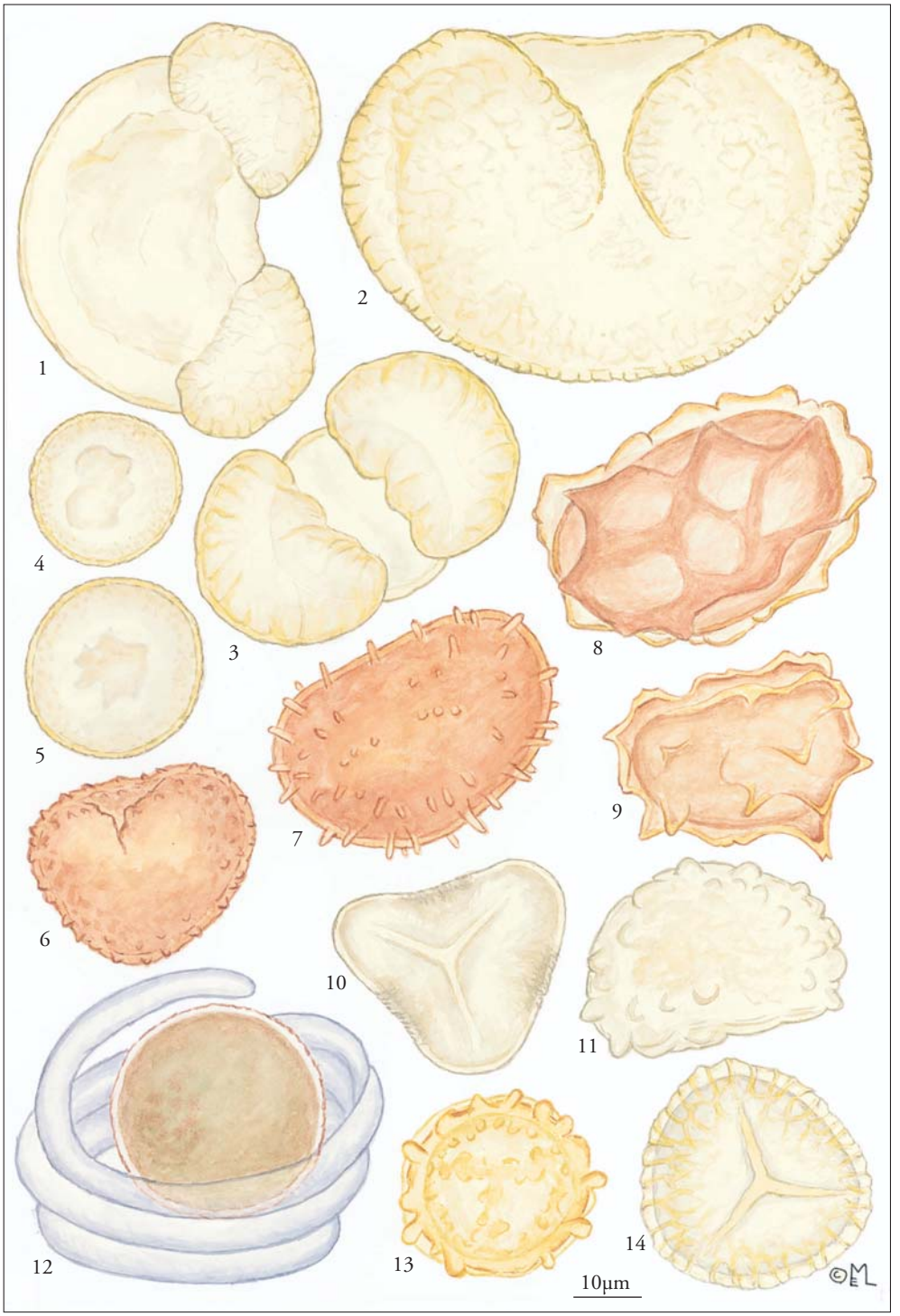

Plate 7
Coniferous pollen and fern spores

Plate 7. Coniferous pollen and fern spores

01 *Pinus sylvestris*, Scots pine, Pinaceae, UK, s
02 *Cedrus libani,* Cedar of Lebanon, Pinaceae, UK, s
03 *Podocarpus neriifolia*, Podocarpaceae, Singapore, s
04 *Taxus baccata*, Yew, Taxaceae, UK, s
05 *Juniperus communis*, Juniper, Cupressaceae, Sweden, s
06 *Pteridium aquilinum*, Bracken, fern spore, UK, s
07 fern spore, rain forest, Australia, t
08 *Asplenium nidus*, fern spore, Singapore, s
09 *Phyllitis scolopendrium*, Heart's Tongue, fern spore, UK, s
10 *Dicranopteris linearis*, fern spore, Singapore, s
11 *Stenochlaena palustris*, fern spore, Singapore, s
12 *Equisetum* sp., horsetail spore with elaters, UK, s
13 *Selaginella pulcherrina*, clubmoss spore, UK, s
14 *Lycopodium* sp., clubmoss spore, UK, s

