Patterns of rural settlement in Sierra Leone: methods of geographical analysis in a tropical environment

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Ph.D. THESIS ABSTRACT.

"PATTERNS OF RURAL SETTLEMENT IN SIERRA LEONE:
Methods of Geographical Analysis in a Tropical
Environment".

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The debate between classical empiricists and those who favour deductive and theoretical research methods is a feature of modern geography. This thesis aims to show that these approaches are complementary rather than mutually exclusive. It also hopes to demonstrate new methods and applications of location analysis in an underdeveloped area where base line information is uneven in quality.

The dissertation is divided into four main parts. In the first, a model settlement pattern for Sierra Leone is devised. This model is based on a stylised subsistence village and the arguments of central place theory. The second part deals with the uses made of aerial photographs, topographical maps, pilot surveys and random sampling procedures in constructing an accurate base map of rural settlement distribution for the whole country, the first of its kind for any West African state. The third part of the work uses purely qualitative and empirical methods. A system of settlement regions is devised and described, and the settlement model is compared with the actual pattern, and with overall changes in settlement structures between 1927 and 1964. An account of rural settlement

evolution using historical sources and comparative mapping is also presented. In the fourth part, a range of parametric and nonparametric tests and techniques of location analysis (e.g. set theory and nearest-neighbour analysis) is used to establish indices of settlement density and nucleation and to test the hypotheses presented in earlier sections of the work.

PATTERNS OF RURAL SETTLEMENT IN SIERRA LEONE:

Methods of Geographical Analysis in a Tropical Environment.

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P R E F A C E

Some apology must be made for both the very variable quality of the photographs in this dissertation, and the cumbersome method of their presentation. Originally it was intended that many of the larger maps and aerial photograph enlargements should be reduced to a size suitable for inclusion in the main text. This depended however, on the skills of a professional photographer. Owing to unforeseen circumstances beyond the writer's control, this help was not forthcoming, and he was obliged to rely on his own limited skills using primitive equipment and limited supplies of materials. Despite repeated efforts, photographs lost all definition when reduced to the size of a quarto page. To accomodate the enlarged size of these maps and photographs, it was necessary to change the entire presentation of the work. The new format is no more than a compromise solution , and the writer must ask for the indulgence of his readers in handling the four separate methods of presenting visual infomation.

TABLE OF CONTENTS.

SECTION 3.

GLOSSARY.

1. Symbols

1.2 = 'Chapter 1, section 2'

Fig. = Maps, photographs and diagrams in Part I

Table = Statistical table in Part I

M = Map in Part 2 (see Chapter 2.2)

P = Aerial photograph in Part 2 (see Chapter 2.2)

PE = Aerial photograph enlargement in Part 2 (see Chapter 2.2)

2. Conventions.

a The upper size limit of rural settlement was fixed at 200 buildings. Few villages with purely rural functions exceed this size. Some of the marketing and service centres are, however, smaller than this, and these were eliminated from the distribution map. (M 2 and 3 in Part 2).

b Two topographical surveys were used extensively. The first was undertaken between 1925 and 1930 and the second from 1956 to 1964. Constant reference to these sources was necessary and the double date description seemed clumsy. Most of the work for the first survey was completed by 1927, and that for ~~for~~ the second by 1964. For convenience, the surveys were indentified in the text by these two dates.

3. Terms

Cell model = An analogue model of settlement structure based on an hypothesis of pattern homogeneity and central place theory. (Chapters 5 and 6 et. seq.)

Standard cell = A 33 square mile grid version of the cell model area used in random sampling and mapping settlement indices. (Chapter 7 et.seq.)

'War-town' = An enlarged defensive village which developed in the ananchistic period before British protection. Few of these settlements had urban functions but the name is used extensively in the literature. It has therefore been adopted here, but itallicised. (Chapters 11 et.seq.)

MAPS, DIAGRAMS and PHOTOGRAPHS.

PART 2.

MAPS (M)

AERIAL PHOTOGRAPHS (P)

AERIAL PHOTOGRAPH ENLARGEMENTS (PE)

TABLES.

I N T R O D U C T O R Y.

CHAPTER 1.

GEOGRAPHICAL ANALYSIS IN UNDERDEVELOPED AREAS : TOWARDS A METHODOLOGY.

1. Introduction: geography and scientific method.
2. Some Developments in Rural Settlement Geography.
3. Rural Settlement Geography in West Africa: some general principles.
4. Conclusion: the main theses.

1. Introduction: geography and scientific method.

National and regional surveys and censuses are an essential feature of planned development in emergent African states. One would expect geographers, with their spatial viewpoint, to be especially involved in this sphere. The lack of such involvement is, however, only too painfully obvious. For every geographer employed by national planning authorities in Africa, there are possibly fifty economists and a hundred other field scientists.

The reasons for this discrepancy are quite clear. Geographers have failed to convince planning agencies because they have for too long relied exclusively on methods which are largely empirical. They have also persevered with an attitude to areal relationships which sometimes has bordered on the semi-mystical. It is not surprising, therefore, that their results often seem peripheral or too imprecise to those who are not aware of the special ethos of the discipline. It is this qualitative approach that has set the subject at odds with other more reputable field sciences. Where they have developed a clearly defined methodology for an increasingly distinctive area of information and have built up a body of laws and theories, geography - and especially the cultural branches of the subject - has continued to rely on purely empirical hypotheses.

The problem may be stated even more simply. Geographers have not been employed as planners because they could not claim to be scientists. They have not been scientists because, until recently, they have failed to subject their work to anything approaching the rigours of scientific method, and have failed to develop an identifiable "geographical" body of laws and theory.

There are four generally recognized stages in scientific research: the inductive classification of observational data; the development of hypotheses from this information; the testing of these hypotheses by as stringent a means as the information allows; and the formulation of theory or laws[1].

The history of scientific advance in most fields has followed these stages of scientific method. The first step has always been the sorting of sense perception data into working groups of species, elements, compounds, or series. Few of the twentieth century sciences have remained at this stage, however. Most disciplines have been modified or completely altered by deductive methods of research. Using these methods, most early systems (e.g. pre-genetic biology, pre-atomic physics) were found to have been highly subjective, conceived from an incomplete understanding and conditioned by the current world-view.

The great lesson of modern science has been to show that although induction is an essential part of any reasoning process (Bertrand Russell's 'step in the dark'), for the physical world no hypothesis or system of classification, no matter how brilliantly conceived, can gain credence until it has been tested.

Although beginning from the same philosophical bases as other field sciences, geographers have continued to rely on methods which most scientists would now regard as a very elementary stage, both in the development of science as a whole and in the individual research process. What Braithwaite[2] has called 'the natural history stage' of classification and description also corresponds to the first steps in a research project using scientific method.

During the last two decades there has been an increasing awareness amongst geographers of these deficiencies. Indeed, it could be argued that the rapid progess in quantification and location analysis has been the result of a traumatic recognition that in the planned societies of the mid-twentieth century, the subject - and particularly its cultural branches - has been left with limited small arms fire to match the heavy artillery of more reputable social and physical sciences.

Burton[3], who has carefully charted the progress of what he terms 'the scientific revolution in geography', maintains that the first phase of this revolution is now over. There is some justification for this view. Few would argue openly today, as Stamp did only three years ago, that the new techniques were simply "using a steam hammer to crack peanuts".[4]

Nevertheless, the rapidity of this change has brought its own problems. In the first place, the pre-occupation with techniques which has characterised this early phase has allowed little opportunity for viewing these methods in a wider context. Means have often been confused with ends. Robinson[5] and others have pointed to the intoxication of using new and frequently obscure techniques when much simpler methods would produce equally valid results. Such trends are perhaps inevitable in this first period and may not be too dangerous in themselves. Those who man the barricades are in no position to evolve sophisticated political theory.

It would seem, however, that the time is now approaching when a longer perspective on the 'scientific revolution' in geography will reveal that the discipline is still some way from achieving an approach which is truly scientific. Already, observers are beginning to draw attention to the fact that the processes of scientific method depend just as much on the empirical techniques of the 'classical' period as they do on the theoretical and statistical methods now in vogue.[6] Qualitative and quantitative techniques should be complementary and not mutually exclusive. On these grounds, much of the debate between 'hypoqualifiers and hyperquantifiers'[7] is irrelevant. Scientific method is essentially eclectic; a dialogue between empirical and inductive approaches and theoretical and deductive tests.

Another feature of the rapidity of recent developments which is particularly relevant to this dissertation is the parochial nature of the body of geographical theory which has so far emerged. All the new ideas of location analysis have been developed in advanced social and economic landscapes of Western Europe and North America. With few exceptions[8] they have only been tested in these environments. A general body of theory is yet to emerge. Here lies the seeds of a dilemma, for it has seemed to some observers that techniques developed to satisfy the sophisticated requirements of conditions in the developed areas of the world cannot be readily used, or even adapted, to those in less well developed regions. This gives rise to the suggestion that in these areas the older qualitative methods alone are still applicable.[9] One of the main aims of this dissertation is to show that this view is retrograde. Restricted methods of research which have been 'superceded' in one area of research are equally invalid in others. Old techniques cannot be passed on like old clothes. If a general system of geographical research is to emerge in the second half of this century, then there is an urgent need to develop a body of theory which is equally grounded and tested in all environments, or no real progress can be made at all.

Moreover, for countries desperately in need of planned development, a body of research which can claim only general educational utility is an unjustifiable luxury. Yet although most geographers working in these regions recognise that they should make themsëlves useful rather than decorative, their methods have failed to gain general acceptance. A major premise of this thesis is that scientific method, which combines inductive and deductive techniques, is an approach which both resolves the methodological debate and provides a way out of practical dilemmas.

2. Some Developments in Rural Settlement Geography.

Many of the broader features of the character and progress of geographical research as a whole are reflected in the development of rural settlement geography. Research in this field concentrated attention first on a purely qualitative analysis and classification of the forms and origins. It has only more recently turned to the quantitative and deductive problems of representing and interpreting the patterns and functional relationships of rural settlement.

In view of the hypothetical nature of early analyses, it is scarcely surprising that much of the work on form and origin of rural settlement in the last forty years has been concerned with the re-appraisal, modification, or rejection of theories put forward at the end of the nineteenth century and during the first two decades of this century. Early theories and systems were produced either by cultural determinists like Meitzen,[10] or in reaction to the broader environmentalist school led by Ratzel, Semple and Huntingdon. It could be argued that the possibilism of Brunhes and Vidal De la Blache was in many ways a reaction to these earlier dogmas and classifications.

Each over-simplification:- Meitzen's Celtic dispersed settlements and Germanic nucleated villages; Seebohm's theory of Roman influence;[11] Gradmann's <u>steppenheide</u> argument[12] for the early settlement of loess soils;-all stimulated a number of studies to distinguish exceptions, or more detailed analyses to show the low value of premature generalisation.[13]

By the end of the nineteen twenties, the work of the French and Belgian social geographers - Demangeon, Arrousseau, and Lefevre in particular - demonstrated that there was an urgent need to sort out the intellectual confusion which had arisen. It was for this reason that the International Geographical Union established its 'Special Commission on Types of Rural Settlement'.[15]

The first reports were delivered in 1928, 1930 and 1931. Since this time the commission has continued to perform the valuable function of a clearing ground for opinion and theory. Despite this work, however, and the valuable contributions of Demangeon and Lefevre in particular, no general system of classification of either forms or patterns has yet emerged which satisfies most regional contexts, even in Europe, let alone other continents. Most of the progress has been towards recognising problems rather than solving them.

If much of the earlier research in rural settlement was directed to problems of origin and terminology, attention has increasingly turned to the difficulties of refining measurement of patterns and spacing, and improving accurate isarithmic representation.

Using the sophisticated French population statistics, Demangeon[16] devised indices to measure the relationship between the number of settlements in each commune and the total population of the unit. Various criticisms of the formula which Demangeon devised - its poor differentiation of dispersed settlement types, its lack of refinement in areas of subtle micro-variation, its limited applicability outside the area of French statistics - led to several attempts to refine the system. A different approach was made by Zierhoffer,[17] whose index was based on the principle of area-per-dwelling. This theme was taken up by Detisme and Debouverie[18] who attempted to distinguish regional variations by applying criteria of size, and arguing that the minimum number of houses which comprise a settlement is roughly proportional to the number of settlements in the area being considered.

Measurements of density based on the distance between isolated houses have been found useful in areas where dispersion is the normal pattern. Studies by Barnes and Robinson[19] in central areas of the United States have been matched by Polish geographers[20] who are working in similar areas of dispersed settlement. By incorporating scale factors - their main criticism of Robinson's system - they have improved the isarithmic quality of their results.

The relationship between the size, spacing and function of rural settlements has been a fairly recent pre-occupation, and has developed out of central place theory[21] (Chapter 5.2). Here, interesting work has been done by Dacey[22], Bracey, Brush and Stafford.[23] Using various empirical criteria to distinguish the increasing scales of importance of settlements - the number of shops of varying types, number of filling stations and other services - and sophisticated statistical techniques, it has been possible to define relationships between size, spacing and function in a clear hierarchical scale.

3. Rural Settlement Research in West Africa: some general principles.

It has been suggested above that the pioneer work of classification and terminology, and most of the theoretical and measuring techniques, have been devised by North American and European scholars. New research into settlement associations anywhere can only be undertaken in the light of these studies. Yet the groundwork of information and experience upon which these systems have been built is taken from developed social systems. It will be obvious that rural settlement conditions in an under-developed country cannot be compared with those of a developed society without considerable reservations, re-assessments, and adaptions.

It is perhaps not surprising, therefore, to find that previous rural settlement research in West Africa, handicapped as it is by a lack of background information, has tended to concentrate on either a broad analysis of regional variations - based on fairly superficial observations - or on the detailed analysis of a sample village or a small group of settlements. The English school, based in Ibadan and Accra, has tended to favour the former approach, whilst the French, working from their research institutes in Dakar and Abidjan, have favoured the latter treatment. A bibliographical summary of these studies will be found at the end of this chapter.[24]

Apart from tentative studies in Ghana by Boeteng and Hunter,[25] there have been few attempts to develop sophisticated measuring techniques, and little has been done to relate previous research in this field to the problem of settlement interpretation in the region. Yet it is argued here, that if a <u>general</u> body of geographical theory is to emerge, as it must for the survival of the discipline, then attempts to knit together the approaches to settlement analysis from all regions must be made.

Some of the dangers of this task are clear enough. Terminology and systems of location analysis devised to satisfy European or American conditions cannot be applied in an under-developed African setting. Transpositions of this kind would clearly be ridiculous. Village-en-tas and village etoile mean little in an area where the teacup has very different connotations[26] and the stylised shape of a star is different from that common in western culture. Similarly, it would be ludicrous to classify settlements by the occurrence of confectioners or filling stations. Other difficulties, however, are not so obvious.

In developed regions, the wide range of settlement conditions, produced first by a long history of change and then by a sophisticated interaction of social and political forces, have given settlement forms and patterns of considerable complexity. A European rural community may still contain something of its early subsistence structure. Elements of the old communal system of life will still be discernible in the site and nucleated character of the village, in the pattern of fields which surround it, and in the communication pattern and place names of the area. But this basic structure will inevitably have undergone considerable modification. The pattern of fields will have been diversified by individual ownership and mechanised cash agriculture, and by the range of agricultural activities which are the product of a technical society and a sophisticated market. Systems will have been modified by the directions of government policy, especially by price controls and subsidies.

Other features of industrial society may cause local variation in rural settlement conditions. Depending on its location, a village may have become, for example, a dormitory settlement for a neighbouring town, a mining community, a tourist attraction, or a de-populated derelict. The variety which all these forces bring to the rural landscapes of Europe do not need further elaboration here.

Bearing all these factors in mind, it would seem axiomatic that the closer one approaches to a pure subsistence society, the narrower will be the range of social and economic preferences and variations and the more uniform will be the settlement structure. Such bald assumptions, however, would be dangerous. It is true that no West African region could match the palimpsest of the English landscape, but within its narrower range of possibilities, there is a quite considerable scope for variation.

The hazards of applying European rationale to West African research problems may perhaps be best expressed in Davisian terms.[27] If one substitutes the word 'culture' for 'structure', one can see that it is not only basic differences in 'stage' of development but equally important differences in 'process' and in the cultural framework from which 'process' evolves.

A range of social and economic values can still bring considerable diversity to rural settlement in apparently homogeneous physical environments. In Africa, much of this diversity can be attributed to the wide range of tribes and cultural groups with varying systems of tribal organisation and family life.

In West Africa alone, there are approximately 200 tribes[28], most of which have their own language. Many of them also have social systems which are different enough to produce differences in rural settlement, even in the same physical environment. The Ibo village, for example, differs considerably from its Yoruba counterpart and the Fulani herders' settlement from the Hausa farming village.

Factors influencing forms and patterns of settlement may be both social and historical. They range from differences in kinship organisation to variation in the intensity of slave-raiding and inter-tribal wars.

In some areas, purely physical factors may cause pattern variations, like the avoidance of endemic disease[29] areas which have so often restricted settlement to less fertile soils on upper surfaces. One must also take into account such features as the use of cattle in the economy, the bias to one crop staple or another, the importance of fishing or hunting, and the development of trade and marketing skills.

External influences can also bring variety to settlement responses - the presence of Islam, the number of European schools and missions, and the appearance of a western economic enterprise like mining or plantation agriculture. Variations may be in a lower key than those of the European landscape, but within the limitations of a peasant economy with a short history of contact with sophisticated systems, there is no doubt that they exist.

For this reason, it is extremely important to avoid the pitfall of drawing what appear to be obvious conclusions from observations based on European theory and a European background of experience and training. Despite these difficulties, principles must be applied and tested in all environments, for only in this way can a general body of theory emerge.

4. Conclusion: the main thesis.

This dissertation has been written from the broad premises presented in this introductory chapter. It has three general aims: firstly, to attempt a synthesis between empirical and deductive methods of research - the essence of scientific method; secondly, to develop techniques of analysis which could have practical applications in development planning; thirdly, to extend the range of geographical theory in under-developed areas. Associated with these broad aims are other more specific intentions; to test new deductive techniques of analysis and to show how these methods are particularly useful in coming to terms with an uneven quantity and quality of source material.

One final point needs stressing. This thesis is an attempt to use and devise practical analytical techniques as well as useful theory, but in many chapters the bias is unashamedly towards means rather than ends. It seemed that this theoretical and methodological exercise was worth the effort, for it is on the ability of geographers to develop a viable body of theory that the future of the discipline as a practical subject depends.

References.

1. Ackoff, 1962; Blaylock, 1961; Braithwaite, 1955; Hempel, 1965; Nagel, 1961; Popper, 1965; Toulmin, 1953; Winch, 1958.

2. Braithwaite, 1955, p.38.

3. Burton, 1963.

4. In discussion following Haggett's 1964 paper, p.380.

5. Robinson, 1961, (A), pp.181-183.

6. Wrigley, in Chorley and Haggett, 1967, p.17.

7. Robinson, op.cit. p.181.

8. Mayfield, 1967, pp.120-167.

9. Wrigley, op.cit., p.18.

10. Meitzen, 1895; Schluter, 1900.

11. Seebohm, 1883.

12. Gradmann, 1910, 1913.

13. Lennard, 1911; Martonne, 1902; Schumacher, 1921; Schoch, 1917; Mouralis, 1924; Blanchard, 1925; Bonn, 1906; Fischer, 1906; Flach, 1914; Bernhard, 1919; Ahlmann, 1928; Woeikof, 1909.

14. Demangeon, 1925, 1927; Arrousseau, 1920; Lefevre, 1923, 1926.

15. Reports and Comptes Rendus, I.G.U., 1928, 30, 31, 36, 38, et al; Lefevre, 1933.

16. Demangeon, 1933, p.225-232; also Bernard, 1931, pp.108-117.

17. Zierhoffer, 1932, pp.410-415.

18. Debouverie, 1943, pp.146-196; Detisme, 1936, pp.189-91.

19. Barnes and Robinson, 1940.

20. Deszczka, 1927; Albert, 1934; Iesman, 1936; Pawlawski, 1938; see also Blumenstock, 1953.

21. Berry and Pred, 1965.

22. Dacey, 1962; and in Garrison and Marble, 1967.

23. Brush, 1953; Brush and Bracey, 1955; Bracey, 1962; Stafford, 1963.

24. Work on rural settlement from the English school includes the following: Boeteng, 1954, 1955; Steel, 1948, 1952, 1957; Prothero, 1954, 1959; Morgan, 1955, 1957; Hilton, 1959; Mabogunje, 1959; Hodder, 1961; Manshard, 1961, 1966; Udo, 1963, 1965; Gleave, 1963, 1967; Goddard, 1965; Kircherr, 1963; Hunter, 1967.
Examples of work in the French school are as follows: Dainville, 1948; Strasfogel, 1949; Bouche, 1949, 1950; Thomassey, 1951; Brasseur, 1952; Bernus, 1956, 1957; Duborg, 1957; Pelissier, 1958; Duplyron, 1959; Brasseur 1952, 1960, 1961; Guy, 1960; Nicolas, 1960; Coulibaly, 1961; Sow, 1962; Pelissier, 1963; Rochette, 1965.

25. Boetung, 1960; Hunter, 1966.

26. The teacup is often used exclusively to serve magical potions in Sierra Leone.

27. Dickenson uses the same metaphor to account for settlement variation in Europe, 1949, p.263.

28. Murdock, 1959, (Map Appendix).

29. Hilton, 1959.

CHAPTER 2.

ARRANGEMENT OF THE DISSERTATION.

1. Organisation.
2. Features of Presentation.

1. Organisation.

The main part of the work is divided into four sections, which as far as possible conform with the main stages of reasoning using scientific method.

The first section develops the initial hypotheses of rural settlement in Sierra Leone, and attempts to relate these to a wider body of theory.

The second section deals with the classification and organisation of settlement data and the construction of a base map of settlement distribution. This map was based on field work, examination of the topographical map and photographic sources, and random sampling techniques. Information was collected in such a form as to be useful in later testing of the hypotheses of the first section.

In the third section, both regional and systematic approaches to empirical analysis are made. The first chapter in the section (Chapter 9) describes, and attempts to account for, apparent regional variations in the settlement pattern, using the settlement base map, aerial photographs, and a background knowledge of the physical and human characteristics of each region identified. Subsequent chapters make some observations on the structure of settlement with attempts to account for deviations from theoretically 'expected' settlement relationships, following the argument in the first section of the work. These deviations are seen as a result of both historical and economic changes during the last three hundred years. During the course of the argument, hypotheses presented in earlier chapters are modified or refined in the light of these observations.

Early in the final section, data is prepared for statistical analysis, and indices are devised and generalised (Chapter 14). By using a fairly wide range of parametric and non-parametric statistical tests, it is then possible both to suggest new methods of analysis and to check many of the hypotheses presented during the empirical stages of the work.

In the last chapter, some attempt is made to draw general conclusions and to assess the strengths and weaknesses of this methodology.

2. Features of Presentation.

The interrelationship of arguments in the approach outlined above did not accord with the normal sequential order of chapters. A consecutive order often implies a strict progression of the argument. Here, such progressions are by no means invariable, and many chapters are complementary or inter-relative. A systems structure was devised to distinguish these inter-relationships (Fig. 1) and should be viewed in conjunction with chapter headings.

This inter-dependence of arguments also necessitated a good deal of cross referencing. Often these references were to arguments rather than points, and therefore to sub-headings rather than to pages. The most suitable system, both of referencing and pagination, seemed to be the use of chapter and sub-heading numbers. (See Glossary).

The next problem concerned illustrative material. It is customary in western Europe to begin a research project with a ready-made body of data and a set of accurate base maps. The researcher in an underdeveloped area does not have this advantage. Base maps and data for this thesis were only produced by a lengthy process of mapping and classifying information from aerial photographs. The most useful by-product of this task was a thorough familiarity with most of the subtleties of variation in rural settlement forms and

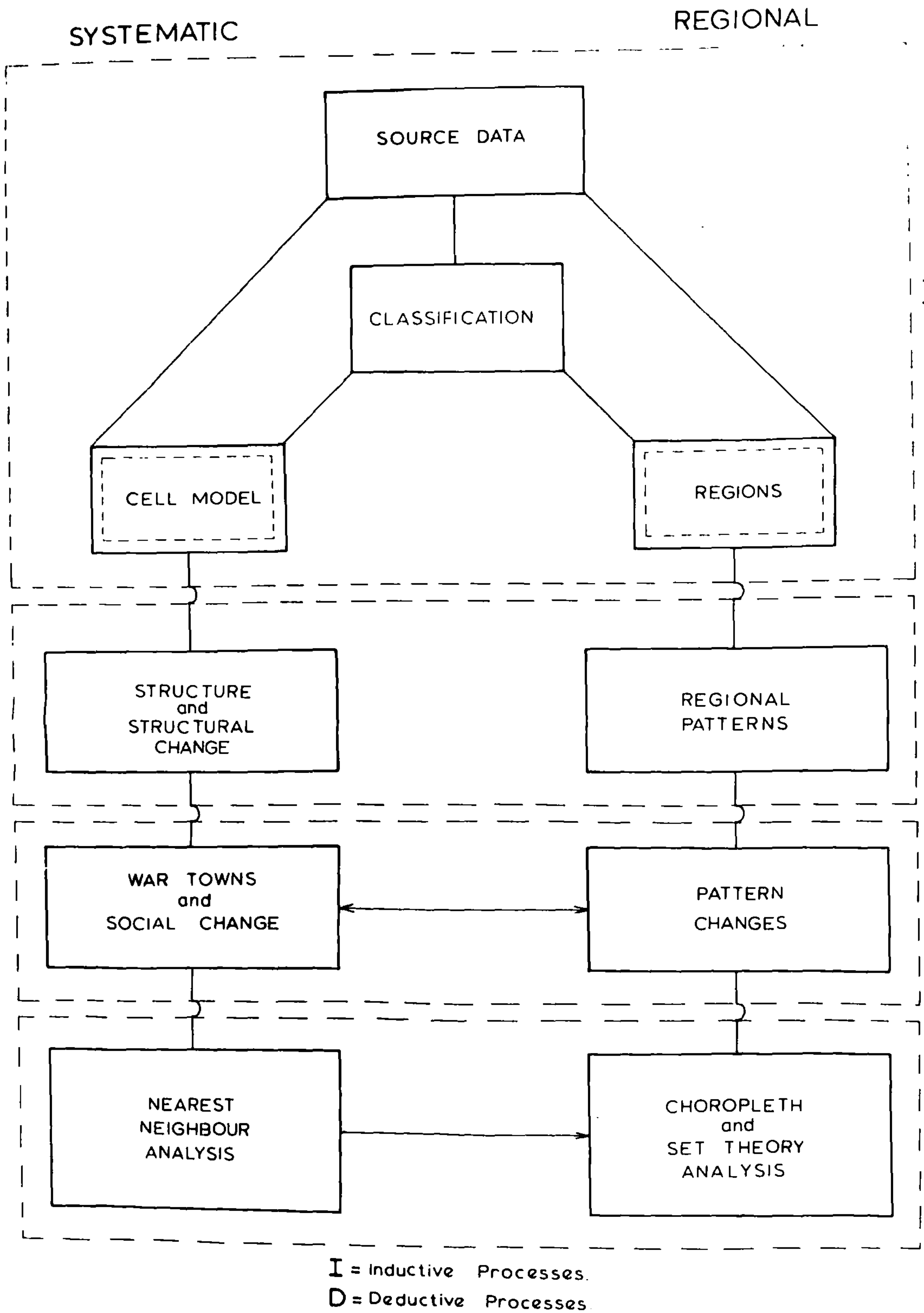
SYSTEMATIC
REGIONAL
SOURCE DATA
CLASSIFICATION
CELL MODEL
REGIONS
I
STRUCTURE
and
STRUCTURAL
CHANGE
REGIONAL
PATTERNS
D
WAR TOWNS
and
SOCIAL CHANGE
PATTERN
CHANGES
I
NEAREST
NEIGHBOUR
ANALYSIS
CHOROPLETH
and
SET THEORY
ANALYSIS
D
I = Inductive Processes.
D = Deductive Processes.

FIG. 1

patterns, even if these were not completely understood at the time of mapping. This thesis will hope to suggest, therefore, that mapping by this method is by no means an empty exercise, just as it will also hope to indicate the value of a fairly pragmatic approach to the problems involved in such an enterprise. For this reason, it seemed appropriate to illustrate arguments by use of aerial photographs. This created a special problem of how to handle such diverse illustrative material — two scales of photographs and several detailed maps which lost definition when reduced to the size of a quarto page. The problem was solved by including all these illustrations under a separate and slightly larger cover (Part II). Both the photographs and maps in this portfolio are identified in the text by special symbols (P = small photo print, PE = enlargement, M = base map).

Preliminary work involved the tabulation of a considerable quantity of statistical information. It was not possible to include all this information in a general appendix. Consequently, the appendices to the main text have been restricted to directly relevant statistical information which could not be included in the main body of the work. A considerable quantity of sampling data has therefore been summarised rather than quoted *in extenso*.

C H A P T E R 3

SOURCES FOR AN ANALYSIS OF RURAL SETTLEMENT IN SIERRA LEONE

1. Published Evidence.

2. Unpublished Evidence.

1. Published Evidence.

The published work on Sierra Leone which was found useful in preparing this thesis falls into four main categories: historical records of the early travellers and administrators; government reports and hand books; articles in academic journals; and topographical maps.

Historical records:

Social and economic change has not proceeded very rapidly in Sierra Leone (Chapter 12.1). Consequently, the records of early travellers have more than merely marginal value when it comes to interpreting present rural settlement conditions. Some very useful information, particularly on the site and form of settlement, can be found in the journals and reports of nineteenth century travellers, missionaries and administrators. Although by no means all areas of the country were described in these accounts, many features of settlement are sufficiently common to most tribes and regions to make wider inferences possible. The most useful of these accounts are the work of Laing[1], Winterbottom[2], Alldridge[3] and Trotter[4], and acknowledgement of their contribution, and those of others, is made in later chapters.

Government Reports and Administrative Handbooks:

The century and a half of colonial administration provided the country with a series of annual, periodic and special reports[5], some of which were marginally useful for an interpretation of the physical and economic features of the regions or districts which they covered. More useful were the Colonial Office Blue Books and the Route Books of the Military Report on Sierra Leone (1908). The former contain details of regions and tribes, and the latter present notes on the relief, vegetation and economy of the area through which army routes passed. The 'Army Books' were also accompanied by a count of huts in each settlement along the routes and a note of intermediate distances. This provided a valuable perspective on settlement conditions in the period immediately following pacification at the beginning of this century.

Academic publications:

A full regional geography of Sierra Leone is yet to be written, and there are few purely geographical monographs or papers which are specifically relevant to this dissertation. Limited use was made of articles in Sierra Leone Studies and the Journal of the Sierra Leone Geographical Association. A greater body of relevant work, in the broad field, was completed by anthropologists and historians. It is appropriate to mention in particular the work of Little[6] among the Mende, and of Finnegan[7] among the Limba people. Notable work on collating information for a wider range of peoples has also been done by McCulloch[8], Fyfe[9], and Kup[10].

Interpretation of the base map of rural settlement distribution (Fig.M.3), now produced as part of the series in Sierra Leone in Maps[11], would have been much more difficult without the work of other contributors to this book. The maps from this series formed an indispensable reference collection for this thesis.

Topographical Maps:

Sierra Leone is a small country (just under 28,000 square miles) and has a compact, almost circular shape. It has therefore been reasonably well served with topographical maps compared with many other larger and less homogeneous states of developing Africa. Maps found useful in this research project were those which covered the whole country at a standard scale. These may be briefly reviewed in two groups; those produced from surveys undertaken before 1930, and those produced from surveys since 1956. The first were based on ground surveys, the second on aerial photographs with limited ground control.

The earliest full map coverage of the country was a series of nine sheets at the scale 1: 250,000 which were the work of the Anglo-French and the Anglo-Liberian boundary commissions of 1895 - 1896 and 1913 - 1914. Most features of relief and drainage were accurately recorded and most settlements were named and located with fair positional accuracy. As one would expect, however, only a subjective and inaccurate impression of relative sizes of settlements was given. A recent revision has no more than altered the superficial details of lettering and communications.

From this first small scale series, however, a useful single map sheet at 1:500,000 has been produced using layer tinting techniques to indicate relief. This map has been revised several times to show new roads and to correct initial errors. This map has formed the most useful basis for comparative mapping, both for government and for purely geographical work.

The first fairly large scale series of maps, at 1:62,500, were produced between 1927 and 1942 by the Colonial Survey Department. This remains the only complete map cover of the country at a large scale. Details of vegetation, drainage and relief (using a fifty foot contour interval) are shown with variable accuracy. Settlement conditions on the other hand, are more reliably recorded (Fig.M.2a). Settlements are not only given a symbol which aims to indicate the actual size, but even the smallest would seem to have been accurately located and named. The methods by which this high standard was achieved will be reviewed later in this chapter.

The second group of maps, which are still in process of compilation by the Directorate of Overseas Surveys, can only serve to bring up to date and correct the errors of the 1:62,500 edition. It cannot hope to match the accuracy, in terms of rural settlement size, of the series produced from ground surveys. These recent maps are being produced at scales which are all larger than the earlier series. A full coverage is being prepared at 1:50,000, and several larger scale editions are being devised at 1:25,000, 1:6,500, and 1:2,500 to cover special areas (e.g. town plans and mining concessions) from the same aerial survey material.

The most important coverage, in terms of this dissertation, is the 1:50,000, which allows close comparison of settlement conditions with the earlier large scale series. There are, however, several drawbacks. In the first place it is not complete. Only maps for the western half of the country have been issued (1965). Secondly, although drainage patterns and communications are for the first time accurately located, vegetation and relief are so far given no more than generalised attention. Thirdly, although settlements are again accurately located, they are shown by a symbol only crudely proportional to the actual size of the unit (Fig.M.2a).

It will be seen from this survey of topographical map sources that each series has severe deficiencies: small scale early editions could only be used as base map outlines; both the larger scale coverages are unreliable or incomplete in terms of physical features; and the most recent full coverage is still unfinished. In other words, no fully comprehensive picture of rural settlement in Sierra Leone could be based on the topographical maps alone.

Within these limitations, however, it became clear that a profitable analysis could be developed from the continuity of accuracy in locating and recording at least the relative sizes of rural settlement which both the large scale map series seemed to show, but in order to use these records, it was necessary to turn to the un-published surveys from which these maps have been drawn.

2. Unpublished Evidence.

Two full scale topographical surveys of Sierra Leone have now been completed. The first was undertaken between 1925 and 1927, and the second began in 1956 and was completed in 1964. These records are the only full scale team surveys of Sierra Leone from which fairly detailed information can be obtained for the whole country. The 1963 'Census of Population'[12], although quite complex in structure, has not yet been computed in anything like the same detail as these two topographical surveys. Much of the illustrative material in this thesis and a good deal of the analysis is based on material produced from these two major enterprises. It seems relevant therefore, to spend some time in discussing these projects and the methods which were used in compiling the topographical maps.

The 1:62,500 Survey, 1927:

The first full scale topographical survey of Sierra Leone was undertaken by the Gold Coast Survey Office of the Colonial administration in 1925 and completed in 1927[13].

The aim was to produce a map coverage of the whole country at the scale 1:62,500. The last sheets of the series were finally issued in 1942, and it still remains the only complete large-scale cover of the country. Unfortunately some of its better features are not repeated in the half-completed initial issue of the 1:50,000 series.

The 1927 survey was a remarkable achievement considering the restrictive budget, rudimentary survey techniques, and the uneven quality of the field staff available. Field parties completed detailed mapping on sheets squared by a 30 degree latitude and longitude grid. Compass traversing was used intensively for every square mile of country, Levelling work accompanied the traverse - with perhaps less consistent accuracy - for contouring at the fifty foot interval.

Although a more objective judgement of the earlier survey awaits the completion of a contoured 1:50,000 edition, it does seem from observation in the field, and comparison with sheets of the new series already produced, that a considerable level of accuracy was achieved in the location of social and economic features, if not in details of relief and drainage. If this is so, it is due in large measure to the surveillance of individual field parties by the central office, and by the detailed quality of the records which it expected the field parties to keep.

Each party was instructed to maintain a number of field record books in which were recorded the details of the survey and a description of the country through which they passed.

The most important of these records for rural settlement studies were the Village Books (FigM2a). Each settlement encountered by the field party (and the close network of the survey makes it unlikely that many were missed) was given an index number and its location recorded on the field sheet and in the Village Book. The surveyor was also required to record in the book the name of the settlement, its accepted spelling, details of its social, religious and commercial functions, and most important, a record of the number of buildings in each settlement unit. In most cases this record was also made on the back of a steel-backed field sheet. As all the field sheets and most of the Village Books have been preserved in the Department of Lands and Surveys in Freetown, it is possible to trace, reasonably quickly, any settlement in the country, and find details of its size, economy, and institutions during the second decade of this century.

The value of this record to an interpretation of change in settlement pattern will be clear. To make such a record of maximum use, however, it was necessary to find a similar source which could yield information approaching this quality and consistency for the modern period. Fortunately, such a source could be found in the aerial survey completed in 1964.

The 1:40,000 Aerial Survey, 1964:

The photographs from which the 1:50,000 map series are being devised had to be of consistently high quality to be useful for detailed mapping. Earlier surveys by the Royal Air Force, undertaken between 1949 and 1951, had failed to measure up to the required standards[14]. Hunting Surveys and Fairey Aviation undertook the work. Considerable care was taken to ensure that contracts were undertaken during the best atmospheric conditions. Such conditions are available only during the dry season from November until April. The work was completed in eight contracts in these months for the years between 1956 and 1964 (Fig. 2). The result is a series of over 3,200 photographs taken from 20,000 feet (1:40,000), all of consistently high quality (Part II).

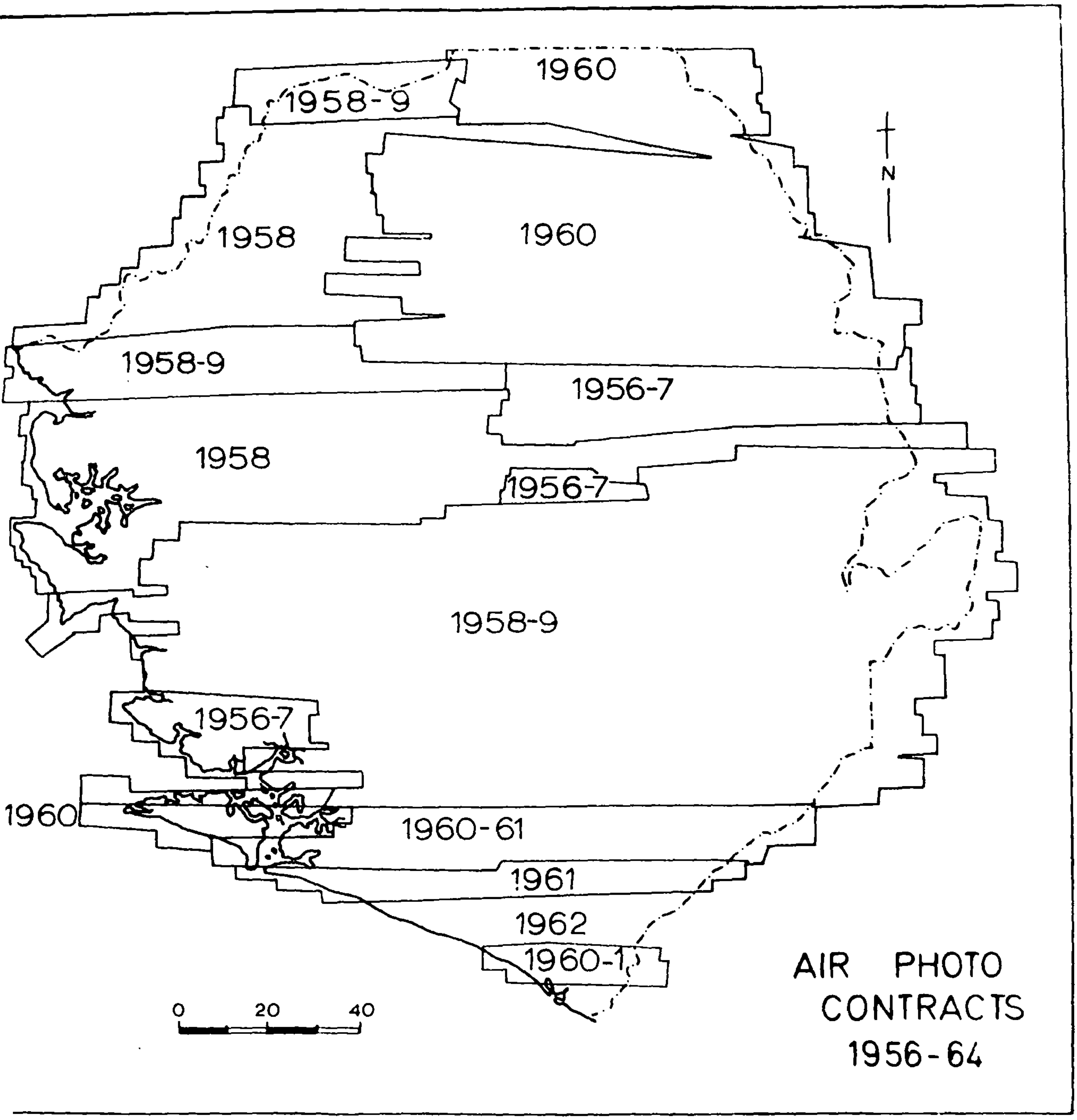
1960
1958-9
N
1958
1960
1958-9
1956-7
1958
1956-7
1958-9
1956-7
1960
1960-61
1961
1962
1960-1
0
20
40
AIR PHOTO
CONTRACTS
1956-64

Fig. 2

Using these photographs, it is possible to identify not only features of relief and vegetation, but even the smallest hamlets. With the aid of a moderately powered hand-lens, it is possible, moreover, to count the actual buildings with a high level of accuracy (Chapter 7.3). The 3,200 prints, which comprise the whole series, were classified by contracts (Fig.2) and keyed onto the new 1:50,000 series. At least for the western half of the country, for which sheets have already been issued, it is a relatively straightforward matter to locate and match the relevant photographs to the correct map sheets. For the eastern half of the country, it is a much more difficult, though not impossible, task to match photographs to the old 1:62,000 series of map sheets.

In the absence of any fully accurate contemporary map series depicting rural settlement in Sierra Leone, these photographs performed the function usually fulfilled in Britain by the largest scale Ordnance Survey editions. Using these photographs, and a considerable amount of cover checking in the field, it was possible to attempt a fairly detailed analysis of the pattern and structure of rural settlement in Sierra Leone, the first of its kind to account for the whole area of an underdeveloped country (Chapters 9,14, 15, 16, 17, 18, 19, 20). Used in conjunction with the field sheets and Village Books of the earlier 1925 - 1930 survey, it was also possible to make an accurate assessment of the changes in rural settlement which have taken place during the last forty years (Chapters 10, 12, 13, 16).

The photographs also played a valuable part in illustrating features of landscape and settlement association. Assembling a representative collection of prints was, therefore, one of the early pre-occupations of this work.

Field Work:

Even though the system of communications is still at a fairly rudimentary stage, the shape and size of Sierra Leone made it possible to reach any part of the country in a single day's travelling. During the course of three years spent in the country, all regions were visited, and several contrasting environments were studied in more detail. Settlements representing all but the most isolated sub-groups were studied on the ground, many at some considerable distance from motor tracks. This experience and background information was found invaluable in interpreting the aerial photographs which inevitably formed the basis of the project. Field work in selected areas was also found useful in checking the techniques used in mapping rural settlement (Chapters 7 and 8).

Many of the impressions and ideas which are the basis of hypotheses presented in this dissertation are the result of these field investigations.

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SECTION
ONE

C H A P T E R 4

RURAL SETTLEMENT IN SIERRA LEONE : A GENERAL HYPOTHESIS.

1. Introduction: the general hypothesis.
2. Some Causative Factors of Homogeneity.
3. The Mainsprings of Uniformity.
4. Conclusion.

1. Introduction: the general hypothesis.

The focus of rural life in Sierra Leone is the village, a clustered community with less than 200 buildings (about 1000 inhabitants) occupying a permanent or semi-permanent site, usually on an interfluve, and surrounded by a well-defined farming territory. A random sample survey (Chapter 7.4) indicated that there were something in the order of 6,600 such settlements in the country, an average of about one village for every four square miles. Out of a total population of almost 2,180,000, all but about 400,000 live in villages of this type[1]. Of the town dwellers, only a small minority, largely expatriate traders, do not hold land rights in a village community.

Bearing in mind the arguments and reservations presented above (Chapter 1.3), it is surprising to find that a pervasive homogeneity extends through most aspects of rural settlement. In fact it is difficult, on first acquaintance, to distinguish many radical differences in the quality of settlement between quite different physical regions and widely separated tribes. Tribal differences and economic and environmental variations do not seem to have produced a wide range in choice of sites, building styles, arrangement of houses, village forms and farming practices, as will be seen in the following brief survey of these factors.

Sierra Leone is occupied by thirteen tribes who have a claim to territory[2]. Of these, by far the most important numerically are the Mende and the Temne with 31 and 30 per cent of the country's total population respectively. These two dominant lowland tribes have tended to assimilate other adjacent smaller tribes both in terms of language and culture. The Krim, Vai, Gola, Sherbo and Buloms may all be regarded as incipient Mende or Temne[3] (PE Nos. 1, 2, 19).

On the plateau, physical isolation and possibly more recent immigration has made for slightly stronger tribal identities. The Yalunka, the plateau Limba and the Koranko all seem to have at least some distinguishable individualities of settlement forms and internal structures (PE Nos. 20 - 25). ~~25).~~

Everywhere, both in the lowlands and on the plateau, villages are sited on interfluves or on river bluffs well above flood levels. The dendritic quality of the drainage pattern throughout the lowlands means that water availability is rarely an important factor in siting settlements in this region. Few potential sites are more than four hundred yards from a perennial stream (Fig. 3). On the plateau, however, the choice of hill top sites for defence (Chapter 11),

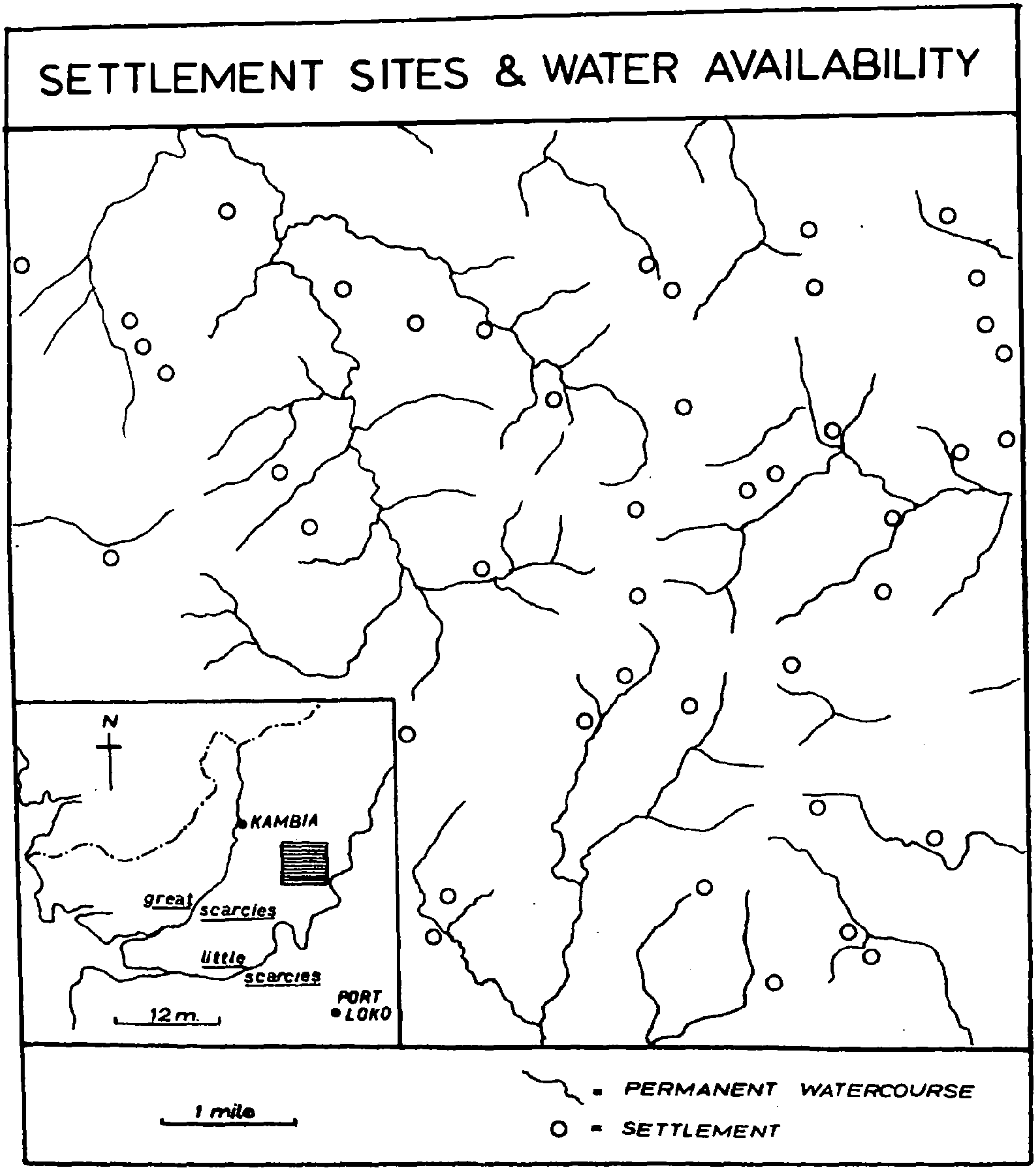

SETTLEMENT SITES & WATER AVAILABILITY
N
KAMBIA
great
scarcies
little
scarcies
PORT
LOKO
12 m.
1 mile
= PERMANENT WATERCOURSE
= SETTLEMENT

Fig. 3

especially amongst the Limba and Koranko, has often resulted in a location a mile or more down precipitous slopes to the nearest water supply. The Yalunka have been limited by the traditionally large size of their villages, a product of their own particular defence arrangements (Chapter 11), to sites near larger perennial streams.

Variation in house styles is quite restricted. The traditional wattle and daub thatched hut varies little from one tribe to another. Both Stoddard and Harvey[4] had difficulty in identifying very marked differences of any real geographical significance, except in the choice of building materials. The distinction between round huts in the plateaux of the interior and square huts in the lowlands, which was noted by Monteil[5] in the French territories, does not seem to have much meaning in Sierra Leone. Round huts are almost as much a part of the traditional Mende and Temne village as they are in the Yalunka and Koranko areas. It would seem rational to suppose that the oblong hut with its ridge-pole roof, which had appeared in the country by the beginning of the nineteenth century,[6] was a European introduction and not a purely indigenous development.

Only slightly more noticeable regional differences may be seen in the type of family compound and the arrangement of huts within the settlement. The extended family is still the basis of rural life in Sierra Leone, although as Mitchell[7], Little[8], and Finnegan[9], all suggest, the size of these units is now diminishing. Family groupings of four and five are now becoming as common as the older extended kinship associations with between twenty and thirty members.

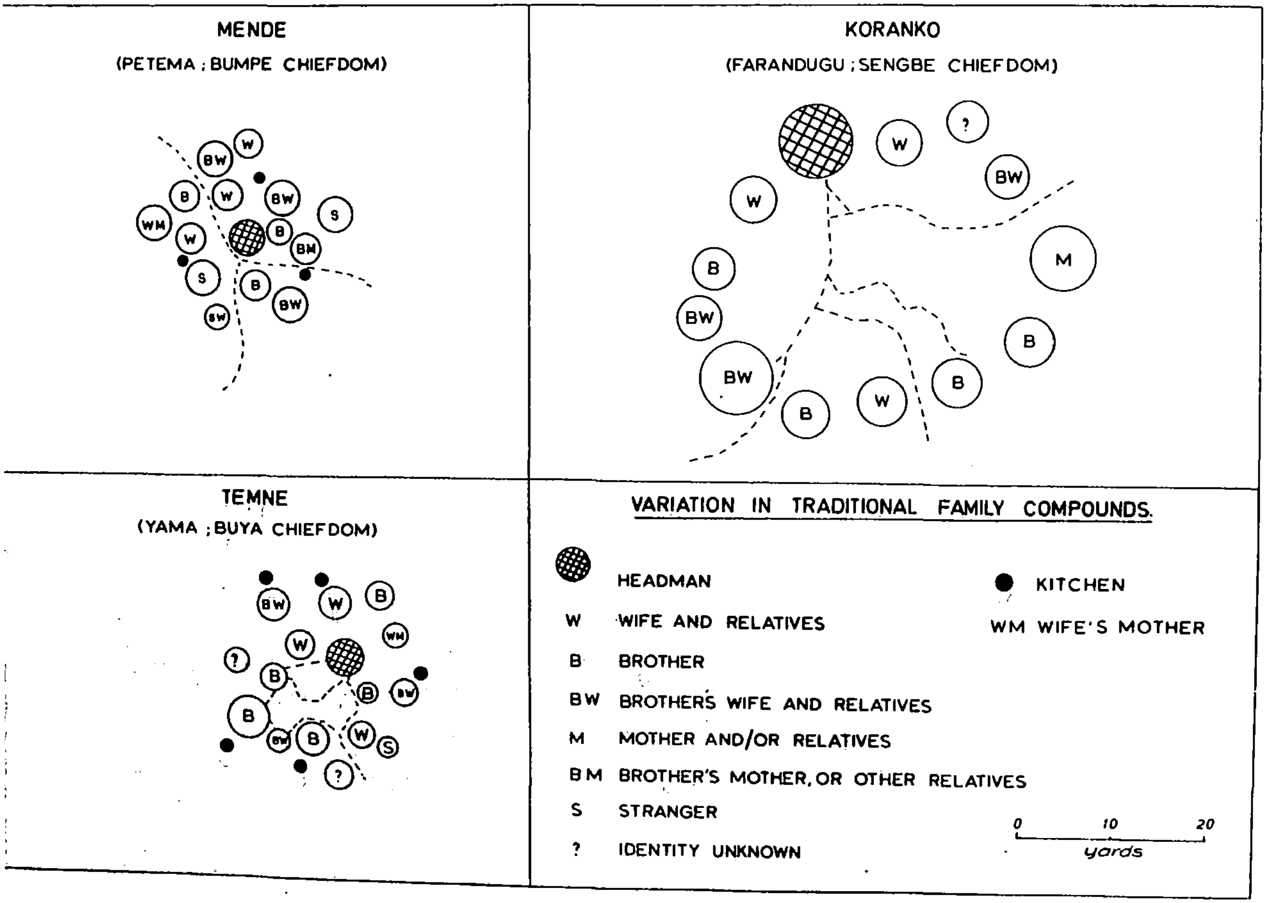
Circular huts normally lead to the development of circular family compounds. This is not only a natural outcome of grouping circular objects in a cluster, but is also the most convenient and economical arrangement for social intercourse.

Within this broad generalisation there are, in Sierra Leone, two distinct types of traditional 'family-compound' arrangements of huts which cause some differences in the internal structure of a settlement.

Amongst the Mende and related tribes, the chief kinsman's hut is placed near the centre of the settlement, and the houses of his relatives would seem to be arranged around his sleeping hut in a fairly closely prescribed order. In the larger family groups, this immediate circle of close kinsmen may be enclosed more haphazardly by a further more or less concentric grouping of minor kinsmen and dependent strangers. (Fig.4). Here there is no neat formal arrangement of buildings and the resulting form is one of apparent disorder (PE Nos. 1, 2, 3). There is some evidence to suggest that this disorder and close juxtaposition may have once had some defensive function (Chapter 11.2), though the reasons for its survival must be purely social.

Amongst the Temne, the house of the chief kinsman is placed within the circle instead of at the centre, and the arrangement of kinship associations is perimetal[10] rather than centrifugal as in the Mende village (Fig.4). In larger villages, this often leads to the development of the circular compounds of lesser headmen around the central chief's compound. This cellular structure is even more common amongst the plateau tribes where outside influences are not so common (PE Nos. 4, 20, 24, 25). For both types of compound, however, the resultant village form is still predominantly circular.

The lands of a village community and the systems of cultivation are even more uniform. There are usually



MENDE
(PETEMA ; BUMPE CHIEFDOM)
KORANKO
(FARANDUGU ; SENGBE CHIEFDOM)
TEMNE
(YAMA ; BUYA CHIEFDOM)
VARIATION IN TRADITIONAL FAMILY COMPOUNDS.
HEADMAN
KITCHEN
W WIFE AND RELATIVES
WM WIFE'S MOTHER
B BROTHER
BW BROTHERS WIFE AND RELATIVES
M MOTHER AND/OR RELATIVES
BM BROTHER'S MOTHER, OR OTHER RELATIVES
S STRANGER
? IDENTITY UNKNOWN
0 10 20
yards

Fig. 4

three concentric zones of activity: the lands within the village area itself; the encirclement of higher woodland; and the main farming area where food staples are grown.

Between and behind the houses, the most intensive agricultural activities take place. A variety of 'stock pot' garnish crops are grown, usually on small mounds which are sometimes fertilised by household refuse. In the areas where cattle or wild animals are a nuisance, fences are erected around these plots, and become a distinctive feature, particularly of Koranko, Limba and Yalunka settlements[11]. (PE Nos. 4, 24, 25).

Surrounding the village is a ring, or "ruff", of taller trees ('high bush') extending from a few yards (PE No. 24) to a quarter of a mile or more (PE No. 3) on all sides of the settlement. In districts where land is scarce, this area may have been depleted (PE No. 7) or may not enclose the settlement completely (PE No. 19), but there are very few villages in the country which have no 'high bush' at all near their outer limits.

