DISTRIBUTION AND DENSITY OF POPULATION 1954-66

By Robert G. Hartley

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Elaboration of the distributional and density patterns of Libya's population indicates some of the causes, characteristics and consequences of the country's demographic change. As Zelinsky[1] maintained... « If we learn to explain numbers, more than half the battle has been won in explaining the location of age groups, literacy and mortality, etc. » Spengler[2] has been more specific in identifying the economic-demographic interrelations of population distribution. Defined as secondary demographic variables, distribution, and hence density, are determined by dynamic variables of fertility, mortality and migration. In turn, numerical aspects of the population influence, and respond to, changes in net national product, distribution of income, employment, investment, consumption and savings. In short, the distributional aspects of population are sensitive indicators of economic and demographic change.

While the demographic-economic interrelationships are reflected in the numerical division of the population, it is hypothesized that physical controls in the environment set critical, quantitative limits to he distribution and density of Libya's rural population. Thus, the process of adjustment from one socio-economic system to a new equilibrium takes place within well-defined and reasonably stable limits. Within the limits set by the physical environ-

ment, however, particularly rainfall distribution, the controls are more a complex of physical and human determinants and are more emphatically qualitative. This section attempts to define these « limits » and to highlight the particular controls which have shaped the current distribution and density changes of the population.

1. General Characteristics of Population Distribution and Density

The outstanding feature of Libya's population distribution is the marked coastal concentration. About three-quarters of the population live within twenty miles of the sea, this proportion being similar in both Tripolitania and Cyrenaica. However, while the density of population doubled between 1936 and 1964, it remained under one person per square kilometre. On a provincial basis the proportions of total population remained relatively stable.

Tripolitania with only 14 per cent of the total area contained two-thirds of the total population in 1964. With a density only one-

Table 1. Provincial Changes in Population Distribution and Density, 1936-64

Population Distribution

	Area 1964		1936			1954			1964		
	000's sq. kms.	% total	Total 000's	% total	Density sq. km.	T	%	D	T	%	D
Tripolitania	250	14	547	64	2.2	738	68	3.0	1034	66	4.1
Cyrenaica	855	49	137	28	0.2	291	27	0.3	451	29	0.5
Fezzan	654	37	48	8	0.1	59	5	0.1	79	5	0.1
Libya	1759	100	733	100	0.4	1089	100	0.6	1564	100	0.9

Sources (a) Ministry of National Economy, Libya. General Population Census 1954, Tripoli, (1959) and Ministry of Economy and Trade, Libya General Population Census 1964, Tripoli, (1966).
(b) Pan, C.L. "The Population of Libya", Population Studies, Vol. 3, No. 1, (1949), p.119

Table 2. Mudiriah Administrative Districts in Northern Tripolitania

1954 - 66

1. Tripoli City
2. Suk El Giuma
3. Taguira
4. Garabulli
5. El Khitna
6. El Alawna
7. Arrgaiat
8. Aulad Ouein
9. Al Ganafdha
10. Accara
11. Beni Daud
12. Beni Khalifa
13. Beni Nuseir
14. El Guassem
15. El Assabaa
16. Kikla
17. El Orban
18. Yefren
19. Arriaina
20. El Zintan
21. El Rujban
22. Giado
23. Irrheibat
24. El Moshashia
25. Aulad Abu Seif
26. El Magarah
27. El Zintan
28. Gantrar
29. Nalut
30. Giosc
31. Tiji
32. El Haraba
33. Cabao
34. Wazzin
35. Ghadames
36. Foughas
37. Derj
38. Sinawin
39. Zawia
40. Zanzur
41. Sorman
42. Ezzahra
43. El Harsha
44. Bir El Ghnem
45. Jude Eddaiem(Olivetti)
46. El Maamura
47. Bianchi
48. Sabratha
49. Al Ajeilat
50. Zuara
51. El Assa
52. Regdalin
53. Homs
54. Cussabat
55. El Amamra
56. Suk El Khamis
57. Gasr Khiar
58. Aulad Musellem
59. Aulad Maarref
60. El Hawatin
61. El Drahib
62. El Wasat
63. El Oteyin
64. El Sabayeh
65. El Saadat
66. El Jamamla
67. El Zarrug
68. El Mahjub
69. Tauorgha
70. Aboungim
71. El West
72. El Guima
73. El Fuatir

Geographical Index of names mentioned in Auble, A. Statistical Paper No.13, Ministry of Planning and Development, Tripoli, (1966), pp. 1 - 5.

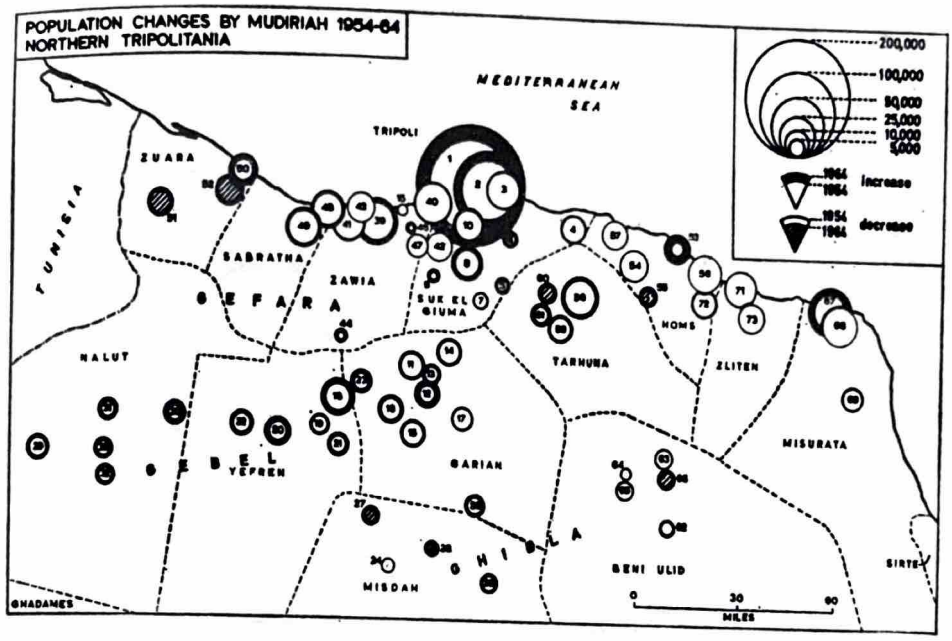
eighth as large, Cyrenaica contained nearly one third of the 1964 population on roughly half of Libya's total area. The Fezzan is the most sparsely populated province, containing 37 per cent of the area and only 5 per cent of the total population.

Within each of the three provinces, however, different micro-distributional patterns were determined by a variety of 'controls' or influences. Figures 1 to 4 describe the distributions of population in the two most densely peopled areas of Northern Tripolitania and Northern Cyrenaica. The proportional circles relate to the total populations of administrative units known as Mudiriah; these were the most detailed population subdivisions afforded by published data for the years 1954, 1964 and 1966. Location of circles corresponds to the approximate of population in the Mudiriah; accurate in small agglomerated populations, but approximate in large dispersed units, for Mudiriah boundaries are unknown and unmapped in many areas. Amalgamation of administrative units between 1954 and 1966 account for changes in the number and location of circles. Place names for the Mudiriah numbers are contained in Tables 2, 3 and 4.

1.1 Population Distribution in Northern Tripolitania

With a marked coastal and inland escarpment concentration Tripolitania's population distribution forms a wishbone shape (Figs. 1 and 2). The large number and size of Mudiriah populations emphasize the fact that in 1964 Tripolitania contained about 66 per cent of the national total, dominating the central coastal zone and forming a pivot for three limbs of population distribution each containing similar proportions of the national total. The eastern coastal zone contained approximately 13 per cent and had a more dispersed Mudiriah distribution than its western counterpart. Centred on Zawia, the Mudiriah populations of the western zone were clumped to the western and southern boundaries of Tripoli, forming a more clustered contingent. The whole coastal zone, stretching from Zuara in the west to Misurata in the east, contained about half the country's total population.

