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Vegetation and landscape from 14th to 17th century AD in Marseille city centre, reconstructed from insect and pollen assemblages

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ABSTRACT

Archaeological excavations performed at “Place du Général-de-Gaulle” in the centre of the city of Marseille provided sediment samples spanning the period 14th–17th century AD and enabled insect and pollen analyses to be made in order to reconstruct vegetation and landscape of the ancient city outskirts. Insect and pollen assemblages reveal that fauna and flora in the area were heavily transformed by agriculture and pastoralism. Stands of *Pinus halepensis* Mill. (Aleppo pine) and *Pinus sylvestris* L. (scots pine), deciduous *Quercus* groves and remnants of Mediterranean *Quercus* forest with *Quercus ilex* L. (holm oak) and *Phillyrea* (mock privet) dominated the landscape. A typical shrubby Mediterranean vegetation (“garrigue”) with Cistaceae (rockrose), Lamiaceae (*Sideritis*) and Scrophulariaceae occurred nearby. Both pollen and insect evidence suggest that *Olea europaea* L. (olive tree), *Ficus carica* L. (common fig) and cereals were cultivated. Nitrophilous plants along with dung beetles indicate that livestock was abundant. Herbaceous plant dependent Coleoptera show that a ruderal vegetation associated with wastelands was established, but hygrophilous plants occurred locally in more humid areas. A variety of darkling beetles is recorded, and indicates that ruins and old stone walls were available. High numbers of beetles associated with pieces of wood soaked with seawater agrees with the hypothesis of a shipyard located nearby, and both halophilous ground-beetles and plants (Chenopodiaceae) indicate that salt pans were probably established in the area, as suggested by archaeological and historical data. Comparison between insect and pollen records shows that (1) there is a broad agreement between both records, (2) phytophagous insects may confirm the local presence of plant taxa, (3) the presence of plants not indicated in the pollen record may be revealed by phytophagous insects only, (4) insect data may provide abundant and original information concerning past human activities and anthropogenic environment.

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1. Introduction

In northern Europe, fossil insect analysis is now well established as a major tool among the many biological disciplines that contribute to reconstruct past environments in anthropogenic contexts from archaeological sites (Buckland and Coope, 1991; Elias, 1994). Elsewhere in Europe, archaeological palaeoentomology is still in infancy. In France, the study of fossil arthropods found during archaeological excavations remains an almost entirely unexplored field of research. However in recent years an increased interest for archaeoentomology was noticed in France, as suggested by the brief account published by Ponel and

Yvinec (1997). Recent French studies deal with various periods, from the Neolithic (Ponel, 1997), to the Roman period and the beginning of the Christian era (Matterne and Yvinec, 1996; Andrieu-Ponel et al., 2000; Ponel et al., 2000), to the Middle-Ages (Duverger, 1994; Huchet, 1994; Bocquillon et al., 1995).

In spite of some important taphonomical problems (Kenward, 1974, 1975, 1976), palaeoentomological reconstruction of ancient environments in anthropogenic contexts is particularly useful when compared with pollen analysis, as insects are less easily subject to long distance passive transport by wind and water streaming. Moreover, the existence of many phytophagous and monophagous/oligophagous beetle taxa associated with particular plant taxa, species or genera, helps to depict past vegetation associated with ancient human settlements and provides hints for the local presence of many plants. Furthermore, many Coleoptera are stenotopic species with narrow ecological requirements; their

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occurrence in insect assemblages may suggest that very specialized habitats were available nearby. Therefore, analyses comparing insect and plant macrofossil data (Moffet and Smith, 1996; Ponel et al., 2000), or insects and pollen data (Andrieu-Ponel et al., 2000; Ponel et al., 2001) are especially valuable.

In this paper, we present an attempt to reconstruct local environment from fossil insect and pollen data obtained from an archaeological site dated to the period 14th–17th century AD and located today in the city centre of Marseille (Bouiron, 1994, 2001), as (1) past vegetation and landscape in this area at that time remain largely unknown due to lack of appropriate sediment deposits, (2) this is an opportunity to compare beetle and pollen records to highlight the potential role of archaeoentomology as alternative tool for palaeoenvironmental reconstruction in archaeological contexts.

2. Materials and methods

2.1. The site

The old city of Marseille was founded 26 centuries ago on the north bank of a “calanque” (deep narrow creek in Mediterranean regions), now the “Vieux-Port” (Fig. 1), and in spite of some eastward

extensions during medieval times, remained confined within the same limits until 1666 AD. Built on three hills, the walled city was bordered by the sea to the south (“Vieux-Port” side) and to the north-west. Beyond the walls, three others hills are located to the N-E, the S-E and on the southern bank of the calanque. The valleys separating these three hills merge together into a small plain, now the “place du Général-de-Gaulle”, our study area (N43°17'43"/E5°22'33", alt. 4 m). Located just outside the main wall of the fortified city, this area remained in a state of dereliction until the 17th century, and was occupied by temporary facilities linked to the port activities (Fig. 2) (Bouiron, 1994, 2001). From 1667 onwards, the area has been submitted to drastic changes: the wall was destroyed, the surrounding ditch was filled and the “Royal Shipyard” was established.

2.2. Sampling

Earthworks associated with the construction of an underground car-park below “Place du Général-de-Gaulle” in the lower part of the main street of Marseille, La Canebière, enabled us to extract several sediment samples. Samples for insect analysis were taken from structures located in a small plain outside the former city walls and were dated from the 14th to the 17th century. They were obtained

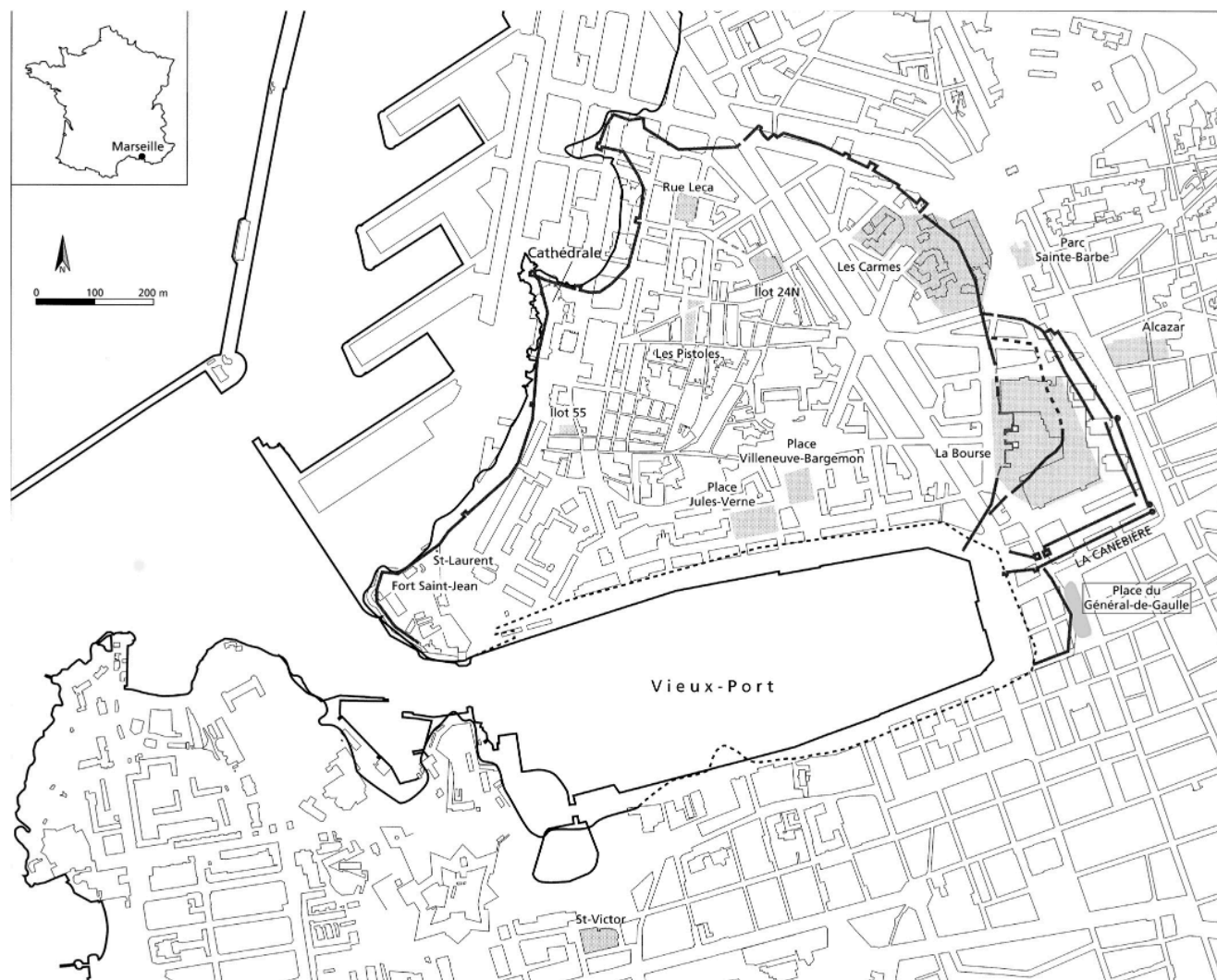


Fig. 1. Location of the “place du Général-de-Gaulle” excavation in the city of Marseille. The position of Hellenistic walls and their successive expansion during the Mediaeval period is indicated.

from four locations (F1, F2, F3 and B) corresponding to two structures, a ditch and a basin (Fig. 3). Three series of samples corresponding to sediment dated to the 16th century and to the lower half of 17th century AD were taken from three different stratigraphical profiles (F1, F2 and F3) cut into the ditch fill located just outside the main wall (Bouiron, 1994). This main wall ("Rampart" on Fig. 3) is about 1 m wide. The ditch or moat is located between this wall and the counterscarp, and run N-W/S-E in the northern part of the excavation, then is oriented to the S-W in the southern part, forming a 40° angle between the two sections. The ditch varies from 12 m in width in the north to 8.50 m in the south. Two other samples (B1 and B2) were taken from a basin (B) (Fig. 3) containing sediments deposited between the 14th and the 16th century AD. Sediment samples were extracted from the lateral walls of trenches cut into the two structures by a mechanical digger. This method enabled us to obtain clean blocks of sediment, with reduced contamination by modern insects and pollen. Sample mass varied from 2.5 to 13 kg in damp field conditions (Table 1). In total, more than 104 kg of sediment were sampled for insect analysis.

