CHAPTER VI

DISTRIBUTION OF TOWNS-SIZE AND SPACING

INTRODUCTION

The whole complex of geographical, socio-economic, and politico-historical factors of a region reflects itself through the distributional pattern and size variations of human settlements both rural and urban as well as in their internal structural, morphological and functional characteristics. In fact, it reflects itself in the development of the structure of spatial organisation of a community or a region. Here we are concerned with only urban settlements. Elements of distance and areas are fundamental in any spatial organisation. Since towns are discrete points scattered over a region and separated by some distance between one another, it is the element of distance which lies at the root of the very concept of spatial system of cities. But in a functional sense, distance may be defined and measured variously, such as transport cost distance of Harris (1954), road distance weighted according to efficiency of roads of Garrison (1956), travel time cost of Voorhees (1955), and others which are even more abstract and involved.

Given a scatter of towns, there is a constant need of linkages and movement from town to town and from rural countryside to towns. This movement implies an over-coming of intervening distances. Inter-town distance thus becomes a crucial element in the spatial organisation. Interpreting Geography as a study of spatial organisation, Watson (1955) describes Geography as a 'discipline in distance,' while Garner's (1967, p. 304-5) premises regarding models of settlement location also underline distance, agglomeration and hierarchical organisation as the basic elements of a spatial organisation. He
notes that there is an orderly adjustment to distance so as to minimize its frictional effect; that there is a tendency to agglomeration to avail its scale economics, and the spatial organisation is hierarchal and focal in structure. 'In this way', he concludes 'movement - minimization, accessibility, agglomeration, and hierarchies are linked together to form a system of human organisation in space' (Garner, 1967, p. 305).

This chapter seeks to analyse movement minimization and agglomeration i.e. distance or spacing, and sizes of towns, and to elucidate the relationship between the two in the region, while the hierarchal structure of the urban system is dealt with in another chapter.

DISTRIBUTION AND SPACING OF TOWNS

The average of distances separating 84 towns of the region is 22.26 kms, and their average density per 1000 sq. kms of area works to be 8.0. Like many other phenomena, towns are not distributed quite evenly over all parts of a region, nor is their density the same everywhere. Variety of size classes of towns introduces further complexities, so that if larger towns become concentrated in some part of a region, other parts remain only poorly served with the specific services of large towns. Thus their distributional patterns 'reflect and condition functional relation among cities... the distance separating cities sets limits, relative to the mode of transport and communication, on the flow of goods and services between them' (Browning and Gibbs, 1961, p. 452).

Search for a method— If an area should be covered efficiently and most economically by a given number of focal points (which for the time being, and for the sake of convenience may better be regarded as of equal significance), a hexagonal pattern of
their distribution best fulfills the need in that it covers the area without leaving any area uncovered and, simultaneously, without any overlapping of covered areas. Then, theoretically, each town would have around it six other towns at equal distances from it and from one another, resulting in a literally uniform distribution. And because such a distribution is the most 'economical'; i.e. serves an area with least number of points, it is also the most dispersed distribution.

Proceeding from this Christallerian (1933) logic, Barnes and Robinson (1940) first worked out a constant inter-town distance for a given region if the towns were so distributed. Since all towns, presumed to be of equal significance, share the total regional area equally, all hexagons will be of equal size. Then the distance between two towns should be equal to twice the height of any one of the six equilateral triangles of the hexagon. Since in an area \( A \), with a given number-\( n \), of towns, the area \( A/n \) of each hexagon is:

\[
\frac{A}{n} = \frac{1}{2} \sqrt{3} \ D^2 ; \quad \text{where} \ D \text{ is twice the height of any one of the equilateral triangles.}
\]

\[
D = \sqrt{\frac{2A}{3n}} = 1.11 \sqrt{\frac{A}{n}}
\]

