

#### IV.—The Granaries of Karanis

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Egypt, as is well known, was the chief source for the grain supply of the Roman empire, and the raising, collection, processing, and transportation of grain naturally occupied the attention of a large percentage of the rural population. Among the papyrus documents receipts for grain as rent and taxes, loans of grain, grain accounts, and leases and sales of grain land play a large part. The granaries in which the grain was stored for either public or private use have been studied exhaustively by Aristide Calderini on the basis of the papyrus documents.<sup>1</sup> Since his monograph was written, however, the excavations of the University of Michigan at the site of the ancient Karanis have disclosed the actual ruins of a number of granaries of the early Roman period.<sup>2</sup>

This site was occupied by a flourishing community over a period of some five centuries.<sup>3</sup> The earliest settlement seems to have dated from the second century B.C. and its prosperity waxed and waned during the succeeding centuries, reaching its height during the second century A.D. The economic depression of the middle of the third century<sup>4</sup> apparently caused the abandonment of much of the outlying area, but the early fourth century saw considerable rebuilding over the completely ruined home sites of the earlier period. Evidences of occupation during the Arab period are

<sup>1</sup> Aristide Calderini, *Θησαυροί* (Milano 1924). *Studi della Scuola papirologica*, 4.

<sup>2</sup> See A. E. R. Boak and E. E. Peterson, *Karanis, Topographical and Architectural Report of the Excavations during the Seasons 1924-28* (Ann Arbor 1931). Three granaries from the B level of occupation, B1, B2, and B115, are described on pp. 9-23 and 64-65. A brief account is also given of the large granary, C65, which at that time had not been fully cleared.

<sup>3</sup> The data on which this study of the granaries is based are drawn largely from the material in the excavation reports, as yet unpublished, of Dr. E. E. Peterson, Director of the Museum of Archaeology at the University of Michigan, who conducted the field work at Karanis from 1926-35. Dr. Peterson generously put these reports at my disposal, and in addition shared with me unstintingly his intimate knowledge of every phase of the excavations.

<sup>4</sup> See M. Rostovtzeff, *The Social and Economic History of the Roman Empire* (Oxford 1926) 427-440.

scattered and of slight significance. Clearly the town was no longer of importance.

It should be pointed out that the entire central area of the village, in which we should expect to find public buildings of importance, was almost completely destroyed by the *sebbakhin* in their operations for the acquisition of fertilizer. Except for re-

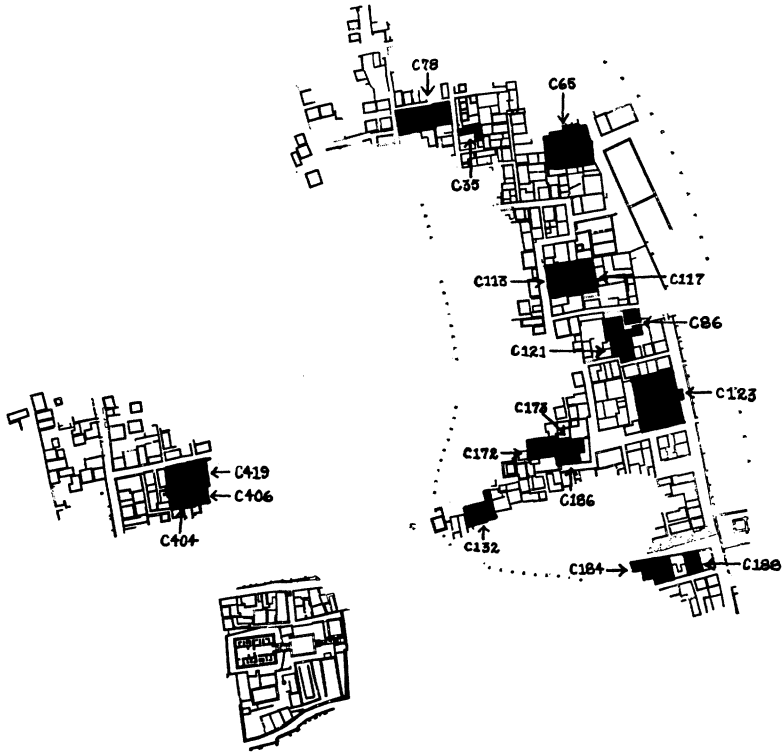


FIGURE 1. Map of the excavated areas at Karanis showing the location of the larger granaries in the C level.

mains of the two temples and their adjacent buildings, the excavations covered only the periphery of the village, a small area on the western side of the mound and a more extensive area on the north, east, and south. The presumption is that the central area was continuously occupied and that the outlying areas were inhabited or abandoned as prosperity rose and fell.

