The Greek-Roman theatre of Taormina: pollen and microanthracological data for the proposal of a ‘Historical Green Park’

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Riassunto

Sono presentati i dati relativi alle analisi polliniche e microantracologiche delle carote TaOr-*orchestra* e TaSc-*scaena* campionate all’interno del Teatro Greco-Romano di Taormina che fu probabilmente costruito nel III sec. a.C., in epoca greca, e poi ristrutturato in epoca romana. Le analisi hanno lo scopo di migliorare le conoscenze sulla flora che caratterizzò il sito e i suoi dintorni in passato, e di offrire la base scientifica per la realizzazione di un parco con ‘verde storico’ all’interno e in vicinanza del teatro. Purtroppo, le carote non hanno fornito sequenze indisturbate perché costituite in gran parte da materiale di riporto. Ciononostante, le analisi relative ai due punti di campionamento hanno permesso di ottenere una lista floristica coerente, realistica e verosimile. Il confronto con spettri recenti da suoli superficiali e cuscinetti di muschio raccolti attorno al teatro ha mostrato che la pioggia pollinica attuale è molto diversa da quella registrata nelle carote, soprattutto per la presenza di piante esotiche. Le analisi polliniche suggeriscono per il parco di Taormina l’utilizzo di siepi di bosso, mirto, rosa e biancospino, e inoltre ginepri e cipressi, piante con frutti eduli come pruni, castagno, noce, vite e olivo, alberi ornamentali quali platano, pini, pioppi, leccio, altre querce, e acanto nelle aiuole.

Introduction

The Greek-Roman theatre of Taormina in Sicily is one of the most fascinating cultural sites in the world (fig. 1). It is a jewel of classical art set in a location overlooking the sea (fig. 2). Renowned since ancient times, it has undergone restoration on several occasions and is thus still in use today. In fact, like others in the region, this theatre is used for both dramatic and musical performances, and in its capacity as open air museum, it is also a popular tourist attraction.

In 2000-2006, Sicily’s Regional Centre for the Project and Restoration (CRPR) developed a Risk Map of the Cultural and Environmental Heritage of this region, and promoted a multidisciplinary study of the theatre to evaluate the state of preservation and the reassessment of the site. The research included bibliographic, archive and geological-geotechnical studies, physical and chemical analyses of stone materials, and vibrometrical and biological monitoring of the fabric (Meli 2004). Most of the research was carried out to check the state of preservation and sustainability of the current exploitation of this archaeological structure.

Within this framework, pollen and microanthracological analyses were carried out to evaluate the possibility of a correct establishment of an ‘historical garden’ at the Taormina theatre by improving the knowledge of plants living in the past around the archaeological site.

The site

The Taormina theatre lies on the top of Monte Tauro, on a promontory located in the eastern part of the small town of Taormina, in the province of Messina - north-eastern Sicily, near the coast between Capo Sant’Andrea and Capo Taormina (fig. 1). Monte Tauro is a calcareous relief with NW-SE orientation and Capo Taormina is in the south-eastern limit.

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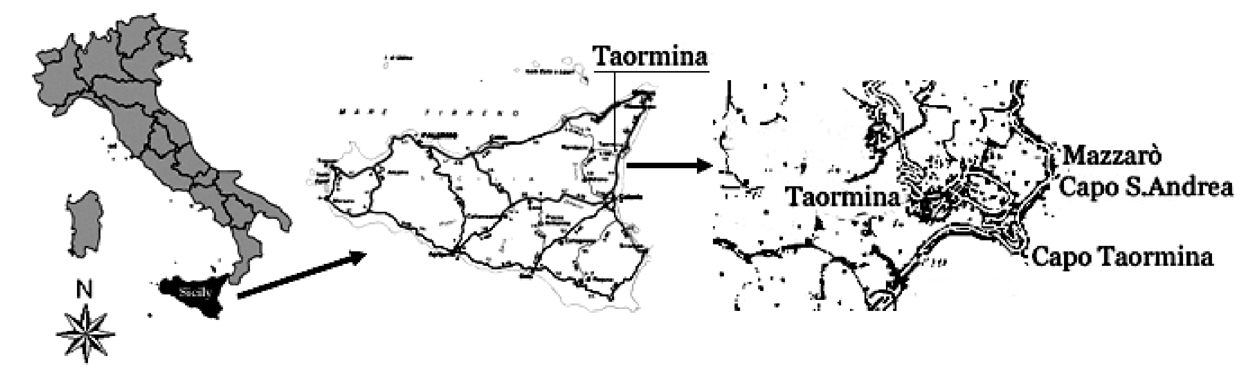


1. - Location map of Sicily and the town of Taormina, in the eastern part of the island.

The theatre covers a surface of about 1 ha, between 220 and 242 m a.s.l. (Cafiso *et al.* 2004). It is 50m wide, 120m long and 20m high, and as such, after the example in Syracuse, it is the Sicily's second largest theatre (Amato *et al.* 2004). In accordance with classical architecture, it is divided into three parts: *scaena*, *orchestra* and *cavea*. The *scaena* is in the SW, and the *cavea* is in the NE (fig. 3). The *scaena* has partially preserved its original form, with the 30x4 m scenic wall, and it ends laterally with two large rooms (*parascaenia*). The *orchestra,* with a diameter of 35m, is located in the centre. The *cavea*, with a diameter of 109m, was originally set in the natural concavity of the mount and here the calcareous-dolomitic substratum of the Monte Tauro constituted its floor.

In the *orchestra* and *scaena*, this substratum is covered by 6-10 metres of reworked material. The latter was repetitively deposited to make the site's floor flatter and more even (Cafiso *et al.* 2004).

Based on the architectural model, the theatre was most probably built in Greek times, in around

2. - View of the Greek-Roman Theatre of Taormina.

the 3[rd] cent. BC. Then it was restructured and enlarged in Roman times, and its use changed from theatrical performances to gladiator shows (Cafiso *et al*. 2004).