Table 1

Correspondence between the reference numbers attributed by Bouiron (1994, 2001), the sample codes, the sample names and the sample ages. Weight in damp field conditions.

Reference number	Code	Sample name	Weight (kg)	Age
Z1 217	28	F1-4	10	16th century
Z1 218	63	F1-3	3	to lower half of
Z1 249	65	F1-2	2.5	17th century AD
Z1 269	81	F1-1	7	
Z2 Esp. III 325	67	F2-5	3	
Z2 Esp. III 326	69	F2-4	3	
Z2 Esp. III 327	72	F2-3	3	
Z2 Esp. III 328	73	F2-2	3	
Z2 Esp. III 363	83	F2-1	8.5	
Z3 Esp. III 247	55	F3-13	4.2	
Z3 Esp. III 250	43	F3-12	3	
Z3 Esp. III 267	57	F3-11	3	
Z3 Esp. III 331 332 333	37	F3-10	5	
Z3 Esp. III 338	35	F3-9	3.2	
Z3 Esp. III 342	45	F3-8	4	
Z3 Esp. III 343	32	F3-7	13	
Z3 Esp. III 351	41	F3-6	4	
Z3 Esp. III 352	47	F3-5	2.5	
Z3 Esp. III 353	39	F3-4	3.5	
Z3 Esp. III 354	53	F3-3	3	
Z3 Esp. III 355	49	F3-2	4	
Z3 Esp. III 360	51	F3-1	4	
Z4 Esp. XV 237	96	B-2	2.5	14th–16th
Z4 Esp. XV 242	96b	B-1	2.5	century AD

In addition, a sequence of 13 pollen samples was directly extracted from the wall of the ditch F3, with an interval of 10 cm between samples. To allow easy comparison, each of the pollen samples was taken in the middle of each of the 13 insect samples from sequence F3.

2.3. Laboratory methods

2.3.1. Insects

Fossil arthropod remains were extracted and concentrated using the standard method (Coope, 1986). Identification of fragments was made by direct comparison with specimens from a modern reference collection. The palaeoecological interpretation of insect assemblages is based on biological and ecological data drawn from various monographs (Caillol, 1908–1954; Hoffmann, 1950–1958; Southwood and Leston, 1959; Théron, 1975–1976; Koch, 1989–

1992; Tempère and Péricart, 1989; Albouy and Caussanel, 1990). Nomenclature and taxonomic order follow Lucht (1987) as closely as possible. Percentages of the main ecological groups of Coleoptera, including aquatic Coleoptera, were calculated for each sampling unit F1, F2, F3 and B. Habitat preferences are drawn from various literature sources and from Koch (1989–1992).

2.3.2. Pollen

Chemical treatment of pollen samples follows Goeury and Beaulieu (1979). Pollen data are represented by a simplified diagram (Fig. 4). The counts are percentages of pollen sum that excluded spores and aquatic plant pollen. The pollen sum ranges from 335 to 368 and the taxonomic diversity from 28 to 57 taxa. The taxonomic content of the ecological groups in the pollen diagram is shown in Table 2. Pollen grains were identified using standard keys and atlases (Faegri et al., 1989; Moore et al., 1991; Reille, 1992–1999), and compared with a modern reference collection preserved at IMBE, Aix-en-Provence.

3. Results

Insect fragments were extremely well preserved, allowing identification to species level or species-group level to be made for about 2/3 of the taxa. Among the 13 pollen samples, only 5 contained a significant number of pollen grains for the analysis. The main taxonomic group represented in the fossil insect assemblages is the beetles (Coleoptera) with 299 taxa (Table 2). Heteroptera and Dermaptera are poorly represented with 6 taxa only, and one species of Scorpionidae was also recovered. The present paper is focused on Coleoptera.

In total, 257 taxa of Coleoptera were obtained from the 22 samples corresponding to the ditch (units F1, F2 and F3), and 107 taxa were identified from the two samples from the basin (B). The number of individuals varies from 3 to 152 (Table 2). The lowest values are recorded approximately in the middle of sequence F3, with 3 and 6.2 specimens per kg in sample F3-7 and F3-8. The highest value is recorded in the basin (sample B-2) with 152 individuals per kg.

Aquatic species are relatively well represented in the three units corresponding to the ditch (Table 3), but surprisingly they are totally absent from the basin B. Very low numbers of beetles associated with water margins and wetlands are recorded in the basin B, conversely dry/open ground insects are relatively abundant. Halobiontic species occur in low numbers in each of the four units. Coprophagous and coprophilous taxa are rather evenly distributed in the four sampling units, with 10–17% of the total number of taxa in each unit. Synanthropic Coleoptera (dependent on humans or human habitations) are rare in structure B, they are much more abundant in the ditch.

The dominant ecological categories include beetles associated with plants, and beetles associated with decaying plant matter. Although the first category may well reflect the local vegetation surrounding the site, the latter may also be linked to human activities, as decomposers are usually an important element of beetle assemblages obtained from archaeological deposits.

In the analyses below, we have not tried to present the results in a chronological way, but collectively, by overall ecological categories. This choice is deliberate. In this anthropogenic context, we do not know anything about sedimentation rates and it is possible that the sediments from the sampled structures were deposited during a short period of time. Moreover, the possibility that the sediment is reworked cannot be ruled out. The samples have been dated from the archaeological context, not directly with ¹⁴C. In these conditions, we do not want to over-interpret the data, which are treated collectively.

[illegible]

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[illegible]

Table 2 (continued)

Sample number	Ditch (F1)												Ditch (F2)												Ditch (F3)												Basin						Ecological categories																																						
	1				2				3				4				5				1				2				3				4				5				6				7				8				9				10				11				12				13				1				2				
	145	120	122	184	336	84	130	170	136	123	65	102	85	119	40	39	25	76	156	64	133	42	19	380																																																									
Number of individuals/kg	20.7	48	40.6	18.4	39.5	28	43.3	56.7	45.3	30.7	16.2	34	24.3	47.6	10	3	6.2	23.7	31.2	21.3	44.3	10	7.6	152																																																									
<i>Oxytelus</i> sp.	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	Coprophilous																																																								
<i>Platysthetus cornutus</i> (Grav.)	9	6	6	6	12	2	5	3	2	4	1	3	7	5	1	–	1	4	5	4	17	6	–	–	Riparian																																																								
<i>Platysthetus spinosus</i> Er.	1	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	1	–	–	–	Coprophilous																																																								
<i>Platysthetus nitens</i> (Sahlb.)	8	1	1	1	1	–	–	–	–	–	1	1	–	–	–	1	1	–	–	–	5	2	–	–	Associated with rotten plant matter																																																								
<i>Stenus</i> sp.	2	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	Riparian																																																								
<i>Lithocharis ochraceus</i> (Grav.)	–	–	–	–	1	1	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Scopaeus</i> sp.	2	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	2	–	–	–	Unclassified																																																								
<i>Lathrobium multipunctatum</i> Grav.	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Eurytopic																																																								
<i>Leptacinus cf. sulcifrons</i> (Steph.)	1	1	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	1	Associated with rotten plant matter																																																								
<i>Phacophallus parumpunctatus</i> (Cyll.)	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Gauropterus fulgidus</i> (F.)	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Gyrophypnus fracticornis</i> (Müll.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Leptolinus nothus</i> (Er.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	Associated with rotten plant matter																																																								
<i>Xantholinus glabratus</i> (Grav.)	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Xantholinus</i> sp.	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Unclassified																																																								
<i>Xantholinini</i> Indet.	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	Unclassified																																																								
<i>Neobisnius</i> sp.	1	1	–	–	2	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Cafius xantholoma</i> (Grav.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	plant matter																																																								
<i>Remus cf. sericeus</i> Holme	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Halophilous																																																								
<i>Gabrius</i> sp.	1	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Halophilous																																																								
<i>Creophilus maxillosus</i> (L.)	1	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Unclassified																																																								
<i>Ocyptus olens</i> (Müll.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Necrophilous																																																								
<i>Ocyptus</i> sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Eurytopic																																																								
<i>Quedius/Philonthus</i> sp.	1	3	2	4	9	5	1	3	1	2	2	3	1	3	–	–	1	2	3	–	2	1	–	–	Unclassified																																																								
<i>Mycetopus</i> sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Tachyporus hypnorum</i> (F.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Tachyporus</i> sp.	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Tachinus flavolimbatus</i> Pand.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Tachinus</i> sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Leucoparyphus silphoides</i> (L.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Falagria sulcata</i> (Payk.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Aleochara cf. bilineata</i> Cyll.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
<i>Aleocharinae</i> indet.	7	5	7	3	7	4	3	3	2	4	1	4	4	3	1	3	–	–	–	–	–	–	–	–	Associated with rotten plant matter																																																								
Pselaphidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Unclassified																																																								
<i>Bryaxis</i> sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Unclassified																																																								

