URBAN AND RURAL LAND DIVISION IN ANCIENT GREECE

THE RESTLESS ENERGY of Greek civilization led for some five hundred years to the constant founding of new communities and the reorganization of old ones. Homer (*Odyssey* 6.9–10), in describing the Phaiakian settlement in Scheria, speaks of a circuit wall for the city, the building of houses and of temples of the gods and of the division of the fields. Implicit in the foundation of new colonies was the notion of equality among the members, exemplified in the division of their prime resource, the land.[1] To achieve this, accurate measurement and equitable division were from the outset essential, even when gods or privileged men were to be honored with larger or better assignments. Land division involved both town and country, as the epigraphical record shows for Kerkyra Melaina in the 4th century B.C., where colonists received plots both inside and outside the walled area.[2] No doubt also the *geonomoi*, dispatched with Athenian colonists, assigned *kleroi* in both town and country.[3] The redistribution both of land and of houses were revolutionary measures in settled communities, and the oaths formulated against this likewise reflect division of urban and agrarian land.[4] So Meton in Aristophanes, *Birds*, 995–996, wishes "to survey the sky and divide it up in fields" but goes on to plan a city, such a city, to be sure, as no Greek city ever resembled.

When it comes to the archaeological record the regular division of urban land for houses is conspicuous but in the Greek world only exceptionally does the countryside reveal its patterns. Nonetheless the link between the two is fundamental, and for both the same techniques of surveying and geometry ("land measurement", cf. Aristophanes, *Clouds*, 202–204) would have been used. Some of the directions in which research needs to be undertaken for understanding the relationship of town and country planning were pointed out over ten years ago by Roland Martin.[5] Our study of the town plan of Halieis has provided us with the opportunity to pursue a number of these problems.

The historical circumstances of the planning of Halieis are obscure. The site had been inhabited as early as the 7th century, and a sanctuary of Apollo was in use a short distance away along the shore of the harbor.[6] The acropolis of Halieis, which had been

[1] Cf. A. J. Graham, *Colony and Mother City*, Manchester 1964, p. 59; David Asheri, *Distribuzioni di terra nell'antica Grecia (Memorie dell'Accademia delle Scienze di Torino* IV, 10, 1966), pp. 13–15.

[2] *SIG*^{3}, 141; improvements in the text have been incorporated by F. G. Maier, *Griechische Mauerbauinschriften*, Heidelberg 1959, I, no. 57.

[3] R. Meiggs and D. Lewis, *A Selection of Greek Historical Inscriptions*, Oxford 1969, no. 49, lines 6–8; cf. Hesychios *s.v.* and Phrynichos, *Praep. Soph.* 57 (De Borries).

[4] Cf. Demosthenes, 24.149; *SIG*^{3}, 526, lines 21–23 (*ICr* III, iv, 8), Ithanos, 3rd century B.C.

[5] Roland Martin, "Rapports entre les structures urbaines et les modes de division et d'exploitation du territoire," *Problèmes de la terre en Grèce ancienne* (*Civilisations et Sociétés* 33), Paris 1973, pp. 97–112.

[6] T. D. Boyd and W. W. Rudolph, "Excavations at Porto Cheli and Vicinity, Preliminary Report IV: The Lower Town of Halieis, 1970–1977," *Hesperia* 47, 1978, p. 335; M. H. Jameson, Δελτ 29, 1973–1974, B′ 2 [1979], pp. 261–264, and *Scientific American* 234, 1976, pp. 76–87.

fortified at least fifty years earlier, suffered destruction *ca.* 590–580 B.C. with much Lakonian pottery in the debris. Votive objects attest the renewed use of the acropolis after *ca.* 580 although no fortifications have been associated with this period.[7] Outside the city the sanctuary of Apollo, with two temples, continued in use in the 6th century. Within the city an orthogonally planned settlement of the 6th century indicates either a recovery after the attack on the acropolis early in the century and a carefully planned rebuilding of the lower town or colonization by successful attackers. Historical considerations, however, weigh against the latter possibility.

The quantity and character of the Lakonian pottery on the acropolis suggest the presence of a Spartan garrison or that the local people maintained close ties with Sparta. In the second half of the 6th century Sparta was dominant in the Peloponnesos, especially in this region after success in the so-called Battle of Champions, *ca.* 545.[8] It is improbable in the highest degree that those who attacked the Spartan or Spartan-supported garrison in *ca.* 590–580 would have been permitted to settle and build a town in the ensuing decades. The alternative is that the destruction at Halieis was only a temporary setback for the Spartans, most likely in their struggle with Argos early in the century, followed by a deliberate, organized rebuilding of the town, which may also have been damaged, once Spartan dominance was securely re-established. Was the new town inhabited solely by the previous inhabitants or were they augmented by or even replaced by new settlers under Spartan mandate?

It is known that by the time of Herodotos the town could be referred to as Ἁλιέας τοὺς ἐκ Τίρυνθος (7.137). It has been argued elsewhere that the independent existence of old Tiryns continued until sometime after the Persian Wars.[9] It has also been observed that no example of the Argive alphabet used by the Tirynthians has been found at Halieis until well into the 5th century. Thus the temptation to see the execution of a town plan as marking the settlement of the Tirythians in the 6th century, presumably with Spartan support, must be resisted. It remains possible that the emigration of victims of Argive expansion to the southern Argolid occurred more than once and that they contributed to the population of Archaic Halieis even if their presence cannot yet be confirmed. It is equally possible that other Spartan dependents had a role in the new town.

The details of the plan of Halieis have been presented elsewhere,[10] but a summary is in order here before proceeding further. Below the unplanned upper reaches of the city are two zones of insulae, of unequal extent and of different orientation. Each zone consists of eight parallel streets, equally spaced, and a smaller number of crossing ave-

[7]Jameson, "Excavations at Porto Cheli and Vicinity, Preliminary Report, I: Halieis 1962–1968," *Hesperia* 38, 1969, p. 319. The chronology and interpretations in the text above incorporate conclusions to be published in *Halieis* I, M. H. Jameson and C. K. Williams, II, edd.

[8]For the most recent discussion see P. Cartledge, *Sparta and Lakonia, A Regional History 1300–362 B.C.*, London 1979, chap. 9, esp. p. 140.

[9]Jameson in ΦΟΡΟΣ. *Tribute to Benjamin D. Meritt*, Locust Valley, New York 1974, pp. 69–73, and N. Verdelis, M. H. Jameson and I. Papachristodoulou, Ἀρχ Ἐφ, 1975, pp. 190–192.

