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## First archaeobotanical contribution to the history of food production and agriculture at Aghmat (Morocco) between the 11th and the 17th c.

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1 **First archaeobotanical contribution to the history of**  
2 **food production and agriculture at Aghmat (Morocco) between the 11<sup>th</sup> and the 17<sup>th</sup> c.**

3  
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20  
21 **Abstract**

22 Aghmat, medieval city of the Haouz region (Marrakech), is described by textual sources as a  
23 prosperous commercial city, surrounded by fertile lands. Located at the foot of the High Atlas, at the  
24 opening of the Ourika valley, it benefited from a geographical situation favourable to the development  
25 of an important irrigated agriculture. However, Aghmat was hit by the great crisis that struck Morocco  
26 at the end of the 14<sup>th</sup> and during the 15<sup>th</sup> c., and was abandoned. It is only in the course of the 16<sup>th</sup> c.  
27 that the locality found a new dynamism, while knowing a deep spatial, demographic and economic  
28 reorganization. Indeed, Aghmat seems to take at this period the shape of a dispersed habitat, entirely  
29 dedicated to a new agricultural development.

30 Since 2005, the extensive excavation of the medieval urban centre and of its levels of abandonment  
31 makes it possible to locally approach this transitional period between two socio-economic systems.  
32 Thus arises the question of the agricultural evolutions and of the role played by the various socio-  
33 economic components on lands management. The recent creation of an archaeobotanical program that  
34 includes both carpological and anthracological analysis seems to be the most promising way to  
35 document these questions. Based on nearly fifty archaeological samples extracted from varied contexts  
36 (hearths, dumps, plantation pits), dated between the 11<sup>th</sup> and the 17<sup>th</sup> c., this work allows proposing a  
37 first review on cultivated/gathered plants.

38  
39 **Keywords:** plant production; terroirs; Middle Ages; modern period; Maghreb; Islamic archaeology

40

41 **1. Introduction**

42 The medieval and Islamic North African city of Aghmat (Morocco), which was abandoned in the  
43 course of the 14<sup>th</sup> century AD, is today a 100 hectare area of ruins, buried under fields of olive trees  
44 and barley, on the location of the rural market town of Ghmat, 30 km south of Marrakech (fig. 1).  
45 Situated at the foot of the northern slope of the High Atlas mountain range, from which it has drawn  
46 its abundant water resources throughout its existence, the city of Aghmat was first mentioned in  
47 Arabic textual sources between the end of the 9<sup>th</sup> century and the middle of the 10<sup>th</sup> century AD:  
48 geographers based in the major Islamic capitals (Cairo, Kairouan, Cordoba) described it then as a  
49 prosperous city that helped to relay trans-Saharan trade to the Mediterranean basin, but above all as a  
50 major agricultural centre in the western Maghreb (Al-Bakri 1911; Al-Idrisi 1866; Al-Yaqubi 1892; Ibn  
51 Hawqal 1938). This position as the granary of Morocco has not been denied for several centuries, to  
52 the extent that it has survived the disappearance of the medieval city: today the polycentric village of  
53 Ghmat enjoys a national reputation as the best nursery in the Moroccan kingdom, supplying  
54 ornamental and fruit plants of all kinds to a very large number of hotels, public parks and buildings,  
55 and private villas throughout the country (Héritier-Salama 2019).

56



57

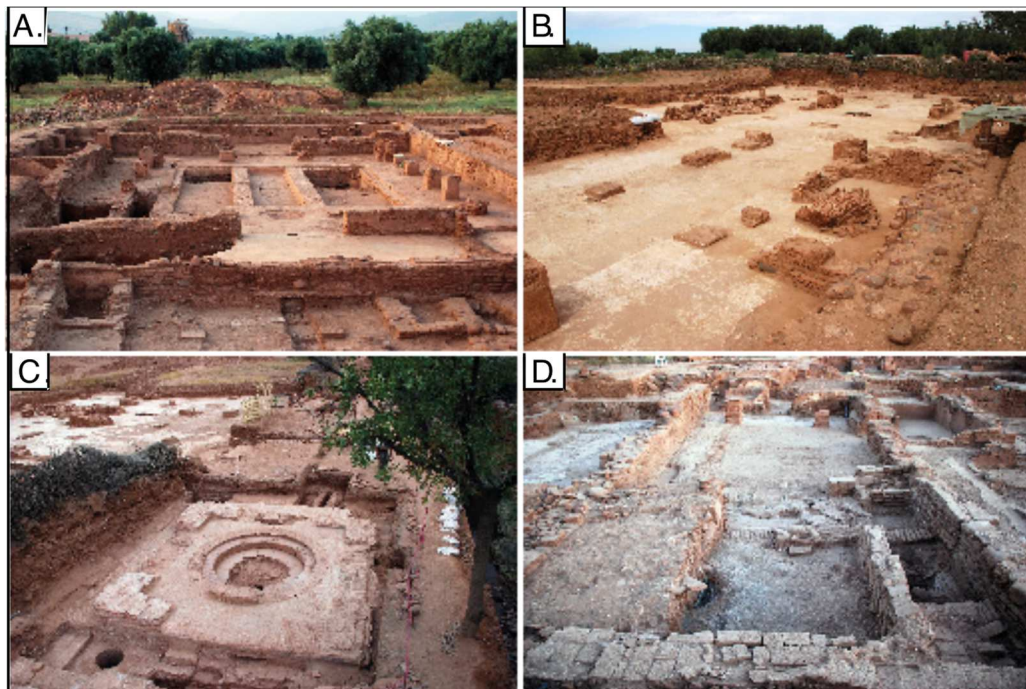
58 Fig. 1: Location and general view of the archaeological site of Aghmat (Mission Archéologique d'Aghmat)

59



60 Since 2005, the Archaeological Mission of Aghmat<sup>1</sup> aims to study, protect and enhance this vast  
61 archaeological site in an exceptional state of preservation. To date, the programme has focused on the  
62 extensive excavation (approximately 3,000m<sup>2</sup>) of the city's monumental area, where the Great Mosque  
63 and its ablution fountain (called *qubba*), the public baths (*hammam*), an elite residence (possibly the  
64 palace) and a wealthy residential area (of inner garden houses also called *riads*) are located (fig. 2).  
65 While the earliest phases of occupation (at least the 10<sup>th</sup> century) are still poorly documented, the main  
66 phase of development of this district seems to date back from the 11<sup>th</sup>-12<sup>th</sup> centuries, which coincides  
67 with the time when the city became the ephemeral (c.1056-1070) capital of the Almoravid Empire.  
68 Then, the site experienced a strong urban dynamism where the buildings were constantly restored or  
69 even rebuilt (Fili, Messier 2015), until the city was rather abruptly abandoned by its elites (mid-14<sup>th</sup>  
70 century) and reoccupied by populations who gradually ruralized its activities and economic balance  
71 (15<sup>th</sup>-16<sup>th</sup> c.) in an architectural landscape that was inexorably deteriorating (Héritier-Salama *et al.*  
72 2016). The monumental district of the city was finally totally abandoned and gradually disappeared in  
73 a scenery that had evolved into a space fully devoted to agriculture, which it has remained until today.  
74 Since 2016, the MAA has developed a line of research dedicated to palaeoenvironments, in both a  
75 natural and agricultural perspective<sup>2</sup>, based on the study of seeds and wood charcoals remains.