The most extensive remains are those from the late first to the middle of the third century A.D. This period is represented by two levels in the excavations, B and C, the second and third levels down from the top. Since the C level represents a period of long continuous occupation of the same sites, there were many alterations of streets, changes in floor and courtyard levels, and structural remodeling of houses. There is frequently no distinct break between the B and C layers, though the B layer shows the abandonment of many underground rooms, storage areas, and the not uncommon conversion of first floor rooms to cellars. Since the C level provides the greatest amount of material for a study of the granaries, it is only this level that will be studied in detail, with some discussion of the changes that were made in the B level. The top level, designated as A, and the remains of the earlier periods, D and E, yield very little to increase our knowledge of the granaries.

As can be seen from the general map of the area for the C layer (Figure 1), there are ten large granaries, C65, C123, C172, C173, C113, C117, C132, C78, C404, and C419. There are also several smaller ones, such as C35, C86, C121, C184, C186, C188, and C406. Many other granaries and storage rooms, forming part of private houses, are not taken into consideration, though in structure they are of the same type as those discussed here.

Previous to the University's excavations, our knowledge of granaries rested almost solely on representations on Egyptian monuments,<sup>5</sup> on models from Egyptian tombs,<sup>6</sup> and, for the Graeco-Roman period, on a lease of a granary,<sup>7</sup> probably from Soknopaiou Nesos, and on the so-called Achmîm mathematical papyrus.<sup>8</sup> From the dynastic sources we know two types of granaries. One was a building resembling our modern silo, provided with a door at the top through which the grain was poured into the granary and with a door at the bottom through which it could be removed. The other is generally represented in the tomb models as a walled

<sup>5</sup> For a discussion of the granaries of the Pharaonic period, with illustrations from tomb paintings and models, see A. Erman, *Life in Ancient Egypt* (London 1894) 433-4.

<sup>6</sup> The models of granaries from the Egyptian tombs are described by J. H. Breasted, Jr., in his *Egyptian Servant Statuettes* (Washington 1948) 10-15; many of them are reproduced in the excellent plates that accompany the volume.

<sup>7</sup> *PLond.* 2.216 (p. 186/7) = W192.

<sup>8</sup> This papyrus, published by G. Baillet in *Mémoires de la Mission archéologique française au Caire* 9.1 (1892) 1-89, contains mathematical problems, of which several concern the calculation of the contents in artabas of granaries in both rectangular and circular form.

courtyard with a series of rectangular bins across one or both sides. These bins are generally roofed, and a stairway leads from the court to the roof, which is provided with trap-doors through which the grain was poured. As in the other form of granary, the grain was removed through doors at the base of the bin. The evidence of the London and Achmîm papyri appeared to fit in well with these early representations, and it has been assumed that no change was made in the construction of the granary through all antiquity.<sup>9</sup>

The new evidence from Karanis shows, however, that the granary in the Graeco-Roman period underwent some changes, although it retained some characteristics of the earlier structure. Two granaries were so extensive and so well preserved that it will be well to discuss them in some detail. The first in point of time is C123, which was built in the second half of the first century, as is clearly shown from the numerous papyri found on the site.

This building occupied an area twenty-two by twenty-eight meters in extent, with its courtyard facing on the main north-south thoroughfare on the eastern side of the village. The original living quarters, on the western side of the building, were entered from a side street that extended to the west from the highway. The main building devoted to grain storage was two stories high, and consisted of vaulted rooms opening onto a central corridor, the arrangement of the second floor duplicating that of the first. Since these vaulted chambers used for storing grain appear to be standard, they merit a detailed description.

The floor plan of the first floor (Figure 2) shows the arrangement of the ten vaulted rooms, five on either side of the high vaulted central corridor. A door from this corridor opens into each storage room. The floor of the storage room is approximately one meter below the floor of the passage-way, and each room is divided into from four to six bins by walls that rise to the height of the floor of the corridor. The wall that runs from the door to the opposite wall is wide enough to walk on, but the walls dividing either side into bins are narrower. Toe-holds are cut in the walls of the bins to make it easier for those who operate the granary to get in and out of them when removing the grain. The height of the rooms from the floor of the bins to the top of the vault is slightly over

<sup>9</sup> See F. Luckhard, *Das Privathaus im ptolemäischen und römischen Ägypten* (Giessen 1914) 81-3.

three meters. Each room is ventilated by a small window, high in the peak of the arch, so that little light is admitted. The rooms are darkened further by a black wash, made of carbon, applied to the mud plaster with which the brick walls are faced.