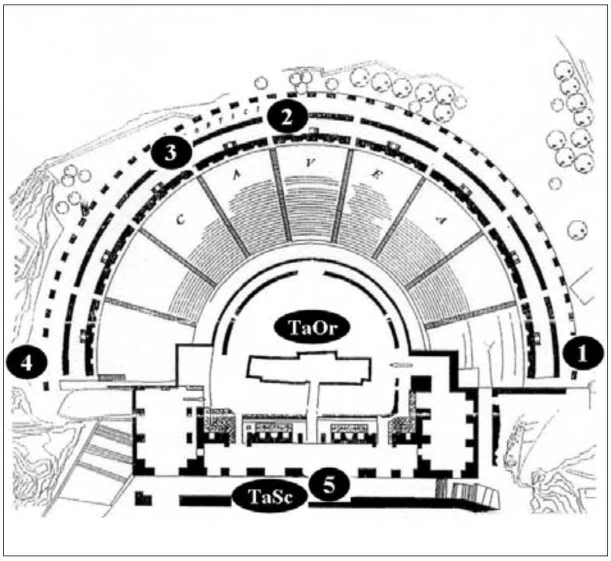
Its history has not been not fully established as the theatre has undergone a complex series of construction phases and structural adaptations, alternated with periods of abandonment, collapses due to natural or human causes, and ancient and modern restorations which have taken place up to its current use (Palla *et al*. 2004). The seismic event in 365 AD that involved the whole central-eastern Mediterranean basin most probably constituted a dramatic event in the theatre's history, causing major structural damage (Bernabò Brea 2000). Many other earthquakes have repetitively hit this area and the whole of eastern Sicily, which lies on several fault systems and has very high seismogenicity. This allows the Taormina theatre to be considered a rare 'seismic fossil' (Cafiso *et al*. 2004: p.56). Since the second half of the 18[th] century, many parts of the theatre have been replaced with different structures or have undergone restoration.

Aim of the research

Following preliminary papers (Accorsi *et al*. 2004; Bosi *et al*. in press), the paper presents synthetic data obtained from preliminary analyses on pollen and microcharcoals from cores TaOr-*orchestra* and TaSc-*scaena* collected on-site in the Taormina theatre.

This work presented several difficulties. In fact, stratigraphic data showed that deposits from the area mostly consisted of rock covered with reworked layers which were unsuitable for pollen analyses and hardly datable (Cafiso *et al*. 2004). Thus, the cores presented here partly or totally consisted of reworked materials which could have been deposited at different times. Nevertheless, as some sandy silt layers possibly containing pollen were present in these deposits, pollen analyses were attempted. Recent pollen rain was checked by analyses of moss polsters and surface soil samples collected on-site.

The two cores chosen for pollen analysis were sampled from two different points of the theatre (fig. 3), thus permitting the comparison and integration of results. Chronological context could not be established with certainty, therefore pollen data will be considered above all to improve knowledge on the flora which characterized the site and the surroundings during the theatre's past life. The aim is to provide, through the archaeofloristic information, a scientific basis for the creation of an historical garden in and next to the theatre.



3. - Planimetry of the theatre with sampling points of cores (TaOr and TaSc) and moss polsters/surface soils (from 1 to 5).

Material and methods

Stratigraphy

Data on the stratigraphy from the geological-geotechnical investigation carried out by Cafiso *et al*. (2004) are reported below. Six cores were collected with a mechanical corer from within the perimeter of the theatre (S1-*scaena*, S2-*orchestra*, S5-*cavea*) and the surroundings (S3 and S4 to the south, S6 to the east) for studies on the hydro-geological collapse and seismic risks. Geological-lithostratigraphical data showed that deposits in the area are mainly constituted of white and grey calcareous and calcareous-dolomitic rocks (sometimes with fractures and carsic microcavities and cavities) covered with thick deposits of reworked materials. The latter were made of sandy silt, silty sand and sand with some gravel or fragments of stone and brick materials which were thought to have been used to level the site's floor (Cafiso *et al*. 2004: p. 34,37). The reworked materials lacked only in S5 from the *cavea,* as this was strongly subject to atmospheric water erosion which prevented the accumulation of incoherent materials and thus consisted only of calcareous rocks. In S3, there is also a thick layer of holocenic detritus under the reworked sediments.

The stratigraphy of cores S1-*scaena* and S2-*orchestra*, investigated for pollen and microcharcoal (fig. 3), is reported briefly below:

a) S2-*orchestra* core, between *cavea* and *scaena*, in the centre of the *orchestra*, is 1750 cm deep: 1750-950 cm = grey calcareous rocks; 950-850 cm = dark silt with gravel filling a carsic cavity of about 1 m; 850-650 cm = grey calcareous rocks; 650-0 cm = reworked material: sandy silt, yellow with rare gravel and brick;
b) S1-*scaena* core, in the *porticus post scaenam* behind the *scaena*, SW side of the theatre, is 2300 cm deep: 2300-1940 cm = grey calcareous rocks; 1940-1920 cm = sand gravel filling a carsic cavity; 1920-1470 cm = grey calcareous rocks; 1470-1420 cm = sand with gravel filling a carsic cavity of about 50 cm; 1420-1060 cm = grey calcareous rocks; 1060-0 cm = reworked material: sandy silt, brown with stone fragments.

Chronology

Unfortunately the stratigraphy did not provide any chronological information for the core tracts examined for pollen and microcharcoals, and likewise, no organic material useful to obtain ^{14}C date was found inside the cores. Further on chronological evidence that emerged from the pollen data is reported (see discussion).

Pollen and microanthracological samples

Samples were collected from cores S2 and S1 by technicians from the CRPR's Laboratory of Bioarchaeology (by Francesca Terranova and Arcangela Valenti). A total of 31 samples from sandy silt layers of the top parts of the cores were collected as follows:

– **TaOr-*orchestra*** = 19 samples from 960 to 20 cm of core S2. The three bottom samples from 960 and 640 cm were unreworked sediments; the others came from reworked layers;
– **TaSc-*scaena*** = 12 samples from 980 to 80 cm of core S1; all reworked layers.

Moreover, 5 recent samples, i.e. moss polster or surface soil samples, were taken to check the site's present pollen rain (fig. 3).