76



77

78 Fig. 2: A. Palatial garden; B. Great Mosque; C. Ablution fountain (qubba); D. House (Mission Archéologique  
79 d'Aghmat)

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<sup>1</sup> Programme co-supervisors: Ronald Messier (MTSU, USA), Abdallah Fili (Chouaib Doukkali University, Morocco), Chloé Capel (CNRS, France).

<sup>2</sup> Under the supervision of Jérôme Ros (CNRS, UMR5554, ISEM, France) and Violaine Héritier-Salama (Paris Nanterre University, France).

81 In this paper, we will present the first results of the archaeobotanical analysis, providing the very first  
 82 archaeological data on food plants and agriculture in this region of Morocco. Although the data are  
 83 still preliminary, they appear to be worth discussing, regarding the scarcity of available  
 84 archaeobotanical data on medieval Morocco (tab. 1), especially in the south of the country, where only  
 85 the settlements of Îgîlîz and Sijilmasa had been studied so far (Ruas 2018).

86

| Site           | Chronology   | Status                            | Type of contexts   | Reference  |
|----------------|--------------|-----------------------------------|--|--|
| Al Basra       | 9th-12th c.  | City                              | Potter's kilns, dumps, housing floors                            | Pollock 1986; Mahoney 2004                             |
| Aghmat         | 10th-17th c. | City, Reoccupation of the city    | Hearths, charcoal/ash levels, traffic levels, dumps, garden soil | Ros, Badri unpublished                                 |
| Asilah         | 11th-13th c. | Rural                             | Housing floors   | Ros, Badri 2020  |
| Badis          | 9th-15th c.  | Port city                         | Concentration of ashes in an inhabited space                     | Pollock 1986   |
| Îgîlîz         | 10th-15th c. | Rural fortress                    | Habitats, fireplaces, ovens, latrines, garbage dumps             | Ruas <i>et al.</i> 2011, 2016a                         |
| Lixus          | 8th-14th c.  | Reoccupation of a city            | Dumps  | Grau Almero <i>et al.</i> 2001, 2010; Perez Jorda 2005 |
| Nakûr          | 9th-11th c.  | City                              | Pit filling  | Pollock 1986   |
| Qsar es-seghir | 12th-15th c. | Port city, Fortress               | Oven, manures  | Pollock 1986   |
| Rirha          | 9th-14th c.  | Occasional reoccupation of a city | Dumps, domestic and artisanal ovens/kilns                        | Ruas <i>et al.</i> 2016b                               |
| Sijilmasa      | 7th-12th c.  | City                              | Habitat floors, ovens, dumps                                     | Mahoney unpublished                                    |
| Volubilis      | 8th-11th c.  | City                              | Storage and activities areas                                     | Fuller 2002, 2004; Fuller, Pelling 2018                |

87

88 Tab. 1: Corpus of medieval and modern archaeological sites with carpological studies in Morocco (adapted from  
 89 Ruas 2018)

90

## 91 2. Material and methods

92 The archaeological team carried out sampling during the various excavation campaigns. During the  
 93 2016 and 2019 campaigns, a total of 137 samples were inventoried and sieved on fine meshes (0.5mm)  
 94 directly on the site, representing 806.75 litres of raw sediment. The samples are issued from a variety  
 95 of contexts: hearths and hearths discharges, charcoal/ash levels, traffic levels, dumps, garden soils.  
 96 Depending on the context of origin, the initial volume of the samples was variable, ranging from 0.2 to  
 97 10 litres. Originally, we intended a complete analysis of the samples by 2021, but due to the COVID-  
 98 19 pandemic, we only had access to the ones stored at the ISEM laboratory (Montpellier, France). For  
 99 this reason, in this paper, the presented results are issued from the complete study of 17 samples for  
 100 seed remains, of 11 samples for wood charcoal remains, and 30 other carpological samples were  
 101 studied in a preliminary way (first identifications, evaluation of abundance).

102 The extraction of seed remains was carried out at the carpological platform of the UMR5554 (ISEM,  
 103 Montpellier) under a Nikon SMZ 645 binocular (magnification x 0.8 to x 5). A sorting with the naked  
 104 eye was not sufficient to see all the remains, nor to observe the diagnostic characteristics sought at the  
 105 time of the determination, in particular for the remains of fine fractions. For carpology, as the  
 106 determinations were made following an anatomical comparison, we used a reference collection of  
 107 fresh and archaeological seeds as well as the following publications: Cappers *et al.* 2006; Jacomet  
 108 2006 and Rameau *et al.* 2008. For anthracological analysis, specific recognition was done using a  
 109 reflection microscope, with the help of reference atlases (Jacquiot 1955; Jacquiot *et al.* 1973;  
 110 Schweingruber 1990; Vernet *et al.* 2001) and the reference collection of the team "Dynamique de la  
 111 biodiversité, anthropo-écologie" (ISEM, UMR 5554). The analyses were performed on an Olympus  
 112 BH2-UMA reflection microscope, with black/white background and x100, x200 and x500  
 113 magnification.

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### 3. Results

#### 3.1. Carpological results

A total of 977 seed remains was collected, from 17 studied samples. Out of the 977 remains, 975 are charred and 2 mineralized. They allowed identifying 55 taxa, among which 17 are determined to the species (tab. 2, 3; fig. 3).

