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THE QUANTITATIVE APPROACH TO THE RELATION BETWEEN POPULATION AND SETTLEMENT SIZE

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CONTENTS

INTRODUCTION

The following group of short papers deal with specific topics bearing on the broad problem of the quantitative expression of relationships between population and settlement size. The subjects treated are diverse in detail, and no attempt is made to achieve any comprehensive or unified synthesis or interpretation. At the same time the several articles have one characteristic in common: they each require the close examination and discussion of numerical data which therefore must be presented as completely as possible. Otherwise conclusions and formulations cannot be appreciated or justified.

I. ON THE NUMERICAL EXPRESSION OF RELATIONSHIPS AMONG ARCHAEOLOGICAL VARIABLES

During recent years numerous investigators have explored the possibility of demonstrating the existence of quantitative relationships among various types of cultural attributes. In the realm of the archaeology and ethnology of primitive peoples attention has been directed to the association between spatial elements, such as site area or other ecological factors on the one hand, and population on the other. It has become evident that discussion is desirable in order to clarify some of the elementary principles governing the formulation of the many relationships which undoubtedly exist.

If more than the vaguest affinity is present, if two parameters or two tangible material variables are causally or even fortuitously connected with each other, then it should be possible to secure the data which would permit a clear algebraic formulation of the association. It is not enough to assert verbally that one entity depends upon another; the manner, direction, and extent of the dependence should be set forth in the rigid language of numbers.

As an illustration, and in no spirit of criticism, we may refer to the exposition of culture and population given by Hester (1962) in his paper on the typology of New World cultures. He shows (ibid., p. 1003) a graph depicting cultural intensity on the ordinate and population density on the abscissa. The curve is in the form of a distribution skewed slightly to the right. The quantities are represented by "low" to "high" for cultural intensity, and "few" to "many" for population. The shape of the curve is deduced from an hypothesis which may be, but is not proved to be, valid. There are no actual values given to either variable so as to demonstrate that this curve ever appears in reality. How much more satisfying it would be if some real figures could be provided and the hypothesis validated for at least one case.

The most cursory inspection of Hester's (1962) Figure 1 indicates that this two-dimensional graph represents more than two variables. Cultural intensity is stated to depend upon food supply, as does also population. Indeed Hester describes this as an "inter-acting system." Furthermore he attributes the skewing of the curve to the "time element," thus introducing a new and wholly independent variable which, strictly speaking, should require another dimension for its representation. In short, Hester's Figure 1 is the visual picture of an idea, or the diagrammatic expression of an hypothesis. It is not the mathematical formulation of the quantitative relationship between two parameters capable of being couched in numbers.

Another type of approach is illustrated in recent papers by Hack (1942) and Schwartz (1956, 1963), and there are of course many others. In each of these three papers the author plotted the relative population of some specific archaeological area in the American Southwest against absolute time in years. In computing the population, each author made the assumption that the number of people at a given moment was directly proportional to another, and measurable, parameter; for example, to total site area, number of villages, or aggregate potsherd count. Here the missing step is the mathematical demonstration that the relationship between population and, say, village number actually may be expressed as a linear function. The assumption is a quite legitimate first approximation, but the final proof would have to rest upon a test with the appropriate numerical data.

However, when we attempt to assemble real evidence for such tests and such proofs, we encounter certain difficulties. These difficulties are infrequently fully appreciated, and certainly are rarely resolved with precision. We shall discuss some of them, restricting the field of interest primarily to that of settlement patterns, and in particular to the relations between space and population.

1. In equating two variables one must be treated as independent, the other as dependent upon it. Frequently there is no difficulty in making a selection. If we trace the trend of population in time, the latter is independent; but if we relate population to space, which determines the other? In many situations, especially those involving floor

space, site size, etc., space occupied is clearly a function of the number of occupants. Population will then be x and space y. However contingencies may arise when an increasing number of people will be contained by the available space and will be restricted in their expansion. Then the ordinates would have to be reversed. The primary requisite is that the reasonable and logical formulation be adopted for each set of data. Interdependencies are to be avoided, such as Hester's (1962) cultural intensity and population density, each of which can be at the same time dependent upon the other. A graph relating them would have little meaning unless each could be paired separately with a third and quite independent variable. Thus with a random population, if one plots for each person height against weight, a close association will be found. But does weight depend upon height or vice versa? There is no solution unless perhaps one plots height and weight separately against age. Then the time course may be used to study both types of size change.

2. If any two parameters are quantitatively related, not only must one be a function of the other, but this function, theoretically at least, must be capable of expression by an equation, the visible presentation of which is a plot or graph. To discover what is the true nature of the function and by what equation it should be expressed, is one of the most troublesome problems confronting any natural scientist. In the present context we are admittedly operating upon a very elementary, unsophisticated level, for the data of archaeology and human ecology will not as yet justify advanced or intricate treatment.

If we ignore, as being beyond the scope of this inquiry, trigonometric and hyperbolic functions, as well as those involving the second and higher powers of x, there remain several possible types of equation which may be applicable to area — population data.

The first is the linear function which, when the values for the two variables are plotted directly on rectangular coordinates, gives a straight line. The general equation is: $y = a + bx$. Here b is a proportionality constant representing geometrically the slope of the line produced by plotting the appropriate figures and statistically the coefficient of the regression of y upon x. The constant a denotes the value of y when x equals zero, or, on the graph, the point of intersection of the regression line with the y-axis. It should also be noted that the exponent of x is always 1.0.

All other functions, when the numerical values are plotted directly, result in curves, not straight lines. If the data are to be handled by even the most rudimentary statistical methods, it is desirable that they be converted to a linear form. With biological and sociological processes this conversion may very often be accomplished effectively by the use of the logarithms of the numerical values instead of those values directly. There are several modes of formulation utilizing logarithms, of which two are of immediate interest in connection with settlement patterns.

A. We plot the logarithms of y against the direct values of x. If the graph is then linear, the relationship may be expressed as $y = ab^x$. Here x itself is an exponent. Using ordinary logarithms we may also write the equation $\log y = \log a + x(\log b)$, or, with natural logarithms, $\log_e y = \log_e a + bx$. The latter expression is often put in the form $y = a\, e^{bx}$. This is the exponential function seen and used widely in following growth processes in organisms or, with a negative exponent, radioactive and other types of decay.

B. We plot the logarithm of y against the logarithm of x. If the data thus rectified show a straight line in the graph, then $y = a\, x^b$, or, in logarithmic form, $\log y = \log a + b \log x$. Here b, not x, is the exponent, and the type of function is better designated logarithmic than exponential.

The extent to which the student will pursue his inquiry into the nature of the relationship between his variables will depend upon (1) how exhaustive he wishes to make his treatment, and (2) how far his data will support extreme accuracy of analysis. The first step would normally be to plot the points directly, exponentially and logarithmically. If visible linearity is produced exclusively by any one of these methods, his problem is solved. Otherwise he must resort to more and more sophisticated methods. Very frequently, however, the intrinsic variability of the data is such that the more elaborate methods are inappropriate.

As an illustration of the material with which it is often necessary to deal, the data which have been published by Naroll (1961) may be cited to show the relationship between the population and the total floor space in primitive villages and towns. (For simplicity we have omitted the large Inca city of Cuzco.) In Figures 1, 2, and 3 respectively the numerical values, with population as x and floor space as y, have been plotted directly, exponentially (semi-logarithmically) and logarithmically. Certain features are immediately evident.

In the linear (direct) plot the points are unevenly dispersed, with nearly half being bunched so near the intersection of the ordinates that they cannot be individually spotted with the scale employed. It would be very difficult to tell whether there is a straight-line function. Plotting log y against x produces a better vertical distribution of points but the trend is clearly curvilinear, concave downward. Plotting log y against log x (Fig. 3) results in a distribution which is approximately, if not exactly, linear. The third method, then, yields the best representation of the data, as Naroll has demonstrated in some detail.

When it is difficult to reach an unequivocal conclusion by constructing graphs, or when it is desired to make comparisons of several to many sets of data derived from different sources or distinguished by variation in some important contributing factor, it is probably best to select a uniform mode of procedure for equating the variables. This is true even though the method selected may not produce in every case the most exact approach to the real function relating the variables. There are a few simple principles which are likely to prove helpful.

When the phenomenon under consideration is a process during the course of which some parameter changes in size or amount—that is to say a rate—then time is the independent variable and the exponential relationship should be investigated. The increase or decrease in such entities as number of settlements, population, or food supply frequently produces a straight line with a semi-logarithmic plot. On the other hand, when there is no change, no rate, involved, and interest centers in the association between the absolute or relative magnitudes of two variables at a single point in time, as, for example between number of settlements and mean food consumption per settlement, it is probable that on the whole the logarithmic formulation is to be preferred. There are several reasons, both theoretical and procedural, why this choice might be made.

A. From the equations $\log y = \log a + b \log x$ and $y = a x^b$ it is seen that b as the exponent of x defines the slope of the line in the log-log plot. It is also the coefficient of the regression of y upon x. As such it constitutes an immediate and practical empirical index to the relation between y and x which may be employed for comparative and descriptive purposes.

B. If the value of b is 1.0, then $y = a x$, and the relationship is linear. In other words, the direct or linear function is a special case of the logarithmic function and is included in it. In dealing with an unknown relationship the more general solution should be sought first, and then if the result warrants, the restricted solution investigated.

C. The quantitative treatment of settlement patterns, populations, influences of the physical environment, and social or economic attributes of a culture almost invariably involve the assembling of an array of data which must be subjected to some sort of statistical analysis. A basic desideratum will be a reasonably symmetrical distribution of points for each parameter or attribute. Nevertheless we very often encounter skewed distributions. When this happens considerable improvement may usually be accomplished if the data are recast as the logarithms. A good illustration of this effect is provided by the data from Naroll (1961) shown in Figures 1 and 3. In Figure 1 the points for both area and population are heavily concentrated toward the region of small values, whereas in Figure 3 the logarithms are relatively evenly distributed over the graph.

D. A corollary to the normalization of the distribution curve is the reduction of undue weight on a few extreme points. Human societies are likely to produce an extensive group of units all more or less similar in magnitude, plus a few of extraordinary size. In taking the arithmetical mean of these the few very large units will throw the average beyond what is really characteristic of the group. However, if we use the logarithms, we may take their average and then reconvert this to the antilogarithm. The geometrical mean is thereby yielded, which, with skewed distributions, tends to represent more truly the characteristic magnitude of the feature.

For instance, let us consider Naroll's data for the population of 18 settlements. The range is from 75 to 200,000 persons if we include Cuzco (this town was deleted in Figs. 1-3 in order to simplify the graphs). Of the 18 places, 16 had a population of 5,000 or less; one had 15,000; and, as mentioned, Cuzco had 200,000. Omitting Cuzco, the arithmetical mean is 2,023; including this city, the mean is 13,021, a figure which gives a distorted picture of the general run of settlements. If we use the logarithms and determine the geometrical means, we get respectively populations of 655 and 900 persons. These numbers much more closely approach the region of densest concentration of village populations, that is the mode, than do those obtained by arithmetical average, and for many purposes are far more satisfactory.

E. It has been mentioned that the regression coefficient b is useful as an expression of the quantitative relationship between two variables. The same may be said of certain other derived magnitudes, such as the standard deviation of the mean and the standard error of estimate. To be sure, the numerical value of these will depend upon the units in which the variables are presented, provided that the direct, linear equation is employed. But in the logarithmic form the units have no influence, and the slope of the regression line will be the same whether, for example, we plot area in tens of square meters or thousands of square feet.

3. Once the nature of the relationship is established, or indeed before it is established, the data at the disposal of the student of settlements and their populations almost invariably require some type of test with respect to the degree or strength of association between the two variables under consideration. As a rule, when plotted the points derived from the observed numerical values will not fall perfectly along a line or a curve, but will be scattered more or less widely, perhaps as a band, but frequently as a cluster or constellation. It is necessary then, if either a linear or curvilinear function is to be established, to evaluate the closeness with which the points will fit any presumed line, and to express the final judgment by means of some numerical constant, in terms of probability. Two simple devices are available for this purpose.

The first method is to determine the conventional coefficient of correlation, *r*. Here is an immediate measure of the strength of association as estimated by the probability level corresponding to the magnitude of *r* and to the number of degrees of freedom provided by the original data.

The second device is to compute the standard error of estimate, or the standard deviation of the values of *y* from the regression line. This term is a measure of the vertical dispersion of the points, and diminishes in magnitude the closer the points fit to the line, until, at the limit, a perfect coincidence, it approaches zero. With archaeologic and ethnographic data, however, the standard error of estimate usually assumes a very appreciable value.

When it is attempted to compare different sets of data with respect to goodness of fit, certain difficulties may arise. The standard error of estimate must be expressed in the same units as are employed for plotting *y*. Hence no comparison is possible unless both graphs or tabulations are based upon identical units. For instance, the standard error of estimate obtained with direct figures cannot be compared with that obtained from the corresponding logarithms. There is, however, a compensating procedure. We may calculate for a specific set of data, first the standard deviation of the points from the *mean* of *y*, and then the standard error of estimate (i.e. the standard deviation from the *regression* of *y* upon *x*). Both these terms are expressed in the same units; that is, those employed for expressing *y*. Consequently the *ratio* of the standard error of estimate to the standard deviation from the mean eliminates the absolute units and becomes a statement of the *relative* degree of dispersion of points. Since the standard deviation from the mean must always be greater than zero, the smaller the ratio the better the fit of the points. In this way any method of formulating the data may be compared with any other.

In brief summary of the foregoing discussion, the following precepts may be offered. If there is to be a truly quantitative analysis of space – population or other similar relationship, all pertinent variables must be cast in absolute numbers. The reasonable and appropriate variable must be designated as independent. The data must be graphed and studied with respect to the governing type of function. The semi-log formulation may be employed when rates are involved, and the log-log formulation for static attributes unless otherwise clearly indicated. Strength of association may be tested by the use of the correlation coefficient and the standard error of estimate. If any particular situation requires exhaustive analysis, then more sophisticated mathematical and statistical methods should be considered.

II. A RESTUDY OF T. T. WATERMAN'S YUROK DATA

In 1920, T. T. Waterman published a monograph entitled "Yurok Geography" which included a series of seventeen maps of villages, of which fifteen lay on the Klamath River and two on the outer coast. All were drawn to scale and showed every known structure and residual pit in their correct relative positions. Thirty years later Cook and Treganza (1950) made an analysis of the data for site area and population of the Yurok by arriving at a rough estimate of the areas shown on Waterman's maps as covered by houses, and considering the population to be represented by the total number of house pits plus standing houses. A high correlation was demonstrated when the logarithms of these magnitudes were plotted, and a logarithmic function appeared to exist. More recently results of other investigators (in particular Naroll, 1961) seem to have confirmed the presence of a logarithmic relationship between population and living area, and have opened up a new field of exploration in the quantitative association of house and site size with respect to number of occupants. In view of these developments a new and closer study of the Yurok data will be of value.

Waterman represented the houses on his maps by rectangles placed according to the location of structures existing in 1920 and of pits left by former houses. He also included sweat houses, together with the principal features of physiographic importance such as rivers, creeks, and contour lines. It is thus relatively easy to mark off desired areas and measure them. The houses on the maps, of course, may be counted, and in addition Waterman (1920:206-207) lists his estimate, derived from informants, of the number of persons each village contained aboriginally. Since the Yurok dwellings were uniformly inhabited by a single family, the population may be computed by multiplying the number of dwellings by the probable family or household size.

The number of houses may be estimated by three methods (shown in Table 1 as methods 1, 2, and 3 respectively). The first is to count all dwellings shown on the maps, whether inhabited in 1920 or present only as a pit. The second is to utilize the pits only, on two grounds: (a) that the modern structures may not have been in existence prior to 1850; and (b) that since most of the data from archaeological sites in California record house pits exclusively, consistency in this respect may be desirable. The third method is to employ Waterman's estimates (op. cit.) for aboriginal house counts as given in the table in his monograph.

Settlement size may be calculated in several different ways, in large measure depending upon the assumption one wishes to make concerning just what constituted the space under consideration. It is clear that we are not dealing with floor space, or aggregate space under a roof, for this would have to be a linear function of the number of houses, but with what we may call site space or living space. This is the total area of the settlement, including the aggregate floor space. The demarcation of site space is necessarily somewhat arbitrary. However, for the purpose of testing the Yurok data, six assumptions have been made; that is six methods have been devised for computing area, none of which perhaps will satisfy all possible ethnographic criteria.

1. A rough approximation is reached by enclosing the cluster of houses on each map by the most appropriate geometrical figure, such as a triangle, rectangle, ellipse, or a combination of these. From the linear scale of feet always provided the area may be derived by formula. This is the method used by Cook and Treganza (1950) in their original study.

2. A minimum living space would be represented by the houses and the land enclosed by them. Consequently the external corner or wall of each house on the periphery of a group, including sweat houses, is connected by a straight line with the one next to it, thus forming an irregular figure which closely embraces the group of houses as a whole. Some slight latitude has to be allowed occasionally in determining which are the peripheral houses, but a reasonably good fit may be secured. The area outlined is then traced off and measured with a polar planimeter.

3. On the assumption that in reality no occupant of a peripheral house is going to be confined within the limits established by the

preceding method, we extend the border of the settlement. Again this must be arbitrary; hence we take a line paralleling the first but 25 feet outward from it.

4. Using the same assumption, we extend the limit to a line drawn 100 feet outward. This distance might perhaps satisfy most day to day local, domestic requirements. Nevertheless more distant activities might need to be accounted for. In general, to estimate the space demanded by these may be not only difficult but impossible. In this particular context, however, it is feasible to make a partial adjustment. The fact has been mentioned that fifteen of the Yurok villages front on the Klamath River and two on the ocean. In all instances the village is oriented strictly toward the river bank or ocean shore, due of course to the heavy dependence upon aquatic sources of food. Consequently it is reasonable to extend the site area from the house cluster to the water's edge.

5. The site is extended as suggested above, by projecting the area produced by method 3 to the shore. Parallel lines are drawn tangent to the outer limits of the figure and approximately perpendicular to the margin of the river or ocean. Thus to the space included by method 3 is added the area lying between it and the water.

6. The site is extended as in method 5, but the figure produced by method 4 (a line 100 ft. beyond the houses) is used as the point of departure.

In order to study the relationship between population (houses) and living space (area) we may plot graphs with the two parameters as coordinates (see Fig. 4). Using the logarithms of the individual values, we find that the points uniformly group themselves in a linear fashion, thus confirming the earlier findings of Cook and Treganza (1950). However it is probably more enlightening to derive certain numerical constants which are subject to interpretation and can be used for making comparisons.

If the log plot of population and area is linear, then the function follows the equation:

$$\underline{\log y = \log a - b \log x} \quad \text{or} \quad \underline{y = a\, x^{b}}$$

Here are two constants, _a_ and _b_, which can have significance for an ethnographic or archaeologic study. We may add a third: the correlation coefficient _r_ (see p. 7).

Considering the plotted figure as a statistical expression, it is evident that we have the regression of the log of one variable upon the log of the other. Then *b* is simply the regression coefficient which characterizes the slope of the line, and *a* is the reading on the *y*-axis of the intersection with the regression line.

The importance of *r* is that it gives us an estimate of the strength, or degree of association, between the two variables—population and living space. If *r* is small, then the association is poor, and even if present is obscured by disturbing factors. If *r* is large, then the association is good, and its validity can be tested by the probability level of *r* for the appropriate number of degrees of freedom. Thus, to use an illustration unrelated to the Yurok, Naroll (1961) tabulated floor space against population for eighteen widely separated settlements and obtained an *r* of +0.88. This he considered, correctly in our opinion, established the interrelationship firmly.

One further problem requires comment. Since we have two variables, population and area, one of them must be treated as dependent upon the other; that is, one must be represented by *x* and the other by *y*. The correlation will not be affected by the decision, but the values of *b*, the regression coefficient, and of *a*, will be quite different, depending upon which parameter is selected as the independent variable. In human terms, does living space or settlement area depend upon population, or does the population depend upon the area? Mathematically either could be expressed as a function of the other. Cook and Treganza (1950:232, fig. 1) used area as *x*. Naroll (1961) used population as *x*. With small settlement societies such as that of the Yurok and most other California tribes, the latter is probably the more satisfactory solution, since we may prefer to believe that the number of people determines the space they occupy rather than the converse. On the other hand, in very densely populated regions many authorities feel that living space does influence the number of people. In the present study we may by-pass this controversy and show the data according to both methods of formulation.

Table 1 gives the values of *r*, *b*, and *a* for Waterman's Yurok villages in pursuance of the three methods described for estimating house number and the six methods for computing area. There is added one estimate, using population method 1 and area method 2, but omitting the two seacoast villages. Moreover, in each case the constants are given when using population and area alternately as the independent variable. The findings may be discussed briefly.