Plate 8
Fungal spores – Ascospores and Uridinales

Plate 8. Fungal spores – Ascospores and Uridinales

1 *Didymosphaeria donacina*, ascospore, Singapore, c
2 *Ophiobolus graminis,* ascospore, [take-all of wheat] UK, s
3 *Leptosphaeria maculans,* ascospore, (see *Phoma lingam*) [canker of brassicas], UK, s
4 *Pringsheimia* type, Costa Rica, t
5 *Mycosphaerella capsellae*, (see *Pseudocosporella capsellae*),[white leaf spot of brassicas] ascospore, UK, s
6 *Phaeosphaeria fuchlii*, ascospore, UK, t
7 *Phaeosphaeria nigrans*, ascospore, UK, t
8 *Micronectriella nivalis* (*Spaerulina*), ascospore, UK, t
9 *Pleospora herbarum*, ascospore, UK, s
10 *Pleospora* type, ascospore, UK, t
11 *Sporormia* type, ascospore, India, t
12 *Didymella* type, ascospore (hyaline), [late summer asthma in man], UK, t
13 *Didymella* type, ascospore (rough), UK, t
14 *Nectria cinnabarina*, [coral spot of woody plants] ascospore, UK, s
15 *Claviceps purpurea*, ascospore, [ergot], UK, s
16 *Venturia inaequalis*, ascospore, (see *Spilocaea pomi*) [apple scab], UK, s
17 *Passeriniella* type, ascospore, Costa Rica, t
18 *Neobulgaria pura*, ascospore, UK, s
19 *Sclerotinia sclerotiorum*, ascospores, [stem rot of many plants], UK, s
20 *Pyrenopeziza brassicae*, ascospores, (see *Cylindrosporium concentricum*) [light leaf spot of brassicas], UK, s
21 *Xanthoria parietina*, ascospore from lichen, UK, s
22 *Helvella crispa*, ascospore, UK, s
23 *Humaria granulata*, ascospore, UK, s
24 *Pyronema confluens*, ascospore, UK, s
25 *Melanospora zamiae*, ascospore, UK, s
26 *Chaetomium globosum*, ascospore, UK, c
27 *Chaetomium indicum*, ascospore, UK, c
28 *Sordaria fumicola*, ascospore, UK, c
29 *Daldinia concentrica*, ascospore, UK, s
30 *Xylaria polymorpha*, ascospore, UK, s
31 *Hypoxylon coccinium*, ascospore, UK, s
32 *Hypoxylon multiforme*, ascospore, UK, s
33 *Rosellinia aquila*, ascospore, UK, s
34 ascospore, UK, t
35 ascospore, Australia, t
36 ascospore, India, t
37 ascospore, India, t
38 ascospore, Costa Rica, t
39 ascospore, Costa Rica. t
40 ascospore, Costa Rica, t
41 ascospore, India, t
42 ascospore, Costa Rica, t
43 ascospore, Costa Rica, t
44 ascospore, Australia, t
45 ascospore, Costa Rica, t
46 ascospore, UK, t
47 *Puccinia graminis*, (a) teleutospore, (b) uredospore, [stem rust of cereals], UK, s
48 *Puccinia striiformis*, teleutospore, [yellow rust of wheat], India, s
49 *Puccinia striiformis*, uredospore, [yellow rust of wheat], UK, t
50 *Puccinia arachidis*, uredospore, [rust of peanuts], India, s
51 *Uromyces fabae*, uredospore, [chocolate spot of beans], UK, s
52 *Triphragmium ulmariae*, uredospore, UK, s
53 *Caeoma euphorbiae-geniculate*, aecidiospore, India, s
54 *Melampsoridiun betulinum*, uredospore, [rust of birch], UK, s
55 *Aecidium mori*, aecidiospore, [mulberry rust], India, s