Town spacing characteristics of Malwa- For Malwa, such a hypothetical constant intertowns distance works out at 39.24 kms. When actual distance between each town and its nearest town are measured and expressed as per cent of the hypothetical distance (Appendix I), they show that these distances are mostly ranging between 15 and 30 kms. or about 40% to 75%, and mean works out 22.26 kms or 56.7% and the standard deviation is 29% of the mean. Browning and Gibbs (1961, p. 453) have worked out similar mean percentages for six different countries.
of the world, viz. Brazil 30.7%, Canada 28.3%, France 63.4%, Italy 60.6%, Mexico 59.5% and Netherlands 66.7%. Malwa with its mean percentage at 56.7 compares consonantly with the last four small countries. The unmistakable difference between the first two large countries and the last four countries is due largely to virtually uninhabited regions in the former category (Browning and Gibbs, 1961, p. 455). In Malwa, there are no such conspicuous vacant tracts. Yet, it is quite unrealistic to expect this percentage value to be very close to 100. This is because even granting other irregularities, they very shape of a region—be it a natural geographical unit or political unit—is not hexagonal or even circular. However, the towns of Malwa deviate only very moderately from uniform distribution.

Spatial variation in spacing of towns— But the above index gives only a summary statement regarding the degree of concentration (or dispersion) of towns. To reveal intra-regional variation in spacing of towns, the values of actual inter-town distances expressed as per cent of their mean value i.e. 22.26 km, renders a good measure. Ignoring the unusual case of Mhow—Mhow, these per cent values range between 50% and 260%, a large number of them being concentrated in range between 70% and 110%. Standard deviation of these values works out to be 36.9, i.e. about one third of the mean. Again, this small S.D. value implies that variation in intertown distance for the region as whole is pretty moderate. When plotted at the respective town location (Plate 14-A), these values reveal some notable spatial patterns in the variation of inter-town distances. This map reveals that there is a definite, though gradual increase of spacing from western part to eastern part. Eastern Malwa comprising Sagar, Raisen, Vidisha, Guna and Sehore districts has markedly wider spacing of towns than the western Malwa. Seven tahsils in the eastern Malwa—4 in Raisen district, two adjacent tahsils of Sehore district, and Lateri tahsil in Vidisha district are devoid of any town. First four towns
with largest distance to their nearest neighbour, namely Bareli, Ashoknagar, Bhopal and Berasia belong to the eastern part. Out of the total of 26 towns in this part, 17 are above the mean. All six towns of Guna, three out of four in Vidisha, three out of five in Sehore, and two out of three towns of Raisen district have markedly wider spacing than the mean. But in Sagar, only two out of eight towns are above the mean value. Besides 7 entirely rural tahsils in eastern Malwa, 17 tahsils have only one town each, three tahsils have two towns, and only Rehli tahsil has three towns.

In the western Malwa, on the other hand, comprising nine districts, not only are the towns more closely spaced but the spatial variation in spacing is also more weak and gradual. The only sizeable pocket of wider spacing than the regional mean is the hilly area of Vindhyan scarp in south western corner covering southern Jhabua district and most of Dhar district. This tract, in fact, makes the western counter part of the practically rural pocket of eastern Malwa, also on the Vindhyan scarp. Out-side this highly dissected hilly tract, only 10 towns out of 51 are above the mean, and only 5 of them are above 110% of the mean. All towns of Dewas and all but one of Ratlam districts are below the mean, while fewer than half of the towns in other districts are but marginally above the mean. Only two towns, Saver and Sailana, are above 120% of the mean. But in southern Dewas, covering central part of Vindhyan scarp, south of the plateau proper, all four towns are less than the mean distance apart. Of the 45 tahsils in the western part, 32 have one town each, and 13 have two towns each, in which case they are markedly closer to each other. When worked out separately, the eastern and western parts reveal some notable differences in their spacing characteristics.

This distributional pattern is corroborated also by a more direct representation of the density of towns per thousand
km² of area. As Plate 14-B reveals, western Malwa mostly has higher density of towns, generally above 7.5 towns/1000 km² and there are several pockets having higher density than 10 towns. But in the eastern part, the density is mostly below 7.5 towns, and extensive areas have even below 5 towns. As elaborated later, this difference is largely a function of size of tahsils, which is distinctly larger in eastern Malwa, than in the western counterpart.