Fig. 1


POPULATION CHANGES BY MUDIRIAH 1954-64
NORTHERN TRIPOLITANIA
MEDITERRANEAN SEA
TRIPOLI
ZUARA
TUNISIA
SABRATHA
ZAWIA
SUK EL GIUMA
NALUT
TARHUNA
HOMS
ZLITEN
MISURATA
GARIAN
MISDAH
BENI ULID
SIRTE
GHADAMES
0 30 60
MILES
200,000
100,000
50,000
25,000
10,000
5,000
1964 1954 Increase
1954 1964 decrease

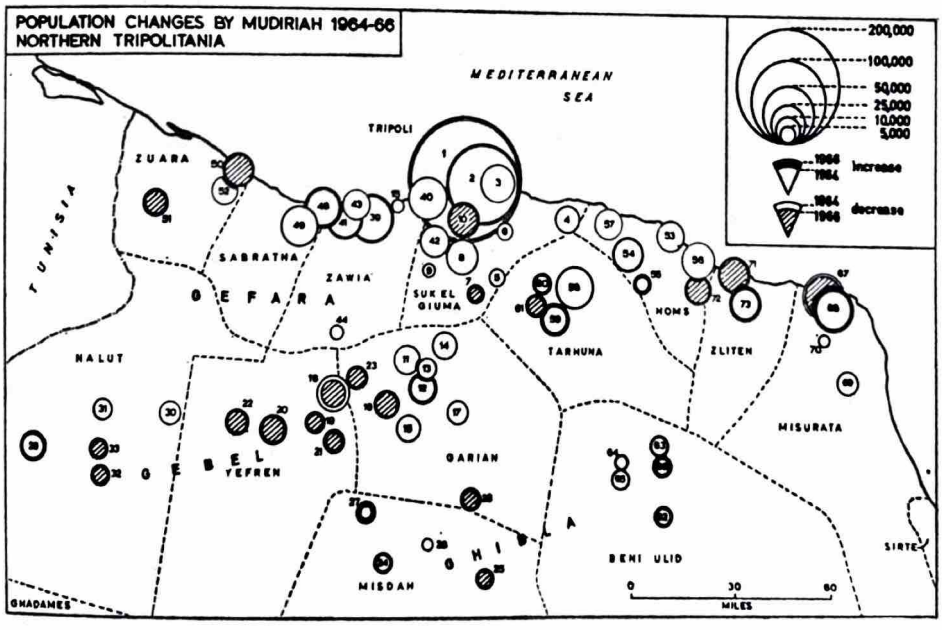
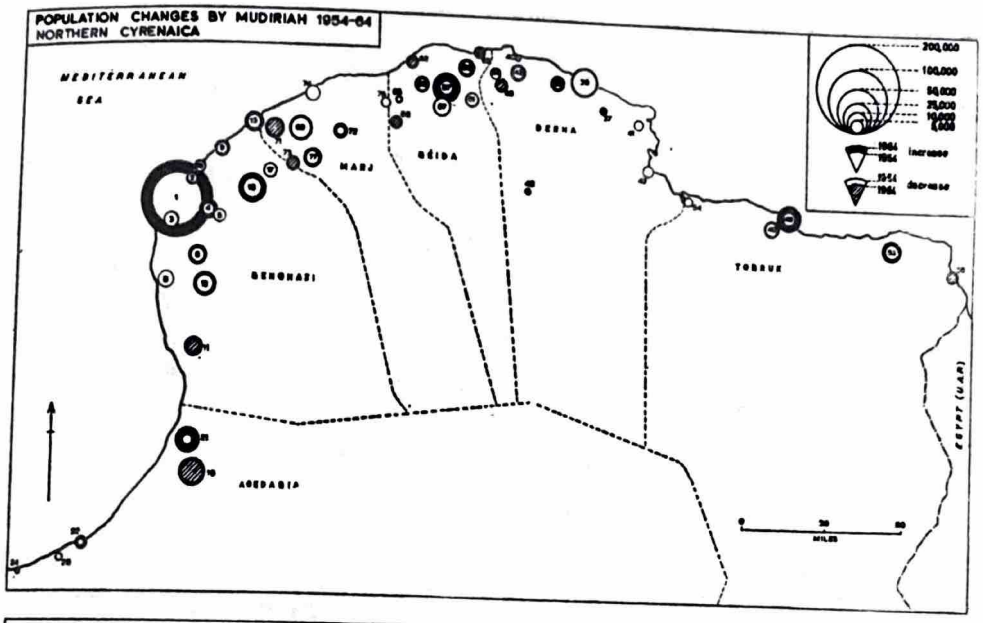

POPULATION CHANGES BY MUDIRIAH 1964-66
NORTHERN TRIPOLITANIA
MEDITERRANEAN SEA
TRIPOLI
ZUARA
TUNISIA
SABRATHA
ZAWIA
SUK EL GIUMA
NALUT
TARHUNA
HOMS
ZLITEN
MISURATA
GARIAN
MISDAH
BENI ULID
SIRTE
GHADAMES
0 30 60
MILES
200,000
100,000
50,000
25,000
10,000
5,000
1966 1964 Increase
1964 1966 decrease

Fig. 2

Fig. 3


POPULATION CHANGES BY MUDIRIAH 1954-64
NORTHERN CYRENAICA
MEDITERRANEAN SEA
MARJ
BEIDA
DERNA
BENGHAZI
AGEDABIA
TOBRUK
EGYPT (U.A.R.)
200,000
100,000
50,000
25,000
10,000
5,000
1964 1954 increase
1954 1964 decrease
0
30
60
MILES

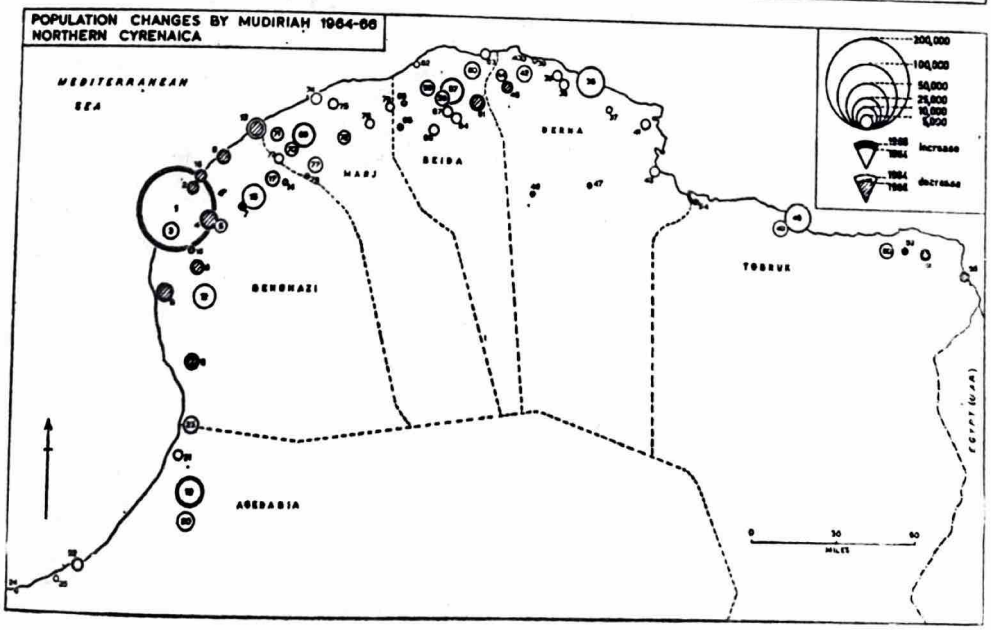

POPULATION CHANGES BY MUDIRIAH 1964-66
NORTHERN CYRENAICA
MEDITERRANEAN SEA
MARJ
BEIDA
DERNA
BENGHAZI
AGEDABIA
TOBRUK
EGYPT (U.A.R.)
200,000
100,000
50,000
25,000
10,000
5,000
1966 1964 increase
1964 1966 decrease
0
30
60
MILES

Fig.4

e 3. Muririah Administrative Districts in Northern Cyrenaica, 1954 - 66

1. Benghazi City
2. Kwefia
3. Guarsha
4. Benina
5. Regima
6. Jardina
7. Al Hamda
8. Ghemines
9. Diriana
10. Bu-Meriam
11. Magrun
12. Solluk
13. Tocra¶
14. Sidi Mahieus
15. Abiar
16. Nuaghia
17. Alemeittaniya
18. Sidi Kalifa
19. Agedabia (Ijdabia) Town
20. Agedabia
21. Zuetina
22. Brega
23. Sidi Sultan
24. Ageila
25. Bishr
26. Marada
27. Jalo
28. Jikerra
29. Aujila
30. Eljof
31. El Hawari
32. Attulab
33. Tazirbu
34. Ribiana
35. Derna Town
36. Derna
37. Martuba
38. Ain Mara
39. Latrun
40. Ras Hilal
41. Um Er Rezzem
42. El Gubba
43. El Temimi
44. Labrag
45. El Giacab
46. El Mikheili
47. El Ezziat
48. Tobruk Town
49. Tobruk
50. Kanboot
51. Kasir El Jidi
52. Bir El Ashab
53. Ain El Gazala
54. Al Gartabah
55. El Berdi
56. Jaghbub
57. Beida Town
58. Beida
59. Messa
60. Shahat (Cyrene)
61. Faydiya
62. El Haniya
63. Sussa (Apollonia)
64. Saltna
65. Al Argub
66. Gandula
67. Omar El Mukhtar
68. Marawa
69. Marj Town (Merj or Barce
70. El Marj
71. Farzugha
72. Tackinnes
73. Sidi Buzeid
74. Tolmeitha
75. Batta
76. El Beyada
77. Gerdes El Abid
78. El Bunnaia
79. Gasr Libya.