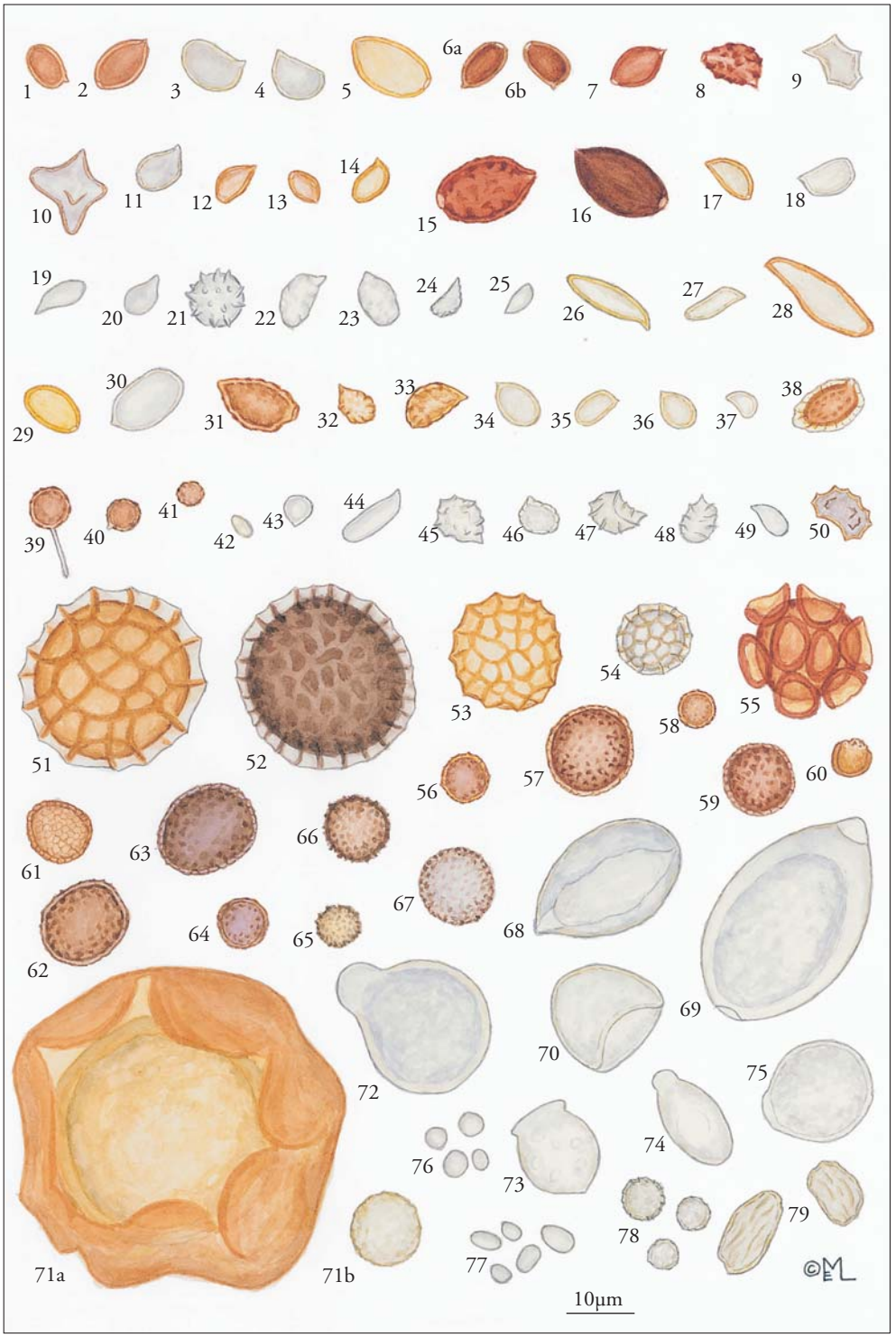

Plate 9
Fungal spores – Basidiospores and others

Plate 9. Fungal spores - Basidiospores and others

1 *Agaricus bispora*, Cultivated Mushroom, basidiospore, UK, s.
2 *Lepiota racodes*, basidiospore, UK, s
3 *Amanita muscaria*, Fly Agaric, basidiospore, UK, s
4 *Amanita rubescens*, The Blusher, basidiospore, UK, s
5 *Bolbitius vitellinus*, basidiospore, UK, s
6 *Coprinus atramentarius*, Common Ink Cap, basidiospores, (a) profile, (b) face view, UK, s
7 *Coprinus micaceus*, Glistening Ink cap, basidiospore, UK, s
8 *Lacrymaria velutina*, Weeping Widow, basidiospore, UK, s
9 *Entoloma rhodopolium*, basidiospore, UK, s
10 *Nolanea staurospora*, basidiospore, UK, s
11 *Pluteus cervinus*, basidiospore, UK, s
12 *Hypholoma fascicularia*, Sulphur Tuft, basidiospore, UK, s
13 *Hypholoma hydophilum,* basidiospore, UK, s
14 *Pholiota squarrosa*, Shaggy Pholiota, basidiospore, UK, s
15 *Panaeolus (Psilocybe) foenisecii,* basidiospore, UK, s
16 *Panaeolus sphinctrinus*, basidiospore, UK, s
17 *Stropharia aeruginosa*, Verdigris Agaric, basidiospore, UK, s
18 *Armillaria mellea*, Honey Fungus, basidiospore, [white rot and death of trees], UK, s
19 *Collybia confluens*, Clustered Tough-shank, basidiospore, UK, s
20 *Collybia maculata*, Spotted Tough-shank, basidiospore, UK, s
21 *Laccaria amethystine*, Amethist Deceiver, basidiospore, UK, s
22 *Mycena crocata*, basidiospore, UK, s
23 *Mycena inclanata*, basidiospore, UK, s
24 *Tricholoma nudum*, Wood Blewit, basidiospore, UK, s