| Phase   |                 | 11th-12th    | 14th-15th     | 15th-17th           |            |
|---|-----------------|--------------|---------------|---------------------|------------|
| Contexts  |                 | Qubba Palace | Houses Hammam | Palace Houses Basin |            |
| Number of samples   |                 | 5            | 7             | 5                   |            |
| Volume (liters)   |                 | 24,5         | 36,6          | 14,7                |            |
| TAXONS  | Type of remains |              |               |                     | Total      |
| <b>Cereals</b>  |                 |              |               |                     |            |
| <i>Avena</i> sp.  | grain           | –            | 1             | –                   | 1          |
|   | grain fg.       | 2            | 1             | –                   | 3          |
| cf. <i>Avena</i>  | grain fg.       | 1            | –             | –                   | 1          |
| <i>Hordeum vulgare</i>                                      | grain           | 11           | 14            | 9                   | 34         |
|   | grain fg.       | 14           | 15            | 24                  | 53         |
|   | spikelet        | –            | 1             | –                   | 1          |
|   | rachis segment  | 11           | 3             | 17                  | 31         |
|   | lemma fg.       | –            | –             | 1                   | 1          |
| <i>Triticum aestivum/turgidum</i>                           | grain           | 5            | 9             | 2                   | 16         |
|   | grain fg.       | 5            | 13            | –                   | 18         |
|   | rachis segment  | 4            | 2             | 4                   | 10         |
| <i>Triticum</i> sp.   | fg. sem         | –            | –             | 3                   | 3          |
| <i>Triticum</i> type mono/dico/spelta                       | sem.            | –            | –             | 1                   | 1          |
| <i>Panicum miliaceum</i>                                    | sem.            | –            | –             | 5                   | 5          |
| <i>Cerealia</i>   | fg. sem         | 41           | 6             | –                   | 47         |
|   | rachis segment  | 1            | –             | –                   | 1          |
| <b>Gathered/cultivated fruits</b>                           |                 |              |               |                     |            |
| <i>Ficus carica</i>   | seed            | 202          | –             | 5                   | 207        |
|   | seed fg.        | 42           | –             | 7                   | 49         |
| <i>Juglans regia</i>  | shell fg.       | –            | 1             | –                   | 1          |
| <i>Olea europaea</i>  | stone           | –            | –             | 2                   | 2          |
|   | stone fg.       | –            | 78            | 4                   | 82         |
| Type <i>Olea europaea</i>                                   | stone fg.       | 3            | –             | 1                   | 4          |
| <i>Olea/Ziziphus</i>  | stone fg.       | –            | 15            | 6                   | 21         |
| <i>Phoenix dactylifera</i>                                  | seed            | –            | –             | 1                   | 1          |
|   | seed fg.        | –            | 1             | –                   | 1          |
| <i>Prunus persica</i>                                       | stone           | –            | –             | 1                   | 1          |
| <i>Punica granatum</i>                                      | seed            | 2            | –             | 1                   | 3          |
|   | seed fg.        | 5            | –             | 3                   | 8          |
| <i>Rubus fruticosus</i> agg.                                | stone           | 5            | –             | 1                   | 6          |
| <i>Rubus fruticosus/idaeus</i>                              | stone           | 1            | –             | –                   | 1          |
| <i>Rubus idaeus</i>   | stone           | 1            | –             | –                   | 1          |
| <i>Rubus</i> cf. <i>idaeus</i>                              | stone           | 1            | –             | –                   | 1          |
| <i>Vitis vinifera</i>                                       | pip             | 14           | 7             | 2                   | 23         |
|   | pip fg.         | 61           | –             | 4                   | 65         |
|   | pedicel         | –            | 1             | 1                   | 2          |
| <i>Ziziphus</i> spp.  | stone           | –            | –             | 1                   | 1          |
|   | stone fg.       | –            | 1             | 13                  | 14         |
| <b>Oleaginous/textile plant</b>                             |                 |              |               |                     |            |
| <i>Linum usitatissimum</i>                                  | seed            | 2            | 1             | 1                   | 4          |
| <b>Pulses</b>   |                 |              |               |                     |            |
| <i>Fabaceae</i>   | seed            | 3            | 1             | 1                   | 5          |
|   | seed fg.        | 13           | –             | –                   | 13         |
| <b>Total number of cultivated plants identified remains</b> |                 | <b>450</b>   | <b>171</b>    | <b>115</b>          | <b>742</b> |
| <b>Total number of identified remains</b>                   |                 | <b>546</b>   | <b>191</b>    | <b>240</b>          | <b>977</b> |
| coprolite   |                 | –            | 1             | –                   | 1          |

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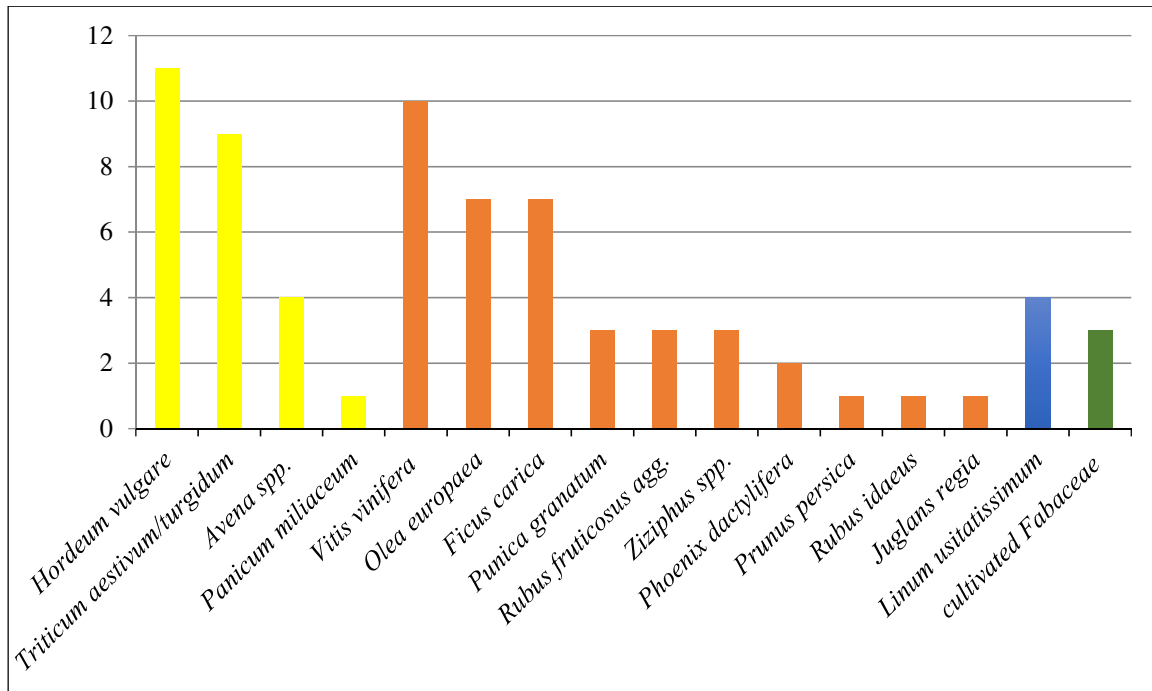
Tab. 2: List and quantification of cultivated/gathered plants carpological remains (fg. = fragment)