The building containing these vaulted storage chambers forms the southern half of the entire granary complex. To the north is

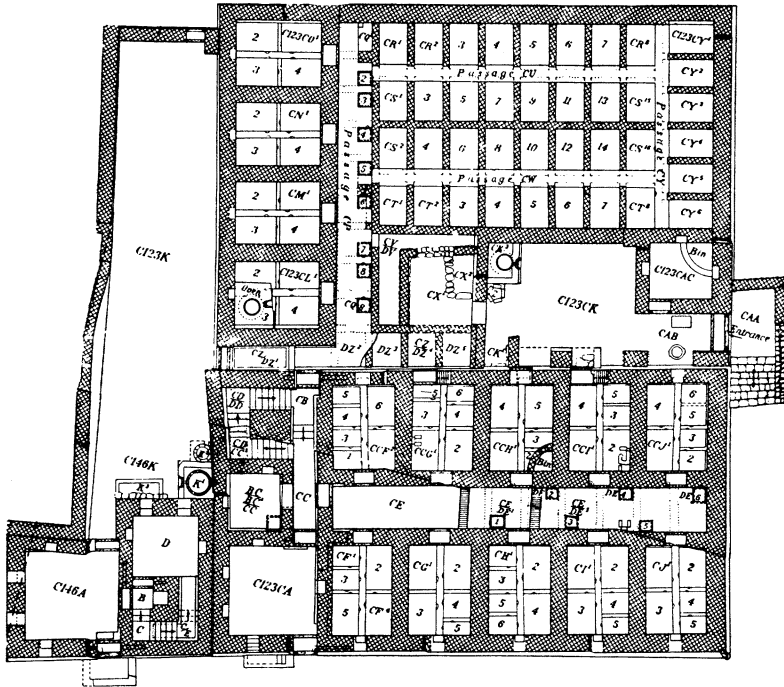


FIGURE 2. Floor plan of granary C123. CA-CD, living quarters; CE, passageway; CF-CJ, CCF-CCJ, CL-CO, vaulted storerooms; CK, courtyard; CS1-16, open grain bins; CR1-8, CT1-8, CY1-6, grain bins with low vaulted roofs.

the large courtyard entered from the main street, and another series of granary bins which differ from those in the southern section. Sixteen bins, apparently unroofed, are surrounded on three sides by twenty-two bins with low vaulted roofs. To the west of the passage that gives access to this group of bins are four other vaulted rooms similar to those in the southern half of the building.



Additional storage is provided by twenty underground vaulted rooms beneath the corridors in both parts of the granary. These rooms are entered by trap doors in the corridor floors.

Some time after C123 was built and after the level of the courtyard had risen about one meter, several of the storage rooms were converted into dwelling space. The bins were filled in to make a new floor at the height of the original door, and three doors were opened in the north wall to give access to the courtyard.

An even larger granary is C65 (Figure 3), a remarkable building, three stories in height, with a ground area of sixteen by eighteen and one-half meters. The rooms at the front of the house, which, like C123, had its main entrance on the thoroughfare that traversed the eastern side of the town from south to north, were apparently used as offices or living quarters. Through one of these rooms a large central courtyard was entered, and the remaining three sides of the court were occupied by storage rooms for grain, built on the same plan as those of C123.

The area under the courtyard was used for underground vaults for grain, which were reached by trap doors, some of which have been found in the floor of the arcade that surrounds the court. The doors to the ground floor storage rooms also open from this arcade, which supports a balcony from which the second floor vaults were entered. Most of the third floor has been destroyed, but enough remains for it to be possible to make a fairly accurate reconstruction of it. Except for the rooms at the front, it consisted mainly of low long vaulted rooms, the vaults running at right angles to those on the floor below. These low storage rooms were reached by trap doors probably from a flat roof. All the details of the construction of storage rooms and bins are the same as in C123: the high arched ceilings, the bins formed below the floor level by low walls reaching only to the height of the door sills, the plastering, and the toe-holds in the bin walls.

These two granaries offer the pattern by which all the granaries in Karanis appear to have been constructed. Two large granaries, C172 and C173, used continuously, at least in part, from the second to the fourth century, cannot be described accurately because of the repeated changes in floor levels; and the difficulty of tracing their original plan is the greater because they lie toward the central area and suffered considerable destruction from the depredations of the *sebbakhin*. Each of the granaries seems to be constructed

on the pattern of the northern half of C123; that is, they comprise a series of open bins with flanking rows of somewhat larger bins with low vaulted roofs.

C113 was another granary built on this plan. It consisted of a series of some twenty granary bins. There is no indication as to whether these bins were open, vaulted, or covered with a flat roof, but the arrangement of the bins is not characteristic of a granary using vaulted storage chambers. The later use of the granary area as a courtyard makes the assumption of unroofed bins the most probable.