25 *Tricholoma album*, basidiospore, UK, s
26 *Boletus chrysenteron*, Red-cracked Boletus, basidiospore, UK, s
27 *Boletus elegans*, basidiospore, UK, s
28 *Boletus scaber*, basidiospore, UK, s
29 *Serpula (Merulius) lacrymans*, [dry-rot], basidiospore, UK, s
30 *Craterellus cornucopioides*, Horn of Plenty, basidiospore, UK, s
31 *Cortinarius elatior*, basidiospore, UK, s
32 *Gymnopilus penitrans*, basidiospore. UK, s
33 *Gymnopilus junonius (Pholiota penitrans)*, basidiospore. UK, s
34 *Inocybe geophylla*, basidiospore, UK, s
35 *Crepidotus mollis*, basidiospore, UK, s
36 *Tubaria furfuracea*, basidiospore, UK, s
37 *Fistulina hepatica*, Beefsteak Fungus, basidiospore, UK, s
38 *Ganoderma applanatum*, basidiospore, [wood decay], UK, s
39 *Bovista plumbea*, basidiospore, UK, s
40 *Lycoperdon giganteum (Calvatia gigantia)*, Giant Puff-ball, basidiospore, UK, s
41 *Lycoperdon perlatum*, basidiospore, UK, s
42 *Phallus impudicans*, Stink Horn, basidiospore, UK, s
43 *Heterobasidion annosum* (*Fomes*), [conifer polypore root and butt rot], basidiospore, UK, s
44 *Pleurotus ostreatus*, Oyster Mushroom, basidiospore. UK, s
45 *Russula ochroleuca*, Common Yellow Russula, basidiospore, UK, s
46 *Russula vesca*, Bare-Toothed Russula, basidiospore, UK, s
47 *Lactarius blennius*, Slimy Milk-cap, basidiospore, UK, s
48 *Lactarius rufus*, Rufus Milk-cap, basidiospore, UK, s
49 *Chondrostereum (Stereum) purpureum*, [silver leaf of trees], basidiospore, UK, s
50 *Thelephora terrestris*, Earth Fan, basidiospore, UK, s