[10]Boyd and Rudolph, *op. cit.* (footnote 6 above), pp. 338–343.

nues (Fig. 1; cf. Fig. 2). The larger, eastern zone consists, in large part, of a great square, bounded clearly by Street 1 on its southeast side, by Avenue B on its northeast side and by Street 8 on its northwest side. The fourth side, on the southwest, is less well defined, but is to be sought in the vicinity of the rocky escarpment at about the 20-meter contour. The length of the side of this square is 221 m., the distance measured from the center of Street 1 to that of Street 8.

The western zone of insulae is less well understood, but probably occupies an area half that of the eastern zone. Its definition is less certain, and, at least in part, is less regular in outline. This group of insulae is seen to form a rectangle, the northeastern side of which is marked by the slightly irregular course of Avenue I, and the northwestern side by Street a. The remaining two sides are to be sought in Street h and Avenue II, but since neither has been located through excavation, they remain hypothetical elements in the plan of the city. Both the regular and therefore predictable character of orthogonal planning and the practical considerations observed in the specific case of Halieis make the existence of these two elements seem almost a certainty.

Comparisons with the rectilinear elements in the orthogonal plan of Halieis have been sought in other planned sites, through which it has become evident that Halieis is, in some respects, unique. The layout of Megara Hyblaia in Sicily, probably early Archaic in date, consists of two zones of insulae with differing orientation.[11] There, the two zones do not appear to represent larger, clearly defined rectilinear units of land as appears to be the case at Halieis. With rare exception the city plans of the Greek world consist of a division of urban land into strips, and this is true of Megara Hyblaia too. While strips of insulae are evident at Halieis, they are subordinate to a larger division of land, the 221 m. square in the eastern part of the city and the rectangle approximately half that size in the west.

A system of land division in the countryside of Tauric Chersonesos has been found to offer an intriguing comparison with aspects of the layout of Halieis. There, large rectilinear patterns of ancient field boundaries have been mapped through many years of excavation and study.[12] The major unit of land seems to take the form of a rectangle 630 by 420 m. and divided into a series of six equal squares, 210 m. on a side. In an epigraphical study, François Salviat and Claude Vatin demonstrated that these 210 m. squares in all probability represent an area of 50 *plethra*.[13] A linear plethron is 100

[11]G. Vallet, F. Villard and P. Auberson, *Mégara Hyblaia*, I, *Le quartier de l'agora archaïque* (École Française de Rome), [Rome] 1976, plan 1.

[12]The farms of Chersonesos in the Crimea can be studied conveniently in Jan Pečírka, "Country Estates of the Polis of Chersonesos," *Ricerche storiche e economiche in memoria di Corrado Barbagallo*, Naples 1970, pp. 459–477; Marie Dufkova and Jan Pečírka, "Excavations of Farms and Farmhouses in the Chora of Chersonesos in the Crimea," *Eirene* 8, 1970, pp. 123–174; Pečírka, "Homestead Farms in Classical and Hellenistic Hellas," *Problèmes de la terre en Grèce ancienne* (*Civilisations et Sociétés* 33), Paris 1973, pp. 140–147; Aleksandra Wasowicz, "Traces de lotissements anciens en Crimée," *Mélanges de l'École Française de Rome* 84, 1972, pp. 199–229.

[13]F. Salviat and C. Vatin, "Le cadastre de Larissa," *BCH* 87, 1974, pp. 247–262, esp. pp. 257–259. The text which alerted the authors to the importance of the 50-plethra unit has now been published in full

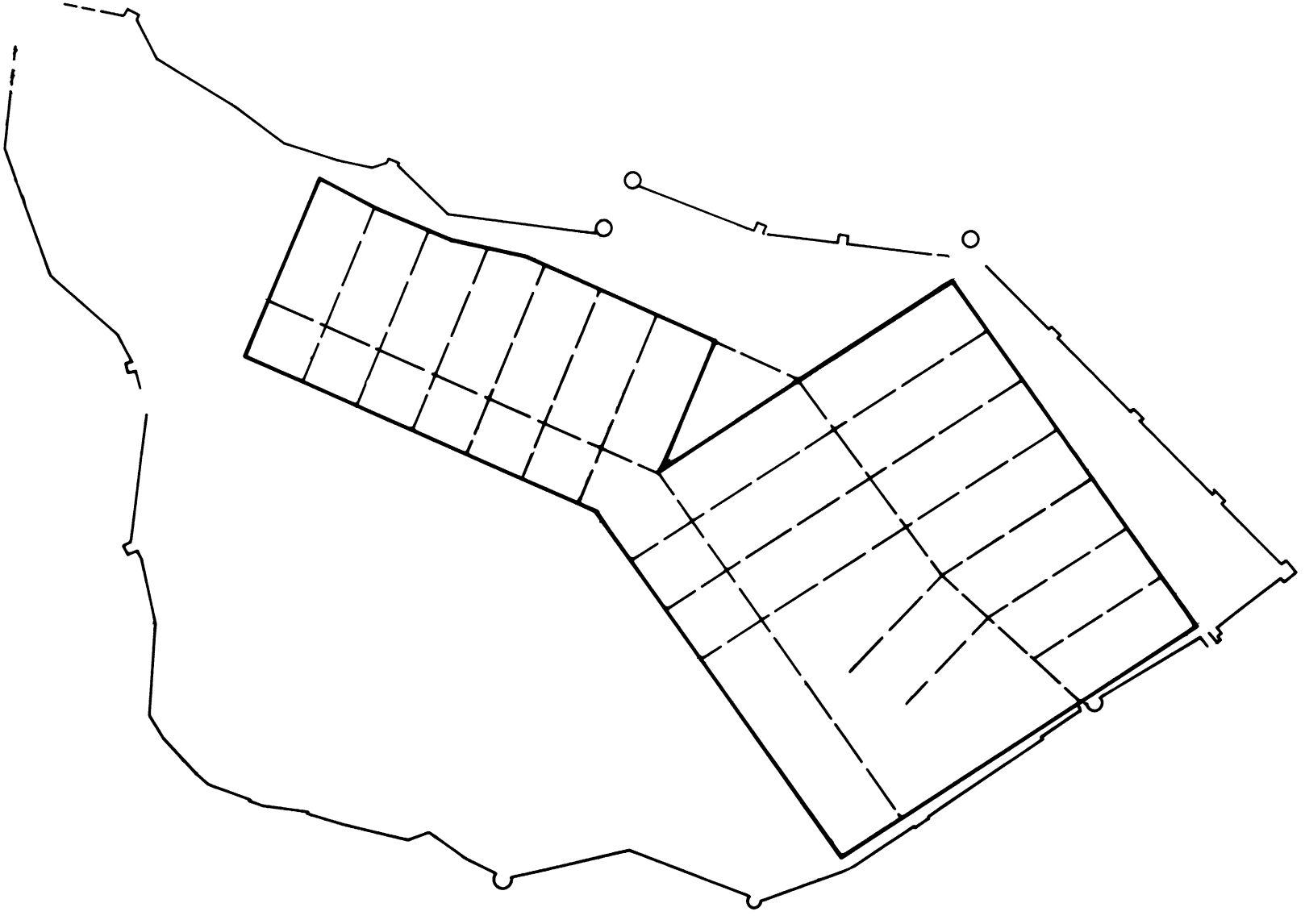

FIG. 1. Schematized reconstruction of the plan of Halieis, presumably reflecting the layout of the 6th century B.C. Cf. Figure 2