Geographical Index of names mentioned in Auble, A. Statistical Paper No. 13, Ministry of Planning and Development, Tripoli, (1966), pp. 1 - 5.

A third zone can also be distinguished. Containing about 13 per cent of the national total, the Gebel Mudiriah form a subsidiary inland alignment. While the population distribution follows a 150 mile escarpment trending south-west from Tarhuna to Nalut, the central areas around Garian are the most important. The remainder of Tripolitania's population is dispersed in the southern part of the province. While scattered, most of the Mudiriah are located around oases, generally aligned parallel with the Gebel escarpment though at the foot of the southern dip slope known as the « Ghibla ».

1.2 Population Distribution in Northern Cyrenaica

Although Cyrenaica's distribution of population shows a similar coastal concentration, both its proportions and groupings of Mudiriah differ markedly from Tripolitania (Figs. 3 and 4). Benghazi City, though eminent amongst Cyrenaican Mudiriah, is smaller than its Tripolitanian counterpart accounting for only 10 per cent of national total. Mudiriah adjacent to Benghazi are also less imposing, while the coastal plain to the north and south of the city forms only 6 per cent of the national total. Most of this population is distributed south of Benghazi City. A further 8 per cent of the Libyan population is concentrated on the Gebel Akhdar trending approximately 120 miles north-east of Benghazi. It is grouped in two similar sized units, one around Marj Town and the other around Beida Town. Derna and Tobruk, as coastal towns, form the bulk of the remaining population concentrated on the northern coast, containing about 3 per cent of the national population. Most of these Mudiriah are small and regularly dispersed.

A similar proportion of the provincial population is distributed in the desert interior, principally in the oases of Jaghbub, Jalo and Kufra.

1.3 Population Distribution in the Fezzan

The small size of the Fezzan population is emphasized by the fact that the total 1964 population could be contained in circle

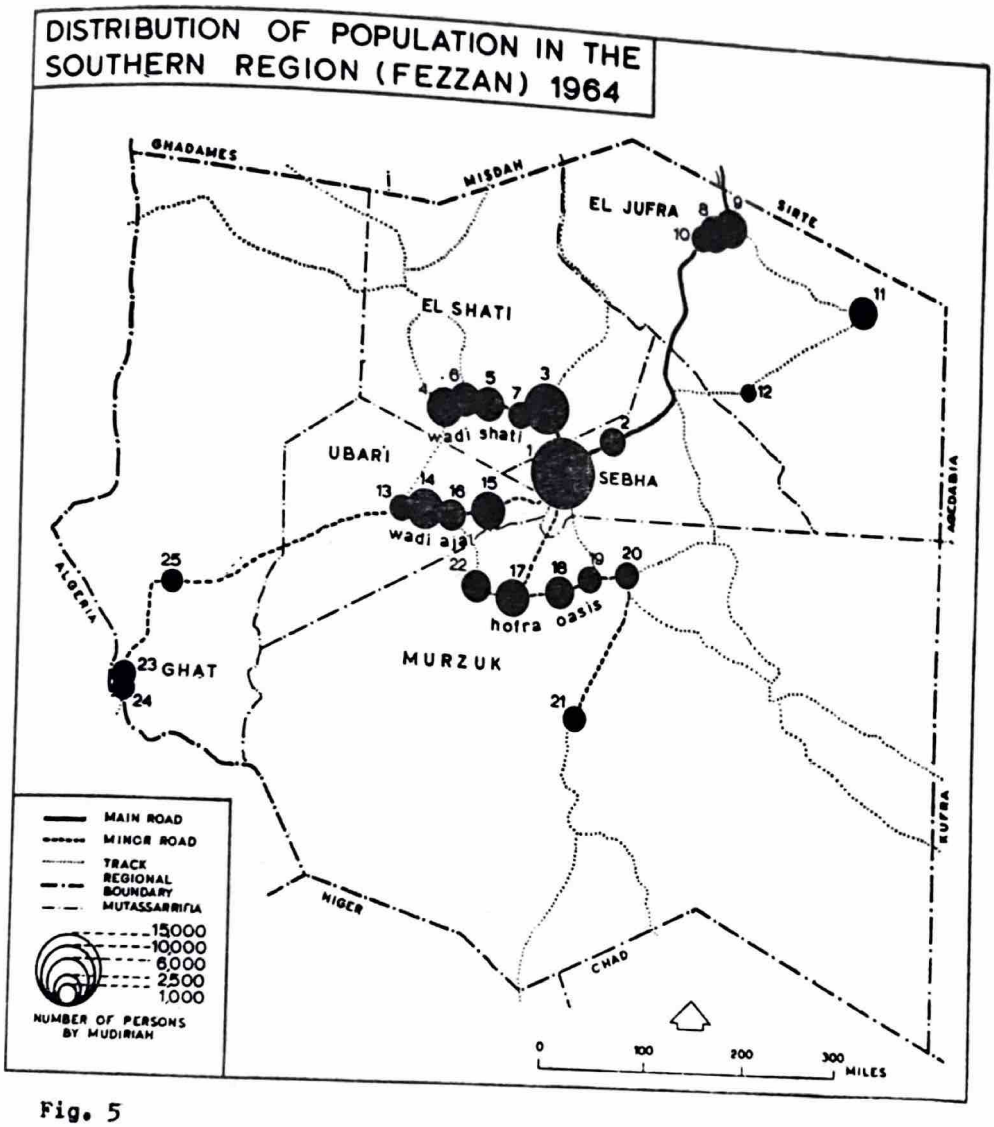

DISTRIBUTION OF POPULATION IN THE SOUTHERN REGION (FEZZAN) 1964
GHADAMES
MISDAH
EL JUFRA
SIRTE
EL SHATI
wadi shati
UBARI
SEBHA
wadi ajal
hofra oasis
MURZUK
GHAT
ALGERIA
NIGER
CHAD
KUFRA
ARCADIA
MAIN ROAD
MINOR ROAD
TRACK
REGIONAL BOUNDARY
MUTASSARRIFIA
15,000
10,000
6,000
2,500
1,000
NUMBER OF PERSONS BY MUDIRIAH
0
100
200
300
MILES