(continued on next page)

Table 2 (continued)

Sample number	Ditch (F1)			Ditch (F2)			Ditch (F3)			Basin										Ecological categories				
	1	2	3	4	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10		11	12	13	1
Minimal number of individuals	145	120	122	184	336	84	130	170	136	123	65	102	85	119	40	39	25	76	156	64	133	42	19	380
Number of individuals/kg	20.7	48	40.6	18.4	39.5	28	43.3	56.7	45.3	30.7	16.2	34	24.3	47.6	10	3	6.2	23.7	31.2	21.3	44.3	10	7.6	152
Corticarini indet.	2	–	1	1	1	1	1	–	–	–	1	2	1	2	1	1	1	1	–	1	2	–	–	6
Melanophthalma sp.	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mycetophagidae																								
Typhaea stercorea (L.)	–	1	–	1	2	–	–	–	–	–	–	–	–	2	–	–	–	2	1	–	–	–	–	–
Colydiidae																								
Aglenus brunneus (Gyll.)	5	7	8	7	24	6	7	12	12	4	4	4	7	9	–	–	3	6	8	2	5	2	–	5
Aulonium ruficorne (Ol.)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Endomychidae																								
Mycetaea hirta (Marsh.)	–	–	2	2	2	–	1	1	1	–	–	–	–	2	–	–	–	–	1	–	–	–	–	–
Coccinellidae																								
Rhyzobius litura (F.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Stethorus punctillum Weise	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–
Scymnini indet.	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
Coccinella septempunctata L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Coccinellini indet.	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lyctidae																								
Trogloxylon impressum (Com.)	–	–	1	1	2	–	–	1	1	2	–	–	1	–	1	–	–	–	1	–	1	–	–	–
Bostrychidae																								
Stephanopachys quadricollis Mars.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–
Rhizopertha dominica (F.)	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Xylomyces praestus (Germ.)	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Scobicia chevrieri (Villa)	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sinoxylon sexdentatum (Ol.)	–	1	1	–	3	–	2	1	–	–	1	–	–	3	–	–	–	–	1	–	–	–	–	–
Anobiidae																								
Dryophilus sp.	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–
Emobius sp.	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stegobium paniceum (L.)	4	4	6	11	14	1	10	12	9	1	1	5	3	4	1	–	–	1	3	1	2	1	–	–
Nicobium castaneum (Ol.)	–	1	–	1	5	1	2	3	3	–	–	2	–	3	–	–	–	1	–	–	–	1	–	–
Anobium cf. punctatum (Geer)	2	2	2	4	8	2	2	8	5	1	–	2	1	1	2	–	1	2	1	1	1	1	–	1
Ptinidae																								
Gibbium psylloides (Czemp.)	–	1	1	1	1	–	1	2	–	–	1	1	–	2	1	–	–	–	–	–	–	–	–	–
Ptinus cf. fur (L.)	1	6	3	2	9	2	4	4	6	3	2	2	2	5	–	–	–	1	4	1	4	–	–	8
Ptinus sp.	–	1	–	1	2	–	–	–	2	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–
Oedemeridae																								
Nacerda melanura (L.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
Oedemera sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Anthicidae																								
Formicomus pedestris (Rossi)	–	–	–	1	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–
Leptaleus rodriguezi (Latr.)	2	1	–	3	–	–	–	–	1	–	1	–	–	–	–	–	–	4	–	2	–	–	–	3
Anthicus cf. tristis (Schm.)	–	–	–	1	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	2
Anthicus quadriguttatus (Rossi)	5	–	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	2
Anthicus hispidus (Rossi)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
Anthicus hispidus/4guttatus (Rossi)	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
Anthicus floralis (L.)	–	–	1	1	4	1	2	1	2	1	–	–	1	1	–	–	–	1	1	–	–	–	–	–
Anthicus instrabilis (Schm.)	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Anthicus (Cyclodinus) sp.	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Anthicidae indet.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Anaspidae																								

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Table 2 (continued)

Sample number	Ditch (F1)			Ditch (F2)			Ditch (F3)			Basin										Ecological categories				
	1	2	3	4	1	2	3	4	5	6	7	8	9	10	11	12	13	1	2					
Minimal number of individuals	145	120	122	184	336	84	130	170	136	123	65	102	85	119	40	39	25	76	156	64	133	42	19	380
Number of individuals/kg	20.7	48	40.6	18.4	39.5	28	43.3	56.7	45.3	30.7	16.2	34	24.3	47.6	10	3	6.2	23.7	31.2	21.3	44.3	10	7.6	152
Cerambycidae																								
<i>Agapanthia cardui</i> (L.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Chrysomelidae																								
<i>Pachnephorus villosus</i> (Dufts.)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Chrysomela banksi</i> F.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2
<i>Phaedon</i> sp.	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Prasocuris junci</i> (Brahm)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
<i>Phyllotreta procera</i> (Redt.)	–	–	–	4	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Phyllotreta</i> sp.	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Haltica</i> sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
<i>Podagrica fuscicornis</i> (L.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	2
<i>Podagrica malvae</i> (Ill.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2
<i>Podagrica fuscipes</i> (F.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	1
<i>Podagrica</i> sp.	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Chaetocnema tibialis</i> (Ill.)	1	–	–	1	1	1	–	–	–	1	–	1	–	–	–	–	–	–	–	3	–	–	–	12
<i>Chaetocnema arenacea</i> (Allard)	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Psylliodes</i> spp.	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bruchidae																								
<i>Bruchus laticollis</i> Boh.	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Bruchus pisorum</i> (L.)	–	1	–	1	3	3	–	2	2	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
<i>Bruchus</i> spp.	3	4	5	3	29	1	9	12	7	5	3	2	6	9	1	–	2	3	1	2	2	–	–	–
<i>Bruchidius</i> sp.	–	–	–	–	–	–	2	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
Scolytidae																								
<i>Scolytus</i> sp.	–	1	–	1	1	–	2	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
<i>Phloeophthorus</i> sp.	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Hylastes angustatus</i> (Herbst)	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Hylastes</i> sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–
<i>Blastophagus piniperda</i> (L.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–
<i>Carphoborus pini</i> Eich.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Carphoborus minimus</i> (F.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–
<i>Hylesinus oleiperda</i> (F.)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Lepesinus fraxini</i> (Panzer)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Phloeotribus scarabaeoides</i> (Bernard)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–
<i>Hypoborus ficus</i> Er.	2	2	5	3	6	3	4	12	10	2	2	6	2	3	1	–	1	2	4	2	4	2	–	–
<i>Crypturgus</i> cf. <i>mediterraneus</i> Eich.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Crypturgus</i> sp.	–	1	–	–	3	1	–	2	–	–	1	–	1	1	–	–	1	–	–	–	–	–	–	–
<i>Coccotrypes dactyliperda</i> (F.)	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–
<i>Pityogenes</i> sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Orthotomicus erosus</i> (Woll.)	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Curculionidae																								
<i>Apion</i> (<i>Malvapion</i>) <i>malvae</i> F.	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Apion</i> (<i>Aspidapion</i>) <i>aeneum</i> (F.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
<i>Apion</i> (<i>Taeniapion</i>) sp.	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
<i>Apion</i> (<i>Ceratapion</i>) sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Apion</i> (<i>Phrissotrichium</i>) sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Apion</i> spp.	–	–	1	–	3	1	2	–	–	1	–	–	–	1	1	–	–	–	–	1	4	–	–	2
<i>Otiorhynchus cribricollis</i> Gyll.	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
<i>Otiorhynchus</i> sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–

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Table 3

Percentages of the main Coleopteran ecological groups in units F1, F2, F3 and B.

	Taxa								Individuals							
	F1		F2		F3		B		F1		F2		F3		B	
	Nt	%	Nt	%	Nt	%	Nt	%	Ni	%	Ni	%	Ni	%	Ni	%
Aquatic	7	5	8	5	14	7	0	0	20	4	12	1	33	3	0	0
Aquatic-Halophilous	0	0	2	1	2	1	0	0	0	0	2	0	1	0	0	0
Halophilous	1	1	1	1	3	2	2	2	1	0	10	1	6	1	7	2
Riparian	10	7	6	4	9	5	3	3	73	13	51	6	123	12	4	1
Terricolous (dry/open ground)	4	3	3	2	4	2	8	8	10	2	4	0	28	3	14	4
Associated with plants	25	25	37	24	44	23	17	17	54	10	119	14	124	12	143	36
Associated with plants-Dry/open ground	1	1	2	1	2	1	4	4	1	0	2	0	1	0	6	2
Associated with plants-Synanthropic	4	3	5	3	5	3	1	1	40	14	108	13	87	8	3	1
Floricolous	1	1	1	1	4	2	0	0	1	0	1	0	8	1	0	0
Pollenophagous	2	1	2	1	2	1	1	1	4	1	11	1	7	1	1	0
Associated with rotten plant matter	22	22	23	15	26	14	18	17	88	16	102	12	177	17	74	19
Synanthropic	15	11	19	13	22	12	8	8	116	21	225	26	190	18	32	8
Coprophagous/Coprophilous	16	12	16	11	18	10	18	17	87	16	121	14	175	16	60	15
Necrophilous	4	3	4	3	1	1	2	2	5	1	9	1	1	0	2	1
Myrmecophilous (dry/open ground)	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0
Nidicolous	1	1	1	1	0	0	1	1	2	0	2	0	0	0	1	0
Eurytopic	6	4	7	5	10	5	11	11	0	0	8	1	15	1	28	7
Unclassified	17	13	15	10	21	11	9	9	53	10	69	8	92	9	25	6

4. Analysis of insect assemblages from structure F (units F1, F2, F3)

4.1. Coleoptera associated with trees and ligneous plants

Phytophagous Coleoptera such as Bostrychidae and Anobiidae are wood-borer insects associated with dead trees; others are predatory, exclusively feeding on larvae of phytophagous beetles. In these assemblages, some of the identified Histeridae species are found living under loose *Pinus* bark, where they prey upon xylophagous Coleoptera such as Scolytidae. Table 4 shows the favourite host-plants for selected tree-dependent Coleoptera.