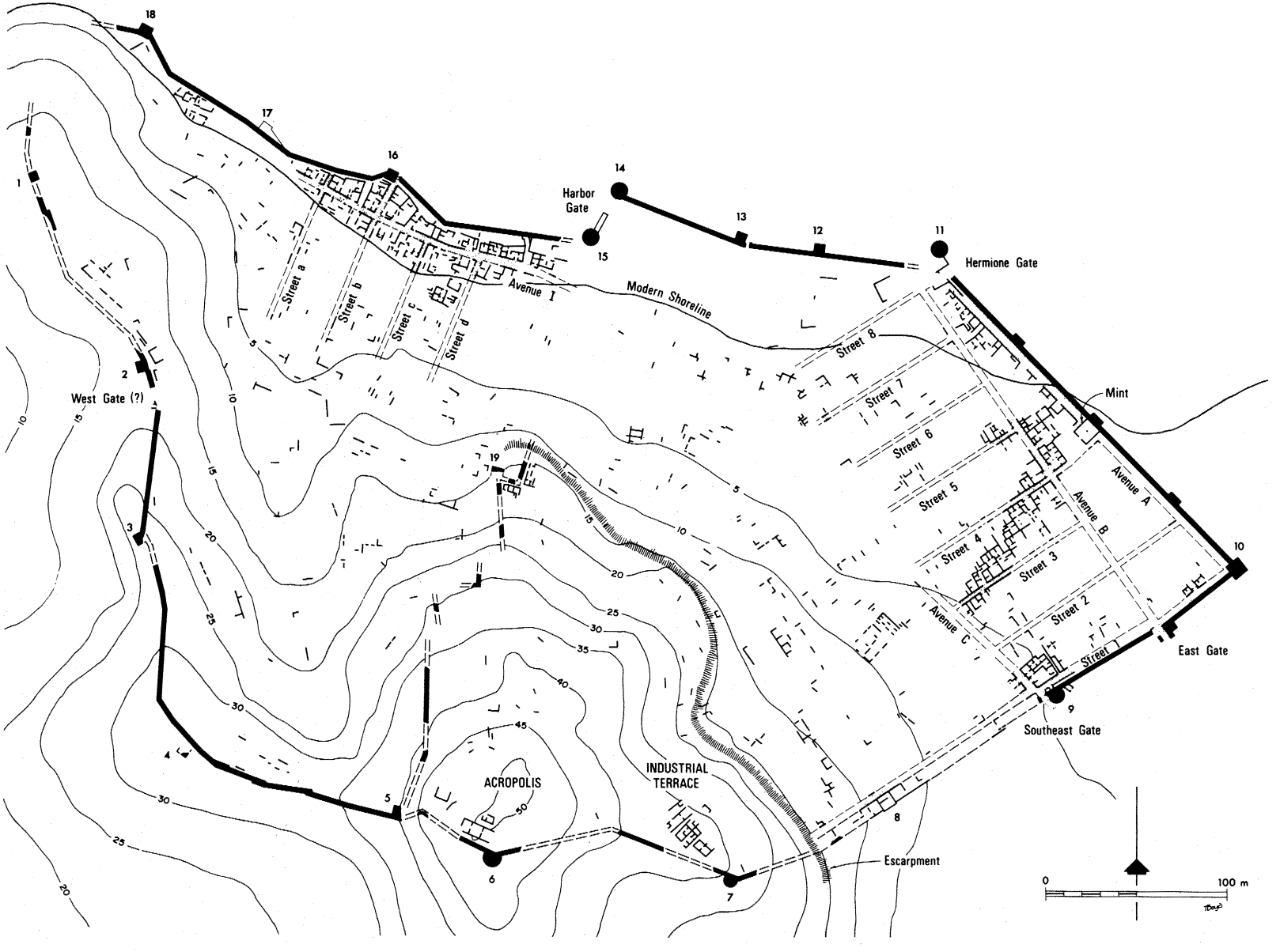

FIG. 2. Topographic plan of Ancient Halieis

feet in length; an areal plethron, therefore, is 10,000 square feet in area, and so a 50-plethra square must occupy 500,000 square feet. Salviat and Vatin derived an area of 50 plethra from the 210 m. squares by assuming a foot of 0.297 m. The derivation is simple: 210 m. ÷ 500,000 = 0.297 m. The length of the side of this square is 707 feet, and its diagonal is 1000 feet.

The large square seen in the eastern zone of insulae at Halieis, as reported above, measures 221 m. on a side and so approximates the size of the 210 m. squares in the Chersonesos. Obviously, if this 221 m. square also represents an area of 50 plethra, as we postulate, the foot utilized in its layout will have been greater than 0.297 m. The foot will be derived in the same fashion: 221 m. ÷ 500,000 = 0.313 m. It has become traditional to refer to a foot of 0.295–0.297 m. as the Attic or Ionic foot and one of 0.326–0.328 m. as the Doric foot. An investigation of units of length in the Greek world makes it clear that these were by no means universal standards. Examples exist elsewhere in the Greek world where a foot neither 0.255–0.297 m. nor 0.326–0.328 m. in length was used. On Aigina a foot of 0.313 m. may have been used in the late Archaic Temple of Apollo, and at Bassai the foot used in the 5th-century Temple of Apollo appears to have been 0.334 m. in length.[14] If a foot of *ca.* 0.313 m. were, in fact, used in the layout of the orthogonal plan of Halieis, then recognition of a major square of 50 plethra seems reasonable. The sides of this square have what seems at first sight an inconvenient measurement at 707 feet, but it is important to bear in mind that there are eight streets bounding seven insulae in both zones of the plan of Halieis. The only possible subdivision of 707 feet in which fractions are avoided is sevenths. We find this observation a compelling argument in support of the hypothesis that at Halieis the plan is based on 50-plethra squares with their corresponding 707-foot sides. The result is a series of insulae spaced at 101-foot intervals, in which the width of the intervening streets is included. There are anomalies in the layout of the eastern zone, as an examination of the plan will show, departures from a strictly orthogonal scheme. If we assume that a major square was laid out first, and subsequently divided into insulae, then perhaps the peculiarities in the system of streets and avenues in this zone are better understood.