Fig. 5

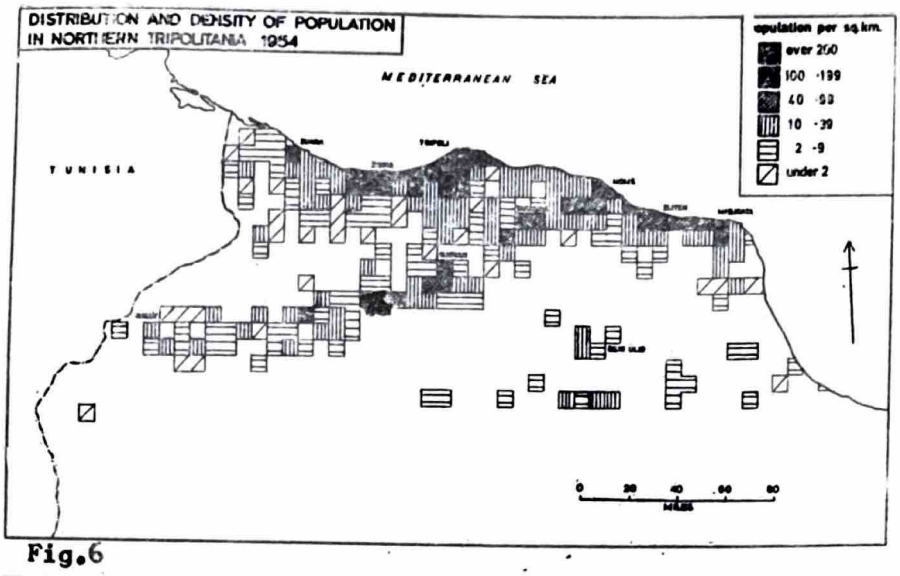


Fig.6

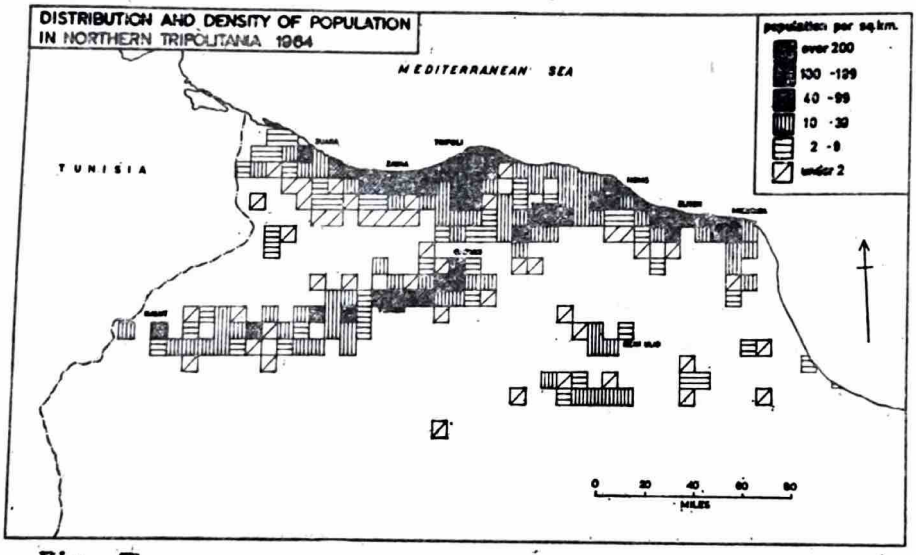


Fig. 7

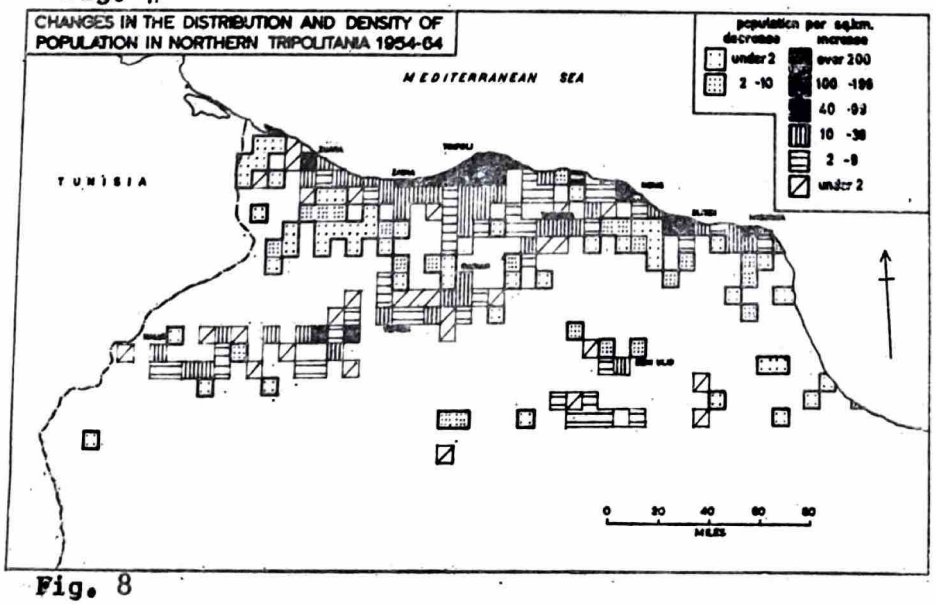


Fig. 8

number 2 on Figure 1. Despite the small scale and dispersed nature of the Fezzan population, however, the region claimed provincial status until 1963. Separated from the two northern provinces, the Fezzan achieved a measure of self-sufficient independence based on the old capital of Murzuk but more recently on Sebha. As Figure 5 shows, the 1964 population was aligned in three parallel zones. The largest group was centred on Sebha containing only about one per cent of the national population, but 18 per cent of the Fezzanese total. The parallel groupings in the north and south, based on Brak and Murzuk respectively, contained a further one per cent of the Libyan population. The outlying cases of Hon, Ghat, and Gatrun, made up the remainder.

2. Distributional Changes 1954-66

While information for northern Tripolitania and Cyrenaica relates to three specific dates, 1954, 1964 and estimates in 1966, a two-phased change in population distribution is apparent.

Table 4. Mudiriah Administrative Districts In the Fezzan,- 1964

1.	Sebha Town	14.	Garifa
2.	El Gedid and Buanis	15.	Bint Bayyah
3.	Brak	16.	Oragen
4.	Idri	17.	Murzuk
5.	Bergin	18.	Traghen
6.	El Hassawna	19.	Um el Araneb
7.	El Maguartia	20.	Zuila
8.	Hon	21.	Gatrum
9.	Waddan	22.	Wadi Atbah
10.	Socna	23.	Ghat
11.	Zella	24.	El Berket
12.	El Fugha	25.	Ouinat
13.	Ubari		

Geographical Index of names mentioned in Auble A. Statistical Paper No. 13, Ministry of Planning and Development, Tripoli, (1966), pp.1 - 5.

Between 1954 and 1964 **Tripolitania's** main increase was concentrated dramatically in the Tripoli complex (Fig. 1). Increases in the settled areas of the coast occurred around Zuara, Zawia, Homs and Misurata. All the Gebel areas extending from Cussabat to Nalut showed sustained increases. Slight decreases were apparent in the western Gefara and the southern Gebel dip-slope, while the eastern coastal region showed a stagnant situation outside the coastal towns. The distribution pattern changed radically after 1964. Half of the western Mudiriah showed a decrease, together with the western Gefara and eastern coastal Mudiriah (Fig. 2). In fact, only Tripoli City and its surrounding districts experienced any significant increase, although districts adjacent to Tripoli began to show a decline.

Although **Cyrenaica's** population distribution has a different pattern from Tripolitania's, a similar two-phased change could be identified. Benghazi City dominated the provincial growth during 1954-64, although there was less repercussion on its neighbouring Mudiriah than in the Tripoli complex (Fig. 3). The new capital of Beida, the eastern port of Tobruk, and the oilfield exploration centre of Agedabia were the major subsidiary growth points. The main areas of decrease occurred in the small Mudiriah surrounding Beida and Marj, and in the plain south of Benghazi. The devastation of Marj by the 1963 earthquake undoubtedly influenced the decrease in population. This pattern was re-emphasized after 1964 (Fig. 4). Benghazi City continued to expand, but this time at the expense of the surrounding Mudiriah. The main towns grew steadily, while the Benghazi plain increasingly became an area of declining population.

The large growth of the **Fezzan** population from 59,000 to 79,000 between 1954 and 1964, and to 86,000 in 1966, cannot be explained purely by demographic processes. Some local population adjustment has taken place. For instance, the old capital of Murzuk has been replaced by Sebha, which doubled its population during 1954-64. However, evidence from recent field work in the Fezzan[3] suggests that the proportions of total population in the three major wadis have remained relatively stable in recent years. Conse-