Table 4

Selection of Coleoptera taxa found in units F1, F2 and F3, associated with trees and woody plants. MNI, minimal number of individuals.

Taxa	Host plants	MNI
<i>Plegaderus saucius</i>	<i>Pinus</i>	1
<i>Cylister elongatum</i>	<i>Pinus</i>	1
<i>Aulonion ruficorne</i>	<i>Pinus</i>	1
<i>Stephanopachys quadricollis</i>	<i>Pinus</i>	1
<i>Xyloniites praeustus</i>	Various broad-leaved trees	1
<i>Scobicia chevrieri</i>	Various broad-leaved trees	1
<i>Sinoxylon sexdentatum</i>	Various broad-leaved trees	13
<i>Ernobius</i> sp.	Conifers	1
<i>Corticeus pini</i>	<i>Pinus</i>	1
<i>Corticeus linearis</i>	<i>Pinus</i>	2
<i>Scolytus</i> sp.	Various broad-leaved trees	5
<i>Hylesinus oleiperda</i>	Oleaceae	1
<i>Lepesinus fraxini</i>	<i>Fraxinus</i> sp.	1
<i>Phloeotribus scarabaeoides</i>	Oleaceae	3
<i>Phloeophthorus</i> sp.	Ligneous Fabaceae	1
<i>Carphoborus pini</i>	<i>Pinus</i>	1
<i>Carphoborus minimus</i>	<i>Pinus</i>	2
<i>Hylastes angustatus</i>	<i>Pinus</i>	1
<i>Hylastes</i> sp.	Conifers	2
<i>Blastophagus piniperda</i>	<i>Pinus</i>	1
<i>Hypoborus ficus</i>	<i>Ficus carica</i> L.	78
<i>Crypturgus</i> spp.	<i>Pinus</i>	14
<i>Coccotrypes dactyliperda</i>	Various palm trees	3
<i>Pityogenes</i> sp.	Conifers	2
<i>Orthotomicus erosus</i>	<i>Pinus</i>	11

The importance of conifer-dependent Coleoptera is striking as 60% of the taxa belong to this category, most of them feeding solely upon *Pinus*. *Carphoborus pini*, *Carphoborus minimus*, *Hylastes angustatus*, *Hylastes* sp., *Blastophagus piniperda*, *Crypturgus* spp., *Pityogenes* sp., *Orthotomicus erosus*, are scolytids living in dead or dying twigs and wood, or under loose barks, together with the Bostrychidae *Stephanopachys quadricollis*. The Anobiidae *Ernobius* live on twigs or inside conifer cones. *Corticeus pini* and *Corticeus linearis* are elongated darkling beetles (Tenebrionidae) that prey upon Scolytidae under loose barks of dead or dying pines. Some of the above-mentioned scolytids are amongst the usual prey of these *Corticeus* species. The ecology of the Histeridae *Plegaderus saucius* and *Cylister elongatus* is similar, both feed upon larvae of scolytid conifer-dependent species. The abundance of these insects suggests that a *Pinus* woodland was certainly present very close to the site. In view of the similarity of the fossil assemblage with the beetle association found today on *Pinus halepensis* Mill. (Aleppo pine) in the Marseille region, it is very likely that the same tree species was growing nearby during the 16th–17th century AD.

Other tree species were also present. For instance, the scolytids *Hylesinus oleiperda* and *Phloeotribus scarabaeoides* live on many Oleaceae including *Olea europaea* L. (olive tree) but also *Fraxinus* (ash) and *Phillyrea* (mock privet). Among the other scolytids, *Lepesinus fraxini* is monophagous on *Fraxinus* spp and provides clear evidence of the occurrence of this tree at that time. By far the most abundant tree-dependent species is the tiny scolytid *Hypoborus ficus*, of which 78 individuals were counted. This insect digs galleries in dead twigs of *Ficus carica* L. (common fig), turning dead wood into dust. Obviously, its host-plant was present on the site, and was probably abundant. This is especially interesting as *F. carica* L. pollen is under-represented or even absent in the pollen record. Surprisingly, several specimens of *Coccotrypes dactyliperda* were identified. During its larval stages this scolytid develops inside the hard albumen contained in the fruit of many palm trees: *Chamaerops*, *Livingstonia*, *Phoenix dactylifera* L., *Phoenix canariensis* Chaub., etc (Lepesme, 1947; Balachowsky, 1949).

4.2. Coleoptera associated with non-woody plants

This group comprises about 15 taxa (Table 5), 4 of which are phytophagous on Malvaceae, and especially on *Malva* spp.

(mallow). The buprestid *Trachys fabricii*, the leaf-beetles *Podagrica fuscicornis* and *Podagrica fuscipes*, and the weevil *Apion malvae* are extremely common today in Provence on several species of mallows, especially in wastelands in suburban areas. Cruciferae are indicated by *Helophorus rufipes*, one of the few *Helophorus* species that feeds on terrestrial plants. *Baris* spp. includes *Baris cuprirostris* and *Baris* cf. *coerulescens*, both living on crucifers. Other oligophagous beetles include the Nitidulidae *Brachypterolus* cf. *urticae* (on nettles) and several leaf-beetles and weevils: *Chaetocnema tibialis* (on goosefoots), *Chaetocnema arenacea* (on the grass *Poa pratensis* L.), *Phyllotreta procera* (on mignonettes), *Apion* (*Ceratapion*) sp. (on thistles), *Sitona* sp. (all species living on Papilionaceae). This group of plants clearly represents a ruderal flora associated with wastelands, i.e., areas trampled by man, roamed by cattle and enriched with nitrogen. In this context, the occurrence in the insect assemblage of *Apion* subgenus *Phrissotrichum* is quite unexpected as this very small beetle belongs to a group of weevils associated with Cistaceae (*Cistus* and *Helianthemum*, rockrose) and hence provides some evidence for more natural vegetation such as “garrigue” (open sclerophyllous shrublands typical of calcareous Mediterranean regions), probably located at some distance from the city walls. Two other Coleoptera contrast strongly with the rest of the assemblage: *Aphanisticus pygmaeus*, a small elongated buprestid that develops inside the stem of various sedges, and *Prasocuris junci*, a leaf-beetle associated with water speedwells; both species are restricted to marshy areas or water margins, therefore it is likely that these insects were confined to wet soils on the bank of the ditch itself.

Table 5

Selection of Coleoptera taxa found in units F1, F2 and F3, associated with herbaceous plants. MNI, minimal number of individuals.

Taxa	Host plants	MNI
<i>Helophorus rufipes</i>	Cruciferae	7
<i>Aphanisticus pygmaeus</i>	Cyperaceae	1
<i>Trachys fabricii</i>	Malvaceae	1
<i>Brachypterolus</i> cf. <i>urticae</i>	Urticaceae	4
<i>Prasocuris junci</i>	<i>Veronica</i> spp.	1
<i>Podagrica fuscicornis</i>	Malvaceae	1
<i>Podagrica fuscipes</i>	Malvaceae	2
<i>Chaetocnema tibialis</i>	Chenopodiaceae	12
<i>Chaetocnema arenacea</i>	<i>Poa pratensis</i>	2
<i>Phyllotreta procera</i>	Resedaceae	5
<i>Apion</i> (<i>Malvapion</i>) <i>malvae</i>	Malvaceae	1
<i>Apion</i> (<i>Ceratapion</i>) sp.	Thistle	1
<i>Apion</i> (<i>Phrissotrichum</i>) sp.	Cistaceae	1
<i>Sitona</i> sp.	Fabaceae	21
<i>Baris</i> spp.	Cruciferae	2

4.3. Coleoptera dependent on decaying plant and animal matter, coprophagous species

This is by far the best-represented ecological category. Some of these insects are directly dependent on rotten material, but many others are predatory species that feed upon other detritivorous insects such as diptera larvae. This group includes the Hydrophilidae *Megasternum boletophagum*, most of the Histeridae, Staphylinidae (especially the genus *Oxytelus*), Cucujidae, the representatives of the families Erotylidae (*Cryptophilus integer*), Cryptophagidae, Mycetophagidae, Colydiidae (*Aglenus brunneus*), Anthicidae (*Omonadus floralis*), and the Scarabaeidae *Diastictus tibialis*, *Pleurophorus*, *Rhyssemus*, *Phyllognathus excavatus*. Such a profusion of insects associated with decaying material strongly suggests that the ditch was certainly used as a rubbish dump and/or connected with a sewage system. Some other species indicate that

carcasses of animals were available: the very large rove beetle *Creophilus maxillosus* preys upon maggots and diptera pupae found on decaying animal carcasses, *Trox* spp. and most of the *Dermestes* are the ultimate exploiters of carrion, eating hairs, dried skin and flesh neglected by other necrophagous insects. It should be noted that numerous remains of horses and donkeys have been discovered in the ditch, probably after a spread of some epizootic disease (Leguilloux, 2001).