In the western zone, again comprising seven insulae in an east-west direction, but of a considerably smaller dimension in the other direction, we recognize a rectangular subdivision of a 50-plethra square. Salviat and Vatin pointed out the tendency to divide the large squares in the Chersonesos into rectangular strips rather than a process of

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by Christian Habicht: "Eine hellenistische Urkunde aus Larisa," in V. Milojčić and D. Theocharis, *Demetrias* I (*Die deutschen archäologischen Forschungen in Thessalien*), Bonn 1976, pp. 157–173.

[14]The length of the stylobate of the Temple of Apollo on Aigina is reported as 31.38 m.; W. W. Wurster, *Alt-Ägina* I, i: *Der Apollontempel*, Mainz 1974, p. 117. A foot *ca.* 0.314 m. results if the temple is considered a hundred footer. The problem of corner contraction, however, makes extraction of the foot unit difficult if it is derived directly from the length of the stylobate. At Bassai the foot length is based on repeated modules in the individual blocks of the superstructure and not on the stylobate. For an Aitolian foot of 0.3125 m. see K. Rhomaios, Δελτ 10, 1926 [1929], p. 33. Thanks are due M. B. Wallace for pointing out helpful references here, and for productive discussions of ancient metrology in general.

quartering in order to maintain a system of planning based solely on squares.[15] We suspect, but cannot prove, that at Halieis the western rectangular zone of insulae represents a strip of 25 plethra, one half the area of the eastern zone.

The concept of major squares, subsequently divided into insulae, is not unique to Halieis among urban plans. A comparable system has already been recognized in the layout of Rhodes, founded in 408/7 B.C.[16] That system was seen to consist of major squares measuring 600 feet, or one stade, on a side. These are divided first into quarters, and each quarter is then subdivided into six equal insulae measuring 100 by 150 feet. The street plan of Rhodes, according to the limited available evidence, adheres more rigidly to the spirit of orthogonal planning than does that of Halieis.

The practical aspects of land surveying must be considered in the context of urban planning. There is no evidence to indicate that the layout of planned Greek cities was based on any widely known theories of planning before the career of Hippodamos of Miletos in the 5th century B.C. The plans of the cities themselves show that planning schemes were simple, needing no more skill to execute than that possessed by surveyors, whose primary occupation otherwise would have been dividing and measuring land and establishing boundaries. In colonies sent out from the 8th century onwards their presence is attested in the form of the planned cities themselves. The layout of any orthogonally planned city was, in our view, most probably conceived as a whole, and we would not suppose that a surveyor laid his city out block by block; instead, he would determine the main lines of the plan first, working with larger land units before eventually subdividing into smaller units. Such a procedure is appropriate whether the city was to be characterized by strip planning or the less common planning by major squares.

There is a controlling factor in every instance of an orthogonal plan, of course, and this is the size of the individual houses to be contained within the insulae. Whatever approach is used for establishing the main lines of an urban plan, strips or squares, the resulting insulae must accommodate the houses. Greek houses in planned cities tend to be square, or nearly so, measuring about 50 or 60 feet on a side. Thus, cities characterized by strip planning most often have insulae measuring 100 or 120 feet in width. In the case of Halieis, the major square, 707 feet on a side, reduces conveniently to units 101 feet in width, comprising both street and insulae, quite suitable for houses on the order of 50 feet square.

This, then, is the character of the city plan of Halieis and the mathematical basis for its layout. The use of the 50-plethra square at Halieis raises a number of fundamental questions to which only tentative answers can be attempted at this stage, *viz.*, (1) what are the implications for the state of practical and theoretical geometry in Greece in the 6th century B.C.? (2) Are there other examples of this unit of land division or of

[15] *Op. cit.* (footnote 13 above), p. 259.

[16] I. Kondis, "Zum antiken Stadtbauplan von Rhodos," *AthMitt* 73, 1958, pp. 148–149; R. E. Wycherley, "The City of Rhodes," *Journal of the Royal Institute of British Architects* 71, no. 2, 1964, pp. 71–73.

agrarian land division in general being used as the basis of town layouts? (3) Where does the plan of Halieis belong in the history of Greek urbanism?

1. Salviat and Vatin demonstrated the prevalence of a 50-plethra unit of agricultural land in the Tauric Chersonesos and at Larissa in Thessaly. In the former the unit was certainly square and this seems very likely to have been the case in Thessaly as well, to the extent that topography permitted. The land-division scheme in the Chersonesos seems to go back to the 4th century B.C.; at Larissa our information comes from the early 2nd century B.C., although clearly the considerable modifications which had occurred in what was at one point a more uniform division of land required some lapse of time. Neither example, however, takes us back to the Archaic period, and as a result we face some difficulties in the case of Halieis.

The practical mathematics involved in laying out squares 500,000 square feet in area is that demonstrated in Plato's *Meno* (82B–85C), as Salviat and Vatin observed. When the side of one square is used as the diagonal of a second, the resulting square has an area half that of the first. A 50-plethra square might have its origins in a 100-plethra square (1,000,000 square feet) having sides of 1000 feet, a rational number, unlike the 707-foot sides of the 50-plethra square. If the sides of the 100-plethra square are used to define the length of the diagonal of another, this second square which we have observed in use is the result. This can also be described as an application of the theorem ascribed to Pythagoras which states that the square of the hypotenuse of a right-angled triangle is equal to the sum of the squares of the other two sides. Expressed arithmetically, where the sides have the value of 1, the diagonal has that of $\sqrt{2}$.

Early Greek mathematics showed considerable interest in the proof of the incommensurability of the diagonal with the sides (one or the other would have to be irrational) but in practical terms an approximation of the square root of 2 had been known to the Babylonians and later to the Egyptians.[17] The use, by the Egyptians, of the "double-remen" (the length of the diagonal of a square whose side was one cubit) for measuring land is thought to have been favored because it enabled areas to be halved without altering their shapes.[18] The use of 50- and 100-plethra squares would have offered the same advantage, despite the irrationality of the sides of the former. Since the Greeks believed that their geometry was learned from the Egyptians and, incorrectly, that all Egyptian land was divided into squares (Herodotos, 2.109), it is arguable that the use of squares in land division and the understanding of the relationship of the diagonal to the area, and hence the approximation of $\sqrt{2}$, came to the Greeks from Egypt before the development of theoretical explanations of the phenomena. Wilbur Knorr has suggested that Egypt may, in fact, have been a major channel for the com-

[17]O. Neugebauer, *The Exact Sciences in Antiquity*, 2nd ed., New York 1973, chap. II, esp. pp. 35–36. Wilbur Richard Knorr, *The Evolution of the Euclidean Elements. A Study of the Theory of Incommensurable Magnitudes and its Significance for Early Greek Geometry*, Dordrecht, Holland 1975, chap. II. G. E. R. Lloyd, *Early Greek Science: Thales to Aristotle*, New York 1970, pp. 32–34.