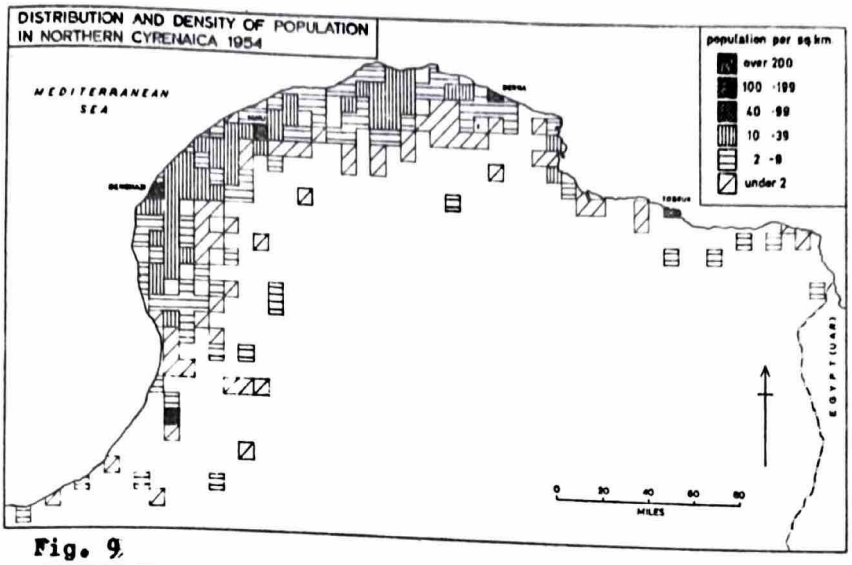


Fig. 9

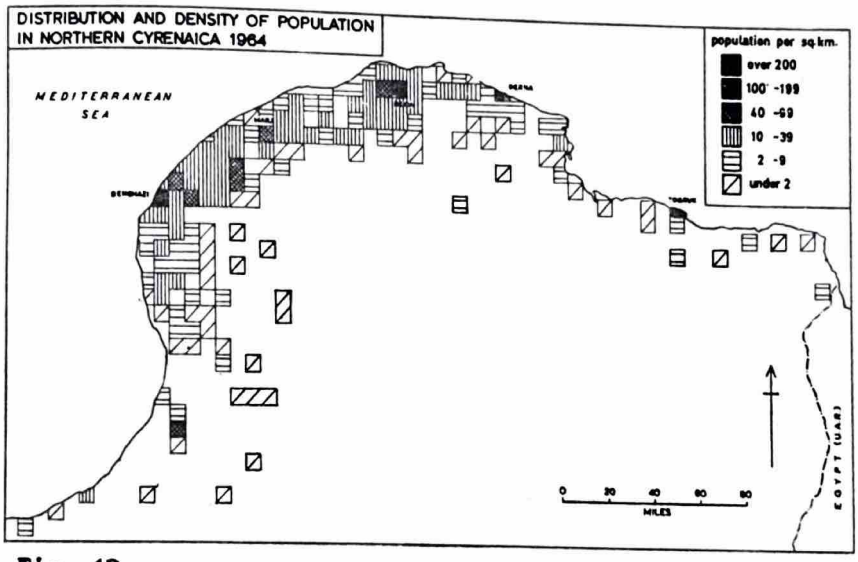


Fig. 10

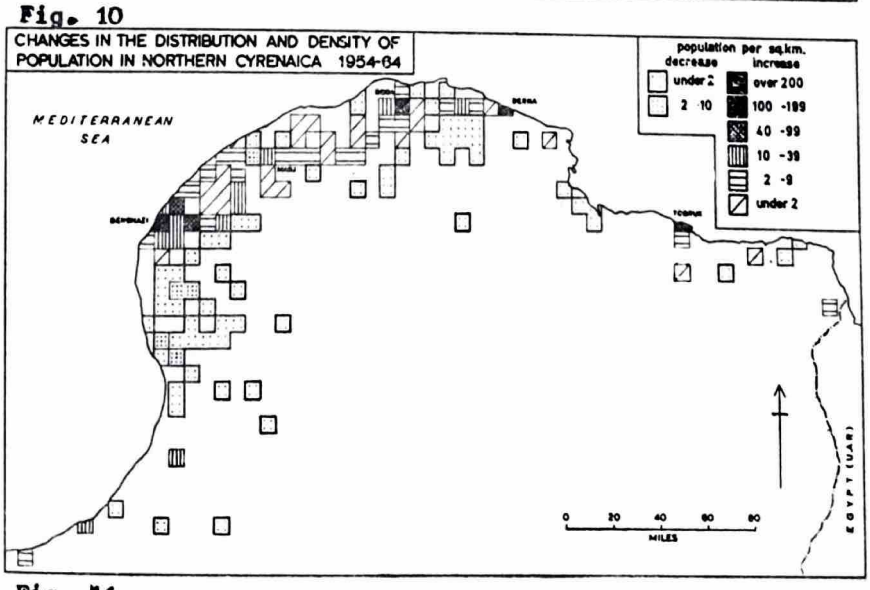


Fig. 11

quently, census enumerations in either 1954 or 1964, together with boundary changes, must account for the exceptional growth in Libya's southern province.

3. Changes in Population Density 1954-64

Ways of depicting geographical distributions depend as much on cartographic convention as on the inherent nature of the phenomena being shown. The clustered nature of mudiriah represented by proportional circles, for instance, indicates changes over time effectively, but fails to relate the population to area. The patterns of density in Northern Tripolitania and Northern Cyrenaica are summarized in Figures 6 to 11. These density surfaces may be thought of statistically as a response surface in which height, i.e. population density, varies as a response to controlling factors. While the density gradients highlight regional disparities and suggest particular environmental controlling factors, the method used in portraying the densities is inevitably a generalization. A 10 kilometre square grid was placed over a dot map for the 1954 population thereby creating an artificial, though standardized, relationship between area and population. *

The settled population in 1954 and 1964 identified in the density maps indicates a similar basic pattern to the Mudiriah distribution; coastal concentration, inland Gebel alignment in Tripolitania, and minor interior oasis groupings. Tripolitania had higher average densities than Cyrenaica though it also experienced

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* A map was published in 1964 on the scale 1:1,000,000 by the Department of Regional Geography, Warsaw, which showed the 1954 distribution of Libyan population using standard size dots, each dot representing 200 persons. The map was checked at the Mutassarrifia district level and was found to be accurate. The 1964 population distribution and density was based on a 1966 map devised by the Ministry of Planning and Development, Libya, although each standardized dot represented 1,000 persons. A more detailed distribution of population in northern Libya on the scale 1:1,000,000, and with each dot representing 200 persons, was undertaken by the writer in 1967.

steeper density gradients, especially inland from the coast (Figs. 6 and 7). Cyrenaica displayed more uniform densities, particularly on the upland Gebel Akhdar, and lacked high rural densities along the coast. Urban centres in Cyrenaica contrasted sharply with low surrounding population densities, a feature not so significant in Tripolitania (Figs. 9 and 10).

Urban centres in both provinces dominated the density increases during 1954-64, particularly Tripoli and Benghazi Cities. Areas of decrease in Tripolitania were the western Gefara, the southern slopes of the Gebel escarpment, and the eastern coastal areas between Tarhuna and Misurata (Fig. 8). The extreme western Gebel around Nalut, and interior oases near Beni Ulid also indicated a decrease. Cyrenaica displayed a similar pattern of change. The southern Benghazi plain was the major zone of decrease, although the Gebel Akhdar, particularly between Beida and Derna, also showed a marked change during 1954-64 (Fig. 10).

4. Regional Co-efficients of Distributional Evenness

As rainfall is a vital element in the land use of northern Libya and hence in the distribution of rural population, an association between rainfall zones and population density provides a basis for inter-provincial comparison. Lorenz curves (Fig. 12) indicate the degrees of population concentration in each northern province, giving some quantitative basis for inter-provincial comparisons.[5] An area of similar size was selected in northern Tripolitania and Cyrenaica, containing approximately 90 per cent of each province's population and equivalent rainfall zones. Rainfall isohyets at 50 mm. intervals were interpolated on a dot map of the 1954 settled population in Cyrenaica.[6] Estimates of the rural population in each rainfall zone had been made in northern Tripolitania.[7] Areal units were arranged in order of decreasing density of population. Both population and areas of rainfall zones were totalled for each density class. Cumulative percentages of rainfall zones (Y-axis) were plotted against cumulative percentages of population (X-