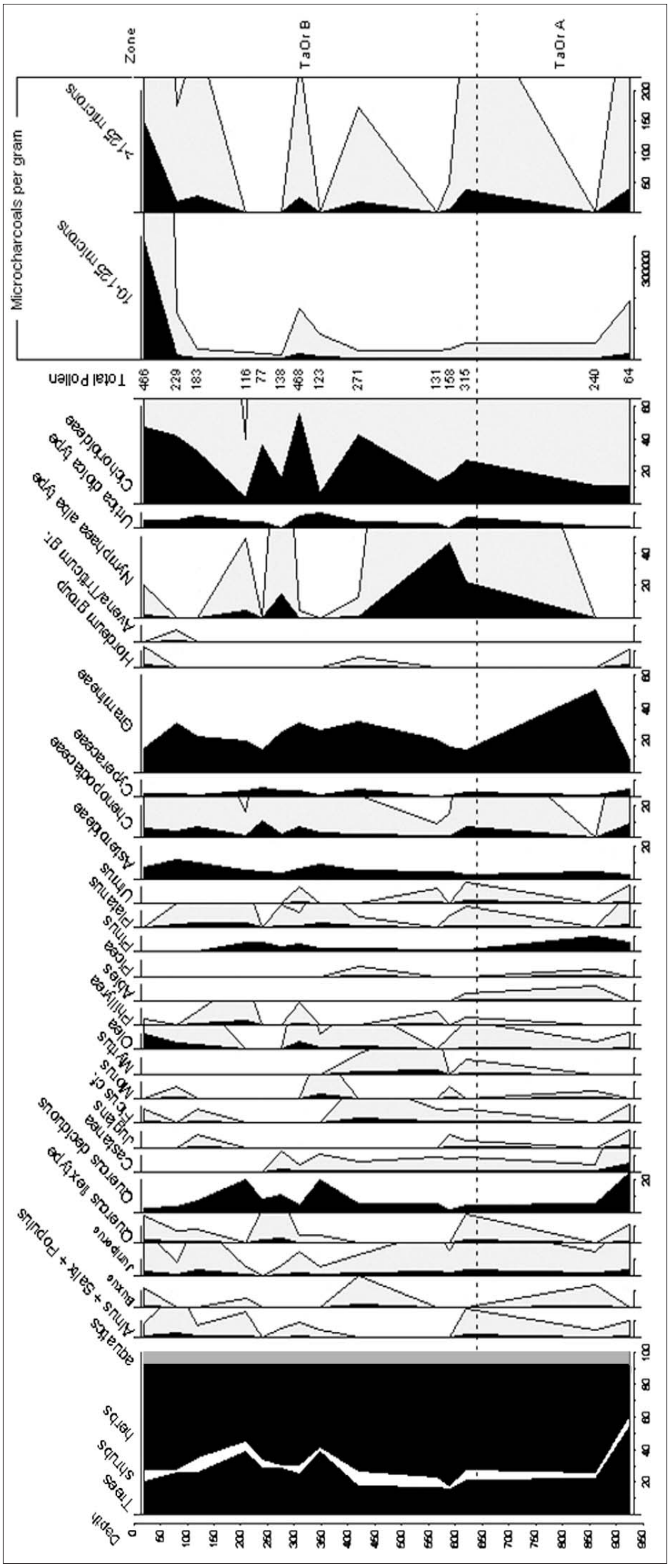
Core samples were treated using a method imported from the Institute of Earth Sciences, Vrije Universiteit Amsterdam (Lowe *et al*. 1996), synthesised as follows. About 10-15 g of sediment was treated with Na-pyrophosphate and HCl 10%, then sieved through a 7 μm nylon mesh, acetolysed for about 10 minutes, submitted to heavy liquid separation (Na-metatungstate hydrate), treated with HF 40%, washed in ethanol 98%, added with glycerol and, finally, stove-dried. Recent samples were treated by boiling with NaOH 10%, acetolysis, HF 40% and HCl 37%. Permanent slides were prepared with glycerol jelly and sealed with paraffin. *Lycopodium* spores were added at the start of the treatments to calculate pollen concentrations, which were expressed as number per gram (pollen = p/g; microcharcoals = m/g).

Pollen analyses were carried out under the light microscope (magnifications of 400x and 1000x). Pollen identification was based on keys and atlases (e.g., Faegri and Iversen 1989; Moore *et al*. 1991; Reille 1992, 1995, 1998), as well as our laboratory's reference pollen collection. The same slides were examined for both pollen and microcharcoal analyses.

Concerning pollen, a mean of about 300 pollen grains per sample was counted in recent samples and in fourteen samples from cores. In the other core samples, pollen content was so low that, to obtain significant data, counts from two close samples were sometimes summed to ensure a total of at least 70-100 pollen grains (TaOr-*orchestra*: samples 4+5, 7+8, 10+11+12, 18+19; TaSc-*scaena*: samples 9+10+11+12; therefore, the number of pollen samples reported in the diagrams are 14 and 9 for TaOr and TaSc, respectively). Diagrams (figs. 4,5) show the pollen spectra percentage calculated on a pollen sum which excludes fern spores and Cichorioideae. The latter, at > 30% in half of the samples, were overrepresented.

Concerning microcharcoal, systematic slide readings followed the method proposed by Bosi *et al*. (in press). Microscopical charcoal particles were subdivided into 4 classes according to the maximum length: small, 10-50 µm; medium, > 50 - 125 µm; large, > 125 - 250 µm; very large, > 250 µm. The classes are grouped into two main categories for brevity in the diagrams, i.e. 10-125 and > 125 µm, and the concentrations are the mean values of the samples grouped as reported above.

Core diagrams were drawn as silhouette (easier



4. - Diagram from core TaOr-*orchestra*. Pollen percentages were calculated on a Pollen Sum which excludes Cichorioideae and ferns; microcharcoal concentrations are expressed as number per gram. For brevity, pollen curves referred to selected taxa, and microcharcoals are summed up into two groups.