|   |                 | Phase             | 11th-12th    | 14th-15th     | 15th-17th           |            |
|---|-----------------|-------------------|--------------|---------------|---------------------|------------|
|   |                 | Contexts          | Qubba Palace | Houses Hammam | Palace Houses Basin |            |
|   |                 | Number of samples | 5            | 7             | 5                   |            |
|   |                 | Volume (liters)   | 24,5         | 36,6          | 14,7                |            |
| TAXA  | Type of remains |                   |              |               |                     | Total      |
| <b>CHARRED REMAINS</b>                                |                 |                   |              |               |                     |            |
| <b>Wild plants</b>                                    |                 |                   |              |               |                     |            |
| <i>Anthemis cotula</i>                                | seed            |                   | –            | –             | 1                   | 1          |
| <i>Avena cf. fatua</i>                                | glume fg.       |                   | –            | –             | 1                   | 1          |
|   | lemma base      |                   | –            | –             | 2                   | 2          |
|   | pedicel         |                   | –            | –             | 3                   | 3          |
| <i>Avena</i> sp.                                      | husk fg.        |                   | 1            | 1             | 26                  | 28         |
| Brassicaceae  | tegument fg.    |                   | –            | –             | 8                   | 8          |
| <i>Bromus</i> sp.                                     | seed fg.        |                   | –            | –             | 1                   | 1          |
| <i>Carex/Rumex</i>                                    | seed            |                   | 1            | –             | –                   | 1          |
| Caryophyllaceae                                       | seed            |                   | 1            | –             | –                   | 1          |
|   | seed fg.        |                   | 2            | –             | –                   | 2          |
| Chenopodiaceae  | fruit           |                   | 1            | –             | –                   | 1          |
|   | seed            |                   | 1            | –             | –                   | 1          |
| <i>Chenopodium murale</i>                             | seed            |                   | 1            | 2             | 1                   | 4          |
| <i>Chenopodium</i> sp.                                | seed            |                   | 2            | –             | 1                   | 3          |
|   | seed fg.        |                   | 1            | –             | –                   | 1          |
| Fabaceae  | seed            |                   | 2            | –             | –                   | 2          |
|   | seed fg.        |                   | 1            | –             | –                   | 1          |
| <i>Galium</i> sp.                                     | seed            |                   | 1            | 1             | 1                   | 3          |
| <i>Lolium multiflorum/perenne/rigidum</i>             | seed            |                   | –            | 1             | –                   | 1          |
| <i>Lolium</i> sp.                                     | seed            |                   | 18           | 1             | 15                  | 34         |
|   | seed fg.        |                   | 1            | –             | 11                  | 12         |
|   | spikelet        |                   | –            | 11            | –                   | 11         |
| cf. <i>Lysimachia</i>                                 | seed            |                   | 1            | –             | –                   | 1          |
| <i>Malva</i> sp.                                      | seed            |                   | –            | –             | 12                  | 12         |
| <i>Medicago</i> sp.                                   | seed            |                   | 1            | 1             | 13                  | 15         |
|   | seed fg.        |                   | –            | –             | 3                   | 3          |
| <i>Medicago/Trifolium</i>                             | seed            |                   | 1            | –             | –                   | 1          |
| <i>Phalaris</i> sp.                                   | seed            |                   | –            | 1             | 1                   | 2          |
| <i>Plantago</i> sp.                                   | seed            |                   | –            | –             | 2                   | 2          |
| Poaceae   | seed            |                   | 13           | –             | 1                   | 14         |
|   | seed fg.        |                   | 27           | –             | 2                   | 29         |
|   | stalk fg.       |                   | 2            | –             | –                   | 2          |
|   | root fg.        |                   | 1            | –             | –                   | 1          |
| <i>Portulaca oleracea</i>                             | seed            |                   | 1            | –             | –                   | 1          |
| Rosaceae  | epidermal spine |                   | 2            | –             | 1                   | 3          |
| <i>Rumex</i> sp.                                      | seed            |                   | 9            | –             | 5                   | 14         |
|   | fg. sem         |                   | –            | –             | 2                   | 2          |
| Scrophulariaceae                                      | seed            |                   | 1            | –             | –                   | 1          |
| <i>Sherardia arvensis</i>                             | seed            |                   | 1            | –             | –                   | 1          |
| <i>Sherardia</i> sp.                                  | seed            |                   | 1            | –             | 2                   | 3          |
| <i>Silene</i> sp.                                     | seed            |                   | 1            | –             | 7                   | 8          |
| <i>Solanum</i> sp.                                    | seed            |                   | –            | –             | 1                   | 1          |
| cf. <i>Vicia</i>                                      | seed            |                   | –            | 1             | –                   | 1          |
| <b>MINERALIZED REMAINS</b>                            |                 |                   |              |               |                     |            |
| <b>Wild plants</b>                                    |                 |                   |              |               |                     |            |
| <i>Buglossoides arvensis</i>                          | seed            |                   | –            | –             | 2                   | 2          |
| <b>Total number of wild plants identified remains</b> |                 |                   | <b>96</b>    | <b>20</b>     | <b>125</b>          | <b>241</b> |
| <b>Total number of identified remains</b>             |                 |                   | <b>546</b>   | <b>191</b>    | <b>240</b>          | <b>977</b> |

124

125 Tab. 3: List and quantification of wild plants carpological remains (fg. = fragment)

126



127  
 128 Fig. 3: Ubiquity of the cultivated taxa in the carpological samples (total of studied samples: 17) (in yellow:  
 129 cereals; in orange: fruits; in blue: textile/oleaginous plants; in green: pulses)

130

### 131 3.1.1. Cereals

132 A total of 226 cereal remains have been encountered in the studied samples (23% of the total number  
 133 of remains), allowing the identification of at least 5 cereals: hulled barley (*Hordeum vulgare*), naked  
 134 wheat (*Triticum aestivum/turgidum*), common millet (*Panicum miliaceum*), a wild or cultivated oat  
 135 (*Avena spp.*) and a possible hulled wheat (*Triticum type monococcum/dicoccum/spelta*). The majority  
 136 of the remains correspond to caryopsis (180 remains), although hulled barley and naked wheat were  
 137 also found as rachis segments (46 remains). The poor preservation of naked wheat rachis segments did  
 138 not allow a more precise identification (hexaploid or tetraploid type). Among the discovered cereals,  
 139 hulled barley is the most frequent and abundant, followed by naked wheat (fig. 3). The status, wild or  
 140 cultivated, of the oat is still to explore, although several remains (lemma bases) discovered in one  
 141 sample were identified as possible common wild oat (*Avena cf. fatua*). Common millet is also present  
 142 but only in one sample, dated from the last occupation phase of the site.

143

### 144 3.1.2. Fruits

145 With 494 remains, fruit species is the plant category delivering the most remains. On the 14 identified  
 146 taxa, we recognized the presence of grape (*Vitis vinifera*), fig (*Ficus carica*), olive (*Olea europaea*),  
 147 walnut (*Juglans regia*), date palm (*Phoenix dactylifera*), peach (*Prunus persica*), pomegranate (*Punica*  
 148 *granatum*), blackberry (*Rubus fruticosus agg.*), raspberry (*Rubus idaeus*) and jujube (*Ziziphus spp.*).  
 149 Grape, fig and olive are both the most frequent and abundant fruit taxa in the samples, while the other  
 150 taxa are identified by less remains and tend to appear more sporadically (1 to 3 contexts) (fig. 3). We



151 observe that grape is just as frequently noted in the studied samples than hulled barley and naked  
152 wheat.