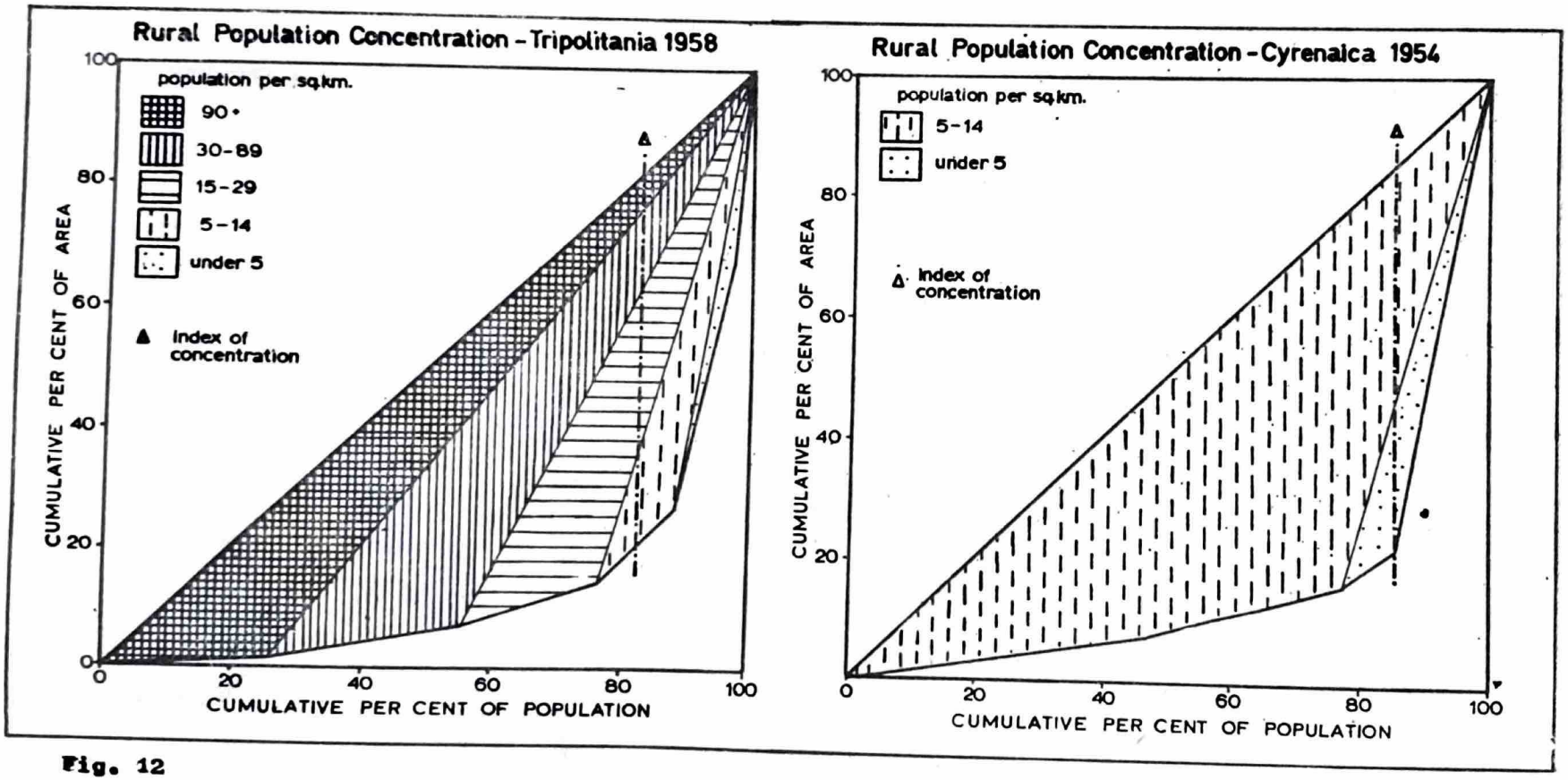
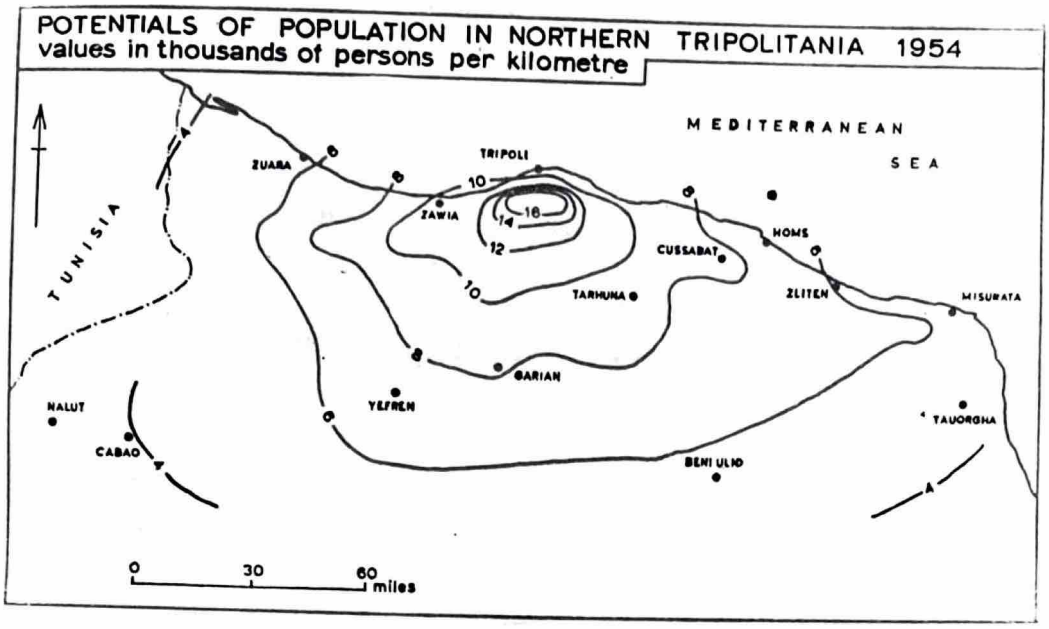

Rural Population Concentration - Tripolitania 1958
population per sq.km.
90 +
30-89
15-29
5-14
under 5
Index of concentration
CUMULATIVE PER CENT OF AREA
CUMULATIVE PER CENT OF POPULATION
0
20
40
60
80
100
Rural Population Concentration - Cyrenaica 1954
population per sq.km.
5-14
under 5
Index of concentration
CUMULATIVE PER CENT OF AREA
CUMULATIVE PER CENT OF POPULATION

Fig. 12

Fig. 13


POTENTIALS OF POPULATION IN NORTHERN TRIPOLITANIA 1954
values in thousands of persons per kilometre
MEDITERRANEAN
SEA
TUNISIA
ZUARA
TRIPOLI
ZAWIA
CUSSABAT
HOMS
ZLITEN
MISURATA
TARHUNA
GARIAN
YEFREN
NALUT
CABAO
BENI ULID
TAUORGHA
0
30
60
miles

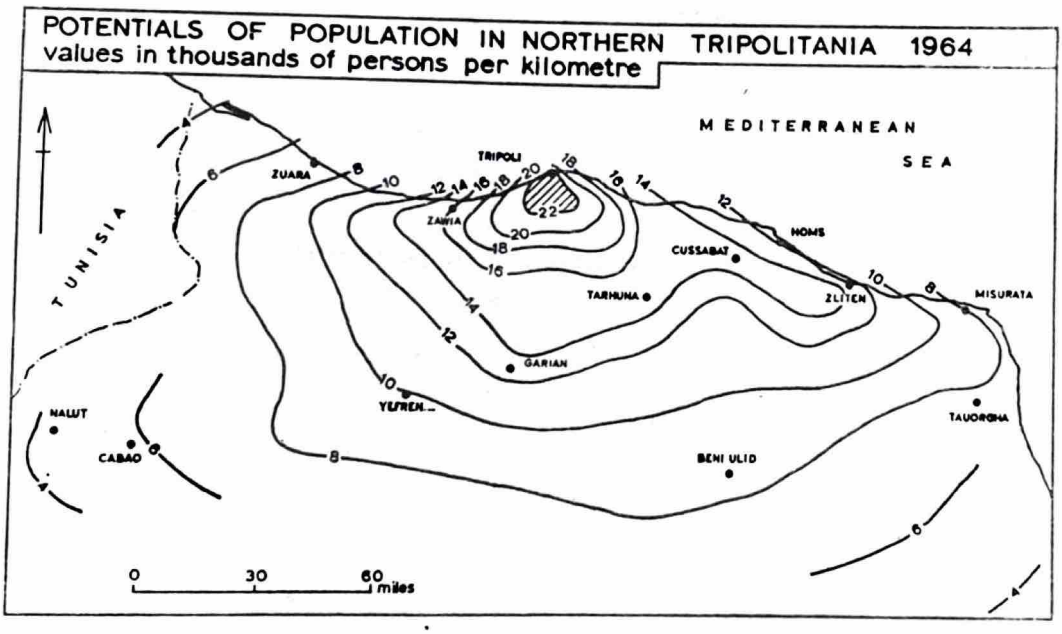

POTENTIALS OF POPULATION IN NORTHERN TRIPOLITANIA 1964
values in thousands of persons per kilometre
MEDITERRANEAN
SEA
TUNISIA
ZUARA
TRIPOLI
ZAWIA
CUSSABAT
HOMS
ZLITEN
MISURATA
TARHUNA
GARIAN
YEFREN
NALUT
CABAO
BENI ULID
TAUORGHA
0
30
60
miles

Fig. 14

axis). The more unevenly the population was distributed the more closely the distribution of population approached the X and Y axes.

A concentration ratio, expressing the area on the graph between the Lorenz curve and the diagonal, as a proportion of the total area below the diagonal, revealed 11 per cent for Tripolitania and 22 per cent for Cyrenaica. Tripolitania therefore had higher densities, a greater variety of density groups and a larger co-efficient of unevenness than Cyrenaica.

5. Population Potentials in Northern Libya

There is an evident tendency for the Libyan population to concentrate in particular areas; in towns, along the coast, and in the higher rainfall zones. Some of these areas have a high population potential. Stewart[8] refers to a population potential as a measure of nearness of people to that point, as a measure of general accessibility, or as a measure of influence of people at a distance. This tendency to congregate represents an attraction of people for people that turns out to have a mathematical as well as a merely verbal resemblance to Newton's law of gravitation. In the physical analogy, the potential is the energy in the field (gravitation) of a unit mass (charge). The energy of a given mass at a point is the potential of that point multiplied by the said mass. Likewise, the « demographic energy »or « interchange » between a population N, and a second population N^2 at distance d is N, times N^2/d. In other words, potential varies inversely with distance.