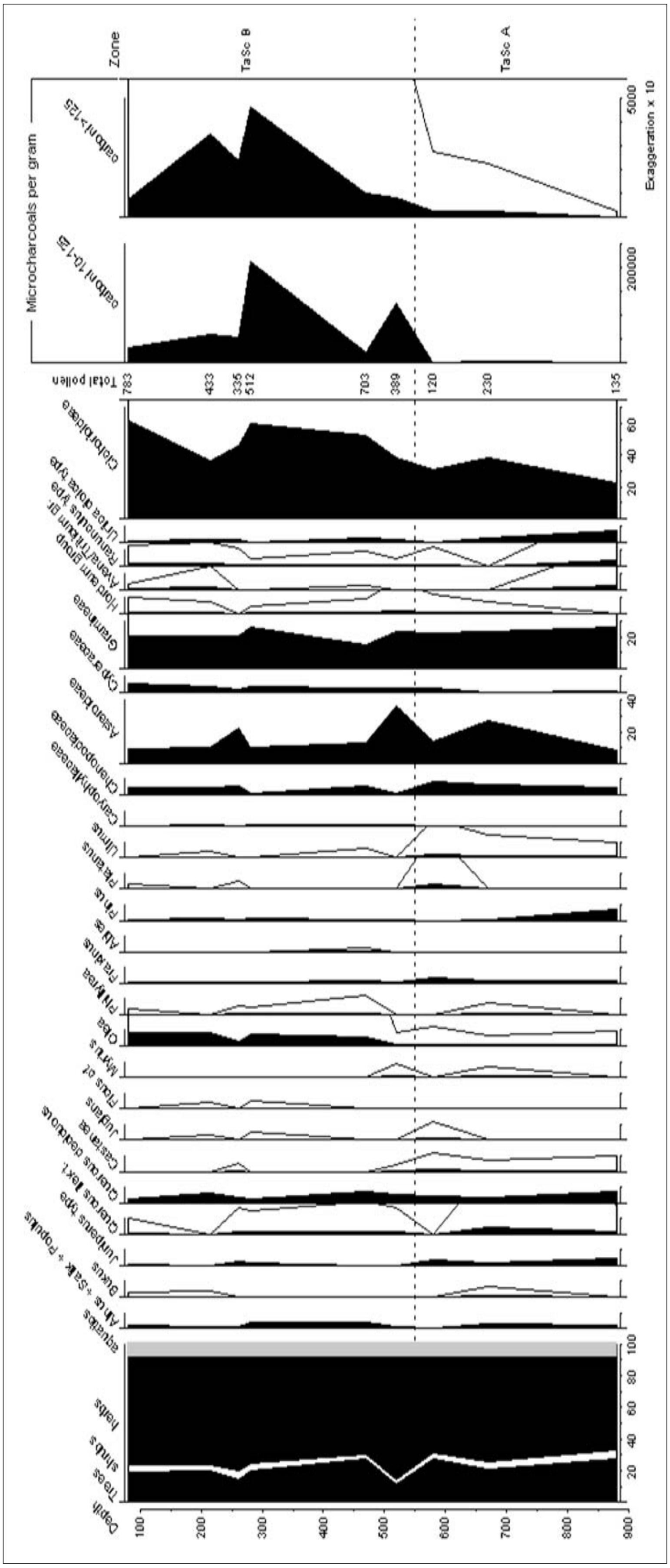
to read than histograms in this case), using Tilia 2.0 and TGView. In each diagram, two main pollen zones were distinguished based on curve changes and CONISS plots (see below). Plant names follow the Flora d'Italia (Pignatti 1982).

Results

In core samples, pollen concentrations varied from very low/low (< 50 / 500 p/g) to medium values (1000-3000 p/g), and concentrations in TaSc-*scaena* were, on average, approximately double those in TaOr-*orchestra* (ca. 1800 p/g versus ca. 900 p/g). Microcharcoals were present in all samples with concentrations ranging from 10^2/g or sometimes 10^3/g at the bottom to 10^5/g in some samples from the central (TaSc-*scaena*) and top (TaOr-*orchestra*) parts of the cores (Figg. 4,5).

Though well-preserved pollen grains were found, most of them were fairly poorly preserved, often with thinned or broken exines, and each pollen type in the same sample showed different degrees of preservation.

Pollen floras in the two cores were fairly similar (123 and 128 taxa in TaOr and TaSc, respectively) with 65% of common taxa (Tab. 1). Gramineae, Cichorioideae, Asteroideae including *Artemisia*, Cyperaceae and Chenopodiaceae prevailed, followed by Caryophyllaceae, Cruciferae, *Plantago*, *Ranunculus* type, Rosaceae and *Urtica dioica* type. Woody plants were mainly represented by deciduous oaks - *Quercus*, pines - *Pinus* and olive tree - *Olea*, together with holly oak - *Quercus ilex* type and plane - *Platanus*. Fruit trees such as plum trees-*Prunus*, chestnut tree-



5. - Diagram from core TaSc-scaena (see also caption of fig. 4).

Castanea, walnut tree-*Juglans* and lianas and grapevine - *Vitis* were present in traces. Shrubs such as box-*Buxus* and a few myrtle - *Myrtus* were present too. Pollen morphology from our records suggested that *Juniperus* type belonged to species of juniper and cypress (probably *Cupressus* cf. *sempervirens*) shrubs and trees. Hygrophilous and hydrophilous plants included both herbs such as water lily - *Nymphaea*, cattail - *Typha* and rush - *Juncus*, and trees/shrubs such as alder - *Alnus*, poplar - *Populus* and willow - *Salix*.

Altogether, pollen diagrams show low woody plant pollen values (=20-30%, up to 50% at the bottom of TaOr-*orchestra*), featuring mainly broadleaves from mixed oak woods and Mediterranean maquis. Hygrophilous woods and wet environments are better represented in TaOr-*orchestra* than in TaSc-*scaena* profile (figg. 4, 5). Herbs largely prevail and are varied, with four *taxa* reaching 20-30% (Gramineae and Cichorioideae in both cores; *Nymphaea alba* type in TaOr-*orchestra*; Asteroideae in TaSc-*scaena*). Cichorioideae are on average ca. 30% of the spectra, reporting higher values in TaSc-*scaena* (39%) than in TaOr-*orchestra* (22%). Such a high presence is quite common in archaeological sites and depends on either anthropogenic activities or the presence of calcareous deposits (Dimbleby 1985; see below).