Although distinguished as a separate zone, this encirclement is in many ways as much a part of the settlement as the huts and compounds. It serves several functions. Originally, it provided a defensive camouflage during the disturbed social conditions which preceded the colonial era (Chapter 11). Today, it protects the village during the firing of secondary fallow growth at the onset of the rainy season and acts as a cover for the cultivation of shade crops (coffee, cocoa, and medicinal plants). Parts of it are set aside for practising the rites of secret societies, especially the Bundu and Poro initiations to adult life. In some tribes, the village latrine is also situated in this area.

Although it performs the same functions in most areas, the size of the 'high-bush' surround varies from place to place and tribe to tribe. The Limba often choose well watered village sites in a hollow or close to a perennial stream, and their settlements are frequently enclosed by several square miles of higher woodland, even in the comparatively treeless areas of the plateau which are occupied by the Wara-Wara Limba.

A similar wide bush surround is a feature of many Mende villages where these defensive encirclements are now being used as shade for important commercial cultivation of cocoa and coffee (PE Nos. 1, 2; ~~P. 22, 23)~~. The Koranko, on the other hand, retain only enough permanent woodland on their hill top sites to shield secret society rites, and the Yalunka village's 'high bush' is often no more than an overgrown stockade of cotton trees (PEs 20-23). In the latter case, 'society bush' is often found at some distance from the enclosing tree ring.

Surrounding the woodland area is the farmland of the community (Fig. 5). In the lowlands, this patchwork of cleared farms, interspersed with old plots in various stages of regenerative fallow, is the main feature of the landscape. Throughout the farms, upland rice is supplemented by guinea corn, bullrush millet, cotton, cow peas, and cassava. Oil palms are scattered through the whole farming area. These are tended first for kernels and later, when they become too tall to climb, for palm wine.

Within this area of farmland, extending up to two miles on all sides of the settlement, temporary and seasonal habitations are to be found. These range from a small hamlet with up to 12 well constructed buildings, to a diurnal shelter for the farming season, erected quickly from local forage materials. Some of the larger hamlets may be nascent villages, but most of them maintain compounds, or houses within compounds, in the main village.[11]

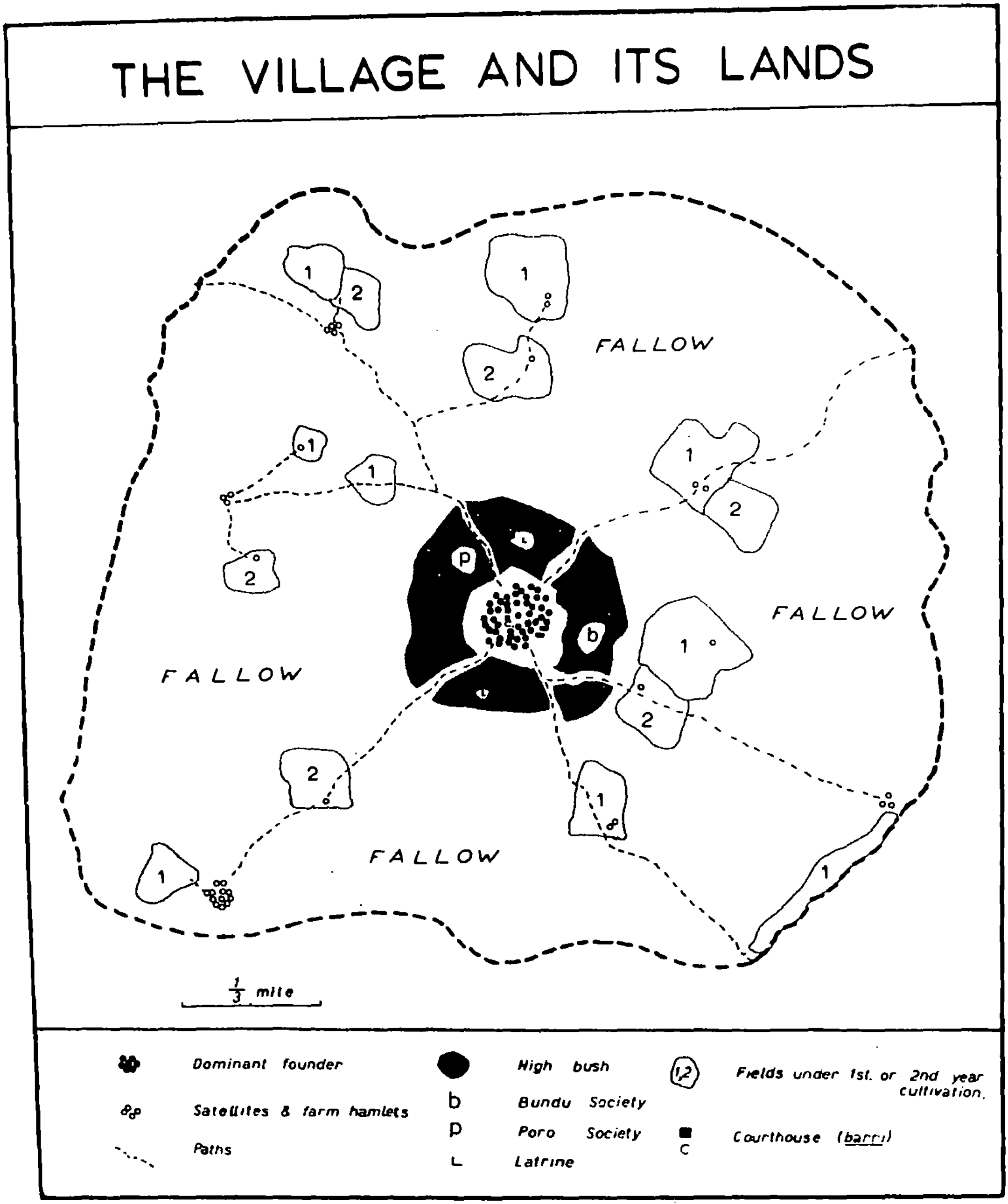

THE VILLAGE AND ITS LANDS
FALLOW
FALLOW
FALLOW
FALLOW
1/3 mile
Dominant founder
Satellites & farm hamlets
Paths
High bush
Bundu Society
Poro Society
Latrine
Fields under 1st. or 2nd year cultivation.
Courthouse (barri)

Fig. 5

In the plateaux of the north-east, many of the upper surfaces and the steeper slopes have been denuded and are therefore of no further use for traditional agriculture. Here, the simple relationships outlined above, tend to be modified. Agricultural activity is restricted to the valleys and more fertile ridge-tops, and farms are found in a linear pattern, with each farming area divided from its neighbours by a negative zone of steep slopes and fire-climax vegetation. (P.1).

2. Some Causative Factors of Homogeneity.

Much of the homogeneity outlined above may be ascribed to the cultural and economic features shared by most tribes. The major studies by Little and Finnegan[12], and a number of smaller scale works, would suggest that most tribes have very similar socio-economic systems which extend to the roots of rural society. Tribes share similar kinship systems, have similar land tenure arrangements[13], cultivate the same types of land in the same ways, share the same crop complexes and have the same food taboos. They also appear to share the same secret society organisations, the same legal and moral sanctions, and the same lack of ability in craft work and trade[14].

It is not the purpose of this dissertation to explore in depth the reasons for these uniformities, and a brief outline of some of the possible causes must suffice.

There are thirteen tribal groups in Sierra Leone, each with its own distinctive language. Dalby[15] has shown, however, that the differences are largely superficial. Most tribes belong to the broad group of Mel and Mande languages and only the Limba have a language totally unrelated to any other group. Examination of historical sources would suggest that this linguistic homogeneity can be attributed to a common regional 'homeland', with most groups sharing the same antecedents. Murdoch[16] used admittedly fairly tenuous evidence to suggest that this homeland was situated in the upper Niger valley. Certainly there is evidence that most tribes in Sierra Leone are fairly recent immigrants, and that the Limba, with their distinctive language, were among the earliest groups to occupy roughly the same territory as they do today[17]. Most of the other tribes would seem to have come, as Kup[18] and McCulloch[19] suggest, from the same broad zone of the northern and eastern savannas. The fluctuations in the political life of this region, during the four centuries before the colonial period[20], could account for the intermittent emigrations from areas which may well have been over-farmed and over-populated. (Chapter 11.3). If this were the case, then the broad uniformity of responses in Sierra Leone is not so surprising.

A 'common homeland' theory, however, is not sufficient in itself to account for such pervasive homogeneities. Firey[21] has recently drawn attention to the way in which African peasant immigrants are fairly un-predictable in their adaptation to new environments. In Sierra Leone, however, it would seem that, given a fairly general avoidance of swamp soils, the soil conditions did not encourage a wide variation in responses, and may have re-inforced cultural and economic similarities which already existed. On upper surfaces and interfluves which are, in general, still preferred for both settlement and cultivation, soil conditions vary very little.

Most of the country is covered by a layer of oxysols of low potential[22]. Soils of this quality can only be farmed successfully by traditional methods if a delicate equilibrium between fallow and cultivation periods is maintained[23]. Within the 'bush-fallow' (Chapter 4.3) traditional system of agriculture practised on all these soils in Sierra Leone, there is little room for variation in techniques. Moreover, the traditional responses still predominate. Despite recent developments in the cash economy, Sierra Leone has one of the most undeveloped rural economies in the macro-region (Chapter 12.1). The whole structure of rural life is still geared to producing food for subsistence or for an extremely local market.

Much of the diversity which is altering settlement patterns in southern Ghana and Nigeria[24], for example, or the pervasive and long term changes which have for long influenced central Africa[25], have still to gain a firm foothold in Sierra Leone. Here the forms and patterns of rural settlement are still those of a subsistence society.

3. The Mainsprings of Uniformity.

It is possible to distinguish two mainsprings for this homogeneous settlement structure: subsistence bush-fallow rotation agriculture, and the patrilineal system of social organisation. Both are closely inter-related and can only be discussed separately at the risk of stressing one at the expense of the other[26].

Bush-Fallow Agriculture:

Although some confusion still exists, it is now less common to regard bush-fallow agriculture as 'shifting cultivation'. This latter term has been avoided for two reasons: firstly, it often implies the movement of temporary settlements as well as the areas under cultivation; secondly, because the term is often indiscriminatly equated with others (e.g. chitamene, ladang and swidden) which have distinctive regional connotations. Bush-fallowing may be defined as that system of 'slash-and-burn' agriculture in which farmed land is rotated around a fixed settlement site.

Bush-fallow farming, by its nature, demands a good deal of co-operation, both for the sophisticated system of land rotation in which land is allocated and re-allocated by the chief and his elders in anything up to a twelve year cycle, and also for the several communal activities of the farming year. Without a close kinship system, the farming of land by this system would be impossible. Most tribes are grouped in patri-clan units in which all members are related under a dominant family. There is usually a distinctive term for this unit (e.g. Mende = kuwuisia or ndehun, Temne = abuna, Limba = meti).

Each clan group forms a village community, often divided into smaller family compounds, which in turn establish subsidiary satellite hamlets (Mende = fakai) in the farmlands (Fig. 5) as the need arises (Chapters 4.1 and 6.1). The farmlands of each village are controlled, in the first instance, by the larger clan group through the authority of the chief and his council of elders. This authority is often de lege rather than de facto, and the effective control, and even ownership of the land parcels in the case of larger settlements, is usually vested with smaller family groups. Control of the land is sometimes complicated by inheritance laws which distinguish between 'original settlers' and those who have acquired land later, either as freed slaves or as immigrant 'strangers'. For most tribes, however, there is no ownership of land except as members of the kinship group which, through the authority of the chief, is responsible for deciding the areas to be cultivated, the length of fallows, and when virgin land should be taken into cultivation[27].

The activities of the farming cycle involve not merely the close family but the whole extended family, which together usually make up the entire settlement. This co-operation is extremely important in forming the character of rural settlement.

The beginning of the farming year is marked by the decision as to which lands will be cultivated in that year. This is done either by the village council (as amongst the Kissi) or by the decision of the family head (as amongst the Temne and Mende). The clearing and weeding of chosen plots is a highly organised activity in which most of the village takes part. Firing takes place between early December and the onset of the rains in June, reaching a peak in April and May. The crops (upland rice is the main staple almost everywhere, intercropped with millets and cassava) are sown on hoed mounds as soon as the first showers arrive.

This is a period of intense activity when the whole family, except the oldest and youngest, occupy farming hamlets (Fig. 5). These hamlets are occupied again before the harvest, to protect the crop from predators, and also for the harvest period (October - December).

Hunting and fishing still play some part in the rural economy, though the high population densities in most areas has led to indiscriminate hunting and larger game has become increasingly rare. Almost all animals are hunted or trapped. Hunting parties are organised on a village basis, though excursions are now usually undertaken for a day at a time. Temporary hunting camps, once the precursors of permanent settlements, are no longer established, except in remote areas of the Gola and Tingi forest reserves.

It will be clear from the above summary of rural activities, that larger groups than those of the immediate family are assembled for communal activities on at least six occasions during the farming year: to burn land; to clear plots; to sow crops; to guard against predators; to harvest; and to make up hunting parties.

It may be argued that the arduous methods of cultivation using primitive tools (the hoe and the matchet) and the fairly sophisticated system of land rotation, which is a feature of bush-fallow farming, would inevitably give rise to a good deal of communal organisation. This communal activity is given further emphasis by the close kinship associations which link most members of the village community together. The village operates as a social and economic unit, with secret society obligations still further cementing bonds. Even today, individual initiative is sufficiently rare to be remarkable.

4. Conclusion.

One may sum up the argument of this chapter in the following way. The range of possible variation in settlement conditions in an under-developed region is smaller than in a developed one. Within the more restricted range of opportunities of a subsistence or semi-subsistence regime, settlement may still display considerable variety. It is usually possible to find clearly distinctive patterns of areal association. In Sierra Leone, however, these distinctions are scarcely apparent and the dominant impression is one of unusual uniformity.

A cursory examination of the photographs presented with this thesis (Part 2) will make it clear that whatever minor variations there may be in detail , a pattern of small villages and hamlets is equally characteristic of coastal plains and high plateaux, of swamps and sandy interfluves; of the tree crops and forest zone of the south-east, where a cash economy is developing most rapidly, and of areas in the north which are most isolated from economic progress. The traditional forms of settlement are just as uniform. In most areas it is possible to find the same choice of sites on narrow interfluves, and the same tight clustering of seven or eight family compounds, each with up to a dozen circular huts, and with systems of construction varying little from one area to another. Around each settlement almost everywhere there is the same characteristic encirclement of 'high bush', a similar pattern of fields and fallows, and a similar scatter of dependent farm hamlets.

This uniformity may be attributed to the narrow range of choices imposed by the environment, but more particularly to a cultural homogeneity and the low level of economic development. Micro-variations in settlement responses would seem merely to contribute to the over-all impression of homogeneity.

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26. Hunter, 1967, p.339.

27. Anon, 1949; Mitchell, 1964.

CHAPTER 5.

CENTRAL PLACE THEORY AND A SETTLEMENT MODEL

1. Introduction.
2. A Critical Review of Central Place Theory.
3. Constructing a Stylised Village.
4. Testing the Model: a field study.

1. Introduction.

One of the early pre-occupations of this dissertation was the 'classification' of settlement information in the form of a distribution map (Chapter 8; Fig. M.3). There seemed to be a sufficiently detailed body of topographical information to attempt a complete and quite refined representation. The apparent homogeneity of rural settlement conditions outlined in the last chapter, however, made it difficult to find a suitable approach to this task.

The main problems may be summarised briefly. The uniformity of settlement conditions made if difficult to identify minor variations in both form and pattern. Yet it might be argued that such variations would have an importance out of proportion to the physical degree of that variation. Expressed in statistical terms, settlement conditions seemed to approximate everywhere to a hypothetical norm, but areas showing even minor variations from this norm, although of low statistical significance, may in fact be in the vanguard of social and economic change. Their identification could be of considerable importance in future economic planning. By the same token, areas showing very homogeneous structures and patterns of settlement, closely approximating to the norm, may reveal those parts of the country which had furthest to progress from traditional standards. It was therefore important to find a method of analysis which allowed a delicate measurement of a very narrow range of conditions.

It seemed that the problem of analysing these small scale deviations could be approached in two ways: by assembling a large body of data from careful field work in all areas of the country, or by devising an average settlement structure - a model which came as close as possible to the hypothetical subsistence norm. This stylised settlement could then be measured against empirical observations.

Limited time, limited finance, and limited linguistic skill, all militated against the first approach. It was thought, moreover, that in these circumstances even the most painstaking and assiduous collection of information in the field would inevitably be marred by the cultural distance between informant and informed. Even minor misunderstandings could build up misconceptions of critical importance in establishing research criteria. In addition, the theoretical approach seemed to have more to offer in two directions.

Firstly, it provided a method which fitted the research context extremely well. For most countries, a rural settlement analysis which was based on a hypothetical norm would have doubtful merits. Areal variation usually ensures that the average village, or the 'typical' settlement structure, is as nebulous and misleading a guide to reality as are 'normal' conditions in most other studies which involve the human factor. It has already been argued above that this generalisation does not seem to apply in the case of Sierra Leone. The use of a settlement model appeared singularly well suited to this situation.

The second factor in favour of this method has wider theoretical implications. Possibly such a treatment could make some limited contribution to the body of theory associated with settlement models. Indeed, the application of this theory to environments other than those for which it was devised inevitably involved a critical re-appraisal of the premises of central place theory.

2. A Critical Review of Central Place Theory.

Central place models may be viewed as by-products of theories of economic location. There seems to be a considerable difference in basic starting points between theories of agricultural location and those of commercial and industrial location. The first central place model was of agricultural location, and was devised by Von Thunen[1] (1826). It would seem to differ radically in approach from Christaller's[2] much later theory (1933) which uses the premises of industrial economics.

Von Thunen's work has been efficiently summarised elsewhere[3] and only a brief survey of his main ideas is presented here. His original theory was developed as a direct result of his experience as a farmer in early nineteenth centry Mecklenberg. He showed that distance from an input centre, whether a farm (his own) or a town (Rostock), had a direct bearing on the intensity of agricultural production, with a clearly defined ring boundary to each group of activities. These limits were determined by 'economic rent'[4], a function of both the distance from the market or collecting point, and the value of the crop.

Two related points, which have a direct bearing on this thesis, can be made concerning this theory. Firstly, Von Thunen's model is essentially static. It was developed for a moment in time, for a fixed location in un-natural isolation from all other areas - a veritable 'isolated state'. Secondly, the argument was developed from the premise of a central point and not (as Lösch would suggest[5]) from an areal unit. It is the marketing or collecting point which is the critical feature of the model. So, although the completed model may be considered as static, with clearly prescribed boundaries, its development was centrifugal from a punctiform base.

Christaller's model, on the other hand, was not developed from the point of view of a producer seeking either a supply or a market, but rather from the basis of a consumer seeking satisfaction. His whole approach was, therefore, centripetal rather than centrifugal as in the Thunen model. This premise is made clear early in his work on central places in south Germany:

> ".......the crystallisation of mass around a nucleus is, in inorganic as well as organic nature, an elementary form of the order of things which belong together in a centralistic order"[6].

This point is emphasised again later in the first part of his work when he is defining one of the central concepts of his theory, 'the range of the good'. He describes this not, as one might suppose, 'the furthest distance which a good may be marketed from a central place', but:

> "the furthest distance a consumer will travel to buy a good offered at a central place"[7].

Clearly, in a theory developed from this standpoint, the next stage in the argument is a hypothetical consumer on the periphery of a given market area being drawn in one or more directions by competing central places. It is not surprising, therefore, to find that the postulation of a multipoint framework was one of the initial steps in the development of the Christaller theory[8]. Very simply, he argued that in an undifferentiated economic landscape with equipotentiality for development in all its parts, and with a multipoint distribution of settlements, then that distribution would be reflected in a hexagonal market area, a shape which minimised consumer movement to market and service centres. He also postulated certain fixed orientations and numbers of settlements within the geometric framework (fixed k). These 'fixed k', as Losch and Haggett[9] (Fig. 9) have since shown, depend on the different possible arrangements of settlements within the hexagonal frame, and on the hierarchy of central places within the system.

In order to develop the theory, Christaller assumed that settlements of the same order in the hierarchy would be of the same size and have the same range of central services. Further, each settlement on a higher level in the hierarchy would exactly duplicate the functions of the smaller central places, at the same time adding functions appropriate to its own place in the hierarchy.

Basic similarities and differences between the Von Thunen and Christaller central place models may be summarised in the following way. Both theories postulate a uniform economic landscape and both models are static in quality. Where Christaller's starting point was a pattern of equally spaced consumers seeking satisfaction at a central place, Von Thunen took the central place as his point of departure. The settlement structure envisaged by Christaller is therefore multiform and his thinking is basically centripetal. Von Thunen's settlement model, on the other hand, is punctiform, with the single central place exerting its influence on an economic field which is isolated from external influences. The theory is therefore egocentric, and within the confines of its static frame, centrifugal.

A general mid-twentieth century interest in urban rather than rural conditions, and in industrial rather than agricultural location, has tended to favour the development of Christaller's theory. His work was taken a stage further by Losch, who emphasised the rigidity of the Christaller model and transformed the fixed k relationship of the original system. This was done by nesting all possible permitted sizes of hexagonal field and then rotating each complex until the greatest number of central places co-incided[10]. A whole literature of central place studies has developed from this re-assessment[11], ranging from the studies in the definition of cluster or random distributions by Dacey[12], to the refinements of urban analysis found in the work, amongst others, of Isard[13], Berry[14], Thomas[15], Garrison[16], Morrill[17], and Beckmann[18].

After 140 years of neglect, the general expansion of interest in central place studies has recently re-focused attention on the work of Von Thunen. It is interesting to note, however, that with one very important exception[19], these re-appraisals have been made from the same urban setting as the development of Christaller's theory referred to above. It is, therefore, not surprising to find that Von Thunen's concept has been severely modified. Sinclair[20], for example, has discovered a 'reverse-order' relationship of zones of activity around the modern large city, which alters Von Thunen's sequence of zones. Grotewald[21] found similar discrepancies in his study of land use around Kansas City and Saint Louis, finding the original model "outdated as far as the urban fringe is concerned"; he concludes, however, that in general "there is nothing wrong with the theory"[21].

In this sentence lies the crux of the problem to be investigated here. Both the original models have now been transformed, modified, or re-worked to fit the sophisticated landscapes of a highly industrialised society in Western Europe and North America, where landscapes are patently not un-differentiated and hierarchies emerge with marked clustering of minor centres around larger central places, and where there are special factors producing discontinuity in service/size relationships, and crop/distance responses. It may be maintained that such transformations were not surprising since all models, and particularly the recent ones, were developed in these sophisticated economic environments.

Basic features of both the early models, however, - their undifferentiated landscapes, their simple relationships and static qualities - would all seem structurally <u>more</u>

consistent with conditions in a pre-industrial, and even a subsistence society, where economic relationships more closely approach the static qualities of both models. Perhaps conditions approaching the idealised landscapes which Von Thunen and Christaller postulated may more appropriately be sought in the less well developed areas. It could be argued that it has been extremely difficult for researchers to find conditions approximating to either model in reality, simply because they were looking in the wrong place at the wrong time. Static qualities of social and economic life must be sought at more basic levels than those found in either Europe or North America.

It is interesting to note, in this context, that both Brush and Bracey[22], who have produced one of the most interesting field tests of Christaller's theory, are joined by Bunge[23] in a plea for experimental work in areas outside those with strong capitalist traditions.

Chisholm[24] has shown that, at least in terms of Von Thunen's theory, some of this work has been done, albeit somewhat 'unconsciously'. Several general principles emerge from these studies, making it possible to envisage a model settlement structure which conforms both with these principles and with the Sierra Leone situation.

3. Constructing a Stylised Village.

In his examination of rural settlement and land use, Chisholm has produced a most valuable vindication of the general principles of location presented by Von Thunen. From his collection of material concerning the village microcosm, two general features emerge.

Firstly, he demonstrates the viability of Von Thunen's economic isodapanes, with intensive output crops generally situated close to the settlement, and with progressively less intensive activities as one moves further away from the centre. Examples are quoted from a range of environments to illustrate the wide application of the principle[25].

Secondly, a basic difference from the original model is defined. In Von Thunen's structure, economic rent delimited the distance at which one range of activities became un-profitable and was replaced by another. For a peasant economy, no such clear demarcation is common. The 'Von Thunen Ring' is replaced by the 'Chisholm Zone of Transition'[26]. For West Africa, studies by Steel[27] and Prothero[28], in southern Ghana and northern Nigeria respectively, show how intensive garden activities of the village, and its immediate environs, give way to farm crops gradually less and less intensive of labour as one moves away from the settlement. Finally, these merge into a zone of cocoa cultivation in southern Ghana and animal husbandry in northern Nigeria, both of which demand fewer man hours per annum than do food crops. More recent studies by Hunter[29] in northern Ghana show similar associations here.

Chisholm's contribution is to draw attention to the fact that these zones do, in fact, have fairly clearly defined limits; that irrespective of physical environment or farming system, there is a definite modification in responses beyond one kilometre from the input centre, and that beyond three or four kilometres, this modification assumes such radical proportions that it limits further expansion from that centre[30]. He would suggest that there is not only a clearly defined 'in-put field' but, more significantly, a field which varies little from one environment to another.

There seems little doubt that in most areas of the forest zone of West Africa, the outer limits of village lands are well defined. Certainly in Sierra Leone, despite the irregularity of cultivation patches, everyone knows these outer limits. Even in areas where settlements have no immediate neighbours, rocks, streams and trees will be identified as boundaries. Köbben, writing of similar conditions in the French Cameroons, remarks that:

> "one is continually amazed by the precision with which everyone knows the boundaries (of village lands) even in the midst of the forest" [31],

and with unconscious Thunenean thinking, likens each settlement to a sovereign state[32].

Given an undisturbed social order, the natural limits of the village territory can be defined by what may be called 'the practical economic radius'. This is the distance which it is socially and physically acceptable to travel in order to farm or to collect forage materials from a given input centre, which in this case is the normal domicile. If a clear limit can be envisaged, then the next stage in the argument is axiomatic. If the village lands are of limited size, then the size of the community which that land supports, for the moment presuming pure subsistence conditions, will also be limited.

The factors which, in these circumstances, operate to define the size of a community, may be reviewed under the following heads:-

a) Economic radius (in this case, practical walking distance to work),
b) The average farmland per person necessary to maintain an accepted standard of living,
c) The yielding potential of the soil and the crop staples,
d) The occurrence of socially necessary forage resources,
e) The average number of persons per dwelling.

~~c) The average numberof persons per dwelling.~~

a) The economic radius:

Evidence collected by Chisholm led him to imply that in the broad environment of the humid tropics, the limiting distance which farmers will travel to cultivate plots is between one and four kilometres[33] (i.e. between 0.62 and 2.48 miles). Reference to further sources has made it possible to define these limits a little more closely.

There is evidence to suggest that as one progresses from the more open country of the savannas into the forest zone, the acceptable 'farming radius' diminishes. Working in the transition zone between these two regions, with the Nupe of central Nigeria, Nadel estimated the mean radius at three miles, or 'one hour's walking distance'.[34] Peters[35] and Allen[36] found similar distances (two and a half miles) amongst the Lala chitamene cultivators in Zambia.

Distances in the forest areas, on the other hand, have been found to be appreciably lower. The French explorer Toutée distinguished the limiting radius at 'between 1500 and 1800 metres'[37] for settlements in the lower Niger valley. Similarly, Greenland and Nye[38], and also Hill[39], in southern Ghana, and Manshard[40], from wider experience in the forest zones of the region, all favour distances of between one and one and a half miles. These same results have also been calculated for Vietnam by Izikowitz[41] and for the Iban of Sarawak by Freeman[42] who has completed one of the most careful studies of man/land relationships in the macro-region.

Before making a general statement concerning these limits, a great deal more detailed testing is necessary in a wider range of environments. Areas where social and economic constraints do not have a significant influence on natural subsistence responses are not easy to find (Chapter 5). For the moment, however, it will be supposed that very few members of a subsistence farming community, in this region of the humid tropics, will willingly travel more than about a mile to farm lands or to follow any other regular enterprise.

b) Farmland per person:

Similar reservations must also be made when attempting to define the acreage of land per person acceptable within a subsistence farming system. For an estimate of this sort, one must take into account the area which it is physically possible for those in a farming unit to clear, plant and weed. This in its turn will depend on the strength and thickness of regenerative growth, on the composition of the farming group, and on work obligations at the periods of maximum farming intensity. To balance against these factors, one must also consider the principle of least effort[43]. No group will cultivate land in excess of the area which is necessary to maintain an accepted diet and to ensure what Allan calls a 'survival surplus'[44] which guards against farming disasters. This area will depend on several factors - the climatic regime, the quality of the soil and the calorie content of the main staple crops - generally in this region either a grain like rice, millet, or maize, or a tuber like cassava or yams. It will also depend on the degree of reliance on forage items[45] and on the system of soil fertilisation.

By far the most careful examination of the problem has been the work of Peters and Allan in their studies of the shifting cultivators of Zambia. Using a system of selective sampling, based on considerable local knowledge, and using both whole villages and individual family groups, they were able to develop and employ methods of measurement to calculate the area under cultivation at any one time ('the garden area') and to relate this to the number of people which this area supported ('the cultivation factor'). Allan was also able to apply similar methods, if not in quite the same detail, to other areas of west and west-central Africa. His findings showed that:

"....... it is not unlikely that a cultivation factor of about half-an-acre per head of population was usual for subsistence systems with a grain staple in two season zones of reliable double rainfall",[46]

and that:

"this may well be the figure for all forest regions of equatorial and sub-equatorial climate"[47].

Other researchers, although not working from such detailed information as Allan, make remarkably similar estimates: Wilson, for the Nyakusa of Rungwe in southern Tanzania, supports the figure of half an acre[48], as do Dugast for the Ndikas of Camaroon[49], Galetti, Baldwin and Dina for the Yoruba of western Nigeria[50], and Reining for the Zande[51]. Irvine[52] generalises from his experience in West Africa and also supports half an acre. Only Winter[53], for the Bwamba on the eastern borders of the Congo Republic, favours a figure which is slightly higher (0.66 acres).

Measurement in several villages in Sierra Leone, using rough pacing techniques, indicated that a similar figure may also be appropriate here. Unfortunately, the difficulties involved in persuading village headmen to allow such exercises, and the unreliability of census information needed to accompany such calculations, forced the writer to abandon an attempt to make a more elaborate survey (Chapter 5.4). Nevertheless, it seemed reasonable to suppose, from such diverse evidence, that half an acre per head per annum could be taken as a fair estimate of a standard relationship in this environment.

c) Yielding potential of the land:

The quality of the soil will obviously influence the time that a cleared garden area will support reasonable yields before declining productivity causes reversion to fallow. Cultivation periods also depend on the cropping system, and the period of time which is allowed for regeneration of fallow before recultivation. The heavily leached oxysols of Sierra Leone will usually bear reasonable yields of upland rice, which is the main staple, for two years[54], although the period of cultivation may be extended by using cassava as a second season crop. Calculations of yielding potentials are sometimes complicated by other plants which are inter-cropped with rice or cassava (e.g. guinea corn, benniseed, bullrush - millet and cotton). A soil which is overcultivated in one cycle needs longer to regenerate, and an average figure is not easy to achieve. However, the soils of Sierra Leone are amongst the poorest in West Africa[55]. Except for the juvenile silts of the riverine and estuatine swamps, they vary from the heavily leached sandy ferralitics of the Bullom sands on the east coast, to the almost as heavily degraded oxysols and latosols which have developed on the Archean granites and schists which underlie much of the rest of the country[56].

Soil scientists and agronomists in both Sierra Leone and Ghana have suggested that on soils of this type two years of cultivation, using the most rational combination of crops available, should be followed by at least twelve years of regeneration[57]. Even minor deviations from these requirements could cause rapid and continuous soil deterioration, with the formation of lateritic hard-pans and fire climax vegetational associations (P.28,29).
In short, it would seem that no more than about one sixth of the potential farming area should be in use at any one time if the system is to be kept in equilibrium.

d) Forage resources:

The critical population of an input centre, in terms of the forage resources of that community, is even more difficult to estimate than the other factors mentioned above. A wide variety of needs have been found in different areas.

For one group, the scarcity or absence of a particular fruit, type of game, or plant needed for ceremonials, may be an important factor in disturbing settlement conditions. For another group, it may be the scarcity of clay for storage pots, or wood for housebuilding, which contributes to settlement disruption.

For one group it may be merely a question of adaptation, of finding substitutes[58]. For another, scarcity of an item may be enough to trigger a change in settlement location. Such factors are impossible to assess without an intensive study of particular settlements over a considerable period of time to enable one to become aware of local preferences and seasonal shifts in resource balances. Studies of this sort are rare[59], and none have been conducted in Sierra Leone. This factor must therefore remain an unknown variable in subsequent calculations.

e) Persons per dwelling:

In order to calculate the number of people to be supported from one input centre, it is necessary to calculate the average number of persons per dwelling. The reasons for this are not immediately obvious and need further explanation. The answers lie in the particular problems presented by this research project.

Most of the basic work of this settlement analysis depended largely on aerial photographs (Chapter 3.2 and 7.3). Calculations of settlement size were based on a count of buildings using a sevenfold magnification hand lens (Fig. M.2a and Chapter 7.3). Any model settlement population must be assessed, therefore, not in terms of number of persons alone, but also in terms of the number of buildings in that settlement.

Once more there were considerable hazards in such a calculation. Some buildings are un-occupied or used as stores. Huts vary in size and the number of people they house (Appendix 1), and minor variations in the social systems of various tribes encourage either a multiplication of small huts with few inhabitants, or fewer huts, each with a comparatively large number of inhabitants.

Porter's studies in Liberia would suggest a figure of 5.5 persons per dwelling[60], but in Sierra Leone the figure appears to be higher. Studies drawn together by Kuczynski, particularly for north-eastern Sierra Leone, and personal research by Little[62], Mitchell[63], and Siddle (Appendix 1), in south-west, central and western areas, respectively, indicated averages in these respective areas of 8,8, 10 and 9 persons per dwelling. From these results it seemed safe to assume that a general average of 9 persons per building would give a fairly reliable estimate of the truepopulation of a settlement in Sierra Leone.

Calculations:

Given the reservations outlined for each of the measures discussed above, and given the generalised nature of any calculation, it was possible to estimate the maximum size of settlement which could be achieved in this environment (Table 1).

In a potential farming area of approximately 1885 acres (i.e. about 1 mile radius), the total area in any one year which should be under cultivation, given maximum potential, may be estimated by dividing the maximum acreage by six (twelve years of fallow followed by two years of cultivation) i.e. about 314 acres. At half an acre per head, this would give a total population of approximately 628. One can rationalise these figures further by subtracting an estimate of the area which Conklin[64] and Winter[65] have both deemed uncultivable for 'ritual, geographical or vegetational reasons'. This they regarded as about 20

MAXIMUM ECONOMIC RADIUS (r)	=	1 MILE - $1\frac{1}{2}$ MILES
MAXIMUM CULTIVATION PERIOD (c)	=	2 YEARS
MINIMUM FALLOW PERIOD (f)	=	12 YEARS
OPTIMUM ACREAGE/PERSON/ANNUM (l)	=	0.5 ACRES
NUMBER OF PERSONS/DWELLING (d)	=	9 PERSONS

DEDUCTIONS:

Maximum farming area (a)	=	$640(\Pi r^2)$ = 1885.2 - 4524.8 acres.
Area left uncultivated (u)	=	$^1/_5a$ = 377 - 905 acres.
Optimum acreage of farmland/annum (o)	=	$\frac{c}{f}(a - u)$ = 251.4 - 603.6 acres.
Optimum potential population consistent with the above (Po)	=	$\frac{o}{l}$ = 512 - 1207 persons.
Number of dwellings	=	$\frac{Po}{d}$ = 57 - 134 dwellings.

TABLE 1

Working Information for a

Settlement Model.

per cent of the total potential area. In this way, the area of potential farmland would be reduced to 251 acres, and the maximum population which this area could support to 512, living in a settlement with about 57 buildings.

In order to establish a possible range of values within which a norm may be sought, a farming radius of between one and one and a half miles was postulated (Table 1). For this radius, figures would need altering as follows. A total acreage of 4,525 acres would be reduced to 3620 acres using the Cohklin and Winter correction. This would give an annual acreage of 603.6 acres, supporting a population of 1,207 persons living in about 134 houses. The generalised nature of these calculations is obvious. When so many ill-defined estimates are interdependent in achieving a final calculation, the results would seem extremely doubtful. The quality of these estimates could only be tested and corroborated in the field. The problem was to find an area in which conditions closely approximated to those postulated for the model, and to discover to what extent there was agreement between theoretical and actual values.

4. <u>Testing the Model: a field study.</u>

It was not an easy task to find areas in Sierra Leone which approximated closely enough to conditions postulated for the model. For most areas in the country, population pressures, the effects on settlement size produced by social and political disturbances, (Chapters 11, 12 and 13), and the interference of the cash economy, although not altering the whole structure of the subsistence settlement responses, were probably enough to alter delicate relationships which this comparison hoped to test. Cursory examinations, both of the photographs and in the field, suggested at first that the chances of finding suitable settlements were extremely limited.

After careful scanning of the 3,200 aerial photographs of the country, however, several settlements were identified in areas of the Gola Forest Reserve in south-east Sierra Leone, where conditions of isolation and 'equipotentiality' of environment seemed to approach very closely to the model situation. Here was an area where settlements and their lands were differentiated one from the other and where contacts with the cash economy were extremely limited.

Two neighbouring settlements, of approximately the same size, were chosen for study. They were Tigbema and Njama, both situated on the west bank of the Luye, one of the headstreams of the Maho river, in Makpele Chiefdom, Kenema District (P.20). Tigbema had recently established a satellite village (Nägbena), and so this served as an indication that the settlement had reached a critical size (Chapter 6.1) and that the chances of matching these villages with the model situation, for which maximum conditions were being estimated, were extremely good.

In order to check man/land relationships, the two settlements were visited by the writer at the end of the dry season, May, 1964. All the farming plots had been cleared and were in process of cultivation. Conditions were ideal for measuring size and area of farmed land. The villagers had been visited by census officials two years previously, however, and were not at all willing to allow this sort of analysis, neither were they particularly co-operative about yet another census of persons per hut. It would clearly have needed much longer than the time available (two weeks at the most) to win confidence. The project was therefore very reluctantly abandoned.

The only result of this enterprise was an over-all impression of a farming community un-touched by outside influences, where the tangible expressions of contact with the cash economy (transistor radios, metal cooking bowls, imported building materials) were rare. It also seemed likely that rational fallow lengths were maintained as most of the recently cleared areas showed evidence, in the size of remaining tree stumps, of at least eight or nine years of growth.

At this stage, the temptation to abandon this approach to settlement analysis was extremely strong. On further reflection, however, it seemed possible to salvage something by a judicious use of the aerial photographs (P.20).

Although it was impossible to distinguish fields under cultivation from those recently reverted to fallow, it was a relatively straightforward matter, using graph paper, to calculate the farming area in square miles, because the land which had been farmed at some time was clearly distinguishable from the surrounding forest reserve. It was also quite easy to make a calculation of the mean farming radius, by setting up twenty radial spokes from

Village	No. of Huts	Inhabitants (approx.)	Farming Area (acres)	Acreage per head	Mean walking radius (miles)
Tigbema	66	594	3904	6.6	1.4
Njama	60	540	2560	5.3	1.2
Model	57-134	512-1207	1885-4525	4.0-3.7	1.0-1.5

Table 2.

A Comparison of Model and Field Calculations

of Optimal Maximum Size of Subsistence Settlements

Following Rational Systems of Bush-Fallow Agriculture.

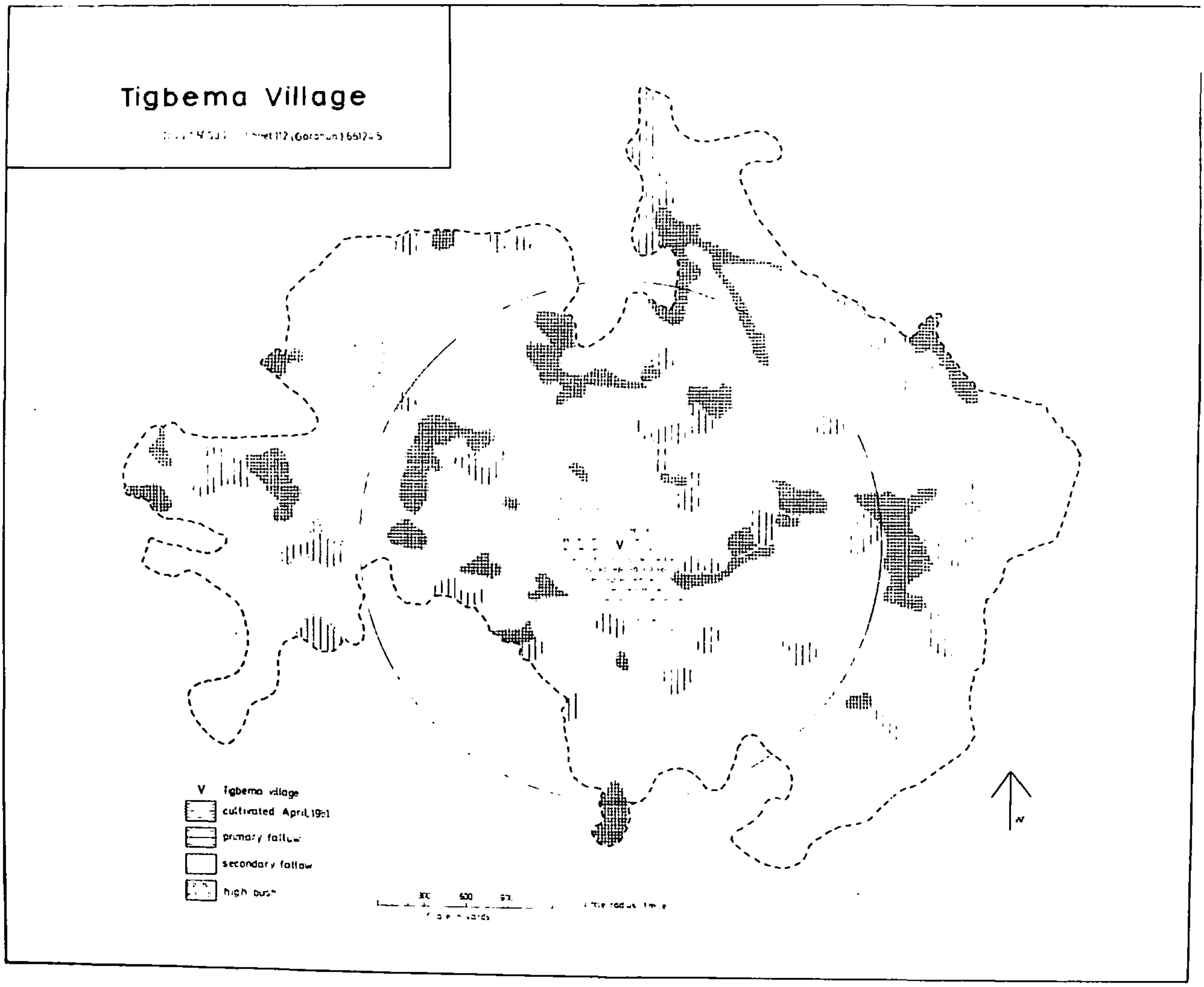
Tigbema Village
V
Tigbema village
cultivated April, 1951
primary fallow
secondary fallow
high bush
300
600

Fig. 6

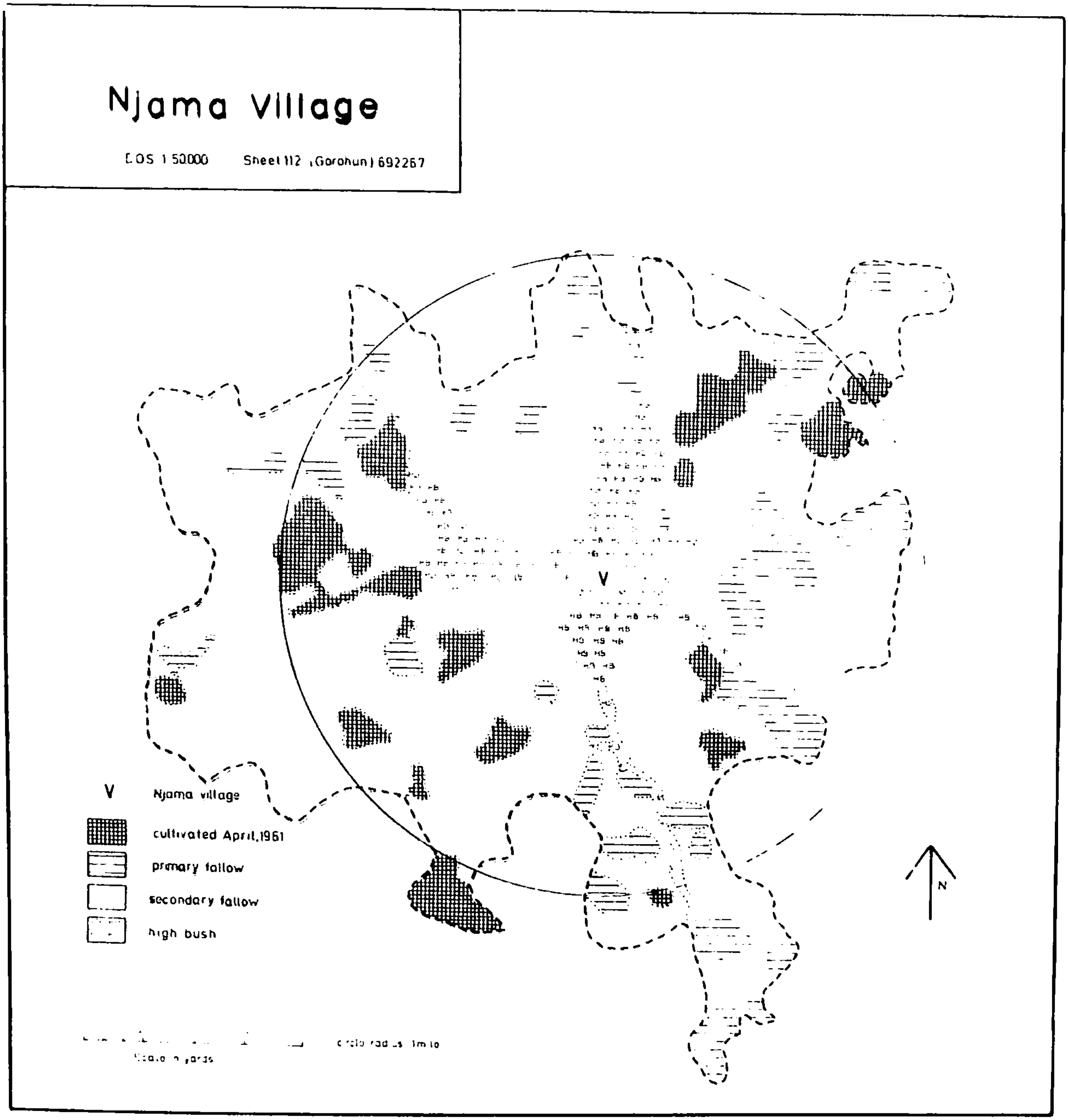
Njama Village
DOS 1 50000
Sheet 112 (Gorohun) 692267
V
Njama village
cultivated April, 1961
primary fallow
secondary fallow
high bush
N

Fig. 7

the centre of each village to the furthest farming limits (Figs. 6 and 7) and averaging their lengths. A count of huts, using a sevenfold magnification hand lens, was checked against the counts of buildings already made on the ground, and it was possible to obtain a close idea of the number of dwellings in the two villages. The results of these calculations are presented in Table 2, where they are compared with relevant model calculations from Table 1.

The very conformity of behaviour of these two settlements was strong argument for the theory presented above. The fact that measurements also corresponded very closely with those of the model was even more encouraging. If one also reduced the total acreage in the calculations, using Conklin and Winter's correction, then the acres per head would be 5.3 for Tigbema and 4.4 for Njama. Presuming a two year cultivation and twelve year fallow cycle, this would be 0.88 and 0.74 acres per head, per annum, respectively. This is close enough to the hypothetical norm of 0.5 acres to be interesting. The fact that two fairly imprecise, and quite independent, sets of calculations should come so close in the final analysis, made it possible to think in terms of extending the hypothesis presented at the beginning of this section.

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4. Krymowski, 1928.

5. Lösch, 1954, p.5.

6. Christaller (Baskin), p.14.

7. Ibid, p.22.

8. Ibid, pp.28-30.

9. Lösch, 1954, p.118; Haggett, 1965, p.119.

10. Lösch, 1954, pp.124, 270.

11. Berry and Pred, 1965.

12. Dacey, 1960, 1962.

13. Isard, 1956.

14. Berry, 1958, (A, B, C); and Garrison, 1958, 1961.

15. Thomas, 1961.

16. Garrison, 1959, 1960, 1962.

17. Morrill, 1962.

18. Beckmann, 1955, 1958.

19. Chisholm, 1962.

20. Sinclair, 1967.

21. Grotewald, 1959, p.354.

22. Brush and Bracey, 1955, p.569.

23. Bunge, 1962, p. 147.

24. Chisholm, 1962.

25. Ibid, pp. 47-73, 124-127.

26. Ibid, pp.47-73.

27. Steel, 1947.

28. Prothero, 1957; See also Jones, 1949, p.31.

29. Hunter, 1967, p.29.

30. Ibid, p.73.

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CHAPTER 6.

THE SETTLEMENT MODEL, AND THE CELL ANALOGUE: A STRUCTURAL HYPOTHESIS.

1. The Cell Analogue and Rural Settlement Structure.
2. Conclusion: a relationship between the theories of Christaller and Von Thunen.

1. <u>The Cell Analogue and Rural Settlement Structure</u>.

It would have been possible to regard the settlement model beginning to emerge from studies outlined in the last chapter as a static unit, in pure Thunenean terms; for it too was conceived as an isolated settlement existing in a stylised economic field surrounded by an economic vacuum. Such a treatment however, seemed basically unproductive. By taking the static, inorganic model and investing it with much more natural organic properties, the hypothesis could be taken a stage further.

It was suggested early in this section, (Chapter 5.2), that the 'isolation' of the original Thunen model gave it un-natural static qualities. No human or organic system is ever in this state. Life ensures a continuum of activity. Just as at some point in time, increases in population and changes in resource evaluation have caused a break-down in the simple harmony of Von Thunen's 'isolated state', in the same way, the population of the model village could not be maintained <u>in optima perpetuo</u>.

Eventually one must envisage the population of the model settlement growing beyond the upper limit established by the conditions outlined in the last chapter. The resultant pressure on resources could be solved in one of four possible ways: by reducing the length of fallows, thereby increasing the area under crops in any one year; by intensifying agricultural production using improved farming methods; by extending the area under cultivation beyond the normally accepted limits; or by "hiving-off" - sending the surplus population to create a completely new settlement.

The first solution is only likely when social or economic pressures from outside make the others impossible (Chapter 11). The peasant farmer has a basic understanding of his environment and, other conditions being equal, usually attempts to maintain a resource-use balance[1]. The second solution is possible, given sufficient group initiative, but innate conservatism make is unlikely even when no other means are open. The third solution is more likely, but involves establishing temporary settlements in order to maintain control of the new lands. Temporary hamlets of this kind are common in most subsistence systems in this sort of environment[2]. There are reasonable grounds for supposing, however, that this is not more than the first stage of the fourth possibility which presents a much more permanent solution, that of complete separation from the parent community.

There is a body of evidence to show that in normal circumstances, in many areas of the forest zone of West Africa, and elsewhere in the continent, settlement does develop by 'hiving-off' from a dominant village. Toutée describes the process in the Niger valley in the following way:

> ".......when the number of inhabitants (of a village) reaches a certain size, the number of houses remains the same. A colony is ejected to a distance of two or three kilometres which founds a village bearing the same name as the founder."[3]

Similar accounts of this process are given by Manshard[4] and by Nadel[5] for central Nigeria, where the Nupe refer to such settlements as tunga, and by Reining[6] for the French speaking territories of west and central Africa.

There can be little doubt that settlement in Sierra Leone developed in much the same way. Dorjahn and Tholley[7] describe the 'sending out of younger sons' by the Tonko-Limba in order that new settlements should be founded.

Accounts by Little[8] and Finnegan[9] of similar procedures suggest that the practice was widespread. The large number of place names which share the same name root but have diminutive suffixes, or prefixes, supports this view.

Several features of this process of sub-division suggest the analogy of a biological cell and its system of division. Chorley[10], quite rightly, warns against the dangers in adopting biological analogues for models. To press an analogy too far in this case would clearly be ridiculous, though the visual as well as the generative similarities are, in this case, quite remarkable.

It has been noted above (Chapter 5.3) that rings of the Von Thunen settlement model usually merge into zones at the scale of the subsistence village microcosm. Settlement in Sierra Leone does not conform with this generalisation. The intensive garden agriculture of the village itself does not merge gradually into a zone of bush fallow farming, which in its turn gives way to less intensive collecting activities. Instead, the two activities are firmly divided from each other by a 'ruff' of high woodland, where less intensive economic activities are carried out. Therefore, the 1,2,3 progression, from most to least intensive activities, is replaced by a

1, 3, 2, sequence, with a negative zone separating the two more intensive farming areas. The economic implications of this restrictive and inefficient use of land resources, with the daily wastage in effort as the farmer passes through the relatively negative zone each day, are quite obvious and are caused by a break down in normal associations. This would seem to be due to social and historical circumstances which will be defined later (Chapter 11).

It was this purely visual similarity to 'cytoplasmic' layers which first suggested the analogy of a biological organism, and provided a term the cell model for the structural model which was used throughout this dissertation.

Using this analogy as a starting point, it seemed profitable to construct the most logical system of 'settlement cell' growth within the terms of reference defined in this section. For this purpose, it was assumed that the hypothetical settlement had just reached its maximum potential size (Table 1). The next stage in settlement growth could be the establishment of a number of kinship compounds just beyond the normal farming radius, the third of the four possible solutions mentioned above. These dwellings would only be occupied during the seasons of an eight to twelve year cycle when the new land was being cultivated. At some stage, however, the increase in the number of these temporary settlements, and the inconvenience of maintaining two dwellings, would be sufficient to produce a general urge to establish a more permanent satellite settlement.

This growth pattern is, admittedly, somewhat idealised. Quite probably, internecine quarrels about a range of possible contentions, ranging from witchcraft to adultery[11], would be the rationalisations of land hunger, and could precipitate a solution even earlier than the maximum conditions postulated here. Usually, however, social and legal ties are maintained with the parent community, and new settlements are always thought of as 'belonging' to the parent community long after the time of foundation[12].

In these circumstances, and for the purposes of this hypothetical model, it seemed reasonable to suppose that the satellite would be established far enough away from the parent to allow it the same potential for development, but that social ties would make the rule 'far enough and no further', thereby establishing a distance equilibrium.

Within the terms of the model calculation (Table 1), this distance would be between 2 and 3 miles (a figure which, incidentally, agrees remarkably well with Toutee's assessment for settlements in the Niger valley, and with Manshard's generalisation for the region as a whole[13]).

The establishment of the first satellite completes the primary stage in the process of settlement growth, one which is similar to cell division in a living organism. After a time, population growth in either, or both of the settlements, would make it necessary to establish a second satellite. In view of the patrilineal social system, and the dominance of the founder settlements, this process would be most likely to be arranged from the original village, and once more a site would be chosen about two miles from it. Therefore the second stage in settlement growth replicates the first.

Presuming that each settlement reserved for itself the same area for potential growth, governed by the same walking distance, then it will be readily appreciated that in these idealised circumstances, only six settlements could be established from one centre before 'areal saturation' completed the stages of structural growth. (Fig. 8).

THEORETICAL STAGES IN PATTERN DEVELOPMENT

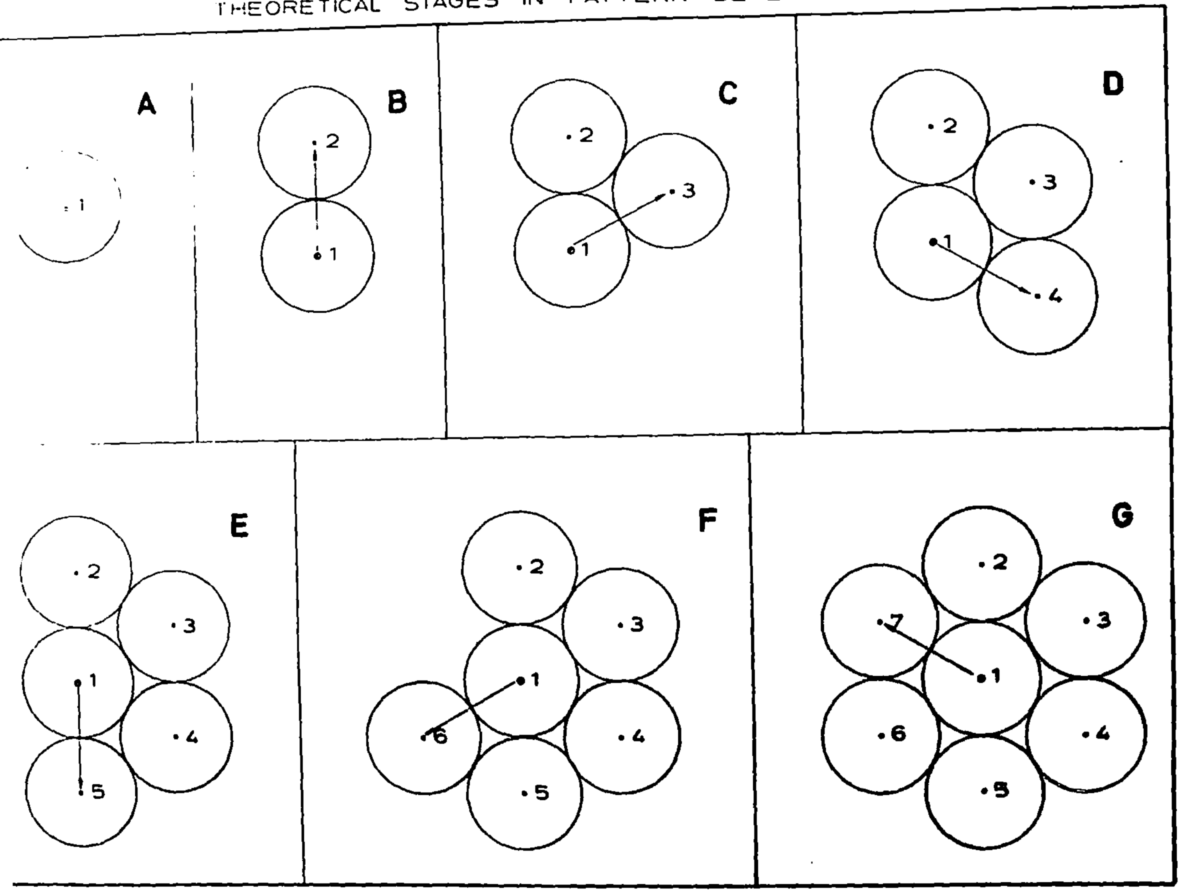

Fig. 8

	Founder village		Satellites		Farm Radius	Farm Area	NN	Cell Area
					in miles or square miles.			
	B	P	B	P				
Field Sample Average	63	562	31	280	1.3	5.3	2.6	37.1
Model cell	57	512	28	252	1.0	3.1	2.0	21.9
Overall Average	60	540	30	270	1.1	4.22	2.3	29.5

B = Buildings

P = Population estimate

NN = Nearest neighbour distance

Table 3

Values for a generalised cell model settlement structure.