1. All nine correlations show high values for *r*. The lowest is +0.751. For 16 degrees of freedom a value for *r* of ±0.590 is at the one

per cent level of probability. Hence any greater value is beyond the one per cent level and must be considered highly significant.

2. Varying neither the methods of counting the houses nor of calculating site area appears to alter the validity of the association between the two parameters. This result implies a very fundamental relationship. It also suggests that an investigator has considerable scope in selecting his method for expressing and computing both population and area as long as he is internally consistent. Theory as to what constitutes living space becomes a secondary consideration, provided that some rational hypothesis be adopted and adhered to.

3. Although the presence of a high correlation is extremely stable, the value of the regression coefficient b is very labile. We may disregard the systematic difference introduced by reversing the ordinates with each combination of population and area method, and consider the values for those calculations only where population is the independent variable.

Changing the method of estimating house number shifts the value of b between +1.393 and +1.023. The significance of the change is not readily apparent. Changing the method of estimating area moves b from +1.593 to a minimum of +0.771. Here it is to be noted that the five methods reported (2 to 6 inclusive) embrace different average areas for the villages.

No. of villages	Area method	Mean area (sq. ft.)	Value of b
17	2	25,450	+1.593
17	3	47,400	+1.167
17	4	131,200	+0.771
17	5	103,000	+1.117
17	6	187,600	+0.850
15	2	28,400	+1.197

The figures are not notably precise, yet there appears an unequivocal tendency for b to diminish as average area increases. It must therefore be concluded that the extent of the area per settlement which is yielded by whatever method of estimate is selected will have a marked influence upon the slope of the regression line; that is to say, the numerical value of b. This conclusion also means that the way in which settlement area changes to correspond with changing population depends upon the specifications according to which the nature of the area itself is established.

The regression constant is of course also sensitive to individual points in the log plot. This feature is seen when two villages are deleted, leaving fifteen instead of seventeen (see Table 1). One of the omitted sites is Tsurai, the point for which falls close to the center group on the graph (see Fig. 4); the other is Omen which has the smallest area of any of the villages. Removing this latter single place radically shifts the trend of the points and therefore the value of *b*.

We must conclude that the constant *b* should be regarded with a great deal of caution and not be employed for comparisons of regions or groups of settlements unless all known sources of variation are carefully controlled. On the other hand, with the accumulation of knowledge, we may eventually be able to utilize the magnitude of the regression coefficient as a test for the theoretical interpretation of empirical relationships.

4. The constant *a* represents the point where the regression line crosses the *y* or vertical axis; that is to say the value of *y* when *x* equals zero. Otherwise stated, this means that when the population is the independent variable *a* describes the limiting, minimal size of the living or settlement area—the smallest area on which there can be any inhabitants at all. This value, as seen in Table 1, is always positive, and might give some clue to living conditions in the region. When the area is taken as the independent variable, then *a* would represent the population when there was no area, a manifest absurdity. Here *a* is always negative, and may be disregarded.

5. The constant *a*, as shown in the seventh column of Table 1, is a logarithm. This may be converted into square feet as such (see eighth column of table) and may give an idea of the smallest possible settlement. An additional characteristic of the system is that when *a*, as the logarithm, is plotted against the logarithm of the mean area for the entire group of settlements, as computed by six methods, a straight line is obtained. Here again is a demonstration of logarithmic function (see Fig. 5). The result is reasonable in that one would expect the calculated minimal area which could support a population to be related to the average area occupied by actual populations under the existing conditions. Furthermore, it is possible that if we knew both *b* and *a* for a particular region, we might be able to estimate the magnitude of individual habitation groups with some degree of success, for these two constants define the position of the regression line and hence permit interpolation of specific values. Naturally the reliability and accuracy of the interpolation is measured by the probability level of the corresponding correlation coefficient, together with the standard deviation of the individual points from the regression.

6. The absolute values of the limiting areas expressed as square feet are of interest. With the first three cases, where the area method is the same (method 1) and the house counts do not differ greatly (199 with method 1; 165 with method 2; 177 with method 3), the difference in *a*, ranging from 1,940 to 5,575 square feet, is due mainly to a corresponding variation in *b*. The steeper the slope of the regression line, the lower the point of its intersection with the *y*-axis. In the second group, where the house number is constant and the area method varies, it is instructive to compare the values derived from *a* with probable minimum values estimated from other considerations.

a in sq. ft.	Area in sq. ft. estimated as stated
650	Area of a house with a 12 ft. radius: 452
3,220	Area covered by a circle of 25 ft. radius: 1,965
22,200	Area covered by a circle of 100 ft. radius: 31,419

The correspondence is far from perfect, but the correct order of magnitude is obtained. With regard to settlement areas which include projections to water fronts, no statements can be made since the total space depends upon the unpredictable linear distance to the shore from the village.

III. CONSIDERATION OF S. K. LOTHROP'S DATA FOR TIERRA DEL FUEGO

The observations and facts which have made possible a quantitative examination of area — population relationships in primitive settlements are derived in large measure from California. The principal exception is the formulation by Narroll (1961) of floor areas and populations in selected villages throughout the world. It is desirable to secure as many cases as possible of local regions within which an independent test can be made. An instance of this sort is provided by the maps and figures published by S. K. Lothrop (1928) concerning the tribes of Tierra del Fuego.

In order to ascertain whether an exponential or a logarithmic function exists relating living area and population, it is necessary to have both site size measurements and population counts or indices for an adequate series of localities. Lothrop describes three groups of sites, all in the general vicinity of Harberton, Tierra del Fuego, and all pertaining to the Yahgan tribe. He also provides three maps (*op. cit.*, Figs.

98, 100, 101) on which the sites are plotted. The number of house pits is likewise given in corresponding tables in the text (*op. cit.*, pp. 184, 187, 188 respectively). A printed scale of distance in feet or meters is supplied with each map.

By placing the printed sheet of the book under a binocular dissecting microscope and laying the edge of a millimeter rule over the line on the map, the equivalent of one millimeter on the rule may be closely estimated in terms of meters or feet on the printed scale. Thus in Figures 98 and 100, one millimeter equals approximately 30.5 meters, and in Figure 101 it equals 28.6 feet. Each site is depicted on the maps as a mass of fine parallel lines. The area of this mass can now be determined by direct measurement of appropriate dimensions. If the outline of the site can be regarded as a rectangle, the long and short axes are multiplied. If it is closest to a circle, then the area is taken as πr^2; if it is oval, then the two axes are measured and the formula for an ellipse (πab) is applied. In certain cases where the form is highly irregular, it is^{2}possible to subdivide the diagram into portions, each of which can be handled separately.

There are, however, two obvious sources of error. The first is in the measurement of the site representations which can never be completely accurate, but this error is random and amounts to no more than a few per cent. The second error is in the original drafting of the maps. Do the areas shown on the maps really reflect the actual size and shape of the sites? From a careful examination of the published result it appears to us that the author did as faithful a job as could be expected, and that certainly, in a broad manner, the relative sizes of the sites are adequately depicted. It is true that we do have only a gross representation, and that we have to allow for considerable latitude in the values for site area; on the other hand the range of calculated square footages for the 65 sites measured runs from 2,600 up to 785,000; in other words a factor of 300. It is very doubtful if inaccuracy in drawing outlines on a map or in actually surveying the sites would reach this order of magnitude. We may therefore accept the areas taken from Lothrop's maps as being an acceptable first approximation.

Population is indirectly determined from the house pits counted. For the purpose of the present study it is not necessary to know the total number of inhabitants, since the point at issue is the relationship between site sizes and site populations without reference to the absolute sum of either. Indeed if we were concerned with totals, we would have to determine whether all the sites and all the houses were simultaneously inhabited, questions of extreme difficulty and answerable only from analysis of archaeological data. But the number of house pits may be considered as directly proportional to the number of people, and therefore a valid *index* to population.

The numerical values are plotted in Figure 6 as the logarithm of the square feet of site area against the logarithm of the house pit count. The scatter diagram for each of the three groups of sites shows a general trend toward a straight line. A further analysis is given in Table 2. The strength of association can be gauged by the values of *r*, the correlation coefficient. The first group shows a value of +0.799, which is well beyond the one per cent level of probability and is highly significant. The second and third groups, with only ten and five cases, give values which lie respectively at about the two per cent and the five per cent levels of probability; in other words moderately but not highly significant. The consolidated data give a value of +0.689 for *r*, which for 65 cases is highly significant. There can be little doubt, therefore, that the Tierra del Fuego region shows the same type of site area—population function as does the Yurok on the Klamath River.

The slope of the regression line *b* differs slightly among the groups of sites shown on Lothrop's three maps. This result is to be anticipated since there are inherent distinctions between any two sets of settlements, and since there is unavoidable variation in the measurement of parameters and calculation of data.

The limiting area *a* is computed from the regression formula, but graphically represents the backward extrapolation of the regression line to its intersection with the *y*-axis. It may be interpreted as indicating the minimum site area which could accommodate any house pits or dwellings. Its numerical value depends upon the slope of the regression line (*b*) and the average of the (logarithms of) the site areas plotted on the ordinate. We note in Table 2 that the second group of sites (from Lothrop 1929, Fig. 100 and table on p. 187) shows the smallest value for *b* and a very large limiting area in square feet as derived from *a*. It is also demonstrated in our Figure 6 that the points for the ten sites in this group are displaced upward, implying, as is true, that the average area of these ten sites is greater than that for either of the other two groups. This probably means simply that Lothrop, in selecting his groups of sites for illustration, picked upon one in which the sites were larger than most of those in the region. Otherwise we would have to search for some intrinsic characteristic setting apart the local area in which the sites of the second group were located.

IV. SETTLEMENT AREA AS A CLUE TO REGIONAL POPULATION

There are a great many localities, inhabited in ancient or recent times, of which the areas are known or can be measured, but for which the populations cannot be determined by enumeration or by indirect documentary evidence. Yet, if the principle of exponential or logarithmic relationship set forth in the previous discussions has general validity, there should exist in every instance a numerical constant which expresses this function for the area and population of the particular community type and ecological province concerned. It follows, therefore, that if we could learn or calculate the value of that factor, we could convert size of settlement areas into the corresponding magnitudes of population.

One possibility exists when, for a homogeneous, relatively compact region, data with respect to even a few of many separate settlements are to be found either in the field or in the literature. If in addition these data supply figures for area or size on the one hand and for population or some directly dependent parameter on the other, we can both examine the validity of the logarithmic relationship and derive a probable value for the regression coefficient. It may then be possible to apply this information to the entire region, and, after a series of adjustments depending upon the individual case, to emerge with a rational estimate of the total population. This paper attempts to explore a single illustrative example and to ascertain whether the logarithmic formula can be applied to a specific region in the manner described.

We have selected a portion of the area of the tribe known as the Chumash, who lived on the mainland and islands of Santa Barbara County, California, at the time of Spanish settlement in 1769. The Chumash settlements actually extended along the coast and on the offshore islands from just above Los Angeles to San Luis Obispo, and into the hinterland as far as the southwestern corner of the San Joaquin Valley. We are interested here in the tightly-packed line of villages which reached from near Ventura westward along the shore and narrow coastal plain to Point Concepción, a distance of approximately 100 kilometers.

The sources consist of the reports written by Palou (Bolton 1926), Crespi (Bolton 1927), Portolá (Smith and Teggart 1909), and Costanso (van Hemert-Engert and Teggart 1910) covering the Portolá expedition of 1769; the later account by Fages (Priestley 1937); the ethnographic survey by Kroeber (1925); and the archaeological investigations of D. B. Rogers (1929).

There are eight sites along the Santa Barbara Channel which were examined by Rogers about thirty-five years ago and for which counts of occupied houses were made by members of the Portolá expedition who visited the villages in 1769. Their names are set forth in capital letters in Table 3. Outline drawings of the sites are given on maps by Rogers (1929). Since the scale of linear units is also given on each map, it is not difficult to measure very accurately the area of each site separately by means of a polar planimeter. It is probable that the representation of the site itself, as drawn on the map, is a reasonably close approximation to the actual area on the ground.

The house counts were made as carefully as circumstances permitted by Fray Juan Crespi, an unbiased and literate explorer and missionary, and by Gaspar de Portolá, who was in command of the expedition. Their figures were quoted by other participants and by later writers such as Costanso, Palou, and Fages. Crespi and Portolá agreed in most cases (see detailed data in Table 4). Where a discrepancy occurs we have either accepted Crespi's figure or, if the difference is considerable, have averaged the two estimates. For some villages the expression "more than" is used. As a partial adjustment in these instances, the stated figure has been increased by ten per cent.

When the logarithms of the values for the eight sites are plotted, the points, despite some scattering, fall approximately along a straight line (Fig. 7). The correlation coefficient between log area and log house count is +0.762. This value, for seven degrees of freedom, lies close to the two per cent level of probability, and the relationship must be regarded as definitely significant. The regression coefficient has the value of +1.317. We now have a credible numerical factor on the basis of which we may expand our calculation in order to evaluate the total population of the region.

In his extensive account Rogers (1929) lists and describes in the text a total of 56 sites, including the eight mentioned above, and refers to the native culture period which ended with the Spanish invasion as the "Canaliño." These 56 sites are listed in Table 3 according to the designations given by Rogers. The localities all fall within somewhat narrower limits than those previously indicated. Roger's eastern border was the mouth of Carpinteria Creek and his western border the mouth of Gaviota Creek. Hence the territory embraced by the 56 sites was smaller than that covered by Portolá's explorations, and smaller than that actually occupied by the Chumash tribe (cf. Kroeber 1925:526). There is no certainty that all the sites were actively inhabited by the Indians in 1769. This point requires further examination.

Of the 56 sites described by Rogers, there are 26, in addition to the eight previously utilized for computing the regression coefficient, which are drawn on Rogers' maps, and the areas of these may be determined by planimeter measurement. These names are underlined in Table 3. We have no house counts for these 26 sites; however counts may be estimated by interpolation of the area values on the logarithmic graph already established. Thus one finds for each area the point on the regression line where the appropriate ordinate intersects and reads off the corresponding house count value on the other axis. The individual estimates may be moderately inaccurate (the standard error of estimate is approximately ten per cent of the mean), but with a reasonably large number of cases the probability is small that any serious systematic error is introduced.

There now remain 22 sites described by Rogers as being essentially contemporary with the Spanish expedition of 1769, for which there are neither measurements of area nor house counts. These are given by name in Table 3 but are otherwise not identified. For these sites the only recourse left to us, but one which cannot be seriously at fault, is to use the average count for the 34 sites already considered. This average turns out to be 37.1 houses or, for convenience, 37. We cannot, of course, argue that these 22 sites actually contained an average of 37 houses, but assume this in order to be able to treat the full site count. If we are in error, it is probably in the direction of overestimation. For the entire 56 sites the total number of houses would be 2,072.

The next step is to convert number of houses to population numbers. If areas are disregarded, it is found that the explorers of 1769 recorded house counts, together with estimated number of inhabitants, for 16 villages. The detailed data for these is given in Table 4 and summarized in Table 5. The average number of persons per house, by direct division, is 9.52. This figure must be subjected to further scrutiny with respect to two factors: first, the size of the individual house; and second, the number of persons ascribed to each village.

The houses on the Santa Barbara coast were large as Indian dwellings go. The chief items of direct testimony are statements by Costanso (van Hemert-Engert and Teggart 1910:132) that the houses are "hasta veinte varas de diámetro" and "contiene cada casa tres, ó quatro familias." This applies to one village. Crespi (Bolton 1927:163), referring to another village, says, "some of them so large that they house many families." Note that he says "some of them." On the other hand it must be pointed out that in the villages west of Gaviota the houses are clearly single family units. Fages uses the word "fuegos" instead of "casas," thus clearly implying small structures.

The over-all average of nine or ten persons per house appears to reflect a mixture of dwelling types. Such an average is definitely too large for uniformly single family units, yet it does not justify an assumption of four or even three families in all the houses. If in the big central villages there were a fair proportion of three to four family dwellings together with rather frequent single family houses, and if at the western end of the Channel all the houses were single family, then we could arrive easily at a minimum of ten persons per house for the entire area.

Turning now to the village populations cited by Crespi and others, we encounter the perennial problem of the reliability of contemporary witnesses. In the present instance it must be emphasized that these were exceptionally responsible and intelligent men with a background of profound experience, each of whom made a very serious effort to achieve an accurate account of his journey, one of great importance to both his church and state. Consequently it is most unlikely that there was falsification or deliberate exaggeration. The only unsettled question is whether they saw all of the natives who inhabited the villages that were visited. Here it must be argued that the reports did not include the total number of souls. In the first place, many of the infants, very small children, and some of the women would not be in the crowds that greeted the white men at each stopping point. In the second place it is repeatedly stated by the diarists that numerous men were absent fishing or visiting the islands, because many of the deep-sea canoes were not in their home ports. In the third place we have the surprising statement of Pedro Fages (Priestley 1937:32), referring to the stretch of villages westward from Carpinteria to Point Concepción, that they average about "six hundred men capable of bearing arms." Men capable of bearing arms would approximate one-third of the entire population. Hence one can interpret Fages' remark as indicating that the villages averaged about 1,800 inhabitants. Although we need not accept Fages' assertion without reservation, in view of the facts as a whole, we may with propriety increase the Crespi-Portolá figures by twenty-five per cent. A corresponding increase from 9.52 to 11.90 would be required in the estimate of the average number of persons per house; let us say, for simplicity, 12 persons. Based on a normal six members per family, this means an average of two families per house, a value which seems to conform to our other evidence concerning house sizes among the Chumash. If we now include all the 56 late culture sites of Rogers, the population of these villages alone would amount to 24,800 persons.

The final adjustment relates to the 56 sites. How many villages along the Santa Barbara Channel coast were actually inhabited in 1769? Crespi mentions 16 villages personally visited or observed by the members of the expedition; undoubtedly many others were missed or ignored in the written account. The first European to see the Santa Barbara Channel was the Spanish maritime explorer Rodriguez Cabrillo who sailed along this coast in 1542-1543. As quoted by Kroeber (1925), Cabrillo, through his pilot, Ferrel, listed in his diary 41 native villages. Kroeber points out numerous spelling variants and duplications which would reduce the number from 41 to 30. Cabrillo, however, did not describe the sector of the coast extending from Carpinteria eastward to the vicinity of Ventura. If we turn to Kroeber's (1925, pl. 48) map of the Chumash territory, we find that he shows as authenticated 29 settlements from Carpinteria westward to Gaviota, inclusive; 3 west of Gaviota to Point Concepción; and 8 from Carpinteria eastward to Ventura; making 40 in all. Thus Kroeber admits 29 on that stretch of coast for which Cabrillo claimed about 30 and where Rogers found 56 recent culture sites. Conceding readily that all of Rogers' sites probably were not simultaneously occupied either in 1542 or 1769, Kroeber nevertheless tends to be ultraconservative both in his interpretation of Cabrillo and in his allocation of villages according to the imprecise ethnographic data. There will be no great error on the side of excessive optimism if we increase Kroeber's estimate and decrease that of Rogers so as to allow 35 villages for the central portion of the coast, 8 for the sector east of Carpinteria, and 3 for the sector west of Gaviota. The total for the entire strip would then be 46 villages.

Finally we revise the earlier figure based upon Rogers' 56 sites. Using a total of 46 villages, an average of 37 houses per village, and 12 persons per house, we get a probable aboriginal population of approximately 20,400. The members of the Portolá expedition thought there was a minimum of 10,000 persons between Ventura and Point Concepción, but they probably did not see all the villages and underestimated the number of inhabitants of those they did see. Kroeber's guess of 10,000 for the entire Chumash tribe must be regarded as much too low. A range of 18,000 to 22,000 souls for the mainland coast alone is more likely to approach the truth.

V. HOUSE AND VILLAGE SIZES IN THE ABORIGINAL CENTRAL VALLEY OF CALIFORNIA

The size and dimensions of aboriginal dwelling houses are important for the description of settlement patterns and the estimation of population in primitive communities. We deal here with the problem as it relates to the Central Valley of California and its peripheral uplands.

As with other parts of California, two distinct and significant sources of information exist—ethnographic or historical documentation and the archaeological site records on file at the University of California Archaeological Research Facility at Berkeley. The former sets forth the results of observation by visitors more than a century ago or of tribal knowledge derived from informants, the latter consist of counts or measurements of house pits taken by students or faculty during field trips or surveys.