Plate 9. Fungal spores - Basidiospores and others *(continued)*

51 *Tilletia holci*, smut spore, UK, s
52 *Tilletia barclayana*, smut spore, [rice smut], India, s
53 *Tilletia caries*, smut spore, [wheat bunt], UK, s
54 *Tilletia* type, smut spore, India, t
55 *Urocystis agropyri*, smut spore, UK, s
56 *Sphacelotheca cruenta*, smut spore, [loose smut of sorghum], India, s
57 *Sphacelotheca reiliana*, smut spore, [head smut of sorghum], India, s
58 *Sphacelotheca sorghi*, smut spore, [covered smut of sorghum], India, s
59 *Tolyposporium ehrenbergii*, smut spore, [long smut of sorghum], India, s
60 *Ustilago avenae*, smut spore, [oat smut], UK s
61 *Enteridium (Reticularia) lycoperdon*, myxomycete spore, UK, s
62 *Badhamia utricularis*, myxomycete spore, UK, s
63 *Leocarpus fragilis*, myxomycete spore, UK, s
64 *Fuligo septica*, myxomycete spore, UK, s
65 myxomycete/smut type spore, India, t
66 myxomycete/smut type spore, India, t
67 myxomycete/smut type spore, India, t
68 *Peronospora parasitica*, sporangium, [downy mildew of brassicas], UK, s
69 *Phytophthora infestans*, sporangium, [potato blight], UK, s
70 *Albugo* sp., conidium, [white rust], UK, t
71 *Peronosclerospora sorghi*, a) oospore, b) conidium, [downy mildew of sorghum], India, s
72 *Conidiobolus obscurus,* primary conidium, UK, s
73 *Entomophthora planchoniana,* primary conidium, UK, s
74 *Erynia neoaphidis,* primary conidium UK, s
75 *Neozygites fresenii*, primary conidium UK, s
76 *Absidia corymbifera*, sporangiospores, [bovine mycotic abortion] UK, c
77 *Absidia ramosa*, sporangiospores, UK, c
78 *Mucor spinosus*, sporangiospores, UK, c
79 *Rhizopus nigricans*, sporangiospores, UK, c

Plate 10
Fungal spores - Mitosporic

Plate 10. Fungal spores – Mitosporic

01 *Septoria tritici*, conidium, [wheat leaf spot], UK, s
02 *Phoma lingam*, conidia, (see *Leptosphaeria maculans*) [canker of brassicas], UK, s
03 *Cylindrosporium concentricum*, conidium (see *Pyrenopeziza brassicae*), [light leaf spot of brassicas], UK, s
04 *Tilletiopsis* sp., ballistosporres, UK, t
05 *Sporobolomyces* sp., ballistosporres, UK, c
06 *Pestalotiopsis theae*, conidium, [grey blight of tea], India, c
07 *Botryodiplodia* sp. conidium, India, s
08 *Botryodiplodia acerina*, conidium, India, s
09 *Blastomyces dermatitidis*, conidium, [blastomycosis in man and animals], USA, c
10 *Chrysosporium* sp., conidium, UK, c
11 *Coccidioides immitis*, conidium, [coccidiomycosis of man and animals], UK, c
12 *Histoplasma capsulatum*, a) macroconidium, b) microconidium, [histoplasmosis in man and animals], UK, c
13 *Sporotrichum* sp., conidium, UK, c
14 *Aspergillus glaucus* (series), conidium, UK, c
15 *Aspergillus niger*, conidia, UK, c
16 *Aspergillus fumigatus*, conidia, [asthma, allergic alveolitis and aspergillosis of man], UK, c
17 *Penicillium frequentens,* conidia, [suberosis in man], UK, c
18 *Penicillium chrysogenum*, conidia UK, c
19 *Penicillium marneffei*, conidia, UK, c
20 *Scopulariopsis brevicaulis*, conidia, UK, c
21 *Paecilomyces varioti*, conidia, UK, c
22 *Paecilomyces* type, conidia, Costa Rica, t
23 *Wallemia sebi*, conidia, UK, s
24 *Trichoderma viride*, conidia, UK, c
25 *Pseudocercosporella capsellae*, (see *Mycosphaerella capsellae*) [white leaf spot of brassicas], conidium, UK, s
26 *Verticillium dahliae*, conidia, [wilt of plants], UK, s
27 *Helicomyces* type, conidium, UK, t
28 *Pyricularia oryzae*, conidium, [rice blast], India, s
29 *Botrytis* sp., conidium, UK, c
30 *Blumeria graminis*, (= *Oidium, Erysiphe*), conidium, [powdery mildew], UK, t
31 *Polythrincium trifolii*, conidium, UK, s
32 unknown conidium, Costa Rica, t
33 *Trichothecium roseum*, conidium, UK, c
34 *Rhynchosporium secalis*, conidium, [leaf blotch of barley and rye]. UK, s
35 *Trichoconis padwickii,* conidium, [stack burn and leaf spot of rice], India, t
36 *Cercosporidium personatum*, conidium, [late leaf spot of peanuts], India, s
37 *Cercospora arachidicola*, conidium, [early leaf spot of peanuts], India, s
38 *Cercospora* sp., conidium, India, t
39 *Beltrania* sp. conidium, India, t
40 *Memnoniella echinata*, conidia, India, s
41 *Stachybotris* sp., conidium, UK, c
42 *Spilocaea pomi*, conidium, (see *Venturia inaequalis*), [apple scab], UK, s
43 *Humicola lanuginosa*, conidium, UK, s
44 *Humicola stellata*, conidium, UK, c
45 *Acremoniella atra*, conidium, UK, c
46 *Tetraploa aristata*, conidium,India, t
47 *Pithomyces chartarum*, conidium, [facial eczema of sheep], UK, s
48 *Pithomyces maydicus*, conidium, Singapore, c
49 *Bispora monilioides*, conidium, UK, s
50 *Asterosporium* sp., conidium, UK, t
51 *Corynespora* sp., conidium, India, t