Within the terms of reference established by the model, this would take place on well prescribed lines, and it was possible to set up the whole model cell structure within the limits set out in Table 3.

Deducing a rational size of the satellites was the most hazardous feature of this calculation. Supposing, however, that the cell model structure still had room for development, it seemed reasonable to infer that between older satellites, which were as large, or almost as large, as the founder, and the most recent offshoots, which were not more than large hamlets, an average size of half the maximum potential would give a reasonable estimate of population conditions for the satellites as a whole. In these circumstances, the area occupied by the cell structure would be about 30 square miles, and the population would be about 2000 persons.

2. Conclusion: a relationship between the theories of Christaller and Von Thunen.

It is now possible to draw together some of the arguments of this section. It will be recalled that in the previous chapter, an outline was presented of the development of 'Central Place' theory from the early models of Von Thunen and Christaller. It was suggested that although both these primary models were static and postulated an un-differentiated landscape, and despite the references to Von Thunen's model by Christaller[14], there were considerable differences between the two concepts (Chapter 5.2). These differences would seem to have led to separate development and the long neglect of Von Thunen's theory. Recent work by Chisholm, which extends the range of Von Thunen's model, made it possible to devise a typical settlement situation for Sierra Leone. By giving this static model organic properties of growth, it was possible to develop a whole structure of rural settlement. This structure is represented by a network of villages equally spaced by the uniformity of their economic fields. It is at this point that one finds a possible relationship between the Von Thunen and Christaller models.

It will be readily appreciated that the hypothetical settlement structure, first conceived in terms of the static Von Thunen model but made dynamic by population growth, exactly represents the homogeneous landscape of equally spaced settlements of the Christaller model when $\underline{k} = 7$[15] (Fig. 9). It seemed possible therefore, to trace, at least

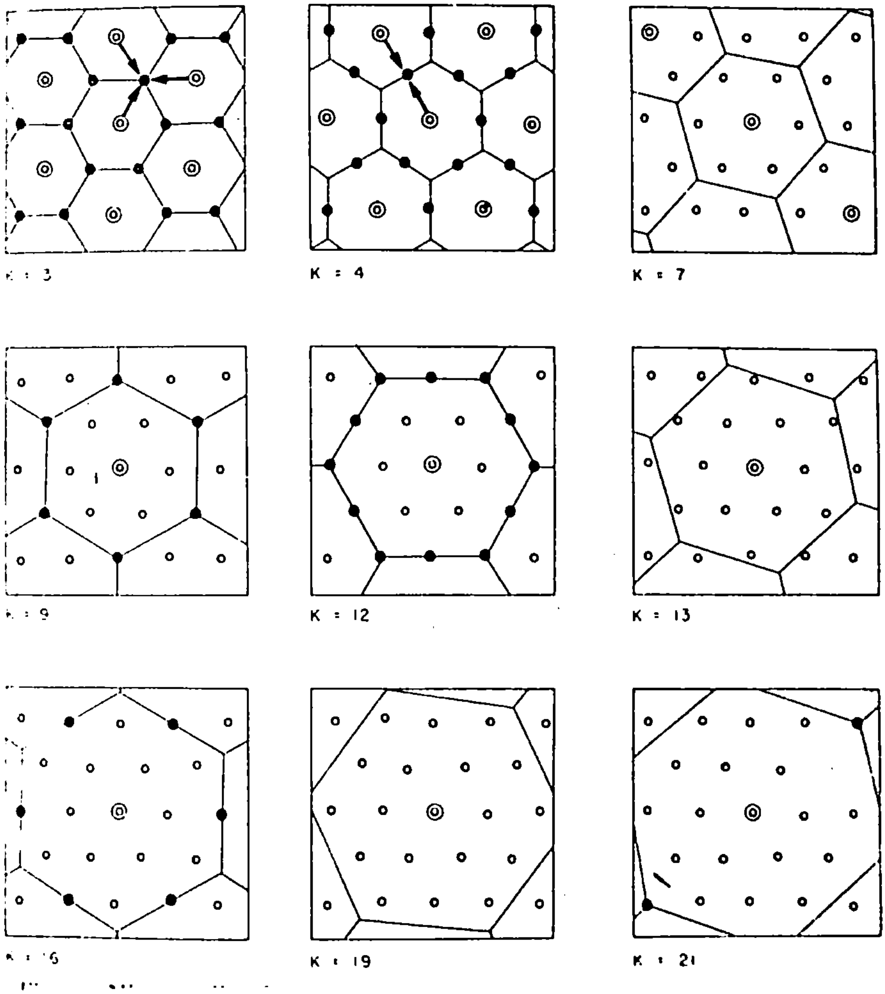

Fig. 9

in theoretical terms, a relationship at subsistence level between two apparently dichotomous branches of central place theory. It also seemed likely that in the settlement pattern of Sierra Leone there may be an ideal test-bed for this hypothesis.

Certainly, much more elaborate testing was necessary. Hypotheses had so far been based on limited empirical observation, and the deduction of what seemed to be the most logical sequence of events. Direct micro-scale analysis by field work seemed to offer only limited possibilities of success (Chapter 5.3). It seemed important, therefore, to broaden both the scope and the range of the thesis by employing a wide range of methods and quite different levels of approach, both of which are evident in many of the subsequent chapters of this dissertation.

References.

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3. Toutée, 1899, p.422.

4. Manshard, 1966, p.246.

5. Nadel, 1946, p.37.

6. Reining, op.cit., p.127.

7. Dorjahn and Tholley, 1959, p.273.

8. Little, 1948, p.51; 1951, pp.27, 104, 107, 108.

9. Finnegan, 1965, pp.58, 59.

10. Chorley, 1964, p.136.

11. The most common reasons for dispute throughout rural Africa.

12. Finnegan, op.cit., p.59,

13. Manshard, op.cit., 1966, p.247.

14. Christaller (Baskin), 1966, p.6.

15, Haggett, 1965, p.119.

S E C T I O N

T W O

CHAPTER 7.

SAMPLING PROCEDURES.

1. Introduction.
2. Sampling Design: some initial problems.
3. The Pilot Survey.
4. Devising a Statistical Sample.
5. The Random Sample of Settlement in 1964.
6. The Random Sample of Settlement in 1927.
7. Conclusion..

1. Introduction.

Considerable time and effort were devoted to the problem of devising an adequate random sample of rural settlement distribution. This sample opened the way to three main lines of enquiry. Firstly, it made it possible to produce the first accurate map of rural settlement distribution for any West African state[1] (Fig. M.3). This map was the base for interpreting pattern associations within the framework of quite limited areal variations, and provided a selection frame for the analysis of special associations (Chapter 13 and Section 4). Secondly, the sample allowed the exploration of theories of the cell model and central place theory outlined in the previous section. Thirdly, it provided the basis for much of the statistical testing of settlement patterns (Chapter 10,&15 - 19). There seemed ample justification, therefore, for spending some time explaining the procedures used in devising the sample.

2. Sampling Design: some initial problems.

Bearing in mind the arguments of earlier chapters, and anticipating the requirements of settlement mapping and the possibilities for an overall structural analysis of rural settlement, it was apparent that most of the subsequent analysis must be based on the aerial photographs (Chapters 2.2, 3.2) from which the most recent topographical map coverage is still being produced. The unrefined state of the 1963 census of population precluded the use of this potentially rich source and there remained no other reliable data except the photographs. With this criterion established, it seemed that any attempt to map or analyse settlement patterns must depend on two prequisites; that the buildings in each settlement could be accurately counted from the photo-prints, and that an adequate categorisation of settlement could be made, based on size and also, if possible, on function.

A systematic preliminary examination of maps and aerial photographs, using hand lenses and stereoscopes, suggested that it would be possible to count buildings per settlement with reasonable accuracy, and that there may also be some relationship between the number of dots representing a settlement on the 1:50,000 map sheets, and the number 'on the ground'. It seemed that any difficulties experienced in relating these two counts could at least be overcome by checking in the field.

It was a little more difficult to establish well defined settlement categories. Two hierarchies may be envisaged, using either empirical or theoretical terms of reference. They are not radically different from each other, but tend to give slightly different impressions of the settlement structure.

If one constructed a settlement hierarchy based on photograph observations and experience in the field, it would have the following structure:

a) Dominant villages ('founders'), with upwards of about 30 buildings.

b) Satellite villages, with between about 13 and 29 buildings.

c) Incipient satellites and large farm hamlets, with between about 6 and 12 buildings.

d) Hamlets and temporary field shelters, with less than 5 buildings.

In general, it would seem that such a categorisation could give a reasonably accurate picture of size and function relationships within the terms of reference established in the first part of the last section (Chapter 4).

A category system based on the <u>cell model</u> and central place theory (Chapters 5 and 6), however, would have a slightly different composition:

a) Founder villages, with 30 buildings or more.

b) Satellites, with 13-29 buildings.

c) Temporary farm settlements, with 12-1 buildings.

In both cases, settlements would be categorised in terms of size and function, with a gradation by the degree of locational stability from permanent founder to temporary shelter. The difference between the two systems is one of emphasis, and also of accuracy of representation.

In the first system, there is a clear distinction between the two categories of permanent settlement and the two temporary ones. The separation of smaller settlements into two groups gives a stress to this feature and creates a balance between the temporary and permanent sides of the structure. It also allows greater refinement in mapping.

In the case of the second system, a more specific accuracy is sacrificed for the sake of a smooth theoretical gradation. This gives a degree of locational instability to the second category by removing the emphasis on temporary settlements, which is a feature of the first system.

With such small differences between the two hierarchies, it was tempting to choose the three tier theoretical structure, even without testing which of the two represented a more accurate picture of actual conditions.

The uncertainties concerning both the choice of a categorisation system and ~~to~~ the methods of counting the buildings per settlement, and also the problems involved in deciding what part the topographical map sheets would play in any mapping technique, made it necessary to hold a preliminary enquiry in the form of a pilot survey. In this enquiry, all possible techniques could be tested against a building by building count of settlements in the field.

It was essential that areas chosen for this pilot survey should both be representative of conditions over a large part of the country, and should also be adequately served by motor tracks. The general homogeneity of rural settlement conditions made it fairly easy to fulfil the first requirement, but the factor of accessibility restricted the range of possible choices to areas within the Mende and Temne cash crop zones which are the only areas where there is an adequate network of motor tracks[2].

3. The Pilot Survey.

Two areas were chosen for the pilot study, one in each of the main tribal areas (i.e. Mende and Temne). For each, the 1:50,000 maps had already been issued (1964). The first covered approximately 280 square miles south east of Kambia in the chiefdoms of Magbema and Bure. The second covered an equivalent area in the south east of the country, in Bonthe District , south-east of Mattru-Jong in Jong chiefdom (Fig. 10). In both regions, down-cutting through a fifty foot erosion surface on Kasila and Bullom soils had left a mature landscape of flat-topped interfluves and narrow marshy valleys. They shared similar settlement densities and both were served by an adequate network of motorable tracks.

During the dry seasons of 1963 and 1964, some fifty settlements of all sizes were examined in each area. Firstly, they were categorised into the fourfold hierarchy using appropriate aerial photographs and a twofold magnification hand lens. These results were then compared with a sevenfold magnification count of buildings per settlement (Fig. M.2). ~~and Appendix 1.).~~

Having completed the aerial photograph counts, the

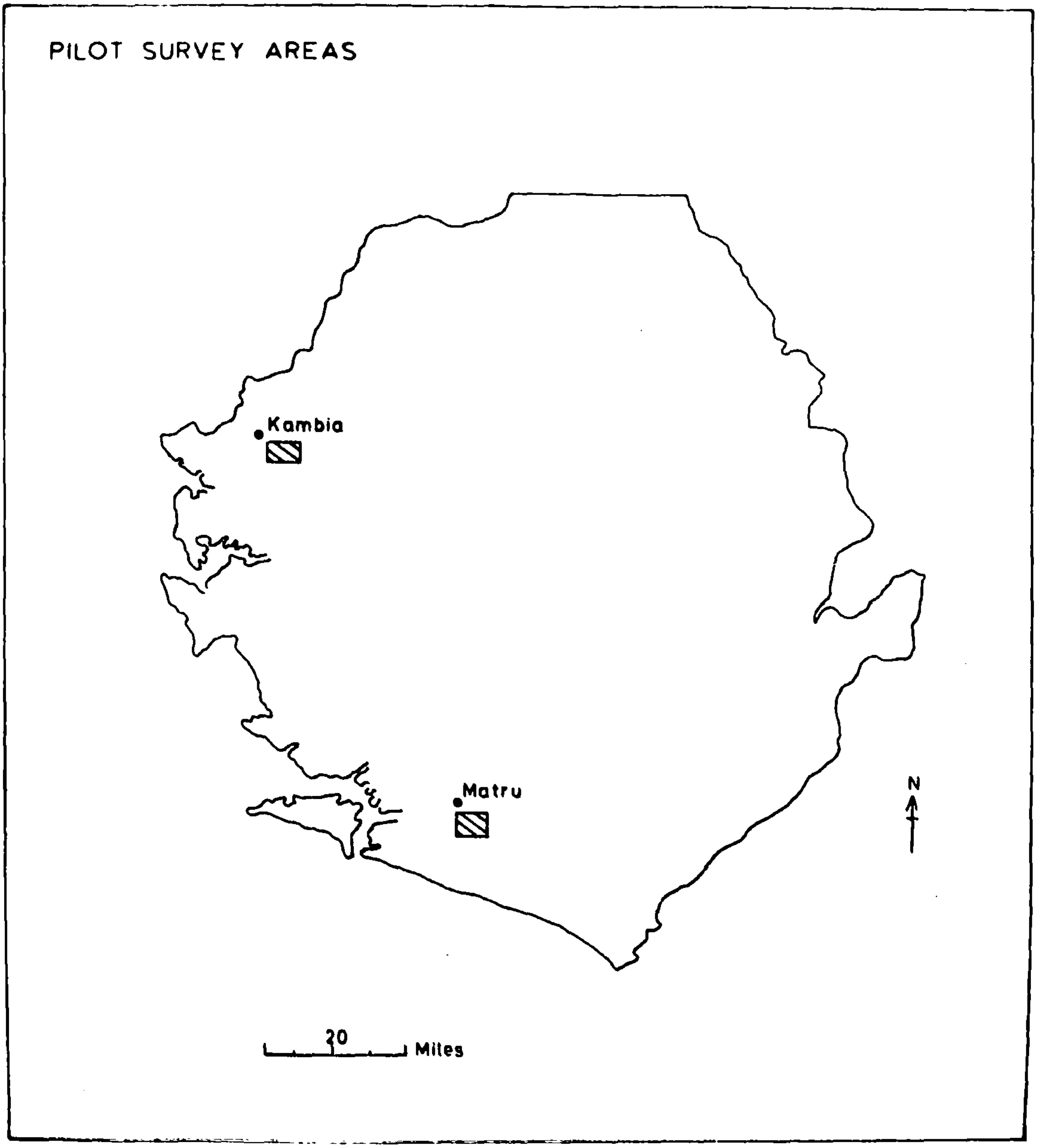

Fig. 10

settlements were next examined on the ground, where details of village life and a fully accurate, double checked count of buildings was made. These results were compared with those derived purely from aerial surveys, and also with the number of dots representing each settlement on the 1:50,000 map (Fig. 11).

Four important points emerged from this survey. Firstly, there was no significant difference in the results from both areas. It seemed, therefore, that one might expect a reasonable consistency in both mapping and counting. Secondly, the survey confirmed the view that a categorisation of settlement based on size and function could be made. Thirdly, there seemed to be at least some relationship between the actual number of buildings counted and the dot representation on the 1:50,000 sheets (Table 4). This relationship, however, decreased for certain ranges of settlement size, and also for settlements on the roadside, whose buildings are often more clearly discernible on the photographs and so tend to get a proportionally higher rating of dots than the clustered settlements surrounded by 'high bush'. Even so, it appeared possible to consider this method of category allocation when making the larger statistical sample.

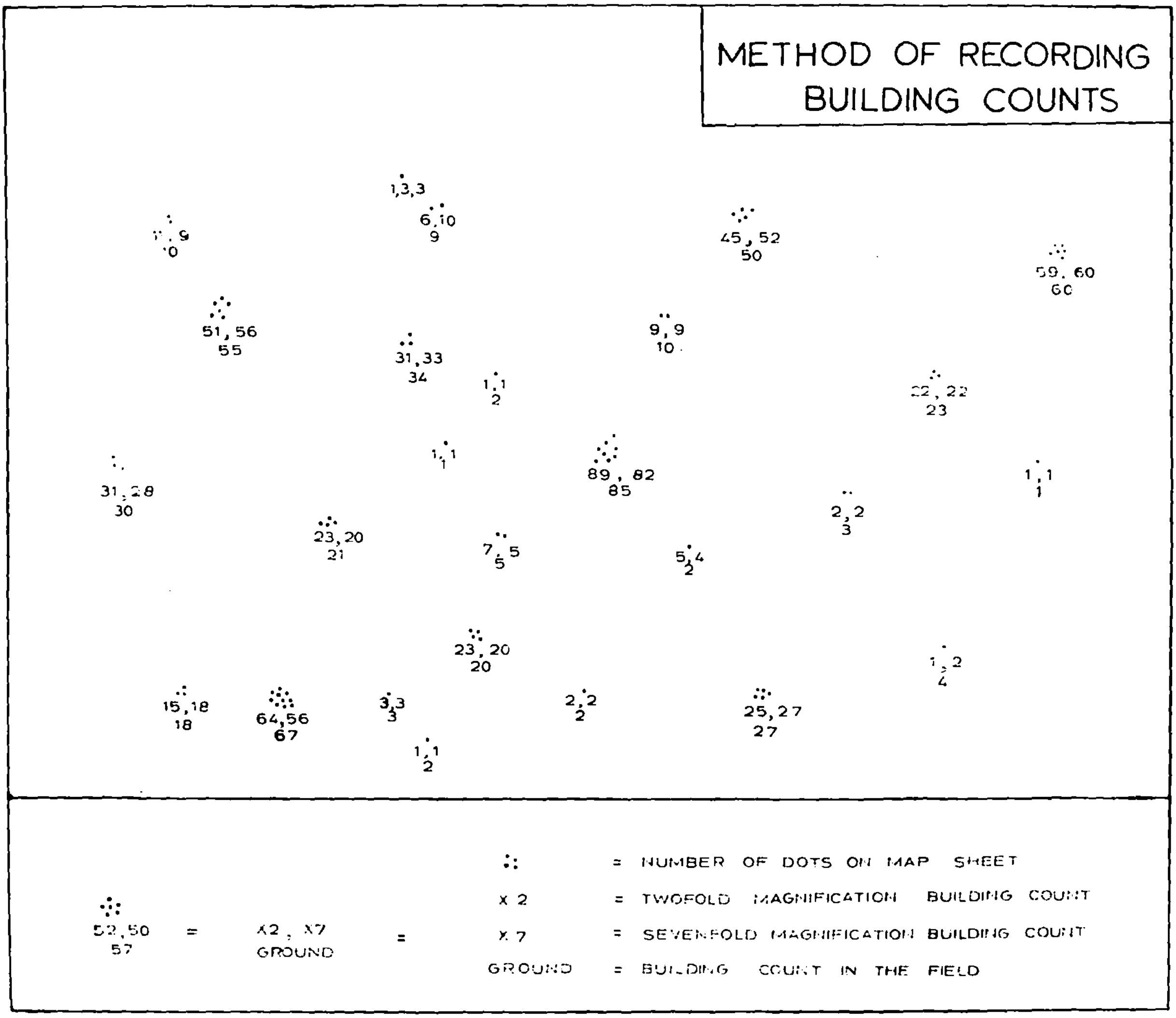
METHOD OF RECORDING BUILDING COUNTS
1,3,3
6,10
9
45,52
50
59,60
60
51,56
55
31,33
34
9,9
10
1,1
2
22,22
23
1,1
1
89,82
85
1,1
1
31,28
30
2,2
3
23,20
21
7,5
5
5,4
2
23,20
20
1,2
4
15,18
18
64,56
67
3,3
3
2,2
2
25,27
27
1,1
2
52,50
57
= X2, X7
GROUND
= NUMBER OF DOTS ON MAP SHEET
X 2 = TWOFOLD MAGNIFICATION BUILDING COUNT
X 7 = SEVENFOLD MAGNIFICATION BUILDING COUNT
GROUND = BUILDING COUNT IN THE FIELD

Fig. 11

Preliminary Categories of Settlement	No. of Buildings	Dot Representation on 1:50,000 Maps	% Degree of accuracy in categorisation using x 7 hand lens
a	200 - 31	8 and over	98
b	30 - 13	3 - 7	78
c	12 - 6	2	75
d	5 - 1	1	95

Table 4.

Relationship Between Map Symbols and Number of Buildings per Settlement in the Pilot Survey (Figs. M.2 and 11).

Finally, there was little doubt that reasonable reliance could be placed on the accuracy of the sevenfold magnification count of buildings from the aerial photographs. The count using a twofold magnification hand lens was proportionally less accurate, but it was decided, nevertheless, to incorporate this in the sample survey techniques.

4. Devising A Statistical Sample.

The encouraging results of this small pilot survey seemed to justify applying the same methods of aerial photograph settlement counting in a full statistical sample survey, with some hope of providing an accurate body of settlement information for the country as a whole. At the same time, techniques used in the sample would provide a basic training for the major task of mapping settlement throughout the country. It would provide valuable practice in the use of hand lenses and stereoscopes, and in the location of photographs for the 1:62,5000 map sheets where there was no 'key', except the map of the contract runs (Fig. 2).

Before devising a sample, there were two initial problems. The first concerned the type of sampling unit to be chosen[3]. The structural and central place characteristics of rural settlement which the sample hoped to test meant that it should be an 'area' rather than a 'point' sample. The most satisfactory areal unit to test the cell model was clearly the hexagon. There were, however, considerable difficulties involved in adopting this type of overlay. Identification of individual settlements from a square aerial photograph in relation to a square map grid would be difficult enough, with over 3,000 prints arranged in 14 contracts (Fig. 2) and covering 100 maps at two different scales (1:50,000 and 1:62,500), especially when the maps at the latter scale were not keyed to the photographs. The task would have been made even more complicated if this information had had to be transferred from the square grid to a hexagonal one. Indeed, the square is only slightly less efficient than the hexagon for the purposes intended here[4]. It was also considerably more convenient.

The grid-base for both the 1:50,000 and 1:62,500 series was fixed at 5 minutes of latitude and longitude. Each 5 minute square, of which there are nine per map sheet, is equal to about 33.1 square miles, the slight variation in size due to the curvature of the earth being insignificant at this latitude. It was noted that this area lay within the range discussed for a possible cell model of settlement structure; i.e. from about 22 - 37 square miles (Tables 2 and 3). Therefore, the 5 minute grid seemed to be potentially significant for checking the arguments presented in the last section.

Having decided on the sampling frame, the next problem was to choose the type of sample. Following the hypotheses of structural homogeneity presented in the last section, there was every likelihood that a range of micro-regional deviations in conditions of the environment would be responsible for some small variations in density, if not in nucleation. The most effective and unbiased sample estimate of the chief characteristics of the whole settlement population would seem to be provided by a stratified sample with a variable sampling fraction[5]. But without any prior knowledge of these supposed density deviations, it was extremely difficult to devise a rational stratification. Moreover, if the main density differences - probably between plateaux and lowlands - meant the selection of a lower number of sample squares from the eastern half of the country, then this would not provide the necessary experience in locating photographs in relation to 1:62,500 map sheets. For the proposed settlement map it was essential that this experience should be gained and the reliability of results be tested.

For these reasons, a simple random sample approach was adopted using a uniform sampling fraction of about one twentieth of the total grid square population. This was large enough to use standard statistical procedures in subsequent calculations, and also to make sampling errors insignificant.

5. <u>The Random Sample of Settlement in 1964.</u>

A grid overlay of the 1:500,000 maps was drawn up using a 5 minute division. Squares were numbered across from the first extreme north-western complete square to the last extreme south-eastern complete square. A sampling fraction of one twentieth gave a total number of 49 selected random squares. Numbers were chosen from a standard list of random numbers[6]. It was found that the sample provided a good distribution of squares over the country as a whole (Fig.M.2c).

In order to distinguish each sample square, a less cumbersome system of identification was called for than that provided by the straight sequence used in random sampling. Accordingly, a graphic system of letters for the horizontal axis, and numbers for the vertical axis, was drawn up (Fig.M.2c). Each unit of the grid could then be readily identified.

Because comparison was intended between the results of this survey and those of the theoretical cell model, it was also important to find a term for the area of the grid square to distinguish it from the area of the model. It seemed, however, that the grid unit was no more than a standardised version of the hexagonal system of the cell model (Chapter 6.1). An appropriate term for this grid square seemed to be the standard cell. This term was therefore adopted and used throughout the thesis.

The sample divided itself into two parts: the western half of the country, already covered by the 1:50,000 maps and therefore provided with a photograph key system ~~(Fig.)~~; and the eastern half of the country, covered only by 1:62,500 maps, which were drawn from 1927 Survey material and for which there was no photograph key except the contract run maps (Fig. 2).

1:50,000 sample squares:

For this part of the sample, two records were made of the settlement in each sample square (Fig.11). Firstly, the numbers of dots representing each settlement on the 1:50,000 map sheet were counted and recorded. Secondly, the aerial photographs for each sample area were located and matched with the map, and the buildings were then counted using the higher (sevenfold) magnification hand lens, the accuracy of which had already been attested by the pilot survey (Chapter 7.3).

The map counts of dots per settlement were categorised from the experience gained in the pilot survey, using the empirical four tier hierarchy (Chapter 7.4). This classification was then compared with that taken from the building by building count which had been obtained by using the hand lens and aerial photographs. The results were not encouraging. Of the 349 d category settlements (farm shelters and fakai) accounted for in this part of the sample, which covered twenty five standard cell squares, 19, i.e. 5 per cent, were mis-classified. Of the 170 c category settlements in the sample, 76 were misclassified, with 31 per cent wrongly attributed to the lower category and 14 per cent to the higher ones.

Similarly, for the 210 b category settlements ('satellites'), 19 per cent were attributed to the a category and 8 per cent to the c group. Again, out of the 40 dominant villages of a category, 23 per cent were wrongly allocated to the b grouping (Table 5).

Despite the findings of the pilot survey, which suggested some relationship between dot representation and actual numbers of buildings per settlement, this relationship was obviously too inconsistent to be applied to the whole settlement pattern. It seemed that the use of map symbols as an aid to categorisation would have to be abandoned if the four tier hierarchy were used. However, because of the enormous labour involved in mapping every settlement in the country, the writer was unwilling to abandon this short-cut method of classification altogether, and so attention was turned to the other settlement hierarchy which had less empirical justification but held out possibilities for extending the cell model theory.

Category ranges were regrouped in a three tier hierarchy according to the following two principles: that

Preliminary Category	No. of Buildings per Settlement	Dot Representation (1:50,000)	% Misclassified		% Accuracy	
			+	-	Random Sample	Pilot Survey
a)	200 - 31	8+	0	23	77	95
b)	30 - 13	3-7	19	8	73	78
c)	12 - 6	2	14	31	55	75
d)	5 - 1	1	5	0	95	98

Table 5

Settlement Categorisation

Using the 1:50,000 Sheet Settlement Symbols

and a Four Tier Hierarchy.

the system should still reflect, as faithfully as possible, the distinction between large dominant villages, smaller satellites, and more temporary hamlets; and that the 1:50,000 map symbols should be able to play some part in the process of classification. The following hierarchy satisfied these requirements:

a) 200 - 36 buildings, (Founder settlements).

b) 35 - 13 buildings, (Satellite settlements).

c) 12 - 1 buildings, (Temporary settlements).

This three tier system, with fairly arbitrary divisions between categories, prevailed on purely pragmatic grounds. Few claims could be made for these categories at this stage beyond convenience and a very tentative hypothesis of functional association. It still seemed quite probable that many dominant founder villages would fall in the b category range and that a number of 'satellites' would have more or less buildings than the limits imposed by this sytem. It was, however, the system which worked, and the one from which a distribution map of settlement for the whole country might be devised.

The practical advantage of this regrouping into three categories was immediate. Using this system it was found that, in most cases, settlements could be correctly classified using only the dot symbols of the 1:50,000 maps (Table 6). Deviations invariably occurred near the class limits, and in order to achieve almost complete accuracy, it was only necessary to use the arduous method of hand lens building counts for those settlements represented by 3,7, and 8 dots on the map. This left a margin of error which was less than 5 per cent in all cases.

These considerations and results seemed to be sufficient justification for adopting the threefold classification of rural settlement, based principally on size and partly on function, for the rest of the random sample. The use of map symbols as the chief means of settlement classification for this half of the country meant a welcome reduction in labour. This gave extra, much needed, time for the more difficult task of settlement identification in the eastern part of the country.

The 1:62,500 sample squares:

As explained above, the 1:50,000 maps have only been completed for the western half of Sierra Leone, and so the much earlier 1:62,500 map cover had to suffice as the base

Category	No. of Buildings	Dot Representation on 1:50,000 map (Fig.M.2a)	% Accuracy of Classification
a	200 - 36	8+	77
b	35 - 13	3-7	73
c	12 - 1	1-2	95

Table 6

Settlement Categorisation

Using 1:50,000 Settlement Symbols and the Three

Tier Hierarchy

for settlement analysis for the remainder of the country. ~~(Fig.)~~. For this area, occupying something in the order of 13,000 square miles, aerial photographs were therefore of paramount importance. Without this coverage, the attempt to produce a full structural analysis and a distribution map of rural settlement would not have been possible.

This part of the sample aimed to continue the sevenfold magnification hand lens count which was the basis of accuracy for the western region. Only in this way, could a fully accurate study of structural features of rural settlement be compiled for the country as a whole. The considerable labour involved, not to mention the physical strain of using high magnification lenses for long periods, made it necessary to devise another short-cut method for the lengthy process of locating, grading and mapping <u>all</u> settlements in this area in preparation for the full distribution map. Throughout the analysis, therefore, a twofold magnification categorisation of each sample settlement, based on 'appearance', preceded the accurate count using the higher powered lenses and stereoscopes.

Photographs were selected from the contract runs to match the areas covered by the sample squares. The appropriate map sheet was only used to assist in the correct identification and location of the larger villages which usually occupied the same sites as they had done at the time of the earlier topographical survey. Having located these settlements, it was easier to identify smaller villages, hamlets and farms whose location had been changed more frquently.

The exercise provided a valuable insight into the locational characteristics of settlement in Sierra Leone, for a surprisingly large number of patterns had changed very little in the past forty years. This information proved extremely useful in formulating theories of cultural continuity developed later in this dissertation (Chapters 11, 12,&13 to 18). It also provided valuable experience in identifying both photographs and settlements, a factor which was to be extremely useful in subsequent mapping.

The value of the twofold magnification hand lens in classifying settlement was made readily apparent by this method of approach. The results may be summarised as follows: for category a there were only 22 villages in the sample, and all were sufficiently distinctive to be correctly classified using the lower powered lens; for the 73 b category villages, 76 per cent were correctly classified by the low powered lens, and almost equal proportions of those mis-classified were allocated to each of the other categories; of the 300 hamlets and farms of c category which were counted in the sample, 90 per cent were correctly classified using the low powered lens, and of those mis-classified, 66 per cent lay within 3 buildings of the class limits.

By checking the settlements which clearly fell close to both of the limits of b category and the upper limit of c category, it was possible to achieve almost complete accuracy whilst using the low powered lens as a basis of classification.

6. The Random Sample of Settlement in 1927.

Using the counting methods described above, it was possible to assemble an accurate body of information concerning the structure of rural settlement in Sierra Leone in the late nineteen fifties and early nineteen sixties. The comprehensive nature of the earlier topographical survey in 1927 (Chapter 3.2) made it possible to compile the same information for the same period forty years earlier.

Although the same random sample could be used on the same grid base, absolute parity was not possible because of the basic differences in counting procedure (Chapter 3.2).

The random sample detailed above was the work of one individual. Limits of accuracy and consistency could be checked in the field. One would hope that errors of judgement had the virtue of consistency. The 1927 data relied exclusively on the conscientiousness and counting ability of a considerable number of partly trained field assistants. It was clearly impossible to assess the detailed accuracy of this work. It was possible however, to deduce the most likely areas of error and to interpret the data in the light of these deductions.

Careful consideration of the problems of counting villages suggested that some sizes of settlement would be more likely to be mis-counted than others. The Mende village, for example, with its confused huddle of buildings (PE 1) would be more difficult to count accurately than the Koranko settlement with its regular lay out and spacing between compounds (PE 24). Inaccuracies of this sort would be impossible to account for. In general, however, it seemed likely that the smaller settlements of b and c categories would be more accurately counted than those in a category for which natural error would be higher and cover-checking would be time-consuming.

Some small scale and limited experiments in the field, using teams of students from Fourah Bay College, showed that this evaluation was correct. Few significant mistakes were made for villages with up to 50 buildings. Beyond this point, however, settlements were progressively more seriously under-counted.

The higher degree of accuracy with settlements below 50 buildings would make a simple comparison of the proportion in each category valid enough, but a more detailed comparison of the numbers and sizes of the larger settlements in a category with those of 1927 would have to be made in the light of these observations.

Given these reservations, it was a relatively easy task to extract information from the Field Sheets and Village Books of the 1925 - 1930 Survey which are lodged in the Lands and Surveys Office in Freetown.

7. <u>Conclusion.</u>

These sample surveys performed several functions. They helped to define the categories of rural settlement which would be used in the construction of the base map which was the starting point of all subsequent statistical evaluation. The main survey of recent settlement conditions helped to establish the limitations and advantages of the shorter methods of settlement mapping. It also provided valuable practice in the identification of settlement and topographical features from the photographs and in the techniques of mapping which were to be used in the compilation of the base map. Finally, both the samples provided a body of accurate information regarding the exact size of a widely representative number of settlements selected in a random manner from areas which totalled 5 per cent of the whole country. These samples were cast in such a way that structural features of the settlement pattern would be revealed and that the theories of the <u>cell model</u> might be tested.

References.

1. Siddle, in Clarke, 1966, p.60.

2. Mitchell, in Clarke, 1966, p.102.

3. Yates, 1960; Cochran, 1953.

4. Haggett, 1965, p.207.

5. Yates, op.cit.; Haggett, op.cit., pp. 191-199.

6. Fisher and Yates, 1957.

C H A P T E R 8.

CONSTRUCTING A BASE MAP OF RURAL SETTLEMENT DISTRIBUTION.

There are just over 22,000 settlements in Sierra Leone. The task of mapping these in a reasonably accurate manner would have been impossible for one person in the time available, without the short-cut systems of categorisation tried and tested in the random sample (Chapter 7.3, 7.4). Using these methods, the map was eventually completed in six months of intensive work.

The inevitable tedium involved in transferring information from one scale to another was alleviated by the interesting settlement associations which emerged from the study of such a large area in considerable depth, and many of the ideas presented in subsequent chapters were conceived during this period of information processing.

This map of settlement distribution was intended eventually for the scale 1:500,000 so that it could be part of the series used in Sierra Leone in Maps[1]. It was not possible, however, to transfer information directly from the large scale sheets to the 1:500,000 base map without considerable locational inaccuracies. It was therefore decided to use the 1:250,000 sheets as the initial transfer base. Most of the villages in the a category, and many of those in the b category, were accurately named and located on these sheets, and it was a fairly straightforward matter to transfer category information onto an overlay of these sheets gridded for the larger scale map covers of the primary analysis. For the 1:50,000map sheets, settlements were categorised using the relationship between dots and the number of buildings already tested (Chapter 7.3 and 7.4). In doubtful cases near the class limits, and periodically even for those for which the classification would not normally be in doubt, aerial photographs and hand lens counts were made. On average, the settlements on about a third of all the photographs covering a map sheet were examined in this way.

The problems of location and categorisation were much less simple for the eastern half of the country which is covered only by the 1:62,500 map sheets. Here, all the photographs needed careful scrutiny, and a full mosaic was assembled for each of the map sheets. Frequently, it was necessary to use twenty or more photographs, usually from different contracts, to assemble one mosaic. Considerable effort was also involved in locating each settlement on the map sheet overlay. Both low and high powered hand lenses and a high quality stereoscope were used extensively, not only to determine settlement sizes, but also to find smaller named and unnamed settlements whose position, number and size had often changed since 1927 when the information for the base maps was collected.

The categorised settlements were plotted first on a 1:62,500 overlay, and then re-located on the 1:250,000 overlay before the basic exercise was completed.

A mosaic of the nine 1:250,000 overlay sheets was then photographically reduced to the scale 1:500,000. Finally, the map was re-drawn using proportional symbols (Fig. M.2b and M.3). ~~Part II).~~

This map provides the first accurate record of rural settlement conditions for Sierra Leone and is also the first of its kind for any West African state. The information recorded on it made possible much of the subsequent analysis in this dissertation. It may be argued, therefore, that the considerable labour involved in its construction was amply re-paid.

References.

1. Clark, 1966, p.60.

S E C T I O N

T H R E E

CHAPTER 9.

A QUALITATIVE AND REGIONAL ANALYSIS OF RURAL SETTLEMENT PATTERNS.

1. Introduction.
2. The Regional Background.
3. Patterns of Rural Settlement.
4. Conclusion.

1. Introduction.

This chapter aimed to use purely visual and qualitative methods to describe and analyse the patterns of the settlement distribution map (Figs. M.3 and 4). To attempt such an analysis for a map as detailed as this, it was necessary to find a suitably systematised approach. The division of the country into settlement regions provided this framework.

The argument was based partly on the comparative series of maps which were brought together in Sierra Leone in Maps[1], partly on extensive field work and partly on a thorough examination of the aerial photographs (Chapter 2). From the full set of prints, a representative collection was made to illustrate the main features of pattern variation described in this chapter (P.1-40). ~~and P.1 - 42, Part II).~~

Using these methods, it was fairly easy to identify broad macro-regional associations. Examination of the topical map series of Sierra Leone in Maps suggested that the most striking discontinuities of pattern were associated, not with any cultural or economic feature, but with the broad geological, lithological and geomorphological divisions[2] of the country. These broad divisions were identified in the knowledge that subsequent modifying sub-divisions might have to be made on the basis of human factors.

Between the lowlands and plateaux, it was possible to distinguish a varying number of settlement associations. These ranged from the fairly considerable variations indicated on the map by Roman numerals, to the smaller scale (lower case letters) and micro variations (Arabic numerals). Not all of these smallest scale variations could be analysed and described in detail, and many must await the more detailed analysis of later research.

2. The Regional Background.

The Plateau and Escarpment Zones:

The main plateau (A I), an extension of the Guinea Highlands, occupies the north-east quadrant of the country. It is composed almost entirely of pre-Cambrian granites and acid gneisses. Upper surfaces generally lie between 1,400 and 2,000 feet, although higher hill masses - the Wara Wara, Sula, Loma and Tingi mountains - attain heights of between 2,000 and 4,000 feet. A long period of sub-aerial erosion, probably punctuated by several phases of uplift, have left the region with a fairly mature landscape[3].

Deep dissection by the four main tributaries of the Scarcies and Rokel rivers, all of which follow north-south, east-west fault lines, gives a landscape in which valley sides are steep and both interfluves and valleys are quite narrow. Though subject to some infilling, valleys are rarely more than 100 yards wide.

A considerable variety of landforms are contained within these generalisations - rock scarps, inselberg-like features, benches and the forelands of the main mountain areas. This, coupled with the inadequacy of morphological research, makes effective generalisation on this aspect of the region extremely difficult.

Other physical characteristics are more easily surveyed. The dry harmattan wind is stronger and lasts longer in this region than elsewhere in Sierra Leone and rainfall is lower and less reliable[4]. Upper surfaces, and many of the valleys, are covered by Guinea savanna. Occasional patches of trees - surrounding settlements and in forest reserves of the Loma and Tingi mountains - would suggest that the area was once covered by a heavier vegetational cover. Today, over-farming, over-burning and over-grazing have produced a vegetation pattern of fire climax species - Lophira elata, Erithrina, Pterocarpus, Laudetia arundetia, and Imperata cylindrica. The area is still extensively grazed, but cropland is now almost entirely restricted to the valleys, or to the flatter of the interfluves.

The plateaux are occupied by five main tribal groups with territorial claims; the Yalunka, Wara-Wara Limba, Koranko, Konno and Kissi. With the exception of the Limba, all are fairly recent immigrants into the region (Chapter 11.3). ~~11.3)~~. Even more recent immigrants, with no territorial rights, are the migrant Fula cattle herders and traders who have infiltrated the region since the end of the last century (Chapter 12.2).

The region is served by one extremely tortuous laterite motor road (known locally as 'Kabala curve'). It remains one of the most backward and most primitive areas in the country, with no cash economy except a passing trade in Fula cattle.

The escarpment zone (A II), which forms the western and southern boundary of the plateaux, is a zone of both physical and human transitions. Considerable variations in the qualities of relief, and possibly of soil, are reflected in more diverse vegetation patterns and in the wider variety of tribes and settlement than in the main plateaux. Economic conditions are also more varied, with barren upper surfaces contrasting with valleys and flats where oil palms are the principal cash crop.

The west facing scarp (A II a) is an area of marked fragmentation with wider valleys and swampy flats - the probable product of Tertiary submergence - separating isolated hill masses of granite which vary considerably in size. Although a distinctive feature throughout this zone, the scarp is more clearly defined in the area between the Sula Mountains and the southern extremity of the Kangari Hills.

The south facing escarpment (A II b) scarcely justifies the use of this term. Wide valleys of the Sewa and Moa drainage basins have been infilled by Tertiary gravels and later sedimentaries. These are separated by the south-west trending arcuate ridges or harder schistose rocks which form the Nimini, Kambui, and Gola Hills. It is therefore difficult to identify the southern limits of the area very effectively.

The Lowlands:

Within the limits of subdued relief, the term lowlands embraces an area of appreciable, if subtle, physical variety.

Generally the surface of the lowland plain lies between 100 and 750 feet, but isolated residuals of old erosion surfaces rise to over 1000 feet, and remnants of other erosion surfaces at 250, 400, 525 and 700 feet have been reported[5]. Moreover, the general geological uniformity of the plateaux is not matched in the lowlands. Here, other belts of pre-Cambrian rock series alternate with downwarped extensions of the plateau granites following north-west to south-east axial alignments. Further complexity is added by the metamorphic intrusions of gabbros and schist (the Freetown Peninsula and the Marampa Schists) and by fluctuating sea levels associated with these disturbances[6].

Changing sea levels are probably responsible for the quite considerable zones of sedimentation, of which the Bolilands[7], the Rokel River agglomerates, the Bullom sands, and the diamondiferous gravels of the Sewa and Moa basins are the most continuous areas.

Coastal features, too, are by no means uniform. Raised beaches, estuarine swamps, peninsulas, bays and headlands, offshore islands, sand dune and marsh complexes alternate along a coastline for which alignment to onshore winds, and the disposition of beach materials, change constantly along its length.

The dominant vegetation pattern throughout these fairly densely populated lowlands is 'farm bush'. Areas of fire and swamp vegetation are probably closely associated with some of the morphological and lithological features outlined above. Rainfall varies between north and south and between coast and interior[8] but, unlike most of the other features discussed here, would seem to have had no direct influence on rural settlement patterns.

There are two main cultural zones in the lowlands. These follow the distribution of the two main tribal groups, Mende to the south and Temne in the north. The Mende are probably the most homogeneous tribe in the country[9]. Although their two main areas of concentration coincide with the middle Sewa and upper Moa river basins, they also extend their influence over most of southern Sierra Leone.

This is the most economically advanced region of the country. The railway, together with a good network of roads and tracks[10], serves the main cash crop zones and also the diamond, chrome and bauxite mining areas.

The Temne concentrate in two areas north-east and north-west of the Rokel river. Here, present economic development is more limited than in Mendeland. The iron ore mine at Marampa and the swamp rice farming areas of both the Scarcies estuary and the Bolilands are of predominant importance to the cash economy of this tribe.

3. Patterns of Rural Settlement.

A I:

The pattern of settlement on the high plateau is generally more uniform, and densities are generally lower, than anywhere else in Sierra Leone. This is an area where there are mainly large villages, usually approaching the upper limits of a category, and dominating up to thirty or forty square miles. The major structural fault lines trend east-west and north-south, and these villages tend to be sited near the valleys, which follow the main structural features and provide both lines of communication and the more cultivable soils (Ps. 1,2,3.).

It is possible to distinguish differences in both density and nucleation between the Yalunka chiefdoms in the north (A I_1) and those of the Korankos further south (A I_2). If these are real rather than apparent differences, they may be partly due to the more broken relief and wider valleys of the Yalunka chiefdoms. These have probably allowed higher densities to develop than in the Koranko areas in the more highly accidented foreland of the Loma mountains[11]. It is more likely, however, that historical and economic factors have played a more important part than physical factors in shaping patterns and densities of settlement. Trotter[12] has suggested that the Koranko chiefdoms were severely raided by the Sofas in the last decades of the nineteenth century, and that areas occupied by this tribe once carried much higher densities. There is also a possibility that the diamond mining areas of Kono, immediately to the south of the region, have encouraged labour migration and the decimation of larger villages in these Koranko chiefdoms.

On the other hand, the Yalunka have been more amenable to immigrant Fula cattle herders than the Koranko, and it was not by chance that areas in the Yalunka chiefdoms of Koinadugu were chosen for a Fula re-settlement scheme[13]. The population of herdsmen, living in small and dispersed temporary settlements, would certainly seem to have influenced the pattern of settlement, both in this area and in the Limba chiefdoms of the western escarpment (P.5). The Yalunka area also has a slight economic advantage over its neighbours. This is because the valley of the Mongo River, in which most of the main Yalunka villages are situated, is also a main route for the illegal trade in cattle with the Guinean Fula across the border[14].

A IIa:

Patterns of settlement in the western escarpment are more complex. In the north, two branches of higher settlement density (A IIa_1) extend southwards to unite in a 'knot' around Makeni, which is the northern railhead town and the administrative centre for the northern province. The western branch coincides with another main ~~cattle and~~ Fula immigration route[15] which follows the flank of the escarpment through Kamakwi. This is also an area where there is considerable interpenetration of plateau outliers and <u>boliland</u> swamps, of small riverine flats and isolated hills. The recent introduction of swamp rice to these <u>bolis</u> may be responsible for the areas of higher settlement density within this zone (P 4.). It is also an important oil palm area, with strong Limba interests in palm wine tapping, a skill for which they have a national reputation.

The eastern branch of higher density follows the Mambole river valley. It, too, is an important Limba oil palm area, and another Fula migration route. This route follows the valley of the Little Scarcies, crosses the Mongo river through its upper basin, and then follows the Mambole valley to Makeni. Throughout this zone there is a distinctive linear pattern of small Fula villages and hamlets, which are clearly distinguishable from the Limba villages in the area (P 5).

Separating these two branches are the Lokko chiefdoms of Sano Lokko, Magbiama, Gowahun, and Libensaygahun. Here (A IIa_2), settlement densities are lower and villages tend to be smaller, partly due to the paucity of perennial streams and the poor quality of land (P 6). It is noticeable that where surface dissection is greater and water availability higher, settlement densities are also higher (P 7).

A more regular zone of higher density and higher nucleation (A IIa_3) occurs in an area of marked surface dissection south and east of Makeni (P 8). Higher rainfall and perennial streams (P 9) may contribute to the fact that this is an important zone of Temne concentration[16].

A IIb:

The south-facing escarpment zone is an area of barren outcrops on the higher watersheds and forest reserves on the lower ones. Settlement is limited to north-south trending valleys of the Teye,Sewa,Male and Moa rivers, where special economic or tribal factors may account for individual variations in settlement pattern. Particularly significant is the zone of high density and nucleation in the upper Sewa valley, where alluvial diamond mining may have caused special settlement associations (P 10). A more obvious association with diamond mining may be attributed to the linear arrangement of villages (A IIa_3) along the roads in the diamond areas of the upper Male catchment area, west and east of Sefadu (P 11).

Finally, there is the zone of Kissi settlement concentration (A $IIb_{3,5}$) in the upper Moa and Meli river valleys, east of Kailahun (P 12). The high concentration in this area is difficult to account for, although the soils seem to be of more than average quality. More important perhaps, are cultural factors[17]. It is probably not without significance that the people of this border tribe, with contacts in both Guinea and Liberia, are the only ones in Sierra Leone to have developed a form of local currency, the 'Kissi penny', which is a short curled iron rod. According to local opinion, a lucrative and clandestine trading system, with neighbouring Kissi across the borders, was already well developed before the appearance of diamonds. This trade could well have been increased by the smuggling of gemstones. Theories of this sort are obviously difficult to corroborate without lengthy (and possibly dangerous) investigation in the field.

B I a:

A clearly defined zone of low settlement densities accords with a belt of pre-Cambrian unfossiliferous sands and clayey sedimentaries known as the Rokel River Series. Most authorities have viewed the soils which develop on these conglomerates as among the worst in the country[18].

There are two distinct types of landscape in this area: undulating surfaces of considerable dissection marked by lateritic hard pans; and lower swampy flats or *bolis*, of varying size, which are covered by 'flood' grasses. These *bolis* are thought to be the product of deltaic formations in what are now the middle courses of the Rokel, Mambole and Pampana rivers, at some period when sea levels were higher[19]. It is possible that the upper surfaces of this part of the lowlands were once more densely settled than they are today. There is evidence of a good deal of over-burning, with extensive tracts of fire climax vegetation, especially *Lophira elata*. Settlement is now restricted to the lower interfluves, or to lines of communication, and agriculture is similarly confined to the valleys and flats.

The area represented by P 13 (B Ia_1) is a typical one from the 'degraded upper surfaces', with villages little more than hamlets, limited cultivation in the valleys and fire-climax vegetation a predominant feature of the landscape. Similar zones of *Lophira elata* and short grass dominance may be found elsewhere throughout the region.

Until very recently, the bolilands would seem to have been avoided. Government encouragement, and the developing interest in swamp rice cultivation on these potentially fertile juvenile soils, may be responsible for the growing diversity of settlement in these areas. Four types of pattern may be distinguished.

Firstly, there is what seems to be an older type of settlement pattern, with small villages on low interfluves above flood levels eking out a marginal existence on traditional lines (P 14). Secondly, there are ribbons of settlement picking out the old trading routes which linked the coast with the interior (B Ia_6 is the best example), two of which are now followed by the main motor roads to Makeni and Kamakwi (P 15). Thirdly, there are the new ricelands with their own distinctive settlement associations. On the one hand, there are those settlements using rice in a traditional system of cultivation, with a scatter of small rice fields extending on each side of a village along a narrow flood plain (p 16). On the other hand, there is the development of a larger scale mechanical rice cultivation, with larger, evenly spaced villages and fewer hamlets (P 17). Fourthly, there are zones of inter-penetration on the edge of the bolilands, where bolis are no more than river flats but are still important enough to cause irregularities in the settlement pattern (Ps. 18, 19).

The importance of minor variations of relief and drainage, in terms of the settlement pattern in the bolis, will be clearly illustrated by these photographs, and has been described by the writer elsewhere[20]. In view of its probable importance in the future development of Sierra Leone, this area deserves much closer study.

B Ib:

The sandy gravels and alluviums of the Sewa and Moa basins, which are both occupied by the Mende tribe, are the second zone of sedimentation with a distinctive settlement association. In this area of heavier rainfall and denser tree cover, upland rice and cassava are the food staples. These are supplemented by oil palms, coffee and cocoa as principal cash crops. Alluvial diamond mining is of more localised, but very considerable, importance. These activities combine to make this area the richest in the country, well served by both road and rail. The core areas of Mendeland are in two 'lobes', in the upper Moa and middle Sewa respectively. These are separated by the forest reserve (A $IIb_{6, 7, 8}$) of the Kambui Hills.

The assart settlements in the Gola forest (B Ib_6), already described above (Chapter 5.3), represent conditions as they were at an early stage of settlement (P 20). This is one of the few remaining areas in this part of West Africa where bush-fallow reponses are probably uninhibited and 'in balance'. Patterns representing progressive stages in the settlement process are shown in the photographs P 21 and P 22. These, together with P 20, illustrate the Mende 'war-town' in much the same form as the Victorian explorers described it (Chapter 11.2).

The pattern of large, evenly spaced, villages is characteristic of the whole region (P 22). The highest densities are found between Kenema and Pendembu. (B Ib_3), one of the country's main cash crop zones[20] and one of the areas best served by motor roads and tracks (P 23).

The patterns of the Sewa Basin (B I b_2) are very similar to those already described (P 24). Slightly more important concentrations of density, at the heads of navigation of the estuarine port of Bonthe, coincide with an important oil palm and coffee zone[21]. Higher densities are also associated with areas of alluvial diamond mining further north (P 25). Large, regularly spaced villages once more predominate.

B I c:

The Bullom sands separate the coastal heterogeneities of settlement pattern from the higher, and more even, densities associated with the Birrimian granite belt (B II). Lines of communication and the swamps of the lower courses of main rivers make for local discontinuities of settlement pattern, but generally the poorer, heavily leached soils of this area would seem to support lower densities of settlement, and villages are usually small. Degradation of the upper surfaces would seem to have caused a shift to valley cultivation (P. 26 and 27).

Throughout this region, and possibly into Kasilas, a transition zone between the coast and the middle belt granites (B II), there is sparser settlement which may be attributed either to especially weak soils, or to a long period of over-cultivation, or to both. Considerable tracts of fire climax vegetation species, particularly *Lophira elata*, are established on large lateritic hard pans.

Photographs have been chosen to illustrate settlement patterns associated with what seem to be stages in a degradation process (Ps. 27, 28, 29). In P. 27, there appears to have been a marked decline in agricultural activity on the interfluves, where the lateritic accretions develop, and an increasing concentration in the valleys. Villages seem to be sited along watercourses. The area represented by P. 28 shows a more advanced stage in the degradation process, with considerable tracts of Lophira on the upper surfaces and few settlements, and P 29 shows complete abandonment of the upper surfaces which now carry only poor tuft grasses. It is interesting to point out, however, that the structure of settlement (a:b:c) remains constant for all these three examples (0:5:21 ; 0:3:29 ; 0:3:21). It might be argued, therefore, that as far as settlement is concerned, the critical stage in degradation occurs quite early.

More normal patterns of settlement occur in association with the residual hills (Occra, Moyamba, Mokanji, Imperri and Gbonge) where soils are probably slightly more stable (P. 30). They may also be found where settlement has moved onto the fertile soils of the valleys (P 31) following the adoption of swamp rice cultivation.

B II:

This is a region where there are generally higher densities of settlement than in the parallel regions to the east and west of it (B I a and c). These higher densities would seem to be associated with a belt of Birrimian granites, and the soils which have developed on this formation.

The predominant characteristic of settlement throughout this region is the proliferation of quite small villages, generally much smaller and closer together than in the main Mende areas (B I b). As with other settlement regions of the northern lowlands, there are a considerable number of zones of sub-differentiation, with special patterns seemingly associated with both old and new trade routes to the coast[21] and with other physical and cultural variations.

In the northern part of the region (B $II_{1,2,3}$), for example, two physical features would seem to be responsible for settlement discontinuities. A tongue of Rokel River Series conglomerates, separated from the main body further east, cuts across the Birrimian granites. As in the whole of Region B I a, where this rock series predominates, there tends to be lower settlement densities. In the same area, a belt of flood plain savanna marks the middle course of the Kaba River, and this too has been a negative area for settlement (B II $_{3}$). These two negative areas are separated by a 'horseshoe' of higher densities on the granite soils (B II $_{1}$). The western part of this 'horseshoe' coincides with the main route to Guinea which passes through Kambia (P 32). The eastern area is one in which oil palm kernels are produced in more than average quantity.

South of this complex area is the main Temne tribal concentration (P 33), broken into a series of east-west belts of larger villages (B II $_{5,7,9,10}$) which appear to pick out the major routeways. Towards the south of the region, a zone of lower density probably marks the Temne/Mende tribal divide (B II 13), further south of which is a zone of uniquely high density and marked fragmentation (B II 14), co-inciding with piassava and swamp rice production in the swampy valleys and oil palm on the interfluves. This area has a well established and long standing trading link with the port of Bonthe. Cash farming has developed and produced an unusual expression of individual enterprise in the form of permanent hamlets, as well as the more typical large Mende villages (P 34). Similar 'head of navigation' anomalies in pattern may possibly be seen in areas B I c_{10} and B III c_9.

B III:

The settlement patterns of the coast are amongst the most clearly identifiable in the country, with a number of fairly obvious responses to variation in coastal physique. Three types of coast line have been identified: sand bar and dune complexes (B III a); cliffed coasts and raised beaches (B III b); and estuarine swamps (B III c).