In the small area excavated on the western side of the hill another large complex of granaries was found, which also appears to have consisted of unroofed bins. C404 has a large area occupied by forty open bins. C419, next to it, apparently contained fourteen good sized bins, and C406, which appears to have been built somewhat later, has a series of eight bins built across the southern half of the original courtyard of C419.

The construction details of the granary, C132, are not clear. At both the north and south ends of the eastern side of the building there were remains of massive foundation walls that suggest that the superstructures were both heavy and high, perhaps towers. They appear to have been balanced by similar structures on the western side. The granary bins that remain occupy the space between these two structures and, from their irregular arrangement, seem to have been of the open type rather than to have formed part of vaulted storage rooms. The plan followed is that of interconnecting passageways between series of bins. Where the bins did not border immediately upon these passageways, the dividing walls were made sufficiently strong to serve as pathways. There are twenty-five bins remaining, but a considerable area is completely destroyed, so that the original extent cannot be determined.

Following the more elaborate pattern of vaulted storage rooms with several bins in each is the building designated as C73. Entrance to the granary proper was from the courtyard into a corridor a little over a meter wide and ten meters long. From this corridor open eight vaulted rooms, somewhat smaller than those of C123, each containing several bins. As in C123 the floor of the bins is almost a meter below the level of the floor of the passageway. The height of the original arched ceilings could not be determined, because of later reconstruction, but it was probably about three



meters. By the late third level the entire building had been converted to an ordinary dwelling and the high vaulted ceilings had been destroyed. The remains of a stairway and the vaulted construction suggest that there was a second story devoted to the storage of grain, but it is possible that the stairway simply led to a flat roof. If so, there were quite probably bins below the roof, similar to those on the top floor of C65.

House C184, which is on the southern edge of the eastern excavated area, was probably also an extensive granary, but there has been considerable destruction. What remains of the granary is a series of four vaulted storage rooms with bins below floor level. The storage rooms open onto a passageway, on the opposite side of which are the remains of three additional bins, which may have been originally part of vaulted rooms, but which seem more likely to have been of the open type.

C78, in the northeast section of the village, is made up of eight rooms opening onto a central corridor. Six of the rooms are vaulted and contain bins for grain. Of the other two, one was probably an office, and the other contains a stairway leading to a second story. A door at the end of the passage opens into an area in which there are two other vaulted rooms, apparently taken over from an earlier building for use by the occupants of C78.

C86 is a small granary that has one interesting feature. There are four small vaulted chambers built in the courtyard of the house; each chamber is entered by a doorway with a wooden threshold slightly more than a meter above the level of the courtyard floor. No steps lead up to these doors, but, where only small operations were carried on, the necessity of lifting the grain over the raised door sill was probably not an important consideration.

Both these types of granary construction are found in smaller vaults or open bins that formed part of individual dwellings. They are supplemented by other simpler methods of storage, underground vaults reached by trap-doors in the floor, or bins constructed by walling off corners of rooms or courtyards. Large jars and even open and unlined pits served also for storing small amounts of grain for domestic use. But it is of course the larger granaries that have the greatest interest for us.

Several of the great granaries of the C level continued in use in the B level with structural alterations necessitated when buildings fell into disrepair, or when the accumulation of debris and drifting

sand filled the courtyards and underground rooms and blocked off doorways. The upper floor of storage vaults of C123 was still in use, although the lower floor, the underground pits, and the open bins had been completely filled in and abandoned. C65, which was apparently constructed about the middle of the second century, remained in use through the late C level and the B level, but by the A level it had been completely buried, so that the house walls of the A level construction above it bear no relation to its walls. C172 and C173, which were closer to the center of the village, were apparently continuously occupied through both the C and B levels of occupation, and the western granary, C172, was one of the few buildings that was still in use in the last occupation period. Its bins were still used for grain storage in the fourth century. The only granary of the B period, for which there is no counterpart in earlier times, is B115, a series of bins found at the very edge of the central devastated area.

The main granaries of importance from the earlier period of occupation in Karanis, before the expansion of the late first century A.D., were those in connection with the two temples, the southern one dedicated to Pnepheros and Petesouchos, and the northern one, whose cult has not yet been determined.<sup>10</sup> These granaries appear to have been of the open bin type, but, since in the earliest periods the village probably extended little beyond the central area of the hill, which has been almost totally destroyed, we cannot be certain that the vaulted storage rooms may not also have been used at this time.