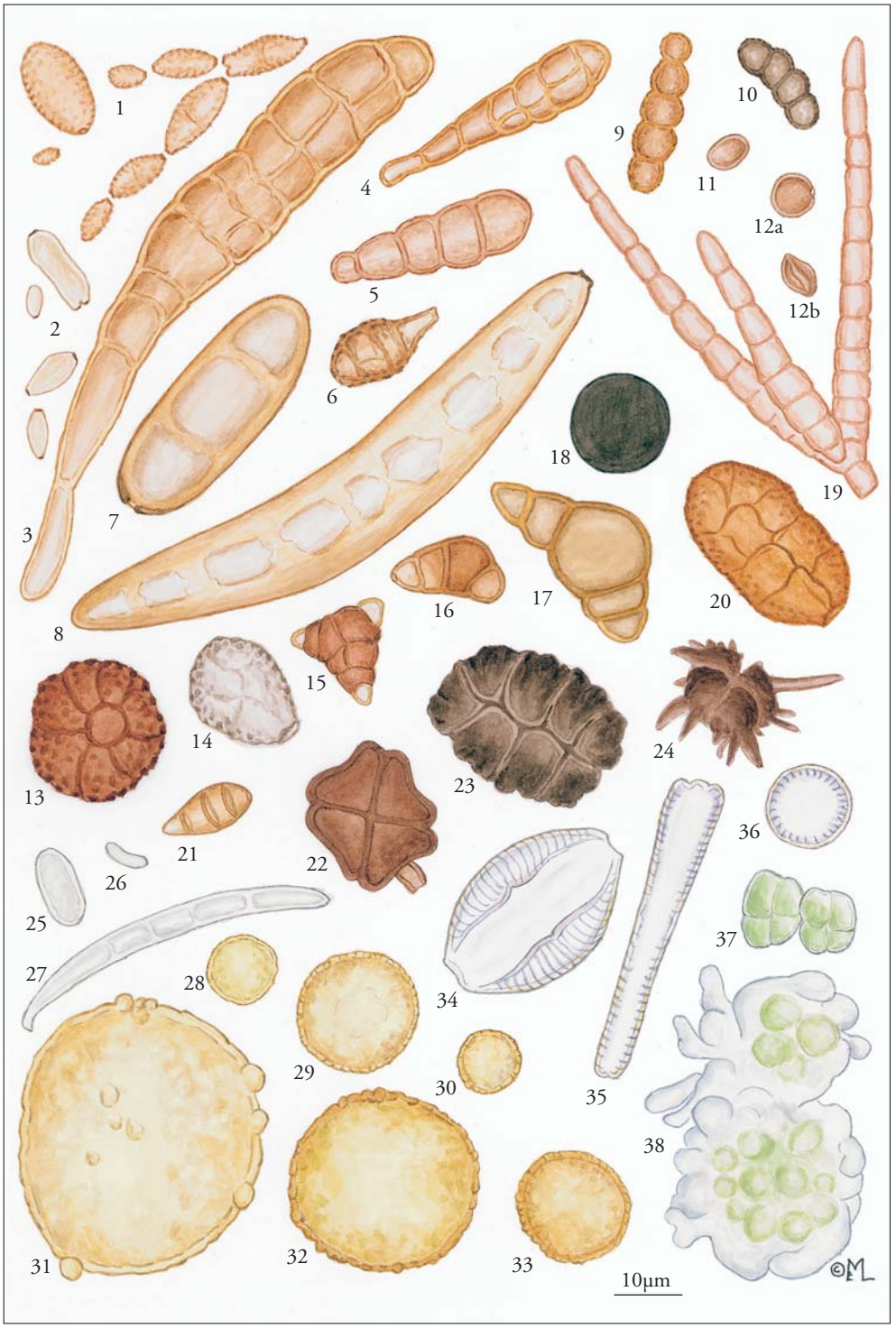

Plate 11
Fungal and moss spores, diatoms and algae

Plate 11. Fungal and moss spores, diatoms and algae

1 *Cladosporium herbarum*, conidia, UK, t
2 *Cladosporium cladosporioides*, conidia, UK, s
3 *Alternaria brassicae*, conidium, [dark leaf spot of brassicas], UK, c
4 *Alternaria infectoria*, conidium, UK, c
5 *Alternaria brassicicola*, conidium, [leaf spot of brassicas], UK, c
6 *Alternaria alternata*, conidium, UK, c
7 *Helmimthosporium (Drechslera)* sp., conidium, UK, t
8 *Drechslera oryzae*, conidium, [brown spot of rice], India, s
9 *Torula herbarum*, conidium, UK, t
10 *Torula* sp., conidium, India, t
11 *Cryptostroma corticale*, conidium, [sooty bark of sycamore], UK, s
12 *Arthrinium (Papularia) arundinis*, conidia: (a) face view, (b) edge view, UK, c
13 *Epicoccum* sp., conidium, UK, t
14 *Epicoccum* sp., conidium, Costa Rica, t
15 *Oncopodiella* type, conidium, UK, t
16 *Curvularia lunata*, conidium, Singapore, c
17 *Curvularia lunata*, conidium, India, t
18 *Nigrospora* sp. conidium, India, c
19 *Ceratosporiella* type, conidium, India, t
20 *Stemphylium* sp., conidium, UK, t
21 *Exosporium* sp., conidium, UK, t
22 *Spegazzinia lobulata*, conidium, India, t
23 *Spegazzinia deightonii*, conidium, India, t
24 *Spegazzinia tessartha*, conidium, India, t
25 *Sphacelia sorghii*, conidium, [ergot of sorghum], India, s
26 *Tubercularia vulgaris*, conidium, (see *Nectria cinnabarina*), [coral spot], UK, s
27 *Fusarium graminiarum,* conidium, UK, s