Four maps were constructed in northern Libya to measure the population potential and to note provincial changes between 1954 and 1964. The procedure in constructing isopleths of equipotentials of population was the same for the four maps. A grid containing 10 km. squares was placed over maps of northern Tripolitania and Cyrenaica, similar to the density maps (Figs. 6 and 11). Calculation of the populations in each square revealed 234

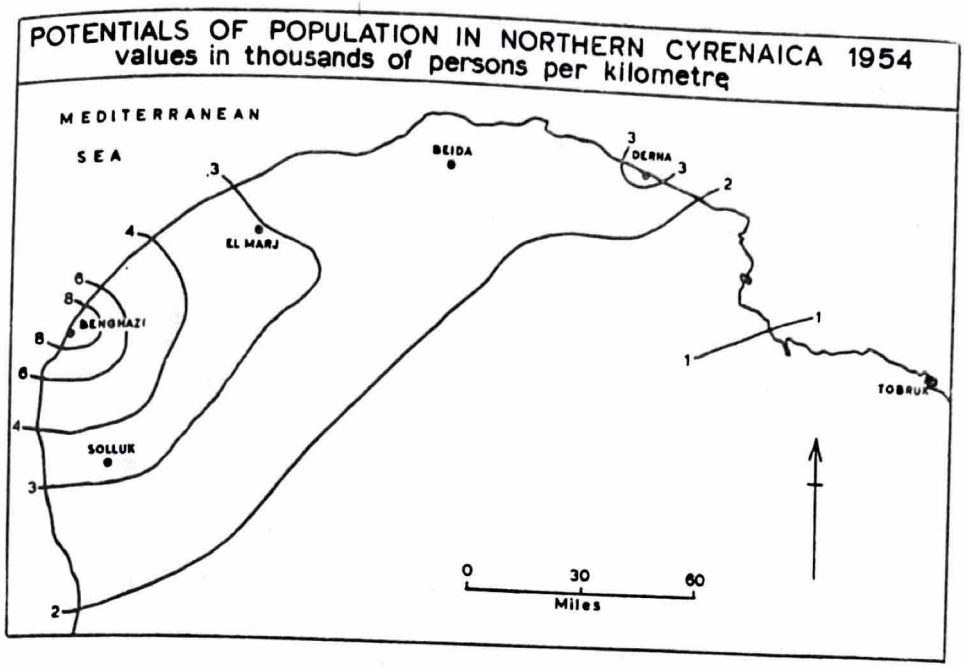
locations in Tripolitania in 1954 and 223 in 1964; Cyrenaica's equivalent locations were 168 and 151 respectively. The population of each district was arbitrarily supposed to be concentrated at the centre of each square. Distance in kilometres was measured by means of two axes, X and Y, giving a 17 x 40 square matrix for both provinces. The sum of a point to all other points on the grid divided by its distance, plus the potential of the point on itself, were calculated on an I.B.M. computer.

The maps of population potential in Tripolitania in 1954 and 1964 (Figs. 13 and 14) have two striking features in common. The major peak in both concentrations is Tripoli City. A dominant axis, or ridge, runs east and west from Tripoli, descending rapidly towards the desert interior. The pattern remained similar during 1954-64, with a slightly higher eastern ridge in 1964. However, values increased about one and a half times over the ten years period.

Cyrenaica shows the increasing importance of Benghazi, but without a well-defined ridge along the coast. A rapid fall of potential inland is broken by a plateau covering the whole of northern Cyrenaica with local peaks around the towns of Derna and Tobruk (Figs 15 and 16). It is significant that the new capital of Beida has had little influence on the equipotential values.

In physics the rate of change of potential with distance in any direction measures the « field intensity » in that direction. The field intensity is the number of people divided by the square of their distance away; it is a directed, or « vector », quantity, while potential is a « scalar » quantity, without direction. « Lines of force » define the field and always run at right angles to the contours of equipotential. The sharpening of the Tripoli and Benghazi peaks, which presumably is still going on, indicates that in this respect also the physical analogue carries into demography. Populations tend to shift slowly along the lines of force towards the peaks of potential. Cyrenaica's triple peak has endured in defiance of this tendency, because the hill and arid areas that intervene

Fig. 15


POTENTIALS OF POPULATION IN NORTHERN CYRENAICA 1954
values in thousands of persons per kilometre
MEDITERRANEAN
SEA
BEIDA
DERNA
EL MARJ
BENGHAZI
SOLLUK
TOBRUK
0
30
60
Miles

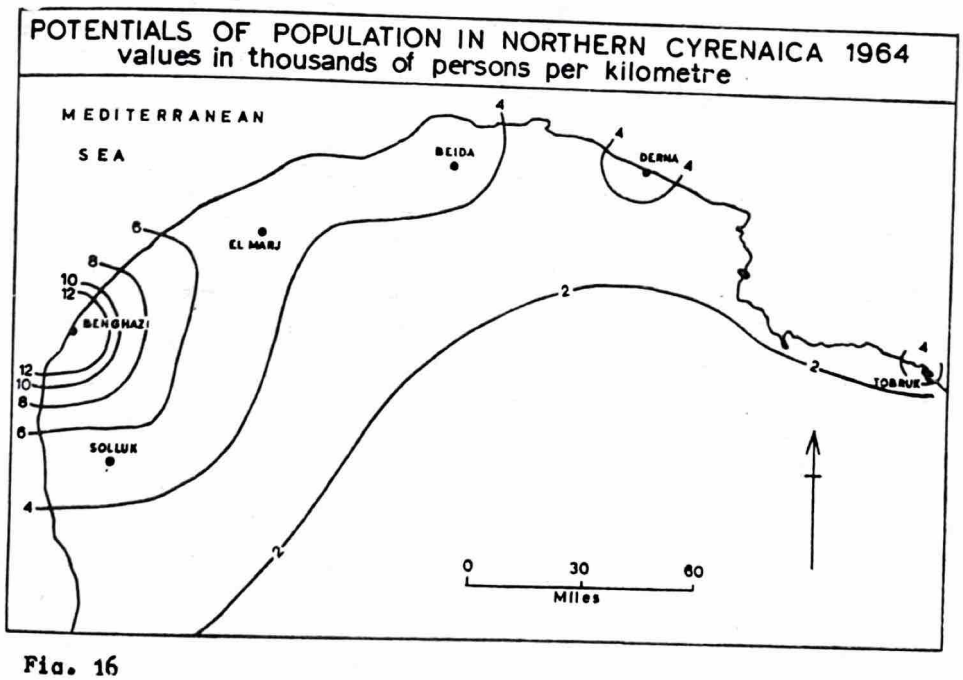

POTENTIALS OF POPULATION IN NORTHERN CYRENAICA 1964
values in thousands of persons per kilometre
MEDITERRANEAN
SEA
BEIDA
DERNA
EL MARJ
BENGHAZI
SOLLUK
TOBRUK
0
30
60
Miles

