POTENTIAL OF BOTANIC GARDENS TO SHOW POLLEN BIODIVERSITY. THE MODENA PROJECT: 1. THE POLLEN FLORA OF THE GARDEN

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ABSTRACT

The paper kick-starts a multifaceted project set up in the Botanic Garden of Modena to acquaint people with pollen biodiversity, thanks to the know-how of the local Laboratory in several fields of Palynology. It concerns Morphopalynology and shows the work undertaken so far: 1) The "Botanic Garden Pollen Type Collection" was organized. About 150 pollen species have been collected so far and about 50 species have been acetolyzed and mounted on slides, which can also be exchanged; 2) The "Botanic Garden Pollen Flora", i.e. the morphological description of pollen of the plants living in the Garden was begun. Six woody species have been described so far (*Cupressus sempervirens*; *Juniperus x media* "Pfitzeriana", *Thuja occidentalis*, *T. orientalis*, *Taxus baccata*, *Taxodium distichum*); 3) Pollen protocols and materials for education and popularisation events were designed and in part already successfully employed in exhibitions for citizens, students from primary to secondary school, and tourists (pollen dust jars, three dimensional pollen models, big round panels with high magnification pollen photos hung from trees, pollen trips throughout the Garden, from microscopes to plants). Pollen proved to be a reliable protagonist to carry out an autarchic process in the Botanic Garden "from the Producer (Research) to the Consumer (People).

KEY WORDS

Botanic Garden, Pollen morphology, Research, Education, Popularisation

INTRODUCTION

Botanic Gardens, being made of living plants and laboratories, are qualified outdoor/indoor museums for studying, managing, and showing plant biodiversity in its many forms. Their role is becoming more important, thanks to the activity of BGCI all over the world, and by now it is a truth universally acknowledged that "*A Botanic Garden is an institution holding documented collections of living plants for the purposes of scientific research, conservation, display and education"* (Oldfield, 2007). Among the plant structures, pollen grains offer an attractive display of biodiversity due to their microscopic size, huge number, great morphological variety consistent with their systematic/phylogenetic position and almost ubiquitous spread over space and time. In the Botanic Garden of Modena, where palynologists have been working for more then twenty five years, the multifaceted project *"Pollen at the Botanic Garden"*, the first of its kind as far as we know, has recently been set up to acquaint citizens with pollen biodiversity, by exploiting the know-how of the local laboratory in several fields of Palynology, e.g. Aero-, Archaeo-, Bryo-, Geo-, Melitto-, Morpho-, Pharmaco-Palynology (Accorsi et al., 2007, Torri et al, 2007). This paper concerns the basic line of the project, i.e. morphopalynology, and involves research, collections, education, and popularisation. It refers to the work undertaken so far: 1) the setting up of the "Botanic Garden Pollen Collection" i.e. the collection of pollen produced by the plants in the Garden, both cultivated and wild, b; 2) the beginning of the "Botanic Garden Pollen Flora", i.e. the morphological description of pollen of plants of the Garden starting with woody plants growing outdoors; 3) the planning of pollen educational process and materials which have been in part already successfully realized and employed during exhibitions for citizens, students and tourists.

THE STUDY AREA

The work was carried out in the Botanic Garden of Modena (Fig.1). The Garden was founded in 1758 by Duke Francesco III d'Este, who reserved a part of the Court Garden as a "herb garden" (Mor & Di Pietro, 1975) so that a teaching in Botany for Medical Science could begin. In 1772 it became part of the University of Modena. Thanks to its position in the centre of the town, inside the Historical Duchy Garden, it plays a strategic role in education (Dallai & Garbari, 1998). The Botanic Garden currently covers an area of ca. one hectare. The number of trees and shrubs growing in the Garden is 702 (2000 census). Gymnosperms are represented by 95 individuals (= 13.5%) and Angiosperms by 607 individuals (= 86.5%). There are 235 species, 147 genera, and 68 families. In the Garden there are scientific laboratories which are active in various fields of Botany (Cytology, Phytogeography, and Palynology/Palaeobotany). All of them promote activity which translates research into education/popularisation (Dallai & Del Prete, 1996, Bosi et al., 2006). Actually, this philosophy has been applied for a long time especially in the Phytogeographycal laboratory, and above all in the research of "*in situ-ex situ* plant conservation"(Sgarbi et al., 2001, Dallai & Sgarbi, 2005; Del Prete et al., 2006), while in other laboratories, as in the palynology it is quite recent.

Fig. 1. The Botanic Garden of Modena.

MATERIAL AND METHODS

Pollen was collected from the trees/shrubs growing in the Garden outdoors and stored in paper bags with labels indicating family, genus, species, number of the individual, collection date, and name of the collector. In the laboratory, the pollen underwent acetolysis (Erdtman, 1960). To observe by LM, two kinds of permanent slides were prepared per species: 1) slides with acetolized pollen mounted in glycerol jelly; 2) slides with "fresh = not acetolyzed" pollen mounted in glycerol jelly stained with fucsin. All the slides were

sealed with paraffin. For SEM observation the acetolyzed pollen was dehydrated in alcohol e covered with gold. Morphological observations were carried out with the methods of the Italian Pollen Flora (e.g. Accorsi, 1985; Accorsi et.Al., 1989) simplified, i.e. making measurements only on fixed pollen, omitting the long lasting observations on mobile pollen in glycerol/water. By LM (magnification:1000 x), 30 pollen grains were measured, while *porus*, *papilla* and deterioration were observed on 1000 pollen grains per species, under. SEM observation was carried out on ca. 50 pollen grains per species, at the interdepartmental centre of large instruments of the University. In the table 1, plants names agree with Pignatti (1982) or IPNI for exotic flora and pollen types with Moor et al., 1991. In the text the following abbreviations were used: BG = Botanic Garden, dM = maximum diameter; dm = minimum diameter.