Table: 6.1 Malwa Plateau: Spatial variation spacing of towns, 1971

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Western Malwa</th>
<th>Eastern Malwa</th>
<th>Malwa as a whole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of towns</td>
<td>58</td>
<td>26</td>
<td>84</td>
</tr>
<tr>
<td>Number of tahsils</td>
<td>45</td>
<td>28</td>
<td>73</td>
</tr>
<tr>
<td>Mean of actual inter-town distances (kms)</td>
<td>20.4</td>
<td>26.4</td>
<td>22.26</td>
</tr>
<tr>
<td>Hypothetical intertown distance (kms)</td>
<td>35.4</td>
<td>46.7</td>
<td>39.24</td>
</tr>
<tr>
<td>Actual mean as percentage of H.D.</td>
<td>57.7</td>
<td>56.4</td>
<td>56.5</td>
</tr>
<tr>
<td>Average size of tahsils (sq.kms.)</td>
<td>1308.5</td>
<td>1646.5</td>
<td>1438.2</td>
</tr>
</tbody>
</table>

Spacing of towns: Nearest neighbour analysis—Clark and Evans (1954) broke a new ground by devising a novel measure of degree of dispersion of points over an area. Presuming a natural distribution as random in a mathematical sense, they derived from the law of probability and with consideration of poisson exponential function (pp. 451-52) an expected mean distance between two nearby points for such a distribution, which they worked out to be equal to:

\[ x = \frac{1}{\sqrt{n}} \]

where, A and n being the area and the number of points respectively and A/n is the area per point. This
being the expected distance if the distribution were random, the ratio of actual mean distance and this expected distance, which they named the 'Nearest Neighbour Statistic' or 'Rn value', gives a statistical measure of the deviation of the distributional pattern of towns from the random i.e. towards dispersion if Rn value is > 1.0, and towards concentration if Rn value is < 1.0. Thus, the Rn value theoretically may range from zero, marking absolute concentration over a single point, through 1.0 which marks a random distribution, up to a maximum value of 2.15 which marks a maximum dispersion and hexagonal distribution (Plate 14-C). They worked out the maximum Rn value from the formula (p. 452).

\[ Rn = \frac{\sqrt{2}}{4/3 \cdot A/n} \]

When applied to district-wise data of Malwa (Plate 14-F), the Rn value for Malwa as a whole works out at 1.26 and ranges from 1.13 to 1.50. Only Indore district is nearly random, while all other districts are approaching a dispersed pattern, with Rn values being more than 1.20. Only Dhar district has a notably more dispersed pattern, its Rn value being 1.50, followed by Mandsaur, Ratlam, Sehore and Ujjain. Thus, this analysis also reveals a fairly highly dispersed and, by implication, regular pattern of distribution of towns. King (1962) applied this method to twenty selected areas of United States and found the Rn values to vary from 0.70 to 1.36. He subjectively classified the distribution with Rn value less than 0.90 as aggregated, between 0.90 and 1.10 as random, and above 1.10 as approaching uniform. By this standard, all districts of Malwa have a distributional pattern of towns that is well- high approaching uniform.

RELATION BETWEEN SIZE AND SPACING OF TOWNS

So far towns have been treated as bearing equal importance. But the rational of expecting of some orderly spacing of towns
fundamentally derives from the Christallerian thesis that towns exist essentially to provide some central services to populace around each, and the service area of each bears direct relation to the size of the town itself. An underlying assumption entailed in this approach is the even distribution of rural population so that area can serve as a parameter of the size of population to be encompassed in service areas of towns. It is thus indispensably important to consider size variation of towns while analysing their distributional pattern. While one may tend to concede certain earlier studies from this obligation (of consideration of sizes) as they related to objects to which size was hardly relevant, it is surprising that King (1962), while studying distributional pattern of urban settlements, notes, with an air of apology, and while it is highly desirable that the variable population size, should eventually be incorporated into the analysis, for the time being it is disregarded (p. 161), or, soon again, 'considerations such as these emphasize the desirability of incorporating the population size variable into the analysis (p. 164-65).

A somewhat round about measure to redress this lacuna, as suggested by Browning and Gibbs (1961, pp. 456-58) can be effected through correlating town sizes with distances to their respective nearest neighbour and also with their respective nearest larger neighbour. For Malwa, the Spearman's Rank Co-efficient of correlation (rho) between town size and distance to nearest neighbour works out to be poor positive correlation +0.23; and that between town size and distance to nearest larger neighbour at +0.665, a fairly high correlation. These latter distances vary from 10 to 175 kms, most of them falling within 20 to 60 kms range while their mean works out at 37.2 kms i.e., very close to the hypothetical intertown distance irrespective of size which is 39.2 kms, but the standard deviation, 28.8 is almost 3/4 of the size of the mean.
Yet, this method has its own weaknesses. In the first place it does not quantify a larger nearest neighbour, which may be only a marginally larger town such as Narsingarh to Biora and one which may be a score of times larger such as Sagar to Banda, or Ratlam to Sailana. Even the consideration of the size of both the town and its nearest neighbour on the lines of Reilly's (1931) 'Law of Retail Gravitation' fails to reckon an under current notion that towns of discrete size class perform a diagnostic set of central services, which in turn, has a somewhat characteristic range of service area.* Thus the towns of only same size order are supposed to complete with respect to their characteristic set of services, and as such intertown distances both theoretical and actual should be reckoned only between towns of the same size order.