Coprophagous species are also present, including many dung beetles (Scarabaeidae) such as *Onthophagus* and *Aphodius*. There is no coprophagous insect strictly dependent on human faeces, so it is impossible to affirm that the ditch was used as a latrine. Moreover, the occurrence of the Hydrophilidae *Sphaeridium* cf. *substriatum*, that lives in large masses of fluid excrement suggests that cows were probably present nearby.

4.4. Riparian, aquatic and sea shore Coleoptera

The banks of the ditch were certainly suitable for riparian Coleoptera. Gently sloping sides and muddy soil with sparse vegetation are suggested by the number of riparian Carabidae such as *Clivina*, *Tachys bistriatus*, *Tachys parvulus*, *Tachys haemorrhoidalis*, *Bembidion varium*, *Bembidion fumigatum*, *Bembidion octomaculatum*, *Bembidion quadripustulatum*, *Bembidion genei*, *Acupalpus notatus*, and *Chlaenius vestitus*. All of them are very common today in Provence. Some riparian Staphylinidae (*Stenus*) are also present.

The aquatic Coleoptera are not very abundant, with only 6 species of Dytiscidae, few Hydraenidae (*Ochthebius*, *Helophorus*) and Hydrophilidae (*Laccobius*, *Enochrus*, *Helochares*, *Berosus*). It is likely that the relatively low numbers of aquatic species and individuals may be attributed to the poor quality of water, and therefore the ditch was probably heavily polluted and eutrophicated. Three specimens of the Dryopidae *Oulimnius tuberculatus* were also recorded here. As this long-toed water beetle is associated with running water (Olmi, 1976), this occurrence perhaps suggests that a small stream was flowing nearby.

An interesting group of species includes the weevils *Mesites pallidipennis*, *Pselactus spadix* et *Amaurorhinus* sp. These insects are almost exclusively restricted to sea shores as they develop in old pieces of dead wood and timber soaked with salt. They suggest that accumulation of drift wood was locally available, either washed on the coast by the sea or deposited during human activities.

4.5. Synanthropic Coleoptera

This group of insects is very important from an economical and historical point of view but it corresponds to a relatively restricted number of species. A significant percentage of Coleoptera identified in the assemblages are cosmopolitan pests associated with stored food products (Table 6). Most of these species are extremely harmful to stored cereals and derived products, both as adults and larvae. *Stegobium paniceum* is even more polyphagous, as it can feed upon a wide range of natural or manufactured stored plant products. Bruchidae (*Bruchus* spp.) are exclusively associated with legume seeds such as peas (Lepesme, 1944; Mound, 1983; Delobel and Tran, 1993).

5. Analysis of insect assemblages from structure B (basin)

Two assemblages were obtained from the basin, but the assemblage “Basin-1” may be considered as a strongly impoverished version of the overlying assemblage “Basin-2” (perhaps for taphonomical reasons). Therefore, we prefer to analyse this structure as a whole and not chronologically.

Table 6

Selection of Coleoptera taxa found in units F1, F2 and F3, commonly associated with stored food products. Species indicated by a (*) are today among the 14 most harmful pests worldwide (Delobel and Tran, 1993). MNI, minimal number of individuals.

Taxa	MNI
<i>Oryzaephilus surinamensis</i> *	27
<i>Laemophloeus</i> cf. <i>ferrugineus</i> *	46
<i>Rhizopertha dominica</i> *	7
<i>Stegobium paniceum</i>	94
<i>Palorus</i> sp. (incl. <i>ratzeburgi</i>)	12
<i>Tribolium castaneum</i> *	4
<i>Tribolium confusum</i> *	7
<i>Tribolium</i> sp.	8
<i>Bruchus</i> spp.	122
<i>Sitophilus granarius</i> *	45
<i>Sitophilus oryzae</i> */ <i>zeamais</i> *	64

5.1. Open environment Coleoptera

The lack of tree-dependent species is striking in these assemblages, and conversely Coleoptera of stony open environments, cultivated grounds, dry fallow lands are abundant. This is the case of the ground beetles *Carabus coriaceus*, *Trechus obtusus/quadristriatus*, *Harpalus rufipes*, all of them are extremely abundant today in cultivated areas throughout Europe. Other species are mostly Mediterranean, characteristic of dry, sandy, stony open grounds and are common in sparsely vegetated rocky areas near Marseille. *Ditomis capito* is a southern phytophagous Carabidae that feeds on seeds of plants, mainly in the parsley family. The Anthicidae *Leptaleus rodriguezi* and *Anthicus quadriguttatus* are very common in sandy places and are usually found below leaves and plant debris accumulated on the ground. The darkling beetles (Tenebrionidae) *Stenosis sardea*, *Pedinus meridianus* and *Scaurus atratus* prefer more rocky substrates and are abundant under stones in limestone regions. Some weevils such as *Otiorynchus cribricollis*, *Trachyploeus* sp. and *Donus crinitus* are also open environment insects, they can be found today around the city of Marseille, in dry stony grassland, not far from the sea. Their host plants remain unknown, but *D. crinitus* has been found on *Artemisia* and other Asteraceae. A group of three species with *Pristonychus algerinus*, *Akis bacarozzo* and *Scaurus tristis* is commonly found in dark and dirty places frequented by humans such as old walls, ruins, cellars, although they can be found also in the wild, along cliffs, in caves, etc. These three species are strictly Mediterranean and become increasingly rare in Provence. Among the other orders, *Forficula decipiens* and *Forficula pubescens* (Dermaptera) are also extremely abundant today in open environments along the sea shores near Marseille. The association of these two earwigs with open environments is attested by Albouy and Caussanel (1990).

5.2. Coleoptera associated with plants

Many phytophagous species suggest that various flora thrived on the site (Table 7): crucifers are indicated by *H. rufipes* (identified in the assemblages from the ditch), thistles are indicated by the longhorn *Agapanthia cardui* and the weevil *Larinus* sp. A group of leaf beetles and weevils is dependent on Malvaceae (mallow). This is the case of *Podagrica* (3 species) and *Apion aeneum*. The flea-beetle *C. tibialis* feeds on Chenopodiaceae, the weevil *Sitona* is associated with Papilionaceae and *Lixus brevirostris* is dependent on *Atriplex* (saltbush). *Chrysomela banksi* is extraordinarily abundant today near Marseille, especially on the bare islands of the small archipelago of Frioul, located off the coast of the Vieux-Port. This leaf-beetle is rather polyphagous but has a predilection for the

Labiataceae *Ballota foetida* Hayek (horehound) and *Marrubium vulgare* L. (white horehound). The very small weevil *Pachytychius squamosus* swarms on grasses, especially on spikes of *Hordeum murinum* L. (false barley), a dominant plant in fallows and wastelands, even in urban and suburban areas. Several specimens of the bug *Tritomegas sexmaculatus* (Cydnidae) indicate that *B. foetida* was abundant nearby and confirms the clue already provided by *C. banksi*. This plant is common on grounds enriched with nitrogen. This assemblage of plants suggested by phytophagous insect occurrences evokes a ruderal flora associated with wastelands, and is comparable with the plant assemblage described from the ditch.

Table 7

Selection of Coleoptera taxa found in unit B, associated with herbaceous and shrubby plants. MNI, minimal number of individuals.

Taxa	Host plants	MNI
<i>Helophorus rufipes</i>	Cruciferae	3
<i>Brachyterolus</i> cf. <i>pulicarius</i> (L.)	<i>Linaria</i> , <i>Antirrhinum</i>	1
<i>Agapanthia cardui</i> (L.)	Thistle	1
<i>Chrysomela banksi</i> F.	<i>Ballota</i> , <i>Marrubium</i>	3
<i>Podagrica fuscicornis</i>	Malvaceae	2
<i>Podagrica malvae</i> (Ill.)	Malvaceae	2
<i>Podagrica fuscipes</i>	Malvaceae	1
<i>Chaetocnema tibialis</i>	Chenopodiaceae	12
<i>Apion</i> (<i>Aspidapion</i>) <i>aeneum</i> (F.)	Malvaceae	1
<i>Apion</i> (<i>Malvapion</i>) <i>malvae</i>	Malvaceae	1
<i>Apion</i> (<i>Ceratapion</i>) sp.	Thistle	1
<i>Apion</i> (<i>Phrissotrichium</i>) sp.	Cistaceae	1
<i>Sitona</i> sp.	Fabaceae	1
<i>Lixus brevirostris</i> Boh.	<i>Atriplex</i>	2
<i>Larinus</i> sp.	Thistle	1
<i>Donus crinitus</i> (Boh.)	Asteraceae	2
<i>Rhytidoderes plicatus</i> (Ol.)	Resedaceae, Cruciferae	1
<i>Pachytychius squamosus</i> (Gyll.)	Poaceae	1
<i>Baris</i> spp.	Cruciferae	2

5.3. Sea shore Coleoptera

The wood boring weevil *P. spadix*, already found in the samples from the ditch, is remarkably abundant in the basin as a minimum of 105 specimens were counted. Moreover, the Oedemeridae *Nacerda melanura* is also present in the same assemblage. This is also a very significant stenotopic species as its larva develops only in old wood saturated with sodium chloride after long immersion in seawater (Caillol, 1908–1954; Théron, 1975–1976). It is common today in Provence on the shores of the Mediterranean, especially in unreclaimed salt pans.