153

### 154 3.1.3. Pulses and oleaginous/textile plant

155 About 18 remains issued from 3 stratigraphic units have been identified as pulses remains (Fabaceae,  
156 2% of the total number of remains). Although their size and general shape presume their cultivated  
157 nature, due to the disappearance of the diagnostic anatomical features, we were not able to identify  
158 them, not even to the genus. Flax (*Linum usitatissimum*) is also identified by 4 remains in 4  
159 stratigraphic units (less than 1% of the total number of remains) (fig. 3).

160

### 161 3.1.4. Wild plants

162 A total of 241 wild plant remains have been collected in the studied samples (25% of the total number  
163 of remains), allowing the determination of 31 taxa among which 5 are identified to the species:  
164 stinking chamomile (*Anthemis cotula*), nettle-leaved goosefoot (*Chenopodium murale*), duckweed  
165 (*Portulaca oleracea*), blue field-madder (*Sherardia arvensis*) and field gromwell (*Buglossoides*  
166 *arvensis*). Most of the discovered taxa are annual species, belonging to the Poaceae, Amaranthaceae or  
167 Fabaceae family, those identified to the species being considered as common crop weeds (Jauzein  
168 1995). The taxa identified to the species tend to generally be observed in rich, dry soils. Nettle-leaved  
169 goosefoot and duckweed are considered as spring crops weeds, while blue field-madder is considered  
170 as a winter crops weed (Jauzein 1995).

171

## 172 **3.2. Overview of future carpological results**

173 In order to evaluate the potential of other samples, a rapid evaluation was carried out on 30 of them  
174 that were available at the ISEM laboratory (Montpellier, France) (tab. 4). This assessment aimed to  
175 identify the main cultivated/gathered taxa present, and to evaluate their abundance.

176 It appears that, in these samples, the recorded taxonomic diversity is similar to that identified in the  
177 fully studied assemblages. Hulled barley and naked wheat are the most frequent and abundant cereals,  
178 present as grains and rachis segments, the latter appearing more abundantly and frequently in the  
179 samples from the last phase of occupation. Oats are identified by grains in all phases of occupation,  
180 although their status remains indeterminable (cultivated, wild). Common millet is identified only in  
181 the last phase of occupation. The diversity of fruit trees remains relatively stable throughout the period  
182 under consideration, although their relative importance seems to vary by phase and according to the  
183 studied context. The case of the olive tree is particularly interesting because, although it is quite  
184 frequent in all 3 phases of occupation, it seems to be particularly abundant in certain samples issued  
185 from a planting pit in one of the garden of the elite habitat (palace). Some fruits, such as peach, walnut  
186 and date, only appear anecdotally in the samples. Flax is present throughout the studied chronology,  
187 but is never encountered in significant quantities. Legumes/pulses are rare in the assemblages;

188 however, some seeds identified as possible alfalfa (*Medicago* cf. *sativa*) were encountered in a late  
 189 sample. Their determination needs to be confirmed by further study.  
 190

|                                   | Phase                  | 11th-12th                 | 14th-15th                  | 15th-17th                                 |
|-----------------------------------|------------------------|---------------------------|----------------------------|---|
|                                   | Contexts               | Qubba - Palace<br>Gardens | Houses - Hammam<br>Gardens | Houses - Basins<br>Reoccupation in Mosque |
|                                   | Number of samples      | 10                        | 10                         | 10  |
| <b>TAXONS</b>                     | <b>Type of remains</b> |                           |                            |   |
| <b>Cereals</b>                    |                        |                           |                            |   |
| <i>Avena</i> sp.                  | grain + grain fg.      | 2 / X                     | 3 / X                      | 4 / X                                     |
| <i>Hordeum vulgare</i>            | grain + grain fg.      | 8 / XXX                   | 8 / XX                     | 8 / XX                                    |
|                                   | rachis seg.            | 5 / X                     | 5 / X                      | 5 / XX                                    |
| <i>Panicum miliaceum</i>          | grain + grain fg.      | –                         | –                          | 3 / XX                                    |
| <i>Triticum aestivum/turgidum</i> | grain + grain fg.      | 8 / XXX                   | 6 / XX                     | 6 / XX                                    |
|                                   | rachis seg.            | 3 / X                     | 2 / X                      | 2 / X                                     |
| <b>Gathered/cultivated fruits</b> |                        |                           |                            |   |
| <i>Ficus carica</i>               | seed + fg.             | 6 / XX                    | 2 / X                      | 2 / X                                     |
| <i>Juglans regia</i>              | shell fg.              | –                         | 1 / X                      | –   |
| <i>Olea europaea</i>              | stone + fg.            | 5 / XX                    | 8 / XX                     | 5 / X                                     |
| <i>Phoenix dactylifera</i>        | seed + fg.             | –                         | 2 / X                      | 2 / X                                     |
| <i>Prunus persica</i>             | stone + fg.            | –                         | –                          | 1 / X                                     |
| <i>Rubus fruticosus</i>           | stone + fg.            | 2 / X                     | –                          | 1 / X                                     |
| <i>Punica granatum</i>            | seed + fg.             | 4 / X                     | 1 / X                      | 1 / X                                     |
| <i>Vitis vinifera</i>             | pip + fg.              | 8 / XXX                   | 5 / X                      | 5 / X                                     |
| <i>Ziziphus</i> spp.              | stone + fg.            | –                         | 2 / X                      | 1 / X                                     |
| <b>Oleaginous/textile plant</b>   |                        |                           |                            |   |
| <i>Linum usitatissimum</i>        | seed + fg.             | 2 / X                     | 4 / X                      | 1 / X                                     |
| <b>Cultivated Fabaceae</b>        |                        |                           |                            |   |
| Fabaceae (big seeds)              | seed + fg.             | –                         | 2 / X                      | 3 / X                                     |
| <i>Medicago</i> cf. <i>sativa</i> | seed + fg.             | –                         | –                          | 1 / X                                     |

191  
 192 Tab. 4: Evaluated ubiquity and abundance of cultivated/gathered taxa in 30 carpological samples (for each taxa,  
 193 the number before the X/XX/XXX is the number of samples in which the taxa was observed; X = 1 to 10  
 194 remains, XX = 10 to 50, XXX = more than 50)

195  
 196 **3.3. Preliminary anthracological results**

197 The first anthracological results come from the study of isolated wood charcoal fragments, collected  
 198 during the 2017 and 2018 missions in order to perform radiocarbon dating. As the reliability of the  
 199 anthracological approach depends partly on the quantity of coals studied/identified (at least 100-150  
 200 per sample or SU depending on the context) (Chabal 1997), the results presented below should only be  
 201 considered as qualitative contributions, without quantitative value, allowing to address for the first  
 202 time in Aghmat the question of exploited wood resources.