The data which are to be found in the site reports on file at the Archaeological Research Facility have been consolidated in Table 6. Here are shown, first, the conventional site designations, and then the tribe concerned and their habitat. Based upon tribal and ecological characteristics, four regions may be distinguished within the territory as a whole. The first consists of the foothill areas occupied by the Wintun at the northern end of the valley and extending down the west side as far as Yolo County. The second embraces the Sierra Nevada foothills in the possession of the Maidu and the Miwok as far south as Madera County. The third includes the foothills of the Coast Ranges in Stanislaus County, believed to have been occupied by the Yokuts, together with the Sierra foothills of Fresno and Tulare counties which were held by the Monache and Yokuts. The fourth region covers the valley floor or flat land from Red Bluff to Bakersfield, irrespective of tribal affiliation.

Next in the table appear measurements of house pits made at the inspection of a site and recorded in the files by field workers. Such measurements have been expressed almost invariably in feet diameter, occasionally as length and width. For area the former measurement may be converted by the ordinary formula $\pi \underline{r}^2$, and the latter by the formula for the area of an ellipse. Each site has been treated as a unit. Where several pits were seen at a site and a range of size is mentioned, the midpoint of the range should be used for the calculation of area. The table presents the original data in feet diameter unless otherwise indicated. Finally, notes are added as they appear in the Facility site records. For comparative purposes the values obtained for floor area at each site are averaged within each region and the result placed in the summary to the table.

Before accepting the mean values for floor space some discussion is necessary. Let us begin with the area which includes the lower foothills surrounding the Sacramento Valley, in possession of the Wintun, from north or northeast of Red Bluff southward to the Sacramento Delta. There are seven sites from which pits (or houses) with diameters ranging from 4 to 14 feet are reported. These are clearly small, standard, single family units such as are seen throughout large sections of Central California. In addition there are two sites, Teh-95 and Gle-10, which show a single pit, respective sizes being 30 by 30 feet, and 40 feet in diameter. These are recorded as a "sweat house" and a "dance house." There is no reason to question the diagnosis, and hence it is evident that the size of the pit may segregate dwelling from ceremonial structures. Moreover it should be emphasized that the maximum diameter reported for an ordinary dwelling house is 14 feet.

In the second region, occupied by the Maidu and Miwok in the Sierra Nevada foothills, there are eight sites, from which are reported pits from 10 to 22 feet in longest dimension, again clearly single family dwellings. In addition, however, there are on record eight sites at which much larger structures were found. These measured from 12 to 52 feet in diameter. Three of them are designated "dance house" (But-65, But-94, Mrp-2), one a "former sweat house" (Mad-29), and one a "present sweat house" (Mad-37). Concerning the last there can be no doubt whatever; concerning the others very little doubt that they are correctly identified by the field observers as pits for ceremonial structures. At each of three other sites (But-66, But-84, Eld-73) only one pit was found and the observers assumed that it was the remains of a dance or sweat house. Important villages which were tribelet centers or "capitals" in which the tribelet chief lived usually contained a ceremonial house (Kroeber 1932:257-259; 1962).

At this point particular attention should be called to sites Mrp-2 and Mad-37, for here the two types of pit occur together. At Mrp-2 there were 15 house pits ranging in diameter from 14 to 22 feet, plus a dance house pit of 52 feet in diameter. At Mad-37 there was at least one house pit 18 feet in diameter, plus the present sweat house of 33 feet in diameter. There can be little question, therefore, that in this area the dwellings did not exceed 22 feet in diameter and that the large pits represent ceremonial structures.

The third region includes sites on both sides of the valley, all of which were probably occupied by Yokuts and tribes of the Mono stock. To the west there are two sites, Sta-129 and Sta-130. At the former was found one pit 33 feet in diameter, with no further description; at Sta-130 there was recorded one pit 47 feet in diameter, designated as a "large dance house," and another pit 35 feet in diameter described as a sweat house. Additionally, there were two pits, each 14 feet in diameter, reported as being dwelling houses. The diagnosis here again may be accepted as correct.

To the east, in the foothills of Fresno and Tulare counties, there are twenty sites reported which show house pits ranging from 6 to 20 feet in their longest dimension; no larger pits were recorded. Consequently there can be no alternative but to consider all the listed pits as being those of dwellings of the single family type.

For the fourth region, the flat valley bottom, the data unfortunately are very scanty. The native groups were wiped out as social entities by 1820 and for more than a hundred years their homesites have been converted to farm land. As a result there are only eight sites at which house pits of any description are on record at the Archaeological Research Facility, although there are a few additional ones mentioned by Schenck and Dawson (1929).

The Facility files begin with Teh-34, Teh-53, and Col-10, at which sites the pits range from 7 to 15 feet in largest dimension, clearly single family dwellings. To these may be added Mer-43 with several pits 18 to 20 feet in diameter. It is these four sites which provide the floor space figure in the summary to Table 6.

There are four additional sites which require comment. Sac-111 and Sac-117 showed a single pit, in each case 25 feet in diameter. There is nothing in the size of the pits or in the site descriptions to indicate the nature of the original structures. At Mer-58 there was one "dance house pit" of 43 feet in diameter, plus twenty others for which no dimensions are given but which presumably were small. Hence the single large pit probably was indeed that of a dance house. At Mer-89 there were two large pits, 35 and 45 feet in diameter respectively, plus others of doubtful number and size, presumably smaller. The large pits may or may not have been those of dance or sweat houses.

One conclusion emerges from the preceding analysis: in the Central Valley and adjacent hills there were two clearly distinct sizes of buildings. The smaller may be regarded without much doubt as single family dwellings; they are overwhelmingly the dominant type in the hill areas regardless of tribe. The larger, in certain instances, must be considered to represent sweat or dance houses, particularly where a single one is found in close propinquity to a cluster of smaller pits. Where one is found alone, especially on the floor of the valley, there is a distinct possibility that we are dealing with a large, multifamily or communal unit. To what extent this is true cannot be determined by the existing—or probable future—field data secured at the sites concerned. In the meantime we may state with some assurance that the normal house type, even in the lower foothills, was the single family structure.

Verbal and documentary evidence comes to us from two sources. The first consists of several accounts written by explorers, missionaries, and soldiers in the early nineteenth century. Many of these have been translated (e.g. Cook 1955b, 1960, 1962) and may be utilized in the English version. A number of them contain information of value concerning village and house organization.

1. The diary of Father José Maria de Zalvidea: In 1806 this missionary visited the villages on the northern slopes of the Tehachapi Mountains directly facing the southern San Joaquin Valley and also the villages on the shore of Buenavista Lake. One of the places seen was Cuia, in the range of the Yokya Chumash, which had nine houses and 41 persons, or 4.56 persons per house. Another was Sisupistu, a village of the tribelet Hometwoli, at the eastern end of the lake. Here Zalvidea counted 28 houses and 50 to 60 men. From enumeration ratios it has been estimated (Cook 1955b:54) that this number indicates a total population of 180 persons, or 6.43 per house. It would appear, therefore, that in this area there were small, single family dwellings.

2. A letter written by Father Juan Martín (Cook 1960:243): This priest visited Tulare Lake in 1804. He went to the village of Bubal, the principal residence of the Wowol. At the end of his third day of travel Father Martín arrived at the first "suburb" of the village and named it La Salve. The heathen concealed their women in "some little huts," but later allowed them to come out. In the evening the party was visited by people from the "main village" which was some distance away. It is clear that La Salve was a small village, peripheral to Bubal, and contained small dwellings, probably single family ones.

3. The diary of Father Ramón Abella: In 1811 this missionary traversed the delta region by boat and ascended the Sacramento River nearly to the city of that name. On his return Father Abella encountered the territory of the Tauquimenes (Cook 1955b:57). The main village had 60 houses and 1,000 people. The houses "teinen en circuito 28 ó 30 varas, con su orcon en medio." A vara is approximately 33 inches; hence the houses were about 990 inches or 82.5 feet in circumference. This means about 26 feet in diameter and 408 square feet in area. If there were 1,000 inhabitants, there would have been nearly 17 persons per house. This figure may seem excessive, yet Abella writes that the first or main village "habrá como unas 1,000 (almas) según lo grande que por aquí son las casas." The indication is therefore that the figures cited represent a considered judgment.

At one league downstream Abella saw another village of 14 houses, and farther on villages of two or three houses. There was evidently a system of main plus suburban villages.

4. The diary of Father Narciso Durán: In 1817 this priest visited the delta and reported on the houses in two villages. One of these, of the Ochejamnes, had 40 houses; the other, of the Chucumnes, had 35 (Cook 1960:274-275). With regard to the latter Durán says explicitly, "We counted 35 houses, some 20, 40, or 50 paces in circumference, a fact which

indicates a large number of people." Note that Durán here says "pasos" (paces), not "varas." The Academy Dictionary lists the "paso geométrico" as being 5 feet, 1,393 millimeters, or 57.6 inches long. Hence these houses would have been from 16 to 40 feet radius and 803 to 4,520 square feet in area. These are truly enormous dimensions; if the pasos of Durán are taken as varas, then the radii are 8.8 and 21.9 feet, and the areas 243 and 1,506 square feet respectively. However, at this point consideration should be given the statements of Estudillo.

5. The diary of Lieutenant José Maria Estudillo: In 1819 this officer conducted a military expedition to the San Joaquin Valley, during the course of which he made a careful examination of the village of Chischa in the Sierra foothills, probably on the middle Kaweah River (Cook 1955b:47). The population was estimated at 1,250 souls, the area at 80,000 square varas or 608,000 square feet. However, the point of greatest interest in the present connection is that Estudillo designated the value of the paso as it was used in Spanish California. He gave dimensions for Chischa as 358 pasos <u>or</u> 626.5 varas long, and 432 pasos <u>or</u> 756 varas across. Hence one paso must equal 1.75 varas or 57.6 inches.

6. The diary of Luís Arguello (1821): This is the account of his famous expedition from San Francisco up the Sacramento Valley, westward to the coast, and back down to San Francisco. Between Suisun Bay and Red Bluff he saw a dozen or more villages which he stated had a population of 500 to 1,000 or more. These all appear to have been located on the banks of the Sacramento River or at the mouths of its tributaries.

Apart from the Spanish-Mexican explorers, there are statements by Americans who early entered the valley. These people repeatedly mention villages of anywhere from 100 to 1,500 inhabitants. In fact the unanimity of opinion on this point is so overwhelming that, in spite of assertions by modern ethnographers, it cannot be seriously doubted that up to 1830 numerous villages of this size were to be seen along the courses of the main rivers from north to south. Concurrently the house number is generally put at 20, 50, or 100. Hence we must think in terms of 5 to 15 or more persons per house.

One of the earlier visitors was John Work, who came down from the Columbia River in 1832. He says (1945:20) that north of Butte Creek "the Indians...dwell in holes in the ground of a conical form." Among the Maidu on the lower Feather River in one village Work (1945:25) counted 28 houses, sunk in the earth so as to resemble "a round hillock." Near Oroville he saw (<u>op</u>. <u>cit</u>., p. 32) four villages of 40 to 50 houses each. These all evidently were single family dwellings.

In the years 1832 and 1833 American explorers entered the Central Valley, primarily as beaver trappers. Among them was J. J. Warner, who later settled in Southern California. He is quoted in An Illustrated History of San Joaquin County, California (1890:28) as saying, "In the fall of 1832 there were a number of Indian villages on Kings River, between its mouth and the mountains; also on the San Joaquin River from the base of the mountains down to, and some distance below, the great slough. On the Merced River from the mountains to its junction with the San Joaquin there were no Indian villages; but from about this point on the San Joaquin, as well as on all of its principal tributaries, the Indian villages were numerous; and many of these villages contained from 50 to 100 dwellings, all of which were built with poles and thatched with rushes."

The Hayes Mission Books at the Bancroft Library in Berkeley, which were assembled by Benjamin I. Hayes of San Diego in the 1860's, contain a newspaper clipping signed by "Trapper," the pen name of someone who was on Ewing Young's expedition of 1832, and who very likely was J. J. Warner. He stated, "The banks of the Sacramento and San Joaquin, and the numerous tributaries of these rivers, and the Tule Lake, were at this time studded with Indian villages of from one to twelve hundred inhabitants each. The population of this extensive valley was so great that it caused surprise, and required a close investigation into the nature of a country that without cultivation could afford the means of subsistence to so great a community."

Later visitors commented repeatedly upon the great loss in population caused by the epidemics of 1833 and subsequent years, and referred frequently to the great size of the former villages by way of contrast with the pitifully small remnant found after 1835. It is very clear that by 1849 the riparian tribes had in effect been obliterated. (For a more extended discussion of these matters see Cook 1955a, 1955b.) One result of this extreme disintegration has been that informants in the early years of the twentieth century were unable to convey to ethnographers an adequate quantitative picture of native culture along the big rivers of the Central Valley. Nevertheless considerable information of value has been recorded.

In the northern valley house sizes have been described by Dixon, Kroeber, and McKern. Dixon (1905), writing of the Northern Maidu, states that he found two types of permanent houses among the groups in and bordering on the valley. Type 1 consisted of a circular or conical house 6 to 12 meters in diameter which would be occupied by "several families," and was most common in the valley proper. Type 2 was found in the foothills, and was 2½ to 5 meters in diameter. Most villages contained from one to 20 houses of type 1. The area range for type 1 is 301 to 1,216 square feet; for type 2 it is 53 to 211 square feet. The latter type is undoubtedly a single family dwelling, and can scarcely have been much less than 150 or 200 square feet in area.

Kroeber (1929) described the Southern Maidu of the Feather River Basin and stated that the houses were of the single family type and that "a village might have six or seven houses." This is a long way from the assertions of Work and other contemporaries, that there were many villages in this region of 50 to 100 houses. In a later paper Kroeber (1932) said that the Wintun had houses on the style of the Patwin, but that they seemed to have been smaller. The Patwin houses have been the subject of a paper by McKern (1923), who bases his text on the testimony of an informant from near Colusa, and describes in detail the construction of houses but gives the sizes of only two. These had respective dimensions of 18 by 22 feet and 23 by 28 feet, or 396 and 644 square feet in area. These values lie within the lower portion of the range of Dixon's type 1 houses of the Maidu. The maximum diameter, according to McKern, averaged 30 feet, or 706 square feet. It is very difficult to see how more than two families or one extended family could live in such a house.

Concerning the delta and the lower San Joaquin River, there is hardly a whisper of ethnographic evidence. The Indians acquainted with this region were so nearly destroyed prior to 1850, the earliest birth date for a reliable modern informant, that we quite lack any substantive cultural data. For the upper San Joaquin and Tulare Lake area we have the significant work of Gayton and of Latta, together with a discussion by Kroeber.

To summarize Gayton's (1948) data: the Chunut and Tachi on Tulare Lake had an oval house, stated to be the most common type in the valley. This was a communal edifice, housing several families. The Bankalachi of upper Deer Creek in the foothills had a conical, single family house. The Wükchumni had a conical house which varied with the size of the family. The Choinimni in the lower foothills had a house which on the average held a family of six; no dimensions are given. The Kechayi in the foothills of the San Joaquin River had a one-room, circular house, 10 feet in diameter, which held a single family. The floor area was 78.5 square feet. The Chukchansi in the Fresno River foothills had a conical house, 12 to 14 feet in diameter, or 133 square feet in area, which held one family. The Michahai and Waksachi of the Kings and Kaweah river foothills had a conical house 9 to 12 feet in diameter, or 87 feet in area, which contained a single family.

F. F. Latta has written two books, of which the more important here is the Handbook of the Yokuts Indians (1949). Latta states that the Yokuts of the valley, as opposed to those of the foothills, built at least five types of dwellings. The permanent houses varied from 10 to 12 feet in diameter to a much larger size. There was a communal house which might reach a length of 300 feet, and might be used by many families. These structures were found among the Wowol, Chunut, and Tachi, also probably among the Tulamni, Tuhohi, and Hometwoli—all valley tribelets. It is suggested by Latta's discussion that these big houses were destroyed by the Spaniards in the early years of the nineteenth century and that they were replaced by smaller dwellings.

The Yauelmani on the lower Kern River built similar, but smaller, houses. Thus a description by T. A. Baker (Latta 1949) of houses in 1863 near Bakersfield shows that the Indians were living mostly in oval shaped shelters, 10 by 15 feet in dimension. It has also been a general observation that the Yauelmani, together with the Wechihit and Apiachi, built a small tule house of oblong shape, probably not larger than 10 by 18 feet. The Yaudanchi built conical winter houses of 12 to 15 feet in diameter, and similarly the Chukchansi and Gashowu. Latta (1949) also gives a description by T. J. Mayfield of the typical house of the Choinimni on upper Kings River. There was one circular room, 10 to 20 feet in diameter, with a smoke hole in the top.

Kroeber (1925:521) lists five types of Yokuts houses. The first is the communal house characteristic of the Tulamni, Hometwoli, Wowol, Chunut, and Tachi: "These houses sometimes ran to a size where they accommodated a little more than 10 families." The second was a modification of the first style, found among the Yauelmani, which "approached" the first style in size. The third type is seen among the valley tribes Wechihit and Tachi, who "today build small tule houses" which are elliptical in form. The fourth was built by the Yaudanchi, Chukchansi, and Gashowu, hill tribes. It was a conical tule dwelling of small size. The fifth was a bark structure similar to the preceding.

The work of these three investigators makes it clear that as far as living memory is concerned, the big communal house never existed beyond the limits of the flat valley, and in the valley itself disappeared at or about the time of the Caucasian invasion of 1800 to 1835.

Considering now the written reports as a whole, certain conclusions appear valid. There were two primary aboriginal house types extant in the Central Valley and neighboring foothills: a large, communal structure which we may designate, following Dixon, as type 1; and a small, single family unit, type II.

Type I is reported from the delta by Abella (1811) and Durán (1817), both of whom took measurements. By inference from village populations and house numbers, the communal house was seen by Arguello (1821) in the Sacramento Valley and by Warner (1890) and "Trapper." These dwellings were also reported by the informants of Dixon, McKern, Gayton, Latta, and Kroeber for riparian villages from the Northern Maidu to the Southern Yokuts. But nowhere is there a trace of type I houses in the foothills, even at the margin of the valley floor. On the other hand, type II is described from hill areas by Zalvidea (1806) and other Ibero-American explorers, together with nearly all the modern ethnographers. The two types therefore conformed to the terrain very closely, in that type I was restricted rigidly to the river and lake bottom lands whereas type II was universal in the uplands.

The data for size indicate that the communal house could vary within wide limits, apparently in accordance with population and space requirements. Hence we have measurements and estimates of from 400 to 4,500 square feet floor area, or even larger if we allow for Latta's 300 foot building. On the other hand, the house of type II is reported very consistently as being of from 100 to 400 square feet.

If we concede the aboriginal distribution of types as outlined, then we have to account for the almost complete disappearance of type I by the 1850's and its replacement by type II, even on the valley floor. The reason is rather clear. The construction and maintenance of the large, multifamily dwelling required, first, level land such as was provided by the broad river flats, and second, a stable society. The second criterion was satisfied by the large, well ordered village and its satellites as they originally existed, backed by a copious, reliable food supply such as could be derived from the rivers, lakes, and marshes. On the other hand, the equilibrium was delicate, and there was little reserve economic strength in the culture. When the Spaniards or the Americans struck, they disrupted the going concern, destroyed the food supply, devastated the villages, dispersed the families by missionization, slavery, disease, and massacre. Hence the survivors simply did not have the material, or probably the emotional, resources wherewith to erect and occupy the big houses. They were forced, if they remained in the old habitat, to adopt the flexible, mobile, inexpensive style of existence provided by the small, single family dwelling, a manner of living to which the hill tribes were already well adapted.

The archaeological site records, as shown in Table 6, now find a logical explanation. The universal occurrence of the single family house in the upland areas merely reflects ancient usage and is to be expected. The occasional appearance of a solitary large house pit undoubtedly indicates the former presence of a sweat or dance house, whether or not so designated by the field observer. At those very few sites in the flat valley where pits of any kind have been discovered, the majority are of the small house type and probably demonstrate the tendency manifested in the past hundred and fifty years to adopt this style as a substitute for the communal dwelling.

The single large pits found at sites Sac-111, Sac-117, Mer-58, and Mer-89 might be regarded as representing communal houses. However, one factor militates against such a conclusion: in three of the four cases mentioned there is one such pit and no others; at Mer-89 there are two. Now the big villages along the rivers are repeatedly described as containing many large houses—up to at least one hundred. The smallest settlements to which I have seen reference are those spoken of by Abella (1811) as consisting of two or three houses. Hence it is very surprising to encounter no archaeological sites showing more than two large pits. One would suppose that if any of the big dwelling house pits survived at a given site some of the others also would persist. As a result we are forced to assume that the pits at the four sites listed above are the remains of relatively recent special purpose structures, such as dance houses.