B III a:

It is difficult to launch canoes from the heavy surf beaches which are the main feature of these areas of the coast. This may be the reason why sea fishing plays only a small part in the lives of the indigenous Bulloms[22]. Even the immigrant Fanti avoid the worst stretches and concentrate in areas where offshore bars and islands afford some protection from the Atlantic surf.

Soils which develop on the sand ridges are weak and heavily leached and settlement is fairly sparse in all these areas. The restriction of sites to sand bars aligned parallel to the coast gives a linear pattern of small villages and hamlets (P 35, 36), especially noticeable on Sherbro Island (B III a_2).

B III b:

On the Lungi Peninsula (B III b_1), use has been made of the relatively rich soils of the 50 foot raised beach to grow fruit and vegetables for the Freetown market. This may well account for the high density of large villages in the area. Moreover, the presence of an offshore bar permits the launching of small craft, and fishing plays an important subsidiary economic role.

On the Freetown Peninsula (B III b_2), embayment of the gneiss and duricrust coastline has encouraged the development of Fanti and Temne fishing communities. These people seem to be taking over the declining Creole settlements

(PE 5) as well as establishing new ones of their own. Groups of larger villages are separated by stretches of lower density in the larger bays where surf beaches have developed.

B III c:

Until fairly recently, all the estuarine swamps were avoided completely. Some of them still remain in this state (P 37; B III c_6). The realization that swamp rice could be grown on de-salinised bunds on these swamps, and the willingness of Temne swamp rice farmers to move into these areas[23], has led to the growth of many large villages. These straggle along almost every available interfluve in the Scarcies estuary, the main rice growing area in the country (B III c_1; P 38), and are also found, in fewer numbers, in the Bullom chiefdoms of the Lower Jong and Yawri Bay (B III c_4; P 39).

Finally, a special high density zone in the region of the Sierra Leone estuary (B III c_3), where many tribal groups are represented (P 40), would seem to be largely the result of history rather than economics. It may be tempting to think that this concentration was a manifestation of the urban attraction of the capital twenty miles away to the west. It is more likely, however, that this relatively fertile area was originally an overspill from the Colony to which it was added in 1862[24], and it may subsequently have become a refuge for tribal peoples seeking colonial protection in the forty years of anarchy before pax Brittanica.

4. Conclusion.

It has been the aim of this chapter to describe some of the micro variations in settlement pattern which seem to disturb the broad homogeneity of settlement responses.

Several factors seem to have been important in producing these micro variations; minor differences of soil and relief on the one hand, and minor differences of tribal economy and trading opportunities on the other. In general there would seem to be a move away from upper surfaces and a development of new and more varied patterns in the flats and valleys. Large areas on the interfluves, especially in the north, are now so degraded that they are practically useless for further agriculture under present systems, and other areas still being farmed would appear to be deteriorating rapidly.

New patterns will obviously continue to emerge and structures may well become much more irregular. Subsistence uniformity will probably be replaced more rapidly than in the past by the wider range of opportunities and choices of social and economic development. The earliest manifestation of these changes may be seen in the areas around heads of navigation and along major trade routes. Newer patterns would seem to be emerging in association with other areas of more recent economic development; e.g. along cattle routes, in the diamond fields, along major motor roads, and in the swamp ricelands.

There has been no attempt to make a detailed and precise assessment of all the microvariations in settlement pattern (distinguished by the arabic numerals on the regional map). It would have been misleading to imply the thorough knowledge of the country that a treatment of this sort would have entailed. The uneven quality of assessment is therefore inevitable, and it must be left to later research workers to check the accuracy of a good many of the hypothetical associations discerned here. Later chapters in this study, will, however, take several of these tenuous findings a stage or more further, using both empirical and deductive methods.

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CHAPTER 10.

RANDOM SAMPLES AND THE 'CELL MODEL' THEORY : SOME HYPOTHESES OF STRUCTURE AND STRUCTURAL CHANGE.

1. Introduction.

The regional analysis of settlement patterns presented in the last chapter was based, to a large measure, on the base map of settlement distribution. The construction of this map, in its turn, depended on the random sample survey. This survey had three main features: an accurate record of the number of buildings in each settlement; a classification into three settlement size categories; and an areal sampling frame (Fig.M.2c; Appendix 3). The count of buildings was sufficiently accurate and the sample was large enough to make generalisations concerning the structure of settlement in the whole country. The threefold categorisation (a, b, c) made mapping a feasible proposition and allowed the construction of density and nucleation indices. The sampling frame (standard cell) was designed both to test the cell model hypothesis (Chapters 5 and 6) and to provide a base for indices. Having completed the survey, it was also possible to compare the findings with those for an identical sample of conditions in 1927, and to a lesser extent with a slightly different sample of settlement relationships in 1908.

2. Sampling Errors for the 1964 Sample.

Before any inferences could be made from these statistics, it was necessary to calculate the margins of error of the sample, even though the sampling fraction which covered 5 per cent of the settlements in the country was large enough to guard against large discrepancies.

Sampling errors were calculated for the 1964 sample only, on the grounds that proportions were the same for 1927, and the one set of results would therefore indicate conditions for both samples.

Berry[1] has shown that the sampling error in a random sample is proportional to the square root of the number of observations. Out of a total of 1069 settlements counted in the sample, 57 were of a, 270 of b and 742 of c category (Table 7). Expressed as proportions (P) of the total number in the sample, $P_a = 0.05$, $P_b = 0.25$ and $P_c = 0.70$. For a sample of this size, the limits within which these values represent the true proportions in the settlement population, with a 95 per cent confidence limit, are as follows: $P_a = {}^{+}/- 0.01$, $P_b = {}^{+}/- 0.02$, $P_c = {}^{+}/- 0.03$. This means that there is a 95 per cent probability that between 4 and 6 per cent of the rural settlements in Sierra Leone are of a category (36 - 200 buildings), between 23 and 27 per cent are of b category (13 - 35 buildings),

Settlement Category	No. of Settlements in Sample		Mean size (in buildings)		Mean number of settlements per sample 'cell'	
	1927	1964	1927	1964	1927	1964
a	77	57	71.2	89.7	1.5	1.2
b	190	270	21.0	20.5	3.8	5.5
c	467	742	6.0	4.0	9.5	14.9

Table 7.

Random Sample Totals and Averages.

and between 67 and 73 per cent are of c category (1 - 12 buildings).

Slightly different procedures were used to calculate the limits within which mean values of buildings per settlement in each category, and the mean numbers of settlements in each category per standard cell, reflected conditions for the whole country.

Standard statistical procedures were used to determine first the standard deviations (s) from the sample means ($\bar{x}$) in order to make a best estimate of the standard deviations of the whole population (σ) using Bessel's Correction[1]:

$$s \sqrt{\frac{n}{n-1}}$$

where n is the number of standard cells in the sample.

Standard errors (SE) of the sample means were then calculated using the usual formula:

$$SE\ \bar{x} = \sqrt{\frac{\hat{\sigma}}{n}(1 - f)}$$

where n = number in sample

f = sampling fraction.

Settlement Category	Buildings per settlement					Settlements per Standard cell				
	$\bar{x}$	s	σ	SE	$\bar{x}$	$\bar{x}$	s	σ	SE	$\bar{x}$
a	89.7	38,6	40.0	+/-	4.64	1.2	1.6	1.7	+/-	0.67
b	20.5	6.0	6.1	+/-	0.35	5.5	4.3	4.4	+/-	0.34
c	4.0	3.4	3.4	+/-	0.14	14.9	8.1	8.2	+/-	0.29

$\bar{x}$ = mean number or mean size.
σ = best estimate of standard deviation.
s = sample standard deviation.

SE = Standard error.

Table 8.

1964 Sample Means and Sample Errors.

The results of these calculations are presented in Table 8.

Within the limits of accuracy defined above (95 per cent), and to the nearest building and the nearest settlement, the mean standard cell will contain 1 large village with 90 buildings, 6 smaller 'satellites' with 20 buildings, and 15 farms and hamlets with 4 buildings. These statistics may now be compared with the hypothetical structures envisaged under cell model conditions.

3. The Sample and the Model.

It was argued earlier (Chapter 6) that under the idealised circumstances of a uniform undifferentiated landscape occupied by bush fallow agriculturalists, using the same range of crops and the same systems of land tenure, a structure of settlement would emerge which closely matched the $k = 7$ hierarchy postulated by Christaller (Fig. 9). It seemed that in the apparently homogeneous conditions of rural economy and physique in Sierra Leone there was an ideal test-bed for the premises upon which the whole superstructure of central place theory has been built. The comparison between mean standard cell figures and those of the model suggests a quite exciting vindication of this hypothesis (Table 9).

Settlement Category	Buildings per Settlement			Settlement per Cell		
	Standard Cell		Model	Standard Cell		Model
	1927	1964		1927	1964	
a	71.2	89.7	60	1.5	1.2	1
b	21.0	20.5	30	3.8	5.5	6
c	6.0	4.0	?	9.3	14.9	42

Table 9.

Comparison of Mean and Model Conditions.

NB. Averages of buildings per settlement from the 1908 Army Book counts, ~~(Appendix)~~, although not strictly comparable with these figures, were as follows: a = 71.8, b = 21.2, c = 10.9

In a <u>k</u> = 7 hierarchy, one central place will serve 6 other smaller centres and 42 minor places. For the subsistence bush-fallow system of the <u>cell model</u>, the equivalent terminology is 1 dominant founder, 6 satellite villages and 42 farm hamlets, or in terms of the <u>standard</u> cell, 1a : 6b : 42c. The parallel is in fact strikingly close (Table 9) for the mean <u>standard cell</u> contains 1.2 larger villages of <u>a</u> category, 5.5 smaller villages and 14.9 farm hamlets. The only major discrepancy, in farm hamlets, is in the most fluid and unpredictable lower stratum of the hierarchy.

It could be argued, of course, that this relationship was quite coincidental. The model was conceived from ill defined terms of reference, and its limits were quite wide. Similarly, the category ranges of settlement size for the random sample only agreed with the model ranges in the most general way, and the area of the <u>standard cell</u> unit merely came close to the mean of three possible sizes for the <u>cell model</u>.

The only valid approach to subsequent analysis, however, seemed to be to develop ideas as if the relationship were valid; to allow it to 'grow' as a theory, and to see how far settlement forms and patterns made sense in the light of this system of thought.

Working from this premise, it was possible to use the whole body of sample and model statistics to build a superstructure of speculative hypotheses which could be re-examined and tested at various stages in the development of the argument. The first of these hypotheses came from one further attempt to test the validity of the relationship between the model and the sample means using purely empirical evidence.

4. The Sample, the Model and Some Population Estimates.

Under the cell model theory, the whole country would be evenly populated by land units of about 29.5 square miles, each containing a population of about 2000 persons (Chapter 6). In this stylised situation, the population of Sierra Leone, which has an area of approximately 28,000 square miles, would be in the order of 2,000,000. If the nearest approach to the cell model is to be found in the mean number per category ratios of the standard cell, then the calculation would be slightly different. The standard cell covers an area of 33 square miles and has a population of 1,880 (using the same mean of 9 persons per building as used in the model calculation). There are about 850 standard cells in the country, and if each one were like the mean cell, the total population of Sierra Leone would be 1,600,000. The actual rural population of the country in 1963 was about 1,800,000 and the total population, including those living in towns with over 1000 inhabitants, was approximately 2,160,000.

The parity between these calculations may once more be viewed as a vindication of the theories of the cell model. In this case it is possible to make a further inference. With at least a quarter of the country occupied by swamps, forest reserves and barren upper surfaces, one must regard the rural population totals as being well beyond the limits of the carrying capacity of the soil under traditional agricultural methods. Such a view would add point to the arguments concerning the apparent trend to valley and swamp cultivation which may now be influencing the patterns of rural settlement (Chapter 9.2, 9.3). It also leads, indirectly, to the next hypothesis.

5. The Inflated Size of Large Villages and Hypotheses of Structural Change.

In the cell model, the maximum size that an a category village might achieve before sending out a satellite was deduced to be about 60 buildings. The random sample revealed that half the villages in the a category had more than 60 buildings without losing any of their purely rural character. In fact the average size of a village in this category was almost 90 buildings (Tables 7, 8, 9, & 10). At the same time, the average size of satellite villages was a third smaller than that envisaged for the model, with 20 rather than 30 as the mean number of buildings.

Comparison with conditions in 1927 (Fig. 12) revealed that whereas the mean size of b villages was the same as in 1964, there were 26 per cent more a category settlements at the earlier date. Although they were, on average, smaller than in 1964, they were still larger than the model would allow (Tables 9 and 10). It will also be noted that compared with the 1:6 Christaller structure of the 1964 survey, the 1927 sample revealed a 1:4 relationship for the mean standard cell. At the same time, the number of c category settlements was less in 1927, though their average size was greater (Table 10).

Visualised in terms of the cell model, the 1927 sample

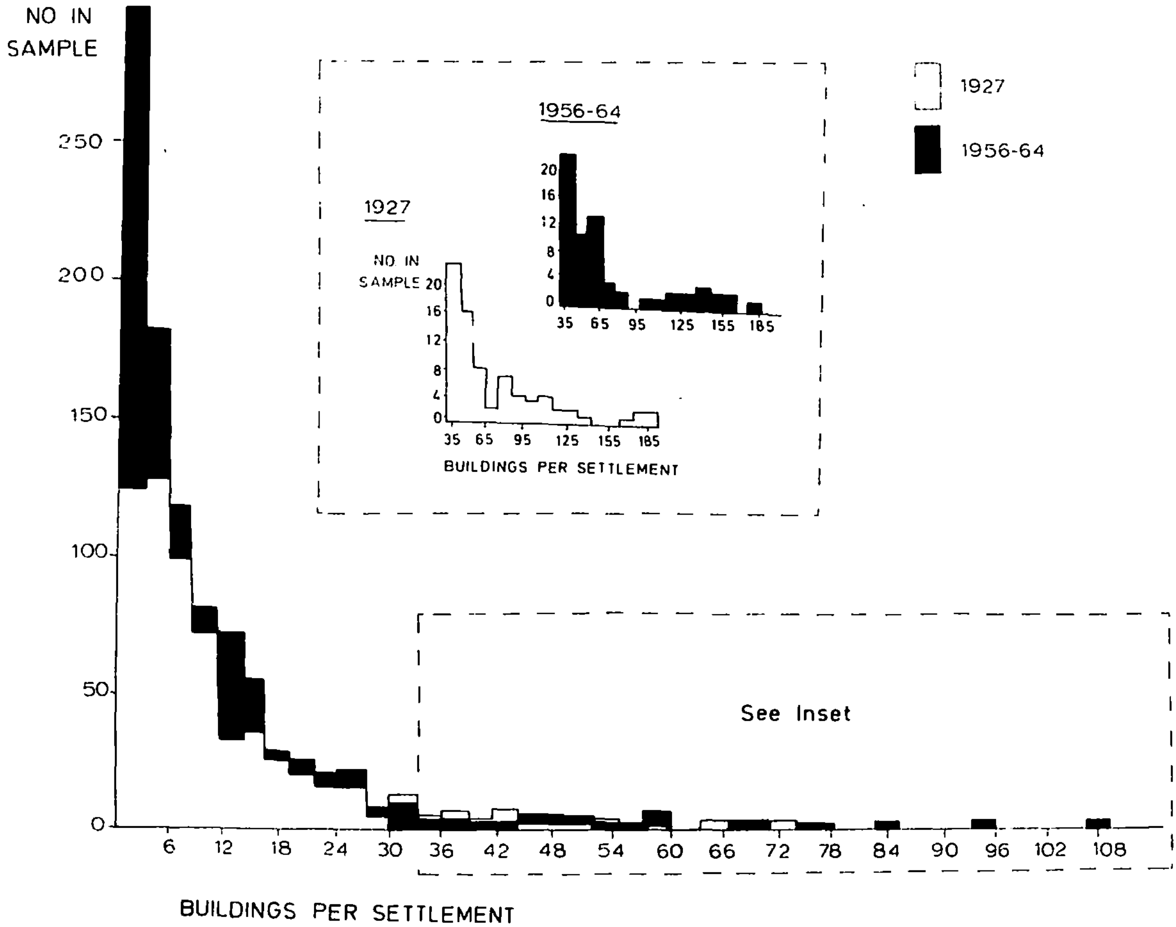
NO IN SAMPLE
250
200
150
100
50
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
96
102
108
BUILDINGS PER SETTLEMENT
See Inset
1927
1956-64
1927
NO IN SAMPLE
20
16
12
8
4
0
35
65
95
125
155
185
BUILDINGS PER SETTLEMENT
1956-64
20
16
12
8
4
0
35
65
95
125
155
185

Fig. 12

Topographical Survey	1925-30	1956-64
Total rural settlement in 5 per cent sample	77a 190b 467c	57a 270b 742c
Total rural settlement population 20(a + b + c)	14,680	21,380
Mean ratios a : b : c (no. in each category per standard cell)	1 : 4 : 6	1 : 6 : 15
Mean No. of buildings per settlement a/b/c	71/21/6	89/20/4

a = 200-36 buildings in settlement
b = 35-13 " " "
c = 12-1 " " "

NB. The proportions of a:b:c in 1908 were 1 : 1.6 : 1.6

Table 10.

Generalised results from Random Sample Surveys.

results would seem to indicate that there has been a restriction in the normal processes of structural growth within the cell, with a concentration of the cell population in the dominant village or central place. This 'diseased' condition would seem to have been a temporary state, for the 1964 structure indicates the re-establishment of something approaching a normal (1:6) structure.

What factors would be most likely to cause such an inhibition in normal growth features, so that dominant villages became irrationally large and did not spawn smaller satellites? In view of the assessments of population size presented earlier in this chapter, it seemed that the most likely answer to this question was land hunger. With settlements competing for satellite space in the conditions of anarchy which preceded the colonial era, there would inevitably be friction. It would not only become more difficult to find space to establish hive-off villages, it would become increasingly dangerous to do so. Moreover, the development of this situation, even in quite limited areas of the country, might well have set off a chain reaction in which people were forced to gather together in larger and larger groups to protect themselves from marauders from other areas who had in their turn been forced to live in too large a group simply because there was no room to expand by normal processes. This meant that demands on the land increased, fallow lengths diminshed, soil was weakened, subsequent crops failed and people became desperate with hunger.

If this explanation is correct, then the coming of *pax Brittanica* may have allowed a gradual resumption of more normal structures, with the numbers of very large villages being reduced and with a proliferation of small villages and hamlets (Fig.12). The increased average size of the smaller total number of *a* category villages (Fig.12) might then be explained in terms of economic progress, with some of these large villages taking on new functions, or having cash injections from labourers absent in the towns and mines (Chapter 12.3). The next two chapters summarise the empirical arguments which ~~would~~ support this hypothesis of structural change.

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C H A P T E R 11.

'WAR-TOWNS' AND THE CELL MODEL THEORY.

1. Introduction.

Examination of the records of early travellers confirmed the impression, outlined at the end of the previous chapter, that many of the larger a category villages once had definite military functions. Further study showed that a network of 'war-towns', as they were generally called, was probably the dominant feature of the human landscape in the period before colonial rule[1]. In the absence of large centres, which are all of recent development, these overgrown villages also provided the framework for such political organisation that existed. The implications of these findings, in terms of cell model theory and the decay of agricultural land in Sierra Leone, are possibly far-reaching, and it seemed important to examine the historical evidence carefully.

2. The 'War-Town' in the Nineteenth Century.

The beginning of European penetration into the hinterland of Sierra Leone, following the establishment of the Colony in 1807, heralded a rapid increase in documentary evidence. There is no shortage of material upon which to draw when reconstructing the character of rural settlement in the nineteenth century. Explorers often gave good descriptions of the villages or 'war-towns' through which they passed, and it is possible to build up a good picture of settlement forms during this period. There can be little doubt that defence was the main factor responsible for the development of an exaggerated nucleation of settlement.

It would seem that the character of the 'war-town' varied slightly between the forested lowlands and the more open and broken landscape of the plateaux (Fig.13 & PEs 1-3, 20-23).

In the lowlands, every village was a small fortress, maintaining several lines of defence. Surrounding each village was a "ruff" of high forest between a quarter and half a mile wide. Its purpose was made clear enough in many of the early descriptions. Alldridge defined a settlement as "a clearing amongst the big vegetation which forms its natural walls"[2] and Winterbottom more graphically described villages "buried deep in the heart of impenetrable forest"[3]. Settlements could only be reached "by a labyrinth of burrows"[4] through the foliage and were defended "by the intricacy of paths leading to them"[5], and the villages were "completely hidden at a few yards"[6].

Within this outer camouflage were the stockades.

The best description of these defence works is given by Davis:

> "This town (Tallias, Bum Kittam District) may be taken as a type of the stockaded towns which the natives erect .... these are surrounded by war fences, usually three in number, the inner being made of a double row of logs 14 to 15 feet high, as thick as a man's thigh and planted some 4 feet deep in .... clayey earth. It is palisaded with logs 6 feet high but split so as to fit together and present a tolerably even surface and pierced by a double tier of loop holes for musketry .... the middle fence is exactly similar except for the addition of chevreux de frise ... bent downwards and unable to support a man's weight. The outer fence is built of a treble row of logs and is very strong. No one who has not seen these fences can realise the immense strength of them. Most of the logs had taken root and were throwing out leaves."[7] (Figs. 13 and 14).

Other writers record that some Mende villages were surrounded by as many as nine such fences (goleisia), interspersed by stake-filled ditches[8], and sometimes enclosing three of four separate villages within one site[9]. ~~(Fig.).~~

The Temne and other lowland tribes were less inventive, sometimes relying exclusively on high bush camouflage[10], sometimes replacing stockades with mud walls[11] in areas where mud was easier to obtain than suitable wood.

Fig. 13

Fig. 14

A final line of defence, particularly in Mende areas, but quite common elsewhere, was provided by a further camouflage device. The houses were clustered together so closely "that they formed a natural maze, not to be penetrated by a stranger without a guide, with the eaves of one hut overlapping the other"[12] and "with narrow, irregular passages between them,which are inexpressibly foul and evil smelling"[13]. If the forest shield were penetrated, and the stockades breached, the inhabitants could still escape through these passages and by secret escape routes into the surrounding forest[14].

Where an attempt was made to count the buildings in these lowland 'war-towns', there are records of settlements with more than 1000 inhabitants. Laing records a population of 2,500 for the Temne war town of Mabang[15] and Koinadugu "a slave town belonging to Falaba" had more than 3,000[16], whilst Falaba itself had 6-10,000. Alldridge distinguishes many 'large towns' amongst the Mende but gives no exact indication of size, except that they were surrounded by many war-fences.[17] Garrett describes Bumpe as "eight towns", and Tikonko as "four towns, the largest having 800 houses"[18]. Although such large villages must have been exceptional, most of the 'war-towns' in the lowlands clearly exceeded 60 buildings, and even an upper limit of 130 buildings, allowed for by the cell model, was frequently surpassed[19].

In the more open country of the plateaux, villages were sited on hill tops which were defended chiefly by the steep slopes leading up to them[20]. They also tended to be large, though with buildings less clustered together than in the lowlands. With a shortage of wood, mud block walls may have been common and the plateau Limba may even have used stone in construction of houses and defence works[21].

Laing provides an interesting account of the Yalunka 'war-towns' in north-east Sierra Leone. The Yalunka settled in the north-east corner of the country in the eighteenth century, following a revolt and flight from the overlordship of the Fulas of Central Guinea[22]. Pressed by large Fula armies, they constructed a series of evenly spaced 'war-towns' (Musaia, Manankon, Sinkunia, Falaba, G'beria and Betaya), each with well over 1000[23] inhabitants and capable of withstanding well organised military pressure. Laing was the first European to reach their main village, Falaba, in 1822, and he provides a clear account of its character.

The town was situated close to the river Mongo "on a low eminence overlooking a wide plain, occupying a square mile of ground"[24]. He estimated the population of the village to be between 6,000 and 10,000, living in closely gathered concentric compounds of circular huts[25]. The whole 'town', dominated in the centre by a large tree, was surrounded "by a strong wall, perforated for musketry",[26] by a thick stockade of hardwood broken by seven gates, and by a ditch 20 feet deep and 20 feet broad[27]. He reports that the stockade had taken root in several places and grown up into large trees "amongst the branches of which the Soolimas (Yalunkas) station themselves"[28] in time of attack. Blyden, visiting the settlement fifty years later, noted that "at that time there were 500 trees, 190 of which were very old"[29]. (~~See~~ Fig.18 and PEs 20 - 23).

Falaba was besieged many times, and on at least one occasion by an army as large as 10,000[30]. It was finally gutted by the Sofas in 1884[31]. Other Yalunka villages were almost equally impressive and there is evidence that the

Koranko also maintained hill top settlements which were nearly as large[32].

3. The Growth of the 'War-Town' Structure.

It will be suggested that the development of the 'war-town' structure, which was so firmly established in the nineteenth century, was the end product of a long chain of historical circumstances which must be traced back to the initial peopling of the country.

Much of the evidence presented here, however, is at best circumstantial. With few written records (except those of Arab and Portugese travellers who wrote largely from hearsay), and little archaeological information, scholars attempting to piece together the early history of Sierra Leone have been forced to lean heavily on the oral and cultural traditions of the tribes. The aim here is merely to suggest what seems to be the most likely chain of events, accepting the limitations of a rudimentary framework of substantiating references. Piecing together the fragments of information available, it would seem that the widespread occurrence of these 'war-towns' was a direct response to fairly dramatic changes in social and economic conditions during the peopling of the country in the four centuries before European rule.

The oral traditions of most of the fourteen tribes who now inhabit Sierra Leone suggest a fairly recent immigration into the forested coastal areas west and south west of the Guinea plateau. Only the Limba and Sherbro seem to have been established in this country before 1400, and most of the others came in a series of immigration waves between the mid-sixteenth and the end of the eighteenth centuries[33]. As Kup implies[34], they were probably pressed into these largely uninhabited areas as refugees from the political upheavals which periodically shook the grassland empires of the western Sudan[35].

It seems that the first immigrants to the area came as hunters and collectors rather than agriculturalists, though they may have practised some sort of incidental shifting cultivation when circumstances allowed. Such an economy would not only be well suited to people in process of migration, it would also be the natural response to a forest environment still largely uninhabited and abounding in game. Tribal traditions support this view. Saint Père describes the immigration of Susu into the northern borderlands of

Sierra Leone in the fifteen century as that of nomads and hunters, staying any time up to a year or two at one site and then setting out again; "building temporary shelters in the forest near running water, and hunting until there was no more game"[36]. Little[37] uses both place name evidence and oral tradition to infer a similar process of immigration for the early Mende groups from the south east and McCulloch[38] describes the entry of the Kono from the east in much the same way.

This idyllic period must have been fairly short lived. Free range hunting and collecting is clearly only possible in areas with very low population densities. This way of life must have become gradually more difficult as more and more immigrant groups arrived, and at some stage a transition was made to the fixed location bush-fallow agriculture which is characteristic of the whole country today. In the disturbed social conditions of the period, such a transition could scarcely have been untroubled.

Although the first immigrant groups may have been peaceful, there are traditions amongst both the major tribes which imply that later arrivals had already acquired more warlike characteristics before they entered the area. In fact each new wave of immigrants - of which the Temne in the fifteenth century, the (now absorbed) Manis in the late sixteenth, and the Mende of the eighteenth century, were the most important groups - caused small scale wars and frequent alignment and re-alignment of tribal areas[39]. For the Temne and allied tribes, it was the Manis who brought war. Both Kup[40] and Rodney[41] quote the Portugese navigator, d'Almada, as their authority to suggest that it was they who taught weak tribes to enclose villages with "three or four fences of stout palisades" (atabanka)[42], and it could be argued that it was this practice which was most responsible for fixing settlements at one site for long periods. For the Mende, it was warriors from the north, taller and fairer than the earlier groups, who taught them the arts of warfare and became their overlords[43].

If these conditions were, in fact, responsible for the beginnings of the 'war-town' structure, it will be argued that the fairly radical changes in the rural economy, produced purely by immigration and population pressure, ensured that the system, once established, was self perpetuating.

Using the arguments of cell model theory outline above

(Chapters 5 and 6) and several items of information which can be culled from the records, it is possible to reconstruct at least a very plausible chain of circumstances which would offer an explanation for the development, not only of individual 'war-towns', but also of a whole system of defensive villages which extended throughout the country.

If one postulates a settlement established in the idealised circumstances of the model - that is in an undifferentiated and unpopulated landscape of equal potential - it is possible to imagine the most likely effects on such a community of increasing pressure of population. In ideal circumstances, it was argued earlier (Chapter 6) that the normal processes of slow population growth would produce 'hiving-off' of satellite communities, with a concommitant, gradual and well controlled extension of area under cultivation. The presence of other 'founder' settlements in the immediate area of expansion, however, would soon cause rivalry for satellite lands. In circumstances of increasing settlement competition, the hypothetical original settlement would have two alternatives: either to abandon normal processes of growth by 'hiving-off' and develop a larger than normal settlement; or to take land by force from their un-welcome neighbours and so gain satellites by conquest. Enlargement beyond the rational maximum under the <u>cell model</u> theory would cause land shortage, shortening fallows, land deterioration and eventually food shortages.

In either case, therefore, the results would be the same with inter-village warfare and raiding for supplies. Conquered village communities, depleted by warfare, could then be enslaved and used to garrison the newly acquired satellites against further attack, and to work the captured lands on behalf of the victors. In these circumstances, it would not be surprising to find many settlements enlarged even further beyond the rational limits by the needs of defence and the increase in numbers produced by the slave community. It is likely that in these conditions of insecurity, the satellites would also be larger and fewer than norm's suggested by the model.

There is at least some tangible evidence to support this theory of modified settlement development. Until recently, food shortages were sufficiently common amongst tribes to be worth a special seasonal name. The period between harvest and planting (June-July), in which food was carefully conserved, is still known as woofe in Temne (meaning "heap up") and as nanoi amongst the Mende. Similarly, large tracts of heavily lateritised and over-farmed land on the upper surfaces of both the plateaux and lowlands (Chapter 9) bear witness to probable food shortages. There can be little doubt that these are areas of long standing degradation and are not the result of recent increases in population. In the 1920s and 1930s, Doyne[44], Martin[45] and Dixey[46] described "distinct signs of soil exhaustion", "large areas of orchard bush", and "widespread lateritisation". Migeod[47] wrote of 3 and 4 year fallows in Kissi in 1926, and even in the late nineteenth century, Garrett[48] noted the lack of trees in the north with extensive tracts of *Lophira elata*. Earlier, Blyden[49] described extensive "prairies" in the same region.

If one has faith in the inherent good sense of subsistence cultivators[50] (given reasonable population density), this situation could only have arisen not because of annual mis-management over a long period, as is often implied by agricultural officers, but through genuine pressure on resources; a pressure on resources which may well be reflected in the calculations in Chapter 10.4 .

There is ample documentary evidence, too, of the strong hold which domestic slavery had in this area, for all tribes undoubtedly used slaves as a labour force before colonial authority forbade it[51]. Indeed, in the circumstances outlined above, it is not surprising that slavery and warfare became part of the cultural pattern, developing functions beyond the short term satisfaction of immediate needs. Slaves were increasingly used as a means of barter, to be exchanged for salt and metalware[52], a function which was further encouraged by European slave traders, and they became one of the few 'currencies' of real value. Warfare gained in sophistication[53] with the introduction of European weaponry, and was eventually waged on slighter pretexts than those of economic necessity.[54] The small itinerant armies, frequently inspired by Moslem ideals, had been a constant source of irritation in the zone of contact with the savannas, and the reputation of these local war lords was sufficient to inspire emulation from forest chiefs. In many areas, skilful warriors attracted to them bands of mercenaries from surrounding districts ('war-boys') who became bandits, terrorising the areas they controlled.[55]

It is, therefore, not surprising to find that the accounts of the first European explorers to penetrate the region are records of progress from one well-defended 'war-town' to the next, with the authority of individual chiefs unreliable only a few miles distant from the towns they controlled. It seems clear that a whole system developed in which each over-populated village 'fortress' was only maintained by the slave population who farmed the settlements on the dangerous periphery. Each farming system of this sort developed an extreme imbalance with the environment, with the inevitable deterioration of land in its turn causing further pressure on resources, further hardship and further intensification of anarchy. It also seems clear that anarchy itself, once it became part of the social pattern, was self perpetuating even without these economic factors.

4. Conclusion: the 'war-town' and the cell model.

In terms of the cell model theory, several stages in the evolution of structures may now be envisaged. The first stage was one in which shifting cultivation was incidental to hunting and collecting, with small agricultural communities developing at major slaughter sites.

The next stage may well have been the development of kinship settlements of fixed location practising bush-fallow agriculture as the areas available for hunting were restricted by further immigration. These kinship villages were then transformed into primitive fortresses with the incursion of Manis and other war-like groups and with the increasing pressure on resources. The dominant village gathered its satellites around it in a war cluster to form a multiple village enclosed by elaborate defence works. The unit completely abandoned its rational (1:6) cell structure and became grossly uneconomic, with over-farming of land in the immediate vicinity and, at first, very few satellites. At best, each dominant village 'took' a neighbouring war cluster and enslaved its population to provide food for the conquering community, or built slave villages specially for this purpose.

This may account for the 'top heavy' structure revealed by the 1908 and 1927 samples, with as many _a_ villages as _b_ villages in 1908 (1:1) and a 1:3 structure in 1927 (Tables 7-9). Since this time, the structural situation has returned to a more normal balance between _a_ and _b_ villages. The next two chapters outline some of the factors and manifestations of changes in settlement during the last forty years.

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3. Winterbottom, 1803, p.87.

4. Alldridge, op.cit., p.127; and also Malcolm, 1939, p.47; Trotter, 1898, p.45.

5. Winterbottom, op.cit., p.87; and also Rankin, 1834, p.237; Little, 1951, p.33.

6. Rankin, op.cit.,p.238.

7. Davis, 1908, p.8; see also Bockani, 1945, p.104; Winterbottom, op.cit., p.82.

8. Alldridge, 1901, pp.185, 193, 230; Thompson, 1857, p.245; Buttikofer, 1890, p.197; Hair, 1961, p.224; Banbury, 1888, p.265; Green, 1750, describes similar defences in Southern Guinea, pp.178, 284, 536; Wallis, 1903 , photos and sketches, p.189; Alldridge, 1910, p.174; Buttikofer, 1890, p.157.

9. Alldridge, 1894, p.128; 1901, pp.56, 106, 185, 193; Garrett, 1892, p.440, 441; Ransom, 1965, pp.54, 55.

10. Winterbottom, op.cit., p.87.

11. Stanley, 1846, p.118; Trotter, op.cit., p.42; Blyden, 1872, p.130; Hair, op.cit.,p.224; Rankin, op.cit., p.237.

12. Alldridge, 1894, p.127; 1901, p.114.

13. Davis, op.cit.,p.5; Malcolm, op.cit., p.47.

14. Alldridge, 1894, p.127; 1901, p.114.

15. Laing, 1825, p.59.

16. Laing, op.cit.,pp.221, 246, 352.

17. See 8 above.

18. Garrett, op.cit., pp.440, 441, 446.

19. Stanley, op.cit., pp.110-112; Winterbottom, op.cit., p.86; Blyden, op.cit., pp.121, 124, 128.

20. Garrett, op.cit., p.444.

21. Migeod, 1926, p.59.

22. Laing, op.cit., pp.250-255; Harnetty, 1939, p.76.

23. Laing, op.cit., pp.221, 252, 266, 351, 353; Blyden, op.cit., pp.121, 128; Garrett, op.cit., p.446.

24. Laing, op.cit., p.264.

25. Laing, op.cit., p.266.

26. Laing, op.cit., p.266.

27. Laing, op.cit., p.264, 352.

28. Laing, op.cit., p.353.

29. Blyden, op.cit., p.128.

30. Laing, op.cit., p 252.

31. Garrett, op.cit.,p.446; Harnetty, op.cit., p.76.

32, Laing, op.cit., p.221.

33. McCulloch, 1964, pp.7, 50, 77, 87; Schenker, 1861, p.3; Dorjahn, 1960, p.158; Willans, 1909; Little, op.cit., p.26.

34. Kup, 1960, pp.116-119; 1962, p. 127.

35. Fage, 1955.

36. See Kup, 1962, p.126.

37. Little, op.cit., p.25.

38. McCulloch, op.cit., p.87.

39. Fyfe, 1962, pp.399, 402, 403, 411, 412, 432, 488.

40. Kup, 1962, p.166.

41. Rodney, 1967, pp.219-246.

42. D'Almada, 1594, pp.81, and also 85, 88, 89.

43. Little op. cit., p.28; McClloch, 1926

44. Martin and Doyne, 1927; 1931.

45. Martin, 1933, p.39.

46. Dixey, 1930, p.192.

47. Migeod, op.cit.,

48. Garrett, op.cit., p.434.

49. Blyden, op.cit., p.122.

50. Firey, 1960, Chapters 1-3.

51. Laing, op.cit., p.221; Little, op.cit., p.38; McCulloch, 1950, p.28; In 1921, 15 per cent of the Mende population were domestic slaves.

52. Little, op.cit., p.37.

53. Malcolm, 1939; Bockani, 1945.

54. Little, op.cit., p.29.

55. Fyfe, op.cit., pp.399, 402, 403, 411, 412, 432, 488.

56. Little, op.cit., p.39.

CHAPTER 12.

CONTINUITY AND CHANGE IN SETTLEMENT FORMS: 1896 - 1964.

1. Introduction: the economic background.

Despite sixty years of peace and the disappearance of the 'war-town' stockades, and despite the impermanence of thatched and mud and wattle buildings, many villages still remain securely immured behind their ruffs of high forest, with their buildings still in tight, insanitary huddles (PEs 1 - 4; P. 22). Part of the reason for this continuity is the social inertia common to peasants everywhere. New reasons were found for retaining the unwholesome and uneconomic responses of the 'war-town' period; hill top sites were retained because of burial sites, new huts were built on the same convenient foundations and therefore in the same tight clusters, and new uses were found for the protective ruff of high forest which separates the village from its farms (Chapter 4.1). However, despite these reasons, it is argued here that the main factor responsible for these survivals has not been social inertia, but the very slow place of economic change during this century.

The Protectorate of Sierra Leone was established in 1896. Attempts to raise taxes by the colonial authorities resulted in the last outbreak of anarchy in the country -

the Hut Tax Wars of 1898[1]. The end of this up-rising signalled the beginning of sixty years of peaceful administration in the territory. But apart from pax Brittanica, other advantages of colonial attachment were slow to materialise. The six decades of British rule were not remarkable for rapid economic progress in Sierra Leone.

In spite of the anarchy of the period before colonial rule, some commercial activity did develop. The focus of nineteenth century trade had been the small river-ports at the heads of navigation (Kambia, Port Lokko, Pujehun and Sumbuya). As Mitchell has shown, these ports had served a considerable hinterland, extending far into the interior, beyond the limits of the Guinea savanna[2]. French control of these territories ended this state of affairs and "trade was lost, the system disintegrated, and the towns declined"[3].

Initial development of the new truncated hinterland of the Protectorate was half-hearted and under-capitalised. A railway line to Pendembu with a branch to Makeni was constructed between 1895 and 1916. It was designed firstly as a means of pacification and secondly to serve the main cash crop zones of the new Protectorate. Its inadequacies, both in length and width[4], may be attributed not only to the difficulties of constructing a line across the main drainage pattern, but also to lack of funds, administrative mis-management, and the *laissez-faire* policies of the colonial regime. Nevertheless, with all its short comings, it remained the only effective commercial and cultural link with the interior until after the Second World War. The first all-weather tarmac road was not constructed until the late fifties. Moreover, rapids in the lower courses of all the main streams has never made the development of river trade with the interior much of a proposition.

With these limitations, it is not surprising that the economy of Sierra Leone was moribund during the first forty years of this century. Activities of the cash economy were restricted to the area twenty miles on each side of the railway and to the much reduced hinterland of the river-ports. During this period, annual export earnings, largely from durable agricultural commodities (palm kernels and kola nuts), rarely exceeded £1,000,000[5].

Sierra Leone is still a poor country, with regular trade deficits of up to £9,000,000, but there has been marked changes during the last twenty years, and export revenues began to exceed £20,000,000 for the first time in the 1950s. These changes are probably largely due to two factors; the development of the mining economy and the growth of a motor road system.

The main stimulus to the economy has come from iron ore and diamonds, which together contribute 80 per cent of the country's export revenue. Gold and chromite have made some contribution in the past and bauxite and rutile may do so in the future, but the dominance of the two main minerals is likely to continue.

Although the Marampa iron ore mine, with its mineral railway line to Pepel on the Sierra Leone estuary, was opened in 1933, it was not until after the last war that production regularly exceeded half a million tons. Today, it is more than 4 million tons, and the mining town of Lunsar, which in 1937 had 6 thatched huts, now has a population of 12,000 inhabitants. Marampa was the first large scale industrial enterprise in the country, and since 1940 it has employed an annual labour force of between 2,000 and 4,000[6]. Workers come from all parts of the country[7], bringing a regular cash return to many villages whose earnings from agriculture must have been sporadic.

Diamond mining has a similar history. The Sierra Leone Selection Trust was first established in 1935, but it was not until the discovery of easily worked alluvial deposits in the Sewa and Moa river basins, in the early 1950s, that the boom really gained momentum. Until 1955, roughly the same number of people were mining for diamonds as were engaged at Marampa. Between 1955 and 1960, however, the labour force in the diamond fields increased from 2,420 to 31,520[8]. There are now few villages in the country which have not 'lost' men to this industry or have not been influenced by monies sent back from the diamond areas.

At the same time as the mines were stimulating migration and the flow of money in the rural areas, the developing motor road network was encouraging, albeit more slowly, the growth of cash cropping, especially of the tree crops - Kola, palm kernels, coffee and cocoa[9]. Since the 1950s, cocoa production has more than doubled, and coffee exports have increased from a modest 132 tons in 1946 to 3,890 tons in 1965[10]. Rice, too, has become a cash crop in the same period[11], contributing to cash incomes especially in the Scarcies estuary. It is these activities which have stimulated the growth of a road system[12] and the development of lorry transport.

The history of economic development in Sierra Leone falls, therefore, into two distinct phases; a long period of laissez faire, which lasted until the second World War, and a much more rapid progress which is still gaining momentum.

It will be argued both in this and the next chapter, that if forms and patterns of rural settlement vary significantly at all, either from one part of the country to another or from one settlement to another, they do so in direct relation to the local impact of new features of social and economic change.

2. Changing Forms of Settlement Before 1946.

The forty years of uneventful but peaceful administration which preceded the Second World War did not produce dramatic changes in the forms of rural settlement. It did, however, allow freedom of movement. During this period, there was an influx of new aliens - African, Europeans and Asian. The Africans came as settlers and traders, the Europeans as missionaries and administrators and the Asians as businessmen. All of them were responsible for introducing at least some new forms of rural settlement, or for causing adaptations in the old.

The first of the African immigrants were of course the Creoles of the Colony. Their grid plan and linear villages, characterised by two storey Caribbean houses[13] and regular plot allocations, were established during the eighteenth century. York (Fig.15 and PE 5), with its grid plan, and McDonald (PE 6), with its line of buildings on each side of the main road, are typical examples.

In general, these settlements may now be regarded merely as interesting survivals, much decayed and largely overtaken by subsequent developments[14]. Creoles did not build their settlements in the Protectorate area and their influence on form is therefore extremely localised.

A more recent group of coastal immigrants are the Fanti fishermen from Ghana, who occupy previously un-inhabited surf beaches from Turner's Peninsula in the south to the Lungi Peninsula in the north. Questions in the field suggested that the first groups arrived in the 1930s, but this is a mere estimate. Whatever the date of their

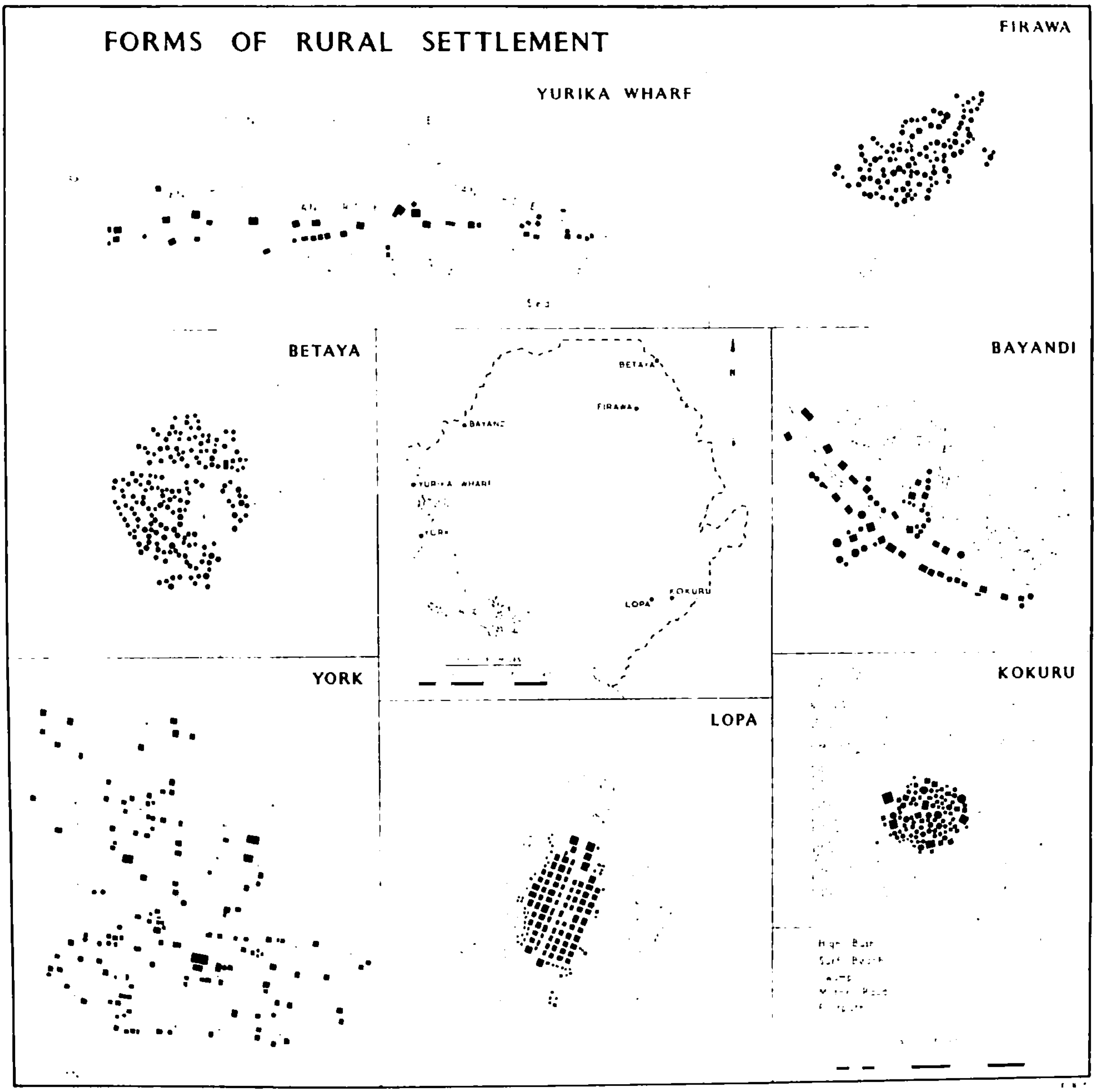

FORMS OF RURAL SETTLEMENT
YURIKA WHARF
FIRAWA
BETAYA
BAYANDI
YORK
LOPA
KOKURU
N
BETAYA
FIRAWA
BAYANDI
YURIKA WHARF
YORK
LOPA
KOKURU

Fig. 15

arrival, their long-hut shelters are a distinctive type of settlement along these beaches.

The largest and most influential group of African immigrants, however, has been the Fula cattle herders and traders. At the end of the nineteenth century, the Fula were already established along the northern borders of Sierra Leone. Trotter, writing in 1898, noted "large herds" of their N'dama cattle in the headwater catchment areas of the Great and Little Scarcies[15], but makes no mention of them further south. During this period, the pastoral Fula were no doubt kept at bay by the antagonisms of the purely agricultural peoples of the forest fringes. During the colonial period, however, they have been able to infiltrate large areas of the northern plateau in search of new pastures, and now comprise approximately 3 per cent of the country's population[16].

Although the more aristocratic of the Fula have taken up trade and become part of village life throughout Sierra Leone, the Fula economy is still predominantly pastoral, with some shifting cultivation using old cattle pens (warris) to grow millet and legumes[17]. The dwellings and settlements of the nomadic and semi-nomadic Fula groups are unlike any others in the country, with a wider range of hut types, from a small straw beehive shelter to a large 'roof-on-sticks' hut (Fig.16).

Their settlements are usually a diffused scatter of individual huts or small family compounds beaded along a watercourse (Fig.16, PE 7, P5) with warri fences circumscribing the unit. These hamlets are a distinctive feature of the Limba and Yalunka chiefdoms in particular, but may also be found in other areas of the Northern Province.

The European missionaries and administrators brought much more localised innovations. They were usually dismayed by the dangerously insanitary 'war-town' villages, but were able to influence only a few in favour of more open plans[18]. Cases of wholescale re-planning are rare. Sometimes, however, an individual has been able to use the natural calamity of a village fire or plague, to persuade the villagers to build a new settlement using the planned form most familiar to the particular missionary.

Tikonko (PE 8) was an important Mende 'war-town' situated on a slight rise and enclosed by a shield of stockade fences and high bush (Chapter 11.2). Missionary endeavour in the 1930s produced an open plan village with

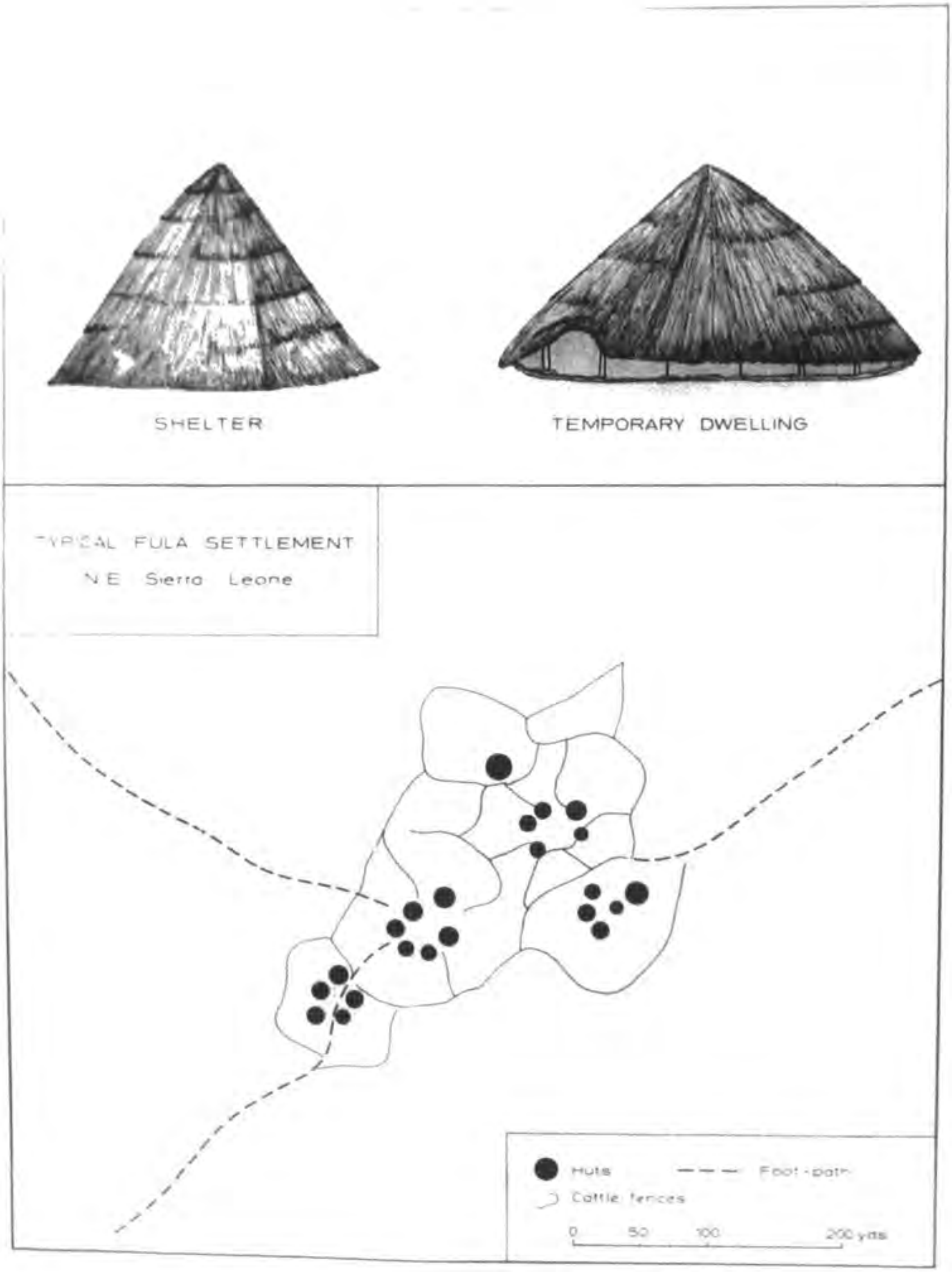

SHELTER
TEMPORARY DWELLING
TYPICAL FULA SETTLEMENT
N.E. Sierra Leone
Huts
Foot-path
Cattle fences
0 50 100 200 yds

Fig. 16

tree-lined streets and piped water supply. Similarly, the Limba 'war-town' of Bafodia (PE 9) was persuaded by an enterprising missionary to move down from its restricted hill-top site to an open location in a wide valley near a permanent stream. The grid plan of this settlement, 30 miles from the main motor road, is a strange testimony to the energy of one isolated American.

Sometimes, an enlightened local headman or village council will organise this type of reconstruction without outside help. This has been particularly evident in the Mende chiefdoms of Kenema District. Lopa (Fig.15; PE 10) was one of the first of the 'initiative' villages, though enlightenment extended, in this case, only as far as the plan. A regular grid division of amazing precision was devised but the houses are still arranged very closely together and the village still retains the spirit, if not the shape, of the old Mende 'war-town'.

The influence of Asian and Levantine traders on rural settlement forms is not so immediately striking. Like the Fula settlements, the Levantine stores have become part of rural life, and they have often been the natural focus of new developments.

3. The Cash Economy and Rural Settlement: 1946 - 1964.

Whereas the forms of settlement introduced by expatriates added localised discontinuities to the broad homogeneity of rural settlement, the growth of the cash economy has at last begun to generate sufficient momentum to reach down and alter aspects of rural life. Recent modifications in the traditional forms of settlement reflect these changes.

One of the most obvious manifestations of the cash economy has been the appearance of new building materials - zinc roofing and cement. These have, in their turn, produced new house styles, and inevitable changes in traditional forms.

A zinc roof costs about £20, and to build a house with a 'pan' roof of this sort and cement walls may cost more than £60. The latter figure represents the earnings of a policeman, or a higher paid manual worker, for six months. It is not surprising, therefore, that the pan and cement house has become a status symbol, and provides a valuable index as to the cash wealth of a village community.

Twenty five years ago, pan roofing was rare in rural areas and annual cement imports stood at a mere 4,000 tons. By 1964, it was difficult to find a village entirely devoid of houses with pan roofs, even in the remoter parts of the country.

The geographical implications of these changes are most interesting. These new materials are causing a change in the shape of buildings and a concomitant disintegration of the traditional arrangement of dwellings in compounds. They also give a new stability to new settlement forms.

The wattle and daub hut of the traditional village is circular in shape and imposes a circular form, not only on the individual family compounds (Fig.4) but also on the form of the village as a whole, especially when it was once gathered behind a stockade.

The square house with the thatched roof, a fore-runner of the pan-roofed dwelling, has been a feature of coastal villages with European contacts for atleast two centuries[19] (Chapter 4.1). It had already caused difficulties of compound orientation in the period before the recent economic changes, for it is difficult to devise a circular arrangement with square buildings, although the attempt has been frequently made (PE 11). The spread of the pan roof has meant that in many settlements the attempt to come to terms with this alien introduction has been completely abandoned, and new linear forms have begun to appear out of the old circular compound structure of the original villages.

The change in traditional forms has been further encouraged by a combination of other factors. The pressures to build houses using the new techniques, materials and shapes, come from both positive and negative forces.

It is gradually becoming more difficult to find 'forage' materials to construct the traditional hut. A hundred and fifty years ago, house building poles were "as thick as a man's thigh"[20]. Today, shorter fallow periods and the general deterioration of vegetation cover has reduced both the quantity and the quality of building materials (Fig. 17).

Having decided to construct a mud or cement block house, the incentive to build away from the old nucleus in a linear form has been encouraged by the lower value which is now being placed on the family compound, with the kinship unit decimated by absentee labour in the mining areas and the towns[21]. The lack of social need to cluster behind a camouflage of high forest, and the added incentive to move out onto a motor track or main routeway, has produced

Fig. 17

an increasingly wide variety of village forms[21], from the traditional, through several stages of modification, to the linear and grid forms which are all recent developments.

Levuma (PE 12), on the railway line to the provincial capital of Bo, was one of the first to re-align itself in a linear form, providing the train with one more stopping place, and leaving the old site still partly occupied. Mesimo (PE 13), on the other hand, has had its old site completely obliterated.

Various stages in roadside re-alignment are illustrated by three examples presented here (PEs 14 - 16). Petema (PE 14) is an old triple-core 'war-town' on the road between Bo and the river ports of Sumbuya and Mattru. It still retains something of its old character, but the chief's compound, and most of its important social and commercial activities, are now concentrated along the road. Bayandi (PE 15; Fig.15) has been subject to two re-alignments, one along the footpath, and the second, at right angles to it, along the new motor road from Kambia to Kukuna, producing one of the first cross-road settlements in the country. Finally, Bunumbu (PE 16) - at the junction of the Pendembu road and the main road from Kenema to the diamond town of Sefedu - is really an offshoot. This is a new form of satellite, with the original village still thriving two miles away along a feeder road[22].