That the open bins were also used in the dynastic period is shown by some of the tomb models. Most interesting is a model of the eleventh dynasty in the Metropolitan Museum,<sup>11</sup> which shows a room divided by a wall on which porters stand with sacks of grain to pour into the bins which are made by narrower transverse walls. Steps lead from the court to the main dividing wall. Other models also show unroofed bins, although the parallel with the Karanis granaries is not so striking.<sup>12</sup>

<sup>10</sup> See A. E. R. Boak, *Karanis, the Temples, Coin Hoards, Botanical and Zoölogical Reports*, Seasons 1924-31 (Ann Arbor 1933) 26 and Plan 4 for the granary adjacent to the southern temple.

<sup>11</sup> Metropolitan Museum, 20.3.11; Breasted (above, note 6) plate 11b.

<sup>12</sup> Breasted (above, note 6) plates 13a-b, 14b.

Although in the many excavations in Egypt little attention has been paid, except at Karanis, to structures of the Graeco-Roman period, there is evidence of similar granary construction elsewhere. In the search for papyri made by Grenfell and Hunt in the village sites in the Fayum,<sup>13</sup> they noted similar series of storage bins. At Ūmm el 'Atl, the ancient Bacchias, they report "On the steep outer slope on the west and north occurred several alignments of small chambers, with brick floors, too small for human dwellings, and probably designed for store-rooms." Also at Kaṣr el Banat, which they were able to identify as Euhemeria, they record that "Some of the other best-preserved papyri were discovered in small chambers not more than a square meter in area, similar to those at Ūmm el 'Atl. These were often arranged in one or more rows side by side, the row consisting of four or five, or even as many as ten chambers, occasionally varied by a somewhat larger one. There was no means of getting in or out from the sides, so presumably they were granaries or store-rooms."

It will be interesting to compare the archaeological evidence regarding the granaries with such information as is available concerning them in the papyri.<sup>14</sup>

The classic reference, cited by Wilcken,<sup>15</sup> Luckhard,<sup>16</sup> and Calderini,<sup>17</sup> is a papyrus in the British Museum, *PLond.* 2.216 = W192. This papyrus comes from the Fayum, probably from Soknopaiou Nesos, and is dated 94 A.D., placing it at the beginning of the period we are considering. The document is a contract for the sub-lease of a granary which is described in the following terms: *θησαυρὸν ἐνεργὸν στεγνὸν καὶ τεθυρομένην, ἐν ᾧ πύργος καὶ αἰλὴ καὶ ταμῖ[α] πέντε καὶ νομβάσι καὶ σιροῖς καὶ τοῖς λοιποῖς χρηστηρίοις.* This description fits almost perfectly a granary such as the southern half of C123.<sup>18</sup> As described above this unit of C123 is a roofed granary with doors; it has a courtyard, with a small room to the right of the entrance, which is probably to be designated as a *πυλῶν*, or gate-building, rather than a *πύργος*. The five store-rooms, *ταμεία*, are probably

<sup>13</sup> B. P. Grenfell, A. S. Hunt, and D. G. Hogarth, *Fayūm Towns and their Papyri* (London 1900) 40, 44.

<sup>14</sup> In general only those papyri are cited here which were published subsequently to Calderini's study of the granaries (above, note 1).

<sup>15</sup> U. Wilcken, *Griechische Ostraka* (Leipzig and Berlin 1899) 1.651.

<sup>16</sup> Luckhard (above, note 9) 83.

<sup>17</sup> Calderini (above, note 1) 42.

<sup>18</sup> See above, pp. 59 f.

the vaulted chambers, and the *σιροί* are the pits, or underground vaults, for storing grain. The word *νουβάσι* remains unexplained. It occurs again in *P Vat.* 11 in the form *νουβω*, where certain property is described as "a court, house, and noubis." Johnson suggests that it may be some appurtenance for storage.<sup>19</sup>

The term *πύργος* may well refer to such a structure as the dove-cote which stands on one side of the entrance court of C65, which is certainly tower-like in form. And in C132 there is evidence of towers on each of the four corners of the granary.

In this lease the lessor undertakes to make necessary repairs and reconstruction, while the lessee agrees to do the plastering and to take care of the grain that is brought in. The lessee agrees also to furnish to the lessor a store-room in the granary without rent or tax, and to return the granary clean and with doors and windows intact at the expiration of the lease.

The petition, *PMich.* 5.226 (37 A.D.), from Tebtunis, also concerns the lease of a granary. This granary belonged to the temple of Sobk (Souchos) and had been leased to a woman who is designated as the *θησαυροφύλαξ*, and to her son and his wife. After the woman's death the priests repossessed the granary and found it in such condition that it could no longer be used for storing the grain to be paid as tax to the state. Specifically the doors had been carried off and the plaster had not been repaired.