It follows that the quantitative settlement pattern of the prehistoric Central Valley is all but lost to us, for the population and house data which we possess cannot be tied to specific sites or villages. However, in general terms and for working purposes some very broad estimates can be ventured. These are based upon the evidence presented previously, which is consolidated for convenience in Table 7.

As a first approximation we have records of 375 sites from Red Bluff to Bakersfield which show a geometrical mean of 25,400 square feet in area. Contemporary accounts frequently indicate a population of 750 persons distributed through about 50 houses. From the figures in Table 7 it appears that 1,000 square feet is a fair estimate of average floor space. This would mean 15 persons per house and 67 square feet of floor space per person. However, certain adjustments appear necessary. An average house number of 50 is too high; the mean of six figures cited for the valley in Table 7 is close to 40. But this (except Dixon's value of one to 20) represents the largest villages which came to the attention of visitors prior to 1850. We must remember Abella's description of the Tauquimnes who had several villages—one of 60 houses, one of 14, and several of one or two. The mean here is 16 houses. Hence, in order to be conservative, we may cut the estimate of 40 in half and allow an over-all average of 20 houses. It is also probable that the number of families, or their equivalent, inhabiting each house reached at least to three, that is to say 18 persons. With a floor space of 1,000 square feet, which seems reasonable, the area per person would be nearly 56 square feet.

Finally, the mean site area of 25,400 square feet seems too small. If one considers that a house with 1,000 square feet of floor space, plus peripheral space for all sorts of domestic activities, would have to preempt fully 3,000 to 5,000 square feet of the site area, it is clear that the total site area would have to exceed 10,000 square feet if more than two houses were to be accommodated upon it. Following this line of reasoning, we may delete the 83 sites listed in the Facility records as being less than 10,000 square feet in area. We then get for the 292 remaining sites a geometrical mean of 41,400 square feet. These values are admitted to be little more than rough surmises, yet they may well lie within the realm of probability for the long extinct valley communal villages.

VI. HOUSE SIZE, SETTLEMENT AREA, AND POPULATION THROUGHOUT NORTHERN AND CENTRAL CALIFORNIA

Part 1

The numerical data which are available to us concerning house sizes, village or site sizes, and population have been examined for three areas within the state of California: the Central Valley, the Santa Barbara Channel, and the lower Klamath River. As a preliminary to examining demographic and ecologic interrelationships through a world-wide spectrum of conditions, it is desirable to assemble all possible information for a territory of moderate but substantial extent, and to tabulate this information in such a manner that it can be made the basis for computation. It is also advantageous if the territory involved can be broken up into smaller units, each representing a region more or less homogeneous in nature and each containing a sufficient number of settlements and people to permit an internal analysis as well as a comparison on a broader basis with other regions. In other words, we might work on two levels, one regional or local, as was done with the Yurok, the other territorial, as could be done with an entire state, country, or civilization.

California provides an admirable laboratory in which to test these ideas, both because the state can be divided into a series of regional units on the basis of aboriginal habitation as well as geographic variation, and because an unusually large amount of information has been accumulated with respect to these units and their ethnography and archaeology.

The first step is to assemble the pertinent data. To this end we have examined as much of the published material as we have been able to find and have scrutinized the file of site records at the Archaeological Research Facility (Berkeley). The results of these inquiries are presented here in the form of two tables.

The first, Table 8, shows those figures at our disposal for several parameters, of which three may be regarded as primary: house size (floor space); village size (site area); and population. House size is expressed as area in square feet, and is calculated from written statements or measurements of linear dimensions. In almost all instances (except the Yurok and Chumash) site area is obtained from the archaeological site survey records. Population cannot be computed from direct estimates of tribal or regional totals because we rarely know how many villages were occupied at a particular time. Hence we rely upon number of persons per family, number of persons per house, and number of houses per village to determine population. Occasionally, but infrequently for California, figures for the number of persons per village are immediately available.

In addition to the above mentioned categories, Table 8 contains several derived magnitudes which are of use for various purposes. Among these are floor space per person, mean total floor space per village, mean square feet of village space per house and per person, and the ratio of floor space to village area. The table also shows a great many gaps and lacunae. This characteristic is referable to the extreme scattering of information in the sources. A single item or figure must often be picked from this or that author and inserted where appropriate as an isolated fact in the table. The complete estimate which accompanies the data for each region must then be formulated, rarely from a single authoritative statement, occasionally by a solid average, but most frequently by utilizing sense and judgment. Thus the results are in a certain measure subjective, and indeed in some instances it has been regarded as preferable to submit no estimate at all rather than to rely upon an almost wholly unsupported guess.

The total number of regions for which sufficient house-site-population estimates can be obtained is thirty. The division initially followed ethnographic lines, that is tribal affinity as established by Kroeber and his students throughout five decades. Thus the Klamath River tribes are considered separately by tribal group (Yurok, Karok, Shasta), and the Yuki and the Pomo are kept as individual units. Secondarily, distinctions have been made along geographic lines both intra- and inter-tribally. These distinctions are based upon two additional factors. The first is the ready availability of data; for instance there is copious, easily segregated information on four groups of the Wintun stock—(1) the Wintu of the Trinity River; (2) the Northern Wintun on the upper Sacramento River; (3) that portion of the Central Wintun who lived on Stony Creek; and (4) the Southern Wintun inhabiting Cache Creek, Putah Creek, and their affluents. The second factor is the lack of data imposed by historical accident. This deficiency in turn necessitates the consolidation of minor regions which on edaphic grounds might deserve separate treatment. For instance, the early destruction of the Athabascans necessitates the use of their territory as a whole. The wiping out of the big river settlements means that the entire Central Valley has to be regarded as a single region. Finally, certain areas are omitted simply because there are no data whatever pertaining to them. Of these the most conspicuous are the periphery of San Francisco Bay and the habitat of the Costanoans and Salinans in the central coast ranges. Although numerous archaeological sites have been recorded, there is complete ignorance regarding details of dwelling construction, family size, and village population.

Of the 30 regions mentioned, 26 are placed in Table 8. The other four are discussed separately in Part 2 of this section. The 26 areas are those in which it is generally acknowledged the predominant, if not the exclusive, house type was that which held a single family, sometimes perhaps an extended family, but never more than an average of eight persons. The calculations for, as well as the characteristics of, these regions are more or less uniform. They can therefore be handled conveniently as a single group in the same table.

The remaining four regions all possess the feature which they contain—multifamily or communal houses—to a significant extent. Each region must consequently be examined carefully and independently in order to arrive at as much as a first approximation of area-population relationships. Two have already been discussed in previous sections, the Central Valley and the Santa Barbara Channel. The others, the interior Pomo and the Wappo, are considered in Part 2 of this section.

A fifth region constitutes a special case: this is Santa Rosa Island for which extensive site records are on file at the Archaeological Research Facility. This island was inhabited by the Chumash, and the population was high at the time of the Spanish occupation. As has been shown by Orr (1951), there undoubtedly were on the island many houses of the communal type similar to those seen on the mainland. However it is probable that they were in the minority. The problem is discussed in Part 2 of this section, but the final decision has been to include Santa Rosa Island in Table 8 in so far as the single family dwellings are concerned, and then to place the estimates adjusted for the communal houses in Table 9.

Part 2

The data for single family houses have been set forth exhaustively in Table 8 and the notes thereto. There still remains the problem of the communal dwelling and its relation to population and area. The situation in the Central Valley and along the Santa Barbara Channel have already been discussed. These areas need not be considered further in detail, although since the final estimates are included in Table 9 some brief recapitulation is desirable.

For the Central Valley it was shown that the communal house would accommodate two to four families, had perhaps 1,000 square feet of floor space, and was present to the extent of about 20 houses per village. Actually, if we average four estimates of floor space derived from two contemporary observers and two modern ethnographers, we get 1,130 square feet for floor space. Similarly, averaging seven estimates of houses per village we get 42 structures. But it can be shown that some of the contemporary observers noticed principally the larger villages; hence 42 is probably a serious overestimate. The missionary, Father Ramón Abella, exploring the delta, found a tribal complex which consisted of one village with 60 houses, one with 14, and "several" with one or two houses. Calling "several" equal to three, the average is 16 houses. Therefore we take 20 as a fair approximation. The maximum number of families per house is four, three would be more common, and two perhaps even more frequent. A count of three families, with 18 persons, is reasonable. For site size it was decided that sites under 10,000 square feet could scarcely accommodate these big houses in any significant number; hence those sites in the Archaeological Research Facility records which were under 10,000 square feet were omitted. The 292 remaining sites average 41,400 square feet. The figures here underlined have been included in Table 9.

With regard to the Santa Barbara Channel Chumash, we have calculated an average of 37.1 houses per village. The direct evidence at hand does not allow an estimate of more than two families or 12 persons per house. However it is known that these data include a number of villages at the far western end of the Channel which clearly contained single family dwellings. Although these villages had to be considered in an evaluation of the total population of the region, for the present purpose of studying the settlements with communal houses they may be disregarded. Therefore the figures cited above may be arbitrarily increased somewhat, say to 2.5 families and 15 persons per house. The mean area of the sites was found to be 101,000 square feet. For the floor space there is no direct record.

The only statement we have encountered is one by Kroeber (1925: 557) that the Chumash house was large, up to 50 feet in diameter. If we regard 50 feet as the extreme, then the range may well have been from 30 to 50 feet, with a possible average of 35 or 40 feet. Using the latter value, we get an area of 1,257 square feet or, rounding it off, 1,250 square feet.

We next consider the interior Pomo, those inhabiting the Russian River watershed and the Clear Lake Basin. For the coastal Pomo there is agreement that the standard house sheltered a single family. Regarding the others there is room for argument. Our knowledge of this segment of the tribe comes from several accounts of conspicuously large villages. Of these the most famous is Senel, or Shanel.

Stephen Powers (1877:168) described this village and drew a careful map of it. There is no reason to question either his accuracy or his veracity. He shows 104 houses (plus five assembly houses). The dwelling houses contained 20 to 30 persons each, which would mean a population of 2,000 to 3,000 persons. However he also says that the five asembly houses could hold 100 men each, implying a population of 1,500 or 14.42 persons per dwelling house. The latter number is supported by an informant of Stewart (1943:45) who said that Senel had 1,500 people.

Stewart also mentions that his informant said the Hopland tribe had 1,500 people. Kniffen (1939:375) mentions the village of Kacha in Sherwood Valley with 12 houses and 125 people, or 10.4 per house. Merriam (1955:41) speaks of the Yokaia Pomo who built houses 40 to 50 feet in diameter and whose ceremonial houses would hold several hundred people. Gifford's (1926) notable study of Cigom, on Clear Lake, showed this village in 1850 to have had 20 houses, with 2.35 families and 11.75 persons per house. The aboriginal value was probably higher, let us say 2.5 families and 15 persons. Barrett (1908, *passim*) describes 34 villages in his day, which had an average of 7.35 houses per village, and this included the remote hill settlements. Kroeber (1925:241) says that the Russian River Pomo had houses which "often sheltered several families," and that the Clear Lake Pomo had elliptical houses with a long axis of 25 to 30 feet, although certain "poor and old people, and individual families were content with an humbler abode."

It is clear that there was a great range of house sizes and types. They held from one to four families, but on the average can be regarded as containing 2.5 families or 15 persons. The floor space must have corresponded. If we think in terms of circular houses, Merriam's figure would be 1,595 square feet. Kroeber's oval house of 25 by 30 feet would be about 600 square feet. The Archaeological Research Facility records show an average of 124 square feet as the mean of the pits at four sites on Clear Lake. A reasonable, even if not wholly satisfactory, compromise will be 900 square feet for the area.

The number of houses per village presents a similar problem. The Archaeological Research Facility records show a mean of 5.0 house pits for 42 sites. Barrett found 7.35 houses as an average in the decimated villages of 1908. Gifford saw 20 houses at Cigom. There were 12 at Kacha and 104 at Senel. The problem of decision here resembles that encountered in the Central Valley; namely, to allow for numerous villages with several big communal houses without overemphasizing this element. Barret's figure of 7.35 houses per village may be taken as a minimum in spite of the archaeological site records. If we have 34 villages with 7.35 houses each, plus one Senel, one Cigom, and one Kacha, we have an average of about 11 houses per village. However there were many more big villages than these three; hence we ought to increase materially the probable number. An estimate of 15 houses per village is as close as we can come.

The site area can be computed only from the Facility records which are reasonably complete for the Pomo territory. The mean of 182 sites is 24,750 square feet.

The valley Wappo, which includes the groups sometimes designated Western, Central, and Southern Wappo, have been thoroughly studied by Driver (1936). His analysis of Alexander Valley shows six permanent towns, of which four had 40 houses each and two had 9 and 11 respectively; the average is 30. Specifically, in 1870 the village of Unutsawaholma had 11 houses, 21 families, and 92 persons. Thus the average number of families per house was 1.91, persons per house 8.35, and persons per family 4.5. Aboriginally, Driver's informants said, there were 17 houses, and the family number certainly can be taken as 6.0. This gives, at 2 families per house, 12 persons per house. After making various correlations, Cook (1956:122) assigns 23 houses to each village of this group, a figure probably nearer the truth than the 30 suggested previously.

One factor is still undetermined. What other villages once existed in the area besides the six studied by Driver? Driver himself mentions nine others, most of which he designates as camp sites. However Merriam and Barrett have both cited names which may have been those of villages unknown to Driver's informants. Hence the actual number of villages may have reached as high as ten or twelve, many of them small. If so, we shall have to reduce the probable average number of houses per village from 23 to, say, <u>15</u>.

One other minor bit of evidence is pertinent. Merriam, in his village lists (see Cook 1956:124), mentions the village of Mi-yahk-ma, which occupied the area surrounding Calistoga. Barrett (1908:269) also mentions this village plus three other smaller ones nearby. It is likely that here was a tribelet with one large and three small settlements. The total population may well have been close to 500 persons. Hence, at 12 persons per house, the total number of houses would have been 41.6 and the average for the four villages 10.4. It seems reasonable, therefore, to accept <u>15</u> as the mean value for houses per village.

With respect to house size, Driver (1936:189) says that the houses were "typical of the area," and were oval in shape with the long axis up to 40 feet. If the short axis be taken at 30 feet, the area is <u>942</u> square feet, not far from the area estimated for the Pomo. Site size can be evaluated only from the records of the Archaeological Research Facility. A mean of 48 sites in Napa Valley gives an average of <u>19,350</u> square feet.

The remaining region which contained multifamily or communal houses and for which we have area figures is Santa Rosa Island. Apart from the fact that the inhabitants were tribally related to the mainland Chumash and hence might be expected to have similar customs regarding dwellings, we have independent evidence from the archaeological work of Phil C. Orr. In his descriptions of the island sites Orr (1951:221) distinguishes between six classes of sites. With respect to size, there are actually only two types: class 1, large house pits; and class 2, small house pits. The former are said to be 40 to 60 feet in diameter, the latter 10 to 20 feet. Using the midpoints of the ranges, the respective areas would be 1,960 and 177 square feet. However, it might be permissible to use the lower estimate for class 1, and say 40 feet in diameter and 1,260 square feet in area.

The difficulty in using Orr's classes lies in tying their occurrence to the corresponding site areas. The Facility has records of sites on Santa Rosa Island which include seven sites with house pits which are specified as belonging to Orr's class 1, and 48 sites where the pits are class 2. The respective geometrical means for area are 25,200 and 25,000 square feet, almost an identity. However one site which contains nine class 1 house pits is stated in the record to have an area of approximately 5,300 square feet, impossibly small and undoubtedly an error. Deleting this site, the mean of the remaining six sites is 32,750 square feet. Even with this correction, the difference in area is not consistent with what one might anticipate with sites containing such diverse types of dwellings.

Concerning the number of persons per house, we have no information whatever except that class 2 was clearly a single family structure. For the others we might use the Channel Chumash value of 2.5 families and 15 persons, but we have no real warrant for doing so.

The counts from the Archaeological Research Facility records of number of houses per village give averages of 8.2 for class 1 and 12.7 for class 2. These are both lower than would be expected on the basis of general description and knowledge of the Channel Islands. On the whole, we are forced to seek some intermediate solution rather than try to formulate different sets of numerical values for two utterly diverse house systems existing side by side and from site to site within a very small total area. Consequently we consolidate the data according to the observed frequency of occurrence of the two types of house, and for simplicity place the results in Table 8 among the regions characterized by having predominantly single family dwellings. This procedure would have to be adopted regardless of whether or not Orr's classification is accepted as valid.

The records show seven sites of class 1 with 57 house pits, and 23 sites of class 2 with 292 house pits. The floor area of a class 1 house is taken at 1,260 square feet and that of a class 2 house at 180 square feet. There are in all 30 sites with 349 house pits, an average of <u>11.6</u> per site or village. The average floor space for the 349 houses would be <u>356</u> square feet. If the big houses held 15 persons and the small ones six persons, then the average number of persons per house would be approximately <u>7.5</u>, and the number of families per house 1.25. For site area the group mean is close to <u>25,100</u>.

Part 3

The figures for the 26 regions featured by single family houses (including Santa Rosa Island) have been repeated in Table 9 and with these have been placed the final estimates for the four regions in which communal houses predominated. These are all mean values for the regions concerned, and when we discuss them we are of course operating on the interregional or intertribal level, <u>not</u> on the intraregional or local level. The data will be examined briefly, and detailed analysis will be reserved for future publication. At this point we wish to determine in a preliminary manner whether there appear to be any close associations or systematic differences among the thirty areas.

The three key magnitudes shown in Table 9 for each region are: (1) the total floor space—equal to mean floor space per house multiplied by mean number of houses per village; (2) the mean village or site area; and (3) the mean estimated population per village. When we equate the first with the third parameter we get on a regional basis the equivalent of Naroll's (1961) function: log total floor space against log population. The result is shown in Figure 8. The log-log relationship is very clear in graphic form. The corresponding value for r is +0.945, which is highly significant. For the slope b we get + 0.622 when we take floor space as the x-axis, and +1.437 when population is used as the abscissa. There can be no further question, therefore, that the logarithmic function holds with floor space for interregional means as well as for scattered single village data as reported by Naroll.

The analogous formulation for log mean village size or site area against log mean population is seen in Figure 9. Here the picture is very different. Let it first be remembered that high correlations and a logarithmic relationship were found <u>internally</u> for log village size against log population in three regions, viz. Tierra del Fuego, Klamath River, and Santa Barbara Channel. Figure 9, illustrating 30 regions, shows rather wide scattering of the points, and r is only +0.374, a value of distinctly mediocre significance. New factors have entered to disturb the logarithmic function.

It is evident that the points on the graph are segregated for three regional complexes: the dots designate the hill-coast environment with single family houses; the crosses denote the five definitely desert people; the circles indicate the four areas in which the houses were principally or entirely multifamily.

If in the calculations we now remove the five desert areas, r becomes +0.747, and if we also delete the four multifamily areas, the value is +0.687. These are not impressive, but are definitely significant values. Finally, if we calculate r for the four multifamily regions alone, the value is +0.986, even for three degrees of freedom highly significant. The provisional conclusion is that in order for the logarithmic relation to be demonstrable for <u>village area</u> against population, certain edaphic and also probably social factors must be held constant, and the entire territory must be homogeneous with respect to these.

Another mode of setting forth these distinctions is seen in Figure 10. Here are plotted the points obtained by taking the ratio of the total floor space to the mean site or village area for each region. The numerical values (multiplied by 100) are given in the last column of Table 9. In Figure 10 both the ratios directly and their logarithms are plotted simply as a continuous distribution, beginning with the smallest and ending with the largest. It is very striking that the first four points, which are the smallest, represent four desert areas. Then comes a sharp discontinuity, broken by only one point by the Achomawi, who lived under arid but perhaps not full desert conditions. There follows a row of 16 points, all of them pertaining to single family house regions of the foothills, coast ranges, and coast. Finally, after a very wide break there are the points representing the regions with multifamily houses. Again it is clear that as far as village area or space is concerned, there are three very distinct groups, whereas when floor space or house area is considered, all the regions form an unbroken exponential continuum. The interpretation of these findings must await further analysis.