Size class-wise Spacing of Towns— For this purpose towns of Malwa have been grouped into four size classes**, and for each class hypothetical intertown distance, following Barnes and Robinson (1940), actual mean distance, as well as their Rn values are worked out as reported and are presented in Table 6.2 below.

This table gives an overview all distributional pattern of towns for each size class as a whole, as well as the degree of their internal variability. Following points emerge from an examination of this table.

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* This idea of hierarchical structure of towns, their central services and their hinterlands are dealt with in detail in the last chapter of this work.

** These are much the same as those adopted by the Census of India for grouping towns into size classes. Only the II class of The Census 50, the to 1 lakh has been merged with next lower class, while the VI class of Census has been merged with the next upper class, because, containing only 3 towns each, they do not make any operationally viable classes of towns.
Table : 6.2 Malwa Plateau: Spacing of towns by size classes.

<table>
<thead>
<tr>
<th>Class</th>
<th>Size in (000)</th>
<th>No. of towns</th>
<th>H.I. (kms)</th>
<th>Actual mean D(rA) km</th>
<th>Actual mean D(rE) % of HD</th>
<th>Exptd D(rE) km</th>
<th>Rn value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>+100</td>
<td>5</td>
<td>160.8</td>
<td>92.6</td>
<td>57.6</td>
<td>72.45</td>
<td>1.28</td>
</tr>
<tr>
<td>II</td>
<td>20 to 100</td>
<td>15</td>
<td>92.9</td>
<td>50.2</td>
<td>54.0</td>
<td>41.83</td>
<td>1.20</td>
</tr>
<tr>
<td>III</td>
<td>10 to 20</td>
<td>27</td>
<td>69.2</td>
<td>36.1</td>
<td>52.2</td>
<td>31.18</td>
<td>1.16</td>
</tr>
<tr>
<td>IV</td>
<td>Below 10</td>
<td>37</td>
<td>59.1</td>
<td>33.9</td>
<td>57.4</td>
<td>26.63</td>
<td>1.27</td>
</tr>
<tr>
<td>All classes</td>
<td>84</td>
<td>39.24</td>
<td>22.26</td>
<td>56.7</td>
<td>17.68</td>
<td></td>
<td>1.26</td>
</tr>
</tbody>
</table>

(1) Whereas the hypothetical, uniform distance is simply the function of number of towns in the size class, the mean actual distances bear largely the same ratio to the hypothetical distances in close vicinity of 55% of the later. There is thus, little difference in the overall spacing of towns of each size class. However, the two middle size classes, II and III, and particularly the latter one, are somewhat less uniform in distribution than the upper most and the lower most classes.

(2) As regards the size of areal variation in the distributational pattern of towns of these size classes, i.e., their internal variation, there are some notable differences amongst the classes. The class I towns are highly variable (S.D. 68% of respective mean) because of the small number of towns, two of them, Indore and Ujjain, are unusually close to each other, similar followed by lower most class of towns (S.D. 43% of respective mean). But the middle classes are much less variable (S.D.'s 24-25% of respective mean values).

Trends in variation in intertown distances within each size class, if any, can be revealed by scatter plot of towns of different size classes, scaling population sizes on the
y axis and distances on the x axis (Plate 14-D). On this class I town have not been shown as they would locate far above. It reveals that:

(1) Two lower size classes do not show any regular relationship between the two variables.

(2) Medium towns show a fairly high positive correlation between the two.

(3) Larger towns also widely scattered and do not show any regular trend.