These new linear forms, although found in most regions of the country, are particularly common in Temne areas (P. 32 and 33) where land tenure arrangements[23] have encouraged the farming of land directly behind a dwelling house. Langley describes this phenomenon as early as the 1930s[24], and it may be that the Temne practice of swamp-rice farming has encouraged the development of these linear and disintegrate forms. Two examples are illustrated here. Kalangba (PE 17), in the Scarcies estuary, is a rice farming settlement typical of many in this area (P 38), and Yurika Wharf (PE 18; Fig15), on the Lungi Peninsula, has rice farming combined with fishing to produce an even more amorphous, almost formless, settlement. In both these cases, the disposition of linear sand dune ridges, or marsh interfluves, may be thought to have a strong influence on form. This is only part of the answer, however, as comparison with Masa (PE 19) will show. Masa is a Krim village which keeps its circular form in very similar physical conditions in the southern swamplands of Pujehun.

Other linear and roadside forms owe their development directly to mining activities. These communities are of a different type to those described above, for they have not grown out of any traditional structure. Their inhabitants are a new class of migrants from a highly mobile stratum of the country's population - erstwhile diamond miners, petty traders from the main towns, and retired government employees from sub-clerical grades.

Mokanji[25] is a mushroom settlement which has grown rapidly outside the entrance of SIEROMCO's new bauxite mine on the main ridge of the Mokanji Hills (Fig.M.1). In 1962 the settlement had only 3 huts, but by 1964 there were 85. This settlement is the type which will possibly become a large, sprawling, unplanned town like Koidu or Lunsar[26].

Petema, on the road between Mattru and the new rutile mining concession (Sherbro Minerals) at Mogwema, is a more characteristic recent development of this sort. About two years ago (1962), its inter-nodal centrality attracted members of the Lebanese trading community who established a collecting post for local commodities, especially rice and piassava, together with a subsidiary retail store. Rice marketing is now centralised, through co-operatives, but the traders remain in the well founded hope that traffic and business will improve as the rich deposits of rutile begin to be worked. Already there are 34 houses and a grid street plan is beginning to develop back from the main road.

One of the problems of the attraction to roads is that, for engineering reasons, the majority of routes follow watersheds where possible. These new settlements are therefore often remote from a dry season water supply, and women must carry water for distances of up to four miles. It seems likely, therefore, that the rate of growth of these roadside settlements will act as a general index of the economic well-being of a region. These settlements will only survive if there is sufficient trade to justify their inconvenient locations, which are neither urban nor rural. Previous development has already fixed the main nodal centres and few of these road settlements can hope to grow in the same way.

One final agent of change deserves special mention, and it is in many ways the most dramatic - the village fire. The normal hazards for traditional villages, with thatch roofs and houses in close proximity to each other, has been substantially increased by the introduction of unfamiliar combustibles (fuel oils, matches, and - less directly - glass bottles). Despite elaborate fire precautions which have probably always been a feature of village life, whole villages are now much more frequently destroyed by fire.

The tendency to downhill migration, which is now common throughout West Africa[27], has still to make a real impact in the isolated northern plateaux of Sierra Leone.

Amongst the plateaux tribes, however, re-siting in more favourable valley locations is becoming more common following these catastrophies. In 1964, the writer visited Bendugu, a Koranko 'war-town' which was one of the first to complete a voluntary migration of this sort. The old village, situated on an interfluve with very steep slopes, had burnt out, and the new settlement was situated in a valley more than a mile away. The old village was being re-built, however, by older conservative elements who preferred to remain with the graves on the hill top. It will be interesting to see how long this original settlement survives.

In the lowlands, re-planning rather than re-siting is the more usual response to a village fire. This has been particularly evident in the Mende chiefdoms of Kenema District, following the example set by Lopa (PE 10). Since independence, the Sierra Leone Government's Ministry of Social Welfare has initiated a Pilot Village Development Scheme[28] to take advantage of local initiative. Under this planned programme of community development, nine villages - Kokuru, Kpandebu, Manyahu, Borborbu, Manyahu, Maijama, Nyandehun, Manyahun and Tengbelu-~~(Fig.~~ have rebuilt their incinerated or delapidated villages within a programme of community development extending from piped water supply to compost making. A healthy competition between these ninevillages has been engendered using something akin to a 'Best-Kept-Village' scheme. The enthusiasm with which this is pursued may well encourage others to join the scheme, producing a new and quite unusual type of rural community ideal. In a continent where village life is being eroded by the impact of economic development, such a development is most encouraging.

4. The Changing Village: some sample study areas.

It is axiomatic that a selection of individual villages illustrating new characteristics of form are, in themselves, no proof that these innovations are indicative of a definite trend. In order to amend this, two widely separated and distinctive groups of settlement were selected for more detailed analysis: the Yalunka villages of the Upper Mongo valley in the north east plateau, and the Temne rice and fishing villages of the Lungi shore.

The Yalunka Villages:

At the end of the eighteenth century, the Yalunka, who were a slave tribe of the Fula in the Fouta Djallon, rebelled and fled southwards establishing a line of large stockaded trading villages in the valley of the Mongo river, one of the main trading routeways from the interior to the coast. The paramount chief's village, Falaba, has already been described (Chapter 11.1), but there were at least six others - Musaia, Manankon, Sinkunia, Gberia, Ganya and Betaya (Fig.M.1). This line of large, well defended villages would seem to have formed a northern marchland, controlling an important routeway, and protecting tribes to the south from marauding armies of Sofa Fula mercenaries[29].

At the time of Laing's visit, in 1822, these villages supported a collective population of 25,000[30], using the village lands of 'protected' tribes, especially the Koranko[31], for seige supplies. Operating in this way, they survived well organised assaults and were not finally overcome until the end of the nineteenth century. Falaba was completely gutted by the Sofa raiders in 1885[32]. All that remained were the trees of the stockade and the surrounding ditches. Other villages survived in various stages of battered decay[33] and their recent fortunes reflect many of the features of change outlined earlier in this chapter.

Betaya (PE 20),~~Fig.),~~ with the symmetry of its six gates (Chapter 11.1) broken by a motor road, still retains much of the character of the settlement described by Laing. Its 27 compounds, although no longer containing "two circles of houses, one within the other", are still arranged concentrically around the chief's compound.~~(Fig.).~~ The mosque is the only pan roof building in the village, a clear index of the subsistent character of the village economy.

Falaba itself (PE 21; Fig.18) is still the village of the paramount chief and has managed some sort of revival, although with a population of 1000[34], is merely a fifth of its former size. Its semi-planned street lay-out still lies within the 500 cotton trees of the over-grown stockade described by Blyden[35]. Its air of relative prosperity is entirely due to the present chief, who has used the tribute

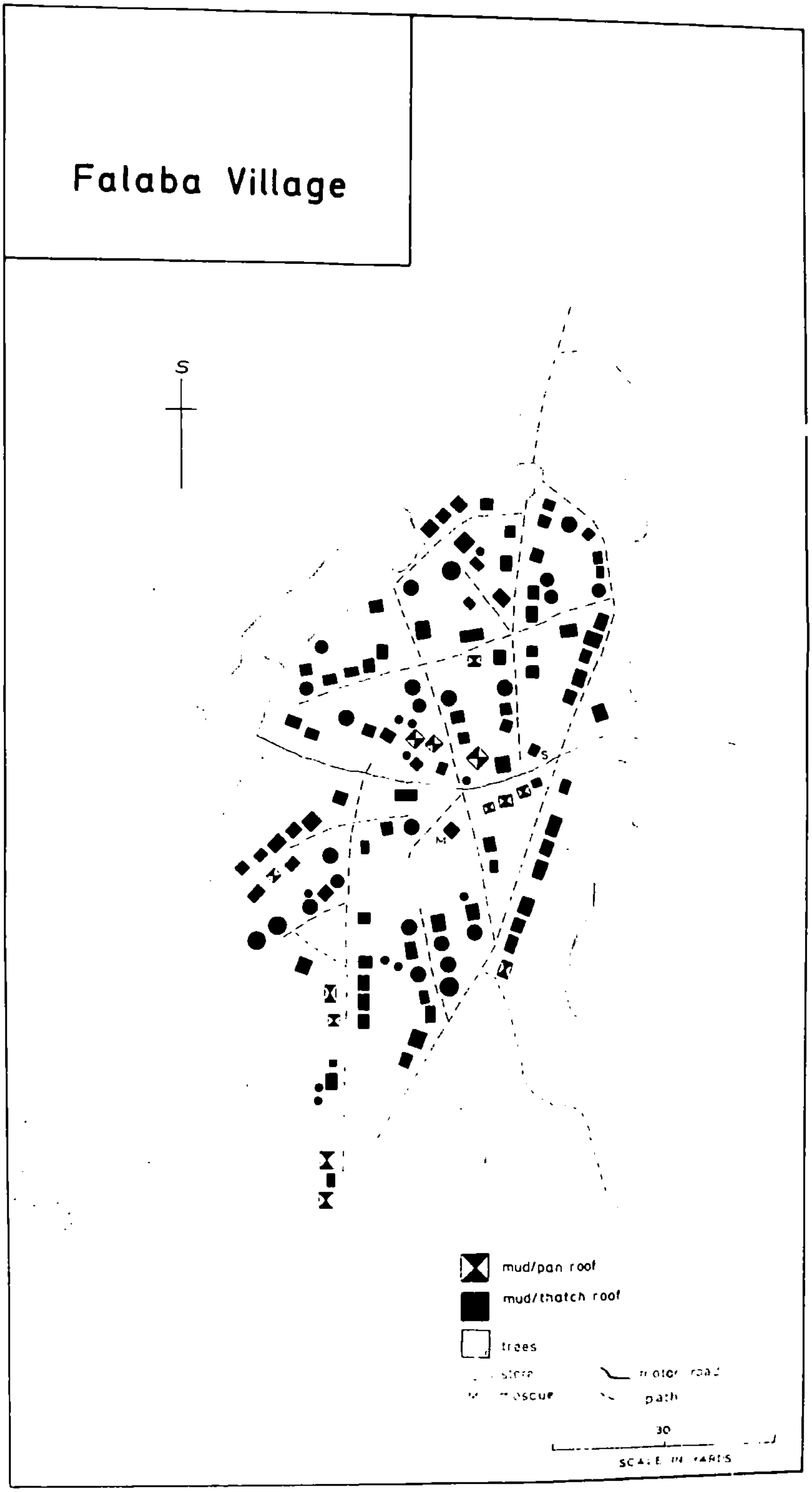


Fig. 18

he receives from other villages (many with relatives in the diamond fields) and from the Fula cattle herders who use his lands to construct many good quality houses. He has also developed the trade in Fula cattle, making Falaba the first of the trading posts and inspection centres in the route to the diamond areas and the south, with something like 6,000[36] cattle passing through the settlement each year. Consequently, out of the 120 houses in the village, 75 per cent have square structures with cement facing to their mud block walls, and 30 per cent have pan roofs. On the other hand, the control of the cash economy by one person is reflected by the fact that the settlement has only one small petty trading store.

Musaia (PE 22; Fig.19) has had its form radically altered by the new economy. Although it was never completely devastated by tribal wars (it had 157 houses in 1890 and 176 houses in 1927[37]), there is no doubt that its subsequent decline has been halted by the growth of trade in Fula cattle and, more important, by the development of a government Animal Husbandry station a mile south of the village. This provides regular wage employment for 30 per cent of the male labour force and so, unlike Falaba, the cash income is disseminated throughout the community.

Musaia Village
trees
mud/pan roof
mud/thatch roof
ba baker
tai tailor
ca carpenter
t trader
pe petty trader
mir musical instrument trader
C chief's house
motor road
footpath
0
25
scale in yards
N

Fig. 19

Today there are about 100 buildings in the settlement, and although still contained within the cotton tree 'stockade', the emphasis has clearly shifted from the traditional compound structure still evident in Betaya, to the linear form of the new Sierra Leone villages. There are now 16 petty traders and craftsmen in ~~the~~ Musaia, including 3 tailors, one musical instrument maker, a baker and a carpenter. The five main stores are owned by three Fula and two Mandingo trading families.

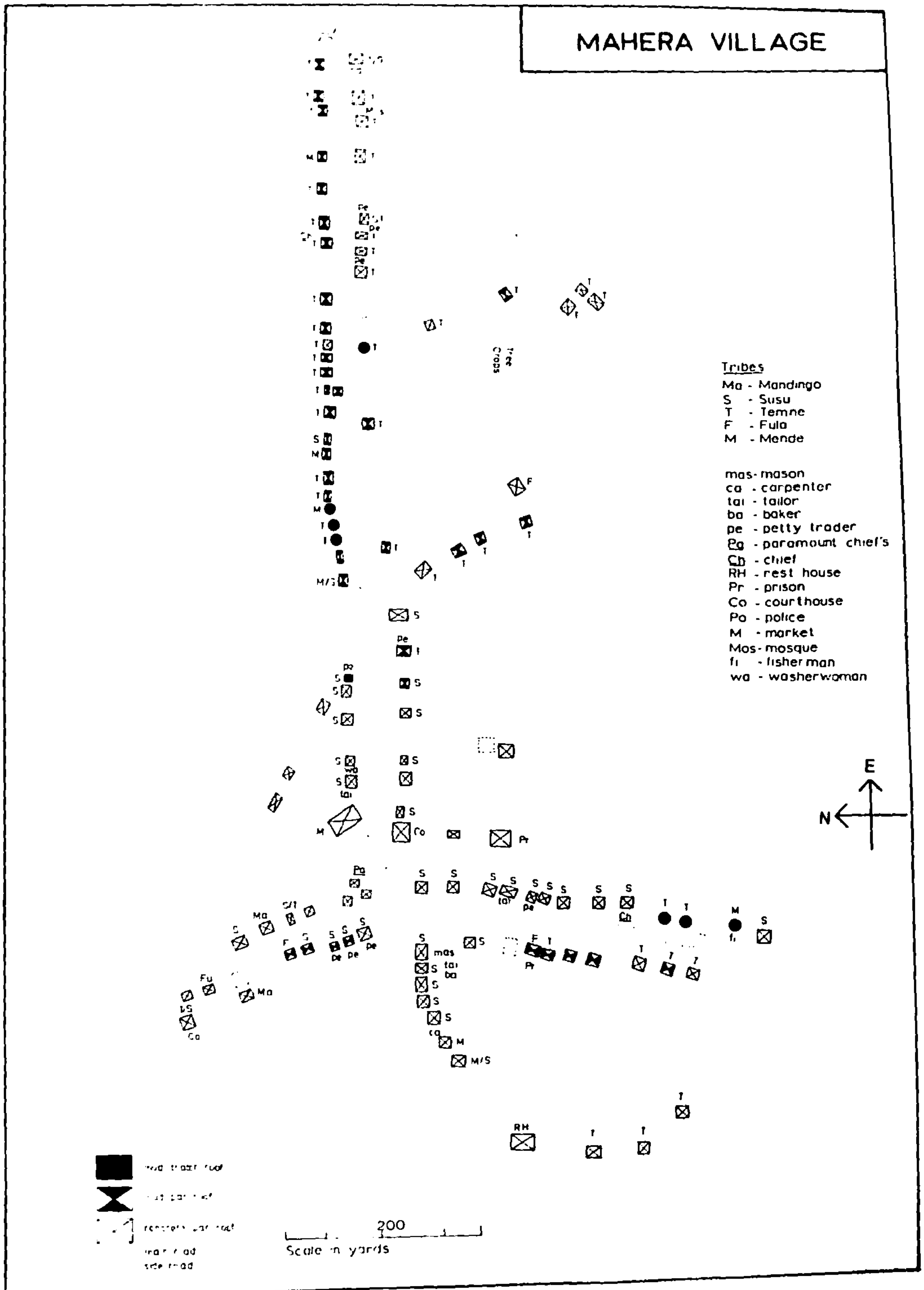
The comparative well-being of Falaba and Musaia stand in marked contrast to the decay of Manankon (PE 23). Although there is no record of its original size, the dimensions of its cotton tree stockade, or what remains of it, and the number of mounds signifying the sites of the old houses, indicate that it was at least as large as Musaia. Most of the families have now been drawn away to Freetown and the diamond fields. Even in 1927 there were only 32 buildings in the village. All that remains today are the old headman and his immediate kinsmen, whose houses have now been re-aligned along the motor road. In this case, the road has been the main instrument of decline rather than improvement.

The Villages of the Lungi Peninsula:

The varying fortunes of the Yalunka villages, in an area of limited economic development, stand in sharp contrast to the uniform prosperity of the settlements of the Lungi peninsula. Villages in this area are chiefly located on a 50 foot raised beach[38] which extends northwards to the swamps of the Scarcies estuary. The area has good alluvial soils, especially in the bunds of the Scarcies ricelands, and the urban market of Freetown is only ten miles away across the Sierra Leone estuary, with a daily contact maintained by the long single sailed Bullom boats taking fruit, vegetables, rice and fish to market.

The unusually healthy economic development of this area has produced a general alteration in the forms of rural settlement throughout the peninsula. The round village has completely disappeared, to be replaced by linear and linear diffused forms. Previously separated villages have coalesced into multiple communities. Originally a Bullom tribal area, the healthy economy has attracted immigrants from other tribes, especially Susu, and the area is developing a multi-tribal character with a wide range of building styles and structures.

Two villages illustrate this new type of settlement:



MAHERA VILLAGE
Tribes
Ma - Mandingo
S - Susu
T - Temne
F - Fula
M - Mende
mas - mason
ca - carpenter
tai - tailor
ba - baker
pe - petty trader
Pa - paramount chief's
Ch - chief
RH - rest house
Pr - prison
Co - courthouse
Po - police
M - market
Mos - mosque
fi - fisherman
wa - washerwoman
E
N
200
Scale in yards

Fig. 20

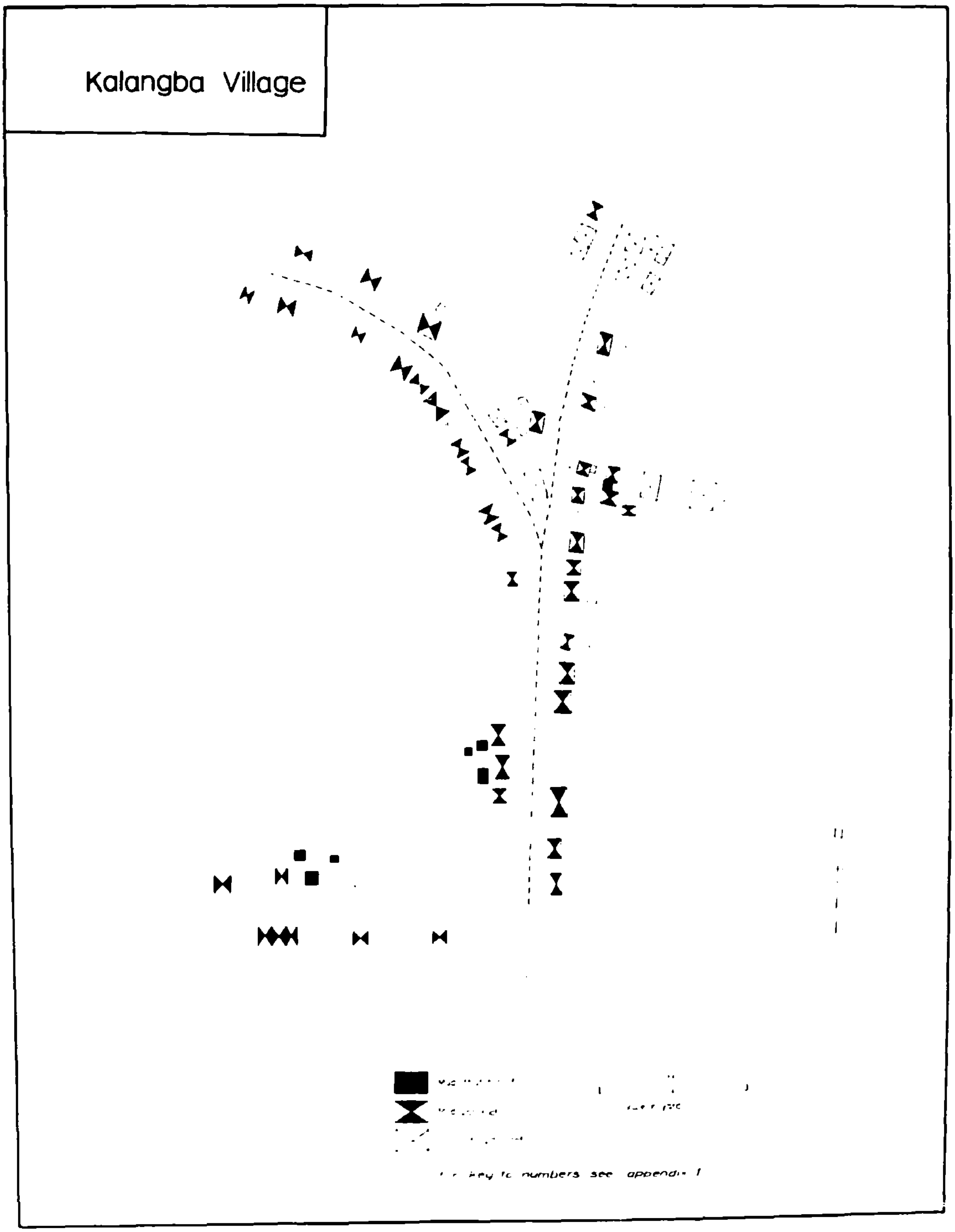


Fig. 21

Mahera on the peninsula proper and Kalangba in the Scarcies rice swamps. Mahera is a linear coalescent village containing two tribes - Temne to the east (42 houses) and Susu to the west (29 houses) - with a scatter of Fula and Mandingo traders and Mende fishermen. The prosperity of the village is reflected in the diverse character of crafts and specialised activities and also in the quality of its buildings. Only dwelling huts have thatches and most of the others have zinc pan roofs and concrete block walls. The demand for the latter has allowed one Susu to establish himself as a cement block manufacturer and trader (Fig. 20).

Kalangba (Fig. 21), although more tribally uniform, also displays characteristics of prosperity, with eighty per cent of the houses zinc pan roofed and with six trading stores.

5. Conclusion.

This chapter has attempted to show that the rapid increase in economic development during the last twenty years has brought some changes in village forms; that whereas most settlements still retain their traditional forms of buildings and circular compounds, there are a growing number in which radical modifications in traditional responses are taking place. Because this development is in its early stages, it seems that planners have a unique opportunity to observe these initial changes and to control and direct subsequent and more general alteration in settlement forms.

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32. Garrett, 1892, p.441.

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CHAPTER 13.

CONTINUITY AND CHANGE IN THE PATTERN OF RURAL SETTLEMENT : 1927 - 1964.

1. Introduction.
2. Patterns of Fragmentation and Decreasing Density.
3. Patterns of Fragmentation and Increasing Density.
4. Patterns of Nucleation and Increasing Density.
5. Areas Where Patterns Have Not Changed.
6. Conclusion.

1. Introduction.

In the last chapter, it was argued that social and economic changes have been slow to manifest themselves in rural Sierra Leone; that until after the Second World War, rural society remained practically unaltered. It was suggested that most of the changes which have occurred in the forms of settlement are of extremely recent origin, impelled by economic progress which has been particularly apparent during the last 10 years. The changes in the over-all means of settlement structure between 1927 and 1964, described earlier (Chapter 10.5), provided some evidence to suggest that these changes were also taking place in patterns of settlement.

Using the same system of data collection and categorisation (from the 1:62,000 and 1:50,000 maps) already employed in random sampling and settlement mapping (Chapter 7), it has been possible to select and map a number of areas reflecting a representative range of the types of pattern changes which have taken place during the last four decades.

Broadly speaking, it seems that there have been four qualities of change: patterns of fragmentation and decreasing density with an increase in the number of b and c villages and hamlets, often accompanied by a reduction in the number of a category villages; patterns of fragmentation and increasing density with many c category settlements becoming villages and the b category villages increasing in number; patterns of nucleation and increasing density in which the number of both a and b category villages has increased; and finally, areas where patterns have not changed.

For each of these four groups, three pairs of map sheets were selected for comparison (Figs.M.12-15); one of each pair from the 1:50,000 series, and one from the 1:62,500 series. In order to avoid confusion, only numbers from the 1:50,000 series have been used.

2. Patterns of Fragmentation and Decreasing Density. (Fig.M.12)

This type of pattern change is represented by three comparative pairs of map sheets (72, 82 and 99) which were selected from different environments.

In the Kissi chiefdoms of ~~the~~ Luawa, Kama, Teng and Tongi (Sheet 72), there has been a considerable decline in the number of large villages. Out of the 41 a category settlements in 1927, only 14 remain. The number of b category settlements has remained the same, whereas the number of hamlets has almost doubled. The reasons for these changes are difficult to assess, except in terms of declining soil fertility[1] and of migration to the diamond areas.

In the area of Mende chiefdoms in the Upper Mali valley west of Pendembu (Sheet 82), the number of large (a) villages has declined from 33 to 24 between 1927 and 1964, whilst the number of small (b) villages has increased from 27 to 42. Migration to diamond areas may also be responsible for these changes, which are most apparent in the south east of this area in the Moa valley where some mining takes place. Another factor is that this is one of the most important coffee and cocoa production zones and this, too, may have increased the social and economic independence from the kinship group and promoted settlement changes.

The last map sheet (Sheet 99) provides a good illustration of the impact of economic development. A liberal chief has allowed private enterprise to develop. A combination of piassava, in which this area has a world monopoly, the spread of swamp rice farming, and enlightened leadership, have produced a dramatic and unique fragmentation of rural settlement. In 1927, the area had a typical 'war-town' structure (i.e. a moderate denisty of large villages with only a few smaller satellites or hamlets). By 1964, there were half as many large villages and the number of farm hamlets had increased from 70, in 1927, to over 400. These small settlements, each comprising one family group, are unusual in that they are occupied permanently.

3. <u>Patterns of Fragmentation and Increasing Density</u>. (Fig.M.13)

The three map sheets chosen for this group were 6, 9 and 58. Sheet 6 covers an area of marked surface dissection in the upper Mongo watershed. In 1927, the area was dominated by 5 large 'war-towns' and there was only one settlement of <u>b</u> category. Although still a relatively low density area in 1964, there were 19 <u>b</u> category villages by this date, and the number of farm hamlets had almost doubled. Part of this increase has been due to the influx of Fula cattle herders (Chapter 12.2, P.5), but the 'disappearance' of one large village is an indication that some fragmentation is also taking place.

In the area covered by Sheet 9, there has been both fragmentation and nucleation in areas adjacent to each other. In the south east, there is part of the middle Mongo flood plain and here, north of Kamakwi, mechanical rice cultivation has been the factor most likely to have caused the increases in density and nucleation, with the development of 9 large villages where there were none in 1927. Further north west, there is a growing trade in Fula cattle which are driven south from the Guinea border to the market in Kamakwi[2]. The large flats of this area make a convenient dry season grazing ground where beasts may put on a little more weight before the sales. Once again, the increase in the number of small hamlets seems to be entirely due to the influx of Fula herders.

In the diamond mining area west of Sefedu (Sheet 58), the fragmentation of settlement has been accompanied by a quite considerable increase in density. The 1927 pattern of small evenly spaced villages has now been replaced by linear alignments of a and b category settlements along the main roads, all of which follow the diamond workings. In 1927, there were only 5 large villages and 12 small ones. By 1964, the number of large villages had increased from 5 to 10 and that of the small ones from 12 to 35. Of these 35 small villages, 22 are located on the main motor roads.

This has been, and still is, an area of new immigration. The recent nature of most of the buildings suggests that the majority of these changes have taken place during the last decade.

4. Patterns of Nucleation and Increasing Density. (Fig. M14).

Most of the areas in which there has been a dramatic increase in settlement density seem to be associated with the recent developments in swamp rice farming. In the Scarcies estuary (Sheet 38), there have been quite remarkable changes in all types of settlements, but the restriction of sites to interfluves and the organisation of large tract swamp rice farming have particularly encouraged the development of large villages. On the northern shore of the Lungi Peninsula alone, the number of these a settlements has increased from 6 to 18 and the number of b villages from 11 to 31, in both cases a threefold increase over the past forty years.

Similar swamp rice development has occurred on smaller flats and flood valleys of the inland Temne chiefdoms on the western periphery of the bolilands (Sheet 41). Increases here have been similarly dramatic. In 1927, there were 2 large villages and only 17 b category settlements, in an area dominated by hamlets. In 1964, there were 76 b villages and 18 large ones. There is little doubt that the Temne were using these marshes for growing rice, even in 1927[3], but the scale was smaller and the settlements were seasonal. Now they are permanent and, with improved communications, the scale of cash sale rice farming has increased[4]. Cash cropping for oil palm has also been encouraged by the developing road and motor track network.

A more complex area of settlement increase is found around the rail head town of Makeni (Sheet 43). This town was no more than a few huts at the railhead in 1927. Today, it is the administrative land trading capital of the Northern Province, with a population of more than 12,000, the third largest centre in the provinces. A development of trade in palm produce and cattle, and increasing interest in mechanical rice cultivation, have caused a marked rise in the density of settlement, and immigrants from Limba, Fula and Temne chiefdoms have added their heterogeneities to the settlement pattern. Most of the larger villages are Limba and Temne. The Limba have made this one of the more profitable areas for the production and distribution of palm wine, for they are skilled tappers and their produce can be sold throughout the country.

North west of the town, there is a distinctive area of Fula settlements, where cattle are pastured before sale in Makeni, their small hamlets once more making a special discontinuity in the pattern. It is noticeable that most of the development has taken place on the granite soils of the escarpment areas, one of the clearest indications yet provided of the value of these soils compared with the neighbouring Kasila soil associations.

5. <u>Areas Where Patterns Have Not Changed</u>. (Fig. M.15)

The map sheets 22, 102 and 79 have been selected to represent the considerable areas where changes in the quality of settlement patterns have not been remarkable. Over much of the plateaux (e.g. Sheet 22), isolation and lack of any form of economic change, except fairly limited emigration to the diamond areas, militate against change. In these Koranko chiefdoms, tribal antagonisms mean that even the Fula penetration has been avoided, and the pattern has altered in only one or two small details.

'No change' patterns have not been restricted to such obviously isolated areas, however. Even near the 'heart' of an area of more marked economic change, it is possible to find poor communication networks and patterns which have not altered in any radical way (Sheet 102). Again, in an area close to Bo, the provincial capital (Sheet 79), where communications are good, there are patterns which have altered very little, and where social and economic changes have had only a small impact. Indeed, one is still left with a strong impression that this is a more normal pattern of settlement responses than that of "marked change."

6. Conclusion.

No attempt has been made in this chapter to represent a full comparative analysis of rural settlement patterns in 1927 and 1964. The aim has been to offer a sufficient range of examples, taken from all regions of the country, to show some of the ways in which the quality of the settlement pattern has become richer and more variable during the last four decades.

The causes of this increasing variety of patterns have been outlined both here and earlier in the work (Chapter 12). ~~12)~~. The principal elements have been the development of the economy, both in mining and agriculture, the increasing mobility of labour, the recent development of road network, and the growing freedom from traditional kinship values and associations.

At the same time, there are large areas of the country where no such changes in either the forms or patterns of settlement are apparent. The importance of these areas must be stressed, for it is too easy to emphasise change at the expense of continuity. It was suggested earlier that sufficient homogeneity is retained to be reflected in the structural means (Chapter 10). Subsequent analysis confirmed the view that patterns and forms may have changed but, in general, structures rarely seem to have been altered completely (Chapter 15).

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S E C T I O N

F O U R

CHAPTER 14.

DEVISING INDICES TO MEASURE PATTERN VARIATIONS.

1. Introduction.
2. Stage One: devising indices of density and nucleation.
3. Stage Two: chloropleth mapping and testing the relationship between density and nucleation values.
4. Stage Three: combining the indices into ordinal ranks, (DN).

1. Introduction.

A set of hypotheses to account for the structure, pattern and forms of settlement in Sierra Leone has now been presented. The arguments in support of these ideas have been based partly on field observations and empirical historical evidence, partly on the classification made possible by the information obtained from the random samples, and partly on the intensive examination of both the aerial photographs and the base map of settlement distribution. For testing the statistical significance of areal variations in settlement pattern, however, it was necessary to generalise the information of the settlement base map. This process of generalisation will now be followed through its several stages.

2. Stage One: devising indices of density and nucleation.

The most useful frame for a quantitative analysis of settlement patterns was the standard cell grid used in the random samples (Fig.M.2c; Chapter 7.4). This unit of 33 square miles was potentially large enough to test the presumptions of the cell model theory (Chapter 6.1) and small enough to show any significant micro-areal variations in the settlement pattern. Accordingly, this grid was superimposed over the settlement distribution map (Fig.M.3) and a full record was made of the total number of settlements of each category (a, b, c) in each grid square (Appendix 3).

To achieve a reasonable independence of results, it seemed important to find a formula for measuring the chief variations and qualities of the settlement pattern which did not depend entirely on the theories of settlement growth expressed in the cell model. Therefore, as little reference as possible was made to the theoretical scale of values, except those already 'built into' the grid structure by the standard cell unit and the initial settlement classification. Only in this way was it possible to avoid the pitfall of a set of indices heavily weighted in favour of producing results which were themselves dependent on the theory which they were hoping to test.

After careful consideration, and some experiments, it was found possible to resolve these standard cell statistics into two measures of settlement pattern for each standard cell. One was an expression of density and the other of nucleation.

Index of Density:

It seemed that the most satisfactory index of density which would satisfy these requirements could be based on the assumption that all three categories of settlement in the standard cell can be viewed as incipient a category villages; i.e. that each settlement of b and c categories had, at least potentially, the chance of becoming a village the size of a category. Working from this premise, it was noted that with only slight generalisation of the mean size of a category settlements, as revealed by the random sample and the sampling error (Chapter 10, Tables 7-10), the mean sizes of all three categories of settlement are in almost direct arithmetical relationship (80 : 20 : 4). Within the terms of this generalisation, therefore, the a category settlement of the mean standard cell may be seen as the sum of 4 b category and 20 c category settlements. These mean sizes of settlements in each category may then be presented as approximate fractions of the mean size of the larger village:

$$\underline{a} = \text{unity}$$

$$\underline{b} = \tfrac{1}{4}\,\underline{a}$$

$$\underline{c} = \tfrac{1}{20}\,\underline{a}$$

By multiplying the number of occurrences (n) in any category in a standard cell by the fraction which their generalised mean size values represent of the generalised mean size of a category settlements, and then adding these results, a reliable index of density (D) could be achieved:

$$\frac{a_n}{1} + \frac{b_n}{4} + \frac{c_n}{20} = \text{Density Index (D)}$$

This rather crude formula may be represented in the somewhat neater form:

$$\frac{20a_n + 5b_n + c_n}{20} = D$$

Index of Nucleation:

The difficulties encounted in devising a suitable index of nucleation were much greater than those of the density formula. Here, no simple generalised value could be used, because for this index each cell had to be viewed on its own merits.

Two features of the settlement pattern could be shown by this index. The smallest settlements, the hamlets and fakai of category c, are much less stable elements of the settlement pattern than the larger settlements of the other two categories. The three categories may, in fact, be viewed as stages in a gradually stabilising continuum of locational permanence, distinguishing those settlements which are most likely to move sites from those least likely to do so. Within each standard cell, therefore, it should be possible to measure not only the degree of nucleation or fragmentation, but also by the same measure, to record the degree of locational instability in the cell. The larger the number of a and b settlements in relation to c, the greater the concentration and stability; the larger the number of c category settlements in relation to the numbers of b and a, the greater the degree of fragmentation and instability.

The first task was to establish a yardstick against which these variations could be measured. The nearest one could come to such a measure was the mean standard cell (1a:6b:15c; Table 10). The chief difficulty now lay in standardising the assessment of b category villages. A larger than average number of a category villages, when the number of c category hamlets and farms remained near the norm, or fell below it, indicated greater than average nucleation (e.g. Appendix 3; Standard Cell No. P2). A larger than average number of c category settlements, where there was not a proportionately large number of a and b category villages, indicated greater than average fragmentation (e.g. Standard Cell No. 06). A greater than average number of b category villages could, however, be interpreted in two ways: either the a villages in the cell were disintegrating and forming into new smaller settlements, or the c category hamlets were growing in size and stability and establishing themselves as more permanent villages. In other words, one might infer increasing fragmentation or increasing coalescence from the same information.

The only satisfactory solution seemed to lie in assessing the qualities of settlement ratios in each cell strictly on its own merits. In these circumstances, it seemed a very difficult task to achieve consistent objectivity in the form of a nucleation index.

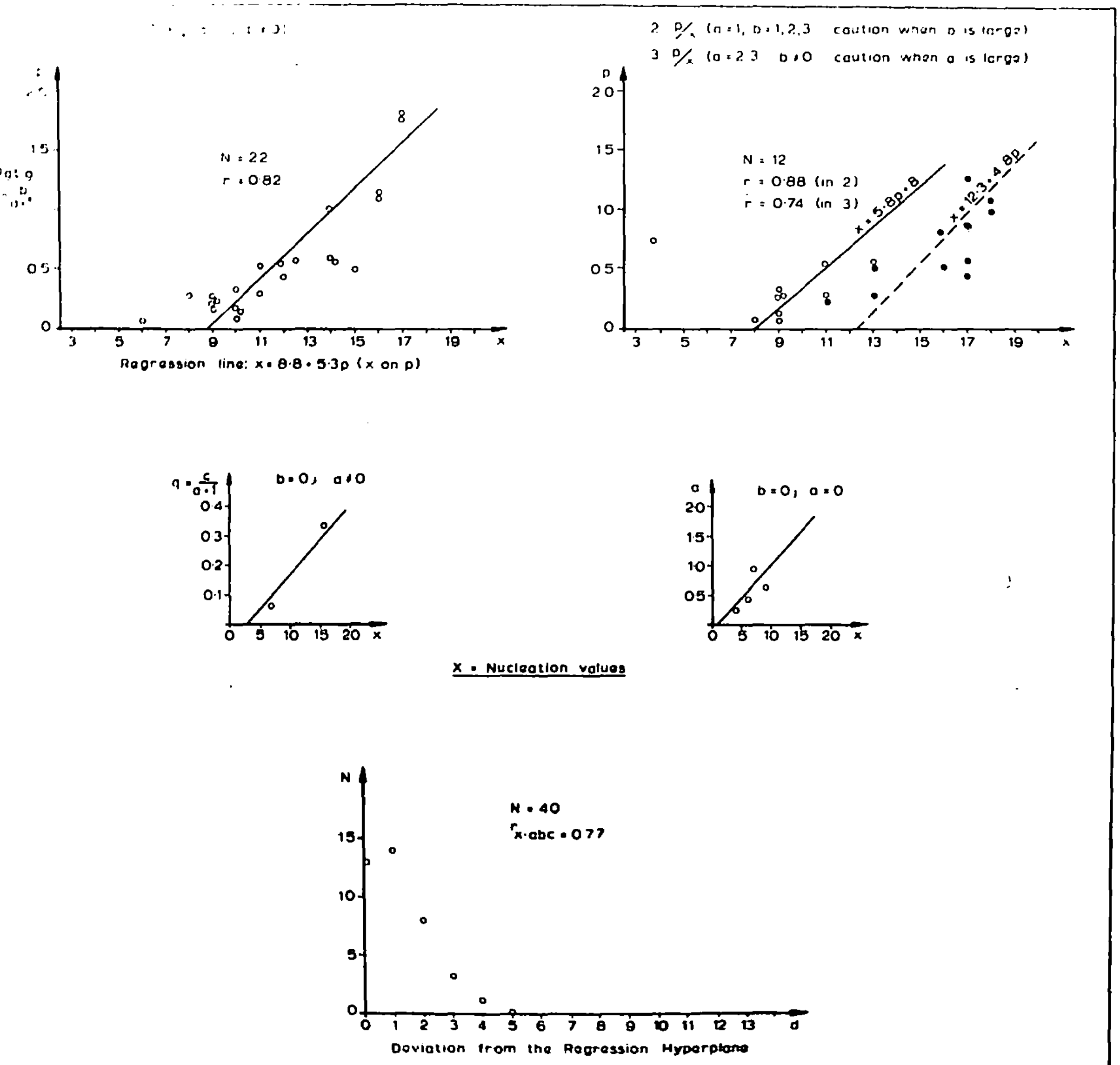
At first, a classification was attempted on a visual assessment of cell characteristics, balancing all three categories one against the other. Key cells were selected to represent a range of these evaluations from 'very dispersed' to 'near normal' and finally to 'highly nucleated'. Attempts were made to fit each cell pattern against the appropriate 'key' cell. So many marginal cases of difficulty were encounted that this method was rejected as impractical.

The problem was eventually solved, in as satisfactory a way as it seemed possible to achieve, by using a statistical method similar to that used for assessing the reliability of subjective marking in examinations[1]. Each standard cell, or the random sample, was given a subjective grading for nucleation on the scale 1 - 20, using 10 as the norm for the mean cell. These values were tested using simple regression analysis (Fig.21) to assess the consistency of allocation. From these results, the following general index of nucleation (N) was derived:

$$12 + a_n + \frac{b_n}{2} - \frac{c_n}{3} = \text{Nucleation Index (N)}$$

where n = number of occurrences in each cell.

Indices were calculated for the 49 standard cells of the random sample (Appendix 2b). Correlation analysis was employed to check the value of the gradings (Fig.22). As one might have expected, correlation of the indices with the individual numbers of each category in each cell in the sample was fairly low (0.43, 0.53, and - 0.17, for a, b and c respectively). On the other hand, the multiple correlation co-efficient (r) was 0.77, which indicated a good fit of the plane to the points. In other words, the



Testing a Subjective Assessment of Nucleation (range 1-20) using Regression Analysis

Fig. 22

calculation showed that a fair account had been taken of all the values in working out any individual cell's subjective placing on the scale.

The formula may therefore be regarded as generally very satisfactory, except where one or more of the a, b c, values in any cell approximates to zero. This deficiency was particularly noticeable in the case of low density cells with few b and c and no a settlements. In these cases, one could postulate neither nucleation nor fragmentation without reference to neighbouring cells. Fortunately, in these low density cells, nucleation indices usually devolved around the mean ($N_s\bar{x}$), which presented the best compromise solution.

3. Stage Two: chloropleth mapping and testing the relationship between density and nucleation values.

From these formulae, D and N indices were calculated for all of the 850 standard cells (Appendix 3) and from these statistics two chloropleth maps were constructed on a ten point scale (Figs.M.5-6). Viewed individually, these maps helped to emphasise some of the main features of areal differentiation of patterns distinguishable in the distribution map (M.3) and made it easier to isolate some of the areas worth closer examination (Chapters 16, 18, 19). A comparison of the two chloropleth distributions, however, was much more profitable than a separate assessment of each individual map.

This comparison of the two maps revealed that on the whole there were few radical differences between the two over-all patterns. Particular qualities of density seemed to be associated with particular qualities of nucleation or dispersion. Before proceeding any further, it seemed important to test whether or not this apparent association had any statistical significance. In order to do this, use was made of the D and N indices of a random sample of 10 standard cells (Table 11). These were given their appropriate ranks according to the chloropleth grades, and tested using Spearman's rank correlation co-efficient (r_{ho}), one of the oldest and best tried of the tests of association between ranked values[2]:

$$r_{ho} = 1 - \frac{6 \sum_{i=1}^{N} d_i^2}{N^3 - N}$$

where d = the difference between the ranks of D and N values for each cell.

N = the summation of paired ranks.

For a nonparametric test, it is necessary to set up a null hypothesis; a statement in opposition to the hypothesis which one is testing[3]. In this case, the null hypothesis is that there is no statistically valid relationship between density and nucleation values; that particular qualities of density are not associated with particular qualities of nucleation in a significantly consistent fashion.

The significance test (t) for samples of this size is:

$$t = r_{ho} \sqrt{\frac{N - 2}{1 - r_{ho}^2}}$$

In this case r_{ho} = 0.94 (Table 11) and the value of $t = 5.9$.

Using the appropriate probability table for this test[4], the above value was found to be significant at well above $p = 0.01$ (99%), and the null hypothesis can be rejected at this level of certainty. With this degree of significance, it is safe to assume that in most cases a given quality of nucleation will be associated with a given

Standard Cell No.	Ranks		d_i	d_i^2
	D	N		
B.24	1	5	- 4	16
C.20	2	4	- 2	4
C.23	1	4	- 3	9
M.4	10	10	0	0
M.21	1	6	- 5	25
O.22	1	6	- 5	25
Q.9	3	6	- 3	9
R.19	1	7	- 6	36
a.24	3	8	- 5	25
a.28	1	6	- 5	25
				$174 = \sum_{i=1}^{N} d_i^2$

d_i = difference between ranks in each cell.

Table 11

Testing the Association of Density and Nucleation Values

(Spearman's Rank Correlation Co-efficient r_{ho}).

degree of density.

4. <u>Stage Three: combining the indices into ordinal ranks, (DN)</u>.

It was now possible to envisage a combination of the two indices into one value (DN), for in this way normal associations could be distinguished from those which were more unusual, thereby isolating areas and patterns which might be worth further detailed consideration. The range of indices were grouped in three ordinal ranks (low, moderate, and high) and a matrix of these ordinal ranks for each index produced a ninepoint scale (i - ix) covering all possible alternative combinations (Tables 12 and 13).

Using this system, it was possible to allocate to each <u>standard cell</u> an ordinal rank - DN - (Appendix 3) and thereby provide three measures of rural settlement structure and pattern (<u>D</u>, <u>N</u> and <u>DN</u>) for each cell unit.

Most of the tests presented in subsequent chapters in this section relied on one or other of the measurements devised here. These tests cover a range of situations from the refined parametric measures to the nonparametric procedures which rely on ranking of data rather than direct representation.

Density	Nucleation	Ordinal Rank
>10.0 - 6.7	>20.0 - 13.4	High
6.6 - 3.4	13.3 - 6.8	Moderate
3.3 - 0.0	6.7 - 0.0	Low

Table 12

Ranges of Values for Ordinal Ranking of Density and Nucleation Indices.

D	N	DN
High	High	I
High	Moderate	II
High	Low	III
Moderate	High	IV
Moderate	Moderate	V
Moderate	Low	VI
Low	High	VII
Low	Moderate	VIII
Low	Low	IX

Table 13

Combined Ordinal Ranks (DN) of Density and Nucleation Values.

References.

1. The writer is indebted to Mr. J.C. Turner of the Department of Mathematics, Fourah Bay College, for assistance in devising this index.

2. Siegel, 1956, pp. 202-213.

3. Siegel, op.cit., pp. 6-7.

4. Siegel, op.cit., p.248.

CHAPTER 15.

THE STATISTICAL SIGNIFICANCE OF STRUCTURAL CHANGES IN THE MEAN VALUES OF SETTLEMENT IN STANDARD CELL SAMPLES: 1927 - 1964.

1. The Statistical Significance of Structural Change: 1927-1964.

The D and N indices for each of the standard cells chosen by the random sample were first used to test the significance of changes in the settlement pattern for the period spanned by the two topographical surveys. Two statistical tests were used, one parametric and one nonparametric. It was possible, in this way, to check the relative merits of both tests in solving a problem of this sort.

Student's "t" Test:[1]

Density and nucleation values were tabulated for the 49 standard cells in the two samples (Appendix 2b). Student's "t" test was used to compare the standard error of the difference between the means $D\ \bar{x}_s$ and $N\ \bar{x}_s$ for both surveys, using the following statistic:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\hat{\sigma}_1^2}{n_1} \quad \frac{\hat{\sigma}_2^2}{n_2}}}$$

where $\bar{x}$ = sample means for D and N.

o = best estimate of variance.

n = number in sample = 49

1 = 1927 sample.

2 = 1964 sample.

For the difference of the two means to be significant at the 5 per cent level, the value of t should be greater than 2 in both cases. In fact, the value of t was calculated to be 0.31 in the case of density, and 1.26 for nucleation (Table 14). There would seem, therefore, to be no statistical significance in the changing qualities of either D or N. The higher value of t for nucleation values may, however, reflect the beginnings of a trend towards new settlement structures in Sierra Leone, along the lines indicated in the last section (Chapter 13).

The drawback of this test was that it presumed a normal distribution of nucleation and density values. For a more thoroughly reliable conclusion, it was necessary to turn to a test which was distribution free.

Chi Square Test:[2]

In order to apply this test, use was made of the nine ordinal rank combinations, DN (Table 13), and not of the

	$\bar{x}_1$	$\bar{x}_2$	$\bar{x}_1-\bar{x}_2$	$\hat{\sigma}_1^2$	$\hat{\sigma}_2^2$	t
D	2.80	2.99	0.18	9.49	7.41	0.31
N	12.16	11.18	0.98	13.73	15.81	1.26

$\bar{x}_1$ = means in 1927

$\bar{x}_2$ = means in 1964

$\hat{\sigma}_1$ = sample standard deviation 1927

$\hat{\sigma}_2$ = sample standard deviation 1964

Table 14

Values for Student's "t" Test of Association Between Rural Settlement Patterns in 1927 and 1964.

D and N values independently as was done in the t test. Each randomly selected standard cell was given its appropriate ordinal rank combination index (Table 13), and the number of occurrences in each of the nine ranks was recorded (Table 15).

As this is a nonparametric test, a null hypothesis had to be set up. In this case, the null hypothesis (Ho) was that there is no statistical significance in the changes which have taken place in rural settlement pattern between 1927 and 1964.

The null hypothesis was tested by the following Chi Square (χ^2) formula:

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{k} \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

where O_{ij} = observed number of occurrences in the ith row and jth column.

E_{ij} = expected number of cases under Ho to be categorised in each rank.

r = no. of categories (9).

k = no. of rows (2).

In this case, Ho stipulates that there is no

Combined D.N. Ranks	1927		1964		Totals
	O	E	E	O	
1	6	5.0	5.0	4	10
11	0	0.5	0.5	1	1
111	0	0.5	0.5	1	1
1V	4	4.0	4.0	4	8
V	3	5.0	5.0	7	10
V1	0	1.0	1.0	2	2
V11	3	3.0	3.0	3	6
V111	30	28.5	28.5	27	57
1X	3	1.5	1.5	0	3
Totals	49	-	-	49	98

O = Observed number of occurrences
E = Expected number of occurrences following a null hypothesis of "no difference".

Table 15.

Calculation of Chi Square Value to Measure Settlement Changes 1927-1964.

difference between the two sets of values, and E is represented here by the mean of the two O values in each case (Table 15). Degrees of freedom (df) can be calculated by setting up an r and k contingency table:

$$df = (r - 1)\ (k - 1)$$

$$\text{i.e.}\ (9 - 1)\ (2 - 1) = 8.$$

Stages in the process of calculating χ^2 have not been presented here as they are summarised in the standard texts[3]. It is necessary merely to state that, in this case, $\chi^2 = 9.0$, and from a table of critical values of chi square[4], it is clear that for 8 degrees of freedom this value is significant ($p = 0.40$). This means that the probability of association between the settlement characteristics in 1927 and 1964 is high.

For the country as a whole, whatever regional and micro-regional variations there may be, it seems from the above results that there has been no significant change in settlement association during the last forty years. The results of the t test were therefore substantiated by a test using a different approach to the same original set of values.

2. <u>Conclusion</u>.

The results of both of these tests seemed to vindicate the hypothesis of a basic homogeneity of settlement structures upon which so much of the argument of this thesis has been based. Despite apparent changes in the pattern in certain areas (Chapter 13) and despite <u>apparently</u> significant variations in the structure (Chapter 10), when assessed purely qualitatively, there is no statistical significance in such changes.

Perhaps these tests do, however, indicate that purely qualitative 'eye-ball' methods of analysis, which allow the identification of changes at a 'sub-significant' level, may have considerable value. It can be argued that at the present stage of economic development in Sierra Leone, this identification may be more important than the tests which show them to be below the level of <u>statistical</u> significance. With this possibility in mind, the results of both statistical tests may reveal a pattern which is poised for more general alteration, rather than one which is static, as an initial reading of these results might suggest.

References.

1. Gregory, 1963, pp.124 - 125.

2. Gregory, 1963, pp. 154, 160; Siegel, 1955, pp.104-110.

3. Siegel, op.cit., pp.104-107.

4. Siegel, op.cit., p.249.

CHAPTER 16.

TESTING THE VALIDITY OF SETTLEMENT REGIONS.

1. Introduction.
2. The Chi Square Test of Regional Differences in the Settlement Pattern.
3. Statistical Tests of Micro-Regional Association Using Small Samples.
4. Conclusion.

1. Introduction.

Earlier in this dissertation, a regional analysis of settlement patterns was presented as an aid to defining micro-scale variations using purely qualitative and empirical methods of analysis (Chapter 9). The aim of this chapter is to use statistical tests to establish the validity of the broader of these regional divisions and to show how nonparametric statistical procedures are particularly useful in this context.

Several recent attempts have been made to use statistics to measure the validity of regional divisions.[1] Working from similar premises to those used in this work, Zobler has used Chi Square tests as well as variance analysis to test patterns of human geography in New Jersey. He writes:

> "If physiological and geological bases of separating the areas from each other are meaningful, the investigator can expect the related data on soils and land use, type of farming and population groups collected from each of these areas, to show a response to the spatial frame by exhibiting non-homogeneous areal distributions."[2]

By using the density and nucleation values of the standard cells ranked either independently, or together in ordinal scale (Chapter 14; Appendix 3), several nonparametric tests were available to assess the quality of regional divisions. Because of the limitations of field information, it has not been possible to give an accurate measure to the physical qualities against which Zobler tested his associations[3]. It was possible, however, to test whether or not settlement variations, expressed in terms of indices, showed any marked variations in relation to supposed physical regions. Under the hypotheses presented earlier (Chapters 4, 5 and 6), one would suppose that many of these variations are not significant in a statistical sense. Tests presented here show the value of these hypotheses of homogeneity.

2. The Chi Square Test of Regional Differences in the Settlement Pattern.

Several regions were selected to be tested by this method. Firstly, the Western Escarpment (AIIa), the Moa and Sewa Basins (BIb) and the 'Middle Belt' Granites (BII) were paired in matrix (Fig.23). Secondly, the Bullom Sands region (BIc) was paired with each of these three in turn (Fig.24). Although the patterns of settlement in all these regions were visually dissimilar, there seemed to be sufficient possibility of association to be worth testing. If they were shown to contain patterns which were

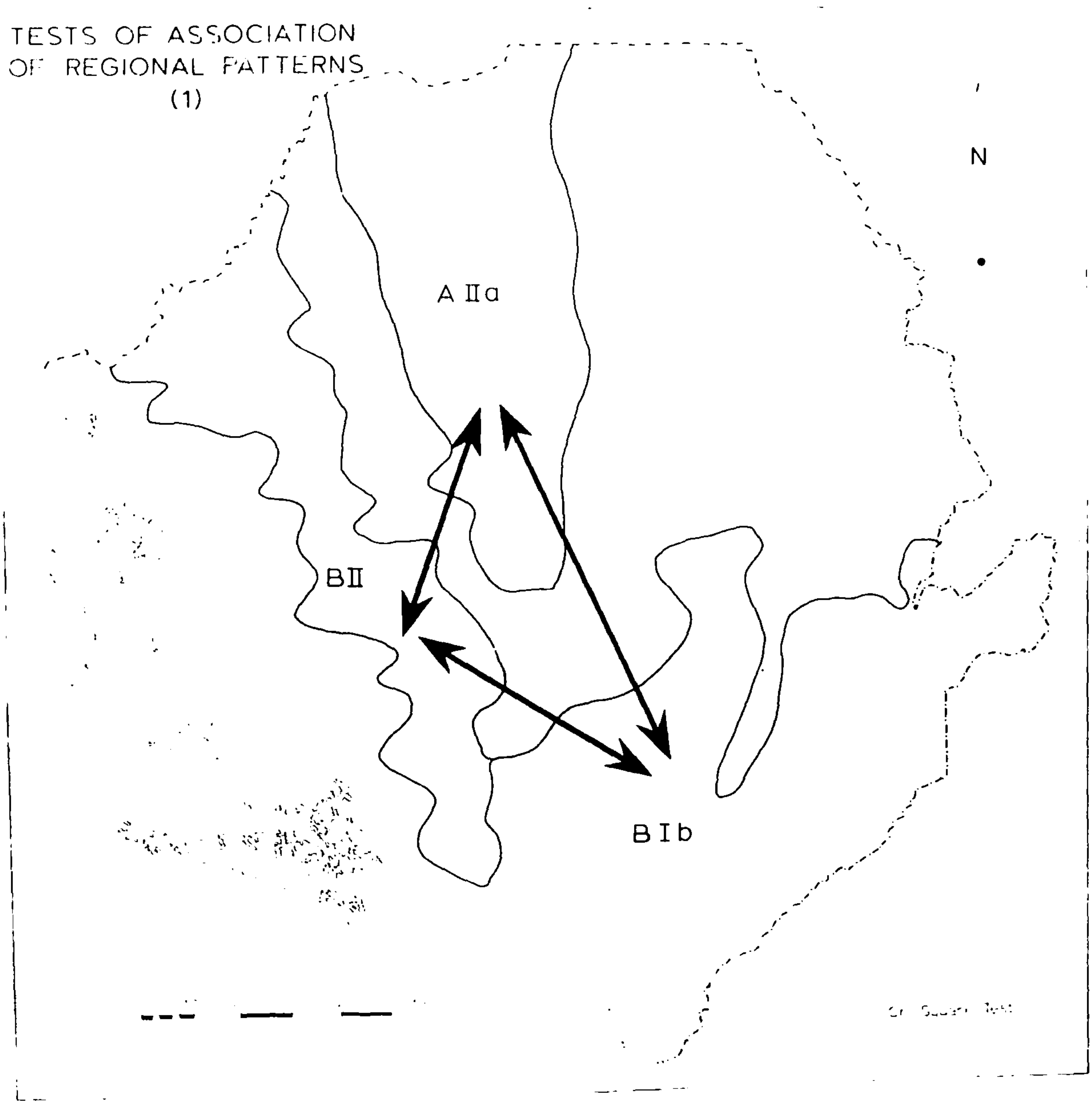


Fig. 23

different from one another, then it could be argued that other more obviously dissimilar regions (e.g. The Main Plateau and the Sewa and Moa Basins) need not be tested.