The importance of plastering in the bins for grain storage is apparent when we consider that the wheat paid as tax must be clean and free from dirt, and that a charge was made for winnowing unclean wheat delivered at the granaries.<sup>20</sup> Plastering the bins would prevent chips and fragments of the mud brick walls from being intermixed with the grain. The storage rooms and bins in the granaries at Karanis are always plastered, commonly with a yellowish mud plaster, but sometimes in the enclosed rooms, as in C123, with plaster that has been given a coating of black wash.

The excavations have also given us some idea of the equipment that might have been included with the granary when it was leased.

<sup>19</sup> A. C. Johnson, *Roman Egypt* (Baltimore 1936) 270. The referee to whom this paper was submitted has called my attention to another possible occurrence of this word in *PLugdBat.* V (P. Brux. Inv. E7616) xii, 10, where it has the form *νουβ*. No light is thrown, however, on its interpretation.

<sup>20</sup> Johnson (above, note 19) 566. Cf. the term *ἀβολος* (*ἀβωλος*) applied to grain frequently in the papyri, Preisigke, *Wörterbuch*, s.v.

From the frequency with which mill-stones and mill-stone bases are found in the courtyards of the granaries, it is certain that mills were one of the appurtenances that one would expect to lease along with the granary. Ovens almost always are an adjunct to the granary courtyard, and we know that bakeries were frequently operated in connection with granaries.<sup>21</sup>

The papyri contain frequent references to *ταμεία*, and the word generally refers either to a store-room or to a storage bin in a room or court.<sup>22</sup> Bins made by building a wall across the corner of a room are found in almost every house in Karanis, as well as in the courtyards.

Among the fourteen Berlin papyri published by Zilliacus,<sup>23</sup> No. 4 contains court proceedings before the Praeses of the Thebaid in the fourth century. The plaintiff [θησα]υρῶ, μάλλον δὲ ἐν οἰκίσκῳ μικρῶ τοῦ θησαυροῦ εἶρχθη, which suggests that he may have been imprisoned in one of the storage rooms of the granary that was provided with a door that could be locked. No remains of doors or locks have been found in connection with the granary store-rooms at Karanis, but they were probably often so equipped.

Aside from the details of the construction of the granaries, the number and extent of those found at Karanis present an interesting problem. It cannot be said with certainty that any of those disclosed by the excavations is to be identified with the *θησαυρὸς τῆς κώμης*. Unfortunately few documents have been found in the granaries themselves and none that throw any light on this subject. For the late first and early second century C123 might because of its size be supposed to have been the state granary, but this particular building did contain many documents that must certainly be connected with it, and none of them suggests any official status. Two families or groups are represented by a sufficient number of papyri to justify the assumption that they were resident in the building. Although much work remains to be done on the documents, many of which are in too fragmentary a condition to permit of easy interpretation, it appears that one group of occupants was

<sup>21</sup> Three piles of bread were found in a room of a building adjacent to the granary B173, but it is uncertain whether the two had any connection. *BGU* 4.1067 and *PBacch.* 13 illustrate the connection between bakeries and granaries.

<sup>22</sup> Calderini (above, note 1) 18–22. Cf. also *PMich.* 5.295 and 298.

<sup>23</sup> H. Zilliacus, *Vierzehn Berliner griechische Papyri* (Helsingfors 1941). *Societas Scientiae Fennica, Commentationes Humanarum Litterarum* 11.4.

engaged in extensive farming of public lands. The other, possibly somewhat later in time, was the family of Gaius Julius Apollinarius, who is represented by many letters published in *PMich.* VIII. From the location in which many of these papyri were found, it is possible that it was the family of Apollinarius that took over as living quarters several of the storage rooms on the first floor of the granary, cutting doors through the northern wall to give access to the courtyard and to the open bins to the north. From the documents it is clear that Apollinarius and his family were land-owners and carried on extensive farming operations. In *P. Mich. Inv.* 5883 (119 A.D.) Apollinarius is described as στρατιώτ(ης) λε(γεώνος) ἡ Κυρ(ηναικῆς), and also as φρουμεντάριος Ἐρώμης. It is tempting in view of his obvious connection with both the army and a large granary to interpret the title of *frumentarius* not in the usual sense of γραμματηφόρος,<sup>24</sup> but in what was probably its original meaning; that is, as a person charged with the provisioning of the army with grain. This interpretation of the office is justified by only one damaged inscription (*CIL* 6.3340). In this inscription the title reads *frumentarius [in] legionem .II. Itali[cam ad] frumentarias [res curandas]*. It seems hardly likely, however, that, if Apollinarius were purveyor to the legion, his title would be given as *frumentarius Romae* instead of *frumentarius in legionem III. Cyrenaicam*. Moreover, there is no indication from the papyrus sources that there was any separate granary or storage for the grain for army use.<sup>25</sup> Grain destined for the *annona militaris* was received by the *sitologi* and deposited in the state granaries, and probably its distinction from the grain designated for transport to Rome was simply a matter of record and accounting.