These results are corroborated also by a composite frequency diagram (Plate 14-D). It reveals that towns of class IV are most variable, ranging in spacing from 5-10 km category to 55-60 km category, and without giving regular trend in the number of towns over this extensive range. Class III towns also vary over a wide range—from 20-25 km to 55-60 km, but they show a definite peak of 10 towns in 30-35 km range. Class II towns are much more regular, ranging from 30-35 km to 60-85, giving a peak in 40-45 km range and descending on either side of it. Class I towns are obviously too variable and discontinuous to give any regularity.

Whereas trends of two upper classes confirm to Bosch's (1954) notion of positive correlation between variation in spacing and the size class of towns, the high variability of IV class markedly vitiates this notion for Malwa.

REGIONALISATION OF SPACING OF TOWNS

But the actual spatial pattern of distribution of towns is portrayed by Plate 15, wherein the actual inter-towns distance, size class wise, are noted as per cent of the actual mean distance of respective classes, and towns of different
classes are also shown by different symbols. Once again, there are notable differences between the eastern and the western part of Malwa covering the same 5 and 9 districts respectively.

(1) Three class I towns are congregated in central part of western Malwa, and particularly Indore and Ujjain are unusually close to each, while other two stand far apart one on the eastern edge and the other on the western edge of eastern Malwa.

(2) Class II towns are markedly more evenly distributed. Yet they show some degree of concentration in the central part of both eastern and western Malwa. Jhabua, Rajgarh and Raisen districts are devoid of these upper classes of towns.

(3) Class III towns are also rather evenly distributed. However, in the eastern Malwa, they are not only too few, 8 out of 27, but are also somewhat concentrated over a narrow belt along the eastern and northern border.

(4) Class IV towns are again more variable and show much variation in spacing between western and eastern parts of Malwa. In the eastern Malwa they are too few, only 10 out of 37, and far apart. In western Malwa intertown distance between half of the towns of this class are only 30% to 70% of the regional mean distance of the class. They are particularly closely spaced in Dewas district where out of total seven towns six belong to this class.

Thus, eastern and western parts of Malwa are significantly different in the distributional pattern of towns—the former has more sparse and somewhat irregular distribution and latter markedly more dense and more regular distribution. However, a minute examination of their distributional characteristics suggests following sub-divisions of the region (Plate 15):

A. Western Malwa

(1) Southwestern zone—It has only small towns and only one medium town. It is again sub-divisible into—(a) Jhabua— with
markedly close spacing of all but one town, all towns being only small ones; (b) Dhar district - with one medium and all other small towns which are most dispersed in distribution.

(2) Northwestern zone - Mandsaur and northern Ratlam districts with towns of small and medium sizes, all fairly closely spaced.

(3) Central zone - Indore, Ujjain - except its Tarana tahsil, and southern Ratlam district and Dewas tahsil, with a notable congregation of towns of all sizes mostly large and medium towns.

(4) Eastern zone - Rajgarh, Shajapur and Dewas districts excluding Dewas tahsil, and the Tarana tahsil. It has a very uniform spacing of all towns, of which only one is of medium size and all others are small ones.

B. Eastern Malwa

(1) Northern zone - Guna, Vidisha, Sagar, northern Sehore districts and Raipura and Begumganj tahsils with a markedly sparse spacing of towns of all sizes.

(2) Southern zone - Southern Sehore and whole Raipura district except its Raipura and Begumganj tahsils. This narrow east-west belt is wholly devoid of towns, with the singular exception of Baraiy, a class IV town, which is as high as 171% of mean distance of this class. Baraiy is thus the most remote town in whole of Malwa.

**FACTORS DETERMINING SPACING OF TOWNS**

Whereas search for a suitable method to describe adequately the spacing characteristics of towns constitutes an important aspect of the problem and has received much tenor of research, the more fundamental problem of explaining these spacing characteristics and spatial variations there-in in terms of physical, human, cultural factors, and also the
cumulative effects of politico-historical accidents, have not received due attention.

**Socio-economic factors**— One major study expressly concerned with this specific problem is King's (1961) multivariate analysis of towns spacing in U.S. He found that, apart from population size of towns being itself a factor in their spacing, towns of a given size-range would be more widely spaced in areas of sparse rural population, extensive nature of farming, low agricultural productivity, low density of total population, and smaller share of manufacturing in working force of towns themselves. However, he found the overall performance of these factors in explaining variation in spacing of towns to be rather low. This may partly be because he chose his sample towns from a vast, heterogenous area.