[18]R. J. Gillings, *Mathematics in the Time of the Pharaohs*, Cambridge, Mass. 1972, p. 208. We have to thank Wilbur Knorr for this and other references and for much valuable guidance on the subject of ancient geometry, but he does not share responsibility for the use to which we have put this information.

munication of Babylonian mathematical knowledge to the Greeks after Mesopotamian mathematics came to be known in Egypt in the course of the Persian occupation in the later 6th century B.C.[19] Knowledge of Egyptian practical methods, however, might have come to Greece still earlier once regular contacts were established in the 7th century B.C. or earlier. One is reminded of the workmen's village of the 14th century B.C. at Amarna consisting of six rectanglar blocks enclosed in a square.[20] Greek and Carian mercenaries were settled in *stratopeda* in Egypt in the late 7th century B.C. If their settlement involved assignment of agricultural land for their maintenance the Greeks would have gained practical experience of Egyptian land division.[21] Residence is a possible source for Greek knowledge of Egyptian practical mathematics and hence of squares in surveying. The Greek sense of a debt to Egypt seems to us justified, though it is unclear whether the knowledge shown in the Archaic plan of Halieis indicates awareness of Mesopotamian mathematics via Egypt or was purely empirical.

2. There is, perhaps, reason to think that the earliest Greek land measuring was primarily in the form of rectangles, just as centuriation in Italy seems to have been preceded by rectangular systems.[22] We have detected no squares in the earliest Greek plans, all in the West, though to be sure we will have occasion to comment on the obstacles in the way of recognizing larger units.[23] At Herakleia-Siris in south Italy the system by which the land was measured, as recorded in two Hellenistic texts but presumably reflecting divisions from early in the city's history, has as the basic unit a rectangle 100 by 120 feet. This is the areal *schoinos* (the linear schoinos was 120 feet; cf. the linear and areal plethron of 100, and 100 by 100 feet respectively). The largest unit was the areal *gyas* of 600,000 square feet (cf. 60 plethra), comprising 50 areal schoinoi.[24] In towns, the linear schoinos of 120 feet, as well as the 100-foot plethron, is common for the short side of long, rectangular insulae.[25] Small squares, which would

[19]In an unpublished paper presented at the History of Science Conference, Edinburgh, August, 1977.

[20]H. W. Fairman, "Town Planning in Pharaonic Egypt," *Town Planning Review* 20, 1949, pp. 44–46 and fig. 9, p. 45 (= F. Castagnoli, *Orthogonal Town Planning in Antiquity*, London and Cambridge, Mass. 1971, p. 59, fig. 23).

[21]A. B. Lloyd, *Herodotus, Book II, Introduction* (*Études préliminaires aux religions orientales dans l'empire romain* 43, 1), Leiden 1975, pp. 14–17. The possibility that agricultural land may have been assigned to the mercenaries is our suggestion. Lloyd also suggests, but without argument, that identical techniques were developed independently, *op. cit.*, pp. 52–53.

[22]F. T. Hinrichs, *Die Geschichte der gromatischen Institutionen*, Wiesbaden 1974, chap. II.

[23]We have not included in our investigations the field patterns reported at Metapontion, which have been discussed in connection with the field systems of Larissa and the Chersonesos by D. Adamesteanu and C. Vatin, "L'arrière pays de Metaponte," *CRAI*, 1976, pp. 119–122. (We are grateful to Professor Adamesteanu for providing us with a large-scale map of the area showing the phenomena.) We find the notion of six squares forming parallelograms of 297 plethra somewhat disturbing, and understand that there is now some doubt as to whether they do in fact represent field patterns.

[24]A. Uguzzoni and F. Ghinatti, *Le tavole greche di Eraclea* (*Università degli Studi di Padova*, *Pubblicazioni dell'Istituto di Storia Antica* VII), Rome 1968. The units of measurement are discussed by Ghinatti, pp. 181–182.

[25]For the frequent use of the 120-foot unit, cf. F. Castagnoli, "Ricente ricerche sull'urbanistica ippodamea," *ArchCl* 15, 1963, pp. 180–181, who uses the Latin term *actus* for this unit. (This and the use of *per strigas* to refer to the division of land into long, narrow rectangles may carry misleading implications,

pose no problems of measurement, e.g., of one, four, and nine plethra, have no more been detected in early towns than have large; they would have sacrificed more space to streets than did the predominant long rectangles. In the countryside they are too small to have figured in major schemes of land division, though many individual properties may have approximated their size and shape.[26] In the one case, at Kerkyra Melaina, where smaller plots are specified, a 1.50-plethra lot of 100 by 150 feet may have been the basic unit.[27]

Even where squares occur they are used side by side with rectangles. Thus, in the Crimea, individual squares are combined in the pattern of two by three to form large rectangles of 300 plethra (and more, with the addition of other irregular units of land), and individual squares are subdivided into rectangular strips. At Halieis, the square is presumably halved on the western side of the town to form a rectangle of 25 plethra and on both sides of town the insulae, the subdivisions of the larger areas, are in the form of rectangles, the least wasteful way, to be sure, of giving all houses direct access to streets.

The recorded sizes of agricultural properties may provide clues to their shapes. This, indeed, is what led Salviat and Vatin to their important observation of the probable existence of 50-plethra squares at Larissa, as well as their evident existence at Chersonesos. From such examples we may deduce the most common sizes of properties. In areas of old settlement no regularity in shape or size of landholdings can be expected.[28] When newly available land is being divided up and assigned, the customary and desirable size of holdings will predominate and, wherever possible, attempts at regular, geometric divisions may be expected, corresponding to the demonstrably egalitarian division of houseplots in new towns. The term *kleros*, in such contexts, carries the implication of "equal lot".

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and we prefer to keep to Greek or purely descriptive terms.) It should be noted that if one does not presuppose two widely used and precisely reproduced feet, the choice between a 100- or 120-foot measurement will not always be clear where there are no other, regular dimensions to confirm the length of the foot. E.g. Kamarina, where 35 m. may represent 100 feet of 0.35 m. or 120 feet of 0.292 m.: P. Pelagatti, "Camarina, Relazione preliminare della campagna di scavo 1961–62," *BdA*, 1962, pp. 259, 262. Among other probable examples, recently excavated, are Naxos, early 5th century B.C., Pelagatti, "L'attività della soprintendenza alle antichità della Sicilia orientale," *Kokalos* 22–23, 1976–77, II [1978], p. 537, where 39 m. would seem to represent 120 feet of 0.325 m.; Lokroi, Castagnoli, *op. cit.*, p. 191 and pl. LXVIII; and Paestum, G. Voza, *ArchCl* 15, 1963, pp. 223–232 and pls. LXXXVIII and XC.