RESULTS AND DISCUSSION

1) The Pollen collection

Pollen has been collected from 142 woody species so far (Tab. 1), which represents 60% of the tree/shrubs species growing in the Garden. Only a third of them have been already acetolized and mounted onto slides (Tab. 1). The latter were chosen in order to represent as many as possible pollen types, for research, educational and popularisation purposes. Slides, stored in boxes with appropriate labels, form a special section of the Palinoteca of the Palynological Laboratory, named "Botanic Garden Pollen Collection". As can be seen in Tab. 1, the collection includes almost all main pollen types: Bisaccate, Inaperturate, Monocolpate, 3-Zonocolpate, 3-Zonocolporate, Pantoporate, Syncolpate. It can be added that other pollen species (not considered here) were collected from woody plants grown in pots and sheltered in greenhouses during the winter. Their pollen completes the collection with other pollen types (e.g. the Poliads of various *Acacia* species).

Tab. 1 Pollen of trees/shrubs collected and slide prepared so far.

Botanic Garden pollen collection (2007 census)					
n.	Genus	speciesr		Family	Slide prepared
33	*Cornus*	*mas*	L.	Cornaceae	
34		*sanguinea*	L.	Cornaceae	
35	*Corylus*	*avellana*	L.	Corylaceae	3-colporate
36		*cornuta*	Marshall	Corylaceae	3-porate
37	*Cotinus*	*coggygria*	Scop.	Anacardiaceae	3-colporate
38	*Crataegus*	*crus-galli*	L.	Rosaceae	
39		*oxyacantha*	L.	Rosaceae	3-colporate
40	*Cryptomeria*	*japonica*	Don	Taxodiaceae	
41	*Cupressus*	*sempervirens*	L.	Cupressaceae	Inaperturate
42	*Eryobotrya*	*japonica*	(Thumb.)Lindley	Rosaceae	
43	*Euonymus*	*europaeus*	L.	Celastraceae	3-colporate
44	*Fagus*	*sylvatica*	L.	Fagaceae	3-colporate
45	*Forsythia*	*sp.*	Vahl.	Oleaceae	
46		*suspensa*	Vahl.	Oleaceae	
47		*viridissima*	Lindl.	Oleaceae	
48	*Fraxinus*	*excelsior*	L.	Oleaceae	3-colporate
49		*ornus*	L.	Oleaceae	3-colporate
50	*Hibiscus*	*palustris*	L.	Malvaceae	
51		*syriacus*	L.	Malvaceae	

52	*Ilex*	*aquifolium*	L.	Aquifoliaceae	3-colpate
53	*Jasminum*	*mauritianum*	Bojer	Oleaceae	3-colpate
54		*nudiflorum*	Lindl.	Oleaceae	
55	*Juglans*	*regia*	L.	Juglandaceae	pantoporate
56		*rupestris*	Engelm. ex Torr.	Juglandaceae	pantoporate
57	*Juniperus*	*chinensis*	L.	Cupressaceae	
58		x media Pfitzeriana”			
59	*Kerria*	*japonica*	(L.) D.C.	Rosaceae	3-colporate
60	*Lagerstroemia*	*indica*	L.	Lythraceae	3-colporate
61	*Laurus*	*nobilis*	L.	Lauraceae	
62	*Lavandula*	*officinalis*	L.	Labiatae	
63	*Lonicera*	*xylosteum*	L.	Caprifoliaceae	
64	*Magnolia*	*obovata*	Thunb.	Magnoliaceae	1-colpate
65	*Mahonia*	*aquifolium*	(Pursh.)Nutt.	Berberidaceae	syncolpate
66	*Malus*	*prunifolia*	(Willd.) Borkh.	Rosaceae	
67		*X purpurea*	(Barbier & Cie) Rehder	Rosaceae	
68	*Myrtus*	*communis*	L.	Myrtaceae	3-colporate
69	*Nerium*	*oleander*	L.	Apocynaceae	stephano-porate
70	*Olea*	*europaea*	L.	Oleaceae	3-colpate
71	*Paliurus*	*spina-christi*	Miller	Rhamnaceae	3-colporate
72	*Paulownia*	*tomentosa*	(Sprengel) Steudel	Bignoniaceae	
73	*Philadelphus*	*grandiflorus*	Willd.	Saxifragaceae	
74		*monstruosus*	Rehder	Saxifragaceae	
75	*Phillyrea*	*latifolia*	L.	Oleaceae	
76	*Pinus*	*halepensis*	Miller	Pinaceae	
77		*laricio*	Poiret.	Pinaceae	
78	*Pistacia*	*terebinthus*	L.	Anacardiaceae	pantoporate
79	*Podocarpus*	*macrophylla*	D.Don	Podocapaceae	
80	*Poncirus*	*trifoliata*	(L.) Raf..	Rutaceae	
81	*Prunus*	*domestica*	L.	Rosaceae	
82		*laurocerasus*	L.	Rosaceae	
83		*mume*	Siebold & Zucc.	Rosaceae	3-colporate
84		*persica*	(L.) Batsch	Rosaceae	
85		*serotina*	Ehrh.	Rosaceae	
86		*paniculata*	Thunb.	Rosaceae	
87		*spinosa*	L.	Rosaceae	
88	*Ptelea*	*trifoliata*	L.	Rutaceae	3-colporate
89	*Punica*	*granatum*	L.	Punicaceae	
90	*Pyracantha*	*angustifolia*	C.K.Schneid.	Rosaceae	
91	*Pyrus*	*betulifolia*	Bunge	Rosaceae	
92	*Quercus*	*ilex*	L.	Fagaceae	3-colpate
93		*pectinata*	Hort ex K.Koch.	Fagaceae	3-colpate
94		*pedunculata*	Ehrh.	Fagaceae	3-colpate
95	*Rhamnus*	*pallasii*	Fisch. & C.A.Mey.	Rhamnaceae	
96	*Rhus*	*typhina*	L.	Anacardiaceae	3-colporate
97	*Ribes*	*alpinus*	L.	Saxifragaceae	
98		*aureum*	Pursh	Saxifragaceae	
99		*fasciculatum*	Siebold & Zucc.	Saxifragaceae	
100		*uva-crispa*	L.	Saxifragaceae	
101	*Robinia*	*pseudoacacia*	L.	Leguminosae	3-colporate
102	*Rosa*	*multiflora*	Thunb.	Rosaceae	
103	*Rosmarinus*	*officinalis*	L.	Labiatae	6-colpate