TABLE 1

Values of r, b, and a for Waterman's (1920) Yurok Data*

No. of cases	Pop. method	Area method	Indep. variable	r	b	a (log)	a (sq. ft.)
17	1	1	pop.	+0.895	+1.393	+1.288	1,940
	1	1	area		+0.544	-0.458	--
17	2	1	pop.	+0.824	+1.207	+1.587	3,870
	2	1	area		+0.564	-0.604	--
17	3	1	pop.	+0.751	+1.023	+1.746	5,575
	3	1	area		+0.551	-0.560	--
17	1	2	pop.	+0.933	+1.593	+0.813	650
	1	2	area		+0.548	-0.319	--
17	1	3	pop.	+0.896	+1.167	+1.508	3,220
	1	3	area		+0.691	-0.849	--
17	1	4	pop.	+0.955	+0.771	+2.346	22,200
	1	4	area		+1.163	-2.627	--
17	1	5	pop.	+0.900	+1.117	+1.896	7,870
	1	5	area		+0.626	-0.886	--
17	1	6	pop.	+0.818	+0.850	+2.423	26,500
	1	6	area		+0.790	-1.587	--
15	1	2	pop.	+0.894	+1.197	+1.227	1,685
	1	2	area		+0.603	-0.515	--

* For methods of calculating population and area see p. 2 ff. of text

TABLE 2

Values of r, b, and a for Lothrop's (1928) Three Groups of Sites

Group	No. of cases	r	b	a (log)	a (sq. ft.)
I. From Fig. 98, p. 182 and table, p. 184	50	+0.799	+0.907	+1.431	2,700
II. From Fig. 100, p. 185 and table, p. 187	10	+0.652	+0.697	+2.234	17,150
III. From Fig. 101, p. 186 and table, p. 188	5	+0.755	+0.912	+1.600	3,980
Total	65	+0.689	+0.792	+1.672	4,700

Notes to Tables 3, 4, and 5

The various sources consulted list in part the same and in part different villages or sites. Consequently there must be considerable unavoidable repetition in the tables.

Table 3 lists the 56 recent or "Canaliño" sites mentioned by D. B. Rogers (1929) in the text of his work. Eight of the names are in CAPITAL letters. These are the ones which were drawn by Rogers on his maps and for which house counts were also made by the Portolá expedition. Those sites whose names are underlined are shown on Rogers' maps but no house counts were made for them. The remainder of the sites are those for which there are descriptions by Rogers but for which there are no further data. For the first group of eight sites the house counts are given as derived from Tables 4 and 5. For the second group of 26 sites the house counts, as obtained by interpolation in Figure 7, are placed in parentheses. For the third group, 22 sites, where the average (see p. 19) is always taken as 37, the house count figures are omitted.

Table 4 shows the data in detail for 16 sites mentioned in the accounts of the Portolá expedition. The populations and house counts are as indicated in the references and notes which follow the table. The areas are from Rogers' maps.

Table 5 summarizes the data from Table 4 and presents the final estimates offered here for area and population.

TABLE 3

"Canaliño" Culture Sites Mentioned by Rogers

Rogers' No.	Site Name	Area (sq. ft.)	No. of houses
1	SHUKU	435,600	45
6	CARPINTERIA	162,250	38
7	MISHOPSHNOW	682,430	110
8	Sandyland		
9	Lyman No. 1	101,160	(30)
13	Kolok	103,800	(30)
17	SHALWAJ	46,000	35
19	Miramar		
20	Swetete		
22	Kashwa		
26	Siuhtun		
27	Amolomol	31,500	(12)
28	Burton Mound	85,400	(20)
29	El Banos		
30	Mispu		
31	Mispu		
33	Mismatuk	29,000	(11)
35	Barger No. 1	46,140	(16)
36	Barger No. 2	43,900	(15)
37	Ushtahash	33,210	(12)
39	Cieneguitas	141,100	(39)
40	Hope Cliff	484,700	(98)
41	San Marcos		
42)	Three sites		
43)	east side of		
44)	Goleta Slough		
45	Twin Mounds		
46	MESCALITAN	1,300,000	110
47	South Side Goleta Slough	132,000	(36)
51	Campbell No. 3	158,900	(41)
56	Williams No. 3		
57	Williams No. 2	83,200	(25)
58	Williams No. 1	197,100	(50)
61	Stow		
62	Larson No. 1	58,000	(19)
63	Larson No. 2	53,200	(17)

TABLE 3 [cont'd.]

Rogers' No.	Site Name	Area (sq. ft.)	No. of houses
64	McCaffery	80,000	(24)
71	Winchester No. 3	65,800	(21)
72	Tecolote No. 1	120,000	(34)
73	TECOLOTE NO. 2	100,000	22
74	Tecolote No. 3		
75	Tecolote No. 4		
76	Eagle Canyon		
77	DOS		
78	PUEBLOS	536,000	120
80	Los Gatos		
81	Las Llagas No. 1	79,600	(24)
82	Las Llagas No. 2	28,800	(11)
83	Las Llagas No. 3	73,300	(23)
84	Ajuahuilashmu	143,500	(39)
86	Refugio No. 1	16,300	(7)
87	REFUGIO NO. 2 (KASIL)	127,000	80
91	La Quemada	69,600	(22)
93	Amolar	82,400	(25)
94	Alcatraz		
95	Alcatraz		
97	Gaviota No. 1		

TABLE 4

Data Concerning Villages Mentioned by Explorers
(For sources refer to notes on pp. 49-50)

No.*	Village Name	Area (sq. ft.)	Popu-lation	No. of houses	Note No.
1	Assumpta		400	30	1
			300	30	2
			400	30	3
2	Santa Conefundis			8	4
3	Shuku	435,600			5
				60	6
			300+	30	7
			400+		8
4	Carpenteria	162,250			9
			400	38	10
			300+	38	11
5	Mishopshnow	682,430		100+	12
			600+		13
6	Shalwaj	46,000			14
			500		15
			500	40	16
			500	30	17
7	Mescalitan	1,300,000			18
				100+	19
				100+	20
			800	80	21
8	Tecolote No. 2	100,000			22
				20+	23
9	Dos Pueblos	536,000			24
			1,000+		25
			1,000+		26
			1,600	120	27

* Numbers run consecutively for convenience only

TABLE 4 [cont'd.]

No.*	Village Name	Area (sq. ft.)	Popu- lation	No. of houses	Note No.
10	Kasil	127,000			28
			400+	79	29
			400	80	30
			800	80	31
11	Gaviota		300	52	32
				50	33
			300+	50	34
12	San Serefino		200	24	35
			130	25	36
13	Santa Ana			20	37
14	Santa Teresa			24	38
			150	50	39
15	Espada		250+	20	40
			250	20	41
			200	30	42
16	Los Pedernales		70	10	43
			60	10	44
			60		45

* Numbers run consecutively for convenience only

Notes to Table 4

No.	Village Name	Ref. No.	Note
1	Assumpta	1	Bolton, H. E., 1927:160. Hereafter referred to as "Crespi."
		2	Smith, D. E. and F. J. Teggart (eds.), 1909:55. Hereafter referred to as "Portolá."
		3	Priestley, H. I. (trans.), 1937:25. Hereafter referred to as "Fages."
2	Santa Conefundis	4	Portolá, p. 56.
3	Shuku	5	Rogers, 1929:41.
		6	Crespi, p. 161.
		7	Portolá, p. 57.
		8	Fages, p. 26: "more populous than Assumpta."
4	Carpinteria	9	Rogers, 1929:46-48, Map 2. This is probably the southern site, east of Mishopshnow.
		10	Crespi, p. 163. Inhabitants "no less" than Assumpta. Some of the houses "with many families."
		11	Portolá, p. 57.
5	Mishopshnow	12	Rogers, 1929:48 ff., Map 2. House estimate, p. 53.
		13	Fages, p. 26.
6	Shalwaj	14	Rogers, 1929, Map 7. Our estimate of area according to scale shown.
		15	Crespi, pp. 164-165.
		16	Portolá, p. 57.
		17	Rogers, 1929:80.
7	Mescalitan	18	Rogers, 1929, Map 16. Our estimate according to scale shown.
		19	Crespi, p. 167.
		20	Bolton, H. E., 1926. Hereafter referred to as "Palou." On p. 156, concerning the island, "a large town in which were counted more than one hundred houses."
		21	Portolá, p. 57. Says 7 towns, smallest 20, largest 80 houses. In latter "we have seen about 800 natives."

Notes to Table 4 [cont'd.]

No.	Village Name	Ref. No.	Note
8	Tecolote No. 2	22	Rogers, 1929, Map 24. Our estimate of area according to scale shown.
		23	Rogers, 1929:201.
9	Dos Pueblos	24	Rogers, 1929, Map 25.
		25	Crespi, p. 169.
		26	Palou, p. 157
		27	Portolá, p. 57. Sixty houses and 400 persons in each village.
10	Kasil	28	Rogers, 1929, Map 28.
		29	Crespi, p. 170.
		30	Portolá, p. 59.
		31	Fages, p. 28.
11	Gaviota	32	Crespi, p. 171.
		33	Fages, p. 28.
		34	Portolá, p. 59.
12	San Serefino	35	Crespi, p. 172.
		36	Portolá, p. 59.
13	Santa Ana	37	Crespi, p. 173.
14	Santa Teresa	38	Crespi, p. 174.
		39	Portolá, p. 59.
15	Espada	40	Crespi, p. 175.
		41	Fages, p. 30.
		42	Portolá, p. 59.
16	Los Pedernales	43	Crespi, p. 176.
		44	Fages, p. 30.
		45	Portolá, p. 61.

TABLE 5

Summary of Data for Sixteen Channel Sites
Listed in Table 4

No.	Village Name	Area (sq. ft.)	No. Persons	No. Houses	Persons Per House
1	Assumpta		400	30	13.3
2	Santa Conefundis			8	
3	Shuku	435,600	440	45	9.8
4	Carpinteria	162,250	400	38	10.5
5	Mishopshnow	682,430	660	110	6.0
6	Shalwaj	46,000	500	35	14.3
7	Mescalitan	1,300,000	800	110	7.3
8	Tecolote No. 2	100,000		22	
9	Dos Pueblos	536,000	1,100	120	9.2
10	Kasil	127,000	800	80	10.0
11	Gaviota		300	50	6.0
12	San Serefino		200	24	8.3
13	Santa Ana			20	
14	Santa Teresa			24	
15	Espada		250	20	12.5
16	Los Pedernales		70	10	7.0
	Average				9.5

TABLE 6

House Sizes in Central Valley and Adjacent Foothills
(Data are for single house pits unless a range or average is stated)

Site No.	Probable Tribe	Habitat	Dimensions* (feet)	Notes
Teh- 13	Wintun	Western hills	4 to 14	
Teh- 22	Wintun	No. of Red Bluff	14	
Teh- 27	Wintun	Western hills	4 to 5	
Teh- 34	Wintun	Valley flat land	7 to 8	
Teh- 53	Wintun	Valley flat land	8 to 15	
Teh- 95	Wintun	No. of Red Bluff	30 by 30	Sweat house
Teh-191	Wintun	No. of Red Bluff	12	
Teh-201	Maidu	Eastern hills	8 by 11	
Teh-235	Maidu	Eastern hills	6 to 8	
Gle- 8	Wintun	Western hills	12	
Gle- 10	Wintun	Western hills	40	Dance house
Gle- 14	Wintun	Western hills	8	
Col- 10	Wintun	Valley flat land	13 by 15	
Yol- 33	Wintun	Western hills	8 to 12	
But- 4	Maidu	Eastern hills	10 average	
But- 6	Maidu	Edge of valley	33	Only 1 pit seen
But- 65	Maidu	Eastern hills	25	Dance house
But- 66	Maidu	Eastern hills	40	Unspecified, 1 pit seen
But- 84	Maidu	Eastern hills	35	Ditto
But- 94	Maidu	Eastern hills	25	Dance house
Eld- 73	Maidu	Eastern hills	30	Only 1 pit seen
Sac-111	Valley tribes	Valley flat land	25	Only 1 pit seen
Sac-117	Valley tribes	Valley flat land	25	Only 1 pit seen
Ama- 40	Maidu	Eastern hills	10	
Cal-112	Miwok	Eastern hills	12	
Sta-129	Yokuts	Western hills	33	Only 1 pit seen
Sta-130	Yokuts	Western hills	47	1 large dance house
Sta-130	Yokuts	Western hills	35	1 sweat house
Sta-130	Yokuts	Western hills	14	2 dwelling houses

* Unless otherwise stated all figures represent diameters

TABLE 6 [cont'd.]

Site No.	Probable Tribe	Habitat	Dimensions (feet)	Notes
Mer- 43	Yokuts	Valley flat land	18 to 20	"several"
Mer- 58	Yokuts	Valley flat land	43	"dance house pit," plus 20 others
Mer- 89	Yokuts	Valley flat land	45	1 pit, others doubtful
Mer- 89	Yokuts	Valley flat land	35	Ditto
Mrp- 2	Miwok	Eastern lower hills	52	1 dance house pit
Mrp- 2	Miwok	Eastern lower hills	14 to 22	15 others
Mad- 9	Miwok	Eastern hills	8	
Mad- 29	Miwok	Eastern hills	12	"former sweat house"
Mad- 37	Miwok	Eastern hills	18	
Mad- 37	Miwok	Eastern hills	33	"present sweat house"
Fre- 57	Yokuts	Eastern hills	6	
Fre-126	Yokuts		20	
Fre-186	Yokuts	Mountains	13	
Fre-355	Yokuts	Eastern hills	16 by 20	
Tul-208	Yokuts	Eastern hills	14.7	"large"
Tul-225	Yokuts	Eastern hills	9.8	
Tul-234	Yokuts	Eastern hills	13.1	
Tul-234	Yokuts	Eastern hills	6.5	
Tul-241	Yokuts	Eastern hills	11.5	
Tul-243	Yokuts	Eastern hills	13.1	
Tul-244	Yokuts	Eastern hills	8.2	
Tul-245	Yokuts	Eastern hills	11.5	
Tul-247	Yokuts	Eastern hills	11.5	
Tul-248	Yokuts	Eastern hills	11.5	
Tul-249	Yokuts	Eastern hills	16.4	
Tul-260	Yokuts	Eastern hills	13.1	
Tul-276	Yokuts	Eastern hills	14.7	
Tul-277	Yokuts	Eastern hills	11.5	
Tul-284	Yokuts	Eastern hills	11.5	
Tul-287	Yokuts	Eastern hills	14.7	

[Summary of Table 6 follows]

TABLE 6 [cont'd.]

Summary: Taking the Average Size Per Site of Unequivocal Dwelling House Pits and Averaging Sites by Region

Region and Tribe	No. of Sites	Average Floor Space
Hills Wintun	7	83.9
Hills Maidu, Miwok	8	119.4
Hills Yokuts	21	135.7
Valley, all tribes	4	156.4

TABLE 7

Data from Documentary Sources

Source	Habitat	Floor Space (sq. ft.)	Number of Inhabitants	Houses per Village	Notes
Zalvidea	Hills		41	9	Cuia, 1 family
Zalvidea	Hills		180	28	Sisupistu, 1 fam.
Abella	Delta	408	1000	60	Tauquimnes, com.
Durán	Delta			40	Ochejamnes, com.
Durán	Delta	803-4520		35	Chucumnes, com.
Estudillo	Hills		1250	210	Chischa, 1 fam. 608,000 sq. ft.
Work	Valley		500-1000	28	Maidu, 1 family
Work	Valley			40-50	Maidu, 1 family
Warner	Valley			50-100	
"Trapper"	Valley		100-1200		
Dixon	Valley	301-1216		1-20	Type 1
Dixon	Hills	53-211			Type 2
McKern	Valley	396-706			Communal
Gayton	Hills	78-133			1 family
Gayton	Valley				Communal
Latta	Valley	12,000(?)			Communal
Latta	Hills	180-300			1 family
Kroeber	Valley				Communal
Kroeber	Hills	113-177			1 family

TABLE 8

Data from Documentary Sources

Detailed data concerning house sizes, village or site sizes, and population for 30 California tribal or geographic regions, together with a final estimate for each region. For discussion refer to text and notes which follow.

Reference or Note	Tribe or Locality	House floor space mean sq. ft.	No. of persons per family	No. of families per house	No. of persons per house	Floor space per person : sq. ft.	No. of houses per village	No. of persons per village	Mean total floor space per village in sq. ft.	Mean area per village : sq. ft.	Sq. ft. per house per village	Sq. ft. per person per village	Ratio total floor space x 100 to village area
1	Yurok		7.5	1	7.5		8.3	62					
2							6.0	45					
3			8.0	1	8.0								
4							8.9						
5							6.8						
6							11.7						
7		439											
8							5.1						
9										28,900			
10										25,450			
11	Estimate	439	7.5	1	7.5	58.5	7.8	60	3424	25,450	3263	424	13.5
12	Wiyot		7.5	1	7.5		8.7						
13							6.5						
14			9.2	1	9.2								
15							9.0						
16			9.1	1	9.1		6.0						
17			6.2	1	6.2		12.5						
18			5.1	1	5.1		10.0						
19		254								28,400			
20	Estimate	254	7.5	1	7.5	33.8	7.6	57	1930	28,400	3738	498	6.8
21	Karok		7.5	1	7.5								
22							4.1						
23	Estimate		7.5	1	7.5		4.1	31					
24	Hupa		7.5	1	7.5								
25			6.4	1	6.4		19.8						
26							11.4						

TABLE 8 [cont'd.]

Reference or Note	Tribe or Locality	House floor space mean sq. ft.	No. of persons per family	No. of families per house	No. of persons per house	Floor space per person : sq. ft.	No. of houses per village	No. of persons per village	Mean total floor space per village in sq. ft.	Mean area per village : sq. ft.	Sq. ft. per house per village	Sq. ft. per person per village	Ratio total floor space x 100 to village area
27	Hupa [cont'd]						11.5						
28							10.6						
29		400											
30							10.3						
31	Estimate	400	7.0	1	7.0	57.1	10.9	76	4360				
32	Chilula		7.5	1	7.5		7.0						
33	Estimate		7.5	1	7.5		7.0	52					
34	Shasta	350		1-2			2.5						
35		266					13.0						
36		176					7.0			18,950			
37	Estimate	264	7.0	1	8.0	33.0	6.0	48	1584	18,950	3158	394	8.4
38	Achomawi	96											
39		121					5.3			14,000			
40	Estimate	110	6.0	1	6.0	18.3	5.3	32	583	14,000	2641	438	4.2
41	Modoc	118					5.4			27,100			
42	Estimate	118	6.0	1	6.0	19.6	5.4	32	637	27,100	5019	847	2.4
43	No. Paiute						3.6			61,500			
44	Estimate	100	6.0	1	6.0	16.7	3.6	22	360	61,500	17084	2795	0.6
45	Athabascan		6.0	1	6.0		5.0						
46			4.4	1	4.4		5.0						
47		125											
48							6.3			6,390			
49	Estimate	125	6.0	1	6.0	20.8	5.0	30	625	6,390	1278	213	9.8
50	Yuki		6.0	1	6.0		25.0						
51			6.0	1	6.0		6.3						
52		78											
53		314											
54							1-25						
55		78					5.1			4,730			
56	Estimate	100	6.0	1	6.0	16.7	6.0	36	600	4,730	788	131	12.7

TABLE 8 [cont'd.]

Reference or Note	Tribe or Locality	House floor space mean sq. ft.	No. of persons per family	No. of families per house	No. of persons per house	Floor space per person : sq. ft.	No. of houses per village	No. of persons per village	Mean total floor space per village in sq. ft.	Mean area per village : sq. ft.	Sq. ft. per house per village	Sq. ft. per person per village	Ratio total floor space x 100 to village area
57	Pomo, coast		6.0	1	6.0		6.0						
58		124	6.5	1-2	6.5								
59		125											
60		204					4.3			2,020			
61	Estimate	150	6.0	1	6.0	25.0	5.1	31	765	4,270	840	138	17.9
	Pomo, interior	See Table 9											
	Wappo, valley	See Table 9											
62	Wappo, hills	254					9.3			19,000			
63	Estimate	200	6.0	1	6.0	33.3	9.3	56	1860	19,000	2042	340	9.8
64	Coast Miwok						5.4			7,030			
65	Estimate		6.0	1	6.0		5.4	32		7,030	1300	220	
66	Wintu		5.0	1	5.0								
67			6.6	1	6.6		6.0						
68		111					4.4			11,200			
69	Estimate	111	6.0	1	6.0	18.5	5.4	33	600	11,200	2074	339	5.3
70	No. Wintun	129					7.0			16,800			
71	Estimate	129	6.0	1	6.0	21.5	7.0	42	903	16,800	2400	400	5.4
72	C. Wintun	82					6.3			8,030			
73	Estimate	82	6.0	1	6.0	13.7	6.3	39	518	8,030	1274	206	6.2
74	So. Wintun	139					6.3			14,030			
75	Estimate	139	6.0	1	6.0	23.2	6.3	39	876	14,030	2227	360	6.2
76	Maidu	192	7.5	1	7.5		3.4						
77							7.0						
78		119		1									
79		123											
80		83	6.0	1	6.0		6.5						
81		106					6.3			13,430			
82	Estimate	125	6.0	1	6.0	20.8	6.6	40	827	13,430	2035	336	6.1
83	Miwok	123											
84				1									
85		122					5.4			14,150			
86	Estimate	123	6.0	1	6.0	20.5	5.4	33	664	14,150	2620	429	4.5

TABLE 8 [cont'd.]