For each region, a sample of standard cells was taken and their D and N indices were tabulated. The frequencies of observed occurrences (O) of each rank for each region were also noted. The null hypothesis was that there is no significant difference in the statistical populations of the settlement indices of the regions and that their settlement patterns may therefore be regarded as homogeneous and the division into regions a mere descriptive convenience. Tables were set out using the standard procedures[4] for determining 'expected' (E) frequencies when samples are unequal in size.

Before making the necessary calculations, however, these results indicated that a further generalisation was necessary. The Chi Square test can only be applied when fewer than 20 per cent of the E values are less than 5[5]. In all cases there were more than the prescribed number of E values below 5. The only possible solution to this problem was to combine contiguous ranks[6] wherever this was possible.

This was not a particularly satisfactory solution and it remains as a deficiency of the method in this context. The amended tables, indicating rank pairings, were then set out (Appendix 4) and the calculation of χ^2 values proceeded.

The results of this test (Table 16) suggest that four of the six pairings show differences which make it possible to regard them as separate and distinctive in terms of settlement pattern, whereas differences between the other two (AIIa: BII, and BIc: AIIa) have a lower level of significance. The quite wide range in significance levels (from 0.001 - 0.50) indicates the limitations of purely visual assessment of regional differences in the settlement pattern.

3. Statistical Tests of Micro-Regional Association Using Small Samples.

Whilst Chi Square methods were fairly adequate for testing associations between the broader regions, they were not useful when it came to testing the significance of variations within settlement regions, i.e. the validity of the settlement micro-regions. Even for the larger units, the combination of ranks made necessary by the small size of

Regions	χ^2	df	Significance Level (a)	Null Hypothesis of "no difference"	
				Accept	Reject
AIIa/BIb	14.4	5	0.001		*
AIIa/BII	10.4	4	0.03	*	
BIb/BII	20.5	5	0.01		*
BIc/BIb	34.7	6	0.001		*
BIc/BII	24.17	6	0.001		*
BIc/AIIa	4.34	5	0.50	*	

To a probability level of 99.9%.

Table 16

Chi Square Values and Significance Levels

of Regional Association for

Selected Settlement Regions (Appendix 4).

samples and the large number of categories limited the value of results. For the analysis of micro-areal variations, attention was therefore turned to tests designed to serve small samples.

Several tests have been devised to examine the difference between populations, either equal or unequal in size, using only small samples[7]. Most of these depend on the ordering of scores from two samples (A and B) in consecutive sequence, irrespective of sample. A statistical estimate of the distribution of values is then made on the theory that a well distributed sequence (ABABABABABA) indicates that the two samples are from the same population, whereas a dichotomous distribution (AAAAABBBBB) shows that the two samples do not belong to the same population. All tests attempt to assess the significance of differences in relation to these two extremes. Some regard the sequence as a rank order, others as a sequence of runs. Two tests were chosen here for their efficiency with small or very small samples: the Mann - Whitney 'U' Test and the Kolmogorov - Smirnov Two Sample Test[8].

The Mann-Whitney 'U' test:

This test is one of the most powerful of the nonparametric tests[9], with a power of efficiency approaching 95 per cent when compared with its parametric equivalent, the "t" Test, and it may be used with small samples. The hypothesis ($\underline{H_i}$) to be tested in this case is that samples are not taken from the same population. This hypothesis can be accepted if the probability ($\underline{p}$) of a score from one sample ($\underline{a}$) being larger than a score from the other ($\underline{b}$) is greater than one half:

i.e. $H_i = p\ (a > b)\ \neq \frac{1}{2}$

where a = a score from one sample.

b = a score from the other sample.

The null hypothesis ($\underline{H_o}$) is that the samples have been taken from the same population.

The test statistic (U) is derived from the number of times a score from the largest sample (n_2) precedes a score from the smaller sample (n_1):

$$U = n_1 n_2 + \frac{n_2\ (n_2 + 1)}{2} - R2$$

where R = the sum of the ranks assigned whose sample size is n_2.

The Kolmogorov - Smirnov Two Sample Test:

This test is 'two tailed' in that it needs no predicted direction of difference[10]. It can also be used with very small samples, providing they are of equal size. The required level of significance of this test is 0.05. The statistic ("D") may be presented in the following form:

"D" = Maximum $(Sn_1 (x) - Sn_2 (x))$

where n_1 = number of occurrences in one sample.

n_2 = number of occurrences in another sample.

$Sn (x)$ = the observed cumulative step function of one of the samples.

The Kolmogorov - Smirnov test was used to test the intra-regional homogeneity of the Bolilands region (BIa) within which 12 micro-regions of settlement variation have been distinguished (Fig. M.4). The null hypothesis was that samples of D + N taken from different areas to the north and south of this region will show that they belong to the same population and that the region has a definite viability. Four standard cells were selected from each of two areas, one to the north and one to the south of the region (K7, L8, M9, N10 and R10, S11, T12, U13; vide Appendix 3). The ranges of values for both density and nucleation were examined and the step functions established. There were six in the case of density and five for nucleation.

The test statistic ("D") values were found to be 1 for density and 2 for nucleation. Reference to significance levels for this test[11] show that the critical value of "D" is 4 when n=4. If the value of "D" is the same or less than 4, then the null hypothesis can be rejected. In this case, therefore, there seems to be some statistical justification for distinguishing the 12 micro-regional divisions of this region.

Testing other regions for a similar hypothesis involved comparison of areas which were frequently unequal in size. The Kolmogorov-Smirnov Test, although rapidly applied, cannot be used when samples are of unequal size. The Mann-Whitney 'U' Test was therefore adopted to test two further regions for intra-regional homogeneity: the Moa and Sewa Basins (B I b), and the Bullom Sands (B I c).

For the Moa and Sewa Basins, 2 samples of nine cells and six cells, respectively, were taken from each of the two main divisions (B I $b_{1 \text{ and } 2}$). The values for both density and nucleation were ranked in ascending size order and assigned to the micro-region from which they were taken. The 'U' statistic was then calculated. The same procedure was followed for samples of standard cells from both the eastern and western areas of the Bullom sands sub-region.

These calculations (Table 17) showed that in both these broad regions 'U' values for both density and nucleation were above the significance level for rejecting the null hypothesis of similarity in pattern at the 0.05 level. Settlement patterns do vary significantly within the macro-regions defined by empirical methods. In general it would seem, therefore, that micro-regional sub-divisions are justified in most cases. This qualification is due to the fact that in the case of nucleation for region B I b, and density for B I c, 'U' values approached acceptance at this level of significance, and it may be suggested that further testing would be necessary before a firm conclusion could be reached.

4. Conclusion.

The homogeneity of rural settlement forms and patterns was a major premise of this dissertation. An analysis of the structure of rural settlement (Chapters 10) indicated that there may have been important modifications of the

Region B I b	D	N	Region B I c	D	N
'U' Value	22.1	13.4	'U' Value	17.5	23.3
Rejection Levels	10	10	Rejection Levels	17	17

Significance level 0.05.

Table 17

'U' Values and Rejection Levels for Testing

Intra-Regional Variations (Mann-Whitney Test).

homogeneous structure in the past. It also showed that new social and economic forces are today beginning to make an important impact on traditional rural settlements, although the over-all impact of these changes may be statistically insignificant (Chapter 15).

A regional analysis of patterns (Chapter 9) has attempted to qualify this generalisation by relating particular settlement associations with physical and human variations. Statistical testing of these regions has now revealed that these qualifications are justified.

Within the limitations of the cell unit of measurement, and the techniques which were used in this chapter, it seems possible to view the settlement regions as a whole and as a viable and useful guide to areal variations. The general homogeneity of patterns and structures indicated earlier (Chapters 4, 10) may have blurred large scale variations, but smaller scale variations can readily be identified.

A general pattern would now seem to be emerging from these findings. Macro-scale statistical tests have so far vindicated the general hypothesis of settlement homogeneity. More detailed empirical and statistical observations suggest, however, that despite this analysis, there have been considerable micro-scale variations in rural settlement conditions both in space and time. If there is to be no contradiction in these two viewpoints, one must presume that such variations have taken place within a broad framework of homogeneity. This is possible. The microscope slide which appears monochrome and static at a low power of observation is transformed into a vivid complex of structures or movements when adjusted to higher powered lenses. In the same way, it seemed profitable to alter the scale of analysis so as to view these variations at micro-scale, and in terms of other more specific hypotheses rather than at the level of statistical observation adopted so far. Subsequent chapters in this thesis attempt to show the value of this modified approach.

References.

1. Bogue, 1957; Mackay, 1958; MacKay & Berry, 1959; Vining, 1953; Zobler, 1957, 1958.

2. Zobler, 1957, p.83.

3. Zobler, op.cit., 1957, pp.85-94.

4. Siegel, 1956, pp.104-111.

5. Siegel, op.cit.,p.110.

6. Siegel, op.cit.,p.110.

7. Siegel, op.cit., pp.95-156.

8. Mann and Whitney, 1947; Kolmogorov, 1941; Smirnov, 1948.

9. Siegel, op.cit.,p.126.

10. Siegel, op.cit., p.127.

11. Siegel, op.cit.,p.276.

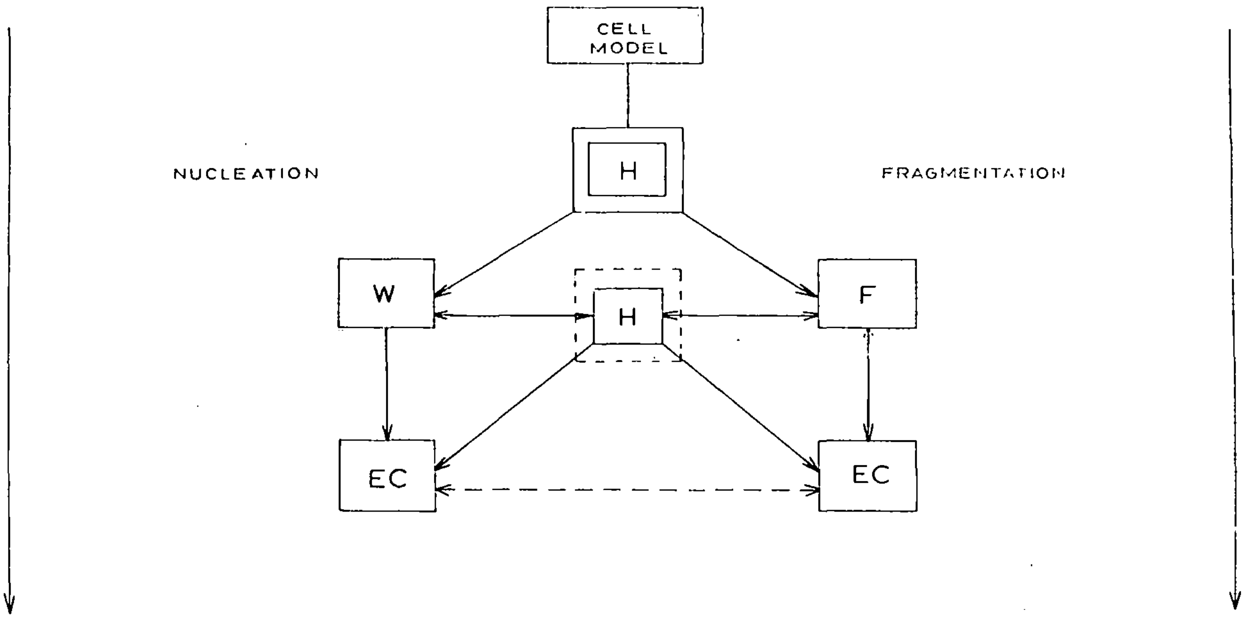
CHAPTER 17.

METHODS FOR DISTINGUISHING AREAS OF SPECIAL PATTERN ASSOCIATIONS : THE EVOLUTIONARY APPROACH.

1. A Sequential System of DN Values.
2. Set Theory as an Aid to Solving Problems of Areal Differentiation.
3. Areal Distributions of DN Sets.
4. Conclusion.

PROJECTING TRENDS OF RURAL SETTLEMENT EVOLUTION

A THEORETICAL SEQUENTIAL MODEL



H AN HOMOGENEOUS 'MODEL' SETTLEMENT PATTERN

W A NUCLEATED WAR-TOWN PATTERN

F A FRAGMENTED SETTLEMENT PATTERN

EC A HIGH DENSITY NUCLEATED PATTERN

Fig. 25

1. A Sequential System of DN Values.

Using the arguments of settlement evolution presented earlier in this dissertation, it seemed possible to view the DN combined ranks (Table 13 and Fig. M.7) as elements in alternative theoretical sequences of settlement evolution. The starting point of this system was taken as the hypothetical transition from shifting cultivation to the fixed settlements of bush fallow agriculture, as shown by the cell model.

The sequences can be briefly presented as follows. The cell model situation (1a:6b:42c) represents a homogeneous response to homogeneous landscape conditions in a period of moderately low settlement density (Table 9 and Chapter 6). This situation may be reflected in the range of D and N values around the means and can be represented by DN = viii (low density, moderate nucleation; Table 13).

From this condition, it has been argued that settlement structures have moved through a 'war-town' period (Chapter 11) ~~11)~~ in which smaller settlements became less numerous and larger settlements evolved, possibly with clustering around the dominant village (e.g. 4a:1b:8c). This pattern may best be represented by the following DN values:

vii (low density, high nucleation); _i_ (high density, high nucleation); _iv_ (moderate density, high nucleation).

More recently, it seems that in some areas social and economic changes have brought about further modifications; with increasing density in one region and decreases in another, both accompanied by marked changes in the quality of nucleation (Chapter 13). Here, a wider range of _DN_ values can be ascribed. For example, a 'war-town' structure, in which there is moderate density and high nucleation (_DNiv_), may have recently become subject to economic changes causing fragmentation, and so moved towards a stage of moderate density and low nucleation (_DNvi_), possibly passing through a period when it had moderate densities and moderate nucleation (_DNv_). On the other hand, a settlement structure may have remained in the 'war-town' state or progressed once more into the stage of 'homogeneous' structures (_DNviii_).

It seemed at first sight, that the number of possible sequences and alternatives was extremely large, and that little could be made of this approach. But after following each possible sequence through its logical alternatives, it did seem feasible to devise a system which could account for all the possibilities. It was very unlikely, for example, that a cell which had passed from a 'war-town' structure to another state would return once again to this condition. Similarly, an area with low density and low nucleation (DNix) could only remain in this state or move towards higher density and greater nucleation (i.e. ix   vi, or viii   v   iv, or ii   i). Less obvious examples (e.g. DNv and viii) were more hypothetical, and the range of sequence alternatives was wider.

With these terms of reference, it was possible, nevertheless, to devise a theoretical sequential system which covered most alternatives (Fig. 25) and also to set out a table of alternatives for each DN value which corresponded with this system (Table 18)~~and Fig. 29).~~

Each DN value could now be clearly seen as part of several sequential systems. A pattern represented by DNi, (Fig. 26) may be a severe case of 'war-town' nucleation, or an area where high density and high nucleation are associated with special economic developments (e.g. rice growing in the Scarcies estuary). On the other hand, a DNviii structure may be an area which social and economic changes have passed by, i.e. an original structure close to the model; or it may be representative of a stage in pattern development when the 'war-town' structure was

Theory of Settlement Evolution	Features of Pattern	Possible Starting Points in DN Sequence	Alternative Sequential Possibilities
Cell Model	Increasing Nucleation (low-moderate density)	IX	IX → VIIII
War Town Formation	Nucleation high-moderate density	VIII	VIII → VII VIII → V VIII — V → IV VIII — V — IV → I
		VIII	VIII → V VIII — V → VI VIII — V — VI → III
	Fragmentation	VII	VII → VIII VII — VIII → IX
		V	V → VIII V — VIII → IX
		IV	IV → V IV — V → VIII IV — V — VIII → IX
		I	I → IV I — IV → V I — IV — V → VIII
Economic and Social Changes	Fragmentation	VII	VII → V VII — V → II VII — V — II → III
		V	V → II V — II → III
		IX	IX → VI
	Nucleation	VIII	VIII → V VII — V → {IV, II} VIII — V — {IV, II} → I
		IX	IX → VIII IX — VIII — V → {II, IV} IX — VIII → V IX — VIII — V — {II, IV} → I

I	=	high density high nucleation
II	=	high density moderate nucleation
III	=	high density low nucleation
IV	=	moderate density high nucleation
V	=	moderate density moderate nucleation
VI	=	moderate density low nucleation
VII	=	low density high nucleation
VIII	=	low density moderate nucleation
IX	=	low density low nucleation

Table 18

Theoretical Sequences of Settlement

Evolution Expressed by

DN Ranks.

breaking up or when a totally fragmented structure was coalescing - both in response to new forces.

One method of checking the accuracy of these estimations, and the theories on which they were based, presented itself. It was argued that the number of times a DN value occurred as an end product in the sequence (Table 18) should be matched by the number of times it occurred in the standard cell population (Appendix 3). In other words, those values which were 'end members' of most sequences should occur most frequently in today's settlement distribution. In this case, the sequence occurrences could be ranked in order and compared with a rank ordering of percentages of each DN value in each standard cell tested, using Spearman's rank order correlation coefficient[1] (r_{ho}).

Under this hypothesis, the larger the number of alternative sequences in which any given value of DN is a member, the more cells with this DN value in the total cell population there are likely to be. On the other hand, the smaller the number of sequences in which a value of DN is a member, the less likely they are to be found in large numbers in the cell population. The null hypothesis for testing was that there was no significant association between the ranked orders of both sets of information (Table 19).

DN	A	B	A_a	B_b	d_i	d_i^2
i	8.8	4	4	3	1	1
ii	3.2	3	7	5	2	4
iii	0.9	4	9	3	6	36
iv	10.2	3	3	4	-1	1
v	16.5	8	2	1	1	1
vi	4.5	3	5	5	0	0
vii	4.1	2	6	6	0	0
viii	49.3	5	1	2	-1	1
ix	2.5	3	8	5	3	9

$$\sum d_i^2 = 53$$

A = Percentage of total number of standard cells.

B = Number of theoretical sequences in which DN value is a member (Table 18).

A_a = Rank order of A

B_b = Rank order of B

$d_i = A_a - B_b$

Table 19.

Testing The Relationship Between Theorteical Sequences of Settlement Evolution and The Standard Cell Population: Spearman's Rank Correlation Coefficient (r_{ho}).

The coefficient of correlation (r_{ho}) was 0.615, which was significant at just under the 0.05 (95%) level, and so it was possible to reject the null hypothesis at this level of certainty.

The strong association revealed by this test seemed sufficient vindication of the theories on which the sequential system was based, and of the accuracy of the sequence calculations. It was now possible to turn to the problems of mapping this information, so as to reveal special settlement areas.

2. Set Theory as an Aid to Solving Problems of Areal Differentiation.

The problems involved in mapping the large number of possible theoretical sequences to which any one DN value may belong seemed best solved by applying the methods of Set Theory.

Set Theory has been defined as:

> "any collection into a whole of definite distinguishable objects which will be called elements"[2]

or

> "a collection of definite and distinguishable objects (either) concrete or conceptual".[3]

It became part of mathematics at the end of the nineteenth century, following the work of Cantor[4] on methods of dealing with runs of different but infinite numbers. It may perhaps best be defined as a form of symbolic logic, a means of gaining fresh insights, rather than a mathematical technique. Set Theory assists with the problems of defining and classifying information which may then be understood more clearly. Its use has recently been extended into the fields of political theory[5], social and economic theory[6], and even linguistics[7]. So far, geographers have made little use of the technique, although both Haggett[8] and Cole[9] have drawn attention to its possibilities. It is hoped that the methods presented here will provide one useful indication of the scope of Set Theory in sorting out alternative explanations of variation in spatial phenomena.

In this development, the following conventional[10] set theory notation will be used:

$\{\quad\}$ = membership of a set.

$\in$ = an element of a set or sub-set.

$\notin$ = not an element of a set or sub-set.

$\cup$ = a union between sets (elements belonging to either or both of two or more sets).

$\cap$ = an intersection of sets (elements belonging to either but not both of two sets).

$\subset$ = a sub-set of a set (elements which are members of a set which are also members of a larger set).

Following the arguments presented earlier in this chapter, and in Chapter 13, it is possible to distinguish four theoretical frames, or sets, to explain variation in rural settlement:

a) A main set (cell model theory) from which all others will be derived. This will be termed set MM.

b) A sub-set reflecting 'war-town' conditions, where there will be high or moderately high nucleation. This set will be called wn.

c) A sub-set reflecting economic development associated with increasing nucleation (en).

d) A sub-set also reflecting economic development but associated with increasing fragmentation (ef).

Each DN value (i - ix) can now be ascribed to appropriate sets in the following way:

MM = [viii]

wn = {i , iv , v , vii , ix}

en = {i , ii , iv , v}

ef = {ii , iii , v , vi}

The sub-set membership of each DN value can also be shown:

i = $wn \cup en \not\subset ef$

ii = $ef \cup en \not\subset wn$

iii = $ef \not\subset en \not\subset wn$

iv = $wn \cup en \not\subset ef$

v = $wn \cup en \cup ef$

vi = $ef \not\subset wn \not\subset en$

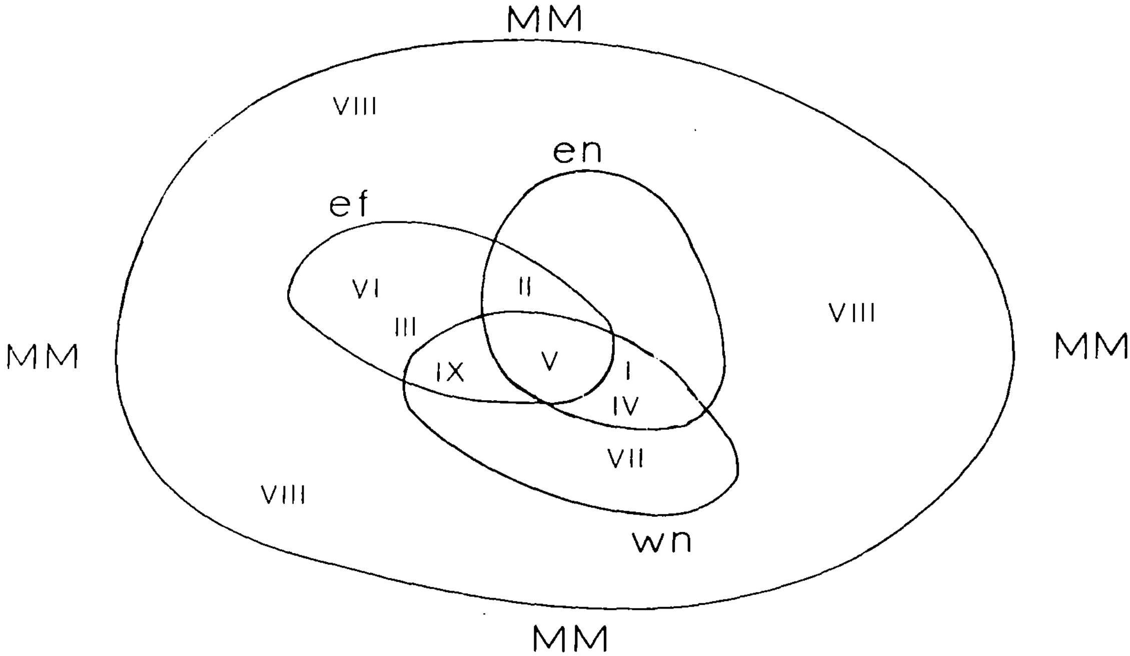
vii = $wn \not\subset en \not\subset ef$

viii = $MM \cup wn \cup en \cup ef$

ix = $wn \cup ef \not\subset en$

These relationships are clearer when constituted in the form of a Venn-Euler diagram (Fig.27). This diagram reveals that only sub-sets ef and wn have elements not included in other sub-sets, and that apart from element viii in the dominant set MM, the elements i, ii, iv, and ix are intersective of sub-sets, with v as a possible member of all sets.

By consulting the table of possible sequences (Table 18) ~~14)~~ and the Venn-Euler diagram (Fig. 27), the DN elements in each set could be arranged in order of importance or intensity for each set in which they were elements. For sub-set en, for example, the following order of significance i, iv, ii, v would distinguish the ordering of DN values most likely to represent the conditions of the sub-set.



VENN-EULAR DIAGRAM OF COMBINED RANKS (DN) THEORETICALLY ARRANGED IN SETS

Fig. 27

Similarly, for sub-set ef the order would be iii, vi, ii, ix, v. DN v, as an element of three sub-sets, would have the lowest level of association. The main set MM seemed best represented by only two grades of association, viii and v, as all other associations were much more dubious.

By using a qualitative chloropleth density range, i.e. mapping the levels of significant membership by intensities of shading, a series of maps of set membership were constructed (Figs. M. 8 - 11).

3. Areal Distributions of DN Sets.

Set MM ; {viii, v} : (Fig. M.8).

The map of this set distribution is further vindication of the theory of homogeneity which was presented at the beginning of this dissertation (Chapter 4) and which has been a major theme of the work. This is the range of values on 'either side' of the mean standard cell, the theoretical starting distribution of all variants. It should be noted that 49.3 per cent of all DN values fall in viii and 65.8 per cent in either viii or v.

If one were to argue that this is the original association which once dominated the whole country, there would be ample justification in this map. The distribution of viii cells is, in fact, a clear indication of the areas where economic development has been most limited; e.g. the un-improved swamps, and much of the north eastern plateau. These are, in a sense, the 'depressed areas' of Sierra Leone, which would indeed be most likely to retain traditional settlement associations. Some viii distributions, however, may reveal areas in transition from one structure to another. These may best be distinguished by using this map in conjunction with the others in this series.

Set wn ; {vii, i, iv, v, ix}: (Fig. M.9).

This distribution distinguishes those areas which are most distinctively 'war-town' in structure, with low settlement densities and high nucleation (vii), from those which may be due to either 'war-town' or economic development or both (wn $\cup$ en), namely iv and i. Finally, there are cells with moderate density and nucleation (v) which could belong to any set.

The problem of producing a meaningful map of these values was not so straightforward. For only one value (vii) is the association with the 'war-town' structure fairly definite. Other sub-set elements are not so clear. The other elements could, therefore, only be related directly to this vii distribution. On the plateaux, for example, the preponderant distribution is of viii, and the vii values could be regarded as survivals of the earlier dominant 'war-town' structure - cultural monadnocks in a plain reversion to more rational settlement patterns. In this region, however, the areas dominated by individual 'war-towns' were possibly greater than in the lowlands, and the standard cell collecting frame unit and calculation would probably mask this.

On the other hand, there are areas of the north west where i, iv, and v are common, but because this region was not densely settled until recently (Fig. M.3), the patterns are clearly not 'war-town' in origin.

One other example of the difficulty of areal variation in response to the 'war-town' situation may be quoted. In the Mende chiefdoms of the south, there is a large 'wedge' of DN i values which may be due to economic development, but this is an area where warfare was once very much a way of life (Chapter 11.3) and one must therefore try to show it as such, even though the structures may now be supported by new economic factors.

Only an empirical evaluation of the importance of each distribution of sub-set elements would seem to give an adequate idea of the relative strength of survival of the 'war-town' pattern in each area.

Within the range of values covered by this sub-set, each area of occurrence on the map was therefore assessed on its own merits, using qualitative judgements. The resultant distribution map is probably more satisfactory in distinguishing these patterns than any other method. The map reveals an important north east - south west trending zone of 'war-towns' which separated the two major tribes (Temne and Mende), and the area of Mendeland where they are known to have been numerous is also clearly distinguished.

Set <u>en</u> ; $\{$i, iv, v, ii$\}$: (Fig. M.10).

Once more it was possible to use a background knowledge of areas of economic development to highlight the parts of this distribution which seemed to show nucleation due to economic factors rather than as a survival of 'war-town' conditions: e.g. the Scarcies swamp lands of the north west, the Temne oil palm and rice areas in the centre, and the main trunk road and railway associations. These could be distinguished from other areas, such as the coffee and cocoa zones of Mendeland, where a 'war-town' structure has perhaps been 'fortified' by economic developments.

Set ef ; {iii, vi, ii, v, ix} : (Fig. M.11).

In areas of the north where there are concentrations of cells with high density and low nucleation values, there can be little doubt that there is an association with the Fula cattle immigrants. This is especially noticeable around Port Lokko, Kamakwi and Makeni which are the chief cattle marketing points. In the south, similar patterns possibly distinguish the development of special cash crops ~~(Chapter~~ or areas subject to migration to the diamond fields in the east (Chapters 9.3 and 13.2).

4. Conclusion.

The maps of the distributions of sets of DN values (Figs.M.8-11) accord with the theories of settlement evaluation presented in earlier chapters. They do not aim to prove relationships. Their main function is to give tangible spatial dimensions to these theories using indices and the sequential model developed in the first part of the chapter. Providing the theoretical framework is sound, set theory helps to distinguish those areas which are most likely to show a relationship to a particular hypothesis, from those which are both less and least likely to do so. The chlorpleth shades of the maps give an impression of these grades of possible association. It is hoped that they thereby distinguish those areas where traditional values are still of paramount importance (sets wn and MM) from those in which new socio-economic factors may be bringing important changes in settlement responses (sets en and ef). Such maps could therefore have important applications in economic planning.

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CHAPTER 18.

NEAREST NEIGHBOUR TESTS OF THE CELL MODEL THEORY OF SETTLEMENT EVOLUTION.

1. Introduction.
2. The Thompson Test of Random Distribution.
3. The Dacey-Clark test of Regular Distribution.
4. The Clark Test of Linear Spacing of Points and the 1908 Army Route Statistics.
5. Conclusion.

1. Introduction.

During the 1950s, ecologists Clark[1], Evans[2] and Thompson[3] devised methods for measuring the degree of regular, cluster, or random distributions of plants and animals using techniques which have become known collectively as 'nearest-neighbour analysis'. More recently, these methods have been taken up by geographers, especially Dacey[4], King[5], and Mayfield[6], to test human distributions. In the last chapter, settlement pattern indices were mapped using set theory and the hypotheses so far presented to account for variation in the pattern of settlement in Sierra Leone. Within the terms of reference of nearest-neighbour analysis, these hypotheses may be summarised in the following way:

a) that settlements are geometrically regular in distribution (cell model hypothesis, set MM; Fig. M.8),

b) that settlements have clustered around dominant central places either for defence or, more recently, for economic advantage ('war-town' and economic nucleation hypotheses, sets wn and en; Figs. M.9 and 10)

c) that regular and clustered patterns never existed, or if they did, then they are now breaking up to form more irregular associations (economic fragmentation, set ef; Fig. M.11).

Three tests were used to assess the merits of these alternative bypotheses. The first method relied on Thompson's statistics without modification. The second test was the present writer's own adaptation of both the Clark and Evans and the Dacey methods, and the third was Clark's statistic for measuring a linear relationship of points.

2. The Thompson Test of Random Distribution.

Thompson compares the average nearest neighbour distances in a given distribution with those expected for a random distribution. For each nearest neighbour level, the mean distance ($\bar{x}_n$) is calculated for any given area using the following statistic:

$$\bar{x}_n = \frac{2\pi \sum r_n^2}{A}$$

where N = number of individuals for which distances are read

r_n = the distance from any one N individual to its n^{th} nearest neighbour

A = area within which measurements are made

For a random distribution, the following formula provides 95% confidence limits:

$$\frac{\left(\sqrt{(4N_n - 1)} \pm 1.96\right)^2}{2\ N}$$

Certain reservations concerning the use of this significance statistic for geographical data will be made below . For most distributions, however, if the mean distance of a nearest neighbour level is above the upper limit of confidence the points show a significant regularity of distribution. If the value lies below the lower limit then there is significant clustering of points.

A sample of ten 1:50,000 sheets covered a wide enough area of the country (approximately 2,800 miles) to test a range of possible variations in nearest neighbour associations (Fig. 28). For such a large test area, and so many villages, it was necessary to set up the data for computer programming using the ICT 1904 Computer[7] and a FORTRAN IV program. This was done by plotting the six figure grid reference of each a and b category village on each of the ten sheets in the sample. A programme was then devised using co-ordinate geometry, and the test statistics were applied to four nearest neighbour levels.

One important feature of the statistic for testing significance has an important bearing on the results of this exercise (Table 20). The statistic is based on the premise that the surface is entirely uniform[8]. On such a surface, the

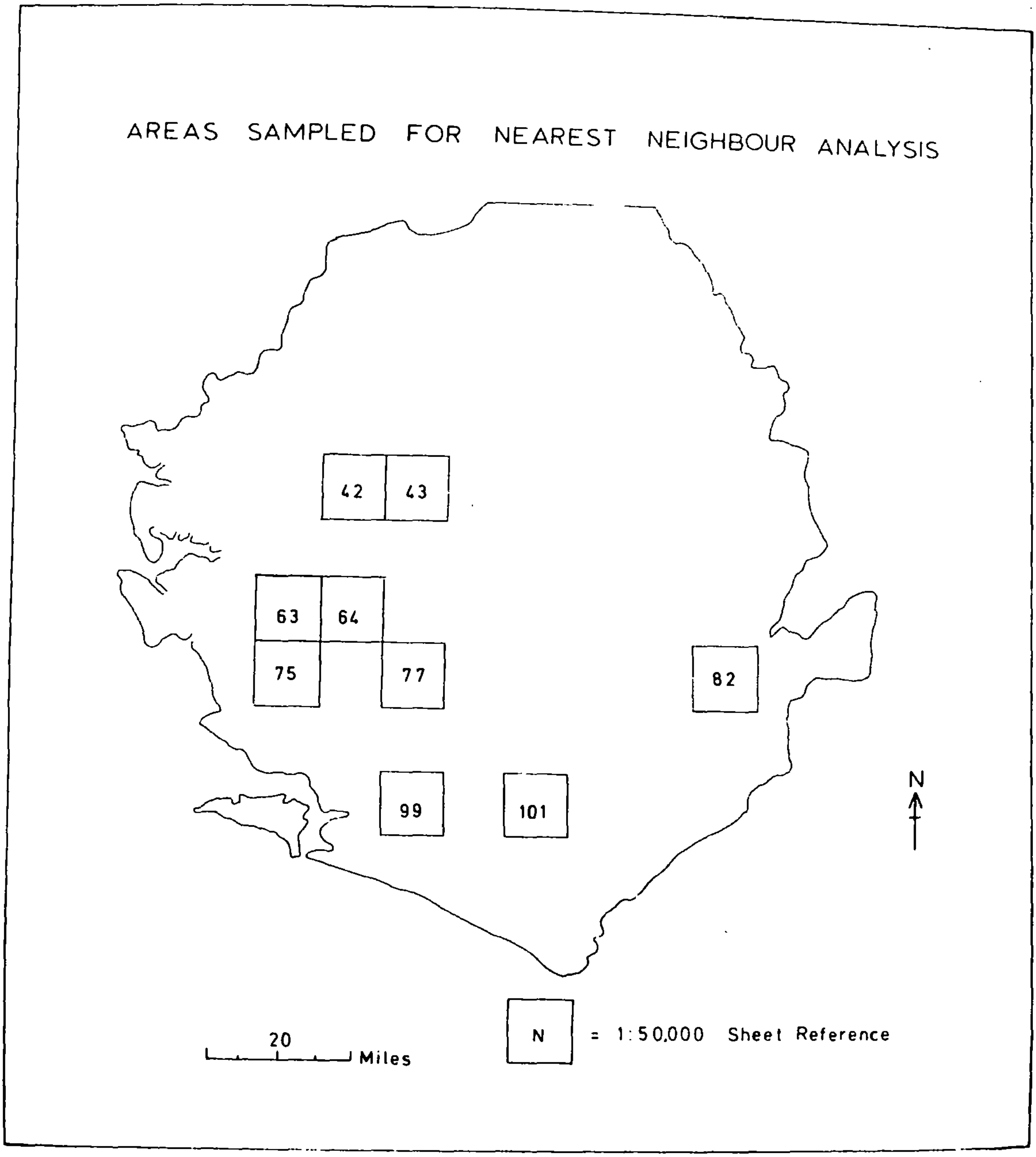

AREAS SAMPLED FOR NEAREST NEIGHBOUR ANALYSIS
42
43
63
64
75
77
82
99
101
N
20
Miles
N
= 1:50,000 Sheet Reference

Fig. 28

1:50,000 Map Sheet Number	Nearest Neighbour Level	Random Distribution Confidence Limits at 95% Probability Lower	Upper	Mean Nearest Neighbour Values
41	1	1.61	2.41	2.19
	2	3.44	4.58	4.66 →
	3	5.32	6.71	6.67 - - →
	4	7.21	8.81	8.86 →
42	1	1.55	2.48	2.08
	2	3.37	4.67	3.83
	3	5.22	6.82	5.99
	4	7.09	8.94	7.98
43	1	1.62	2.41	2.30 - - →
	2	3.46	4.57	4.39
	3	5.33	6.70	6.10
	4	7.23	8.80	7.91
63	1	1.33	2.76	2.47
	2	3.04	5.06	4.15
	3	4.81	7.28	5.71
	4	6.62	9.48	7.01
64	1	1.62	2.40	2.46 →
	2	3.46	4.57	4.62 →
	3	5.33	6.69	6.45 - - →
	4	7.23	8.80	8.14

Continued....

1:50,000 Map Sheet Number	Nearest Neighbour Level	Random Distribution Confidence Limits at 95% Probability: Lower	Upper	Mean Nearest Neighbour Values
75	1	1.23	2.89	←1.49
	2	2.88	5.24	←2.61
	3	4.62	7.51	←4.32
	4	6.39	9.73	←6.16
77	1	1.64	2.38	2.47→
	2	3.49	4.54	4.61→
	3	5.37	6.65	6.46 - ->
	4	7.27	8.75	8.88→
82	1	1.35	2.73	←1.21
	2	3.06	5.02	←2.62
	3	4.84	7.24	←3.28
	4	6.66	9.43	←4.29
99	1	1.64	2.37	2.32 - ->
	2	3.49	4.53	4.61→
	3	5.37	6.65	6.48 - ->
	4	7.28	8.75	8.33 - ->
101	1	1.40	2.68	2.60 - ->
	2	3.13	4.95	4.19 - ->
	3	4.92	7.15	7.15→
	4	6.75	9.33	9.12 - ->

$p = 0.50$

——→ Significantly regular
- - → Probably significantly regular
←—— Significantly clustered

Table 20

Mean Nearest Neighbour Values and Significance Levels (Thompson Test) the points in the distribution have the opportunity to inter-act one with another without any 'outside' interference. In the case of geographical surfaces, one cannot presume such a 'noise-free' situation. The landscape of equipotentiality may be approached but it can never actually exist. A varying proportion of the land surface covered by any map sheet will be uninhabitable for "social, geographical or economic reasons"[9]. To test the significance of settlement spacing, these elements should be accounted for in the calculation. If they are not (as in this case) then a greater degree of randomization can be expected than would otherwise be the case.

Examination of the results will show that many of the apparently random values do in fact approach the upper limits of the random range. In these cases, one may reasonably presume a higher degree of possible significance than an initial reading of the results would imply.

Three types of mean nearest neighbour qualities can therefore be distinguished from these results: those which are definitely significant at 95% probability, showing either cluster or regular distributions; those which are probably significantly regular, approaching the upper limits of the random range; and those which are definitely not significant, falling near the centre of the random range. These three orders of significance have been indicated in Table 19.

With this reading of the results, it will be seen that out of 40 mean nearest neighbour levels calculated from the 10 map sheets, 19 show probably significantly regular distributions, 8 show significant cluster distributions and only 13 are entirely random. The areas where cluster and random distribution occur are those in which economic changes are thought to be influencing settlement patterns (Chapters 9.3, 13, 17.3: Figs. M.10, 11, 12, 13, 14). It would seem safe to assume that, in most areas, regular cell model type spacing of villages has become less common as new values interfere with subsistence responses. The fact that such a large area still shows a definite tendency to regularity is a vindication of the theoretical premises on which this thesis is based.

Despite the useful nature of these results, however, the generalised treatment of whole map sheets was a deficiency of the method. Each map sheet covered areas where special micro-variations in pattern are clearly evident and these variations are masked by the over-all means of the Thompson formula. To give a more spatially orientated result, attention was turned to the Dacey and Clark methods of analysis.

3. <u>Testing the 'Cell-Model' Hypothesis of Regular Distribution.</u>

Clark and Evans, and Dacey[10], used different methods to determine the characteristics of specified point distributions - a field of prairie-dog burrows in the first case and the settlement pattern of south western Wisconsin in the second.

Clark and Evans devised a formula (R_n) to define a point pattern in terms of a continuum of values from maximum clustering ($R_n = 0$) to completely random ($R_n = 1$) and then to maximum regularity ($R_n = 2.149$). This formula may be expressed as follows:

$$R_n = \frac{\bar{D}_{obs}}{0.5\left(\frac{A}{N}\right)^{-\frac{1}{2}}}$$

where $\bar{D}_{obs}$ = mean nearest neighbour distance between points
A = area chosen for study
N = number of points measured

Dacey used a much more complex procedure involving an 'unbounded' hexagonal frame, the geometric properties of a hexagon, and the Poisson series to define significant departure from regularity in terms of either randomization or clustering of points.

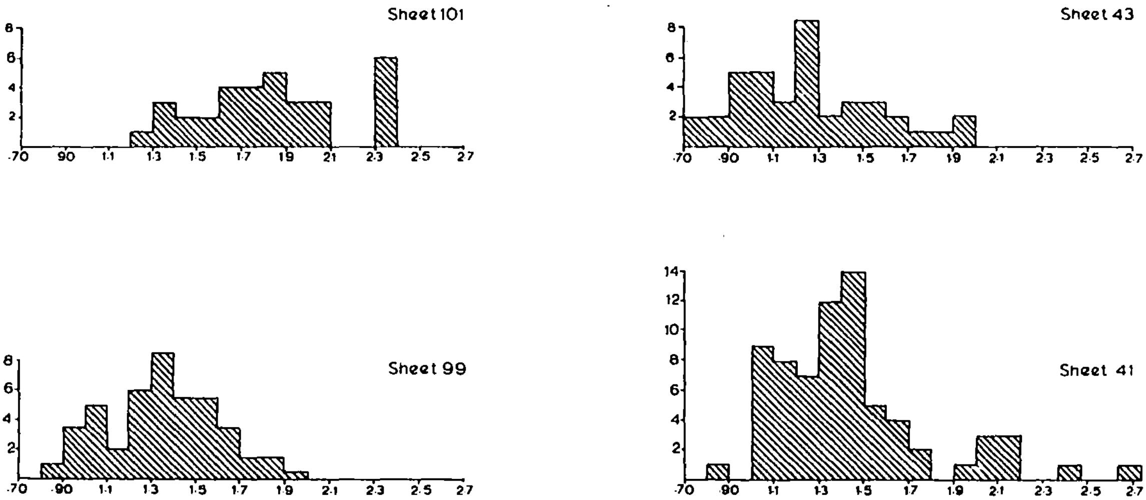
It was noted that in both cases the test was devised and the results expressed in terms of the whole area under consideration. There was no reason for Clark to consider a smaller unit area within the whole field and, for his test situation, Dacey lacked a suitable model for 'bounding' his hexagon and measuring micro-areal variations in pattern.

For this present study it was possible to use the <u>cell model</u> hexagonal field as the model for calculation, and in this way to combine Dacey's geometric idea with the comparative simplicity of the Clark and Evans formula. The area under consideration in the Clark-Evans statistic is of unspecified size. It could be equally applied to the distribution of rare trees throughout the <u>taiga</u> or to the arrangement of particles in a metal bar. There seemed to be no reason why it should not therefore be applied to the arrangement of places within an area bounded by a hexagon of specified size located over a chosen central place. The <u>cell model</u> provided a suitable hexagonal field, and within the terms of the hypothesis (Chapters 5 and 6; Figs.8,9), there was no difficulty in locating its centre over any village of <u>b</u> or <u>c</u> category and measuring nearest neighbours to that central point within each sextant of the hexagon. It was then possible to use the Clark and Evans statistic (R_n), though in this case both the area (A) and the number of points (N) are constants with A = 3.31 square miles and N = 6.

Four 1:50,000 map sheet areas were chosen for analysis using this method (Nos. 41, 43, 99, 101; Fig. 28). A hexagon, appropriately scaled to the cell model hypothetical situation, was divided into sextants and super-imposed on the pattern under analysis, with its centre located over a chosen central place. The distances (d) of the six nearest neighbours to this central point (choosing the nearest neighbour in each sextant) were measured. The sum of the six distances was divided by six and so a mean nearest neighbour distance was derived ($\bar{D}_{obs}$), and $\underline{R_n}$ values were calculated. If any sextant had no point within its 'field', the central point was abandoned and the hexagon overlay was aligned over a new central place.

An analysis of the results of this exercise (Appendix 5 and Fig. 29) reveal some interesting features which substantiate the conclusions outlined at the end of the previous part of this chapter. A fairly wide range of conditions show a marked bias towards the regular side of random. The sheets with the most random patterns (Nos. 42 and 43), as revealed by the Thompson test, show a range of $\underline{R_n}$ values extending through most

NEAREST NEIGHBOUR ANALYSIS
(AFTER CLARK AND DACEY)



Number of occurrences at each of the R_n levels (·70—2·70)

Fig. 29

associations, except clustering. The Dacey-Clark test shows the complex qualities of pattern in this area of bolilands west of Makeni, and'middle granites' west of Port Lokko respectively (Fig. M.4).

Sheet 99 (Matru Jong) covers part of the area where fragmentation of settlement seems quite marked (Figs. M.11, 13, and Chapters 9.3, 13.3). The possibly regular distributions which the Thompson test revealed may in fact represent a trend to more random patterns. The Dacey-Clark test showed that although the range of $\underline{R_n}$ values was from 0.81 (definitely clustered) to 1.99 (fairly regular), the highest proportion fell between 1.20, and 1.60, the mean being 1.35 (Appendix 5). This would seem to indicate an evolutionary process from set MM to set ef conditions (Fig. M.11).

For Sheet 101, the Middle Waanji river in south central Mendeland, the emphasis is quite different. Although the Thompson test would suggest that both distributions have similar qualities ('trending to regular'), the range of $\underline{R_n}$ values, from 1.2 - 2.4, show a marked grouping in the range 1.6 - 2.1. This area shows a more pronounced tendency to regular distribution than those of the middle Jong.

4. <u>The Clark Test of Linear Spacing of Points and the 1908 Army Route Statistics</u>.

From the evidence presented so far, it would seem that the rural settlement patterns in Sierra Leone are, in general, tending to move from regular distributions (which conform with the premises of the <u>cell model</u> hypothesis) to more irregular associations which possibly reflect recent economic and social changes. There is little or no indication of cluster distributions which might be attributed to 'war-town' conditions. The only areas where they have been significant (Sheets 75 and 82) are in conditions where recent economic forces may be more important. Two alternative explanations may be offered. Either the 'war-town' period may not have disturbed the basic regularity of distributions after all, or recent changes have blurred older cluster patterns. In order to assess these alternative explanations, use was made of the earliest settlement census taken in Sierra Leone (the record of villages along army routes in 1908) and the Clark statistic for assessing a linear dispersion of points.

Clark has shown that for a distribution of points along a line a random distribution is signified if $^2/_3$ of the points have reflexive $\underline{n}^{th}$ order nearest neighbours (i.e. when point <u>x</u> is point <u>y</u>'s nearest neighbour and point <u>y</u> is point <u>x</u>'s, and not point <u>z</u>'s, nearest neighbour).

Negative grouping, when the number of points with n^{th} order reflexive nearest neighbours are significantly less than $(^2/_3)^n$, indicates regularity of spacing. Positive grouping, when the number of points with n^{th} order reflexive nearest neighbours are significantly more than $(^2/_3)^n$, indicates clustering of points.

For this test, a random selection of army routes was made from the route numbers (Fig. 30). The settlements along each chosen route were classified according to the 1964 values (Chapter 7·4) into categories a, b, and c and the distances between all a and b category settlements were noted, and the number of first order reflexive nearest neighbours was recorded. Against this 'observed' relationship was plotted the 'expected' number under a random distribution, the deviation could then be calculated and chi-square values recorded, using the appropriate tables for 1 degree of freedom (Table 21).

For the 25 routes analysed, 16 had less than the expected number of reflexive first nearest neighbours, again showing a strong tendency to regular spacing. Of these, 10 showed as 'definitely significant' using the chi-square test and a probability level of 95%. Of the 10 routes showing a positive difference from the $^2/_3$ proportion, 3 showed significant clustering of villages (Routes 15, 18, ~~21A~~ and 39). All these were

ROUTE DIAGRAM

to accompany Vol. II of the Military Report on Sierra Leone

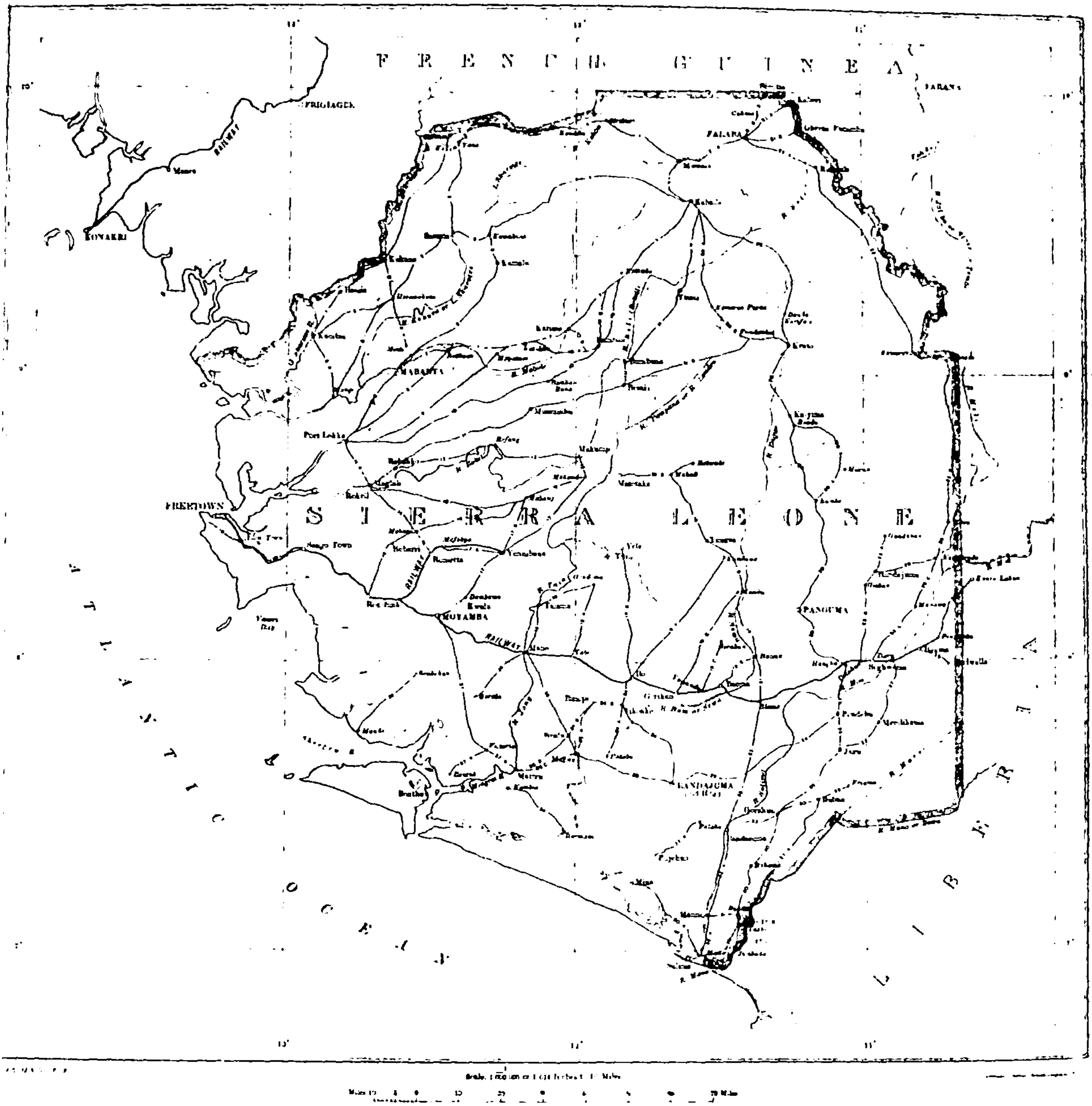


Fig. 30

Route No.	From	To	No. of villages	First Reflexive Nearest Neighbours			df =1
				Obs	Expected	Difference	
32 A	Sulima	Bandasuma	12	9	8.00	+ 1.00	.125
39	Sembehun	Mando	10	8	6.67	+ 2.67	.814
21 A	Kaliere	Musaia	7	6	4.67	+ 2.67	.379
33	Bandasuma	Blama	21	10	14.00	- 4.00	1.14
33	Blama	Makali	12	7	8.00	- 1.00	.125
22 B	Manson	Navu	16	12	10.67	+ 1.33	.016
22 B	Navu	Daru	22	12	14.67	- 2.67	.049
22 B	Daru	Juru	17	12	11.33	+ 0.67	.004
15	Freetown	Songo	24	22	16.00	+ 6.00	2.25
18	Mano	Gondoma	8	10	5.33	+ 4.67	4.09
18 A	Gondoma	Tabe	8	2	5.33	- 3.33	2.08
13	Rokel	Mabang	19	8	12.67	-4.67	1.72
19 A	Bo	Kambona	17	6	11.33	- 5.33	2.51
37A&B	Moyama	Matru	23	16	15.33	+ 0.67	.003
20	Kabala	Jahama	22	10	14.67	- 4.67	1.49
20 A	Kayima	Bumbe	10	4	6.67	- 2.67	.814
20 A	Bumbe	Hanga	10	4	6.67	- 2.67	.814
28	Hanhga	Joru	13	6	8.67	- 2.67	.081

Continued.....

....Continued

Route No.	From	To	No. of villages	First Reflexive Nearest Neighbours			df=1
				Obs.	Expected	Difference	
9	Port Lokko	Mayatami	8	6	5.33	+ 0.67	.008
6	Port Lokko	Kamakwi	18	14	12.00	+ 2.00	.034
10	Port Lokko	Bombali	19	8	12.67	- 4.67	1.72
7	Port Lokko	Pendembu	6	1	4.00	- 3.00	2.25
11 A	Magbile	Mosomu	10	4	6.67	- 2.67	.814
11 A	Mosombo	Besaia	13	6	8.67	- 2.67	.082
5 A	Saimaia	Mange	15	8	10.00	- 2.00	.040
5 A	Mange	Kambia	20	10	13.33	- 3.33	.080

Obs = Observed
df = Degrees of freedom (Chi square)

Level of significance (p) = 0·5

Table 21

Comparison of Number of First Reflexive Nearest Neighbour of Villages on Selected Army Routes (1908) (Fig. 30) associated with important trade routes. The first two are directly connected to the railway line, and the third with an important trade route which passed down the Sewa valley ~~and~~ either to the railway at Blama or down to the coastal port of Sulima.

The tendency to regularity would seem to have been much more pronounced at this period. The over-nucleation of the 'war-town' phase of settlement evolution does not seem to have produced at the same time any significant clustering of settlements. The cell model homogeneity was retained despite the disruption of population expansion and short fallowing.

5. Conclusion.

The dominant impression to be gained from this series of tests is that the cell model argument has been largely vindicated. All the methods used in this chapter have shown a definite and often significant tendency to regular distribution. It would also seem rational to assume from the particularly marked bias to regular distribution shown by the army route test, that the randomization revealed by the Thompson and Dacey-Clark tests is a recent phenomenon and one produced by new economic and social forces. Further, the 'war-town' argument for clustering may be rejected, and for this hypothesis, one may presume only considerable inflation in size beyond rational 'farming area' limits with the retention of a regular spacing of villages.

These conclusions can only be accepted, however, if the limitations of the tests used in this chapter are kept firmly in mind. The Thompson method tends to over-generalise the results. The Dacey-Clark method overcomes this difficulty but involves the rejection of central places which do not have neighbours in each of the sextants of the hexagonal overlay, and these results are therefore slightly biased by the rejection of possibly anomolous distributions which fall beyond the scope of the model frame. A linear distribution, or a pattern of very widely spaced places, for example, would not appear in the calculations.

For the 1908 statistics, the army routes may be assumed to have followed established trackways where these existed, and these would not be the straight-line distances assumed by the statistic. It might be supposed that in the large number of calculations involved, the irregularities would be self cancelling, but this is an un-tested assumption.

Notwithstanding these reservations, viewed collectively the methods used in this chapter have provided the most useful and exciting vindications of hypotheses presented in earlier chapters.

References.

1. Clark, 1956.

2. Clark and Evans, 1954.

3. Thompson, 1956.

4. Dacey, 1960; 1962; and in Garrison and Marble, 1967, pp.277-287.

5. King, 1962.

6. Garrison and Marble, 1967, pp. 120 - 139.

7. Courtesy of the Ministry of Finance, Government of Zambia.

8. The writer is indebted to Dr. C. Ball of the Department of Physics, University of Zambia, for this interpretation of the results.

9. Chapter 5.3.

10. Clark and Evans, op.cit.; Dacey, 1962.

CHAPTER 19.

TESTING THE INFLUENCE OF RECENT ECONOMIC DEVELOPMENT ON SETTLEMENT PATTERN.

1. Introduction.
2. Motor Roads and The Settlement Pattern.
3. Swamp Rice Cultivation and The Settlement Pattern.
4. Heads of Navigation and The Settlement Pattern.
5. Tribal Variation and The Settlement Pattern.
6. Conclusion.