104	*Rubus*	*fruticosus*	L.	Rosaceae	3-colporate
105	*Salix*	*caprea*	L.	Salicaceae	
106	*Sambucus*	*nigra*	L.	Caprifoliaceae	
107	*Schinus*	*polygamus*	(Cav.) Cabrera		
108	*Sorbus*	*torminalis*	(L.)Crantz	Rosaceae	3-colporate
109	*Spartium*	*junceum*	L.	Leguminosae	
110	*Spiraea*	*cantoniensis*	Lour.	Rosaceae	
111	*Syringa*	*vulgaris*	L.	Oleaceae	
112	*Tamarix*	*africana*	Poiret	Tamaricaceae	3-colpate
113	*Taxodium*	*distichum*	(L.) Richard	Taxodiacecea	inaperturate
114	*Taxus*	*baccata*	L.	Taxaceae	inaperturate
115	*Tecoma*	*radicans*	Juss.	Bignoniaceae	3-colporate
116	*Thuja*	*occidentalis*	L.	Cupressaceae	inaperturate
117	*Thuja*	*orientalis*	L.	Cupressaceae	inaperturate
118	*Tilia*	*mongolica*	Maxim.	Tiliaceae	
119		*platyphyllos*	Scop.	Tiliaceae	3-colporate
120	*Trachycarpus*	*excelsus*	H.Wendl.	Palmae	
121	*Ulmus*	*laevis*	Pallas	Ulmaceae	
122	*Viburnum*	*lantana*	L.	Caprifoliaceae	
123		*odoratissimum*	Ker-Gawl.	Caprifoliaceae	
124		*tinus*	L.	Caprifoliaceae	3-colporate
125	*Wisteria*	*sinensis*	(Sims)Sweet	Leguminosae	

2) The Botanic Garden Pollen Flora

The morphology of six species has been studied so far: four of them belong to the Cupressaceae family, one to the Taxaceae and the other to the Taxodiaceae (Fig. 2). A brief description for each of them is reported below.

1) Cupressus sempervirens L., Italian Cypress, Cupressaceae, pollen collected on 09.05.2006

Acetolyzed pollen - *Pollen units*: monads. *Size* – Medium-sized; dM = 30,6 (21,5 - 35,0) µm ± 2,4 µm; dm = 29,0 (18,0 - 34,0) µm ± 3,0 µm; dM/dm: 1,06 (1,0 - 1,19) ± 0,04. *Symmetry*: radiosymmetric. *Amb*: circular-subcircular (oval). *Shape*: spheroidal. *Apertures*: inaperturate. *Exine - sculpture*: psilate (LM), microscabrate-microverrucate (SEM), with scattered microgemmae, single or in groups, usually few, microspinulate (SEM); *thickness*: 1,3 (0,6 - 2,2) µm ± 0, 6 µm; I.E= 0, 04 (0,02-0,08) ± 0,02. *Deterioration*: split = 6%, folded = 70%. Fresh pollen – same morphology as in acetolyzed pollen, with the following differences: *Size*: dM = 29,1 (21,0 - 33,0) µm ± 2,3 µm; dm = 28,0 (20,2 - 32,0) µm ± 2,2 µm; dM/dm: 1,04 (1,00 - 1,15) ± 0,04. *Exine - thickness*: 0,7 (0,2 - 1,2) µm ± 0,1 µm; I.E.= 0,01 (0,01 - 0,05) ± 0,004; *Intine – thickness*: ⅓ - ½ of dM; in split pollen, it comes out of the exine, still surrounding the cytoplasm and swells up to 30 µ m. *Cytoplasm – shape*: starry, spheroidal or a mass of little spheres; *size*: ⅓ - ½ of dM. *Deterioration*: split grains = 30%, crumpled = 9%. Note: neither porus nor papilla nor pollen units other than monads were observed, according to the majority of Authors. Pori were observed by Accorsi et al., 1989; Grilli Caiola *et al.*, 2000. Other pollen units (e.g. tetrads) and papilla were observed by Accorsi *et al.*, 1989.

2) Juniperus x media **"Pfitzeriana"**, Chinese Juniper, Cupressaceae, pollen collected on 07.04.2006

Acetolyzed pollen - *Pollen units*: monads. *Size* – Medium-sized; dM = 29,1 (25,0 - 33,5) µm ± 1,8 µm; dm = 27,3 (22,0 - 32,0) µ m ± 2,4 µ m; dM/dm 1,1 (1,00 - 1,25) ± 0,1. *Symmetry*: radiosymmetric. *Amb*: circular-oval, frequently wavy. *Shape*: spheroidal. *Apertures*: inaperturate. *Exine - Sculpture*: psilate (LM), microscabrate-microverrucate (SEM), with scattered microgemmae, single or in groups, usually few, microspinulate (SEM); *Thickness*: 1,0 (0,8 - 2,0) µ m ± 0, 2 µ m; I.E= 0, 03 (0, 02-0, 08) ± 0, 02. *Deterioration*: split grains = 4%, folded grains= 68%. Fresh pollen - Morphology as in acetolyzed pollen, with the following differences: *Size*: dM = 27,8 (25,0 - 31,9) µm ± 1,7 µm; dm = 26,6 (23,5 - 30,8) µ m ± 1,5 µm; dM/dm: 1,05 (1,00 - 1,17) ± 0,04. *Exine - Thickness*: 0,9

(0,5 - 1,6) µm ± 0,3 µm; I.E.= 0,03 (0,02 - 0,06) ± 0,01; *Intine – Thickness*: ⅓ - ½ of pollen radius; in split pollen it comes out of the exine, still surrounding the cytoplasm and swelling up to 20 µm. *Cytoplasm – shape*: starry; *size*: ca ½ of dM. *Deterioration*: split = 42%. Note: papilla was observed in 1, 5 % of grains under LM; porus (circular, 1, 5-2 µm) was observed in 0, 2 %of grains. They are not quoted in the literature.