It is interesting that the largest of the granaries, C65, was situated directly across the street from the large building which, from the papyri found in it and from its extent and structure, can be reasonably identified as military barracks and headquarters of the detachment of legionaries or auxiliaries stationed at Karanis. It seems probable, however, in view of the papyrus evidence, that this great granary was not a military store-house, but that it was, from the late second through the third century, the *θησαυρὸς τῆς κώμης* of Karanis. It is not surprising that the garrison should be

<sup>24</sup> See *PMich.* 8.472.16 and note.

<sup>25</sup> See J. Lesquier, *L'armée romaine d'Égypte d'Auguste à Dioclétien* (Cairo 1918) 350-68.

stationed near it, since it was one of the functions of the occupying legions to provide security for the collection and safe transport of government grain to Alexandria for its ultimate destination, Rome.<sup>26</sup>

Since there is no reference in the papyri to more than one *θησαυρὸς τῆς κώμης*, the other granaries of almost comparable size must have served some other purpose than the storage of tax grain; although it is possible that the term *θησαυρὸς τῆς κώμης* was used to designate an administrative unit, but that for actual storage several granaries in various parts of the village might have been needed.

There are also many private granaries attested in the papyri, the evidence for which has been collected by Calderini.<sup>27</sup> How extensive these private granaries may have been is not evident from the papyri. Nor can we tell whether they were operated chiefly for the storage of private supplies of grain, or in connection with commercial dealings in that commodity. Grain merchants are mentioned in several papyri,<sup>28</sup> but we do not know for what purpose they purchased grain. *PMich.* 2.127, I, 15 mentions *σιτοκαπήλους ἐν τοῖς θησαυροῖς*.

Granaries in connection with the temples are also well known,<sup>29</sup> and it is interesting that series of storage bins were found as adjuncts to both the temples excavated at Karanis. They were used not only for storage of the grain needed for the subsistence of the priests and their families and for the payment of taxes, but they were also leased to private persons and in this way they brought revenue to the temples.

The imperial and other large estates in Egypt also had their own granaries.<sup>30</sup> Whether these granaries were as a rule on the estate or in the villages is not certain, although in *BGU* 7.1646 it is specifically stated that the granary of the Vespasian estate was *περὶ τὴν . . . κώμην*, and therefore not actually in Tebtunis. This does

<sup>26</sup> Wilcken, *Grundzüge*, 395, 413 and Johnson (above, note 19) 491, 670.

<sup>27</sup> Calderini (above, note 1) 41–5. See also *PMich.* 2.121 Recto, III, xiii, 1, and IV, ii, 1, *PMich.* 6.396, and *PPrinc.* 3.117.

<sup>28</sup> Johnson (above, note 19) 346–7.

<sup>29</sup> W. Otto, *Priester und Tempel im hellenistischen Ägypten* (Leipzig und Berlin 1905–8) 2.123–8, and Calderini (above, note 1) 45, 111.

<sup>30</sup> A granary of the *οδοῖα* of Livia Augusta occurs in *PSI* 9.1028, and the unpublished papyrus from Tebtunis, P. Mich. Inv. 735 mentions a granary of Julia Augusta . . . and the children of Germanicus. A granary on the Vespasian estate is leased in *BGU* 7.1646.

not preclude the possibility that the granary might be located in the village if the estate land was scattered and the village provided a convenient central location.

Large granaries may also have been built for the members of another group, the *δημόσιοι γεωργοί*.<sup>31</sup> These state farmers formed associations with elders and secretaries who were empowered to act for them, to lease lands and to issue receipts for the delivery of grain. From the grain collected the rentals were paid to the state, but the granaries were probably also used to store the remaining produce for the members of the association.<sup>32</sup>

There are a number of interesting problems in the construction of the granaries themselves. The vaulted storage rooms seem designed in a way that is wasteful of space, since the large area above the dividing walls of the individual bins could not be used for storage. The method of construction employed was, however, necessary where a second or third story of the building was to be devoted to bins for grain. The usual ceiling construction in the Graeco-Roman house in Egypt consisted of beams placed across from side wall to side wall, covered with woven mats, and then plastered with mud or sealed with a layer of mud bricks.<sup>33</sup> A ceiling so made would not be sufficiently strong to support the weight of hundreds of artabas of grain stored in another series of bins above it. The vaulted construction provided the strength required to carry the second story of storage vaults. Since the individual bins must be accessible, the height of the vault would have to be sufficient to allow men to walk along the dividing walls. Because the vaults were enclosed, ventilation would be essential to prevent spoilage of the grain. Stored grain to remain in good condition must be kept cool and dry. The air space in the storage chambers, the windows at the top of the vault, and the black wash frequently applied to the plastered walls may all have been intended to provide the conditions requisite for good grain storage.