28 *Schistidium antartica*, moss spore, Antarctica, s
29 *Funaria hygrometrica*, moss spore, UK, s
30 *Barbula fallax*, moss spore, UK, s
31 *Bartramina patens*, moss spore., Antarctica, s
32 *Bryum algens*, moss spore, Antarctica, s
33 *Ceratodon purpureus*, moss spore, UK, s
34 diatom, India, t
35 diatom, UK, t
36 *Cyclotella* type, diatom, India, t
37 *Gloeocapsa* sp, algal group, UK, t
38 *Cladonia* sp., lichen soredium, UK, s

Plate 12
Miscellaneous

Plate 12. Miscellaneous

01 skin scales with bacteria, UK, t
02 *Thermoactinomyces* sp., actinomycete spores, UK, c
03 *Sacharopolyspora rectevergilla*, actinomycete spores, [bagassosis in man], UK, c
04 *Streptomyces* sp., actinomycete spores UK, s
05 *Bacillus subtillus*, bacteria, UK, c
06 *Staphylococcus aureus*, bacteria, UK, c
07 plant hair, UK, t
08 cotton fibre, UK, s
09 hyphal fragment, UK, t
10 pro-xylem, UK, t
11 meta-xylem, UK, t
12 cat fur, UK, s
13 piece of feather, UK, s
14 *Tetramitus sp*., amoeboid cyst, Tristan da Chuna, t
15 mite pellet, UK, t
16 part of mite leg, UK, t
17 insect scale, UK, t
18 moth scale, UK, s
19 a – d insect hairs, UK, t
20 part of insect leg, UK, t
21 part of insect compound eye, Australia, t
22 *Thecamoeba* sp., UK, t
23 diesel particles, UK, s
24 small talc (magnesium silicate) particles, UK, s
25 combustion product, UK, t
26 particles from soil, UK, t
27 fly ash spheres, UK, t
28 particles from soil, UK, t
29 carbon shards from bonfire, UK, t
30 tyre roll, UK, t
31 combustion product, UK, t
32 combustion product, UK, t