203 In the framework of our study, 29 charcoal fragments issued from 11 SU were identified (tab. 5). They  
 204 allow us to record a diversity of 14 taxa: evergreen oak (*Quercus coccifera/ilex*), filaria/buckthorn  
 205 (*Phillyrea/Rhamnus*), poplar (*Populus* sp.), ash (*Fraxinus* sp.), juniper/berbera thuja  
 206 (*Juniperus/Tetraclinis articulata*), a leguminous tree (cf. Fabaceae), a monocotyledon  
 207 (*Motocotyledon*), olive (*Olea europaea*), pomegranate (*Punica granatum*) and fig (*Ficus* sp.) trees, as

208 well as two *Prunus*, one of them being identified as a cultivated one (almond or peach tree, *Prunus*  
 209 type *dulcis/persica*).  
 210

| Phase<br>Contexts<br>Number of samples   | 11th-12th<br>Qubba<br>1 | 14th-17th<br>Souk<br>11 |              |
|--|-------------------------|-------------------------|--------------|
| <b>TAXONS</b>                            |                         |                         | <b>Total</b> |
| cf. Fabaceae                             | 1                       | –                       | 1            |
| Fabaceae/ <i>Ficus</i>                   | 1                       | –                       | 1            |
| <i>Ficus</i> sp.                         | 5                       | –                       | 5            |
| <i>Fraxinus</i> sp.                      | 1                       | 2                       | 3            |
| <i>Juniperus/Tetraclinis</i>             | 1                       | –                       | 1            |
| Monocotyledon                            | 4                       | –                       | 4            |
| <i>Olea europaea</i>                     | –                       | 3                       | 3            |
| <i>Phillyrea/Rhamnus</i>                 | –                       | 1                       | 1            |
| <i>Populus</i> sp.                       | –                       | 1                       | 1            |
| <i>Prunus</i> type <i>dulcis/persica</i> | –                       | 1                       | 1            |
| <i>Prunus</i> sp.                        | 2                       | –                       | 2            |
| <i>Punica granatum</i>                   | 1                       | –                       | 1            |
| <i>Quercus coccifera/ilex</i>            | 2                       | 3                       | 5            |
| <b>Total number of remains</b>           | <b>18</b>               | <b>11</b>               | <b>29</b>    |

211 Tab. 5: Identification and quantification of wood charcoal remains  
 212

#### 213 4. Discussion

214 Although the archaeobotanical results remain preliminary, the discovery of such a wide diversity of  
 215 exploited taxa, in both seed and wood charcoals remains, authorizes a first discussion on past plants  
 216 and environments exploited at Aghmat between the 11<sup>th</sup> and the 17<sup>th</sup> c.  
 217

##### 218 4.1. Exploited terroirs: a mosaic landscape

219 As soon as the medieval city emerges, the richness of its agriculture is praised by numerous medieval  
 220 texts that provide a relatively homogenous picture of the terroirs associated with the town. They  
 221 mention the co-existence of two main great terroirs: an irrigated one in the plains, and a rain-fed one in  
 222 the mountains, that included pastures (Al-Yaqûbî 1892; Ibn Hawqal 1938; Al-Idrîsî 1866). The  
 223 recurrent description of abundant gardens, both on the outskirts of the city and within the city,  
 224 underlines the importance of local horticulture and arboriculture. A large date palm grove and  
 225 orchards are also mentioned (Al-Bakrî 1911; Al-Idrîsî 1866; Ibn al-Khatîb 1983).

226 Indeed, despite the preliminary and exploratory nature of the archaeobotanical study, several  
 227 environments seem to have been exploited: a rather open and dry plant cover (*filaria*/buckthorn), the  
 228 river borders (poplar), perhaps of the nearby Ourika river, as well as cultivated areas, that certainly  
 229 included irrigated orchards (for pomegranate, date palm, maybe also almond/peach tree, grapevine,  
 230 olive tree, fig tree), gardens and/or crop fields (cereals, pulses, flax). Although an important date palm

231 grove is mentioned by textual sources, no charcoal of this species has been discovered so far, only a  
232 few seeds. If the fruits of this local production were indeed common and consumed by the population  
233 of the site, the scarcity of discovered remains might be related to waste management, that did not  
234 favour the charring of the seeds, or to taphonomical issues (significant fragmentation, intense  
235 carbonization preventing the identification of the rest?). Regarding evergreen oak, ash and walnut tree,  
236 discovered in the studied charcoals remains and as shell fragment (walnut), their origin must be  
237 questioned, since they do not grow nowadays in the plain of Aghmat: were they « naturally » present  
238 near the site during medieval and modern times, in cool stations in the case of ash, or in garden for the  
239 walnut tree? Or are the identified remains issued from imported wood and fruits, perhaps from the  
240 mountain terroir located on the slopes of the High Atlas? To favour one or the other of these  
241 hypotheses, it will be necessary to develop the anthracological approach, by questioning the  
242 frequency, abundance and role of these taxa in the food and fuel economy of the site, and by  
243 documenting the contexts in which they are identified. Finally, the case of flax must be considered.  
244 Indeed, the plant, not mentioned as being part of the local agricultural landscape by textual sources, is  
245 identified as seeds in several samples issued from the different phases of occupation. In the case of a  
246 local production, its culture certainly required a controlled irrigation, also necessary to treat its fibers.

247

#### 248 **4.2. Agricultural activities and food habits**

249 With the exception of Al-Idrīsī who mentions the existence of mills dedicated to flour production on  
250 the banks of the river (Al-Idrīsī 1866), there are very few descriptions of the daily-life agricultural  
251 activities led at Aghmat in medieval or modern texts. In this regard, archaeobotanical remains are the  
252 main source of information.

253 Cereals are one of the main plant category in the carpological samples, both in terms of abundance and  
254 frequency. Given the heterogenous nature of the samples, it is impossible to affirm that the identified  
255 weeds (stinking chamomile, nettle-leaved goosefoot, duckweed, blue field-madder, field gromwell)  
256 come from the same field as those on which the cereals were grown on, and therefore to argue about  
257 the agrarian practices specific to each cereal (seeding season, cutting height, farming regime). The  
258 recurrence of hulled barley and naked wheat indicates widespread use of these grains in the site's food  
259 economy. The composition of the samples (mainly grains, few rachis segments, weed seeds) suggests  
260 that the cereals were processed somewhere else, and that « clean » to « semi-clean » products were  
261 transported to the heart of the city. The registered fruits remains correspond to charred consumption  
262 waste (pips, seeds, stone, no entire fruits, no fruit flesh), encountered in domestic hearths as well as in  
263 the hammam hearths. The role of the flax discovered in the site, whether for food, oil or textile  
264 production, is not clearly defined at the moment.