Reference or note	Tribe or Locality	House floor space mean sq. ft.	No. of persons per family	No. of families per house	No. of persons per house	Floor space per person : sq. ft.	No. of houses per village	No. of persons per village	Mean total floor space per village in sq. ft.	Mean area per village : sq. ft.	Sq. ft. per house per village	Sq. ft. per person per village	Ratio total floor space x 100 to village area
87	Mono		5.1	1	5.1		3.6						
87	Estimate	125	5.1	1	5.1	24.5	3.6	18	454				
88	Yokuts, hills	123											
89		136											
90		133	6.0	1	6.0								
91		131					3.8			11,720			
92	Estimate	131	6.0	1	6.0	21.8	3.8	23	498	11,720	3084	510	4.2
93	Tübatulabal		6.0	1	6.0		4.0						
94		75					3.3			33,100			
95	Estimate	75	6.0	1	6.0	12.5	3.7	22	278	33,100	8949	1505	0.8
96	Paiute, Mono Co.	110					2.5			40,350			
97	Estimate	110	6.0	1	6.0	18.3	2.5	15	275	40,350	16140	2690	0.7
98	Paiute, Inyo Co.						5.5			99,200			
99	Estimate	100	6.0	1	6.0	16.7	5.5	33	550	99,200	18044	3006	0.5
	SRI - Class 1	See Table 9											
100	SRI - Class 2	177											
101			5.0										
102							12.7			25,000			
103	Estimate	177	6.0	1	6.0	29.5	12.7	76	2250	25,000	1968	329	9.0
	Central Valley	See Table 9											
	Channel Chumash	See Table 9											

References and Notes to Table 8

No.

1 Kroeber (1925:16) states that the Yurok had a population of 1,052 persons, in 141 houses, in 17 settlements on the Klamath River from Rekwoi to Kepel. He gives 7.5 as the average family or household number. This means 8.3 houses per village, and 62 persons per village.

2 Kroeber (1925:17) states 6.0 houses and 45 persons per village.

3 Kroeber (1925:17) cites the count of 1852 as giving 544 persons in 68 houses, an average of 8.0 persons per house.

4 Kroeber (1925:19) cites the count of 1895 which gives 151 houses and 384 persons for 17 villages. This means about 2.5 persons per house, far too low for an aboriginal value. It is therefore omitted from the table.

5 Waterman (1920:206). The average of 42 villages is based upon Waterman's estimate of aboriginal house numbers.

6 Waterman (1920, passim). This is the average of houses and house pits shown by Waterman on his maps for 17 villages, and is used in Section II of this paper.

7 Kroeber (1925:78). This is the average size of 4 houses according to measurements made by Kroeber.

8 Cook (1956:83). This is the estimate of the mean of 78 villages derived from Waterman, Kroeber, and Merriam.

9 Archaeological Research Facility records. The mean of 11 sites, the records for which are to be found in the files.

10 The average area of 17 sites, maps for which are given by Waterman. See Section II for discussion dealing with the Yurok. The figure 25,450 sq. ft. is obtained by Method 2.

11 As for all other regions, this estimate is the best value which can be assigned to each category in consideration of the available evidence. The figures are not necessarily averages but may be weighted according to reliability of source and thoroughness of coverage. In this case the floor space and household number is

accepted directly from Kroeber. The number of persons per village is derived from the average of houses per village multiplied by 7.5. The area is that obtained by Method 2 from Waterman's maps.

12 Kroeber (1925:116). The mean of 8 villages.

13 Loud (1918, passim). The mean of 22 villages.

14 Loud (1918, passim). The mean of 3 villages.

15 Loud (1918:266, 339). A single site, Loud's number 67, in or about 1850.

16 Loud (1918:266). The same site in 1860, after attrition.

17 Loud (1918:259). Loud's site number 4 in 1850.

18 Loud (1918:269). Loud's site number 112 in 1850.

19 Archaeological Research Facility records. The figure for floor space is the mean of 3 sites; that for site size the mean of 8 sites.

20 See Note 11. Kroeber's value of 7.5 for household number is accepted as applying to the Wiyot. The number of houses per village is based upon the mean values of Kroeber and Loud. Loud's sites numbers 4, 67, and 112 were unusually important and probably exceeded the average size.

21 Kroeber (1925:17).

22 Cook (1956:98). The mean of 61 villages derived from Kroeber's (1936) lists. There are no data in the literature or in the Archaeological Research Facility files on Karok village or house size.

23 See Note 11.

24 Kroeber (1925:17).

25 Kroeber (1925:131, 138). The mean of 5 villages. Kroeber here departs from his own rule of 7.5 as household number for the northwestern tribes.

No.

26 Cook (1956:100). This is according to the 1851 census, for 7 villages.

27 Cook (1956:100). According to Goddard's map, for 11 villages.

28 Cook (1956:100). According to Gibbs' map, for 9 villages.

29 Goddard (1903:13).

30 Archaeological Research Facility records. The mean of 9 sites.

31 See Note 11.

32 Kroeber (1925:138).

33 See Note 11.

34 Dixon (1907:416-418) says the houses were rectangular, 5 x 6-7 meters (350 sq. ft.). They were often occupied by more than one family, but these seem to have been related, i.e. extended families. Villages were usually small with no more than 2 or 3 families.

35 Leonhardy (n.d., passim). This is a careful study of the Iron Gate No. 2 site on the Klamath River. Leonhardy found 13 house pits, but thinks only about 5 were inhabited at one time. He cites measurements of 8 house floors with an average of 266 sq. ft. He also states that the houses were conical, not rectangular.

36 Archaeological Research Facility records. The house areas are the mean from 4 sites; the site areas the mean from 18 sites; the house number the mean of pits at 5 sites.

37 See Note 11. The house floor space is the mean of the three estimates shown. Persons per family is taken at 7.0, but persons per house is increased to 8.0 in order to cover Dixon's claim for extended families. Number of houses per village is a compromise between the mean of 7 house pits found by the Facility and Leonhardy's idea that only 5 out of 13 house pits at Iron Gate were occupied at the same time.

38 Kroeber (1925:312) states explicitly that the houses were small, rectangular, 8 by 12 ft. or less. They were necessarily single family dwellings.

39 Archaeological Research Facility records. For house floor space the mean of 10 sites; for number of houses the mean of 24 sites; for site area the mean of 95 sites.

40 Floor space is the approximate average. Family and household number of 6.0 is reasonable in view of the very limited floor space. However, there is another consideration involved. Beyond the borders of the northwestern tribes (Yurok, Wiyot, Hupa, and perhaps the Shasta) and with the exception of those tribes possessing communal houses (Pomo, Wappo, Central Valley groups, and the Chumash), all authorities agree in taking the house as single family, and in putting the persons per family and per house at 6.0. In view of such unanimity of opinion, this figure is used consistently hereafter.

41 Archaeological Research Facility records. The floor space and houses per village are the means of 8 sites; the area the mean of 30 sites.

42 See Notes 11 and 40.

43 Archaeological Research Facility records. Village area is the mean of 76 sites in Lassen County, and includes a few peripheral Maidu sites near Susanville. The number of houses (house pits) per village is the mean of 9 sites.

44 The floor space per house is an approximate average of that found for the adjacent tribes, the Modoc and Maidu, and that for the related groups to the south, the Tübatulabal and the Paiute of Mono and Inyo counties. The family composition is taken as the unit conventional for the area (see Note 40).

45 Cook (1956:104). The recent authoritative work by Baumhoff (1963) on the food ecology of the Athabascans, while treating exhaustively of population, does not include data covering house and village areas.

46 Goddard (1924:219). The family number probably relates to post-contact times. The Athabascans were destroyed by the white man very early in the 1850's.

47 Kroeber (1925:241).

48 Archaeological Research Facility records. The house number is the mean of 3 sites, the area the mean of 29 sites. Of these 9 are Mattole (coastal), the remainder Wailaki and Kato. The site

No.

48 area mean for the Mattole alone is 16,420 sq. ft., for the interior groups, 4,180 sq. ft. However we have no other data which would justify a segregation of these subtribes, and the general average must stand.

49 The estimate of 5.0 for houses per village is based upon Goddard's ethnographic study, and is accepted in preference to that of 6.3. The latter figure is derived from only 3 archaeological sites.

50 Foster (1944:176) and Cook (1956:107). The figure for houses per village is based upon a single, unusually large village described by Foster.

51 Gifford (1939, passim). Referring to the Coast Yuki, Gifford gives house numbers for 7 villages, based upon the memories of informants (see Cook 1956:106).

52 Foster (1944:159, 226).

53 Foster (1944:226) states that the "common houses" were 10 feet in diameter. The Huchnom, however, had houses like the Pomo, that were 20 feet in diameter.

54 Foster (1944:159, 160, 176, 226) says that the Hop Ranch, founded by fugitives, had 50 houses and was "twice the size of the average nohot." But Kicil, a nohot, had 24 houses and was "one of the largest rancherias." On the other hand, there were numerous satellite villages which had no more than one or 2 houses.

55 Archaeological Research Facility records are unusually complete for this area. Number of houses per village is the mean of 162 sites. Site area is the mean of 402 sites, including both the coast and the interior. The figure for floor area is based upon site Men-455 which showed 21 house pits, ranging from 7 to 12 feet in diameter. This agrees with Foster's statement (see Note 54) that the common dwellings were 10 feet in diameter.

56 The value of 78 square feet area conforms with both ethnographic and archaeologic evidence, yet we have to allow for at least a few larger structures among the Huchnom for it is not possible to segregate this group upon any other grounds. The figure 100 square feet is therefore a compromise. The estimate of 6.0

houses per village increases the house pit evidence of 5.1 in order to allow for Gifford's very clear data on the coast. It is impossible to compensate for the few large nohots described by Foster other than to balance them against the very small peripheral settlements.

57 Kniffen (1939:388). Mean of 15 villages. Based upon the memories of informants.

58 Loeb (1926:159) describes the houses as 10 to 15 feet in diameter and says, "This variety of house...is said to have contained as many as twelve people." However two informants stated that their own houses had contained respectively 6 and 7 persons. Furthermore 12 people could not find sleeping space in a house 10 to 15 feet in diameter.

59 Kroeber (1925:240).

60 Archaeological Research Facility records. Floor area is the mean of 4 sites; houses per village, the mean of 15 sites; site area, the mean of 71 sites.

61 Floor space is the average of the three estimates reported, as is the number of houses per village. Mean site area represents an adjustment. The 71 sites mentioned in Note 60 are almost exclusively in Sonoma County. Thirty-two of them are fishing camp sites with an area under 1,000 square feet, a size highly improbable for a permanent settlement with approximately 30 inhabitants. Hence it is justifiable to omit the camp sites and average only those with an area over 1,000 square feet. The result, with 39 sites, is 4,270 square feet, a figure which is consistent with that obtained for the coast Yuki just to the north.

62 Archaeological Research Facility records. Number of houses per village is the mean of 19 sites; site area is the mean of 99 sites. Floor space datum is based upon one house pit at Nap-221, near Middletown, which was 18 feet in diameter. Some further help is provided by two Wintun sites on upper Putah Creek and two Pomo sites on Highland Creek in Lake County—all four in the vicinity of Nap-221. The average house pit diameters were respectively 13, 12, 8, and 18 feet. The over-all average is 12.75 feet or an area of 128 square feet. As a compromise we have reduced the Wappo figure from 254 to 200 square feet.

No.

63 See Note 62.

64 Archaeological Research Facility records. Number of houses per village is based upon 5 sites; mean site area, upon 84 sites.

65 We use the usual family number, 6.0.

66 Du Bois (1935:28) makes some rather ambiguous statements. She says, "Each bark house contained a biologic family of three to seven people, so the population of a settlement might run from twenty or thirty up to one hundred and fifty or two hundred people." This means an average family size of 5.0, with a single family per house. But with the specified family and house size, and the population mentioned, there would have been from 4 to 40 houses. The latter figure is quite improbable. No such villages are reported by any other observer for the hills surrounding the Sacramento Valley.

67 Du Bois goes on to quote an informant who had lived in a village of six houses with 30 to 50 people. This means a family number of 5 to 8.3 persons, or an average of about 6.6.

68 Archaeological Research Facility records. House size is the mean of three sites, Teh-13, Teh-22, and Teh-121, all located in the hills of northwestern Tehama County, close to the Wintu. There is no evidence for believing that the Wintu houses were materially different. Number of house pits per village is the mean of 18 sites, and site area, the mean of 114 sites.

69 We retain the customary 6.0 for family size. For the number of houses per village, we roughly average the value given by Du Bois' informant with the site mean. There is no reason to attempt any adjustment for very big settlements, the existence of which is implied but not demonstrated by Du Bois.

70 We know of no published ethnographic data for the Wintun proper, apart from the Wintu and the Patwin. Hence dependence is placed entirely upon the archaeological site records.

The whole ethnic stock is here divided into three portions: the Northern Wintun includes the hill and upland villages located in Tehama and Shasta counties; the Central Wintun segment is confined to the Stony Creek area in Tehama and Glenn counties, an area which has been intensively surveyed; and the Southern

Wintun includes the Wintun (plus a few Patwin and Lake Miwok) living in the hills of the Cache Creek and Putah Creek watersheds.

For the Northern Wintun the house size is the mean of 7 sites; number of houses per village is the mean of 66 sites; site area is the mean of 143 sites.

71 We use the customary value 6.0 for family size and number of persons per house.

72 The three figures are respectively the means for 2, 31, and 105 sites. The house area is probably too small, but there is no evidence to justify a change.

73 See Notes 70 and 71.

74 Archaeological Research Facility records. The three figures are respectively the means for 5, 37, and 101 sites.

75 See Notes 70 and 71.

76 Kroeber (1925:397). Data from American Valley, Plumas County.

77 Kroeber (1925:397). Data from Indian Valley, Plumas County.

78 Dixon (1905:174).

79 Kroeber (1925:241).

80 Kroeber (1929:260). The mean of 7 villages.

81 Archaeological Research Facility records. The three figures are respectively the means of 2 sites (both in Northern Maidu territory), 47, and 92 sites.

82 House size is the average of the five figures shown. For the number of houses per village, the figure for American Valley is disregarded.

83 These are the Sierra Miwok, from Amador to Madera County. The floor space figure is based upon Kroeber's (1925:241) statement that the Maidu and Miwok both used a circular house 10 to 15 feet in diameter.

<u>No.</u>

84 Barrett and Gifford (1933:200).

85 Archaeological Research Facility records. The three figures are respectively the means of 3, 13, and 136 sites.

86 Estimates as previously outlined.

87 The house data for the North Fork Mono are taken directly from Gifford (1932:57-61). There were 1,232 inhabitants, living in 239 houses, in 67 villages. No area data are given by Gifford, and there are no site records in the files of the Archaeological Research Facility. Gifford's figures, of course, apply to times remembered by informants after 1850, hence the averages may be too small for consideration as aboriginal. The house floor space is the approximate average of those found among the Maidu, Miwok, and hills Yokuts. There is no reason to suppose that the Mono houses were significantly different.

88 This is for the small, single family house used by the hills Yokuts according to Kroeber (1925:521).

89 The mean of four sets of measurements given for different tribelets by Latta (1949:87, 91, 92, 98).

90 Data from Gayton (1948). The family number is stated as 6 (p. 145). the non-communal house is single family (pp. 59, 161, 186, etc.). The floor area is the average of five sets of measurements given for various tribelets.

91 Archaeological Research Facility records. The three figures are respectively the means of 16 sites (in Tulare County), 44 sites (in Fresno and Tulare counties), and 109 sites.

92 The floor space is the average of the four figures shown. The number of houses per village and site area are from the Archaeological Research Facility record files.

93 Explicit statements by Voegelin (1938:4).

94 Archaeological Research Facility records. The three figures are the means respectively of 4, 4, and 18 sites.

95 Estimates as previously discussed.

96 Archaeological Research Facility records. Means respectively of 9, 19, and 44 sites from Mono County exclusively.

97 Estimates as previously discussed. The conventional 6.0 is used for family number.

98 Archaeological Research Facility records. For Inyo County exclusively. For houses per village the mean is of 18 sites, all in Owens Valley. For village area the mean is of 55 sites, also in Owens Valley.

99 For the estimate of floor space, an approximate average of the Mono County Paiute and the Tübatulabal was taken. The dwellings were all the single family, desert type. For household size the conventional 6.0 is used.

100 Floor space derived from the statement of Phil C. Orr (1951:221) that Class 2 houses on Santa Rosa Island were 10 to 20 feet in diameter.

101 This is the figure used by Meighan and Eberhart (1953:119) in computing population on San Nicolas Island. We can see no reason why it should be smaller than that accepted for all other native groups.

102 Archaeological Research Facility records. For the number of houses per village the mean is of 9 sites; for site area the mean is of 7 sites.

103 Estimates as previously discussed. However it should be noted carefully that the figures given in the estimate in Table 8 for Santa Rosa Island apply only to those sites which in the Archaeological Research Facility records are specifically stated to contain houses of Orr's class 2. The distinction between classes 1 and 2 and their occurrence is discussed in full in Part 2 of Section VI of this paper. The figures which represent the combination of the two types, together with necessary adjustments, are shown in Table 9. Since the great majority of houses on Santa Rosa appear to have been class 2, the region as a whole is treated in the graphs and calculations as an area with single family dwellings.

TABLE 9

Final Estimates for the 30 Tribes or Localities Listed in Table 8 Together with a Series of Magnitudes derived from These Estimates

[Also included are the estimates for 4 regions having communal houses. These estimates are discussed in the text but are not included in Table 8]

Regional Number	Tribe or Locality	House floor space mean sq. ft.	No. of persons per family	No. of families per house	No. of persons per house	Floor space per person : sq. ft.	No. of houses per village	No. of persons per village	Mean total floor space per village in sq. ft.	Mean area per village : sq. ft.	Sq. ft. per house per village	Sq. ft. per person per village	Ratio total floor space x 100 to village area
1	Yurok	439	7.5	1.0	7.5	58.5	7.8	60	3,424	25,450	3,263	424	13.5
2	Wiyot	254	7.5	1.0	7.5	33.8	7.6	57	1,930	28,400	3,738	498	6.8
3	Karok		7.5	1.0	7.5		4.1	31					
4	Hupa	400	7.0	1.0	7.0	57.1	10.9	76	4,360				
5	Chilula		7.5	1.0	7.5		7.0	52					
6	Shasta	264	7.0	1.0	8.0	33.0	6.0	48	1,584	18,950	3,158	394	8.4
7	Achomawi	110	6.0	1.0	6.0	18.3	5.3	32	583	14,000	2,641	438	4.2
8	Modoc	118	6.0	1.0	6.0	19.6	5.4	32	637	27,100	5,019	847	2.4
9	No. Paiute	100	6.0	1.0	6.0	16.7	3.6	22	360	61,500	17,084	2,795	0.6

10	Athabascans	125	6.0	1.0	6.0	20.8	5.0	30	625	6,390	1,278	213	9.8
11	Yuki	100	6.0	1.0	6.0	16.7	6.0	36	600	4,730	788	131	12.7
12	Pomo, coast	150	6.0	1.0	6.0	25.0	5.1	31	765	4,270	840	138	17.9
13	Pomo, interior	900	6.0	2.5	15.0	60.0	15.0	225	13,500	24,750	1,650	110	54.5
14	Wappo, valley	940	6.0	2.0	12.0	78.6	15.0	180	14,100	19,350	1,290	107	72.7
15	Wappo, hill	200	6.0	1.0	6.0	33.3	9.3	56	1,860	19,000	2,042	340	9.8
16	Coast Miwok		6.0	1.0	6.0		5.4	32		7,030	1,300	220	
17	Wintu	111	6.0	1.0	6.0	18.5	5.4	32	600	11,200	2,074	350	5.3
18	No. Wintun	129	6.0	1.0	6.0	21.5	7.0	42	903	16,800	2,400	400	5.4
19	Central Wintun	82	6.0	1.0	6.0	13.7	6.3	39	518	8,030	1,274	206	6.4
20	So. Wintun	139	6.0	1.0	6.0	23.5	6.3	39	876	14,030	2,227	360	6.2
21	Maidu	125	6.0	1.0	6.0	20.8	6.6	40	827	13,430	2,035	336	6.1
22	Sierra Miwok	123	6.0	1.0	6.0	20.5	5.4	32	664	14,150	2,620	442	4.5
23	Mono	125	5.1	1.0	5.1	24.5	3.6	18	454				
24	Yokuts, hill	131	6.0	1.0	6.0	21.8	3.8	23	498	11,720	3,084	510	4.2
25	Tübatulabal	75	6.0	1.0	6.0	12.5	3.7	22	278	33,100	8,949	1,505	0.8
26	Paiute, Mono Co.	110	6.0	1.0	6.0	18.3	2.5	15	275	40,350	16,140	2,690	0.7
27	Paiute, Inyo Co.	100	6.0	1.0	6.0	16.7	5.5	33	550	99,200	18,044	3,006	0.5
28	Sta. Rosa Isl.	356	6.0	1.25	7.5	47.5	11.6	87	4,130	25,100	2,164	288	16.4
29	Central Valley	1,130	6.0	3.0	18.0	62.8	20.0	360	22,600	41,400	2,070	115	54.6
30	Sta. Barb. Chan.	1,250	6.0	2.5	15.0	83.3	37.1	557	46,400	101,000	2,723	181	45.9

FIG. 1. The data presented by Naroll (1961) for 17 primitive villages (the city of Cuzco is omitted). Naroll's values for area, given in square meters, have been converted to units of 100 square feet and shown as such on the ordinate. The abscissa gives number of persons. The small rectangle close to the intersection of the ordinates encloses the space on the graph which is occupied by the 8 points representing the smallest villages.