1. Introduction.

Qualitative regional analysis of settlement patterns (Chapter 9; Fig. M.4) suggested that, despite a macro-scale homogeneity, there may be considerable micro-scale variations. Selective comparative mapping of the actual changes in settlement pattern during the last forty years showed that structures have indeed changed more radically in some areas than others (Chapter 13). Various causes were suggested for these different qualities of pattern and rates of change. Set theory analysis (Chapter 17.2 and 17.3) has helped to give better areal dimension to both the possible causes and the degree of changes, although the method has done nothing to prove hypotheses. It is the purpose of this chapter to show how certain non-parametric statistical tests can give more substance to theories of association between settlement patterns and types of economic and social development.

From the range of possible associations, four main ones have been selected for testing by these methods: the relationship between settlement patterns and motor roads; the effect on patterns of swamp rice farming; and the effect on patterns of differences of tribe.

2. Motor Roads in The Rural Settlement Pattern.

The impact of the lorry-routes on rural settlement forms has already been demonstrated (Chapter 12 and PEs 14, 15 and 16). Its influence on pattern is more difficult to assess. Experience in the field would indicate that since the recent construction of re-aligned tarmac roads-from Freetown to the junction at Mile 47, and from there both to Lunsar and to Taiama Bridge on the Bo road - settlements have migrated, and that linear patterns of road-side villages have been developing. Similar patterns along the main laterite roads, especially in the diamond areas (Fig. M.3), would also seem to have developed. The significance of these new developments on minor roads and feeders is less obvious. These possible associations could only be open to analysis, however, if the types of road were distinguished in the form of an index.

After careful consideration, and a number of experiments, an index was devised which distinguished five grades of road:

i) Tarmac main road.

ii) Laterite main road.

iii) Feeder to tarmac main road.

iv) Feeder to laterite main road.

v) Motorable path, feeder to feeder

~~Motorable path, 'feeder to feeder'~~.

In order to give a relative value of importance to the length and quality of road in each standard cell, the lengths of road were measured in a sample of standard cells, and from these results a simple scale of multiples was devised to give suitable weighting to each road quality and type. The index (R) may be presented in the following form:

$$R = \frac{8(2T + L) + 4(2Ft + Fe) + 2P + 1}{10}$$

where T = length of tarred main roads in miles per standard cell.

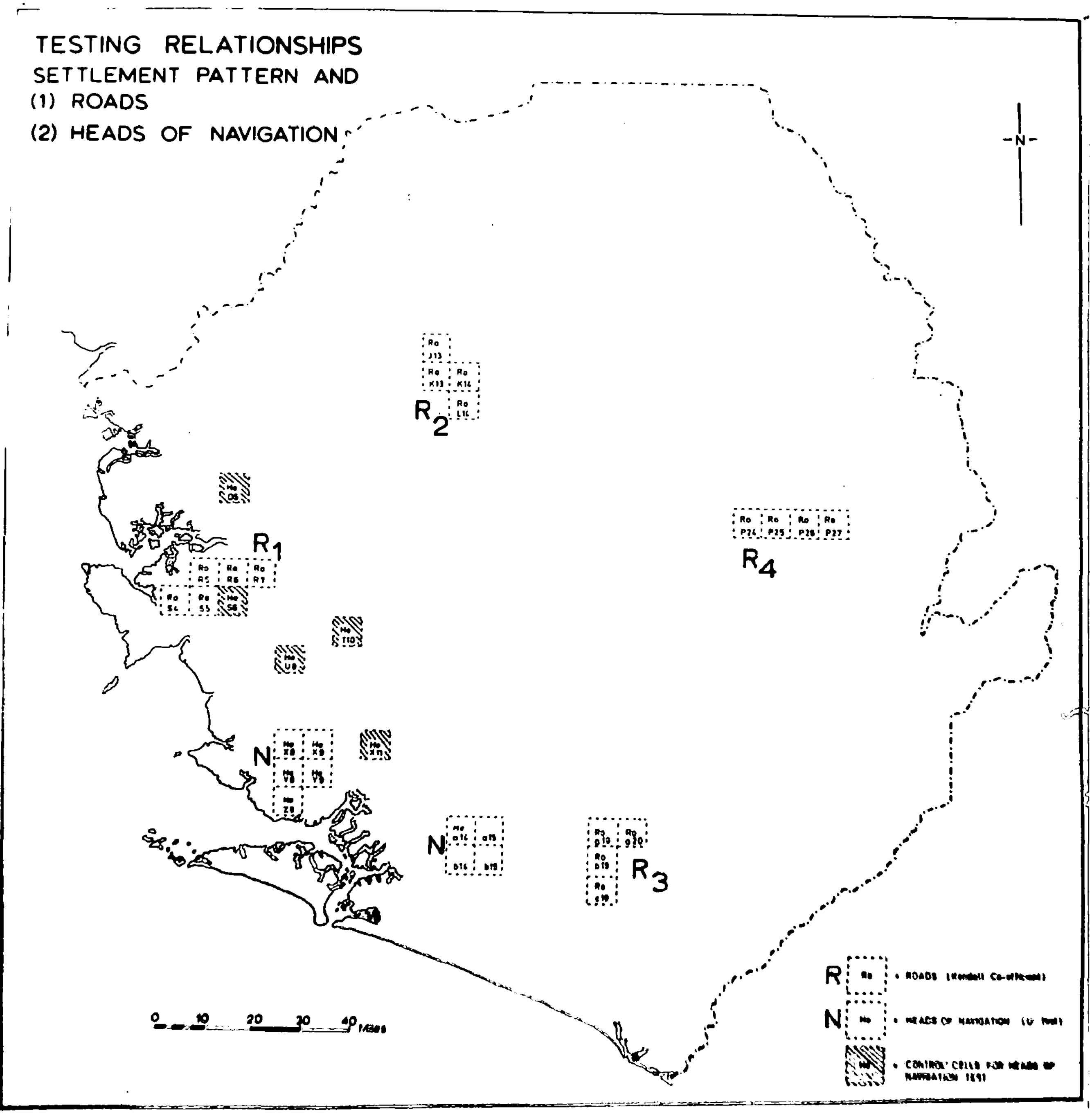
L = length of laterite main roads in miles per standard cell.

Ft = length of feeders to tarred main roads in miles per standard cell.

Fe = length of feeders to laterite main roads in miles per standard cell.

P = length of motorable paths and 'feeder to feeder' roads in miles per standard cell.

Standard cells in four areas were selected for testing: the main road to the provinces from Freetown from Mile 18 to Mile 47, a stretch of the Makeni - Kamakwi road, and similar lengths of the Koribundu- Petema, and Koindu - Jaiama roads (Fig. 31).



TESTING RELATIONSHIPS
SETTLEMENT PATTERN AND
(1) ROADS
(2) HEADS OF NAVIGATION
N
R1
R2
R3
R4
N
N
R
N
0
10
20
30
40

Fig. 31

Road lengths, for each of the standard cells through which the respective stretches of road passed, were measured using the Mitchell map of the 1965 road network[1] as an overlay. Road indices (R) were then calculated and tabulated against D and N indices (Appendix 3 and Table 22) for each of the standard cells from the areas listed above. Use was made of Kendall's Correlation Coefficients[2] (r_{dn}, r_{dro}, r_{nro}), and the Partial Correlation Coefficient ($r_{dn.ro}$), to test the degree of association between all three indices in the table, using methods set out in the standard texts[3]. These results (Table 22) may now be summarised and evaluated.

Examination both of the distribution map (Fig. M.3) and of aerial photographs, and subsequent comparative mapping, suggested that the influence of the motor road on settlement pattern might be quite considerable. The use of this test statistic showed that this influence is by no means uniform, and that in some cases the apparent association suggested by visual comparison may be illusory.

For the first area (Mile 18 - 47 on the Freetown - Bo road), the test statistic showed a fairly strong relationship between the road and settlement. It also revealed a particular relationship between the road and

	Standard Cell No.	D	N	R	Kendall Coefficient
Area 1	S4	15.8	21.3	13.0	$r_{dn} = 0.80$
Mile 18– " 47	S5	7.7	14.3	8.8	$r_{dro} = 0.60$
	R5	6.6	13.0	3.2	$r_{nro} = 0.80$
	R6	9.2	15.3	13.2	
	R7	7.5	14.8	11.2	$r_{dn.ro} = 0.58$
Area 2	L14	10.9	17.8	6.4	$r_{dn} = 0.33$
Makeni	K13	4.0	12.2	6.2	$r_{dro} = 0.33$
-	K14	4.4	13.2	4.0	$r_{nro} = 0.33$
Kamakwi	J13	5.0	10.7	4.8	$r_{dn.ro} = 0.25$
Area 3	a19	4.0	12.8	8.1	$r_{dn} = 0.66$
Koribundu	a20	3.0	13.8	3.2	$r_{dro} = 0$
-	b19	6.8	18.3	7.0	$r_{nro} = 0$
Petema	c19	4.5	16.2	8.0	$r_{dn.ro} = 0.70$
Area 4	P24	2.9	13.7	4.0	$r_{dn} = 0$
Koindu	P25	2.4	9.0	6.4	$r_{dro} = 0.66$
-	P26	4.8	11.5	13.2	$r_{nro} = 0$
Jaiama	P27	4.4	12.0	8.7	$r_{dn.ro} = 0.32$

D = Density Values
N = Nucleation Values
R = Road Index

Table 22.

Correlation between Motor Roads and Settlement Patterns in Selected Areas (Kendall Coefficients).

nucleation of settlement. There is a high degree of correlation between density and nucleation in this area (0.80). The higher the density, the more likely it is to occur in large villages rather than in a string of smaller settlements, and these large villages also have few dependent hamlets. When the road factor is held constant (i.e. 'removed' from the calculation by partial correlation), the degree of the correlation between density and nucleation ($r_{dn.ro}$) falls considerably (0.80 - 0.58). It would seem, therefore, that the road exerts considerable influence on both the density and nucleation of settlement in this area.

In the second area (Makeni - Kamakwi), there is much less marked association between these factors, although the degree of association (r_{dn}) diminishes from 0.33 to 0.25 when the road is 'removed' from the correlation. It is clear that in this case one must look for another factor to account for pattern variation in this area.

For the third area (Koribundu - Petema) a fairly significant relationship between density and nucleation values (0.66) is only slightly altered (0.66 - 0.77) by partial correlation. Similarly, there would seem to be no clear association between either density or nucleation and the road. One must presume that whatever the effect it has on the forms of individual villages (Chapter 12.3), the road has so far made a limited impact on the patterns of settlement in this region.

In the last area to be analysed by this method (Koindu - Jaiama), the relationship between the road and density values is quite marked (0.66), whereas the degree of association between other factor combinations is non-existent. When the road factor is removed, the association between density and nucleation increases very slightly (0.0 - 0.32). It seems, therefore, that the road attracts settlement but does not produce nucleation. Perhaps this is to be expected in the diamond mining area, where immigrants are more likely to settle in small groups rather than large ones.

It was quite clear from these tests that the degree of association between the road and settlement patterns varied both in extent and in quality. One can only presume, however, that this influence is likely to increase as marketing and services improve. All that is certain is that there is no immediately predictable way in which this is likely to happen for any particular region. In some areas, large villages will grow up along the roads, as along the

Freetown - Bo road, in others, like the mining areas there may be merely a ribbon of small hamlets and minor villages. The factors involved in these variations deserve closer attention than the present analysis allows, especially if future rural planning is to take account of such developments.

3. <u>Swamp Rice Cultivation and Settlement Patterns</u>.

The connection between swamp rice cultivation and certain variations in rural settlement pattern is quite obvious in certain areas, especially in the Scarcies estuary (Fig. M.3 and P.38). For other areas, the association has not been so obvious, and attribution has been more tentative (Chapter 9.3). Moreover, it seems that responses may be different for different forms of rice cultivation and between different tribal groups. The organisation necessary for quite large scale operations in the Scarcies and bolilands may have led to the development of large nucleated villages. In the new rice areas of the Mende chiefdoms, however, especially where swamps are restricted to narrow valleys, (e.g. P.24,34), plots are inevitably smaller and individual enterprise may be producing small hamlets of a more permanent character than the traditional <u>fakai</u>.

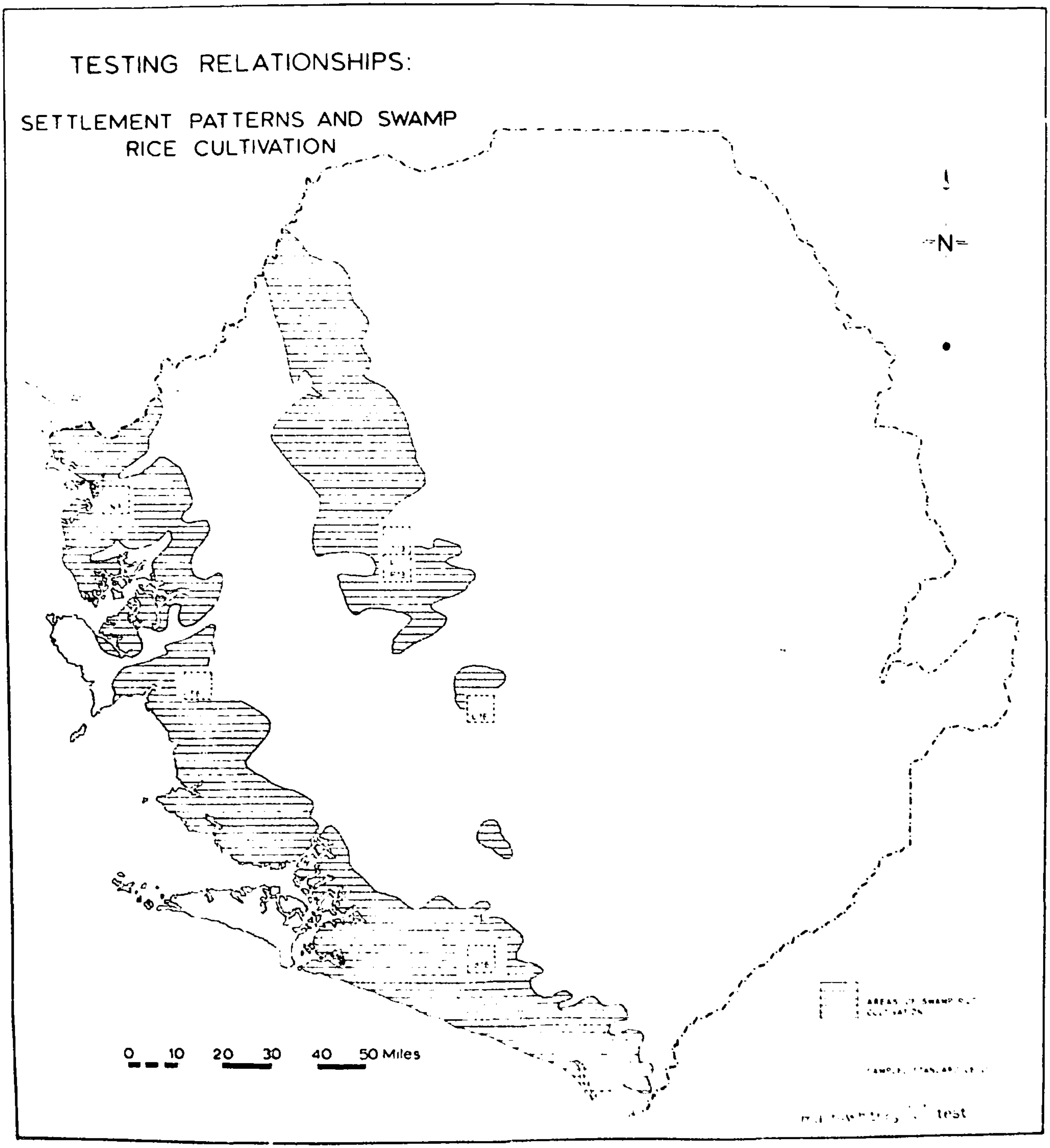

TESTING RELATIONSHIPS:
SETTLEMENT PATTERNS AND SWAMP RICE CULTIVATION
N
0 10 20 30 40 50 Miles
test

Fig. 32

Standard cells from swamp rice areas were selected to test the degree of correlation between swamp rice farming and new patterns of rural settlement (Fig.32).

An index (S) to show the areal importance of swamp rice for each standard cell was based on the area per standard cell which was under swamp rice at the time of the 1956-64 photographic survey[4]. Standard cells representing a range of these indices were selected and ranked and the respective D and N values for each of these cells were compared with the swamp rice index (Table 23), using the same Kendall correlation techniques as those already described in the previous part of this chapter.

The results of this test were quite revealing. The very high correlation (0.87) between swamp rice and settlement density indices (r_{sd}) showed that the activity has probably already caused a well marked and significant change in settlement patterns. At the same time, the quality of nucleation or fragmentation has not altered so clearly (0.66 - 0.68).

From this small scale and fairly limited test, it would seem that people tend to retain the same structure of settlement, i.e. the same relationships between a, b and c, even though the density of settlement increases. If this

Standard Cell No.	D	N	S	Kendall Coefficient of Correlation
N.3	16.7	21.8	1	
d.16	8.7	19.5	2	$r_{dn} = 0.66$
T.6	5.9	11.8	3	$r_{ds} = 0.87$
P.13	3.5	11.7	4	$r_{ns} = 0.60$
O.13	1.5	8.5	5	$r_{dn.s} = 0.68$
U.16	1.8	12.0	6	

D = Density value

N = Nucleation value

S = rank order of sampled cells in terms of area under swamp rice cultivation.

Table 23.

Correlation Between Swamp Rice Cultivation

and Rural Settlement Patterns

(Kendall Co-efficients of Correlation).

is the case, then development of permanent hamlet occupation in the Jong valley (Fig. M.3) must be ascribed to different causes than the development of swamp rice, and the high nucleation of the Scarcies and boli riceland developments would seem more apparent than real. Following this argument, even with a continued movement from degrading upper surfaces to swamp rice in the valleys estuaries and flats, the basic qualities of nucleation seem likely to remain unaltered.

The sampling distribution of the Partial Correlation Co-efficient is not yet known[5], and one of the limitations of the method is that no degree of statistical significance can be attributed to these results. The value of the test in areas where there has been limited data collection, will however be made clear by this series of tests, even though the results are purely relative.

4. Heads of Navigation and Rural Settlement Patterns.

One of the hypotheses presented in the empirical regional analysis (Chapter 9.3) was that special settlement patterns were associated with the heads of navigation (Fig. M.3 ; B $Ic_{2, 9, 12}$), possibly due to longer contact with the cash economy. To determine the extent of this association, use was made of the Mann-Whitney 'U' Test (Chapter 16.3). Two heads of navigation areas were selected for testing, both in the Sherbro river estuary region. The first (Area A) was around Sembehun, and the second (Area B) was south of Mattru Jong (Fig.31).

The density and nucleation values of four standard cells in each of these two areas were compared with the same values for a random selection of standard cells taken from the whole area of region B Ic (Table 24). The null hypothesis for testing in this case was that there was no difference between settlement patterns in the vicinity of heads of navigation and those patterns in the general region in which these areas lay (i.e. B Ic).

The 'U' values for these comparisons revealed low probabilities of significance for rejecting the null hypothesis in all cases except the density of settlement in Area B, and that was only marginally significant (p. = 0.019 when the significance level for rejection is p. = 0.02). It would seem that in this case visual impressions are quite misleading, and that patterns in these areas do not warrant micro-regional distinction.

5. Tribal Variation and the Settlement Pattern.

Distribution and choropleth maps indicated that some

	Area A (Sembehun)		Area B (Mattru Jong)	
	D	N	D	N
'U'	7	5	2	8
p	0.176	0.086	0.019	0.238

Significance Level (p) = 0.02

Table 24.

Testing the Association Between Settlement Patterns and Heads of Navigation (Mann - Whitney 'U' Test).

variations in the settlement pattern may well be attributed to tribal differences (Chapter 9.3). Areas were selected from different tribal territories (Fig. M.1) where differences of tribe, rather than of economy or of physical conditions, seemed to be the most obvious causes of apparent variations in settlement pattern, and a sample of standard cell statistics was taken from each area. Patterns from Yalunka, Plateau Limba and Koranko tribal territories were compared with each other by taking a sample of alternate standard cells, and a similar sample was made for a comparison of Temne and Mende patterns. The 'U' Test was again employed, under the null hypothesis that economically and physically similar areas occupied by different tribes will have similar settlement patterns. Calculations proceeded in the standard manner and the results have been summarised (Table 25).

It will be clear from these results that tribal differences may produce different qualities of nucleation or dispersion of settlement, but that the density of settlement varies according to other factors. The results are insufficiently conclusive, except in the case of Mende and Temne, and Yalunka and Koranko comparisons, to make any firm generalisations. Such differences in the qualities of nucleation are in any case clearly visible from the

DENSITY VALUES							
Tribe A	Tribe B	d_1	d_2	'U'	Critical Level of 'U'	Ho	Hi
Mende	Temne	10	10	33	23	*	
Yalunka	Koranko	11	14	59	40	*	
Yalunka	Limba	11	9	17	23		*
Limba	Koranko	9	14	37	31	*	
NUCLEATION VALUES							
Tribe A	Tribe B	d_1	d_2	'U'	Critical Level of 'U'	Ho	Hi
Mende	Temne	10	10	23	23		*
Yalunka	Koranko	11	14	31	41		*
Yalunka	Limba	11	9	48	23	*	
Limba	Koranko	9	14	34	31	*	

Significant Level = 0.05

d = sample size (number of standard cells).

*Ho= null hypothesis accepted

*Hi= alternative hypothesis accepted.

Table 25.

Comparison of Standard Cell Values from Different Tribal Territories in Similar Physical and Economic Regions (Mann-Whitney 'U' Test).

distribution map (as they also are in the Kissi areas of the eastern pedicle) and it could be argued that they do not really need statistical proof. There may, however, be special differences between the patterns of other tribes which it is impossible to distinguish at this level of information because of the interference of other 'hidden' physical and economic variables.

6. Conclusion.

It has been the purpose throughout this dissertation to show the utility of methods rather than to present a fully comprehensive set of results. The methods and statistical tests used in this chapter must therefore be viewed in the light of this purpose. It would have been possible and interesting to present a full analysis of, for example, the impact of motor roads on rural settlement, but space and intention did not permit such an analysis. The main general conclusions which can be drawn from these results is, firstly, that the attribution of associations by simple empiricism and comparison of maps is often misleading or erroneous, and secondly, that statistical tests can add refinement to judgements which are valid.

References.

1. Mitchell, in Clarke, 1966, p.102.

2. Kendall, 1948; Siegel, 1956, pp.213-219.

3. Siegel, ibid.

4. Hawapathirani, in Clarke, 1966, p.76.

5. Siegel, 1956, p.228.

C O N C L U S I O N.

CHAPTER 20.

THEMES AND ARGUMENTS

"There are different sorts of conflicts between theories. One familiar kind of conflict is that in which two or more theorists offer rival solutions of the same problem. In the simplest cases, their solutions are rivals in the sense that one of them is true and the others are false. More often, naturally, the issue is a fairly confused one, in which each of the solutions proferred is in part right, in part wrong and in part just incomplete or nebulous."

Gilbert Ryle, "Dilemmas" p.1.

This thesis was written during a period when considerable intellectual ferment was taking place within the discipline. Those who favoured new theoretical and deductive methods of research entered into debate with those who believed that older empirical approaches still had most to offer. The chief purpose of this disseration has been to demonstrate that this argument is unproductive and to a large measure irrelevant.

It is still tacitly assumed in many quarters that a researcher who adopts one of these approaches is committed to rejecting the other. The main thesis which has been presented here is that a research project which relies on the procedural stages of scientific method depends equally on empirical and deductive techniques, and that the relationship between the two approaches is in the nature of a dialogue rather than a debate.

The approach followed throughout this work has been one in which theory has been modified or substantiated by both inductive and deductive procedures, and the arrangement of chapters was designed to show this balance between the two sides. In a study using this approach and of this length (Fig. I), it is difficult to convey the excitement involved in testing a carefully constructed empirical model against reality, and in advancing empirically based hypotheses which could be tested by more analytical methods. However, a summary of the main stages of the argument may serve both to emphasise the more significant ideas presented above and to give a more realistic impression of the absorbing nature of this holistic approach to a research project.

In the introduction (Chapter I), the analogy of a palimpsest was used to describe the subtle complexities of association, both in space and time, which are a feature of the settlement geography of Western Europe. It was also suggested that the simple relationships of a peasant society in Africa may not be as uniform as they at first appear (Chapter 1.3). Despite this reservation, Sierra Leone's cultural uniformity and low level of economic development do seem to have produced a settlement landscape of unusual uniformity. It was this apparent homogeneity which became the theoretical frame of the dissertation.

In the first stage of the argument, a model was developed on the premise that if conditions were uniform then such a model could realistically represent conditions throughout the country and provide a yardstick against which minor variations in form and pattern of settlement might be measured (Chapter 4). This approach made it possible to distinguish the main features of Sierra Leone's especially 'fine-tone' settlement palimpsest, and to set up a series of hypotheses to account for it. To carry the analogy further, it seemed that the 'original manuscript' had been slightly modified at various dates in different ways rather than completely effaced or overwritten. For this reason, it has been difficult to distinguish the letters and words which have been altered, and the various times at which these alterations took place. Only by reconstructing a stylised reproduction of the original document (Chapters 5 and 6) has it been possible to distinguish stages in the process of overwriting and alteration.

Following this approach, a theory of rural settlement evolution was developed, beginning with the peopling of the country which probably took place in the comparatively short period of time between the end of the fourteenth and the end of the eighteenth centuries (Chapter 11.3). The free range hunting and collecting of this primary stage was probably replaced quite quickly in most areas by fixed location bush-fallow agriculture as people adapted to their new environment and population densities increased. It was argued (Chapter 4) that in a homogeneous physical environment, the pattern of settlement which developed would be quite uniform. This uniformity became the premise of the cell model theory.

In some areas, conditions approaching those of the cell model (Chapters 5 and 6) may have been established and maintained for many years, with the settlement pattern developing by slow cellular growth. But in other regions, fresh waves of immigrants, with concommitant pressures on resources and the resulting conflicts, caused a quick transition to the 'war-town' structure (Chapter 11). These 'war-towns' were common throughout the country but seemed best developed in the forests of the south and in the northern plateaux. It was probably at this stage of settlement development that the most serious degradation and over-farming of upper surfaces took place, particularly on the least stable soils of the plateaux and the nongranite soils of the lowlands (Chapter 9).

This period of increasingly acute imbalance with the environment came to an end with the extension of British rule at the end of the nineteenth century. In the first forty years of peaceful, if uneventful, colonial administration, settlement structures gradually reverted to something approaching the norms of the bush-fallow system with a disintegration of some of the larger 'war-towns' (Chapter 12). But high rural population densities and the degradation of traditional farming lands remained a problem, and inadequate spacing between settlements, with consequent short fallows, ensured that degradation continued. The 'hungry season' became a problem which could only be alleviated by increasing food imports. In response to this situation, it seems that people have gradually begun to abandon the older farmlands in favour of the cultivation of swamp soils which were avoided 80 years ago.

At the same time, the immigration of new groups, the spread of new ideas, and the diminishing opportunity for carrying on traditional systems appear to have added heterogeneity to a uniform set of responses, with uneven reactions to innovation between tribes and regions (Chapter 13).

20.0

Since the last World War, economic advances would seem to have brought a gathering momentum of change and a greater variety of responses, both in the form and pattern of settlement. This change is recent enough, however, not to have obliterated traditional responses, and in many areas it is still possible to find representative forms and patterns for all the stages of settlement evolution outlined above, with the exception of the earliest ones. At the same time, large tracts of the country seem little influenced as yet by the social and economic innovations of the twentieth century, except for the limited side-effects of peaceful administration. In these circumstances, the broad homogeneities of form and pattern seem, in most areas, to have been modified rather than completely altered (Chapter 12 and 13).

In the last part of the dissertation, various methods were used to refine measurements of fairly minor spatial structural and temporal variations in rural settlement. A range of deductive and statistical techniques were employed to extend or modify the theory presented above. Some of the virtues and drawbacks of location analysis from limited data were also suggested.

In the ~~introducing~~ first chapter of this work, the lack of geographers in government planning in developing countries was deplored. During the development of the thesis, two practical aspects of geographical research in an underdeveloped area were constantly in mind; the lack of reliable information and the need to develop techniques of analysis which have a wider application than purely academic research. One of the problems of macro-scale research in rural Africa is the absence of working data. Researchers are constantly faced with the problems of turning 'sows ears into silk purses' - of using rudimentary sources to establish detailed arguments. If this disseration has been successful in demonstrating pragmatic techniques of data collection, mapping and statistical analysis which could find practical application in planning work, it will indeed have served a useful purpose.

The theoretical side of this work has, on the other hand, less immediate practical implications. Apart from the substantive association between the Christaller model and the basic pattern of settlement, revealed by structural and 'nearest neighbour' analysis, many of the other hypotheses are less clearly defined. What emerges is not so much a well substantiated theory of settlement evolution and pattern, but a roadway towards such a theory. Many of the ideas presented need much more detailed re-examination using a broader base of background information and field data than was available to this writer.

When considering the limitations of this study, some consolation was derived from the knowledge that at least these problems are characteristic of the approach.

> "........ a theorist is not confronted by just one question or even by a list of questions numbered off in serial order. He is faced by a tangle of wriggling, intertwined and slippery questions. Very often he has no clear idea of what his questions are until he is well on the way to answering them. He does not know, most of the time, even what is the general pattern of theory that he is trying to construct, much less what are the precise forms and inter-connections of its ingredient questions. Often .... he hopes, and sometimes he is misled by the hope, that the general pattern of his still rudimentary theory will be like that of some reputable theory which in another field has already reached completion .... Unlike playing cards, problems and solutions of problems do not have their suits and denominations printed on their faces. Only late in the game can the thinker even know what have been his trumps."

Gilbert Ryle, "Dilemmas", pp.7-8.

B I B L I O G R A P H Y

ABBREVIATIONS.

A.A.A.G.	Annals of the Association of American Geographers.
A. de G.	Anmales de Géographie.
A.M.S.	Annals of Mathematical Statistics.
B.A.A.S.	Proceedings of the British Association for the Advancement of Science.
B.G.G.A.	Bulletin of the Ghana Geographical Association.
B.S.B.E.G.	Bulletin de la Societé Belge d'Etudes Géographie.
C. d'O.M.	Cahiers d'Outre Mer.
C.R.C.I.G.	Comptes Rendus du Congrès International de Géographie.
D.T.C.	Department of Technical Cooperation.
E.G.	Economic Geography.
G.A.	Geografiska Annaler.
G.J.	Geographical Journal.
G.R.	Geographical Review.
G.Z.	Geographische Zeitschrift.
I.B.G.	Papers and Proceedings of the Institute of British Geographers.
I.F.A.N.	Institut Français d'Afrique Noire.
I.G.U.	International Geographical Union.
J.A.S.	Journal of the Africa Society.
J.A.S.A.	Journal of the American Statistical Association.
J.G.	Journal of Geography.
J.R.G.S.	Journal of the Royal Geographical Society.
J.S.L.G.A.	Journal of the Sierra Leone Geographical Association.

J.T.G. Journal of Tropical Geography.

L.S.G. Lund Studies in Geography.

N.G.J. Nigerian Geographical Journal.

R.C.I. Proceedings of the Royal Colonial Institute.

R.G.A. Revue de Géographie Alpine.

R.G.S. Royal Geographical Society.

R.S.A. Papers and Proceedings of the Regional Science Association.

S.L.S. (O.S., N.S.) Sierra Leone Studies (Old Series, New Series).

T.E.S.G. Tijdschrift voor Economische en Sociale Geographie.

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A P P E N D I C E S

APPENDIX 1.

Persons per House.

a) Musaia

b) Mahera

House No.	Age of House (in years)	No. of Inhabitants Men	Women	Children	Total No. of Inhabitants
1	6	4	2	3	9
2	1	1	1	0	2
3	16	4	4	10	18
4	19	4	4	15	23
5	8	1	2	3	6
6a	3	2	1	5	8
6b	3	1	1	0	2
7	25	3	3	5	11
8	3	1	1	1	3
9	18	7	5	8	20
10	8	2	2	1	5
11	1	5	2	1	8
12	19	4	4	15	23
13	32	7	8	16	31
14	32	5	5	11	21
15	8		mosque		-
16	15	3	2	2	7
17	3	5	8	4	17
18a	31	3	4	5	12
18b	?	7	6	5	18
19	14	2	1	0	3
20	3	8	2	9	19

House No.	Age of House (in years)	No. of Inhabitants Men	Women	Children	Total No. of Inhabitants
21	3	3	2	4	9
22	7	2	2	0	4
23	18	3	3	3	9
24	16	1	2	3	6
25	15	3	3	5	11
26	16	1	1	2	4
27	4	3	3	1	7
28	4	4	8	4	16
29	11	2	2	1	5
30	2	?	?	?	?
31	?	?	?	?	?
32	8	5	4	8	17
33	11	7	4	3	14
34	?	5	4	4	13
35	2	?	?	?	?
36	16	4	4	2	10
37	7	2	1	2	5
38	7	?	?	?	?
39	7	1	3	5	9
40	3	2	4	12	18
41	6	1	3	3	7
42	8	1	4	3	8
43	11	2	2	5	9

House No.	Age of House (in years)	No. of Inhabitants			Total No. of Inhabitants
		Men	Women	Children	
44	1	1	6	12	19
45	10	?	?	?	?
46	11	1	3	10	14
47	12	?	?	?	?
48	12	?	?	?	?
<u>Totals</u>	496	133	136	211	480
<u>Means</u>	10.5	2.7	2.8	4.3	9.8

House No.	Age of House (in years)	No. of Inhabitants Men	Women	Children	Total No. of Inhabitants
1	19	3	2	2	7
2	15	mosque			-
3	15	3	5	6	14
4	4	3	3	1	7
5	?	?	?	?	?
6	?	1	3	4	8
7	?	4	3	2	9
8	?	?	?	?	?
9	35	2	3	0	5
10	6	2	3	6	11
11	16	1	2	2	5
12	7	3	3	8	14
13	under construction				
14	4	2	2	4	8
15	7	4	4	3	11
16	17	5	10	5	20
17	?	?	?	?	?
18	?	?	?	?	?
19	1	3	1	0	4
20	20	7	5	6	18
21	?	3	5	0	8
22	?	1	1	0	2
23	4	4	4	20	28

House No.	Age of House (in years)	No. of Inhabitants Men	Women	Children	Total No. of Inhabitants
24	?	tailors			-
25	?	tailors			-
26	?	tailors			-
27	under construction				
28	15	3	3	8	14
29	16	4	5	5	14
30	18	3	2	1	6
31	17	?	5	7	?
32	?	administrative			-
33	15	4	4	13	21
34	15	3	3	10	16
35	?	?	?	?	?
36	?	7	5	2	14
37	?	2	3	2	7
38	10	6	6	3	15
39	?	6	5	4	15
40	?	?	?	?	?
41	3	1	1	9	11
42	5	4	2	2	8
43	?	2	2	0	4
44	?	0	0	0	0
45	?	0	0	0	0
46	20	5	4	12	21

House No.	Age of House (in years)	No. of Inhabitants Men	Women	Children	Total No. of Inhabitants
47	?	1	2	0	3
48	1	1	3	2	6
49	10	4	4	4	12
50	21	1	3	7	11
51	1	3	1	4	8
52	30	8	8	5	21
53	40	5	5	5	15
54	4	1	4	2	7
55	?	6	4	6	16
56	4	1	3	2	6
57	40	8	5	5	18
58	20	3	1	4	8
59	?	?	?	?	?
60	1	1	3	2	6
61	?	3	1	0	4
62	20	5	4	12	21
63	?	0	0	0	0
64	?	?	?	?	?
65	?	?	?	?	?
66	5	5	1	2	8
67	5	?	?	?	?
68	8	2	1	0	3

House No.	Age of House (in years)	No. of Inhabitants Men	Women	Children	Total No. of Inhabitants
69	8	3	2	5	10
70	derelict				-
71	11	3	1	0	4
72	25	1	1	0	2
73	?	?	?	?	?
74	4	1	5	7	13
75	20	5	5	5	15
76	27	3	2	3	8
77	15	6	5	5	16
78	20	8	8	5	21
79	?	0	3	0	3
80	26	2	1	6	9
81	10	4	5	7	16
82	20	2	2	0	4
83	20	?	?	?	?
84	20	?	?	?	?
85	26	2	4	9	15
86	26	?	?	?	?
87	5	6	5	4	15
88	11	6	4	6	16
89	?	?	?	?	?
90	3	1	2	4	7
91	5	2	5	6	13

House No.	Age of House (in years)	No. of Inhabitants Men	Women	Children	Total No. of Inhabitants
92	8	2	3	2	7
93	?	4	5	2	11
94	?	7	3	0	10
95	?	rest house			-
96	8	1	0	0	1
97	?	0	0	0	0
98	12	1	2	11	14
<u>Totals</u>	844	229	235	296	748
<u>Means</u>	13.8	2.6	2.6	3.3	8.4

APPENDIX 2.

Random Sample Returns

a) Buildings per Settlement: 1927 and 1964

x = number of buildings in the settlement
y = number of settlements with x buildings
xy = total number of buildings for each x value

b) Settlements per Standard Cell: 1927 and 1964.

a = settlements with 200-36 buildings
b = settlements with 35-13 buildings
c = settlements with 12-1 buildings

D = Density index (Chapter 14.2)
N = Nucleation index (Chapter 14.2)
DN = Combined ordinal rankings (Chapter 14.2)

2a

Group a

x	y	xy
36	7	252
37	1	37
38	4	152
39	3	117
40	3	120
41	1	41
42	2	84
44	1	44
47	1	47
48	1	48
50	4	200
51	1	51
54	3	162
55	1	55
56	2	112
57	2	114
58	2	116
60	1	60
62	1	62
63	1	63
64	3	192
65	2	130
66	1	66

Group a

x	y	xy
75	1	75
80	1	80
85	1	85
95	1	95
110	1	110
117	1	117
120	1	120
130	2	260
136	1	136
140	1	140
144	1	144
147	1	147
150	1	150
157	1	157
160	1	160
180	1	180

Group b

x	y	xy
13	22	286
14	28	392
15	29	435
16	23	368
17	18	306
18	20	360
19	12	228
20	14	280
21	7	147
22	7	154
23	14	322
24	9	216
25	9	225
26	9	234
27	6	162
28	8	224
29	10	290
30	8	240
31	1	31
32	4	128
33	5	165
34	9	306
35	4	140

Group c

x	y	xy
1	183	183
2	60	120
3	81	243
4	61	244
5	72	360
6	65	390
7	45	315
8	51	408
9	34	306
10	35	350
11	21	231
12	40	480

Group a

x	y	xy
36	5	180
37	2	74
38	2	76
39	1	39
40	5	200
41	2	82
42	2	84
43	3	129
44	1	44
45	1	45
46	4	184
47	1	47
48	4	192
49	1	49
50	2	100
51	1	51
52	1	52
53	1	53
56	1	56
57	2	114
58	2	116
60	1	60
62	1	62

Group a

x	y	xy
64	1	64
70	1	70
72	1	72
76	1	76
77	1	77
80	1	80
81	1	81
82	1	82
83	1	83
84	1	84
88	1	88
89	1	89
90	1	90
94	1	94
95	2	190
98	1	98
106	1	106
107	1	107
111	2	222
115	1	115
116	1	116
128	1	128
134	1	134

Group a

x	y	xy
144	1	144
167	1	167
176	1	176
179	1	179
187	1	187
192	1	192

Group b

x	y	xy
13	15	195
14	14	196
15	10	150
16	17	272
17	14	238
18	13	234
19	7	133
20	9	180
21	12	252
22	5	110
23	11	253
24	9	216
25	7	175
26	9	234
27	3	81
28	8	224
29	6	174
30	5	150
31	2	62
32	5	160
34	5	170
35	4	140

Group c

x	y	xy
1	31	31
2	45	90
3	62	186
4	49	196
5	57	285
6	36	216
7	34	238
8	45	360
9	29	261
10	35	350
11	22	242
12	22	264

1927						
St'd Cell No.	a	b	c	D	N	DN
B 24	0	1	5	0.4	10.8	VIII
C 14	1	2	1	1.4	13.7	VII
C 20	0	0	6	0.3	10.0	VIII
C 23	0	1	4	0.4	11.2	VIII
E 15	0	0	6	0.3	10.0	VIII
F 9	1	1	6	1.5	11.5	VIII
F 14	0	2	12	1.0	9.0	VIII
F 22	6	10	12	8.6	19.0	I
G 24	0	4	19	1.7	7.7	VIII
G 26	0	0	9	0.4	9.0	VIII
H 18	2	3	6	2.9	13.5	VIII
H 24	0	0	23	2.2	4.3	IX
I 12	1	1	3	1.3	12.5	VIII
I 21	0	0	2	0.1	11.3	VIII
K 17	0	1	2	0.3	11.8	VIII
M 4	0	0	3	0.1	11.0	VIII
M 6	0	0	4	0.2	10.7	VIII
M 18	1	2	9	1.8	11.0	VIII
M 19	9	4	5	10.0	21.3	I
M 21	2	7	18	4.3	11.5	V
N 25	2	4	13	3.4	11.7	V
O 22	1	12	18	4.3	13.0	V

1964						
St'd Cell No.	a	b	c	D	N	DN
B 24	0	2	11	1.0	9.3	VIII
C 14	0	0	5	0.3	10.3	VIII
C 20	1	1	15	2.0	8.5	VIII
C 23	0	0	11	0.6	8.3	VIII
E 15	1	3	11	2.3	10.8	VIII
F 9	0	3	8	1.2	10.8	VIII
F 14	0	3	14	1.5	8.8	VIII
F 22	1	4	1	2.1	14.7	VII
G 24	0	1	0	0.3	12.5	VII
G 26	0	2	4	0.7	11.7	VIII
H 18	1	6	50	5.0	0.0	VI
H 24	0	0	9	0.5	9.0	VIII
I 12	4	6	24	7.2	11.0	II
I 21	0	1	5	0.5	10.8	VIII
K 17	1	8	14	3.7	12.3	VIII
M 4	8	10	18	11.4	19.0	I
M 6	6	14	23	10.7	17.3	I
M 18	0	5	8	1.7	11.8	VIII
M 19	0	4	6	1.3	12.0	VIII
M 21	0	0	6	0.3	10.0	VIII
N 25	0	3	8	1.2	10.8	VIII
O 22	0	2	7	0.9	11.7	VIII

1927

St'd Cell No.	a	b	c	D	N	DN
O 25	0	5	12	1.8	10.5	VIII
P 21	0	1	3	0.3	11.5	VIII
P 28	0	0	4	0.2	10.7	VIII
Q 8	1	2	6	1.7	12.0	VIII
Q 9	0	4	20	1.8	7.3	VIII
Q 12	0	2	29	1.8	3.3	IX
Q 17	0	3	6	0.9	11.5	VIII
Q 22	0	2	11	0.9	9.3	VIII
Q 24	1	3	14	2.3	9.8	VIII
R 19	0	0	15	0.7	7.0	VIII
T 6	1	3	7	3.0	12.2	VIII
T 12	2	2	3	2.3	14.0	VII
T 27	2	5	6	3.3	14.5	VII
U 5	0	1	2	0.3	11.8	VIII
U 6	5	6	9	5.7	17.0	IV
U 15	8	24	21	13.8	25.0	I
V 15	0	4	18	1.7	8.0	VIII
W 7	2	7	6	2.7	15.5	IX
X 8	1	11	17	2.3	12.8	VIII
Y 7	4	4	8	5.2	15.3	IV
Z 22	6	5	11	7.5	16.8	I
a 24	6	1	9	6.7	15.5	I

1964

St'd Cell No.	a	b	c	D	N	DN
O 25	0	1	5	0.5	10.5	VIII
P 21	1	1	13	1.9	9.2	VIII
P 28	0	4	15	1.8	9.0	VIII
Q 8	1	11	27	5.1	9.5	V
Q 9	0	12	24	4.2	10.0	V
Q 12	1	7	5	2.0	14.8	VII
Q 17	1	4	30	3.5	5.0	VI
Q 22	0	1	15	1.0	7.5	VIII
Q 24	1	0	15	1.8	8.0	VIII
R 19	0	1	0	0.3	12.5	VIII
T 6	2	11	23	5.9	11.8	V
T 12	2	19	15	7.5	18.5	I
T 27	1	4	15	2.8	10.0	VIII
U 5	4	12	11	7.6	18.3	I
U 6	0	16	9	4.5	17.0	IV
U 15	0	11	8	3.2	14.8	VII
V 15	0	13	22	4.4	11.2	V
W 7	0	4	17	1.9	8.3	VIII
X 8	2	10	37	6.4	6.7	V
Y 7	1	13	23	5.4	9.6	V
Z 22	3	5	15	5.0	12.5	V
a 24	2	5	5	2.0	14.8	IV

1927

St'd Cell No.	a	b	c	D	N	DN
a 28	0	1	3	0.3	11.5	VIII
b 14	1	5	10	2.5	12.2	VIII
C 20	4	5	9	5.4	15.5	IV
d 19	8	12	16	11.2	20.7	I
d 21	3	11	12	5.8	16.5	IV

1964

St'd Cell No.	a	b	c	D	N	DN
a 28	0	0	2	0.1	11.3	VIII
b 14	3	16	98	11.9	0.0	III
c 20	4	6	4	5.7	17.7	IV
d 19	4	5	8	5.7	15.8	IV
d 21	1	3	14	2.5	9.8	VIII

APPENDIX 3.

Standard Cell Statistics.

Cell No.	=	Standard cell grid square (Fig. M.2c)
a	=	Number of settlements in the cell with 200-36 buildings
b	=	Number of settlements in the cell with 35-13 buildings
c	=	Number of settlements in the cell with 12-1 buildings
D	=	Index of Density (D))
N	=	Index of Nucleation (N)) Chapter 14.2
DN	=	Combined Ranks)
*	=	cells selected by the random sample (Fig. M.2c)

Cell No.		a	b	c	D	N	DN
A	17	1	2	12	2.1	10.0	VIII
	18	2	0	27	3.3	5.0	IX
	19	0	1	8	0.7	10.1	VIII
	20	0	0	15	0.8	7.0	VIII
	21	0	3	11	1.3	9.8	VIII
	22	1	2	3	1.7	13.0	VIII
	23	1	7	11	3.3	12.8	VIII
	24	1	2	7	1.9	11.7	VIII
B	10	1	0	0	1.0	13.0	VIII
	11	0	1	12	0.8	8.5	VIII
	12	0	3	16	1.5	8.2	VIII
	13	0	1	14	1.0	7.9	VIII
	14	0	0	5	0.3	10.3	VIII
	15	0	1	4	0.5	11.2	VIII
	16	0	3	3	0.9	12.5	VIII
	17	1	2	14	2.2	9.3	VIII
	18	0	0	11	0.6	8.3	VIII
	19	1	2	12	2.1	10.0	VIII
	20	0	2	4	0.7	11.7	VIII
	21	0	0	13	0.7	7.7	VIII
	22	1	1	8	1.6	10.8	VIII
	23	1	0	14	1.7	8.3	VIII

Cell No.	a	b	c	D	N	DN
* 24	0	2	11	1.0	9.3	VIII
25	1	0	2	1.1	12.3	VIII
C 10	0	1	4	0.5	11.2	VIII
11	1	1	6	1.6	11.5	VIII
12	0	1	15	1.0	7.5	VIII
13	0	2	12	1.1	9.0	VIII
* 14	0	0	5	0.3	10.3	VIII
15	0	0	4	0.2	10.7	VIII
16	0	0	6	0.3	10.0	VIII
17	1	4	19	3.0	8.7	VIII
18	0	2	14	1.2	8.3	VIII
19	1	0	13	1.7	8.7	VIII
* 20	1	1	15	2.0	8.5	VIII
21	0	2	12	1.1	9.0	VIII
22	0	1	13	0.9	8.2	VIII
* 23	0	0	11	0.6	8.3	VIII
24	1	3	8	2.5	11.8	VIII
25	0	2	6	0.8	12.0	VIII
26	0	2	7	0.9	10.7	VIII
D 9	0	0	1	0.0	12.0	VIII
10	0	0	11	0.6	8.3	VIII

Cell No.	a	b	c	D	N	DN
11	0	0	21	1.0	5.0	IX
12	1	1	14	2.0	8.8	VIII
13	0	2	6	0.8	11.0	VIII
14	0	1	4	0.5	11.2	VIII
15	0	0	13	0.7	7.7	VIII
16	0	1	6	0.6	10.5	VIII
17	1	4	8	2.4	12.3	VIII
18	1	1	12	1.9	9.5	VIII
19	0	0	6	0.3	10.0	VIII
20	0	0	5	0.3	10.3	VIII
21	0	2	2	0.6	12.3	VIII
22	0	1	1	0.3	11.8	VIII
23	0	1	4	0.5	11.2	VIII
24	0	2	5	0.8	11.3	VIII
25	0	1	9	0.7	9.5	VIII
26	0	0	4	0.2	10.7	VIII
27	0	0	1	0.0	12.0	VIII
E 8	0	0	1	0.0	12.0	VIII
9	0	0	6	0.3	10.0	VIII
10	0	2	3	0.7	12.0	VIII
11	0	4	13	1.7	9.7	VIII
12	0	1	11	0.8	8.8	VIII

Cell No.	a	b	c	D	N	DN
13	0	8	11	2.6	12.3	VIII
14	0	2	6	0.8	11.0	VIII
15	1	3	11	2.3	10.8	VIII
16	0	1	8	0.7	10.1	VIII
17	0	5	12	1.9	10.5	VIII
18	1	2	9	2.0	11.0	VIII
19	1	3	1	1.8	14.2	VII
20	0	3	3	0.9	12.5	VIII
21	0	4	8	1.4	11.3	VIII
22	0	0	4	0.2	10.7	VIII
23	1	0	3	1.2	12.0	VIII
24	0	1	2	0.4	11.8	VIII
25	0	0	2	0.1	11.3	VIII
26	0	1	4	0.5	11.2	VIII
27	1	1	4	1.5	12.2	VIII
28	0	1	0	0.3	12.5	VIII
F 8	1	3	4	2.0	13.2	VIII
* 9	0	3	8	1.2	10.8	VIII
10	0	3	18	1.7	7.5	VIII
11	1	5	22	3.4	8.2	V
12	3	15	18	7.2	16.5	I
13	1	12	20	5.0	12.3	V

Cell No.	a	b	c	D	N	DN
* F 14	0	3	14	1.5	8.8	VIII
15	0	11	14	3.5	12.8	V
16	2	5	19	4.2	10.2	V
17	2	7	28	5.2	8.2	V
18	0	1	23	1.4	4.8	IX
19	0	2	1	0.6	12.7	VIII
20	0	1	5	0.5	10.8	VIII
21	0	3	3	0.9	12.5	VIII
* 22	1	4	1	2.1	14.7	VII
23	0	0	4	0.2	10.7	VIII
24	0	1	1	0.3	11.8	VIII
25	0	2	1	0.6	13.7	VII
26	1	0	2	1.1	12.3	VIII
27	1	1	6	1.6	11.5	VIII
28	0	1	6	0.6	10.5	VIII
G 8	0	0	2	0.1	11.3	VIII
9	3	10	9	0.0	17.0	IV
10	0	4	15	1.8	9.0	VIII
11	0	1	6	0.6	10.5	VIII
12	0	2	17	1.4	7.3	VIII
13	0	13	32	4.9	7.8	V

Cell No.		a	b	c	D	N	DN
G	14	0	8	30	3.5	6.0	VI
	15	0	3	23	1.9	5.8	IX
	16	0	4	18	1.9	8.0	VIII
	17	0	8	10	2.5	12.7	VIII
	18	0	5	26	2.6	5.8	IX
	19	1	7	33	4.4	5.5	VI
	20	0	3	9	1.2	10.5	VIII
	21	0	1	4	0.5	11.2	VIII
	22	0	1	3	0.4	11.5	VIII
	23	0	2	2	0.6	12.3	VIII
*	24	0	1	0	0.3	12.5	VIII
	25	1	0	2	1.1	12.3	VIII
*	26	0	2	4	0.7	11.7	VIII
	27	0	1	1	0.3	11.8	VIII
	28	0	3	1	0.8	13.2	VIII
	29	0	2	4	0.7	11.7	VIII
H	7	0	8	16	2.8	10.7	VIII
	8	1	9	6	3.6	15.5	IV
	9	1	3	8	2.2	11.8	VIII
	10	0	2	5	0.8	11.3	VIII
	11	0	1	35	2.0	0.8	IX
	12	2	12	22	6.1	12.7	V

Cell No.		a	b	c	D	N	DN
H	13	0	11	31	4.3	6.5	VI
	14	0	2	15	1.3	7.5	VIII
	15	0	3	12	1.4	9.5	VIII
	16	1	10	29	5.0	8.3	V
	17	1	5	20	3.3	8.8	VIII
*	18	1	6	50	5.0	0.0	VI
	19	0	1	6	0.6	10.5	VIII
	20	0	1	1	0.3	12.2	VIII
	21	0	2	3	0.7	12.0	VIII
	22	0	1	1	0.3	12.2	VIII
	23	1	1	7	1.6	11.2	VIII
*	24	0	0	9	0.5	9.0	VIII
	25	0	0	4	0.2	10.7	VIII
	26	0	0	1	0.1	11.7	VIII
	27	0	1	3	0.4	11.5	VIII
	28	1	1	3	1.4	12.5	VIII
	29	0	6	0	1.5	15.0	VII
	30	0	2	1	0.6	12.7	VIII
I	5	1	9	13	3.9	13.2	V
	6	1	5	24	3.5	7.5	V
	7	6	8	18	11.9	16.0	I

Cell No.		a	b	c	D	N	DN
I	8	2	7	18	4.7	11.5	V
	9	1	9	5	3.5	10.2	V
	10	1	2	17	2.4	8.2	VIII
	11	0	6	19	5.0	8.7	V
*	12	4	6	24	7.2	11.0	II
	13	2	16	28	7.4	13.2	II
	14	1	2	43	3.7	0	VI
	15	1	4	38	3.9	2.3	VI
	16	3	8	34	6.7	7.7	II
	17	0	13	35	5.0	4.6	VI
	18	1	6	19	3.5	9.7	V
	19	0	1	13	0.9	8.2	VIII
	20	1	2	1	1.6	13.7	VII
*	21	0	1	5	0.5	10.8	VIII
	22	0	1	2	0.4	11.8	VIII
	23	0	0	2	0.1	11.3	VIII
	24	1	0	4	1.2	11.7	VIII
	25	0	0	3	0.2	11.0	VIII
	26	0	1	1	0.3	12.2	VIII
	27	1	1	7	1.6	11.2	VIII
	28	0	3	2	0.9	12.8	VIII
	29	0	2	5	0.8	11.3	VIII
	30	0	2	6	0.8	12.7	VIII

Cell No.		a	b	c	D	N	DN
J	5	1	20	28	7.4	13.7	I
	6	2	8	23	5.2	10.3	V
	7	5	14	37	10.0	11.7	II
	8	1	8	16	3.8	11.7	V
	9	0	6	16	2.3	9.7	VIII
	10	1	1	13	0.9	8.2	VIII
	11	1	7	18	3.5	10.5	V
	12	0	7	22	2.9	8.0	VIII
	13	3	4	19	5.0	10.7	V
	14	0	0	36	1.8	0	IX
	15	2	7	24	5.0	9.3	V
	16	2	10	29	6.0	9.3	V
	17	1	13	29	5.7	9.8	V
	18	1	2	16	2.3	8.7	VIII
	19	0	2	3	0.7	12.0	VIII
	20	0	0	0	0	12.0	VIII
	21	0	1	6	0.6	10.5	VIII
	22	1	0	2	1.1	12.3	VIII
	23	0	2	3	0.7	12.0	VIII
	24	0	1	0	0.3	12.5	VIII
	25	0	0	0	0	12.0	VIII
	26	0	0	2	0.1	11.3	VIII

Cell No.		a	b	c	D	N	DN
J	27	0	1	2	0.4	11.8	VIII
	28	0	1	2	0.4	11.8	VIII
	29	0	2	4	0.7	11.7	VIII
	30	0	0	2	0.1	11.3	VIII
K	1	2	0	2	2.1	13.3	VIII
	2	1	1	7	1.6	11.2	VIII
	3	1	3	1	1.8	14.2	VII
	4	0	15	16	4.6	14.2	IV
	5	6	20	19	12.0	21.7	I
	6	3	22	17	9.4	20.3	I
	7	7	22	21	13.6	23.0	I
	8	3	10	16	6.3	15.3	IV
	9	1	6	16	3.3	10.7	VIII
	10	0	2	22	1.6	5.7	IX
	11	4	4	10	5.5	15.3	IV
	12	1	6	22	3.6	8.7	V
	13	2	5	14	4.0	12.0	V
	14	2	7	13	4.4	13.2	V
	15	1	14	22	5.6	12.7	V
	16	2	11	29	6.2	9.8	V
*	17	1	8	14	3.7	12.3	V

Cell No.		a	b	c	D	N	DN
K	18	0	13	10	3.8	15.2	IV
	19	0	2	5	0.8	11.3	VIII
	20	0	2	5	0.8	11.3	VIII
	21	1	0	3	1.2	12.0	VIII
	22	0	2	2	0.6	12.3	VIII
	23	1	0	2	1.1	12.3	VIII
	24	0	1	2	0.4	11.8	VIII
	25	0	0	2	0.1	11.3	VIII
	26	0	1	5	0.5	10.8	VIII
	27	0	2	3	0.7	12.0	VIII
	28	0	0	3	0.2	11.0	VIII
	29	0	4	5	1.3	12.3	VIII
	30	0	8	3	2.2	15.0	VII
	31	0	2	0	0.5	13.0	VIII
L	1	5	4	13	6.7	15.3	I
	2	4	5	20	6.3	11.8	V
	3	9	12	18	12.9	21.0	I
	4	5	14	19	9.5	14.7	I
	5	4	19	13	9.9	19.2	I
	6	5	12	14	8.7	18.3	I
	7	1	10	15	4.3	13.0	V