5.4. Coleoptera dependent on decaying plant and animal matter, coprophagous species

Strictly synanthropic Coleoptera are exceedingly rare in these assemblages, and very few specimens of *Oryzaephilus surinamensis*, *A. brunneus*, and *Sitophilus oryzae/zeamais* were counted. Conversely, a high number of taxa found in this unit are dependent on decaying plant and animal matter (as previously described from units F1, F2 and F3).

Coprophagous Coleoptera are especially abundant in this unit and provide evidence concerning past land use and environment. *Bubas bison* is very often associated with cow dung, secondarily with horse dung. Today it is confined to the littoral plain and the Camargue, in the wettest parts of the area near salt marshes and salt pans; it prefers entirely open environments. *Aphodius elevatus* is commonly found in old dry faeces such as cow dung, sheep, horse, and human faeces. *Thorectes intermedius* is restricted to the littoral zone and is predominantly found in cow dung, but it may feed upon

a wide range of excrement, even organic material from plant origin. *Geotrupes niger* is ubiquitous as regards vegetation and soil but is markedly attracted by human faeces (Lumaret, 1990). *S. cf. substriatum* has already been found in the ditch and suggests that cows were possibly present. The occurrence of *Aphodius contaminatus* is quite unexpected. This dung-beetle is very rare today below 500 m altitude. However, it was frequently reported from Camargue in older catalogues (Caillol, 1908–1954; Thérond, 1975–1976). The occurrences of *A. contaminatus* at low altitude, especially in Camargue, are attributed to high soil dampness in this region (Lumaret, 1978).

6. Pollen analysis

The plant groups used in the pollen diagram (Fig. 4) and corresponding pollen taxa from the ditch are indicated in Table 8. Pollen assemblages from profile F3 indicate an open landscape (samples 9–11: 30% < A.P. < 40% of the pollen sum) dominated by a dry Mediterranean garrigue with stands of evergreen *Quercus* (probably *Quercus ilex* L., holm oak, and *Quercus coccifera* L., kermes oak) associated with deciduous *Quercus* (certainly *Quercus pubescens* Willd., pubescent oak, the only deciduous oak present nowadays), and patches of pine forest, probably *P. halepensis* Mill. (Aleppo pine) in warmer areas, and possibly *Pinus sylvestris* L. (Scots pine) in colder places such as northern slopes or cold valley bottoms.

Table 8

Plant groups and corresponding pollen taxa identified in sediments from the ditch, "Place du Général-de-Gaulle" excavation.

Plant groups	Pollen taxa
Algae	<i>Botryococcus</i> , <i>Pediastrum</i> , Zygnemataceae
Apiaceae	Apiaceae, <i>Ammi</i> type
Brassicaceae	<i>Draba</i> type, <i>Sinapis</i> type
Cereals sum	Cerealia type, <i>Secale</i>
Compositae sum	<i>Anthemis</i> type, <i>Aster</i> type, <i>Calendula</i> , <i>Carlina</i> type, <i>Centaurea collina</i> L., <i>C. nigra</i> L.
Deciduous <i>Quercus</i> forest	<i>Corylus</i> , deciduous <i>Quercus</i> , <i>Lonicera</i> , <i>Tilia</i> , <i>Ulmus</i>
Sclerophyllous Mediterranean forest	<i>Erica arborea</i> L. type, <i>Juniperus</i> , <i>Olea</i> , <i>Phillyrea</i> , <i>Quercus ilex</i> L. type
Ferns	monoolete spores, <i>Ophioglossum vulgatum</i> L., <i>Pteridium aquilinum</i> (L.) Kuhn, trilete spores
Garrigue herbs	Brassicaceae, <i>Bupleurum</i> , <i>Cistus</i> , <i>Cuscuta</i> , <i>Euphorbia</i> , <i>Geranium</i> , <i>Helianthemum</i> , <i>Odontites</i> , <i>Ononis</i> , <i>Rosmarinus</i> type, <i>Sanguisorba minor</i> Scop., <i>Sideritis</i> , <i>Verbascum</i>
Halophytics	Chenopodiaceae, <i>Atriplex</i> type
Hygrophilous and aquatics	<i>Dipsacus</i> , <i>Filipendula</i> , <i>Iris</i> , <i>Potamogeton</i> , <i>Sparganium</i> / <i>Typha</i> , <i>Thalictrum</i>
Mesophilous trees	<i>Abies</i> , <i>Betula</i> , <i>Carpinus</i> , <i>Cedrus</i> , <i>Fagus</i> , <i>Picea</i>
Segetal herbs	<i>Centaurea cyanus</i> L., <i>Polygonum aviculare</i> L., <i>Turgenia</i> sp.
Nitrophilous herbs	<i>Artemisia</i> , <i>Plantago coronopus</i> L., <i>P. lanceolata</i> L., <i>P. major</i> L./media L.
Riparian trees	<i>Alnus</i> , <i>Fraxinus</i> , <i>Salix</i>
Ruderal herbs	<i>Galium</i> , <i>Malva</i> , <i>Mercurialis</i> , <i>Reseda</i>
Varia	<i>Calluna</i> , <i>Ericaceae</i> , prequaternary taxa, <i>Primula</i> , <i>Rumex</i> , <i>Sagina</i> type, <i>Scutellaria</i> type

From the base to the top of the profile, three zones have been distinguished. Zones 1 and 3 are characterized by very high percentages of arboreal pollen, among them *P. halepensis* and *P. sylvestris*. Low values of *Cannabis* type (hemp) and a short peak of Poaceae are recorded in sample 4 (zone 1). Hemp was certainly cultivated in the past in Marseille, the name of the main avenue, "La Canebière", derives from the name of this plant widely used in rope factories at that time.

In zone 2 (samples 11, 10 and 9), the assemblages are marked by an expansion of halophytic Chenopodiaceae and *Atriplex*, a pollen type which comprises the genus *Atriplex* (saltbush) and salt adapted shrubs of littoral marshes including *Sueda* (seepweeds) and *Salicornia* (glasswort). High pollen values of *Olea* (olive tree), the presence of *Castanea* (chestnut), *Secale* (rye), the continuous curve of Cerealia and the occurrence of agricultural field plants *Centaurea cyanus* L. (cornflower), *Polygonum aviculare* L. (knotgrass) and *Turgenia* sp. indicate agricultural activities close to the site. Cereal cultivation was located very close to the site, as pollen of agricultural field plants is not carried very far away from cultivated areas (less than 2 km). The significant values of nitrophilous plants including *Plantago coronopus* L. (plantain) and Cichorioideae suggest that livestock was present in the area.

A variety of herbaceous plants from the garrigue community have been identified in the pollen assemblages, such as Cistaceae including *Cistus* and *Helianthemum* (rockrose), Scrophulariaceae (*Odontites* and *Verbascum*, mullein), Lamiaceae (*Sideritis* and *Rosmarinus* type, rosemary), Brassicaceae, *Euphorbia* (spurge), *Geranium* (cranesbill) and the parasitic plant *Cuscuta* (dodder). Few shrubs characteristic of this Mediterranean association have been identified: *Phillyrea* (mock privet), *Juniperus* (juniper) and evergreen *Quercus* (*Q. ilex* L. type), a type including *Q. coccifera* L. (kermes oak), a dwarf tree typical of garrigue. The record of *Erica arborea* L. type is very interesting, because in Provence, this pollen type comprises *E. arborea*, heather typical of "maquis" (Mediterranean shrubland restricted to siliceous substratum), and *Erica multiflora* L., today growing on calcareous substrates along the seashore between Marseille and Toulon. At the site, it is more likely that *E. multiflora* was present on the limestone hills around the calanque.

The pollen of *Filipendula* has been identified in sample 10. This taxon does not correspond to the hygrophilous taxon *Filipendula ulmaria* L. Maxim. (meadowsweet) usually found in wetlands but is likely to correspond to *Filipendula vulgaris* Moench (dropwort), which is the only *Filipendula* recorded today in Bouches-du-Rhône department (Molinier, 1981), where it grows in dry grasslands dominated by *Bromus* or *Brachypodium*.

The sustained values of *Botryococcus* indicate that the site was a shallow ditch with stagnant water in which *Botryococcus* colonies were very abundant and could form floating mucilaginous masses at the water surface. The few occurrences of *Pediastrum* and Zygnemataceae confirm that the ditch was not deep, and contained eutrophic water. The floating macrophyte *Lemna* could expand in open water zones of the site. The ditch was also colonized by hygrophilous and aquatic *Iris*, *Dipsacus* (teasel), *Sparganium*/*Typha* (bur reed/reedmace), and *Potamogeton* (pondweed).

High concentrations of microscopic charcoal particles (Fig. 4) in the pollen slides are typical of environments marked by human impact. This confirms that fire was used to open the landscape as it is still the case today in Mediterranean regions, where shepherds use this to expand grasslands for cattle grazing.

7. Discussion

Insect assemblages from structure F (the ditch) are marked by a relatively high number of woody-plant dependent Coleoptera, suggesting that many tree and shrub species grew nearby. The hypothesis that some of the woody-plant dependent Coleoptera originate from structural timbers used in the construction cannot be ruled out, however most (if not all) of these insects are associated with small dead or dying branches and twigs, or live under dehiscent barks of old dead trees. More probably, the majority of these tree-dependent Coleoptera were associated with decaying trees in natural or semi-natural conditions, growing close to the site.



Fig. 2. The city of Marseille during the 17th century, from Maretz (1631). The location of the “place du Général-de-Gaulle” excavation is approximately in the lower right corner of the picture.