In the climate of Egypt, where rainfall was not a consideration, open storage of grain was also satisfactory. This type of storage is exemplified in the northern half of C123. Here open bins are

<sup>31</sup> Johnson (above, note 19) 393. Cf. also the ordinance of the association of tenants on imperial estates, *PMich.* 5.244.

<sup>32</sup> In view of the connection of a number of *δημόσιοι γεωργοί* with C123, it is not impossible that it may have been built for the use of such an association of farmers of state lands.

<sup>33</sup> Boak and Peterson (above, note 2) 26-7.



flanked by bins covered only by low vaulted ceilings. These vaults were open toward the central area, and they formed a sort of wall around the open bins.

These two types of granary were probably designed to meet different needs. The individual vaults could be leased for private storage, and they could be locked and sealed as a protection against theft.<sup>34</sup> If grain was to be stored over a long period of time, the enclosed vault would probably preserve it in better condition, and would protect it from contamination. *PUPPs*. 2 R, I (157/8 A.D.) from Theadelphia, records payments made to the guild of transport animal owners for moving the crops of grain of the years 152/3 to 155/6 A.D. It is not certain whether this indicates that grain that had remained in the granaries over a period of six years was now being shipped to Rome, but, if so, it is clear that the granaries were prepared to store grain for long periods of time, and moreover that the crops of the different years were separately stored.

On the other hand, when the grain was only stored briefly in private granaries before being transferred to the state granary, or in the state granary while awaiting shipment to Alexandria, the open bins would be adequate. This would be true also of grain that was to be sold or to be used in bakeries.

Another problem presented by the granaries is the purpose of the infinite number of small bins. Separate bins would be required for the separate crops stored in the granaries, wheat, barley, aracus, orobus, beans, lentils, cneus, and other commodities.<sup>35</sup> They must also have been designed to provide separate storage space for grain belonging to individuals.

The two kinds of storage suggest also a possible explanation for the two types of large wooden stamps that have been found at Karanis and elsewhere.<sup>36</sup> These stamps are sometimes cut, as are ordinary seals, with the letters reversed, so that when the impression is made, the writing can be read in the normal way. Some of them, however, have names or letters so carved that, if they were

<sup>34</sup> Calderini (above, note 1) 86-88.

<sup>35</sup> Johnson (above, note 19) 505-6.

<sup>36</sup> Grenfell, Hunt, and Hogarth (above, note 13) plate XVI shows two such stamps from Umm el 'Atl. See also Zaki Aly, "Sitolgia in Roman Egypt," *Journal of Juristic Papyrology* 5 (1950) 295-6 and plates 4 and 6. His explanation of the use of these stamps makes no distinction between those which are cut in reverse and those which are not.

used to make an impression, the writing on the sealing would be in reverse. It is possible that the former type was used to impress the owner's name in mud or clay used to seal the doors of the storage rooms in the granaries, while the latter were simply placed on the piles of grain in the open bins to indicate the owner.

There are a great many questions that arise in connection with the operation and use of the granaries that cannot well be taken up within the limitations of this paper, but that open up interesting avenues of speculation. For example it might be possible to make an estimate of the amount of grain that could be stored in the extant granaries. According to the calculations in the Achmîm mathematical papyrus,<sup>37</sup> a cubic ell would contain three and three-eighths artabas of grain. Since a cubic ell is approximately one-tenth of a cubic meter, an average bin, measuring a meter on each side and a meter in depth, would hold between thirty-three and thirty-four artabas. Since there is a great diversity in the size and shape of the bins, the capacity probably varied from twenty-five to fifty artabas. But even if we were able to make an accurate computation of the amount of grain that could be stored in all the granaries that have been preserved, we could still make no reasonable estimate of the total amount that could be accommodated at Karanis, because of the complete destruction of so large a part of the village. All we can say with certainty is that provision was made for the storage of large amounts of grain in granaries that occupied a considerable proportion of the town's total area.

<sup>37</sup> See above, note 8.