In the TaOr-*orchestra* diagram (fig.4), two main zones were identified, corresponding to unreworked or reworked layers (see stratigraphy above):

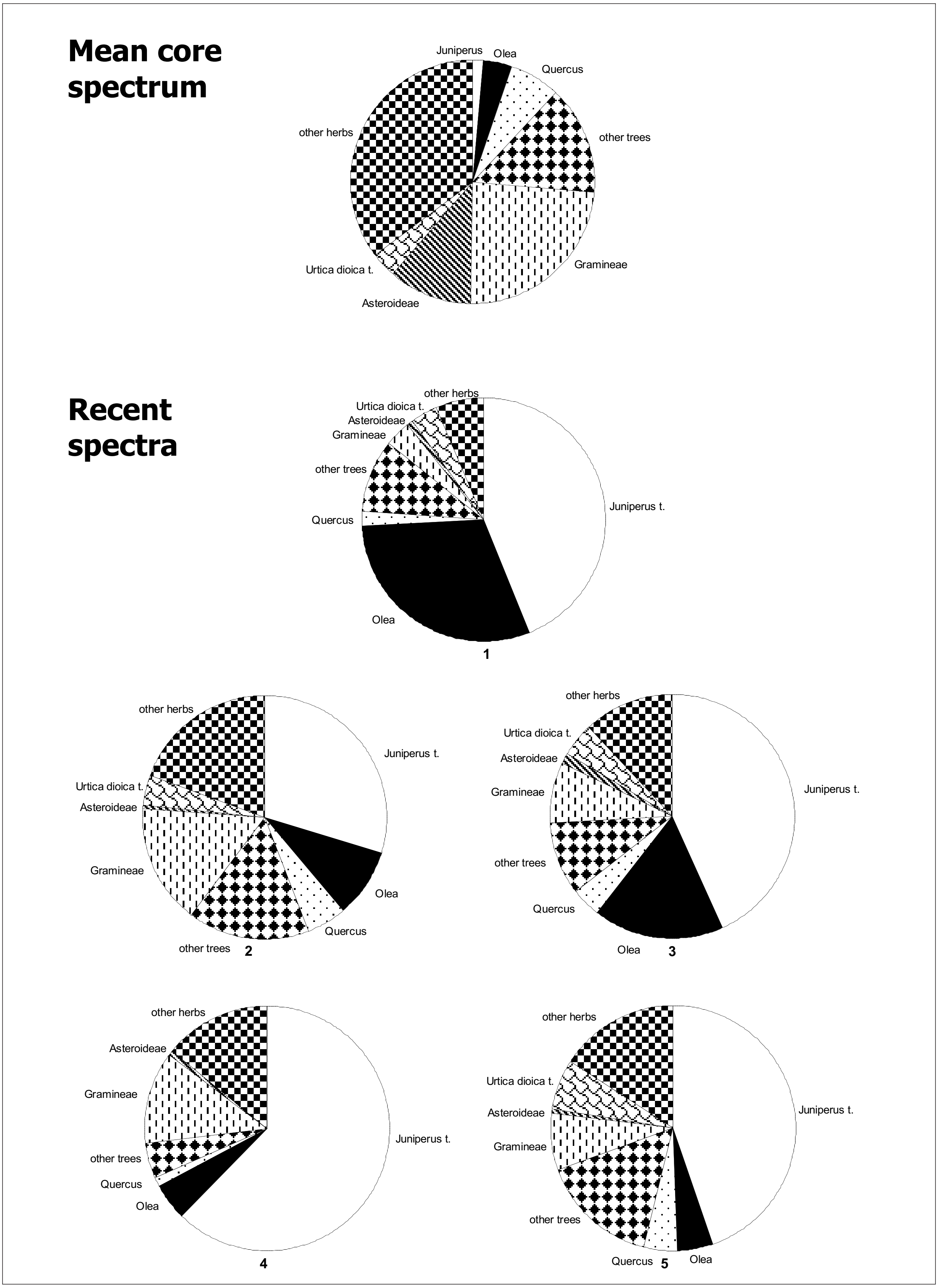
a) TaOr A – from 940 to 640 cm; unreworked sediment = at the bottom woody pollen values were relatively high, with mainly