Herbaceous plants were abundant, diverse and dominated by ruderal taxa, but hygrophilous plants grew close to the ditch. The highly eutrophic water and the dense algal community were certainly not favourable to water beetles, probably because the structure was used as dumping area, as suggested by the abundance of species associated with all type of decaying matter and those associated with stored food products. The possibility that the ditch was used as sewage system, maybe connected to a cess-pit, should be analysed in the light of results obtained in Britain by many archaeoentomologists (e.g., Kenward and Hall, 1997; McCobb et al., 2004; Kenward and Carrott, 2006; Smith, 2013), who tried to define among insect assemblages “indicator groups” or “indicator packages” typical of cess-pits. As expected in such environment, Diptera (*Psychoda alternata*, *Eristalis tenax*, *Fannia scalaris*, etc) have been shown to play an important role as indicator species. Unfortunately, considering the absence of taxonomists able to identify fossil Diptera from our assemblages, this important group was overlooked in our analyses.

However it is possible that the high numbers of pest Coleoptera found in the assemblages from the ditch are due to the accumulation of sewage mud carried into the ditch by drainage. Osborne (1983) has demonstrated that such a high concentration of species associated with food in some archaeological sediments may be attributed to the accidental human consumption of insects in heavily infested products (such as bread). The beetle remains are subsequently excreted with faeces, then accumulate in cesspits. The abundance of pests of stored products in archaeological cess-pits (e.g., *Bruchus pisorum*, *Sitophilus granarius*, *O. surinamensis*, *Laeophloeus ferrugineus*) is also mentioned by Smith (2013).

Insect assemblages from structure B (basin) suggest that the palaeoenvironment near the site was mainly dry and rocky, open, with diversified low ruderal vegetation. Conversely the ground was certainly locally very damp around the modern “Vieux-Port” (fossil occurrences of *A. contaminatus*), with a more hygrophilous vegetation. Ruins and old stone walls were present. The rarity of synanthropic Coleoptera associated with stored food products is not in agreement with the role of latrines attributed earlier by archaeologists to this structure.

In spite of a broad agreement between insect reconstructions obtained from the ditch (F) and the basin (B), some striking differences should be explained, especially because both are located within the same restricted area. Unexpectedly, aquatic species are totally absent from the basin B. This structure might not be favourable to these insects, probably because the vertical walls of this structure (built with stone blocks) and the deep water were not favourable to water beetles. For the same reason, low numbers of riparian and wetland beetles are recorded in the basin, whereas dry/open ground insects are relatively abundant. This contrasts with the assemblages obtained from the ditch, where the relative importance of the same ecological categories are reversed. These discrepancies may be explained as follows: the ditch may be compared with a natural pond surrounded by hygrophilous flora and fauna, whereas the walled basin likely acted as a very large pitfall trap opened level to the ground, thus providing a good image of the past wandering beetle fauna in the area but not generating any biotope favourable to riparian or aquatic insects. Low values of synanthropic taxa associated with stored food products found in the basin B suggest that the assemblages obtained there are less

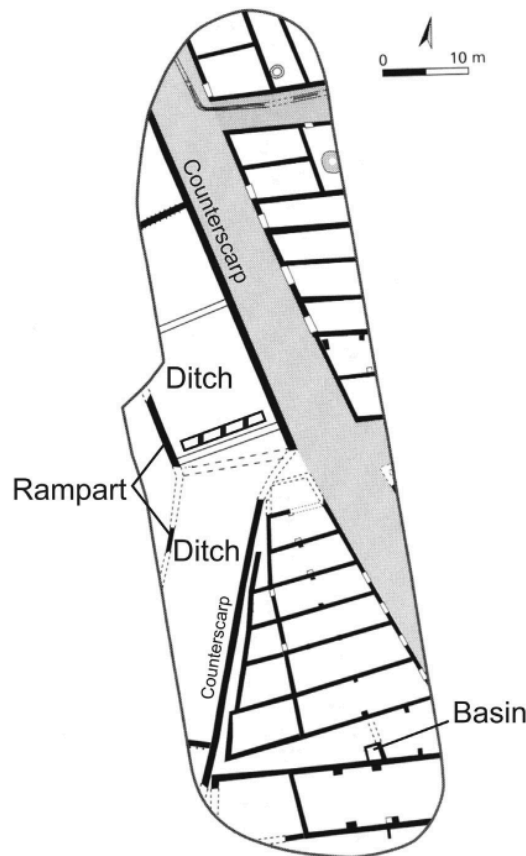


Fig. 3. Location of the sampled structures. The hatched rectangle indicates the location of the three profiles from the ditch (F1, F2 and F3).

influenced by human impact than the ditch, which was certainly connected to a sewage system (Bouiron, 2001).

Another surprising discrepancy is the high number of tree-dependent Coleoptera in structure F (the ditch), compared with the lack of such insects in structure B (the basin). We can assume that sediments from both structures were deposited within a relatively narrow interval of time, so it is difficult to infer that such differences reflect vegetation changes. It is more likely that for structural reasons indicated here, the area above the basin was less able to capture flying insects (such as those living on trees), compared with the largely open ditch. As a whole, the insect data suggest that basin B provides a more accurate picture of the very local environment located around the depositional site, whereas the ditch provides evidence both of the local fauna with many aquatic or hygrophilous insects, originating from the ditch itself, in combination with flying insects originating from a wider area and carried into the site by wind.

There is a broad agreement between insect and pollen record concerning the overall picture of the local landscape during the studied period. In short, the plant communities were probably composed of alternating patches of thinly forested groves, open garrigues, wastelands roamed by cattle, and cultivated areas. The woody vegetation was dominated by *Pinus*, certainly *P. halepensis* Mill. (Aleppo pine) but *P. sylvestris* L. (Scots pine) was also probably present in cooler places. Insect data indicate that these trees were present locally and that pollen grains did not originate from some remote region. No strictly *Quercus*-dependent Coleoptera were recorded, nevertheless oak trees occurred nearby as suggested by

pollen data, in the form of *Q. pubescens* Willd. stands and also sclerophyllous Mediterranean forest with evergreen *Quercus* (*Q. ilex* L. or *Q. coccifera* L.). There is very little indication from the insect record of the local presence of plants typical of garrigue, with the exception of Cistaceae (rockrose). However, unlike insects, pollen data show that a portion of the area was occupied by a garrigue, secondary vegetation which could have thrived as a consequence of repeated burning (cf. evidence of pyrophytes including Cistaceae in both insect and plant records).

Insect assemblages from both structures include several species associated with pieces of wood soaked in saltwater. It is likely that human activities resulting in the accumulation of driftwood or planks from old ships were taking place nearby. This hypothesis is supported by historical data, as it is known that a shipyard was established in this area, at the bottom of the modern "Vieux-Port", formerly "Plan Fourmiguier" (Fig. 2). Moreover, archaeologists have discovered well levelled flat areas attributed to ancient saltpans (Bouiron, 2001). *N. melanura* is common today in salt marshes and unreclaimed saltpans, so this hypothesis may well prove right. However the possibility that these insects developed into floating trunks and branches naturally washed ashore by the sea cannot be ruled out.

Halobiontic ground species occur in the four units and are undoubtedly associated with sea shore and salty grounds. However, the relatively low numbers of individuals raise questions concerning the connection of the ditch with the sea. It is likely that saltwater did not penetrate the ditch, at least when the sediments analyzed in this work were deposited: high concentration of NaCl would lead to the elimination of most of the taxa to the benefit of truly halobiontic insects. Obviously, this is not the case here. The sporadic occurrence of halobiontic species should be attributed to passive or active transport of insects by air or water directly from the sea shore or from saltpans, located not far away from the ditch and the basin. Pollen assemblages confirm that the depositional environment of the ditch was not salty and not connected to the sea. Nevertheless, the high representation of Chenopodiaceae and *Atriplex* type in pollen spectra indicate that saltpans existed probably along the shore nearby.

Wetland plants communities thrived in the ditch, probably because this structure contained still and very eutrophic water, very favourable to the bloom of algae such as *Botryococcus* (Fig. 4). A helophytic vegetation with *Iris*, *Sparganium* or *Typha* could develop along the margin of the depression, as indicated by pollen data. The record of *Lemna* confirms the presence of standing water in the ditch. This interpretation from the pollen data is in agreement with the insect data (occurrence of Coleoptera associated with hygrophilous plant). A riparian arboreal community is represented by *Alnus*, and some pollen grains of *Fraxinus* and *Salix*. Insect data show that *Fraxinus*-dependent Coleoptera were present, but there is no evidence for *Salix*- and *Alnus*-dependent insects.