FIGURE 1

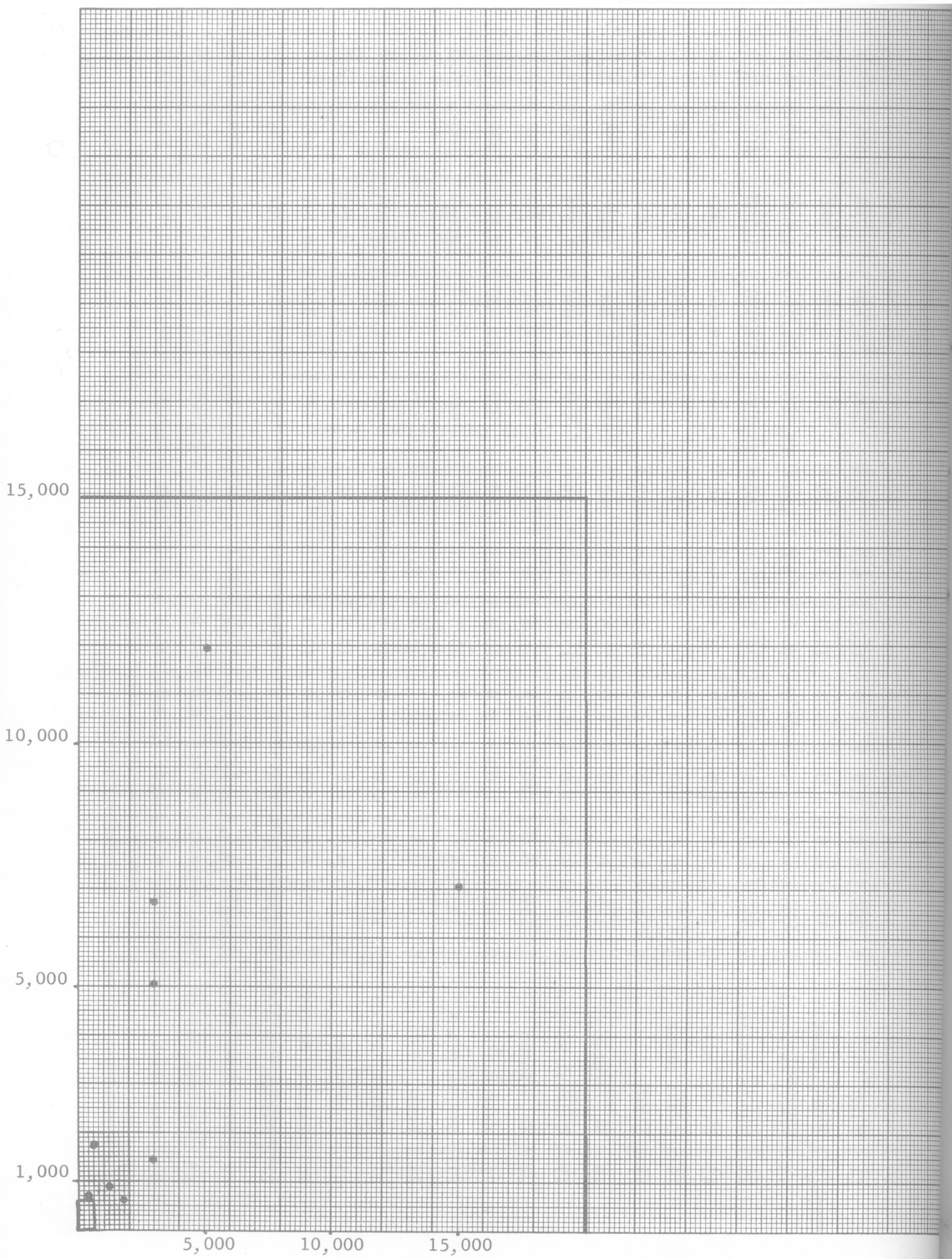


FIG. 2. As Fig. 1 except that floor space is expressed as the logarithms of the values shown in Fig. 1.

FIGURE 2

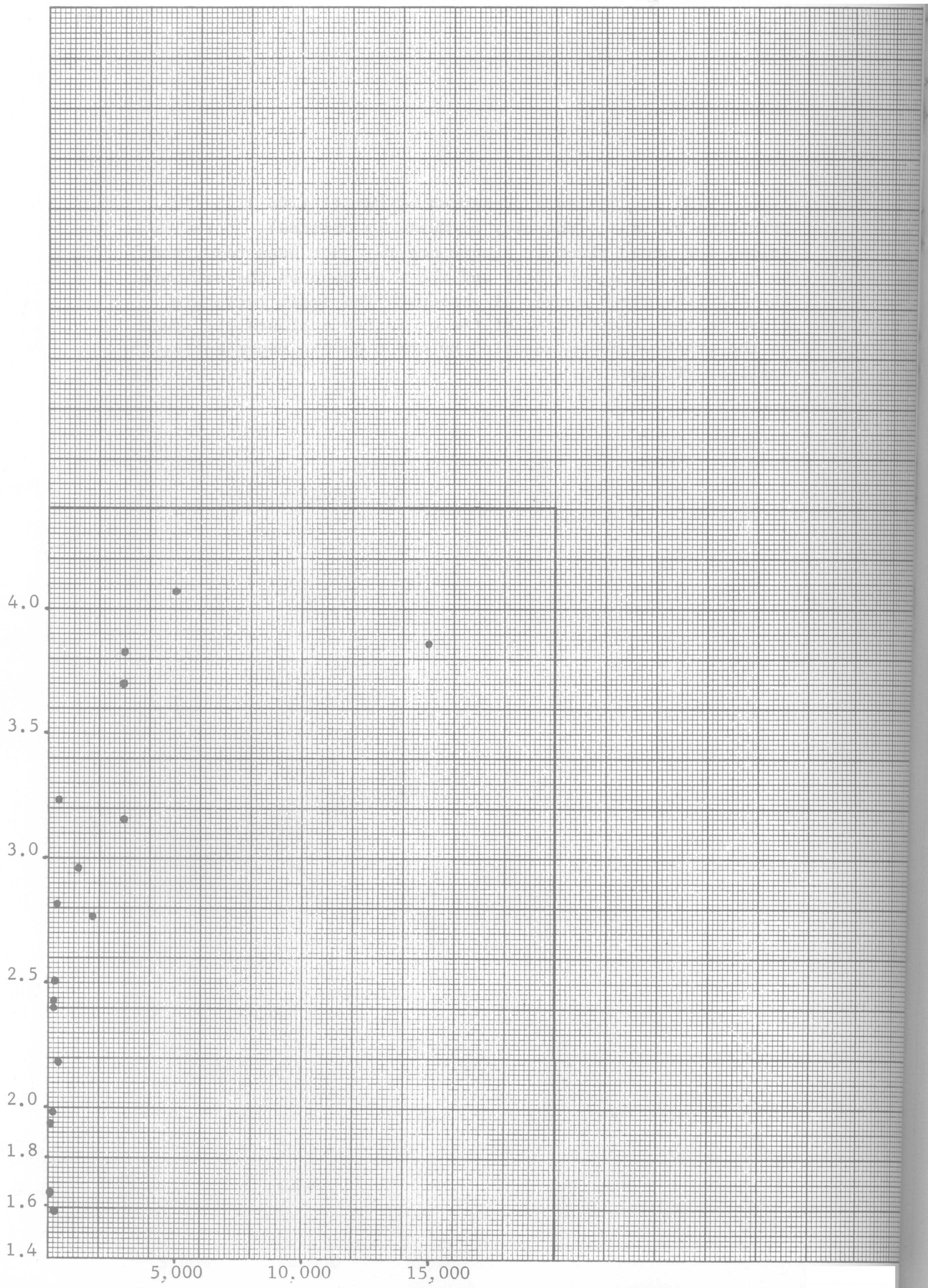


FIG. 3. As Fig. 2 except that number of persons is also expressed as the logarithms of the values shown in Fig. 1.

FIGURE 3

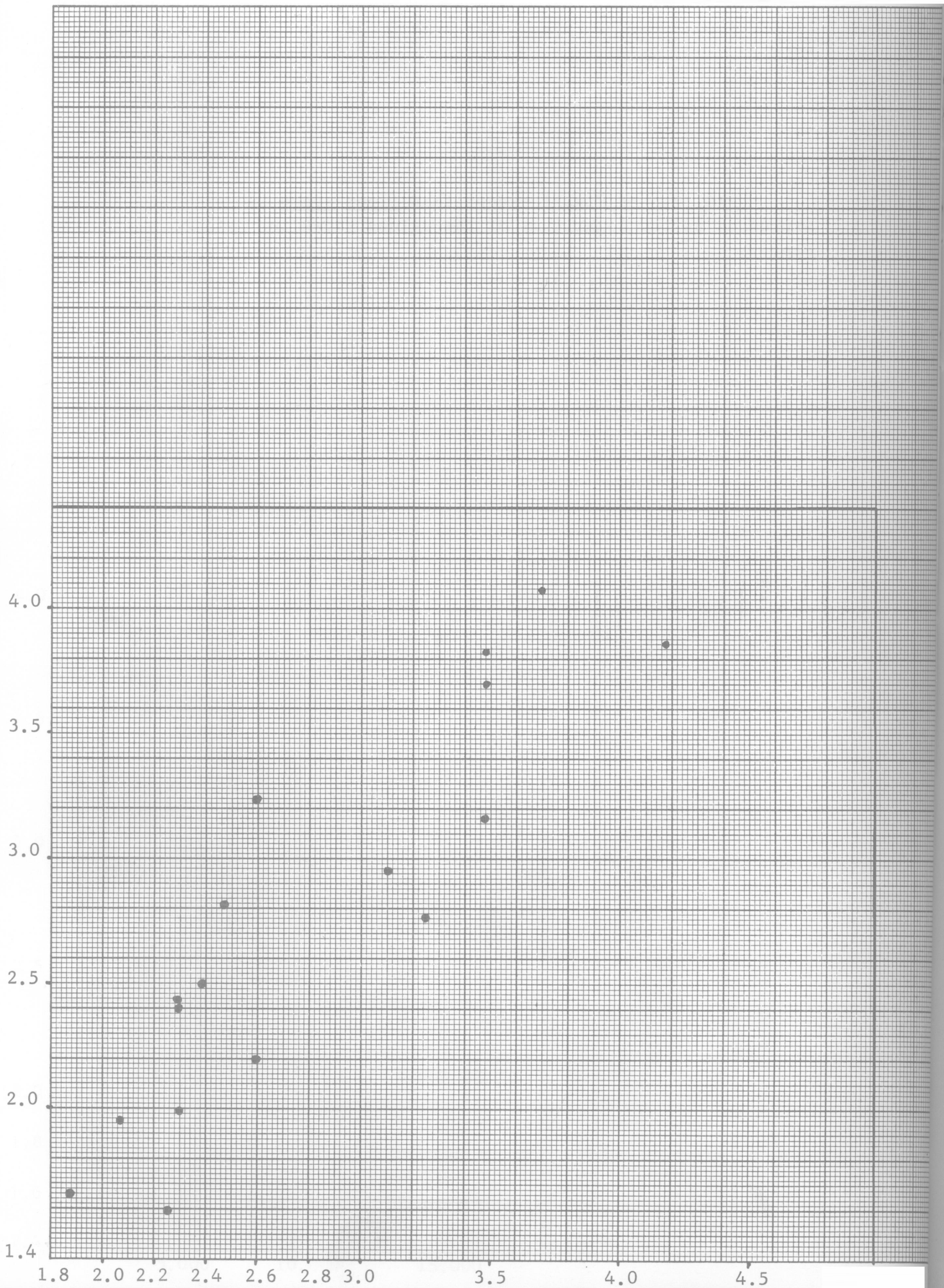


FIG. 4. Log plot of area by method 2 against house count by method 1. Ordinate is log of area in 100's of square feet; abscissa is log of number of standing houses plus pits. The regression line is drawn for all 17 points with b equal to 1.593 (see Table 1). The two points circled are Omen and Tsurai. The second regression line where b equals 1.197 refers to the remaining 15 points.

FIGURE 4

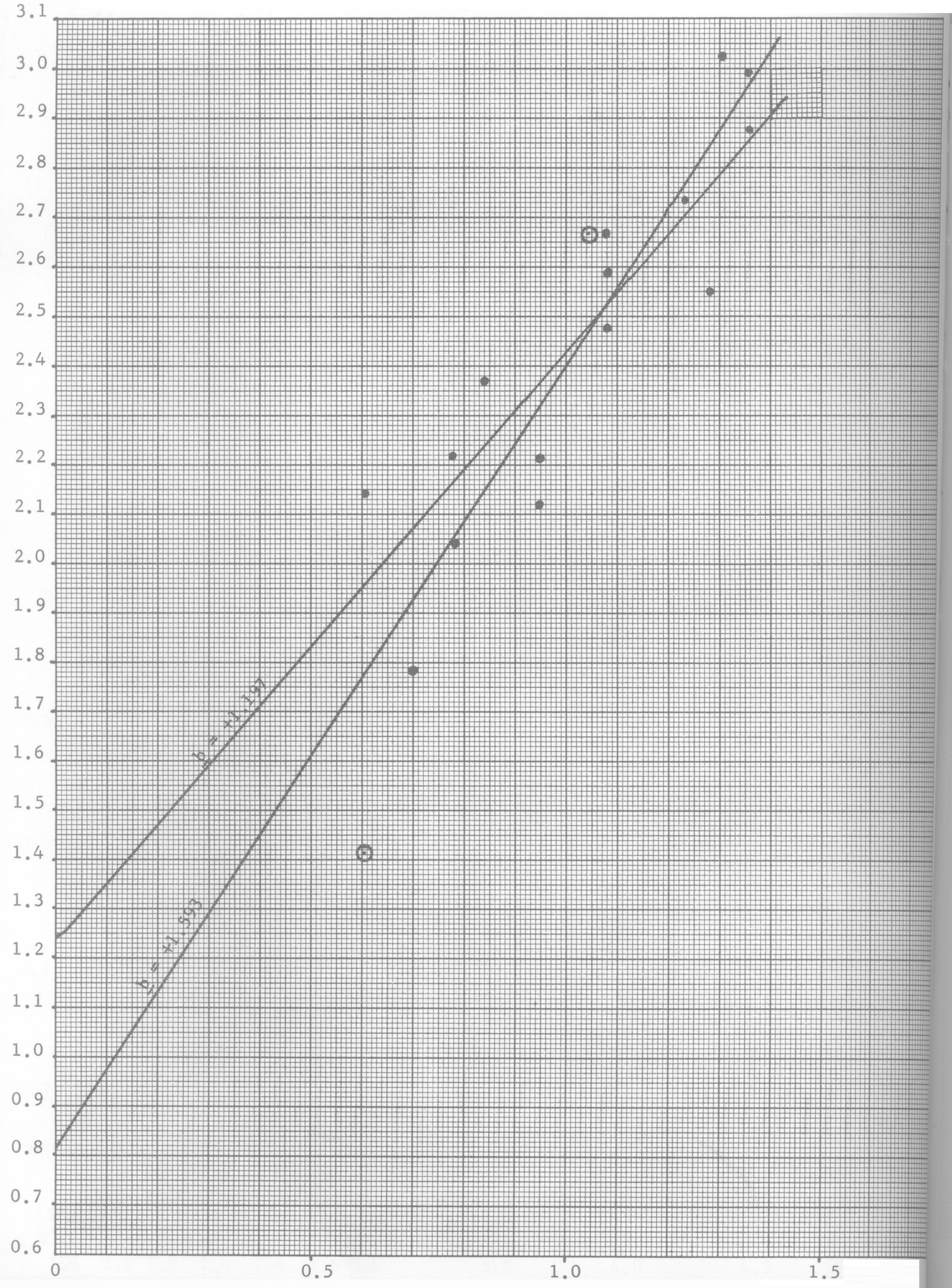


FIG. 5. The average log of the area is determined for all 17 (or 15) sites according to the six methods described in the test, and plotted on the abscissa. On the ordinate is plotted the value of a (as the logarithm shown in Table 1). The regression line is also shown. The value of r is +0.967.

FIGURE 5

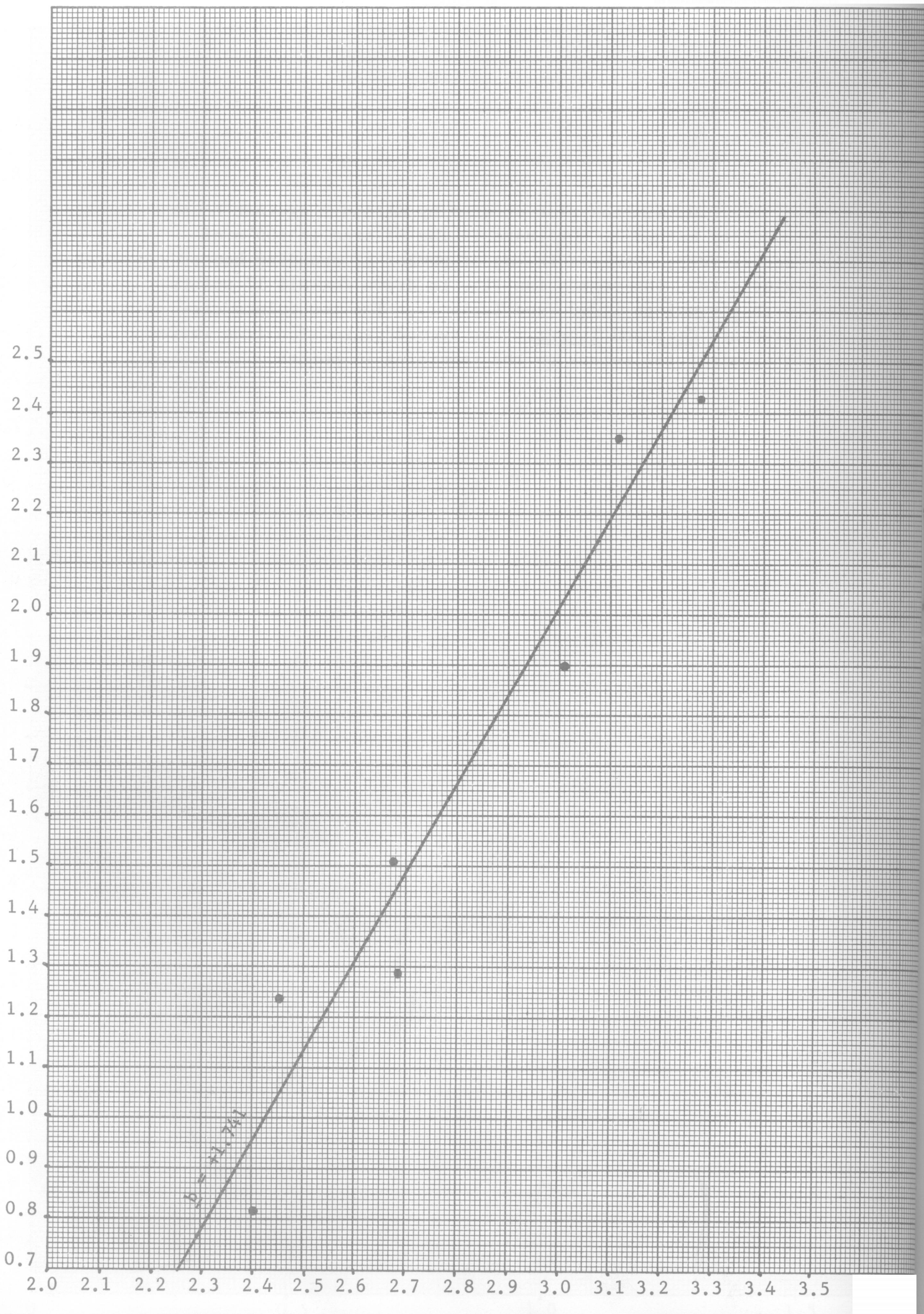


FIG. 6. Ordinate is logarithm of site area in 100's of square feet. Abscissa is logarithm of number of house pits. The dots denote site group no. 1, the circles group no. 2, and the crosses group no. 3.