For Malwa, the mean spacing of towns was correlated, on district wise data, with the density of rural population, intensity of farming, agricultural productivity and share of manufacturing in the working urban population, and the results (Table 6.3) came to be fairly good and in harmony with King's (1961) findings.

**Table 6.3** Relation between Town spacing and some selected Factors.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Coefficient of correlation-(r)</th>
<th>Variance (r^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Density of rural population</td>
<td>- 0.743</td>
<td>0.552</td>
</tr>
<tr>
<td>2. Intensity of farming</td>
<td>- 0.178</td>
<td>0.031</td>
</tr>
<tr>
<td>3. Agricultural productivity</td>
<td>- 0.644</td>
<td>0.414</td>
</tr>
<tr>
<td>4. Share of manufacturing in urban population</td>
<td>- 0.328</td>
<td>0.107</td>
</tr>
</tbody>
</table>

Of these factors, density of rural population, and agricultural productivity are highly significant, while the
remaining two factors are much less so, particularly, the intensity of farming.

**Politico-historical factors**—Sheer statistical analyses, however rigorous, may none-the-less fall short of adequate explanations of the patterns of towns' spacing, especially because these methods cannot properly incorporate political-historical factors in the gamut of their variables. Realising the immense dimensions of this problem, therefore, it is but imperative, as Haggett (1965, p. 113) has also stressed, that historical factors behind the development of present urban system should also be duly incorporated.

In Malwa, most of the small towns, which are also quite marginal in urban status, are recognised as towns almost decisively by virtue of their being administrative headquarters of their respective tahsils, or, before the state Re-organisation in 1956, of the pretty principalities which were later reorganised mostly as tahsils. For politico-historical reasons traced elsewhere (chapter II of this work), western Malwa came to contain a large number of small states, mostly of a low political status, as compared to the eastern Malwa. And this fact largely explains the differences between these two parts of the region in respect of the size and distributional characteristics of towns. The influence and prestige of these ruling houses, which existed till quite recently, and whose name was associated with their headquarters, was invariably an important factor in acquiring urban status from Census authorities to these otherwise insignificant places. Thus, the basic 'raison d'être' of the most of such towns was administrative services. In so far as the administrative service is, and has been, the prime function of these small towns, and there occurs mostly one town in each tahsil, and their population size is almost uniformly small, the size of tahsils naturally becomes the decisive factor in spacing of towns, particularly
the small ones.* This factor largely explains the unmistakeably more sparse spacing of towns in eastern Malwa as compared to the western Malwa. This is corroborated by the fact that ratios of western to eastern parts are 1:1.30 for mean inter town distances, and 1:1.25 for average size of tahsil. By the incorporating in this logic the fact that 7 tahsils in eastern Malwa are devoid of any towns against none in western Malwa, the remaining difference between the two ratios is also explained.

SIZE GRADATION OF TOWNS

So far the concern has been solely with the patterns of 'spatial distribution' in terms of dense-sparse, and regular-irregular spacing of towns, with or without the consideration of their population sizes. As is postulated in deductive theory and confirmed by empirical observations, one finds that there are more and more numerous towns of smaller and smaller sizes. Only then can these be close spacing or higher frequency of smaller towns.

Deriving directly from this notion, there comes up another aspect of the problem: the patterns of distribution of town sizes over whole size spectrum, or simply the pattern of size gradation of towns. Here the 'patterns of distribution' refers to a 'vertical distribution'— along the size spectrum— as against the 'spatial or horizontal distribution.'

Rank size relationship— Like the spatial distribution of towns, the distribution of towns along the size spectrum is also shown to follow some systematic trend of gradation (Stewart, 1958, pp. 240). Studies on this problem have usually analysed the

* The same factor of size differences of tahsils also controls the degree of urbanization; explained in the chapter III of this work and also in Ayyar, N.P. and J.L. Jain (1974).
regularities in the relative size of each successively smaller town to the largest one in the region. Such a relationship between size and rank of towns was though noted as early as 1913 by Auerbach but it is Zipf (1941) who profound expounded the relationship to the world, employing it as a measure of coherence in the urban systems of nations. In Zipf's (1941) version, the relationship, also called 'rank size rule', holds that in any areal unit, say a nation, if the cities are ranked in the decreasing order of population size, then population of the rth ranked city can be expected to be:

\[ P_r = P_1 r^{-q} \]

where, \( P_r \) = Population of rth ranking city
\( P_1 \) = Population of 1 ranking city
\( q \) = a constant, which is generally quite close to unity.