3) Thuja occidentalis L., Northern White-Cedar, Cupressaceae, pollen collected on 08.04.2006

Acetolyzed pollen - *Pollen units*: monads. *Size* – Medium-sized; dM = 28,6 (24,2 - 31,9) µm ± 1,5 µm; dm = 26,1 (22,0 - 30,0) µm ± 2,0 µm; dM/dm: 1,10 (1,00 - 1,38) ± 0,08. *Symmetry*: radiosymmetric. *Amb*: circular-oval, rarely elliptic. *Shape*: spheroidal. *Apertures*: inaperturate. *Exine - Sculpture*: ground surface psilate (LM), microscabrate-microverrucate (SEM), with microgemmae (sometimes > 1 µm), quite dense, single or in groups, microspinulate (SEM); *Thickness*: 1,0 (0,5 - 2,2) µm ± 0,4 µm; I.E.= 0,03 (0,02 - 0,08) ± 0,021. *Deterioration*: split = 1 %, folded = 72%. Fresh pollen - Morphology as in acetolyzed pollen, with the following differences: *Size*: dM = 28,4 (24,5 - 31,2) µm ± 2,1 µm; dm = 26,5 (22,0 - 30,50) µm ± 2,0 µm; dM/dm: 1,1 (1,0 - 1,3) ± 0,1. *Exine - thickness*:0,9 (0,5 - 1,5) µm ± 0,3 µm; I.E.= 0,03 (0,02 - 0,05) ± 0,01; *Intine – Thickness*: ⅓ - ½ of pollen radius; in split pollen it comes out of the exine, still surrounding the cytoplasm and swelling up to 10 µm. *Cytoplasm – Shape*: starry, kidney-shaped; *Size*: > ½ of dM. *Deterioration*: split = 5%, crumpled 5 % . Note: microgemmae larger than 1 µm are not quoted in the literature.

4) Thuja orientalis **L.**, Chinese or oriental arborvitae, Cupressaceae, pollen collected on 07.04.2006

Acetolyzed pollen - *Pollen units*: monads. *Size* – Medium-sized; dM = 30,3 (27,5 - 35,0) µm ± 1,7 µm; dm = 27,8 (22,0 - 31,0) µm ± 1,9 µm; dM/dm: 1,1 (1,0 - 1, 3) ± 0,1. *Symmetry*: radio symmetric. *Amb*: circular-oval, rarely elliptic. *Shape*: spheroidal. *Apertures*: inaperturate. *Exine - Sculpture*: psilate (LM), microscabrate-microverrucate (SEM), with scattered microgemmae (sometimes > 1 µm), single or in groups, microspinulate (SEM); *thickness*: 1,4 (0,8 - 2,2) µm ± 0,4 µm; I.E.= 0,05 (0,03-0,07) ± 0,01. *Deterioration*: split = 50%, folded = 30%. Fresh pollen - Morphology as in acetolyzed pollen, with the following differences: *Size*: dM = 30,3 (25,0 - 38,5) µm ± 3,0 µm; dm = 28,8 (23,0 - 36,3) µm ± 2,9 µm; dM/dm: 1,05 (1,00 - 1,10) ± 0,03. *Exine - thickness*: 0,9 (0,4 - 1,1) µm ± 0,2 µm; I.E.= 0,03 (0,01 - 0,04) ± 0,01; *Intine – thickness*: ⅓ - ½ of pollen radius; in split pollen it comes out of the exine, still surrounding the cytoplasm and swelling up to 15 µm. *Cytoplasm – Shape*: starry, spheroidal, mass of little spheres; *Size*: ca ½ of dM. *Deterioration*: split = 82%, crumpled = 1%. Note: as in *Thuja occidentalis*.

5) Taxus baccata **L.,** European Yew, Cupressaceae, pollen collected on 09.05.2006

Acetolyzed pollen - *Pollen units*: monads. *Size* – Medium-sized; dM = 25,6 (22,0 - 28, 0) µm ± 1,7 µm; dm = 23,0 (18,7 - 27,0) µm ± 1,9 µm; dM/dm: 1,1 (1,0 - 1,3) ± 0,1. *Symmetry*: radiosymmetric,. Unisymmetric. *Amb*: obtusely 3,4-angular, rarely circular-subcircular. *Shape*: polyhedric-spheroidal. *Apertures*: inaperturate. *Exine - Sculpture*: ground surface psilate-scabrate (LM), microscabrate-microverrucate (SEM), with microgemmae in a even carpet, microspinulate (SEM); *Thickness*: 2,0 (1,1-3,3) µm ± 0,5 µm; I.E= 0,08 (0,04-0,01) ± 0,04. *Deterioration*: split = 4%, folded = 610%. Fresh pollen - Morphology as in acetolyzed pollen, with the following differences: *Size*: dM = 23,6 (20,2 - 28,6) µm ± 2,0 µm; dm = 21,7 (18,7, - 24,2) µm ± 1,4 µm; dM/dm: 1,04 (1,0-1,1) ± 0,03. *Exine - Thickness*: 1,4 (0,4-2,0) µm ± 0,5 µm; I.E= 0,03 (0,01-0,05) ± 0,01; *Intine – Thickness*: ⅓ - ½ of pollen radius; in split pollen it comes out of the exine, still surrounding the cytoplasm and swelling up to 13 µm. *Cytoplasm – Shape*: starry, spheroidal, mass of little spheres; *Size*: ca ½ of dM. *Deterioration*: split = 53%, crumpled = 2 %. Notes: the presence of microgemmae larger than 1 µm is not quoted in the literature.