Pollen Flora
Trees - Shrubs - Lianas
Aceraceae (*Acer campestre* t.); Anacardiaceae (*Pistacia);* Apocynaceae (*Nerium oleander*); Aquifoliaceae (*Ilex* t.); Betulaceae (*Alnus, Betula*); Buxaceae (*Buxus*); Cannabaceae (*Humulus* cf.); Capparaceae (*Capparis* cf.); Caprifoliaceae (*Sambucus nigra*, *Viburnum* cf.); Cistaceae (*Cistus* cf., *Helianthemum*); Corylaceae (*Carpinus betulus*, *Corylus*, *Ostrya carpinifolia/Carpinus orientalis* t.); Cupressaceae (*Juniperus* t. including *Juniperus* and *Cupressus*); Dioscoreaceae (*Tamus communis*); Ephedraceae (*Ephedra fragilis* t.); ERICACEAE; Fagaceae (*Castanea*, *Fagus*, *Quercus ilex* t., *Quercus* cf. *pedunculata*, deciduous *Quercus*); Hippocastanaceae (*Aesculus*); Juglandaceae (*Juglans*); Leguminosae (*Cytisus* cf., *Genista* cf.); Liliaceae (*Smilax* cf.); Moraceae (*Ficus* cf.; *Morus nigra*); Myrtaceae (*Myrtus*); Oleaceae (*Fraxinus* cf. *excelsior*, *F.* cf. *ornus*; *F.* undiff; *Jasminum* cf.; *Ligustrum*; *Olea*, *Phillyrea*; Oleaceae undiff.); PALMAE; Pinaceae (*Abies*, *Cedrus*, *Picea*, *Pinus*); Platanaceae (*Platanus*); Rutaceae (*Citrus*); Ranunculaceae (*Clematis*); Rhamnaceae (*Ziziphus*); Rosaceae (*Crataegus*, *Prunus*, *Rosa*); Salicaceae (*Populus*, *Salix*); Tamaricaceae (*Tamarix*); Taxaceae (*Taxus*); Ulmaceae (*Ulmus*); Vitaceae (*Vitis*).
Herbs
Acanthaceae (*Acanthus* cf.); Alismataceae (*Sagittaria*); Boraginaceae (*Echium*, *Symphytum*); Callitrichaceae (*Callitriche*); Campanulaceae (*Campanula* t.); Cannabaceae (*Cannabis* cf.); Caryophyllaceae (*Cerastium* t., *Paronychia* cf., *Spergularia* cf.); Chenopodiaceae (*Beta* cf., Chenopodiaceae undiff.); Compositae (*Ambrosia* t., *Anthemis* t., *Artemisia*, *Aster* t., *Carthamus* cf., *Centaurea nigra* t., *Centaurea cyanus* t., *Centaurea* undiff., *Cirsium*, Asteroideae undiff., Cichorioideae); Convolvulaceae (*Convolvulus*); Crassulaceae (*Sedum* t.); Cruciferae (*Hornungia* t., *Matthiola*, *Sinapis* t., Cruciferae undiff.); CYPERACEAE; Euphorbiaceae (*Euphorbia*, *Mercurialis*); Gramineae (*Avena/Triticum* gr., *Glyceria*, *Panicum* cf., *Hordeum* gr*.*, *Phragmites* cf., Gramineae undiff.); Guttiferae (*Hypericum* cf.); Hydrocharitaceae (*Hydrocharis* cf.); Juncaceae (*Juncus* cf.); Labiatae (*Mentha* t., *Stachys*, *Teucrium*); Leguminosae (*Dorycnium* cf., *Lotus* t., *Medicago sativa*, *Melilotus* cf., *Onobrychis* t., *Trifolium*, *Vicia,* Leguminosae undiff.); Lemnaceae (*Lemna*); Liliaceae (*Allium* t., *Asphodelus*, Liliaceae undiff.); Malvaceae (*Malva* t.); Nymphaeaceae (*Nymphaea alba* t.); ORCHIDACEAE; Papaveraceae (*Papaver*); Plantaginaceae (*Plantago* cf. *afra*, *Plantago major*, *Plantago* undiff.); Plumbaginaceae (*Armeria* cf.); Polygonaceae (*Polygonum aviculare* t., *Rumex*); Primulaceae (*Anagallis*, *Hottonia palustris*, Primulaceae undiff.); Potamogetonaceae (*Potamogeton* cf.); Ranunculaceae (*Ranunculus* t., *Thalictrum,* Ranunculaceae undiff.); Resedaceae (*Reseda lutea* t.); Rosaceae (*Filipendula*, *Potentilla* t., *Sanguisorba*, Rosaceae undiff.); Rubiaceae (*Galium* t.); Saxifragaceae (*Saxifraga granulata* t.); Scrophulariaceae (*Linaria* t., *Rhinanthus* t., *Verbascum* cf., *Veronica* t., Scrophulariaceae undiff.); Solanaceae (*Solanum*); Typhaceae/Sparganiaceae (*Typha/Sparganium*); Umbelliferae (*Daucus*, Umbelliferae undiff.); Urticaceae (*Urtica dioica* t., *Urtica* cf. *pilulifera*); Valerianaceae (*Valeriana*); Verbenaceae (*Verbena*); Zygophyllaceae (*Tribulus* cf.).
cf. = confront; t. = type; gr. = group; undiff. = undifferentiated

Table 1. - Pollen flora from the Greek-Roman Theatre of Taormina: list of pollen taxa recorded in the two cores.

deciduous *Quercus* and *Pinus*; *Nymphaea* was absent and Cichorioideae low; all woody plants and most herbs, with only three minor exceptions, i.e. *Glyceria*, *Reseda* cf. and *Veronica* type, were common in the following zone. Microcharcoals were present, with some large/very large records;

b) TaOr B - above ca. 640 cm; reworked material = woody pollen was fairly constant and abundant; presence of *Nymphaea* (up to 46% at 590 cm) and higher values of Cichorioideae; at the top, *Olea* and microcharcoal increase. The most significant and prevalent *taxa* in the bottom



6. - Pollen data from past and recent spectra: selected taxa and groups (t. = type). *Quercus* includes deciduous *Quercus* and *Q.ilex* type. Pollen sums exclude Cichorioideae (negligible in recent spectra). Past spectrum is calculated on the mean values of TaOr-*orchestra* and TaSc-*scaena* core samples. Recent spectra are the 5 moss polsters and surface soils collected around the theatre.

samples were also important in this zone (deciduous *Quercus*, *Pinus*, *Juniperus* type, *Olea*, *Quercus ilex* type, Asteroideae). Cichorioideae had higher values (35% versus 11% in the previous zone), like Chenopodiaceae, while Gramineae (14% versus 38%), Caryophyllaceae and *Ranunculus* type had lower values. Microcharcoals had prevalently lower values with minor oscillations and rose at the top of the diagram.

In the TaSc-*scaena* core diagram (fig. 5), two main zones can be observed, corresponding to two main reworked layer deposition phases:

a) TaSc A - below ca. 550 cm = relatively lower concentration of microcharcoals, lower percentages of Cichorioideae, traces of *Olea* and slightly higher percentages of *Pinus* and *Juniperus* type;

b) TaSc B - above ca. 550 cm = clear increase of microcharcoals, and evident increase of *Olea* and Cichorioideae.

In recent spectra, pollen concentrations were high (> 400,000 p/g) and the state of preservation was good/very good. Trees and shrubs dominated in all spectra (mean: 80%). *Olea* and *Juniperus*-type pollen, the latter including several types, largely prevailed. *Acacia, Ailanthus*, *Casuarina, Citrus* pollen and other exotics featured heavily in these spectra. Herbs are essentially Gramineae, and Cichorioideae are rare (fig. 6). Microscopical charcoal is decidedly less than in the core samples, also including a few large records.