In other words, population of the rth ranking town should be rth fraction of the largest town, because the exponent q, which is the slope (in terms of tangent value) of the line of log-normal distribution, is generally close to one (Berry, 1970, p. 64). Zipf's work inspired many empirical studies in diverse areas of the world. Amongst them those which compared many and diverse areas are more important ones. Steward (1958, p. 241) examined the ratio between first and second ranking cities for 72 countries, and found these ratios to vary about the median value of 1/3 rather than 1/2, indicating a high degree of primateness. Berry (1970) examined a sample of 38 countries and found 15 countries with high degree of 'primateness' rather near the log normal distribution, and 9 intermediate between the two. Berry (1967, p. 77) also traced this rank-size curve for U.S. for each decade from 1790 to 1950, which are strikingly parallel to each other and in good harmony with log normal distribution, which signifies a steady state of rank size relationship there for this one and a half centuries. Another
similar trace of rank-size curves for England and Wales from 1801 to 1911 by Robson (1973, p. 30) also strongly corroborates this finding.

Thus, rank-size scheme generates a continuously descending smooth curve of city size gradation, which obviously comes at odds with stepped curve of city sizes with discrete tiers generated by Christaller-Losch scheme of hierachal ordering of central places. But the difference between these diverse schemes of pattern of vertical distribution of city sizes can be resolved to a reasonable degree through the incorporation of factors—random or otherwise—causing distortion of both the rank-size curve and the hierachal tiers, as demonstrated by Berry and Garrison (1958) and Beckmann (1956). Particularly, if due allowance is made for the fraction of city populations engaged in non-central, special functions, the two schemes come into good harmony with each other. For the rest, it should be remembered that the rank-size rules is only an empirical finding, while the hierachal scheme is a deductive theory, so that some differences are rather inherently involved between the two. (Stewart, 1958, p. 240).

An exhaustive discussion on various explanations advanced in this connection, such as the functional specialization, regional disparities in the density of population and general level of economic development etc. by Robson (1973, pp. 27-37) deserves mention. It may, however, be reiterated that most of these explanations, except that of the functional specialization, are little applicable to the Malwa, due to its high degree of homogenity in these respects.

Towns of Malwa, when plotted by population sizes against ranks on a log log scale (Plate 14-C) show a curve very close

* For details of this scheme, see Chapter IX, Urban Systems of Malwa, of this work.
to the log normal distribution with, of course, somewhat ascending upper-most limb and a rather suddenly descending tail end. This approaches towards a shape, popularly known as S-shaped curve in such studies. Stewart (1958, p. 246) has constructed these curves for Sweden and Denmark at various points of time from 1800 to 1956, to show the development of S-shaped curve in these countries. His 1956 curve for Sweden has a strikingly similar shape to 1971 curve for towns of Malwa and is therefore, reproduced here for comparison (Plate 14-G).

Notwithstanding a good deal overall conformity between the actual rank-size curve for Malwa and log-normal distribution curve, a close examination of plot (Plate 14-G) reveals following notable features:

(1) All the 5 towns of one lakh and over population size have population in excess of the expected population by log-normal curve (rank size rule of Zipf). Of them, only Bhopal is extremely high having 56% more population than expected, while all others are below 25% in excess (Appendix I).

(2) Then there is a big gap in size, and the 6th ranking town is only a little over half the size of 5th ranking town. It is little over 3/4 of its expected size. From this downwards, the deficiency of population size decreases rather steadily upto 14th town (Sehore population 36 ths.). This and next town, Bina, stand exactly on the line of expectancy log-normal curve, and 16th town (Nagda 32.5 ths.) is just above the line.

(3) From this again there is notable gap, and 17th town (Shajapur population 25 ths.) is somewhat short of expected size. For next two towns the deficiency increases, then it decreases for next four towns, and increases again for the next town. Thus these 7 towns by themselves trace a S-shaped curve in miniature.
(4) There appears again a moderate gap in population size and next town (25th Sarangpur population 15000) is again notably below the expected size. From this point downwards the deficiency decreases steadily, though very gradually, up to 7500 population size; then sizes keep almost at constant distance from the expectancy line or very slightly increase upto 6th thousand level, whence downward the deficiency increases suddenly for last 5 towns.