6) Taxodium distichum **(L.) Richard,** Swamp Cypres, Taxodiaceae; pollen collected on 07.04.2006

Acetolyzed pollen - *Pollen units*: monads. *Size* – Medium-sized; dM = 30,7 (26,0 - 34,0) µm ± 2,0 µm; dm = 29,0 (23,5 - 33,2) µm ± 1,6 µm; dM/dm: 1,05 (1,00 - 1, 17) ± 0,05. *Symmetry*: radiosymmetric. *Amb*: circular-subcircular, rarely oval. *Shape*: spheroidal. *Apertures*: inaperturate, in part (15% of grains) papillate (= with a blunt conical papilla 3-3,5 µm long). *Exine - sculpture*: scabrate (LM), crusted, i.e. made of layers of flat merged

microgemmae (SEM), overlapped by microgemmae as in the previous species; *thickness*: 1,2 (0,6-2,0) µm ± 0,,6 µm; I.E.= 0,04 (0,02-0,07) ± 0,01. *Deterioration*: split = 50%, folded = 45%. Fresh pollen - Morphology as in acetolyzed pollen, with the following differences: *Size*: dM = 28,3 (24,7 - 34,1) µm ± 1,4 µm; dm = 26,6 (21,8 - 33,0) µm ± 3,4 µm; dM/dm: 1,07 (1,00-1,16) ± 0,05. *Papilla* in 1,5% of grains (largely conical, 2-2,2 µm long). *Exine* - *thickness*: 0,8 (0,2 - 1,2) µm ± 0,3 µm; I.E= 0,02 (0,01-0,03) ± 0,01; *Intine – Thickness*: ⅓ - ½ of pollen radius; in split pollen it comes out of the exine, still surrounding the cytoplasm and swelling up to 11,5 µm. *Cytoplasm – Shape*: starry, spheroidal, mass of little spheres; *Size*: ca ½ of dM. *Deterioration*: split = 51%, crumpled = 2%. Note: the crusted exine is not quoted in the literature.The above reported data basically agree with the literature (Beug, 1962; Caramiello et al., 1992; Caramiello & Fossa, 1993; Ciampolini & Cresti., 1981; Erdtman G., 1943; Faegri & Iversen, 1992; Feliziani, 1986; Grilli Caiola et al., 2000; Hyde & Adams, 1958; Moore et al., 1991; Nilsson et al., 1977; Reille M., 1995), adding some characters (the rare papilla in Taxus, the rare porus in Juniperus and the crusted exine in Taxodium. Further investigations might show is if they are casual differences r if they depend on the cultivated status of the parent plants.

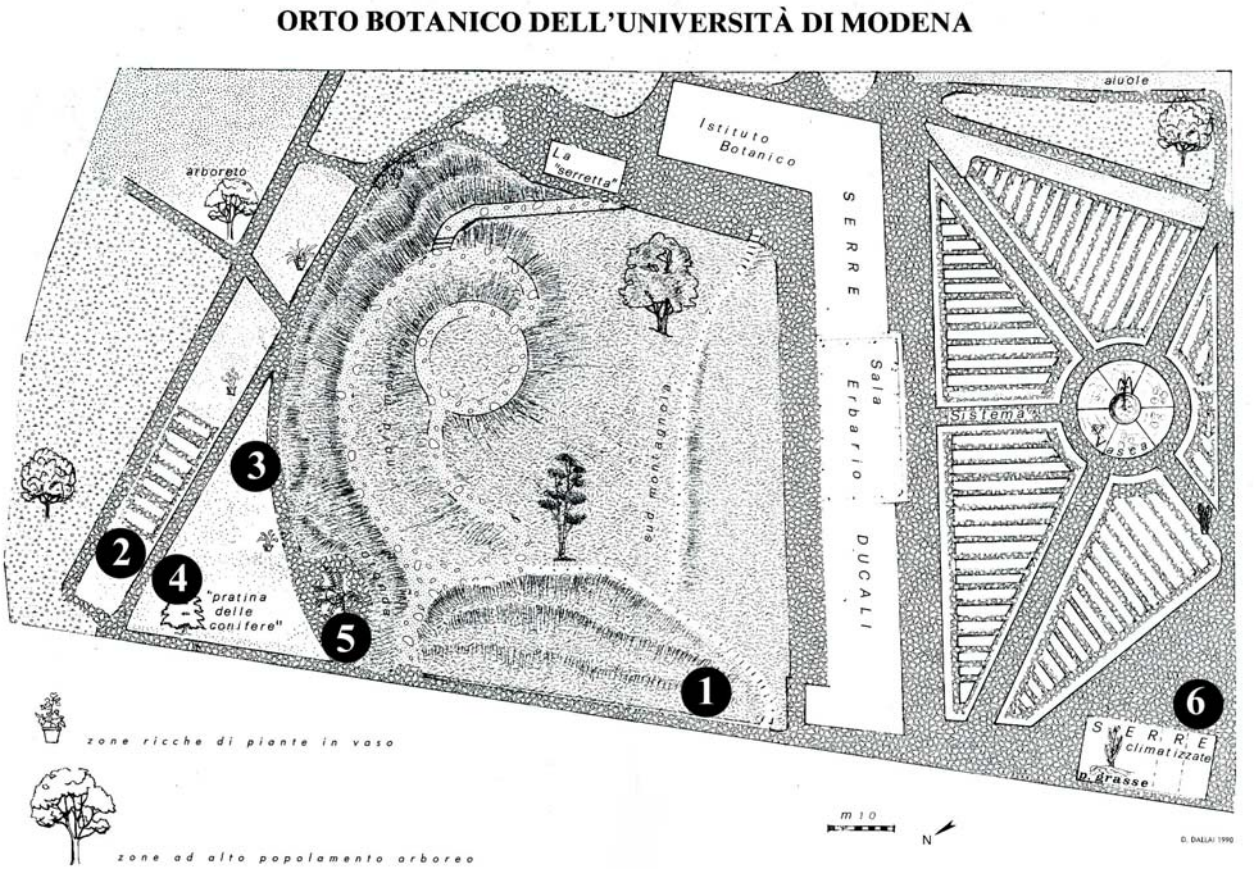

Fig. 2. Location of the Plants studied for the Garden Pollen Flora : 1. *Cupressus sempervirens*, 2. *Juniperus x media* "Pfitzeriana", 3. *Thuja occidentalis,* 4. *Thuja orientalis,* 5. *Taxus baccata*, 6. *Taxodium distichum*