Castagnoli (*op. cit.*, p. 193, note 57) suggests that the duodecimal system with the 120 foot unit was characteristic of Ionic areas, and the decimal (i.e., with the 100-foot plethron) of Doric areas. Against this may be the apparent absence of the 120-foot unit from Chersonesos, of ultimate Doric origin but in a predominantly Ionic region, and the presence of both 60-plethra and 25/50-plethra units in Thessaly (see below, p. 337).

[26]In a group of 11 properties on Crete, all but one in vines, five are described as *tetraplethriai*, and the other sizes are 2, 6 (arable), 10, 20, and 22 plethra: *IG* IX 1, 693; *SIG*^{3}, 940.

[27]In the foundation on that island by Issa, properties of 1.50, 3, and 4.50 plethra are mentioned: see footnote 2 above.

[28]In a list of properties at Abai in Phokis, the size of twelve can be read: 2, 3, 6, 12, 13, 30, 40, 90, 96, and 110 plethra, of which only the 13- and 30-plethra sizes are repeated (once each), *IG* IX 1, 87.

For Athens we have references to grants of land of 100 plethra,[29] and to properties of less than and more than 300 plethra (Plato, *Alcibiades* I, 123C; Lysias, 19.29) and once to one of 60 plethra (Isaios, 5.22). A property of 50 plethra in Macedonia is mentioned in a letter of Philip V (*SEG* XIII, 403), and at Pharsalos in the 3rd century B.C. grants of 60 plethra were made (*IG* IX 2, 234; Schwyzer, *Dialectorum graecarum exempla*, Leipzig 1923, 567). At Delphi, under Hadrian, there were grants of both 40 and 60 plethra.[30]

The texts from Larissa have now been published more fully (*SEG* XXVI, 672–676).[31] In A (*SEG* XXVI, 672), out of 40 properties of 10 plethra or larger, 27 are in multiples of 25 plethra (25, 50, 100, 150, 225, and 250; we include properties within 10% of these figures, but 19 are round numbers). Of the rest, four represent properties of 10 plethra, two of 20, one perhaps of 40 (37.9: cf. another of 132.7, and one of 161 which we have arbitrarily interpreted as 150) and perhaps one of 60. Properties in the 40–60-plethra range are believed to have been standard for the maintenance of citizen families in Classical Greece.[32] We might, therefore, expect to find 40, 50, and 60 plethra as common units. The predominance of 50 plethra, along with its subdivisions and multiples, is clear from Larissa. At Pharsalos and Hadrianic Delphi 40- and 60-plethra lots are standard. In Athens people thought in terms of 100 and 300 plethra, it seems, but the reference to 60 plethra is a reminder that 300 could be regarded as a multiple of 60 as well as of 50 or 100 plethra. So long as properties of 40 and 60 plethra were common, one would expect them to have been expressed, in new land-division schemes, by rectangles with rational sides. Squares of these sizes would have had both sides and the diagonal irrational. On the other hand, the 50-plethra unit fitted easily into a system of squares or rectangles (e.g., 25 plethra as half a 50-plethra square or a 500 by 500-foot square; 100 plethra as a square, or as a rectangle consisting of two 50-plethra squares). But despite the example of Chersonesos and perhaps of Larissa, the use of squares seems not to have had as prominent a place in Greek land division as it did in Roman. We are, however, only beginning to learn about colonial land use from regions where the social and topographic conditions were most amenable to large scale, geometric divisions.

In view of the limited use of squares in Greek land-division schemes, it may not be surprising that, to our knowledge, only one other occurrence of large squares has been recognized in Greek town planning, that for the city of Rhodes. It should be noted, however, that there are inherent obstacles in our recognition of the use of large squares.

[29] Demosthenes, 20.115; cf. Plutarch, *Aristides*, 27.2. That the source may be a forgery of the 4th century B.C. does not affect its value for our present purpose; cf. J. K. Davies, *Athenian Propertied Families*, Oxford 1971, p. 51.

[30] C. Vatin, "Ordres et classes dans les institutions Delphiques," *Recherches sur les structures sociales dans l'antiquité classique*, Paris 1970, pp. 261–262.

[31] Habicht (*op. cit.*, footnote 13 above), who rejects the view of Salviat and Vatin that these are fragments of a cadaster of all the land of Larissa (*BCH* 87, 1974, pp. 254–256) and suggests instead that they record land appropriated for the sanctuary of Zeus Eleutherios early in the 2nd century B.C.

[32] A. B. Cooper, "The Family Farm in Greece," *CJ* 73, 1977/78, pp. 168–170.

In few cities has excavation gone beyond the detection of a grid formed by sets of rectangular insulae. Rarely has a sufficient area been uncovered and measured accurately so as to determine the existence of a larger plan. Still less, of course, is understood of older cities without a grid which were continuously occupied and rebuilt piecemeal. (Users of standard works on ancient city planning should be warned that actual-state plans of cities may differ considerably from familiar reconstructed plans, often based on very little excavation.) Even for cities with a grid, frequent rebuilding and a degree of imprecision in construction with mud-brick and non-ashlar masonry add to the difficulty of detecting such basic information as the size of the foot used and hence the measurements of insulae and larger units.[33] The foot length used even in an individual city varied, as is evident at Halieis, and, indeed, followed no absolute standard in the Greek world in general,[34] so that to appeal to the foot used in a prominent local temple may not reveal the foot used for the town grid. Students of town plans may also have been too ready to assume the presence of a standard foot or a standard insula and have rarely considered the possibility of larger over-all systems. Finally, the inclusion or exclusion of streets in modules has not received much attention. Did land measurement proceed by measuring out a basic unit of 100 or 120 feet, adding a street, and then another 100- or 120-foot unit and so on? Or were houseblocks and streets conceived of and measured out as a single unit? Or was a larger block of land, either rectangle or square, measured out and then subdivided for insulae and streets? We have already indicated our view that preliminary measurement of the total area to be occupied by a new or renovated settlement was normal, followed by subdivision into the smaller units used for houseblocks and streets. We raise these questions in the hope that future studies in this field may help to answer them. Meanwhile they have a bearing on our efforts to place the plan of Halieis in the context of the development of Greek city planning.