Then ignoring insignificant, minor irregularities, we find that but for high position of 14th to 16th towns (Sehore-Bina and Nagda ranging from 36000 to 32500 in population), the curve from 6th town to 79th town would have given virtually a strait line, just below the log-normal line, and very gradually approaching the latter downwards. To this would be added an upper limb of first 5 town, of marked excess of population and a lower tail of 5 towns with steeply declining population and increasing deficiency. These five petty towns, in fact, do not matter at all in an over all situation. Then only class I towns appear to be over predominant in population size. This may be called the 'primateness' of class I towns as a whole.

Amongst the 3 notable deviant towns in the otherwise virtually log-normal curve of medium and small towns, two towns Bina and Nagda are obviously the cases of extreme specialization in non-central functions and the third Sehore-may have received repercussions of the vicissitudes in the position of Bhopal nearby after 1956. Proportionately, Bhopal's much large size of is obviously due to the sudden spurt in its growth in the last two decades.

An unusually big gap between 5th town, Ratlam and the sixth town Mhow constitutes the real unmistakeable discontinuity in whole array of otherwise quite gradual gradation of town sizes. Also, it can not be adequately accounted for by
the usual argument of functional specialization, or by political
historical factors, either. This gap, in fact, signifies a big
chasm between cities of one lakh and over population, and the
remaining array of small towns.

The reason behind this gap is more basic, and economic
in nature. As a good many empirical observations suggest, if
one examines the trends of size class structure and notes, in
particular, the duration of stay of towns, in the course of
their growth, in each size class, over a wide span of time, one
finds that it is in class II (50,000 to 99,999 population range)
that the stay is shortest, notably shorter than in either III
or IV classes (V & VI classes are rather unviable). Many
observers tentatively conclude therefore, that by the time a
small town reaches the size of about 1/2 to 3/4 of a lakh
population, it attains economic and organisational infra-
structure necessary for it to embark upon a new phase of
vigorous growth as a real, distinctly more viable urban entity,
and soon crosses the cardinal mile stone of 1 lakh population
size. That is why in all decades and all areas this class is
found to be the smallest one, nay, rather marginal one only,
in respect of the number of towns in it. So much so, that
sometimes it happens that all the few towns of this class have
moved up into the next upper class, while none from the next
lower class has been able to join this class, so that the class
II remains unrepresented in that decade. No wonder then that,
while analysing the trend of size class structure of towns,
Jagathpathi (1963, p. 172) emphatically remarks, 'Class II
has shown a very unsteady history owing probably to the fact
that no town stays in that category for long'. A closer
examination of growth rates of towns would reveal that this
demographic threshold for a town to embark upon a vigorous
growth phase lies more precisely in the vicinity of 3/4 lakh.
This is a universal factor behind the notable degree of
'primateness of class I towns as a whole, in many areas, as also in this region, with little variation in this situation over time (Bhatia, 1962).

Seen in this light, class II (of census) of towns, in an operational sense, may better be regarded as missing, because all the 3 towns stand much near the lower margin of this class and well below the 3/4 lakh level. Out of these operational considerations, these 3 towns are merged with the next lower class of census for many practical purposes, in this work.

Thus, the argument of functional specialization in non-central functions, invoked to bring harmony between log-normal curve of rank size rule and stepped curve of Christaller type hierarchal scheme, works well in the case of Malwa.

Moreover, the rank-size curve for Malwa shows some regular tiers or sudden breaks in the continuity, though of course there is some variation in population size of towns of each tier. The curve, thus, itself stands somewhat mid-way between the types of size distribution required by Zipf's rank size-rule and Christaller-losche's hierarchal schemes.

Also, as illucidated later, the major discordances between population sizes and centrality scores of respective towns is explained well by the hypothesis of functional specialization in non-central functions. The five smallest towns, as noted before need not disturb, as they are, by their very small size and functional infrastructure, quite immaterial.

In general form, the curve has an upper limb or head with steep gradient, rising above the line, but stooping at the very top; a major middle part or trunk which is staright, lower than the line and very gradually slanting towards the line of expectancy towards the lower end; and a lower limb or tail suddenly digressing downward from expectancy line.
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