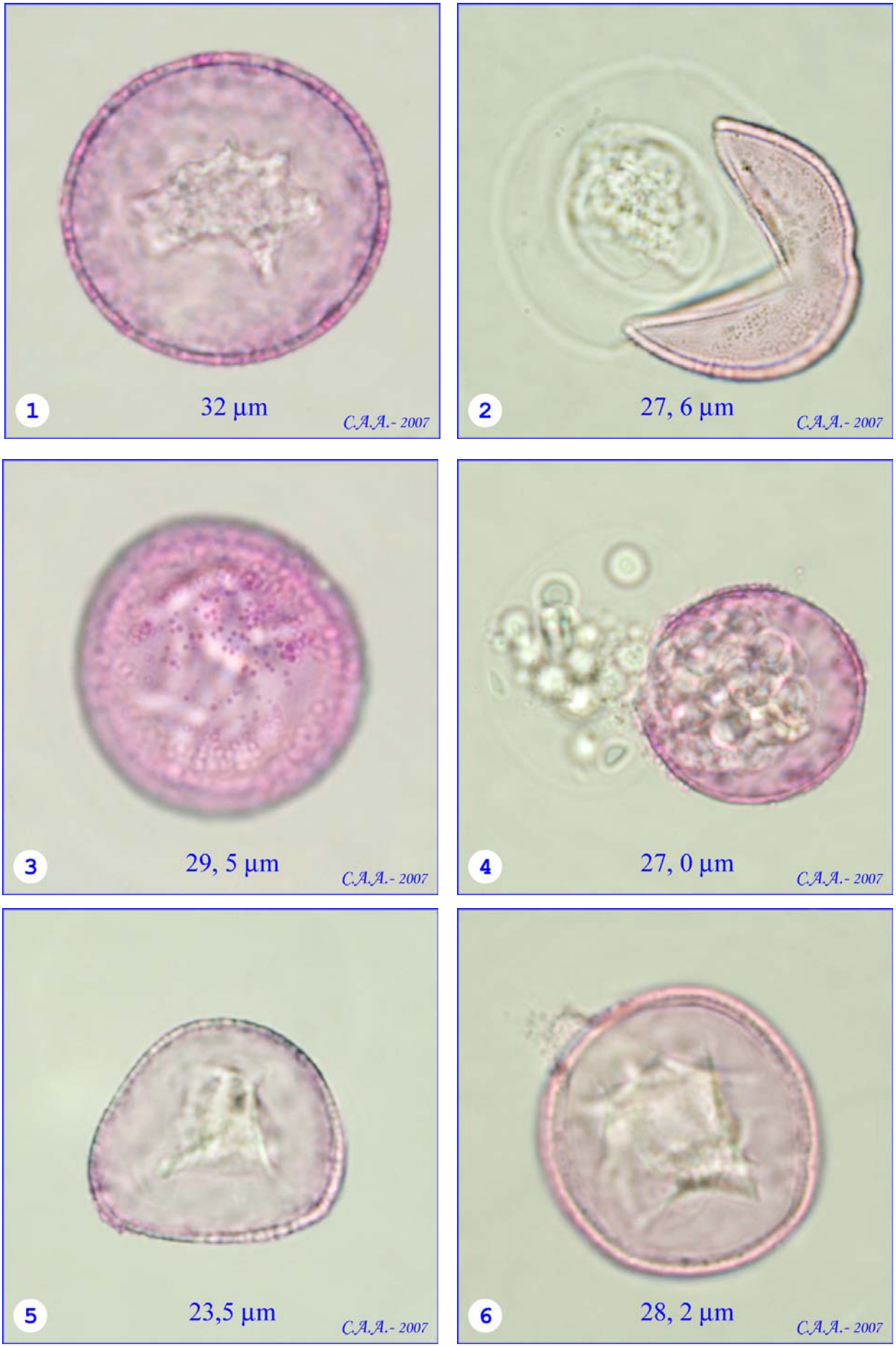

Fig. 3. The Garden Pollen Flora, "Fresh pollen", LM. – 1. *Cupressus sempervirens*, 2: *Juniperus x media*