3. The Rhodian system of larger squares proposed by the late Ioannis Kondis has some conspicuous differences from that which we detect at Halieis. Kondis argued for squares with sides of 600 feet (and a foot of 0.335 m.) subdivided into as many as 24 rectangles of 100 by 150 feet, or 8 rectangles of 150 by 300 feet. The streets are included in these rectangles so that the size of the actual blocks of houses, the insulae, depends on how much space is taken up by the adjacent streets. The chief differences from Halieis are (a) the large unit of 36 plethra (600 by 600 feet) as opposed to 50 plethra (and its half, 25 plethra); (b) the smaller blocks of 100 by 150 feet as opposed

[33]E. g., at Demetrias, where a foot of 0.278 m. would yield an insula 180 feet wide, and a foot of 0.333 m. one of 150 feet (P. Marzolff in *Demetrias* I (footnote 13 above), p. 11, note 20). There has also been uncertainty at Naples where Castagnoli sees a width of 120 feet (with, presumably, a foot of 0.308 m.) instead of one of 125 feet of 0.296 m. (Castagnoli, *Orthogonal Town Planning in Antiquity*, Cambridge, Mass. 1971, pp. 35, 133). At Selinous, blocks of 89 feet (and 11-foot streets) by 534 feet (with a foot of 0.328 m.) have been proposed: D. Theodorescu, "Remarques préliminaires sur la topographie urbaine de Sélinunte," *Kokalos* 21, 1975, pp. 108–120. One notices, however, that these same measurements yield a block of 100 by 600 feet using a foot of 0.292 m.

[34]See footnote 14 above and detailed discussions of this aspect of ancient metrology by O. Broneer, *Isthmia*, I, *Temple of Poseidon*, Princeton 1971, Appendix I: The Foot Measure; J. E. Jones *et al.*, "An Attic Country House Below the Cave of Pan at Vari," *BSA* 68, 1973, pp. 421–424.

to the longer blocks of *ca.* 101 by *ca.* 350 feet (it is not clear whether the larger Rhodian blocks of 150 by 300 feet belong to incompletely divided or incompletely utilized squares); (c) the single orientation and single grid at Rhodes as opposed to the different orientation of the two sides of the town plan of Halieis, not to mention the non-orthogonal areas between and adjacent to them.

Kondis and James McCredie have seen in the plan of Rhodes an innovative approach to be associated with the name of Hippodamos of Miletos whose contributions to city planning clearly lie well beyond the introduction of the orthogonal grid, now known to have been widely used in the Archaic period.[35] McCredie attributes to him a sophisticated geometrical system with a theoretical (i.e., social and political) basis, though it is not obvious how that basis manifests itself at Rhodes. Nonetheless, when put in historical perspective, the grandiose system of large squares at Rhodes will be seen to be of a quite different character from the modest one and a half squares of Halieis, and the agrarian origin of the latter need not be expected for the former. Thus, the stade square of 36 plethra is not attested as a unit of agricultural land, the closest thing being an isolated property of 18 plethra in an inscription from Olympia (*Dialectorum graecarum exempla* 419). Block lengths of 600 feet (the Herakleian linear gyas) have been detected in the urban plans of Metapontion and Naples.[36] There is frequent use of the 120-foot width, the schoinos, for the short side of insulae, but street widths are usually extra so that five blocks add up to more than a 600-foot stade.[37] There is no precise parallel for the Rhodian system as a whole.[38] We may legitimately ask if town

[35]J. R. McCredie, "Hippodamos of Miletos," *Studies Presented to George M. A. Hanfmann* (*Fogg Art Museum Harvard University Monographs on Art and Archaeology* II), D. G. Mitten *et al.*, edd., Mainz 1971, pp. 95–100. There are chronological difficulties in associating the same individual with Peiraieus, Thourioi and Rhodes (see Castagnoli, *op. cit.* [footnote 33 above], p. 135, note 33), but it is the new approach, not the particular planner that concerns us here.

[36]Naples, Castagnoli, *op. cit.* (footnote 33 above), p. 133, and Metapontion, *ibid.* (but at least once this length seems to be subdivided into approximately 200 and 400 feet; see the plan in Adamesteanu, *La Basilicata antica* (DiMauro), [1974], p. 49, and *idem*, *Metaponto*, Naples 1973, pp. 33–38 and fig. 10). We have pointed to the possibility of 600-foot-long blocks at Selinous (footnote 33 above), and the same possibility may be suggested for Himera with blocks of 100 by approximately 500 feet (so N. Bonacasa, *Himera* II, Rome 1976, p. 10, where the insulae are given as 32 m. by 196 m., but cf. J. W. Graham, "Notes on Housing Districts at Abdera and Himera," *AJA* 76, 1972, p. 300).

[37]See footnote 25 above. On the other hand, Castagnoli (*op. cit.*, [footnote 33 above], p. 133) seems to take the streets in Naples as part of the 120- by 600-foot block. For the possible inclusion of streets in 100-foot units, cf. Selinous, if Theodorescu is right (see footnote 33 above), and Kasmenai, where the exceptionally narrow 25–26 m. block widths, taken together with streets of *ca.* 3.10–3.50 m., would approximate 100 feet with a foot of *ca.* 0.29 m.: Castagnoli, *ArchCl* 15, 1963, p. 192.

[38]House blocks at Kassope in Molossia appear to be 100 feet wide (30.30 m.) and at least 145 feet long, but there is, as yet, no published information on the precise length: Τὸ Ἔργον, 1979, fig. 33, cf. Τὸ Ἔργον, 1977, p. 70; S. Dakaris, *Cassopaia and the Elean Colonies* (*Ancient Greek Cities* IV), Athens 1971, fig. 49.

The general idea of large avenues, *plateiai*, running in both directions and thus creating squares or less narrow rectangles, is implicit in Diodoros' description of Thourioi (XII.10.7) but the distances and the shapes of the units are not recorded: cf. Kondis, Ἀρχ Ἐφ, 1956 [1959], pp. 106–113.

In view of the uniqueness of the Rhodian large-square system of 36 plethra, it is worth considering whether in fact a 50-plethra square was used, with the 201 m. sides representing 707 feet of 0.284 m. The

plans were not unique in each case, just as architectural designs, e.g., of Doric temples, while often very similar, differ in each case despite common principles.