Discussion

When discussing the palynological results it must be borne in mind that the materials examined are not ideal for pollen analysis, especially as they are mainly characterized by reworked materials. As cores did not provide undisturbed sequences, pollen data are affected by biases concerning the evolution of the plant cover in and next to the site, and also possibly the flora. Nevertheless pollen data offered some reliable suggestions regarding the objective of this work, i.e. the identification of a plant list useful for the creation of an historical garden, which are resumed in the following points.

a) Suggestion offered by pollen data concerning chronology. The TaOr-*orchestra* diagram shows, as seen above, two pollen zones (fig. 4). The lower one, pollen zone TaOr A, concerns samples underlying the reworked deposit. Its pollen assemblages are clearly of holocenic age and show a more forested and mesophilous flora-vegetation than in the subsequent zone (TaOr B). We interpreted these pollen grains as included in sediments which filled cavities or microcavities in the calcareous rocks, possibly having arrived there through fractures in the rock. We also assumed, as a reasonable hypothesis, that pollen zone TaOr A could be dated to the earliest part of the life of the theatre, i.e. classical, Greek-Roman times. Concerning the upper pollen zone TaOr B and also the entire TaSc-*scaena* diagram, which is completely derived from reworked materials and characterized by a vegetation which is both drier and more affected by anthropic activity, it is reasonable, based on stratigraphical position, to interpret that the materials are younger than those in zone TaOr A. Moreover, as they do not show any exotic-type pollen, which was found, instead, in the recent samples (see below), the reworked deposits studied do not contain recent sediment and precede the green decorative setting currently found around the theatre, which includes many exotic plants.

b) Preservation and reworked/unreworked layers. First and foremost, calcareous layers, which are common in the area, are not conservative for pollen and in general favour the survival of the more resistant and recognizable pollen such as Cichorioideae (Dimbleby 1985). Then, pollen from archaeological sites is generally known to have different states of preservation in the same sample, and is frequently poorly preserved, especially in arid zones (Horowitz 1992). In the case of Taormina, different materials with differently preserved pollen were most probably part of the reworked layers. For example, silt collected outside the site could have been transported inside and sooner or late would have mixed with other deposits in the theatre. In samples coming from unreworked material (zone TaOr A; fig. 4), differences in the state of preservation were not so frequently observed on the whole, which agrees with the assumption that deposition was undisturbed in this tract.

c) Floristic-vegetational value of pollen data. Due to the nature of the examined cores (reworked in long tracts), the reliability of their pollen assemblages mainly regards the flora as information about vegetation is limited. As far as vegetation is concerned, a marginal topic in this paper, and with particular reference to the TaOr-orchestra diagram, a change from more mesophylous vegetation with less anthropic influence to a drier vegetal landscape with more human impact can be inferred from pollen records. As regards flora, the key topic of the paper, it can be observed that the variable state of preservation and the abundance of Cichorioideae suggested that different degrees of deterioration had occurred in the samples. This means the pollen list cannot be completed. However, it can be observed that many samples were examined; that they come from two different points on site; and that pollen lists from the two diagrams, considered as a whole, are long and similar, providing coherent, realistic and reliable information about the flora (Tab. 1).

d) Reworked assemblages testify different anthropic events and past environments. As stated above, most of the material was reworked and not regularly stratified. This prevents any reading of these sections of the diagrams from an evolutionary perspective. Even though the reworked tracts might be made of reworked materials of different ages, the changes visible in the diagrams should be generally considered casual changes mainly linked to anthropic transport of material from somewhere in the surroundings into the theatre rather than real changes in plant cover around the site. Nevertheless, different events can be distinguished in each diagram:

– **in the TaSc-*scaena* diagram**, two main zones based on *Olea* pollen and microcharcoals may correspond to reworked deposits collected from different areas, or they may have been transported to the site at different times. For example, if the time difference hypothesis was true, the second phase would have been more affected by widespread local and regional fires. Apart from the aforementioned differences, no other important diversity was observed. More specifically, there is no diversity between the pollen lists from these two zones, which means that the plants in the area from which the materials were collected (most probably not far from the theatre) must have been almost the same in both phases;
– **in the TaOr-*orchestra* diagram** zone B, besides evidence of place/time differences, anthropic events are shown which are similar to those in the TaSc-*scaena* diagram although less strong. One particular event of interest testifying antropic action involving past environment emerges from the reworked deposit, i.e. the "*Use of silt to make floors in the orchestra"*. A high amount of *Nymphaea* pollen was found in the TaOrB zone at about 50 cm above the TaOrA zone (fig. 4). Water lily pollen is not frequent in deposits, and a high amount is generally indicative of growth in the immediate vicinity. Our hypothesis is that this pollen first accumulated in fresh water rivers or ponds where the plants grew. Then silt including water lily pollen must have been collected from wet places and transported to make the floors in the theatre. Based on the pollen, there are no clear elements to identify a precise area, but it should be remembered that wet environments are not that widespread in Sicily and that the Alcantara river runs near Taormina. It has a hydrographic basin of 573 km^2, which extends through a beautiful regional river park and hosts wet environments suitable for aquatics. Water lily needs permanent water. It prefers shallow water and does not grow more than 3-4 m in depth (Ellenberg 1988). On the other hand, *Nymphaea alba* L. ssp. *alba* has never been collected during the current century and is considered extinct in Sicily by Raimondo *et al*. (1992).

e) Traces of plants from classical times? As discussed above, the bottom of the TaOr-*orchestra* core is considered unreworked sediments deposited prior to the reworked ones, and we assume that their pollen assemblages (pollen zone TaOr A) testify the plants of the area at the time of the construction of the theatre, or in classic times in general. Therefore we can extract knowledge from the pollen flora of these samples about plants growing around the site at those times. The area featured broadleaf and conifer woods which were thicker than later on. Some hedges with box and juniper, and trees such as chestnut, walnut, olive, holly oak and plane would have been the first greenery to frame the young theatre. The aforesaid trees/shrubs, plus some accompanying herbs, form a first list of plants useful for the creation of an "historical garden" around the theatre (trees/shrubs: *Buxus, Castanea*, *Juglans, Juniperus, Olea, Quercus ilex* type, *Platanus, Viburnum*; herbs: Caryophyllaceae, Compositae, *Hypericum*, *Ranunculus* type). Knowledge from classic literature supports this selection. In fact, for example, it is known that according to the Greek way of thinking (also supported by the VII book of The Odyssey), gardens were supposed to be delimitated by hedges, and fruit plants – including grapevine – were generally preferred to purely decorative trees. Olive trees and planes were grown in the large streets of Athens, and plane trees in particular were highly valued for their shade (Baumann 1993).