Cell No.	a	b	c	D	N	DN
L 8	4	11	29	8.2	11.8	II
9	1	16	25	6.3	12.7	V
10	1	4	21	3.1	8.0	VIII
11	0	5	15	2.0	9.5	VIII
12	1	3	11	2.3	10.8	VIII
13	1	9	14	4.0	13.8	IV
14	5	17	23	10.9	17.8	I
15	1	13	12	4.9	15.5	IV
16	1	12	10	4.5	15.7	IV
17	3	11	21	6.8	12.8	II
18	3	4	13	4.7	12.7	V
19	0	3	6	1.1	11.5	VIII
20	0	0	8	0.4	9.3	VIII
21	0	0	4	0.2	10.7	VIII
22	0	0	0	0	12.0	VIII
23	0	1	3	0.4	11.5	VIII
24	0	0	6	0.3	10.0	VIII
25	0	1	4	0.5	11.2	VIII
26	0	2	0	0.5	12.5	VIII
27	0	1	3	0.4	11.5	VIII
28	0	2	2	0.6	12.3	VIII

Cell	No.	a	b	c	D	N	DN
L	29	0	0	4	0.2	10.7	VIII
	30	0	1	6	0.6	10.5	VIII
	31	0	3	13	1.4	9.2	VIII
M	1	2	2	6	2.8	13.0	VIII
	2	4	8	20	7.8	13.3	VIII
	3	8	11	59	13.7	5.8	III
*	4	8	10	18	11.4	19.0	I
	5	6	13	20	10.3	17.8	I
*	6	6	14	23	10.7	17.3	I
	7	1	10	19	4.5	11.7	V
	8	2	25	37	10.1	14.5	I
	9	4	17	29	9.7	14.8	I
	10	1	18	25	6.3	13.7	IV
	11	1	7	18	3.7	10.5	V
	12	0	11	28	4.2	8.2	V
	13	1	10	13	4.2	13.7	IV
	14	3	19	61	10.8	4.2	III
	15	3	15	28	8.4	13.2	II
	16	3	13	11	6.8	17.8	I
	17	1	7	15	3.5	11.5	V
	18	0	5	8	1.7	11.8	VIII

Cell	No.	a	b	c	D	N	DN
M	19	0	4	6	1.3	12.0	VIII
	20	0	2	13	1.2	8.7	VIII
	21	0	0	6	0.3	10.0	VIII
	22	0	0	2	0.1	11.3	VIII
	23	0	0	3	0.2	11.0	VIII
	24	0	2	8	0.9	10.3	VIII
	25	0	3	11	1.3	10.2	VIII
	26	0	5	8	1.2	11.8	VIII
	27	0	1	8	0.7	9.8	VIII
	28	0	3	8	1.2	10.8	VIII
	29	0	1	4	0.5	11.2	VIII
	30	0	1	14	1.0	7.8	VIII
	31	0	3	9	1.2	10.5	VIII
N	1	3	3	4	4.0	15.2	IV
	2	8	10	15	11.3	18.0	I
	3	12	13	28	16.7	21.8	I
	4	6	15	20	10.8	18.8	I
	5	3	6	13	5.2	13.7	IV
	6	0	10	15	3.3	12.0	VIII
	7	2	14	26	6.8	12.3	II
	8	1	13	18	5.2	13.5	V

Cell No.	a	b	c	D	N	DN
9	3	12	37	7.9	9.2	II
10	3	15	40	8.8	9.2	II
11	1	2	12	2.1	10.0	VIII
12	0	10	11	3.2	13.3	VIII
13	0	7	12	2.4	11.5	VIII
14	3	10	16	6.3	14.7	IV
15	6	10	23	9.7	15.3	I
16	3	9	16	6.2	14.2	IV
17	1	9	2	3.4	16.8	IV
18	1	5	5	2.5	13.8	VII
19	0	2	5	0.8	11.3	VIII
20	0	1	13	0.9	8.2	VIII
21	0	1	1	0.3	12.2	VIII
22	0	0	3	0.2	11.0	VIII
23	0	1	3	0.4	11.5	VIII
24	0	1	6	0.6	10.5	VIII
* 25	0	3	8	1.2	10.8	VIII
26	0	3	9	1.2	10.5	VIII
27	0	5	7	1.6	12.2	VIII
28	0	0	17	0.9	6.3	IX
29	0	2	7	0.9	10.7	VIII
30	0	4	7	1.4	11.7	VIII

Cell No.	a	b	c	D	N	DN
31	0	2	7	0.9	10.7	VIII
32	0	0	2	0.1	11.3	VIII
0 1	5	5	4	6.5	15.8	IV
2	13	10	13	15.7	25.7	I
3	6	13	18	5.2	18.5	IV
4	4	10	15	7.3	16.0	I
5	1	8	25	4.3	8.7	V
6	0	5	42	3.4	0.5	VI
7	0	5	18	2.2	8.5	VIII
8	1	4	40	4.0	1.7	III
9	3	9	40	7.3	6.2	III
10	1	11	34	5.5	7.2	V
11	0	4	21	2.1	7.0	VIII
12	0	1	14	1.0	7.8	VIII
13	0	3	15	1.5	8.5	VIII
14	1	4	20	3.0	8.3	VIII
15	1	9	30	4.8	7.5	V
16	2	10	20	5.5	11.7	V
17	1	12	13	4.7	14.7	IV
18	0	0	5	0.3	10.3	VIII
19	0	0	11	0.6	8.3	VIII
20	0	0	8	0.4	9.3	VIII
21	0	1	7	0.6	13.2	VIII

Cell	No.	a	b	c	D	N	DN
*	22	0	2	7	0.9	11.7	VIII
	23	0	0	4	0.2	10.7	VIII
	24	0	3	6	1.1	11.5	VIII
*	25	0	1	5	0.5	10.5	VIII
	26	1	4	8	2.4	12.3	VIII
	27	0	9	10	2.8	13.2	VIII
	28	0	1	11	0.8	9.3	VIII
	29	0	0	8	0.4	9.3	VIII
	30	0	0	9	0.5	9.0	VIII
	31	0	1	9	0.7	9.5	VIII
	32	1	3	15	2.5	9.5	VIII
P	1	5	2	2	5.6	17.3	IV
	2	17	5	2	19.4	18.8	I
	3	1	5	8	2.7	12.8	VIII
	4	1	7	11	3.3	12.8	VIII
	5	2	16	15	6.8	17.0	IV
	6	0	7	43	3.9	1.2	VI
	7	0	8	31	3.6	5.7	VI
	8	1	16	27	6.4	12.0	V
	9	1	12	28	5.4	9.7	V
	10	4	14	38	9.4	10.3	II
	11	2	11	21	5.8	12.5	V

Cell	No.	a	b	c	D	N	DN
P	12	2	11	15	5.5	12.5	V
	13	1	7	14	3.5	11.8	V
	14	1	11	0	3.8	18.5	IV
	15	4	6	8	5.9	16.3	IV
	16	1	11	20	4.8	11.8	V
	17	0	5	22	2.4	7.2	VIII
	18	0	0	11	0.6	8.3	VIII
	19	1	0	15	1.8	8.0	VIII
	20	0	1	17	1.1	6.8	VIII
*	21	1	1	13	1.9	9.2	VIII
	22	0	1	9	0.7	9.5	VIII
	23	0	1	4	0.5	11.2	VIII
	24	1	6	7	2.9	13.7	VII
	25	0	6	18	2.4	9.0	VIII
	26	1	11	21	4.8	11.5	V
	27	1	10	18	4.4	12.0	V
*	28	0	4	15	1.8	9.0	VIII
	29	1	2	20	2.5	7.3	VIII
	30	1	5	16	3.1	10.2	VIII
	31	1	7	8	3.2	13.8	VII
	32	1	9	40	5.3	4.2	VI

Cell No.		a	b	c	D	N	DN
Q	2	3	7	2	4.9	17.8	IV
	3	2	3	5	3.0	13.8	VII
	4	1	4	14	2.7	10.3	VIII
	5	0	8	22	3.1	8.7	VIII
	6	2	13	30	6.8	10.5	II
	7	2	13	41	7.3	6.8	II
*	8	1	11	27	5.1	9.5	V
*	9	0	12	24	4.2	10.0	V
	10	0	16	36	5.8	8.0	V
	11	0	4	13	1.7	9.7	VIII
*	12	1	7	5	3.0	14.8	VII
	13	1	8	16	3.8	11.7	V
	14	2	8	7	4.4	15.7	IV
	15	2	6	17	4.4	11.3	V
	16	1	6	16	3.3	10.7	VIII
*	17	1	4	30	3.5	5.0	VI
	18	0	2	9	1.0	10.0	VIII
	19	0	1	8	0.7	9.8	VIII
	20	0	0	18	0.9	6.0	IX
	21	0	13	14	1.5	8.8	VIII
*	22	0	1	15	1.0	7.5	VIII
	23	0	0	11	0.6	8.3	VIII
*	24	1	0	15	1.8	8.0	VIII

Cell	No.	a	b	c	D	N	DN
Q	25	0	5	10	1.8	11.2	VIII
	26	2	2	12	3.1	11.0	VIII
	27	1	3	19	2.2	8.2	VIII
	28	0	6	21	2.6	8.0	VIII
	29	0	5	10	1.8	11.2	VIII
	30	1	8	19	3.5	10.7	V
	31	0	8	19	3.0	9.7	VIII
R	1	6	1	0	6.3	18.5	IV
	2	5	3	0	5.8	18.5	IV
	3	0	5	15	2.0	9.5	VIII
	4	1	10	31	5.1	7.7	V
	5	2	14	24	6.6	13.0	V
	6	3	20	23	9.2	15.3	I
	7	3	13	25	7.5	14.8	I
	8	2	8	23	5.2	10.3	V
	9	1	9	23	4.4	9.8	V
	10	2	12	29	6.5	10.3	V
	11	2	13	19	6.2	14.2	IV
	12	5	3	15	6.5	13.5	IV
	13	5	8	13	7.7	16.7	I
	14	0	12	21	4.2	11.0	V
	15	2	7	27	5.1	8.5	V

Cell No.		a	b	c	D	N	DN
R	16	0	10	22	3.6	10.2	V
	17	1	9	31	4.8	7.2	V
	18	0	0	6	0.3	10.0	VIII
*	19	0	1	0	0.3	12.5	VIII
	20	0	2	9	1.0	10.0	VIII
	21	0	3	14	1.5	8.8	VIII
	22	1	1	8	1.7	10.8	VIII
	23	0	7	13	2.4	10.7	VIII
	24	2	1	10	1.8	13.8	VII
	25	0	0	1	0.1	11.7	VIII
	26	0	0	20	1.0	5.3	IX
	27	0	2	18	1.4	7.0	VIII
	28	0	8	31	3.6	5.7	V
	29	0	3	13	1.4	9.2	VIII
	30	3	4	19	5.0	10.7	V
	34	0	11	44	5.0	2.8	VI
	35	0	3	16	2.6	8.2	VIII
S	1	8	2	2	8.6	20.3	I
	2	6	2	8	6.9	16.3	I
	3	2	7	40	5.8	4.2	VI
	4	7	28	35	15.8	21.3	I
	5	3	14	23	7.7	14.3	I

Cell No.		a	b	c	D	N	DN
S	6	2	13	22	6.4	13.2	II
	7	0	1	23	1.4	4.8	IX
	8	0	4	18	1.9	8.0	VIII
	9	1	3	17	2.6	8.8	VIII
	10	4	12	13	7.7	17.7	I
	11	3	17	27	8.6	14.3	I
	12	2	16	34	7.7	10.7	II
	13	3	9	20	6.3	12.8	V
	14	0	8	40	4.0	2.7	VI
	15	1	8	12	4.1	13.0	V
	16	2	10	16	5.3	13.7	IV
	17	1	12	31	5.6	8.7	V
	18	0	3	11	1.3	9.8	VIII
	19	1	2	8	1.9	10.3	VIII
	20	0	1	7	0.6	9.2	VIII
	21	1	6	13	3.2	11.7	VIII
	22	3	4	5	4.3	15.3	IV
	23	1	9	7	3.6	15.2	IV
	24	0	3	10	1.3	10.2	VIII
	25	1	0	13	1.7	8.7	VIII
	26	2	4	28	4.4	6.7	VI
	27	0	5	14	2.0	9.8	VIII
	28	1	4	24	3.2	7.0	VIII

Cell	No.	a	b	c	D	N	DN
S	29	2	6	19	4.5	10.7	V
	30	3	2	7	3.9	13.7	IV
	33	2	9	22	5.4	11.2	V
	34	1	24	37	8.9	12.7	II
T	2	1	2	10	2.0	10.7	VIII
	3	9	6	30	12.0	14.0	I
	4	14	25	28	21.2	29.2	I
	5	5	9	30	8.8	11.5	II
*	6	2	11	23	5.9	11.8	V
	7	2	4	20	4.0	9.3	V
	8	0	2	31	2.1	2.7	IX
	9	1	5	25	3.5	7.2	V
	10	2	18	23	7.7	15.3	I
	11	2	23	30	9.3	15.5	I
*	12	2	19	15	7.5	18.5	I
	13	0	14	9	4.0	16.0	IV
	14	1	15	14	5.5	15.8	IV
	15	0	6	9	2.0	12.0	VIII
	16	0	5	8	1.7	11.8	VIII
	17	0	3	22	1.9	6.2	IX
	18	2	0	11	2.6	10.3	VIII
	19	2	1	14	3.0	10.3	VIII
	20	1	6	6	2.8	14.0	VII

Cell	No.	a	b	c	D	N	DN
U	11	1	9	33	4.9	6.5	VI
	12	1	6	15	3.3	11.2	VIII
	13	0	20	5	5.3	20.3	IV
	14	0	19	5	5.0	19.8	IV
*	15	0	11	8	3.2	14.8	VII
	16	1	2	6	1.8	12.0	VIII
	17	1	3	8	2.2	11.8	VIII
	18	0	2	5	0.8	10.5	VIII
	19	0	4	13	1.7	9.3	VIII
	20	0	7	6	2.1	13.5	VII
	21	0	6	8	1.9	12.3	VIII
	22	1	7	11	3.3	11.0	VIII
	23	1	9	10	3.8	14.2	IV
	24	0	9	9	2.7	13.5	VII
	25	0	5	24	2.5	6.5	IX
	26	2	8	27	5.4	9.0	V
	27	3	6	23	5.7	10.3	V
	28	6	1	22	7.4	11.2	II
	29	1	4	33	3.7	2.0	VI
	30	1	6	20	3.3	6.0	IX
	31	0	5	24	2.5	6.5	IX
	32	3	5	17	5.1	11.8	V
	33	0	6	16	2.3	9.7	VIII

Cell No.		a	b	c	D	N	DN
U	34	2	8	12	4.6	14.0	IV
V	5	3	3	2	3.9	15.8	IV
	6	2	7	29	5.2	7.6	V
	7	1	18	21	6.6	15.0	IV
	8	0	9	30	3.8	6.5	VI
	9	1	1	14	2.0	8.8	VIII
	10	1	7	6	3.1	14.5	VII
	11	0	5	14	2.0	9.8	VIII
	12	2	3	31	4.3	5.2	VI
	13	1	15	19	5.7	14.2	IV
	14	1	20	11	6.6	19.3	IV
*	15	0	13	22	4.4	11.2	V
	16	1	6	12	3.1	12.0	VIII
	17	1	3	8	2.2	11.8	VIII
	18	0	1	8	0.7	9.8	VIII
	19	2	2	10	3.0	11.7	VIII
	20	0	6	7	1.9	12.7	VIII
	21	0	5	11	1.8	10.8	VIII
	22	3	2	14	4.2	11.3	V
	23	0	9	14	3.0	11.8	VIII
	24	2	3	13	3.4	11.2	V
	25	2	5	9	3.7	13.5	IV
	26	2	6	12	4.1	13.0	V

Cell	No.	a	b	c	D	N	DN
V	27	3	3	25	5.0	8.2	V
	28	3	7	29	6.2	8.8	V
	29	5	6	16	7.3	14.7	I
	30	0	9	26	3.6	7.8	V
	31	0	7	26	3.1	6.8	VIII
	32	1	0	16	1.8	8.0	VIII
W	5	4	6	7	5.9	17.7	IV
	6	2	19	19	7.7	17.2	II
*	7	0	4	17	1.9	8.3	VIII
	8	0	2	16	1.3	7.7	VIII
	9	0	5	12	1.9	10.5	VIII
	10	0	7	11	2.3	10.8	VIII
	11	0	5	14	2.0	9.8	VIII
	12	0	5	16	2.1	9.2	VIII
	13	1	15	26	6.1	11.8	V
	14	0	16	33	5.7	8.0	V
	15	0	12	27	4.4	9.0	V
	16	1	1	16	2.1	8.2	VIII
	17	0	1	26	1.6	3.8	IX
	18	0	1	5	0.5	8.8	VIII
	19	1	8	17	3.9	11.3	V
	20	1	8	9	3.5	14.0	IV

Cell No.		a	b	c	D	N	DN
W	21	2	7	12	4.4	13.5	IV
	22	1	6	7	2.9	13.7	VII
	23	1	8	21	4.1	10.0	V
	24	1	7	13	3.4	12.2	V
	25	1	2	10	2.0	10.2	VIII
	26	3	6	11	5.1	14.3	IV
	27	2	7	14	4.5	12.8	V
	28	1	14	21	5.6	13.0	V
	29	3	7	24	6.0	10.5	V
	30	1	10	17	4.4	12.3	V
	31	1	6	10	3.0	12.7	VIII
X	5	1	1	0	1.3	13.5	VII
	6	1	14	18	5.4	14.0	V
	7	0	10	21	3.6	10.0	V
*	8	2	10	37	6.4	6.7	VI
	9	0	10	46	4.8	1.7	VI
	10	0	10	23	3.7	9.3	V
	11	1	9	15	4.0	12.5	V
	12	2	8	10	4.5	14.7	IV
	13	1	9	11	3.8	13.8	IV
	14	0	12	35	4.8	6.3	VII
	15	0	3	20	1.8	6.8	VIII

Cell No.	a	b	c	D	N	DN
16	1	7	14	3.5	11.8	V
17	2	2	30	4.0	5.0	V
18	2	1	29	3.7	4.8	VI
19	1	7	21	3.8	9.5	V
20	3	8	15	5.8	14.0	IV
21	3	10	11	6.1	16.3	IV
22	4	9	16	4.1	15.2	IV
23	6	4	17	7.9	14.3	I
24	1	3	14	2.5	9.8	VIII
25	2	9	11	4.8	14.8	IV
26	5	12	12	8.6	19.0	I
27	5	8	23	8.2	13.2	II
28	6	7	9	8.2	18.5	I
29	8	3	18	9.7	15.5	I
30	6	4	17	7.9	14.3	I
31	1	7	9	3.2	13.5	VII
Y 5	5	12	5	8.3	21.3	I
6	2	15	19	6.7	15.2	I
* 7	1	13	23	5.4	9.6	V
8	1	9	50	5.8	0.8	VI
9	0	6	73	4.7	0	VI
10	0	6	24	2.7	7.0	VIII
11	1	6	22	2.6	8.7	VIII

Cell No.		a	b	c	D	N	DN
	12	2	6	14	4.2	12.3	V
	13	4	5	11	5.8	13.0	V
	14	2	3	30	4.3	5.5	VI
	15	2	0	15	2.8	9.0	VIII
	16	1	1	2	1.4	12.8	VIII
	17	2	10	18	5.4	13.0	V
	18	4	8	17	6.9	14.3	I
	19	4	5	9	5.7	15.5	IV
	20	2	7	8	4.2	14.8	IV
	21	2	9	6	4.6	16.5	IV
	22	6	0	14	6.7	13.3	II
	23	6	8	10	8.5	18.7	I
	24	0	5	8	1.7	11.8	VIII
	25	3	3	33	5.4	5.5	VI
	26	2	11	15	5.5	14.5	IV
	27	2	13	12	5.9	16.5	IV
	28	5	7	20	7.8	12.8	II
	29	1	7	30	4.3	6.5	VI
	30	1	3	6	2.1	12.5	VIII
	31	o	2	0	0.5	13.0	VIII
Z	7	1	16	28	6.4	12.0	V
	8	2	4	29	4.5	6.3	VI
	9	0	7	19	2.7	9.2	VIII

Cell	No.	a	b	c	D	N	DN
Z	10	0	0	7	0.4	9.7	VIII
	11	2	3	7	3.1	12.2	VIII
	12	0	11	8	3.2	14.8	VII
	13	2	8	17	4.9	12.3	V
	14	1	9	36	5.1	5.5	VI
	15	2	6	10	4.0	13.7	IV
	16	4	3	7	5.1	15.2	IV
	17	5	7	14	7.5	15.8	I
	18	5	7	14	7.5	15.8	I
	19	6	4	13	7.7	15.3	I
	20	0	8	6	2.3	14.0	VII
	21	4	2	11	5.1	13.3	V
*	22	3	5	15	5.0	12.5	V
	23	1	1	13	1.9	9.2	VIII
	24	1	3	5	2.0	12.8	VIII
	25	2	12	29	6.5	10.3	V
	26	3	7	6	5.1	16.5	IV
	27	4	5	12	5.9	14.5	IV
	28	0	2	7	0.9	10.7	VIII
	29	2	2	12	3.1	11.0	VIII
	30	0	1	4	0.5	11.2	VIII
a	10	0	1	7	0.6	10.2	VIII
	11	4	8	29	7.5	10.3	II

Cell	No.	a	b	c	D	N	DN
a	12	4	8	34	7.7	8.7	II
	13	1	15	38	6.7	7.8	II
	14	2	15	64	9.0	0.2	III
	15	3	10	34	7.2	8.7	II
	16	5	10	17	8.4	16.2	I
	17	5	6	6	6.8	18.0	I
	18	5	3	9	6.2	15.5	IV
	19	1	9	14	4.0	12.8	V
	20	2	3	5	3.0	13.8	VII
	21	3	2	7	3.9	13.7	IV
	22	4	3	9	5.2	14.5	IV
	23	1	4	6	2.3	13.0	VIII
*	24	2	5	5	2.0	14.8	VII
	25	7	6	4	8.7	20.7	I
	26	2	4	1	3.1	15.7	VII
	27	0	0	8	0.4	9.3	VIII
*	28	0	0	2	0.1	11.3	VIII
	29	0	0	2	0.1	11.3	VIII
b	5	1	9	2	3.4	16.8	IV
	6	0	8	14	2.7	11.3	VIII
	7	2	10	33	6.2	8.0	V
	8	0	9	35	4.0	4.8	VI
	9	0	3	8	1.2	10.8	VIII

Cell	No.	a	b	c	D	N	DN
b	10	0	1	5	0.5	10.7	VIII
	11	0	4	11	1.6	10.3	VIII
	12	0	5	11	1.8	10.8	VIII
	13	2	14	57	8.4	2.0	III
*	14	3	16	98	11.9	0	III
	15	2	11	54	7.5	1.5	III
	16	8	12	14	11.7	21.3	I
	17	8	6	12	10.1	19.0	I
	18	6	7	17	8.6	15.8	I
	19	5	6	5	6.8	18,3	I
	20	6	4	4	7.2	18.7	I
	21	5	1	9	5.7	14.5	IV
	22	2	5	9	3.7	13.5	V
	23	4	4	9	5.5	14.3	IV
	24	5	2	10	6.0	14.7	IV
	25	8	1	22	9.4	13.2	II
	26	3	4	8	4.4	14.3	IV
	27	0	2	1	0.6	12.7	VIII
	28	0	1	1	0.3	12.2	VIII
	29	0	0	2	0.1	11.3	VIII
c	8	0	1	35	2.0	0.8	IX
	9	0	8	27	3.4	7.0	V

Cell	No.	a	b	c	D	N	DN
c	10	0	3	13	1.4	9.2	VIII
	11	0	7	20	2.8	8.8	VIII
	12	1	15	26	6.1	11.8	V
	13	2	13	32	5.4	9.8	V
	14	0	9	30	3.8	6.5	VI
	15	1	12	27	5.4	10.0	V
	16	10	11	14	13.5	22.8	I
	17	7	8	20	10.0	16.3	I
	18	3	14	20	7.5	15.3	I
	19	3	5	4	4.5	16.2	IV
*	20	4	6	4	5.7	17.7	IV
	21	3	6	9	5.0	15.0	IV
	22	6	2	3	6.7	18.0	I
	23	0	2	7	0 .9	9.7	VIII
	24	2	6	12	4.1	13.0	V
	25	2	6	7	3.9	14.7	IV
	26	2	2	11	3.1	11.3	VIII
	27	1	1	2	1.4	12.8	VIII
	28	0	0	3	0.2	11.0	VIII
d	9	0	4	12	1.6	10.0	VIII
	10	0	4	22	2.1	6.7	VIII
	11	2	11	31	6.3	8.2	V

Cell	No.	a	b	c	D	N	DN
d	12	2	10	22	5.6	11.7	V
	13	3	13	15	7.0	16.5	IV
	14	1	10	16	4.3	12.7	V
	15	1	5	21	3.3	8.5	VIII
	16	6	9	9	8.7	19.5	I
	17	3	5	20	5.3	10.8	V
	18	5	7	13	7.4	16.2	I
*	19	4	5	8	5.7	15.8	IV
	20	2	7	12	4.4	13.5	IV
*	21	1	3	14	2.5	9.8	VIII
	22	5	7	15	7.5	15.5	I
	23	1	3	3	1.9	13.5	VII
	24	0	0	14	0.7	7.3	VIII
	25	1	0	4	1.2	11.7	VIII
	26	0	0	0	0.0	11.0	VIII
e	12	0	4	10	1.5	10.7	VIII
	13	0	5	23	2.4	6.8	VIII
	14	0	8	22	3.1	8.7	VIII
	15	0	4	11	1.6	10.3	VIII
	16	1	5	9	2.7	12.5	VIII
	17	0	4	7	1.4	11.5	VIII
	18	1	6	9	3.0	13.0	VIII
	19	4	4	8	5.4	15.3	IV
	20	2	3	9	3.2	13.5	VII
	21	0	2	7	0.9	10.7	VIII

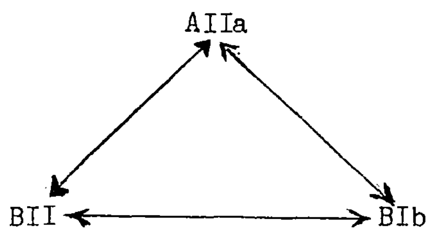
Cell No.		a	b	c	D	N	DN
e	22	1	10	16	4.3	12.7	V
	23	2	2	13	3.2	10.7	VIII
	24	1	0	5	1.3	12.3	VIII
	25	0	0	0	0.0	11.0	VIII
f	14	0	7	6	2.1	13.5	VII
	15	1	3	12	2.4	10.5	VIII
	16	0	3	13	1.4	9.2	VIII
	17	1	5	6	2.6	13.5	VII
	18	1	4	6	2.3	13.0	VIII
	19	0	6	8	1.9	12.3	VIII
	20	0	7	4	2.0	13.2	VIII
	21	1	7	5	3.0	14.8	VII
*	22	1	6	9	3.0	13.0	VIII
	23	2	5	3	3.4	15.5	V
	24	2	0	2	2.1	13.3	VIII
g	17	0	1	3	0.4	11.5	VIII
	18	1	1	7	1.6	11.2	VIII
	19	0	2	10	1.0	9.7	VIII
	20	0	2	11	1.1	9.3	VIII
	21	0	4	8	1.4	11.3	VIII
	22	0	6	12	2.1	11.0	VIII
h	19	0	0	6	0.3	10.0	VIII
	20	0	1	12	0.9	8.5	VIII
	21	0	2	9	1.0	10.0	VIII
	22	3	4	13	4.7	12.7	V

Cell No.		a	b	c	D	N	DN
i	20	1	2	4	1.7	12.7	VIII
	21	0	2	8	0.9	10.3	VIII
	22	0	0	0	0.0	11.0	VIII

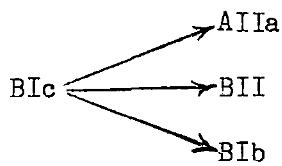
APPENDIX 4.

Chi Square Test of Regional Association (Figs ; Table)

1.



2.



O = Observed number of occurrences in <u>standard cell</u> sample.

E = Expected number according to the null hypothesis of 'no difference'.

1

Paired Rank (DN)	AIIa		BII		Totals
	O	E	O	E	
I	4	(7.8)	10	(6.2)	14
II	3	(5.0)	6	(3.9)	9
IV+VII	10	(11.8)	11	(9.2)	21
V	24	(21.8)	15	(17.2)	39
VI+IX	11	(6.7)	1	(5.3)	12
VIII	9	(6.8)	5	(6.2)	14
Totals	61		48		109

1

PairedRank (DN)	AIIa		BIb		Totals
	O	E	O	E	
I+II	7	(9.5)	14	(10.5)	21
IV	6	(9.9)	16	(12.1)	22
V	24	(16.7)	13	(20.3)	37
VI+IX	11	(6.3)	3	(7.7)	14
VII	4	(4.5)	6	(5.5)	10
VIII	9	(14.0)	22	(17.0)	31
Totals	61		74		135

1

Paired Rank (DN)	BIb		BII		Totals
	O	E	O	E	
I	10	(8.0)	10	(12.0)	20
II	6	(4.0)	4	(6.0)	10
IV+VII	11	(13.1)	22	(19.9)	33
V	15	(11.1)	13	(16.8)	28
VIII	5	(10.7)	22	(16.2)	27
Totals	47		71		118

2

Paired Rank (DN)	BIc		BII		Totals
	O	E	O	E	
I	5	(11.3)	17	(10.6)	22
II+III	3	(6.7)	10	(6.3)	13
IV	4	(8.8)	13	(8.2)	17
V	14	(18.6)	22	(17.4)	36
VI	10	(6.7)	3	(6.3)	13
VII	2	(2.1)	2	(1.9)	4
VIII+IX	41	(24.8)	7	(23.2)	48
Totals	79		74		153

2

Paired Rank (DN)	BIc		BIb		Totals
	O	E	O	E	
I+II	8	(15.6)	32	(24.3)	40
III	0		0		0
IV	4	(11.7)	26	(18.3)	30
V	14	(15.6)	26	(24.4)	40
VI	10	(4.7)	2	(7.3)	12
VII	2	(3.1)	6	(4.9)	8
VIII+IX	41	(28.2)	31	(43.8)	72
Totals	79		123		202

2

Paired Rank (DN)	BIc		AIIa		Totals
	O	E	O	E	
I+II	8	(6.9)	7	(8.1)	15
IV	4	(5.1)	7	(5.9)	11
V	14	(17.9)	25	(21.1)	39
VI+III	10	(7.3)	6	(8.7)	16
VII	2	(3.2)	5	(3.8)	7
VIII	41	(38.6)	43	(45.4)	84
Totals	79		93		172

APPENDIX 5.

Nearest Neighbour Statistics

(Clark and Dacey Method)

Sheet No.	=	1:50,000 Topographical Map Sheet (Fig. 28)
d values	=	Nearest neighbour distances in miles to the central place specified (grid reference) within each sextant of a hexagon with its centre located over the central place.
Rn	=	Test Statistic (Chapter 18.3)

Sheet 41

Settlement	Grid Reference	d values I	II	III	IV	V	VI	$\sum d$	$\bar{D}$. obs	Rn
Hagbuntama	560910	0.9	1.5	1.6	1.1	1.5	2.0	8.6	1.43	1.23
Mafuri	576915	1.0	2.0	1.3	2.0	1.7	2.0	10.0	1.66	1.40
Matakali	567888	1.5	1.8	1.4	1.0	2.0	2.0	9.7	1.62	1.36
Gbombana	576875	1.0	2.0	0.5	0.7	2.0	3.0	9.2	1.53	1.31
Makabari	583872	0.5	0.6	1.0	1.8	2.5	1.5	7.4	1.23	1.06
Mafuri	579864	0.7	0.7	2.0	1.7	1.5	1.8	8.4	1.4	1.19
Mabai	549859	2.2	2.0	1.8	0.8	1.3	2.5	10.6	1.7	1.48
Mawil	598882	2.1	0.7	1.1	1.6	1.0	1.4	7.9	1.3	1.10
Maseka	602891	0.6	1.7	2.2	0.9	1.7	1.2	8.3	1.4	1.19
Gbiton	607904	1.0	2.0	1.4	1.7	0.8	2.0	8.9	1.7	1.44
Marenka	518920	2.2	2.5	2.1	1.8	1.3	2.5	12.4	2.1	1.78
Kitenti	551932	1.3	1.3	1.7	1.5	1.0	2.3	9.1	1.5	1.27
Taua	590930	1.7	1.4	1.0	1.0	1.2	0.7	7.0	1.2	1.02
Futa	512814	1.0	1.6	2.5	1.0	2.0	2.2	10.3	1.7	1.44
Mabunputa	528819	1.0	2.2	2.0	2.2	1.0	2.2	10.6	1.8	1.53
Magboronga	548846	1.3	0.9	2.2	1.2	2.2	2.1	9.9	1.7	1.44
Makump	566835	0.3	0.4	1.1	1.8	2.7	1.2	7.5	1.3	1.10
Mafenkina	577839	0.5	0.4	1.5	2.5	1.3	1.3	9.5	1.6	1.36
Makali	568841	0.3	0.5	1.8	1.5	1.7	1.3	7.1	1.2	1.02
Gbonkopila	538808	1.7	1.0	2.5	1.5	1.3	1.6	9.6	1.6	1.36
Rokel	561809	1.5	2.4	0.9	0.8	2.9	1.9	10.3	1.7	1.44
Sanda	570819	.8	1.0	1.3	1.3	1.0	2.1	7.5	1.25	1.06
Magbankan	590822	.8	1.7	1.3	1.4	2.0	0.8	8.0	1.33	1.10

Sheet 41

Settlement	Grid Reference	d values I	II	III	IV	V	VI	d	$\bar{D}$. obs	Rn
Makapr	590808	1.2	.9	1.0	1.7	1.6	2.4	8.9	1.48	1.27
Konta	519782	1.7	2.0	1.9	0.3	2.8	1.6	10.3	1.72	1.44
Katik	525782	0.4	2.3	1.8	2.7	2.6	1.8	11.6	1.93	1.65
Benkia	565765	1.9	2.8	2.1	2.4	0.6	2.6	12.4	2.06	1.74
Makane	575765	0.6	2.3	2.9	1.2	2.1	2.4	11.5	1.91	1.61
Rosint	590773	2.0	2.0	1.7	2.1	1.0	1.7	10.5	1.75	1.48
Masungbun	542745	1.2	2.7	2.5	1.9	3.2	2.0	14.5	2.42	2.04
Katik	598738	2.2	3.0	3.1	2.0	3.5	3.5	17.3	2.88	2.39
Bane	615785	0.7	0.6	1.5	3.2	3.0	1.6	10.6	1.77	1.48
(no name)	612796	2.3	1.2	0.8	1.9	2.4	1.6	10.4	1.73	1.48
Futa	622789	0.8	0.8	0.8	2.9	3.5	0.7	9.5	1.58	1.36
Masangban	636795	0.6	1.5	0.6	2.7	1.5	0.8	7.7	1.28	1.10
Baka	642798	0.6	0.8	2.6	1.0	2.0	2.8	9.8	1.63	1.40
Magberi	630801	1.2	2.0	3.5	0.9	0.6	0.9	9.1	1.52	1.27
Mabonka	652812	1.1	1.6	2.3	2.5	1.5	3.6	12.6	2.10	1.78
Kambia	658755	2.7	3.3	3.3	3.1	2.3	3.6	18.3	3.05	3.00
Mambure	699728	3.5	0.8	1.8	2.0	3.2	3.1	14.4	2.40	2.04
Royel	696829	1.6	2.8	2.0	1.7	1.4	1.4	10.9	1.82	1.53
Marenka	670830	0.9	1.6	1.6	1.6	2.9	1.2	9.8	1.63	1.40
Magbafat	602819	0.9	2.2	0.9	2.8	2.0	1.0	9.8	1.63	1.40
Makali	610832	0.8	0.7	2.3	1.0	1.4	2.8	9.0	1.50	1.27
Kamba	621832	0.9	2.9	2.7	2.8	2.4	0.7	12.4	2.07	1.74
Konta	615844	1.2	1.7	2.8	1.9	0.8	1.5	9.9	1.65	1.40

Sheet 41

Settlement	Grid Reference	d values I	II	III	IV	V	VI	d	D̄. obs	Rn
Rosint	678842	1.0	1.6	2.3	1.8	1.4	0.8	8.9	1.48	1.27
Gbalan	660849	1.2	1.1	1.2	2.3	2.7	1.8	10.3	1.72	1.44
Karina	669865	1.2	2.0	1.5	1.1	2.3	2.6	10.7	1.78	1.53
Kukuna	611861	1.2	1.8	1.8	1.6	0.7	3.2	10.3	1.72	1.44
Rotifunk	617871	0.8	2.1	0.4	1.5	1.1	2.5	8.4	1.40	1.19
Gbane	612875	0.4	0.9	1.1	1.2	1.2	1.4	6.2	1.03	0.89
Mabere	632878	0.7	1.2	1.7	2.5	1.5	2.5	10.1	1.68	1.44
Kalangba	659880	3.0	2.2	1.2	3.6	1.5	2.5	14.0	2.33	1.99
Magbaukita	890630	1.0	1.9	1.9	0.8	1.6	1.0	8.2	1.37	1.14
Makomne	629906	1.0	1.9	1.0	2.0	1.3	1.6	9.8	1.63	1.40
Gbinti	639919	1.2	1.2	2.6	1.1	2.1	2.8	11.0	1.83	1.57
Rosar	694882	1.9	0.9	1.7	1.5	2.0	2.2	10.2	1.70	1.44
Masine	692915	0.9	2.2	1.5	3.0	2.5	1.4	11.5	1.92	1.61
Gbenten	652921	1.0	2.3	0.8	1.4	1.5	1.8	8.8	1.40	1.19
Roten	625930	1.4	2.6	1.6	2.2	1.2	2.0	11.0	1.83	1.57
Balandugu	666932	0.7	1.0	1.8	2.5	1.4	2.0	9.4	1.57	1.31
Kotolon	682942	1.1	0.7	1.8	1.0	1.3	1.7	7.6	1.27	1.06
Gberi	702924	0.7	1.5	2.0	0.7	1.6	1.7	8.2	1.37	1.14
Petifu	720898	1.4	0.4	2.1	1.0	2.0	1.5	8.4	1.40	1.19
Mabure	702891	2.2	1.0	1.6	0.7	2.8	1.5	9.8	1.63	1.40
Bombo	724875	0.9	1.6	0.8	1.2	1.9	2.1	8.5	1.42	1.19
Makapr	729862	1.3	0.8	2.7	1.3	0.7	1.8	8.6	1.43	1.23
Masim	709862	1.5	1.2	1.2	1.6	0.8	2.5	9.8	1.63	1.40

Sheet 41

Settlement	Grid Reference	d values						d	$\bar{D}$. obs	Rn
		I	II	III	IV	V	VI			
Makera	706850	1.5	1.3	1.3	1.8	2.2	0.8	8.9	1.48	1.27
Lungi	730849	1.6	0.7	2.3	0.6	1.5	0.8	7.5	1.25	1.06
Funknyin	729840	0.6	0.8	1.7	3.2	2.2	1.9	10.4	1.73	1.48
Masembe	720790	1.2	2.1	1.2	2.8	2.8	1.3	11.4	1.90	1.61
Magbanda	701781	1.2	2.0	3.2	3.4	2.2	2.5	14.5	2.42	2.04

Sheet 43

Settlement	Grid Reference	d values I	II	III	IV	V	VI	d	D̄. obs	Rn
Mabotima	087875	2.2	1.9	1.2	2.5	3.5	2.1	12.4	2.23	1.91
No name	085904	2.4	2.1	1.3	1.8	2.4	1.9	11.9	1.98	1.70
Maburagura	108901	2.0	3.3	2.2	1.4	2.2	1.2	12.3	2.05	1.74
Makabi	121913	1.2	0.4	1.0	2.2	1.1	2.4	8.3	1.38	1.19
Masungbo	124919	0.4	1.2	2.6	2.8	2.2	1.0	10.2	1.70	1.44
Mamburugo	137906	1.2	1.8	1.5	1.5	3.6	1.2	10.8	1.80	1.53
Pudung	142882	1.2	1.6	1.1	3.0	2.5	1.5	10.9	1.82	1.53
Mabaikuli	069868	1.2	2.2	1.5	1.2	2.5	2.5	11.1	1.85	1.57
No name	065842	1.5	1.8	1.7	2.3	1.2	2.8	11.3	1.88	1.61
Matamba	082832	1.9	2.8	3.2	1.6	2.5	1.2	13.2	2.20	1.87
Masiya	075808	1.5	2.2	1.6	3.2	2.5	2.9	13.9	2.32	1.95
No name	128819	0.7	2.1	2.0	2.9	2.5	1.5	11.7	1.95	1.23
Mangere	138825	0.7	2.2	1.3	1.7	2.4	1.8	10.1	1.68	1.44
Makoi	166937	0.8	0.3	2.8	0.8	1.0	1.4	9.1	1.52	1.27
Mahari	178924	0.7	1.1	1.5	1.0	1.4	2.0	7.7	1.28	1.10
Mamara	174901	1.0	1.3	1.0	1.5	1.2	1.6	7.6	1.27	1.06
Mabuio	158894	1.5	2.5	1.2	1.2	1.1	1.5	10.1	1.68	1.44
Maranka	168876	1.0	1.2	1.5	0.6	0.8	1.1	6.2	1.03	0.89
Mafare	175865	0.6	1.0	0.5	1.2	1.3	0.8	5.4	0.90	0.76
Matumbu	178872	0.5	1.2	0.6	0.7	1.8	0.6	5.4	0.90	0.76
Manke	201872	1.4	0.7	1.0	0.8	1.1	1.1	6.1	1.07	0.89
Magbise	177847	1.0	1.5	1.2	0.6	0.7	1.5	6.5	1.08	0.93

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Settlement	Grid Reference	d values I	II	III	IV	V	VI	d	$\bar{D}$. obs	Rn
Masungbo	182822	1.5	1.4	0.6	1.0	1.0	1.2	6.7	1.12	0.93
Masapri	181806	0.9	1.0	2.1	0.6	0.8	1.5	6.9	1.15	0.97
Mabura	182783	0.8	0.6	1.7	1.3	1.3	1.8	7.5	1.25	1.06
Korife	191764	1.3	1.5	1.3	1.8	0.7	1.3	7.9	1.32	1.10
Makump	218755	1.1	0.5	1.2	1.3	1.6	1.8	7.5	1.25	1.06
Roching	235726	0.3	0.4	2.6	1.4	2.7	1.5	8.9	1.48	1.27
Mambole	238763	1.2	2.3	1.2	0.8	1.3	1.8	8.6	1.43	1.23
Mabure	212782	1.6	1.2	0.9	2.5	0.8	1.9	8.9	1.48	1.27
Petbana	217806	1.3	1.9	0.6	1.2	0.7	1.3	7.0	1.17	0.97
Makama	239809	1.1	1.3	1.5	1.7	1.7	2.0	9.3	1.55	1.27
Masimena	237865	0.7	1.1	1.4	1.0	0.8	1.5	6.5	1.08	0.93
Mafonike	238377	0.8	1.0	2.0	0.7	2.3	2.3	9.1	1.52	1.27
Paulap	267869	1.5	2.3	1.4	1.5	0.7	0.8	8.2	1.37	1.14
Kunshu	213908	1.0	3.1	2.3	0.7	1.0	1.3	9.4	1.57	1.31
Mango	199933	1.9	0.4	2.0	1.4	2.3	1.9	9.9	1.65	1.40
Matinka	262929	1.2	1.0	2.1	1.0	0.2	3.2	8.7	1.45	1.23
Lilia	187909	1.7	1.1	1.2	1.3	1.3	1.6	8.2	1.37	1.14
Moria	099768	1.8	2.7	1.8	1.5	1.8	1.2	10.8	1.80	1.53

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Settlement	Grid Reference	d values I	II	III	IV	V	VI	d	$\overline{D}$. obs	Rn
Mongeriwo	080522	1.9	2.0	2.7	2.5	1.9	2.3	13.3	2.22	1.87
Mosati	077479	3.3	2.5	1.5	2.0	1.6	1.2	12.1	2.02	1.70
Gendema	081455	1.6	1.5	1.7	1.0	1.6	1.6	9.0	1.50	1.27
Jagbwema	065432	1.0	1.7	1.6	2.1	2.8	1.3	10.5	1.75	1.48
Tisana	087379	0.6	1.4	1.6	1.9	2.3	1.5	9.2	1.55	1.31
Kambalo	095384	0.6	2.4	2.4	1.0	1.7	1.9	10.0	1.66	1.40
Magbagi	067362	0.8	2.4	2.8	1.5	1.6	1.6	10.7	1.78	1.53
Mosapo	100356	1.5	1.7	0.6	1.6	2.8	1.5	9.7	1.62	1.36
Momongo	100350	0.7	2.1	2.5	1.2	2.7	2.3	11.5	1.92	1.61
Mokale	128540	0.5	1.4	1.6	1.6	1.8	2.4	9.3	1.55	1.31
Mokepi	128548	1.3	2.8	1.2	1.7	0.5	2.2	9.7	1.62	1.36
Mokpanja	162550	1.3	1.2	0.6	1.0	1.2	1.6	6.9	1.15	0.97
Nguala	172548	0.7	1.3	1.7	1.7	3.0	0.7	8.1	1.35	1.14
Buyama	170535	0.7	1.0	1.1	0.8	1.4	1.9	6.9	1.15	0.97
Mokagbo	151532	1.8	1.5	1.3	1.0	2.1	0.5	8.2	1.34	1.14
Mojaba	150526	0.5	1.2	1.5	0.5	2.5	1.6	6.8	1.13	0.97
Nauguehun	142519	0.5	1.5	1.3	2.0	211	1.8	9.2	1.53	1.31
Fayama	110518	1.8	2.1	0.7	1.7	1.7	2.7	10.7	1.78	1.53
Masapo	108505	0.8	2.5	1.0	2.0	2.5	2.1	10.9	1.82	1.53
Majugonda	169524	0.8	1.6	1.2	1.7	0.7	2.1	8.1	1.35	1.14
Mogbei	180515	1.5	2.0	2.2	1.6	0.9	2.1	10.3	1.72	1.44
Magongbe	157502	1.6	1.7	1.4	1.5	1.7	1.3	9.2	1.53	1.31
Juihun Tisana	115490	1.0	1.5	1.4	2.5	1.0	2.6	10.0	1.66	1.40

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Settlement	Grid Reference	d values I	II	III	IV	V	VI	d	$\bar{D}$. obs	Rn
Madina	131489	0.3	0.2	1.4	1.0	1.8	2.0	6.7	1.12	0.93
Mogbodo	132484	0.3	0.2	0.9	1.2	1.2	2.0	5.8	0.966	0.81
Tekibe	137488	0.3	0.2	0.9	1.8	1.5	2.1	6.8	1.13	0.97
Wongife	147478	0.8	1.2	1.6	2.6	1.5	1.6	9.3	1.55	1.31
Tolobu	167482	1.4	2.2	2.2	0.9	2.3	1.2	10.2	1.70	1.44
Nyanihun	170468	1.6	1.2	2.7	1.7	0.9	2.5	10.4	1.73	1.48
Logbana	102471	1.6	3.4	1.4	1.1	1.6	1.7	10.8	1.80	1.53
No name	121471	0.7	1.1	1.2	1.2	1.5	1.0	7.9	1.32	1.10
Njala	106462	1.0	2.1	0.6	1.0	1.6	1.5	7.8	1.30	1.6
Katomahun	121459	1.0	0.7	1.8	1.1	2.0	2.0	8.6	1.43	1.23
Bisawo	139456	1.1	1.5	2.2	2.0	1.2	2.6	10.6	1.76	1.48
Bandataina	198467	0.3	0.4	1.7	1.7	1.2	1.3	6.6	1.43	1.23
Moyowa	200461	1.9	0.3	1.1	2.1	1.8	0.4	7.6	1.27	1.06
Maka	179451	2.6	1.2	1.0	1.3	2.6	2.2	10.9	1.82	1.53
Madina	138434	0.8	0.8	1.8	1.2	2.8	1.2	8.6	1.43	1.23
Wulai	100438	1.6	1.6	2.0	1.3	1.0	2.0	9.5	1.58	1.36
Mokita	126434	1.7	1.8	0.9	1.0	0.8	0.9	7.1	1.18	1.02
Bandajumpa	141422	0.7	3.4	0.7	0.8	1.0	0.7	7.3	1.22	1.02
Luawa	154428	1.1	0.8	2.4	2.6	1.0	0.8	8.7	1.45	1.23
Semabu	191432	2.4	1.2	0.8	2.3	1.3	1.5	9.5	1.58	1.36
Jagahun	198422	0.8	3.1	2.1	0.5	1.0	1.6	9.1	1.52	1.27
Nyandahun	198414	2.9	3.1	2.0	1.2	1.4	0.5	11.1	1.85	1.57
Sembehun	147412	1.2	0.7	3.0	2.7	2.0	0.5	10.1	1.68	1.44

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Settlement	Grid Reference	d values I	II	III	IV	V	VI	d	$\overline{D}$. obs	Rn
Gbangiyema	130416	0.8	0.8	0.8	1.0	1.4	2.1	6.9	1.15	0.97
Kali	142404	0.6	2.7	1.5	0.9	1.0	1.2	7.9	1.32	1.10
Mopite	102398	1.5	2.4	1.5	1.5	1.2	1.0	9.1	1.52	1.27
Mowago	121391	0.7	1.6	0.9	1.7	1.2	1.5	7.6	1.27	1.06
Foya	132392	0.7	1.7	1.5	1.5	1.0	1.0	7.4	1.23	1.06
Blama	144380	1.0	1.2	1.0	2.6	2.3	1.5	9.6	1.60	1.36
Kale	182386	2.4	2.6	2.0	2.2	2.6	2.3	14.1	2.35	1.99
Nyandehun	123378	1.8	1.0	1.3	1.4	0.8	2.3	8.6	1.43	1.23
Gangama	122363	0.8	1.2	1.8	1.5	2.0	2.9	10.2	1.70	1.44
Segburema	142363	1.2	1.4	1.0	2.7	1.8	3.0	11.1	1.85	1.57
Gambia	115338	1.3	1.7	2.3	1.3	1.5	1.0	9.1	1.52	1.27
(Gbanduma (Nyandahun	165343	2.0	0.9	2.1	2.7	1.8	2.8	12.3	2.05	1.74
Tonsu	179342	0.9	0.5	2.5	2.7	1.3	1.7	9.6	1.60	1.36
Gerehun	198348	0.6	2.3	1.2	3.6	1.6	1.6	10.9	1.82	1.53
Fabu-Badu	200541	0.7	2.0	1.1	1.7	1.9	1.2	8.6	1.43	1.23
Jombohun	210539	0.7	2.0	1.6	2.6	1.0	2.3	10.2	1.70	1.44
Manyawama	258545	2.2	1.0	1.6	3.1	0.8	1.9	10.6	1.76	1.48
Bandaisa	252531	2.3	0.9	1.5	1.2	2.0	2.3	10.2	1.70	1.40
Manoma	213525	2.2	1.4	0.9	2.2	2.4	2.1	11.2	1.87	1.57
Tevulahun	267518	1.2	1.7	2.6	1.8	1.0	2.4	10.7	1.78	1.53
Kapuima	264502	3.3	1.0	1.6	1.5	2.5	1.8	11.7	1.95	1.65
Magbevo	289498	0.3	1.[illegible]	2.2	3.0	1.5	1.4	9.9	1.65	1.40

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Settlement	Grid Reference	d values I	II	III	IV	V	VI	d	$\overline{D}$. obs	Rn
Gbonge	238491	2.2	2.7	1.8	1.9	2.6	2.1	13.3	2.22	1.87
Motami	202493	2.2	1.7	2.5	1.8	2.0	2.3	12.5	2.08	1.78
Mokaiwa	210481	1.8	2.4	1.3	1.2	0.9	2.7	10.3	1.72	1.44
Nhablama	218462	1.1	1.2	1.2	2.1	1.2	2.0	8.8	1.47	1.65
Yumbuma	252463	1.9	2.4	3.0	0.9	2.4	1.5	12.1	2.02	1.70
Fomaia	265453	0.9	2.0	1.8	2.5	1.8	3.0	12.0	2.00	1.70
Ngiyebu	232449	1.2	2.5	1.6	2.2	1.3	1.7	10.5	1.75	1.48
Kebawana	212430	0.6	1.6	1.0	1.3	2.0	1.8	8.3	1.38	1.19
Bauya	222430	0.6	2.3	1.3	3.0	1.0	1.8	10.0	1.66	1.40
Motuwo	260426	1.7	2.7	3.0	0.6	2.3	2.2	12.5	2.08	1.78
Gondama	258418	6.6	3.0	1.8	2.1	2.3	3.1	12.9	2.15	1.82
Naji	224414	1.7	1.0	2.0	3.0	1.5	0.8	10.0	1.66	1.40
Ngiyema	235391	1.4	1.8	2.1	2.0	1.5	1.2	9.7	1.62	1.36
Jahun	267390	2.0	1.8	3.1	2.2	1.1	1.7	11.9	1.98	1.70
Likono	249374	1.3	1.2	1.9	2.2	0.9	1.6	9.1	1.52	1.27
Petewoma	275375	1.1	0.4	1.1	1.2	1.2	3.6	8.6	1.43	1.23
Tihun	212369	0.6	1.9	2.4	2.3	1.7	1.8	10.7	1.78	1.53
Vaama	222364	0.7	2.0	1.9	1.4	1.3	1.6	8.9	1.48	1.27
Baiama	222338	1.7	1.0	0.4	1.5	0.6	1.5	6.7	1.12	0.93
Sami	277354	0.8	1.6	1.0	1.5	1.0	0.5	6.4	1.06	0.89
Pehun	276355	1.6	1.5	1.6	0.8	0.5	1.2	7.2	1.20	1.02

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Settlement	Grid Reference	d values I	II	III	IV	V	VI	d	$\overline{D}$. obs	Rn
Blama	089520	2.2	1.7	2.8	3.5	2.0	3.3	15.5	2.58	2.22
Sogomo	098546	1.1	1.7	1.9	3.1	1.7	3.6	13.1	2.18	1.87
Baraka	128549	2.5	2.4	3.0	1.9	1.6	1.7	13.1	2.18	1.87
Meyama	164533	3.0	2.6	2.5	2.0	2.9	2.5	15.5	2.58	2.22
Kponima	131509	2.1	2.5	2.5	2.6	3.6	2.4	15.7	2.62	2.22
Lago	064498	2.0	3.6	2.8	2.5	2.6	2.7	16.2	2.70	2.30
Bontivo	052440	2.0	3.6	1.3	1.6	3.4	1.9	13.8	2.30	1.95
Yanihun	079459	3.6	0.8	2.6	2.0	2.5	2.6	14.1	2.35	1.99
Gaiovra	092462	2.8	0.8	3.2	2.2	3.0	3.6	15.6	2.60	2.22
Kigbema	140450	1.5	3.0	3.1	1.9	3.1	3.6	16.2	2.70	2.30
Bellor	061420	1.1	1.3	3.4	3.5	2.6	2.5	14.4	2.40	2.04
Bandajuma	071379	2.6	2.5	3.3	1.2	1.4	1.0	12.0	2.00	1.70
Kpeteoma	057378	1.0	1.2	3.0	1.6	2.6	2.7	11.1	1.85	1.57
Nyeyama	035389	2.2	2.8	1.8	1.5	2.6	1.9	12.8	2.13	1.82
Dina	999381	1.3	3.4	2.4	2.2	2.0	3.5	14.8	2.47	2.08
Gandorhun	029359	1.8	2.3	1.8	2.1	2.2	3.1	13.3	2.27	1.91
Kobebu	062358	1.2	1.9	1.4	2.1	1.2	1.5	9.3	1.55	1.31
Misela	057338	1.4	1.6	2.4	1.6	3.5	2.2	12.7	2.12	1.82
Gombahun	082360	1.2	1.3	3.2	2.5	2.8	1.6	12.6	2.10	1.78
Pehela	110324	1.8	2.9	1.1	1.3	2.2	1.4	10.7	1.78	1.53
Pewama	121338	0.5	1.0	2.3	2.5	2.8	1.0	10.1	1.68	1.44
Pewema	131332	0.5	1.4	1.3	1.6	1.9	2.7	9.4	1.57	1.31
Gbewebu	122355	0.5	1.1	2.5	2.5	1.6	0.5	8.7	1.45	1.23
Mbelebu	128381	1.0	1.9	2.3	1.6	1.7	3.0	11.5	1.92	1.61

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Settlement	Grid	d values						d	$\bar{D}$. obs	Rn
	Reference	I	II	III	IV	V	VI			
Foindu	097410	3.4	1.9	2.7	1.7	2.4	2.3	14.4	2.40	2.04
Kenema	128381	1.8	1.4	2.2	2.6	1.4	2.3	11.7	1.95	1.61
Futa	159363	1.0	1.5	2.4	2.6	1.8	2.9	12.2	2.03	1.74
Buma	165378	2.8	2.7	1.6	2.3	1.0	1.7	12.10	2.07	1.74
Maiagolehun	131354	1.8	2.4	1.2	0.6	1.7	2.5	10.2	1.70	1.44
Masa	182358	1.6	1.7	2.6	1.8	2.2	2.0	11.9	1.98	1.70
Jalandama	798348	1.1	1.0	2.0	1.6	2.7	1.1	9.5	1.58	1.36
Vaiuahun	201415	0.6	2.5	2.8	3.0	2.4	1.6	12.9	2.15	1.82
Laoma	193408	0.7	3.2	2.0	2.6	1.4	2.6	12.5	2.08	1.78