265 Among the few agricultural activities described by textual sources, one of them, considered as  
266 important, has not been brought to light by our study so far. Indeed, ancient authors have described the  
267 production and use/consumption at Aghmat of the argan tree (leaves, wood, fruits) (Al-Bakri 1911).

268 Argan fruits were collected, used as fodder for cattle, more precisely goats (Al-Zuhri). The nuts  
269 rejected by these animals were then roasted and crushed with a hand grinder to make a paste, which  
270 was pressed to extract a large amount of pure oil (Al-Zuhri). This oil was considered as a staple food  
271 in the daily-life of the inhabitant during medieval and modern times: it was used for cooking, to fry the  
272 doughnuts sold at Aghmat's souk, for lighting and even in the pharmacopoeia and cosmetics of the  
273 Masmud women (Ibn al-Baytar, 1990). These testimonies on the argan tree raise questions. The plant,  
274 now absent from the Ourika plain, was considered as an important element in the daily life of the  
275 Masmoudies, and several authors agree on the presence of the argan tree in the surroundings of  
276 Aghmat. But so far, no carpological or anthracological remains of this species have been identified in  
277 the studied archaeobotanical samples, while being abundant in the archaeobotanical samples of Îgîlîz,  
278 medieval settlement contemporary of Aghmat's earliest phase (11<sup>th</sup>-12<sup>th</sup> c.) and located in the Anti-  
279 Atlas (Ruas *et al.* 2011, 2016). Its absence at Aghmat could be explained by the small number of  
280 studied samples, by the type or location of sampled contexts, or by the location where argan fruits were  
281 processed, if the generated waste was discharged and/or charred outside the excavation area.

282

#### 283 **4.3. Rise and fall of a city: what consequences on agriculture?**

284 Between the 11<sup>th</sup> century and the 17<sup>th</sup> c., Aghmat underwent several major changes: consecrated as the  
285 capital of the Almoravid dynasty between 1057 AD and 1062 AD, Aghmat becomes at the beginning  
286 of the 12<sup>th</sup> century a great commercial centre, engaged in intense trade with Sudan while developing  
287 economic relations with the Iberian Peninsula and the Mediterranean world. This situation came to an  
288 end a century after, when the Merinids took Marrakech in 1269 AD, putting an end to the Almohad  
289 domination in western Maghreb. Aghmat thus became a second-rate city and, with the arrival of the  
290 Saadians in 1554 AD, emptied of its population, thus becoming a deserted city, gradually ruralizing its  
291 activities and economic balance. Such a complex history raises the question of how these great  
292 historical socio-economic dynamics found an echo in the plant economy of the site.

293 The earliest textual sources praise, as mentioned before, the great diversity of exploited landscapes  
294 (crops, gardens, orchards, date palm grove) and the richness of local plants productions, that included  
295 numerous fruits (pomegranate, pears, grapes, carobs, apples, quinces, apricots, sour cherries, bitter  
296 oranges, mulberries), and vegetables (fava beans, aubergines, gourds, turnips, cabbages). In the 14<sup>th</sup>  
297 century, Ibn al-Khatîb, who visited the city, describes it as on the brink of its decline, mentioning  
298 grapevine, fig and olive trees, while evoking the harmful effect of the social and political troubles on  
299 crops. In the 16<sup>th</sup> century and later, several travellers such as Leo Africanus (1980), Marmòl (1667) or  
300 Richardson (1860), describe a devastated but still fertile land, where grapevine and olive trees are still  
301 cultivated, in association with vast crop fields, probably cereals.

302 Based on archaeobotanical data, so far, we do not observe any type of main changes or evolutions in  
303 the exploited taxa, nor in the practices. Through all the documented phases, we identify a common  
304 agro-horticultural fund over the entire period, the staple productions being hulled barley, naked wheat,



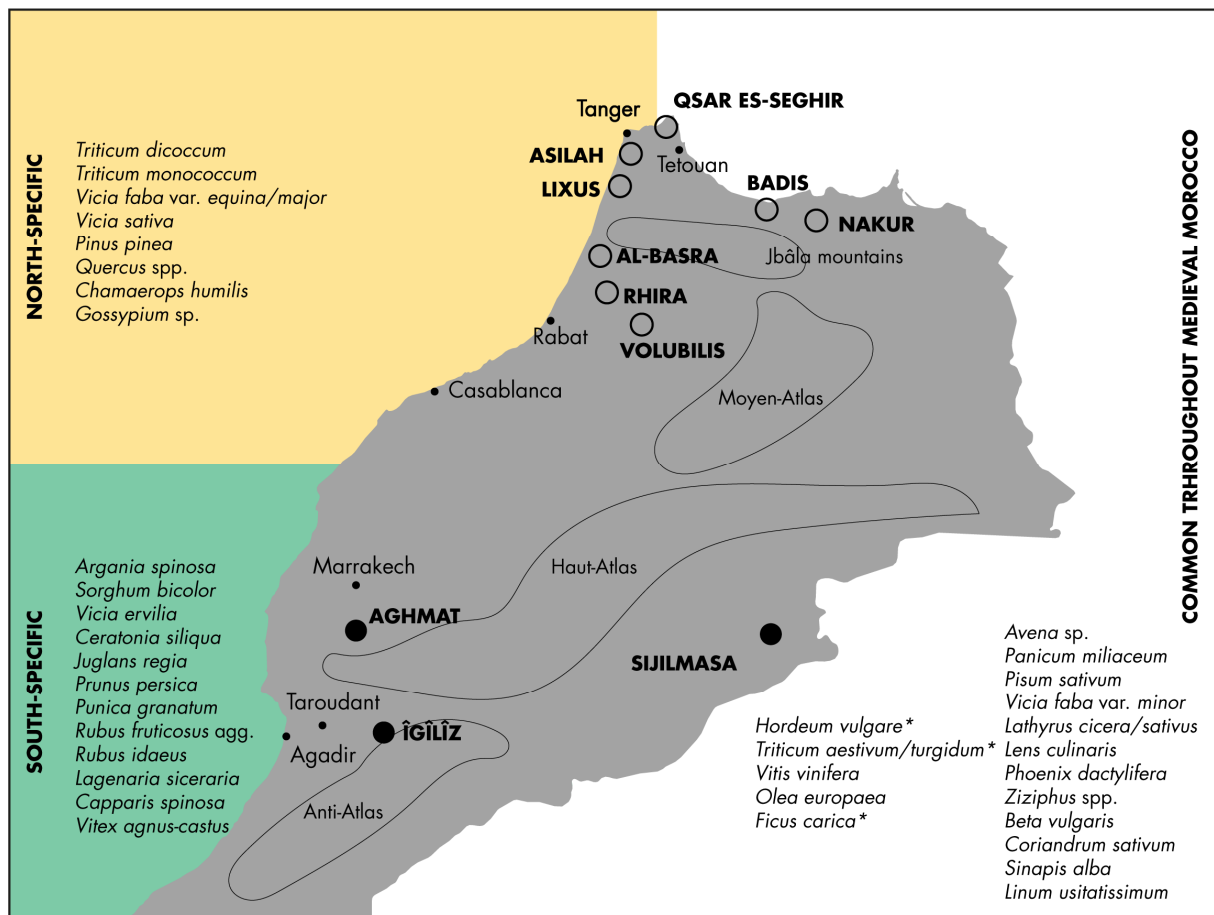
305 grape, olives and figs, their frequency and abundance varying depending on the context. Nonetheless,  
306 the presence in some samples from the 15<sup>th</sup>-16<sup>th</sup> c. of common millet, generally more associated with  
307 rural contexts and peasant populations, of numerous barley rachis, and of a possible alfalfa, might be  
308 an indicator of the ruralisation of this part of the city. This hypothesis will have to be confirmed by the  
309 study of a more complete corpus of samples. Concerning the exploited/consumed fruits, we do not  
310 observe a loss of diversity, the same taxa being present in the earliest and latest samples of the site. If  
311 some fruits (peach, walnut, raspberry) are present only during one phase of occupation, we consider it  
312 as due to the weakness of the corpus studied at the moment, and not as a sign of changes in the  
313 agricultural practices.