Old pictures dated to 1631 AD (Fig. 2) show that cultivated fields, probably including orchards, existed just at the North-East and the East of the investigated site in the outskirts of the "Vieux-Port". From pollen and insects, it has been possible to identify several types of agricultural activities. The main one was probably the cultivation of olive trees as shown by high values of *Olea* in the pollen diagram. This event could be correlated with the increase in olive cultivation that took place in Provence during the 16th–17th centuries (Leveau et al., 1991). It is also recorded (but not radiocarbon dated) in the sub-recent sections of pollen diagrams investigated in Provence: Var department: Seillons (Triat-Laval and Reille, 1981), Etang de Berre and surroundings: profile C2 (Laval et al., 1991), profiles C3 and C10 (Laval and Médus, 1994); Etang du Pourra (Laval et al., 1992), Le Vallat Neuf (Triat-Laval, 1982), Poudrière de St Chamas D25 (Triat-Laval, 1978), Camargue: Grand

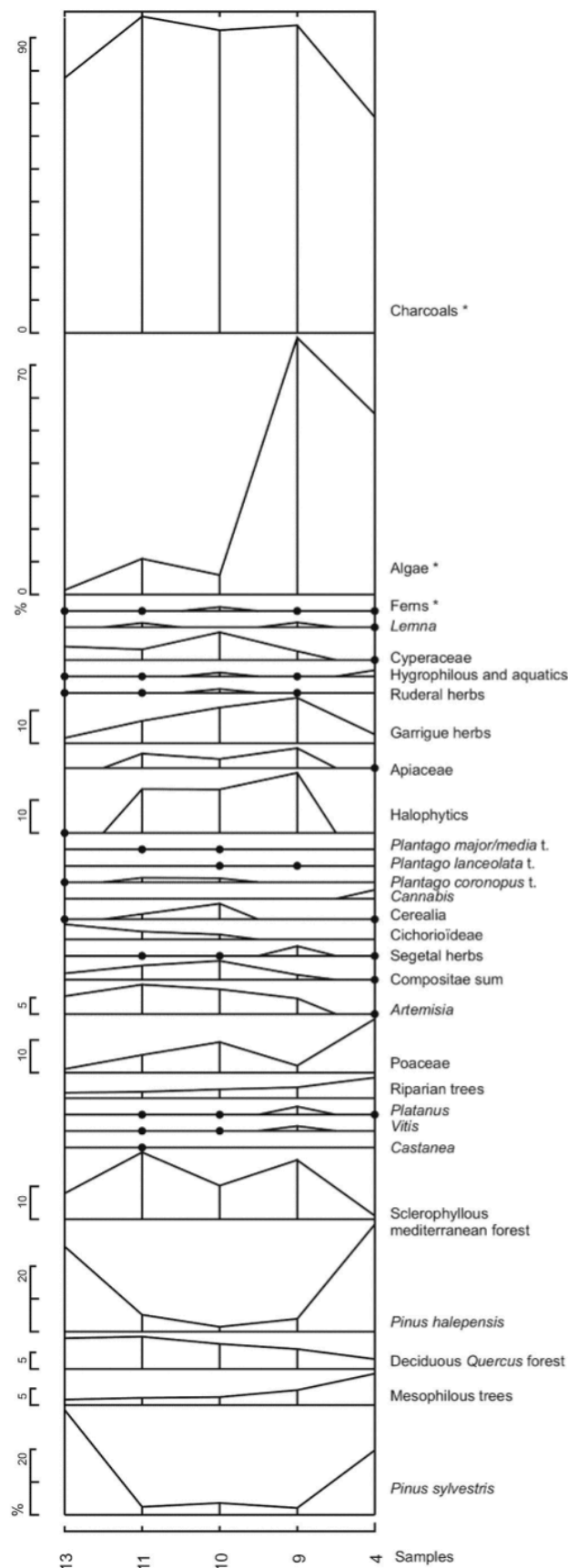


Fig. 4. Relative frequencies percentage pollen diagram. Taxa indicated by (*) are excluded from the pollen sum.

Palud de Fos D20 (Triat-Laval, 1978), and Arles: La Calade (Andrieu-Ponel et al., 2000).

The record of *Cerealia* and *Secale* in the pollen profile indicates that cereals were cultivated very close to the site, in the outskirts of the city, probably on flat and fertile natural areas or on small anthropogenic terraces ("restanques"). The presence of agricultural field plant pollen tends to indicate that pollen grains of cereals came from local cultivation and not from warehouses in the commercial port. The presence of *F. carica* L. (common fig) is revealed by a profusion of the bark beetle *H. ficus*. This evidence is particularly valuable, as *Ficus* is never detected in pollen records because of its cleistogamic reproduction (Proctor et al., 1996). *Ficus* was then intensively cultivated in the vicinity of the site, as it is still the case today in Provence, in gardens and orchards.

Pastoralism was certainly well developed, as indicated by high representation of nitrophilous Cichorioideae or *P. coronopus* L. and by the high number of coprophagous and coprophilous taxa, suggesting that dung was readily available. Large grazers (horses, cows, possibly sheep) were certainly abundant nearby, but human faeces may also account for these relatively high percentages of dung beetles. Unfortunately coprophagous and coprophilous taxa are very rarely dependent on any particular species of mammals, so it is impossible to be more precise about this point. The intensity of agriculture and pastoralism is also attested by the high representation of phytophagous beetles dependent on a wide range of ruderal plants such as those growing in wastelands today around Marseille.

The presence of the palm tree dependent scolytid *C. dactyliperda* in the insect assemblage is unexpected though fossil specimens of this beetle have also been reported from archaeological deposits in Oman by Costantini and Audisio and Costantini (2000). The dwarf palm *Chamaerops humilis* L. is probably native in Mediterranean France (Médail and Quézel, 1996) but this hypothesis remains a matter of debate, as no sound historical proof has been found for Provence. However the hypothesis of *C. dactyliperda* populations associated with *Chamaerops humilis* in wastelands outside the walls of the city of Marseille cannot be ruled out (Ponel and Lemaire, 2012). Concerning *Phoenix* species, *P. canariensis* Chaub. (Canary Island date palm) so profusely cultivated in many cities of the French Riviera, and elsewhere in the Mediterranean region, was imported from Canary Islands as late as 1864, then extensively planted from 1882 onwards (Durnerin, 1990). *C. dactyliperda* swarms today everywhere on *P. canariensis* but its late introduction rules out the hypothesis of this tree being present at Marseille during the period 14th–17th century. The story of *P. dactylifera* L. (date palm) is quite different, as this palm has always been a main food resource for Mediterranean human populations, and its early appearance in France is dated to the 16th century in Provence (Durnerin, 1990). *P. dactylifera* is therefore a potential host-plant for *C. dactyliperda* in the medieval city of Marseille. A third hypothesis is the possible transport of *C. dactyliperda* from North Africa, along with imported dates. The port of Marseille ("Porte de l'Orient") has always played a major role as the terminus of trading routes originating from the whole Mediterranean Basin, and this hypothesis of the association of *C. dactyliperda* with imported food products is rational... however, *Phoenix* pollen or macrofossils have never been identified in archaeological deposits in Marseille (Durnerin, 1990).

Platanus is recorded in pollen diagram since Greek times (Triat-Laval, 1978; Triat-Laval and Reille, 1981). It is also reported in Western Europe from the 16th and 17th centuries (Benzi and Berliocchi, 1999) and was used to shadow courtyards, gardens or cart tracks. Its generalization in the French Mediterranean cities is very late and date to the 19th century (Benzi and Berliocchi, 1999). The absence of *Celtis* in the pollen record is a surprising feature as this tree, more than *Platanus*, has been planted for a very long time in urban Provence (Triat-Laval, 1978).

Comparable urban sites that yielded rich Coleopteran assemblages are virtually absent in the Mediterranean basin (Buckland and Coope, 1991; Elias, 1994), and elsewhere in France nothing has been published on this subject. In Northern England the recent review by Kenward (2009) provides some insight on this period (Late medieval to modern: AD 1350 to present), but deposits of this date were largely neglected in the past, considered as too recent by archaeologists, and most of them were subjected to evaluations only. Moreover, the information is patchy, probably for taphonomic reasons, and many sites yielded very small insect assemblages. As a whole, the sites from this area yielded insect faunas that bear some resemblances with those from Marseille, and especially with samples from the ditch. Stored product pests such as *S. granarius* and *O. surinamensis* are regularly recorded (Kenward, 2009), but *Tipnus unicolor* and *Niptus hololeucus*, abundant in Northern England sites, were not identified at Marseille. Most of the assemblages from England include ecological categories well represented at Marseille, with aquatic beetles, waterside species, dung beetles, and even woody-plant dependent beetles such as *Leperisinus* (Hall et al., 2002). The main obstacle in comparing the assemblages from Marseille and from Northern England is that non Coleopteran material were overlooked during the analyses at Marseille: Diptera (such as fly puparia), parasite eggs (*Ascaris*, *Trichuris*), Human lice, etc. were not analyzed as a consequence of the lack of taxonomic knowledge concerning these difficult groups. Considering the signification of such material in the interpretation of archaeological deposits and structures, further analysis of these groups of invertebrates in future archaeological investigations in Marseille (and elsewhere in France) would be extremely important.

The other structure investigated at Marseille (the basin) has yielded a quite different "subnatural" Coleopteran fauna, in which the Mediterranean element is dominant (e.g., *D. capito*, *Pristonychus algerinus*, *Macrolister major*, *L. rodriguezi*, *S. sardea*, *A. bacarozzo*, *S. tristis*, *S. atratus*, *P. meridianus*, *T. intermedius*, *O. cribricollis*, *D. crinitus*, *Rhytidoderes plicatus* ...). For biogeographical reasons, the beetle assemblages from Northern England reviewed by Kenward (2009) are very different from our assemblages, in spite of the presence in both contexts of stored product pests (e.g., *O. surinamensis*, *Sitophilus* sp.). However this synanthropic element is very rare in the basin, by comparison with N. England.

8. Conclusion

In conclusion, the present study has clearly shown the nature and intensity of human occupation in the study area. Information provided by archaeoentomology allowed us to provide an improved picture of the human impact on the environment, compared with results based solely on pollen analysis and archaeology. This comparison suggests that (1) there is a broad agreement between both records, (2) phytophagous insects may confirm the local presence of plant taxa, (3) the presence of plants not indicated in the pollen record may be revealed by phytophagous insects, and (4) insect data may provide abundant and original information concerning past human activities and anthropogenic environment. Furthermore, many Coleoptera species are stenotopic, with narrow ecological requirements, their occurrence in the insect assemblages may suggest that very specialized habitats were available nearby, many of which could not have been detected by any other kind of proxy data.

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