Subsequently, in the Roman period, the garden was considered a place of culture and art. The most striking features of a Roman garden were lines of large trees, among which the plane appears to have been a favourite; rows of fruit-trees, especially vines, and trunks of trees often covered with ivy; alleys or walkways *(ambulationes)* formed by close evergreen hedges including box, yew-*taxus*, cypress, myrtle and laurel-*Laurus*. There were also *Acanthus* flowerbeds, a symbol of prestige and wellbeing, and *Iris, Ruta*, *Viola* (Pliny and Cicerone in Smith 1870).

In classic times, most plants were chosen for their symbolic significance. Several of the taxa recorded in the Taormina cores are included in the extremely long list that emerges from the numerous books on the subject (e.g., Baumann 1993; Brosse 2004; Cattabiani 2006). To quote but a few examples, box was a symbol of continuity of life in the Underworld and of eternity, and as such, like other evergreens, was sacred to Hades; moreover, it was symbol of chastity. Myrtle, on the contrary, was a symbol of fecundity, sacred to *Venus*; it was also a symbol of victory, a plant of cleanliness, a funerary plant like the cypress, and its leaves were used to envelope cadavers in the same way as olive and black poplar trees. Hawthorn-*Crataegus* (namely the species *C. oyacantha*) was considered a symbol of hope. Commonly used for marriage decorations and to form an impenetrable green wall in Greek gardens, it was also recommended by Pliny – together with rose shrubs – to discourage thieves. Cypresses, pines, poplars, plane, holly oak and other oaks were planted along the streets, together with box and myrtle hedges. Topiary art (*ars topiaria*) which consisted in tying, twisting, or cutting trees and shrubs (box in particular, but also myrtle, laurel and holly oaks) into the figures of animals, ships and letters was also commonplace. *Acanthus*, symbol of immortality, was frequently featured in flower beds.

f) More Mediterranean plants in the following periods. The reworked sediment of the two cores were deposited in subsequent times, most probably on several occasions, as already mentioned. On the whole, pollen data show a prevalence of plants from open areas in arid environments, and also elements from meadows and fresh-water environments which could have been located at varying distances from the site. Among shrubs and trees, *Quercus ilex* type, *Olea*, *Pistacia*, *Phillyrea*, *Myrtus* and *Nerium oleander* trees were typical of the plant cover of the Mediterranean region, and it is worth noting that the latter three were absent in the bottom pollen zone TaOr A of the TaOr-*orchestra* diagram. Data fit well with the hypothesis that reworked materials were collected not far from the site or in the region. Microcharcoals must have mostly arrived from far away and this suggests that they mainly corresponded to ash dust rather than to fires near the site. In fact, the largest charcoals are considered strongly indicative of local fires, such as for example those made in hearths (Caramiello and Arobba 2003). Anyway, in Taormina, according to Bosi *et al*. (in press) local fires, some of which may even have burned inside the theatre, can be inferred from the peaks shown in TaSc-*scaena* (zone TaSc B, fig. 5).

g) Past and recent spectra. Comparison with the recent spectra, from moss polster and surface soil samples, shows that past pollen rain is profoundly different from current rain. Besides much higher pollen concentrations (also found in surface soil, which is more comparable with past samples than moss samples), recent spectra shows very good pollen preservation, clear prevalence of *Olea,* low microcharcoals and one feature that is especially important for the paper's objective, i.e. the presence of various exotic pollen types that testify the exotic plants currently growing in the site and surroundings, which are aliens in terms of the theatre's history (e.g. *Acacia*, *Aesculus*, *Casuarina*, *Citrus*…). Among exotic pollen there are high percentages of *Juniperus*-type whose morphology, at a preliminary analysis, suggests the presence of different species of Cupressaceae, other than the *Juniperus* and *Cupressus* (*C*. cf *sempervirens*) identified in the cores samples. Therefore, the comparison between core and recent spectra suggested that, notwithstanding taphonomical problems and human disturbance, pollen data from TaOr and TaSc cores can be reasonably attributed to past landscape and events regarding the theatre's history.

Conclusion

Like other classic sites in Sicily, the Greek-Roman theatre of Taormina is still a living place which today hosts remarkable performances whose attraction is increased by its wonderfully preserved structures and charming setting. This encourages the Regional Council to undertake and envisage for the future practices such as the creation of a park area designed according to the site's history which will be incorporated into the theatre's restoration plan. Written sources have shown the different consideration that Greeks and Romans had for their gardens, and this allows us to infer that the decorative greenery in Taormina would had changed as a result of the passing from one culture to the other. In the subsequent centuries other changes certainly occurred but the pollen data obtained so far does not yet enable us to disentangle them.

Altogether, pollen suggested a list of plants which have been present in or near the theatre during moments of its life without providing, though, details of its chronology.

Within the list attention is focused on pollen belonging to plants known to have had symbolic significance or ornamental use in classic times. In the core analyses, as said above, pollen indicated box, myrtle, rose, hawthorn, juniper and cypresses, together with plum, olive, chestnut and walnut trees, vines and also planes, pines, poplars, oaks (including holly oaks) and *Acanthus*.

All considered, the following should feature predominantly in Taormina's future historical garden: *Buxus* hedges, joined by *Myrtus* and thorny *Rosa* and *Crataegus* shrubs; some *Juniperus* and *Cupressus*; trees arranged in rows, with preference to fruits trees, such as *Prunus,* which produce fresh fruits; olive trees, holly oaks; and possibly *Vitis* arbours near the walls. Shrubs with beautiful flowers, such as *Nerium oleander,* should also be planted, in addition to shadow gardens with *Acanthus* and a few other flowers. Several *Platanus* trees could be planted along the street next to the entrance, for ornamental purposes. If possible box and holly oaks should be arranged in accordance with the topiary art favoured by the Romans.

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