314

#### 315 **4.4. Aghmat and its contemporaries: first comparison**

316 So far, the available carpological data for medieval and modern Morocco remain limited, with only 11  
317 studied sites in the whole country (fig. 4). The comparison between the different sites suffer from  
318 several difficulties, inherent to: their unequal status (urban, rural, commercial, religious) and their  
319 strong geographical disparity (north, south, coast, plain, mountain); the corpus of samples (diversity of  
320 sampled contexts, quantity of studied samples, original volume of sampled sediment); and finally, to  
321 the study protocol that was applied (proper sieving and extracting method, quantification of the  
322 remains). For this reason, it is important to keep in mind that the comparison we propose is  
323 preliminary, simply aiming to contextualize the archaeobotanical data of Aghmat on a larger scale.

324



325  
 326 Fig. 4: Cultivated/gathered plants identified by carpological remains in medieval and modern Morocco  
 327 (compilation established after Ruas 2018, Ros and Badri 2020 and Ros unpublished) (black dots = southern sites,  
 328 great dot with black outline = northern sites; the asterisk indicates that the plant is present in all sites)

329  
 330 Among the staple crops, some are common to the entire studied area, regardless of the location or  
 331 status of the sites, particularly cereals (naked wheat, hulled barley), legumes (peas, fava beans, lentils),  
 332 and some fruit trees (olive and fig trees, grape vine). These staple productions are also common to the  
 333 major part of the medieval western Mediterranean (for ex. Ruas 2005; Peña-Chocarro *et al.* 2019).  
 334 Some of the secondary agro-horticultural crops are found in both northern and southern Morocco, such  
 335 as common millet, flax, date palms and jujube trees, but not in every site. Others are, for the moment,  
 336 only identified in the north (einkorn, emmer, common vetch, stone pine, cotton) or south (sorghum,  
 337 pomegranate, peach, walnut, carob, argan, bitter vetch, bottle gourd, caper, vitex) (fig. 4). This greater  
 338 diversity identified in the south might be caused by a source effect, Îgîlîz being a site with an  
 339 important quantity of studied samples, and, more importantly, a wider diversity of contexts, which  
 340 favour a better representation of different plant categories and types of remains.  
 341 It is interesting to note that, according to this first comparison, Aghmat has more productions in  
 342 common with the sites located in the far north of Morocco than with the "neighbouring" site of Îgîlîz,  
 343 which stands out for the prominent role played by the argan tree, and to a lesser extent by the  
 344 sorghum, in its agro-horticultural production (Ruas *et al.* 2011, 2016b). This significant difference in

345 production highlighted by the carpological studies could have been interpreted as resulting from a sort  
346 of environmental or even socio-economic limit, the Îgîlîz area being in a zone dominated by the argan  
347 grove, whereas Aghmat and the Ourika valley correspond to a predominantly olive-growing area,  
348 which is manifested by the important presence of olives in the archaeobotanical assemblages of the  
349 site. But, as mentioned earlier, the reality of Aghmat is more ambivalent, with textual sources  
350 mentioning the role played by argan oil in the domestic dietary practices of the medieval populations  
351 of the zone. This strong difference between the carpological assemblages of Îgîlîz and those of  
352 Aghmat could be explained by the existence of different practices, or by a production of argan oil in  
353 Aghmat taking place in areas/neighbourhoods not yet documented by archaeology.

354

## 355 **5. Conclusions**

356 The first archaeobotanical results allowed highlighting the staple productions of the medieval and  
357 modern agriculture of Aghmat. If barley, wheat, grapevine, olive and fig trees are common  
358 productions during the whole studied period, the status, role and management (terroirs, irrigation  
359 practice) of secondary exploited taxa, such as millet, flax, pomegrenate, date palm, remain to be  
360 investigated. The presence of certain taxa (ash, evergreen oak, walnut, raspberry) in the  
361 archaeobotanical samples will also have to be discussed, in order to determine if they are proof of the  
362 exploitation of a second terroir, located in the nearby mountains, or of the existence of these taxa in  
363 the plain. Although the site knows major socio-economic changes, the evolution of the agricultural  
364 spectrum (diversification or, on the contrary, agricultural specialization) between the 11<sup>th</sup> and the 17<sup>th</sup>  
365 c. are yet to be enlightened (development of millet crops, artificial meadows, on-site cereal  
366 processing?).

367 The archaeobotanical potential of the site was confirmed by our approach. The next few years will see  
368 the complete studies of the remaining samples, and the implementation of systematic sampling during  
369 future field phases. The obtained archaeobotanical data, once placed in their chronological and spatial  
370 context, within each sector of the site, will allow a more detailed documentation of the plants,  
371 practices, and terroirs exploited, according to the status of the inhabitants of Aghmat. To complete this  
372 approach, a CNRS project intitled « AGrosystèmes Historiques du Maroc: Adaptations,  
373 Transformations - L'exemple de la région du Haouz » has been initiated in 2020, combining an  
374 isotopic approach, aimed at highlighting the practices linked to manuring and irrigation of certain  
375 species (hulled barley, naked wheat, grapevine, olive tree), and a research on the past diversity of the  
376 grapes and olives exploited at Aghmat, thanks to geometric morphometrics applied to the pips and  
377 stones collected in our samples (Terral *et al.* 2004, 2010). The archaeobotanical approach carried out  
378 in this paper was thus a first step towards a better knowledge of the agricultural practices of this still  
379 little known region.

380

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