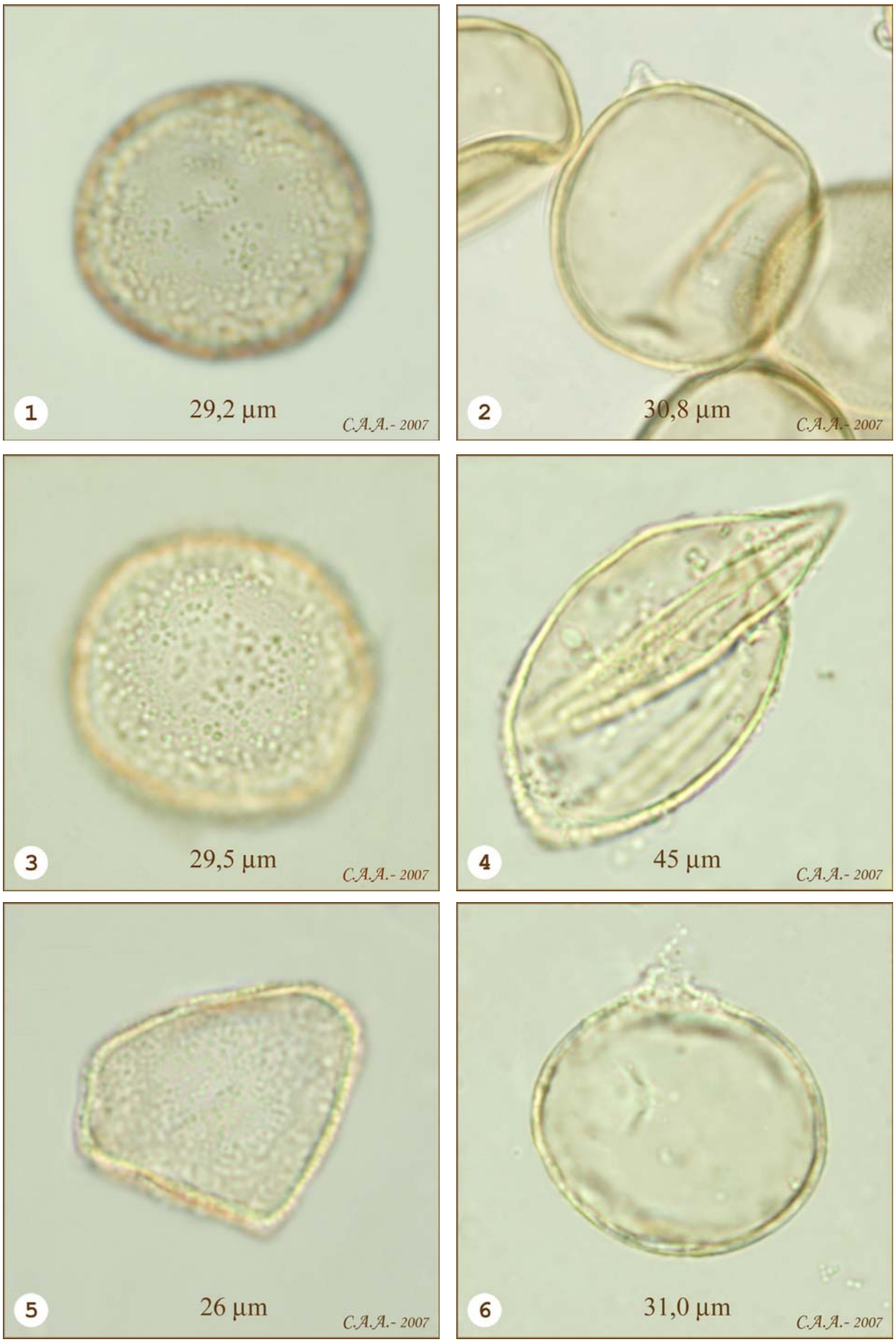

Fig. 4. The Garden Pollen Flora, "acetolyzed pollen", LM. – 1. *Cupressus sempervirens*, 2: *Juniperus x media* "Pfitzeriana", 3. *Thuja occidentalis,*4. *Thuja orientalis,* 5. *Taxus baccata*, 6. *Taxodium distichum.*

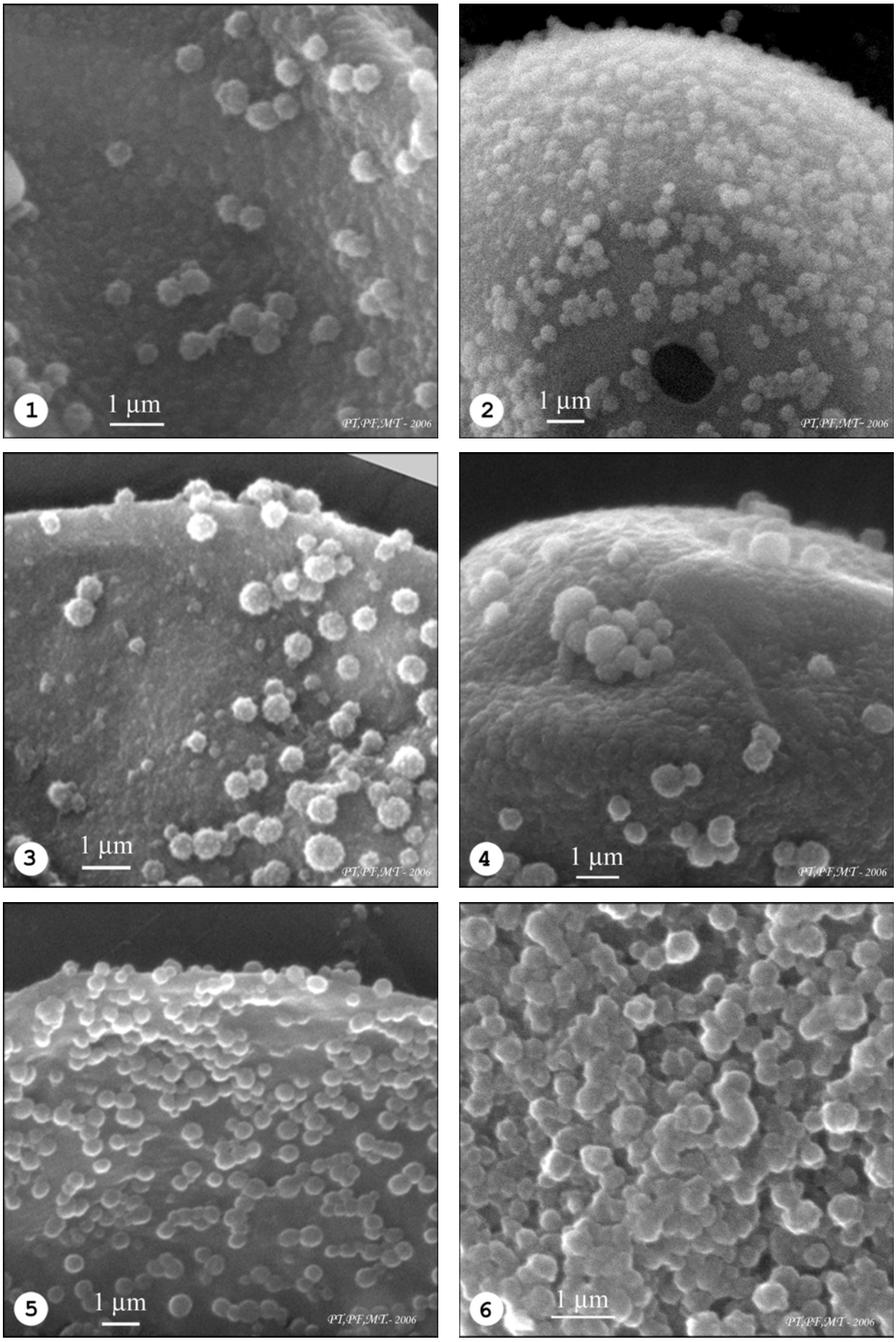

Fig. 5. The Garden Pollen Flora, "acetolyzed pollen", SEM. – LM. – 1. *Cupressus sempervirens*, 2: *Juniperus x media* "Pfitzeriana", 3. *Thuja occidentalis,*4. *Thuja orientalis,* 5. *Taxus baccata*, 6. *Taxodium distichum.*