FIGURE 6

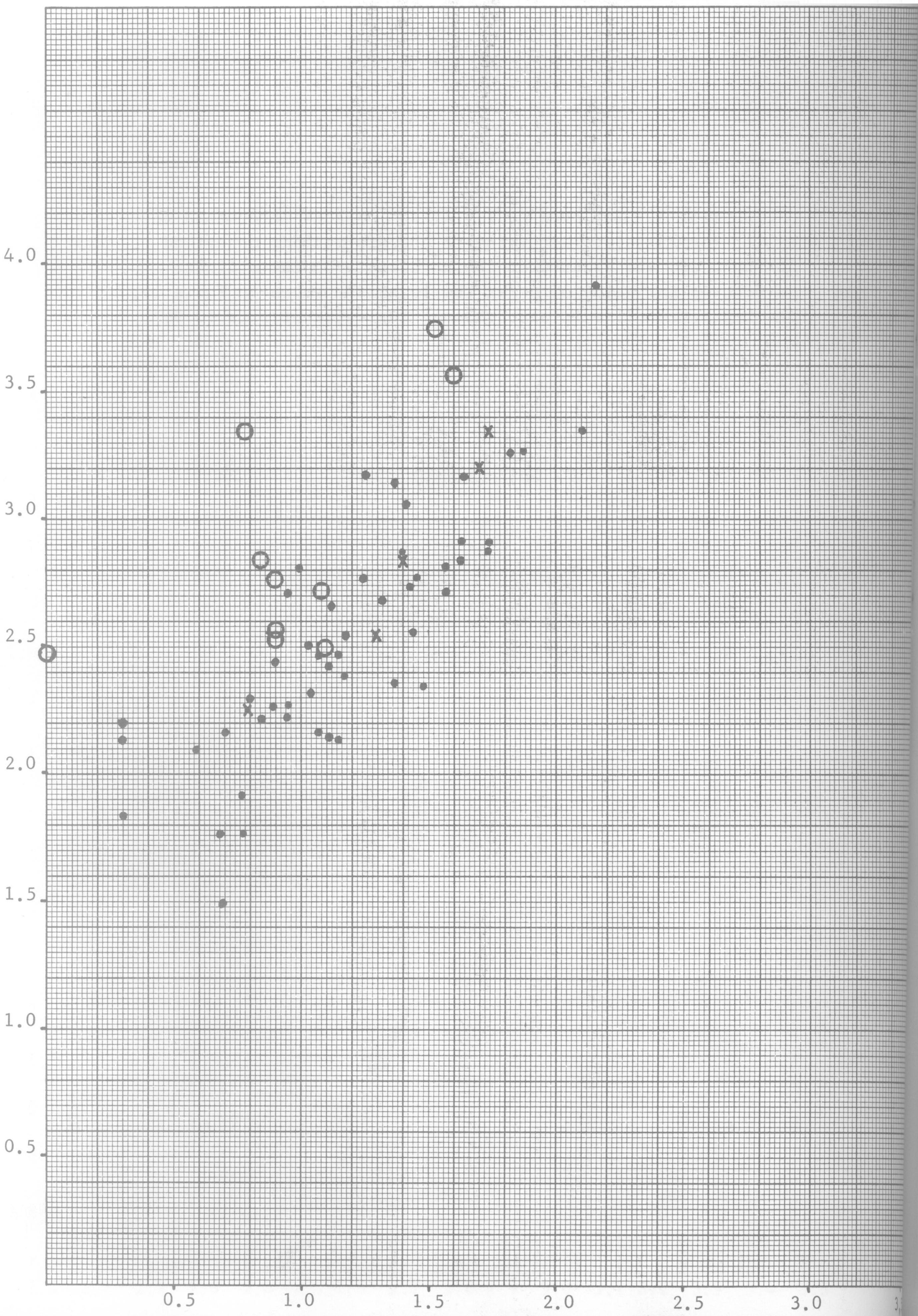


FIG. 7. For the eight sites discussed in the text the logarithm of the area in 100's of square feet (as drawn on Rogers' maps) is plotted on the ordinate against the logarithm of the number of houses as stated by Crespi _et al_. on the abscissa.

FIGURE 7

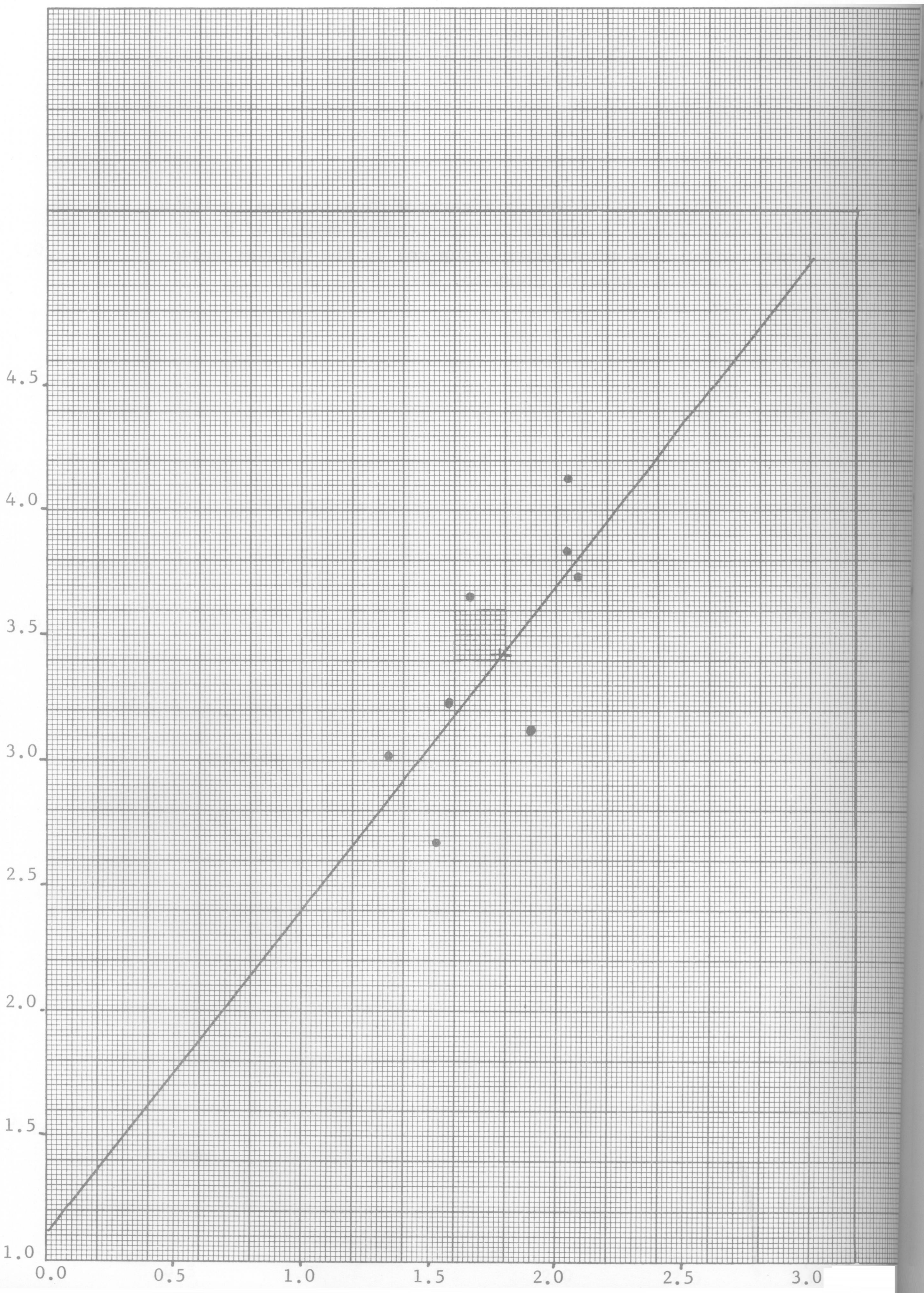


FIG. 8. Log total floor space on the ordinate, log mean number of persons per village on the abscissa. Dots are single family, circles multifamily regions. The regression line is shown for b = 1.437.

FIGURE 8

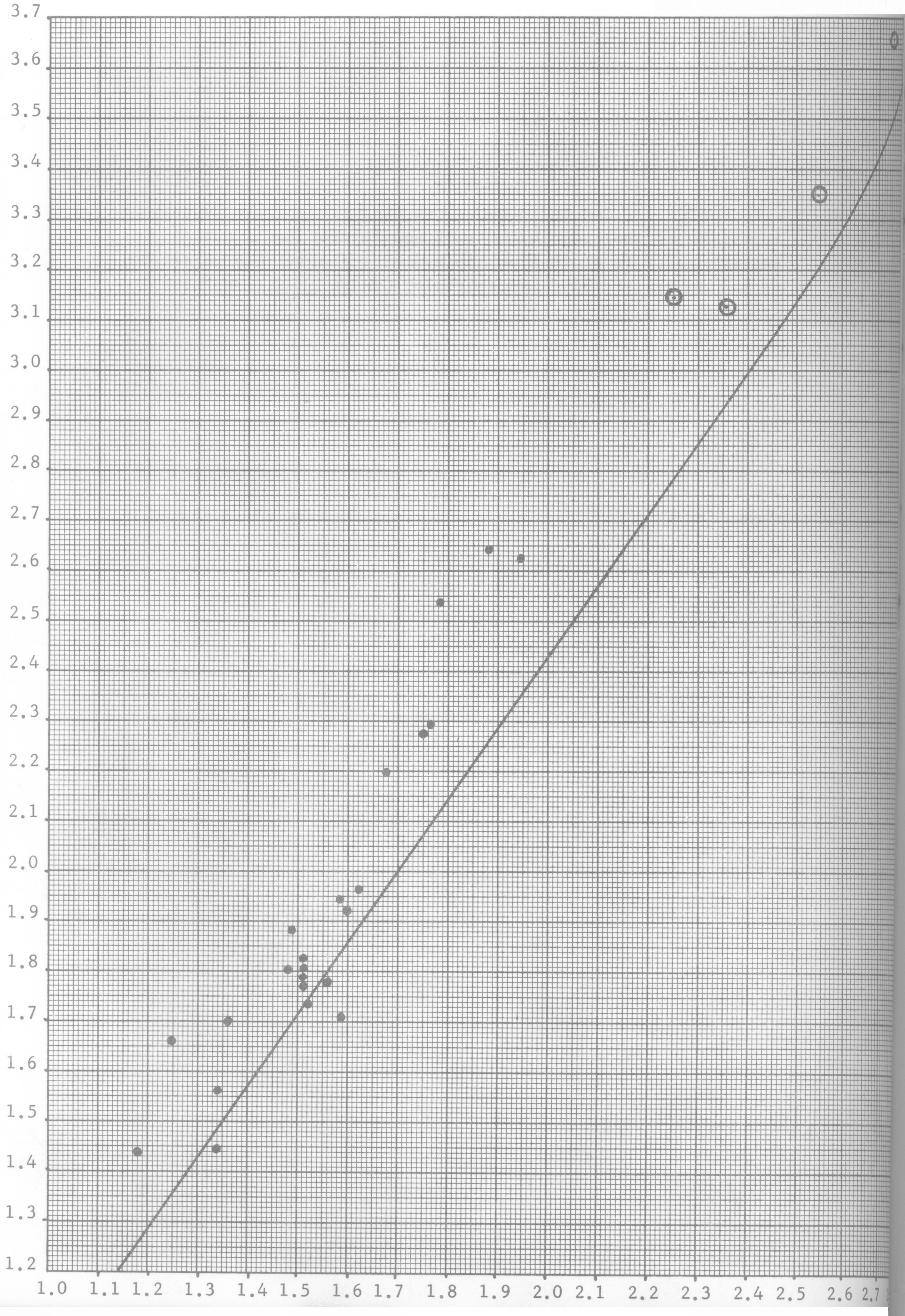


FIG. 9. Log village area on the ordinate, log mean number of persons per village on the abscissa. Dots are single family, hill and coast; crosses single family desert; circles multifamily hill and coast.

FIGURE 9

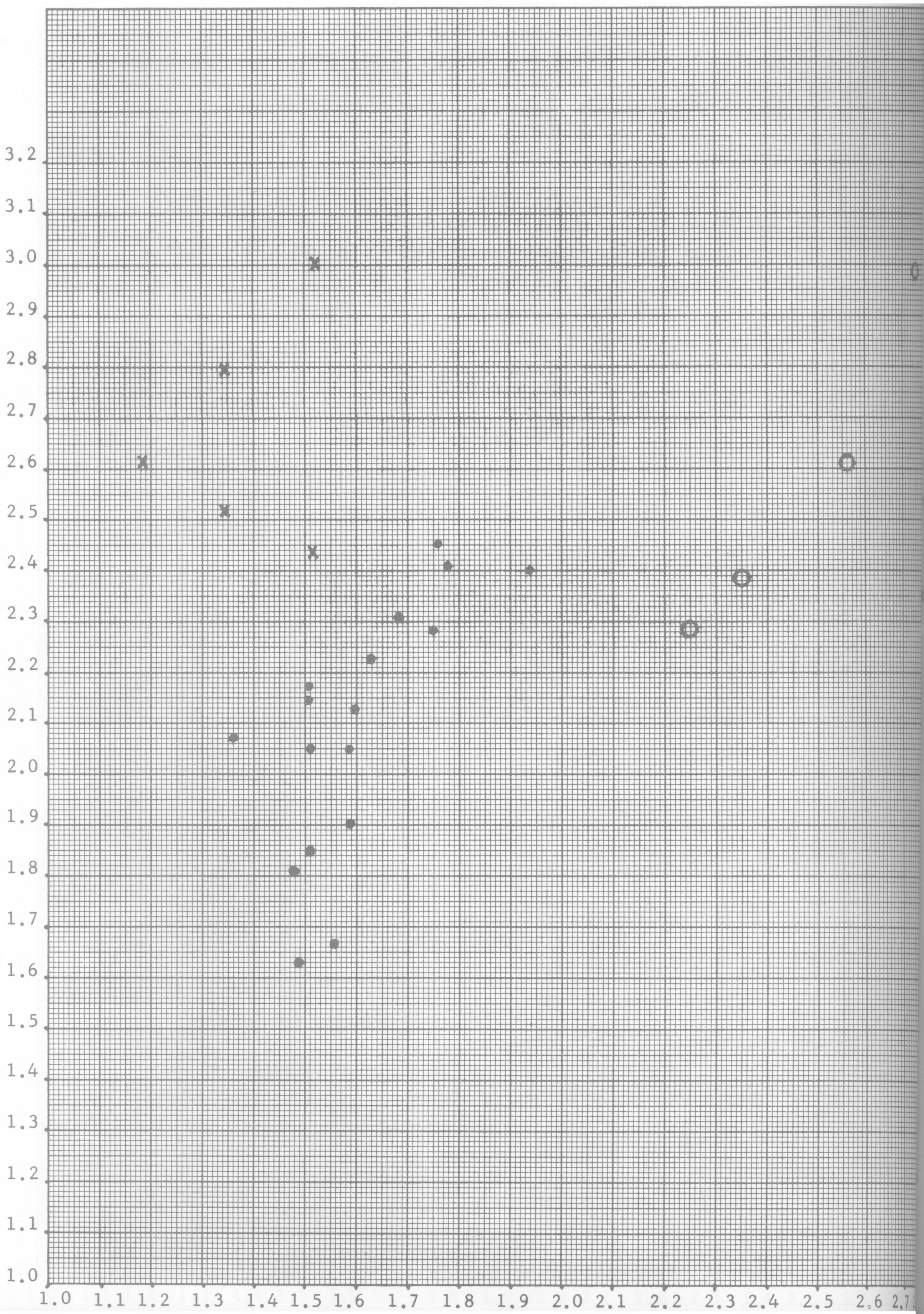
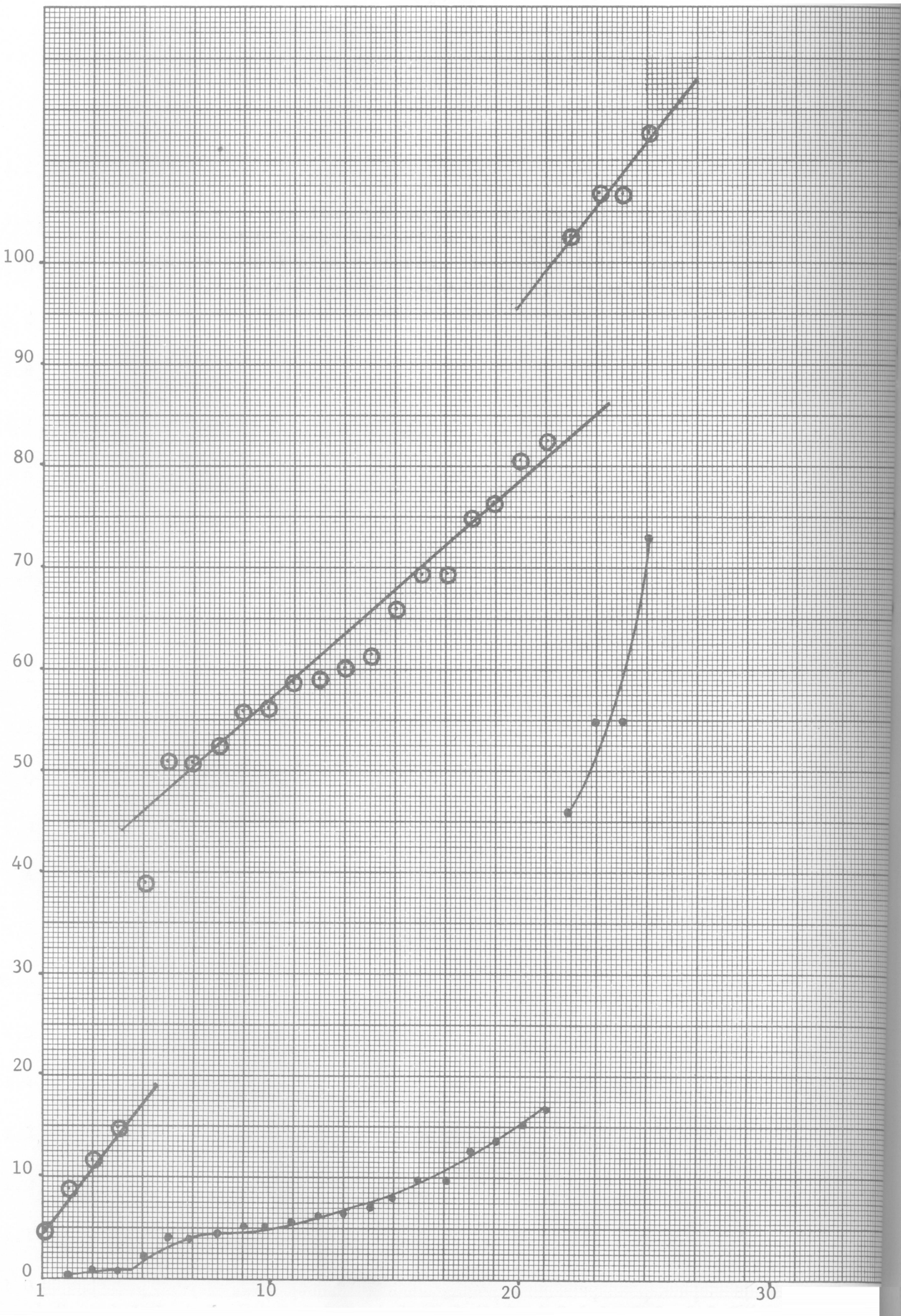


FIG. 10. Ratio of floor space to village area is shown by dots on the ordinate. The corresponding logarithms are shown by circles. The abscissa shows simply the numerical sequence of 25 regions spaced at equal intervals on the graph. Lines are drawn approximately connecting series of points.

FIGURE 10



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AAnt	American Antiquity
BAE	Bureau of American Ethnology
UC	University of California
-AR	Anthropological Records
-PAAE	Publications in American Archaeology and Ethnology

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