Most Archaic foundations show a grid of rectangular blocks divided by larger streets, mostly on their short sides, and smaller streets on their longer sides. The accumulation of insulae, not the pattern of streets, determines the organization. The emphasis is on the equal distribution of shares of land in town as well as in the countryside. This is an approach that Martin has associated with new towns of a primarily agricultural orientation.[39] A contrasting principle, as we would see it, rather than a contrasting type of town, emphasizes the intersections of major streets and the siting of public areas or buildings in terms of the street pattern, while maintaining more or less regular blocks of houses. The former emphasis, on blocks, can be seen in such towns as Himera and Naxos,[40] and the latter, on streets, in the earliest known plan in the West, at Megara Hyblaia.[41] For the most part, whichever emphasis prevails, blocks are large and unbroken and the networks of streets are relatively wide meshed and simple.[42]

In foundations of the 5th century B.C. and later the blocks become smaller and the streets correspondingly more numerous and prominent.[43] This also appears to be a characteristic of Thourioi founded in 443 B.C., which, as noted above, we know only from a description in Diodoros. To be sure, what we have described as characteristic of Archaic plans continues to be found in some later cities, perhaps continuing an Archaic practice, and some early cities show relatively small blocks in places.[44] Hellenistic foundations with relatively large blocks, such as Demetrias and Antiocheia on the Orontes, signifi-

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insulae then, without streets, would be blocks of 100 by 150 (or 150 by 300) feet, while the streets occupied the remaining 107 feet on each side (in Kondis' scheme, the streets are included in the block units). Kondis compared the stade length of 600 feet to the stadium at Rhodes (*op. cit.*, p. 148), but since it is not evident that a measurement from starting line to starting line is known, much less one that is contemporary with the founding of the city, and since no details of the stadium have been published to our knowledge, the comparison is too general to be helpful. Diodoros' reference to stoas a stade in length (xx.100.4) will agree with either interpretation, though a 600-foot building along the 707-foot side of a square allows room for the main streets on either side. But probably the reference should not be taken too literally.

[39]Martin, *op. cit.* (footnote 5 above), pp. 97–107.

[40]Himera (footnote 36 above), Naxos (footnote 25 above). Cf. also Metapontion (footnote 36 above), Lokroi (Castagnoli, *ArchCl* 15, 1963, p. 191 and pl. LXVIII), Kaulonia (*ibid.*, p. 195 and pl. LXIX), Herakleia (*ibid.*, pl. LXVII) and the great majority of West Greek foundations of the Archaic period.

[41]Vallet *et al.*, *Mégara Hyblaea* I (footnote 11 above).

[42]Lokroi, 120 by 900 feet, judging from the published plan (footnote 40 above); Taras is reported to have blocks of *ca.* 71 by 140 m., approximately 240 by 480 feet (F. G. Lo Porto, "Topographia antica di Taranto," *Taranto nella civiltà della Magna Grecia* (*Atti del decimo convegno di studi sulla Magna Grecia*, 1971), Naples 1972, pp. 366–367.

[43]Cf. Miletos, after 479 B.C., but see the comments of Castagnoli, *op. cit.* (footnote 33 above), pp. 12–14; Priene: 120 by 160 feet, T. Wiegand and H. Schrader, *Priene*, Berlin 1904, p. 50; Doura-Europos: 100 by 200 feet, F. E. Brown, *The Excavations at Doura-Europos, Preliminary Report of the Ninth Season*, I, *The Agora and Bazaar*, New Haven 1944, pp. 19–20; Tyndaris: also 100 by 200 feet, F. Barreca, "Tindari dal 345 al 317 a. Cr.," *Kokalos* 4, 1958, pp. 145–150 and pl. 53; Olynthos: 120 by less than 300 feet, D. M. Robinson and J. W. Graham, *Excavations at Olynthos*, VIII, *The Hellenic House*, Baltimore 1938, pp. 29, 47; Demetrias, footnote 33 above.

[44]E.g., the 120- by 200-foot blocks of Metapontion (footnote 36 above).

cantly do not use the standard block widths of 100 and 120 feet, favored earlier, avoid long and narrow proportions and have conspicuous networks of avenues and streets.[45]

It is reasonable to think that as the insulae became smaller and subordinate to the main streets in determining the organization of the town they would no longer serve as the basis of measurement, i.e., a surveyor would not conceive of the town as a series of blocks but would determine the lines of the main streets first, and so certainly by this time if not earlier would be working with the larger land units to be subdivided eventually into the smaller units. This is consistent with the large squares of Rhodes within which the actual blocks of houses are not of a predetermined size. It may also allow for the abnormal block sizes of Antiocheia and perhaps Demetrias since they may need to be taken together with adjacent streets as subdivisions of larger areas. With the example of Rhodes in mind we would do well to look for other cases of large units in later towns. Agrarian measurements, whether narrow strips with short sides of 100 or 120 feet (the linear plethron and schoinos) or larger rectangles of 30, 40, 50, or 60 plethra, are less relevant when a complex grid is being constructed.

In this sequence Halieis, with its relatively small blocks and its use of a large square, may be compared to the later foundations, but in other respects it is Archaic. The streets are narrow (average width *ca.* 2.60–2.80 m.) and the proportions of the blocks remain narrow, giving the effect of strips. While showing, like Rhodes, the subdivision of a large area rather than the building up of discrete blocks, the "modern" qualities of Halieis are illusory. The subdivisions correspond to the rectangles into which the squares of property at Chersonesos are divided. The absence of a single orientation at Halieis results from the laying out of two large "fields", as the topography of the site dictated. No doubt for rural land division, too, varied orientation was usually necessary in the broken landscape of the southern Argolid. In a part of Greece where new foundations were rare and space for comprehensive, organic plans no less so, we see a simple, perhaps amateurish application of agrarian land division, independent of the great foundations of Magna Graecia and Sicily and prior to the development of the more complex concepts of the Classical Age.

It may be that Halieis will prove to have an uncommon or even unique type of plan.[46] Whatever its peculiarities and specific details, it has served as a stimulus to the

[45]For Antiocheia and comparable cities, see Martin, *L'urbanisme dans la Grèce antique*, 2nd ed., Paris 1974, pp. 166–176; Castagnoli, *op. cit.* (footnote 33 above), pp. 136–137; J. Lauffrey, "L'urbanisme antique en proche Orient," *Acta Congressus Madvigiani* 4, Copenhagen 1958, pp. 7–26.

[46]We do not know whether the towns of Chersonesos in the Crimea and Pharsalos in Thessaly used the land divisions detected in their countryside. The rectangles of 120 by 200, 400 and 600 feet in the city of Metapontion (footnote 36 above) are not known to reflect a pattern of squares or rectangles in the countryside, but agree with the system used in the Herakleian inscriptions (footnote 24 above). Herakleia uses narrow rectangles, presumably 120 feet wide (36.80 m.: Adamesteanu, *op. cit.* [footnote 36 above], p. 109. The narrow streets, the *stenopoi*, are 4 to 5.55 m. wide. It is not clear how to reconcile this information with the insulae of 55 by 175 m. reported by Castagnoli, *op. cit.* [footnote 33 above], p. 134). In small units, and perhaps in large, if we knew whether streets were included in the reckoning for purposes of measurement, Herakleia seems to have used the same system for town and country, and this may have been generally true for the Greek West.

investigation of what we take to be an essential link between town and country, one which is consistent with the predominantly agricultural character of the economy and society of Greek towns. In the absence of evidence to the contrary we suggest that at least in the earlier stages of Greek town planning the principles and practice of land division were the same for town and country, although varying to some degree region by region. We hope that by presenting this hypothesis we will have encouraged further research on these problems.

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