3) Pollen in Education- Popularisation

Although pollen has been used for several years in short seminars and laboratories organized outdoors/ indoors in the Garden especially for students, from primary to secondary school, the "pollen project" has multiplied and improved this activity. In the current year, besides the pollen slides of trees/shrubs of the Garden, some pollen objects have been prepared and successfully employed in educational processes and in popularisation events. They are: pollen dust jars, three dimensional pollen models, made by E. Barberini according to Accorsi et al., 1992, with size magnified at 10^9 (Fig. 2), big round panels (diameter = 40 cm) with high magnification pollen photos hung from trees/shrubs (Fig. 3). The latter, conceived by Accorsi, Dallai & Torri, were especially successful. These pollen products were used in several 2007 exhibitions where the palynological laboratory and the Garden collaborated in close connection, from microscopes to plants. Some of their titles are reported below: 1) "*Spore traps, devices inhaling nature*", 2) "*The pollen game*" (Barbieri & Torri, 2007), 3) "*Watching and feeling Pollen in the Botanic Garden* "; 4) "*Pollen peeps out to artists*" (Olmi et al., 2007).

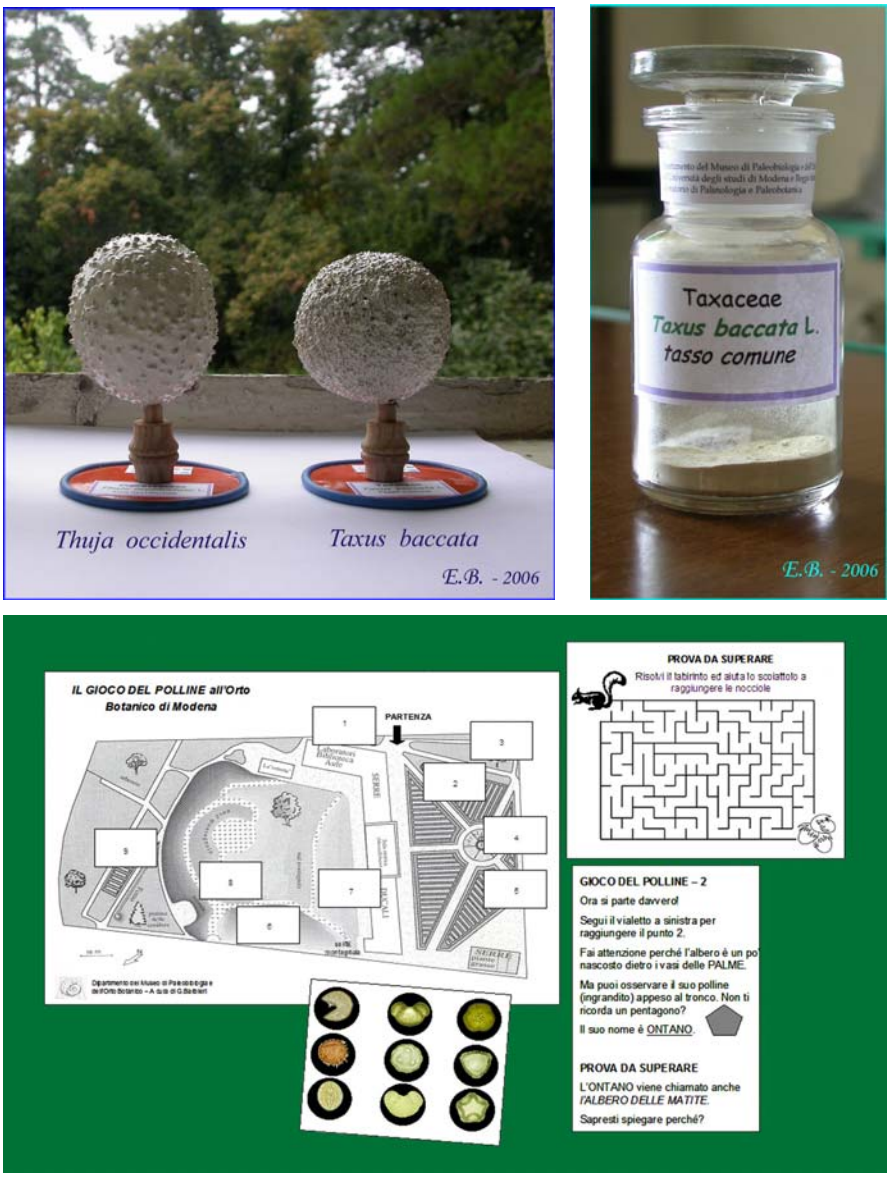

Fig. 6. Examples of the pollen materials for exhibition.

Fig. 7. Examples of the pollen panels.

Fig. 8. Examples of the pollen panels on trees/shrubs during exhibitions in the Garden.

CONCLUSION

Based on the work carried out so far the project "Pollen at the Botanic Garden", undoubtedly ambitious, appears to have the intrinsic vitality essential for a long lasting program which attempts to connect research with education-popularisation in various fields of palynology. Morphology, the basic field of the project, involved in this paper, proved to be a very reliable means of addressing people of various ages and backgrounds about the awareness of plant biodiversity. Thanks to the *Garden Pollen Flora* and the *Garden pollen collection,* palynologists can realize an autarchic process "from the Producer to the Consumer" in the Botanic Garden. Plants produce pollen grains, which are microscopic, light, uncountable carriers of biodiversity, invisible to people. Pollen research is carried out indoors inside the laboratory, and makes it visible. Pollen returns outdoors, into the Garden, and shows its biodiversity to people. Pollen, on the big panels, slightly waving hung from trees and peeping out through the leaves, amaze people and inspire artistic feelings, suggesting differences and similarities which create an awareness of plant biodiversity more than other plant structures.

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