Fig. 16

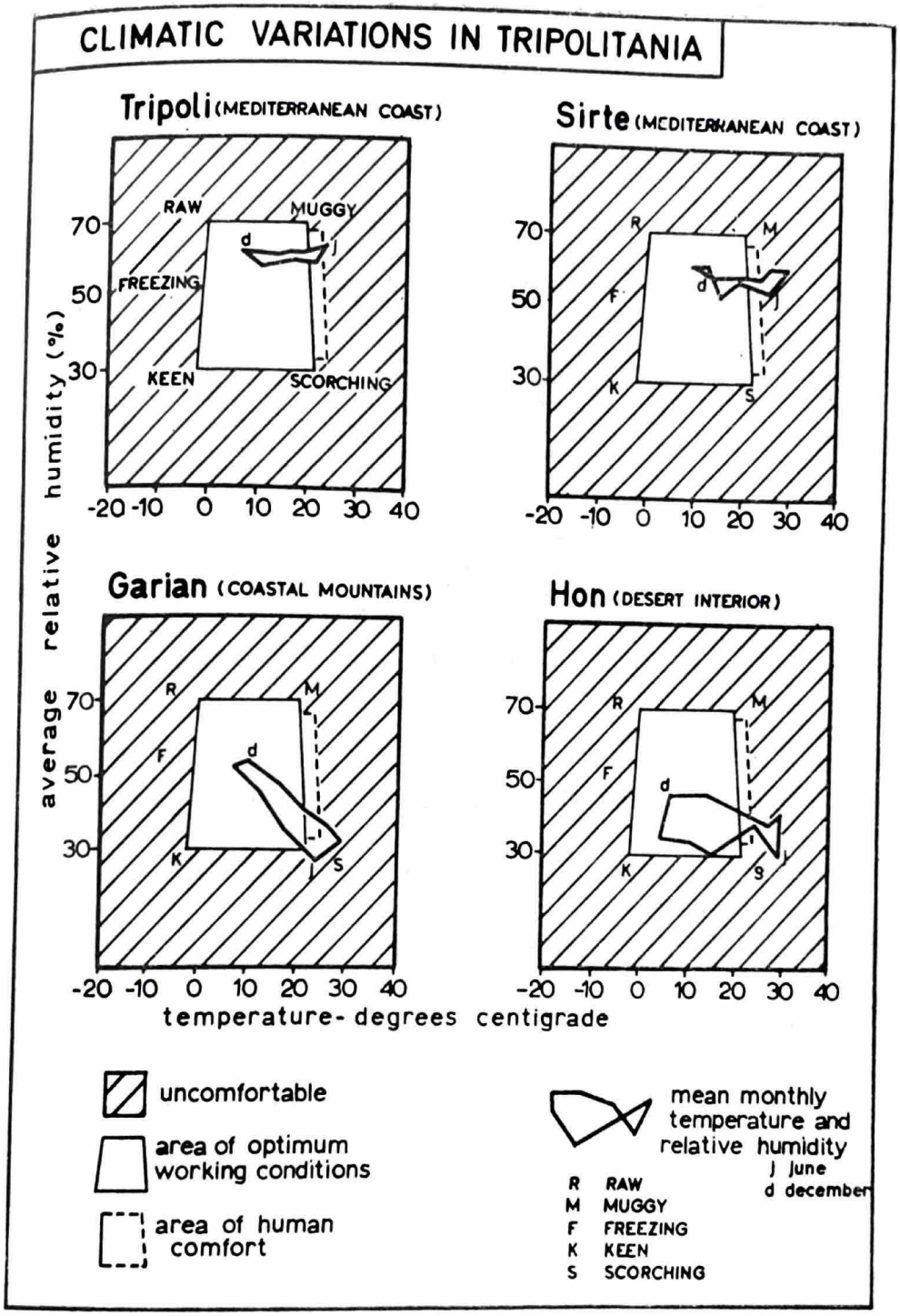

CLIMATIC VARIATIONS IN TRIPOLITANIA
Tripoli (MEDITERRANEAN COAST)
Sirte (MEDITERRANEAN COAST)
Garian (COASTAL MOUNTAINS)
Hon (DESERT INTERIOR)
RAW
MUGGY
FREEZING
KEEN
SCORCHING
average relative humidity (%)
70
50
30
-20 -10 0 10 20 30 40
temperature- degrees centigrade
uncomfortable
area of optimum working conditions
area of human comfort
mean monthly temperature and relative humidity
J june
d december
R RAW
M MUGGY
F FREEZING
K KEEN
S SCORCHING

Fig. 17

keep the Benghazi-Derna and Derna-Tobruk concentrations separated, notwithstanding their mutual attraction.

There is, thus, a tendency of human groupings toward a maximum. In Libya this maximum appears to be in urban areas, rather than coastal or higher rainfall zones. The maximum is never fully achieved because of a counterbalancing tendency and demographic force; otherwise there would be one city at the peak and no ridge or rural lowland. Therefore, while the tendency of accretion of people at peaks and ridge increases, some people must remain spread out to maintain contact with the rural occupations and environment.

The patterns and measures of population distribution, density, concentration and potential outlined in the foregoing section form the basis for a more detailed investigation of the determining influences. United Nations' studies have indicated that..... « within limits man determines his pattern of population distribution ».[9] In order to identify some of these 'limits' and controls, each province's population distribution is analysed in terms of its physical and non-physical conditions.

6. Tripolitania's Rural Population Distribution

6.1 Temperature, Humidity, Rainfall and Agricultural Production

While atmospheric temperature alone need not impose undue limitations on man's physiology or on his ecological environment, a large temperature range combined with relative humidity can set limits. Optimum living and working conditions are not necessarily coincident in all parts of the province. The selection of four climatic regimes shows the northward amelioration of extremes (Fig. 17). Moderating influences from the Mediterranean Sea make Tripoli's location the most favoured physical environment for optimum working and living conditions. Extremes of temperature increase both east and west along the coast, but are particularly sharp inland. Only the Gebel acts as a moderating influence. Thus, mean annual temperature ranges of 14°C on the coast

increase by 4°C only forty miles inland, and may reach 25°C in interior regions. [10]

However, it is the indirect influences of the physical environment which set more specific limits to Libya's œcumene.* The presence or absence of water is the critical factor in Tripolitanian agricultural production, and hence in influencing the distribution of the rural population. Low precipitation limits water supply in general and soil moisture in particular, thus imposing limits on the size of the animal population and agricultural production. The reliability and effectiveness of precipitation tend to increase where diurnal and annual temperature ranges are of moderate proportions, thereby affecting vegetation types and growth conditions. Stewart[11] estimated that seven out of twenty years have damagingly low rainfalls, particularly effective in areas existing on marginal amounts of rainfall.

The optimum conditions for the various types of agricultural production vary throughout the country. However, barley, the principal annual crop, seldom produces a profitable yield in a location where the average rainfall is less than 200 mm. per annum. This occurs even when the rain falls during the growing season and does not vary with the quality of the land.[12] Even the olive, second in value of Tripolitanian crops produced, and well suited to the north Mediterranean lands, is confined basically to areas where annual average rainfall does not fall below 200 mm.[13]

Despite the fact that scattered oases and areas benefiting from wadi moisture exist productively in regions with less than 200 mm., it can be considered to be the minimum amount of moisture required to yield reliable crops. Moreover, levels of agricultural technology pertaining in Tripolitania have developed little in the field of extending the cultivated area beyond these limits. Perennial crops can produce profitable yields with less moisture than is required by cultivated annual crops. Below 150 mm. of

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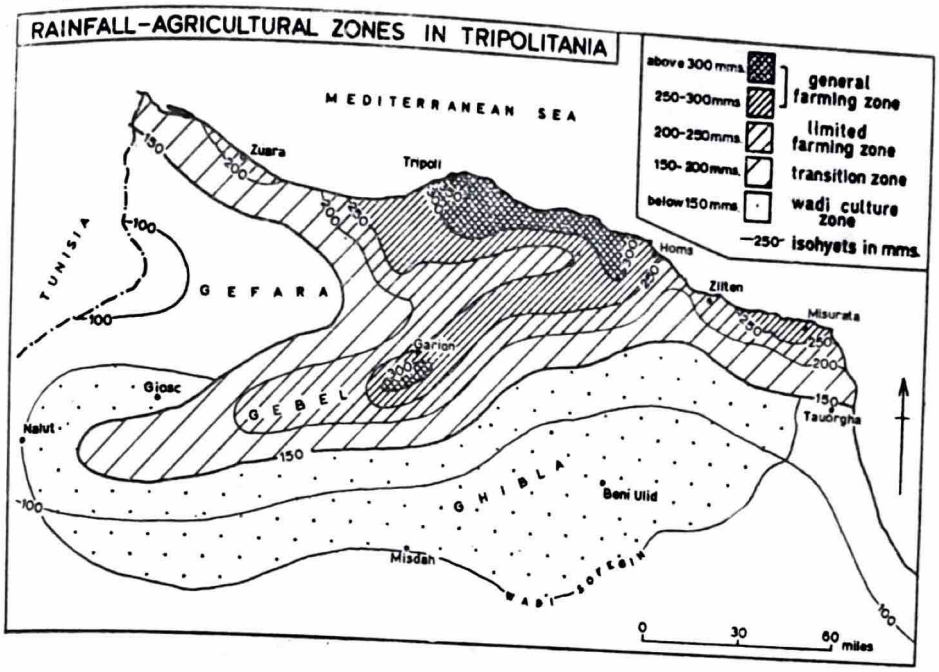
* As defined by Trewartha, G. T. « A case for Population Geography », **Annals Assoc. Am. Geog.**, Vol 43, (1953), p. 92.

Fig. 18


RAINFALL-AGRICULTURAL ZONES IN TRIPOLITANIA
above 300 mms.
250-300mms.
general farming zone
200-250mms.
limited farming zone
150-200mms.
transition zone
below 150 mms.
wadi culture zone
250 isohyets in mms.
MEDITERRANEAN SEA
Zuara
Tripoli
Homs
Zliten
Misurata
Tauorgha
Garian
Giosc
Nalut
TUNISIA
GEFARA
GEBEL
GHIBLA
Beni Ulid
Misdah
WADI SOFEGIN
0
30
60 miles

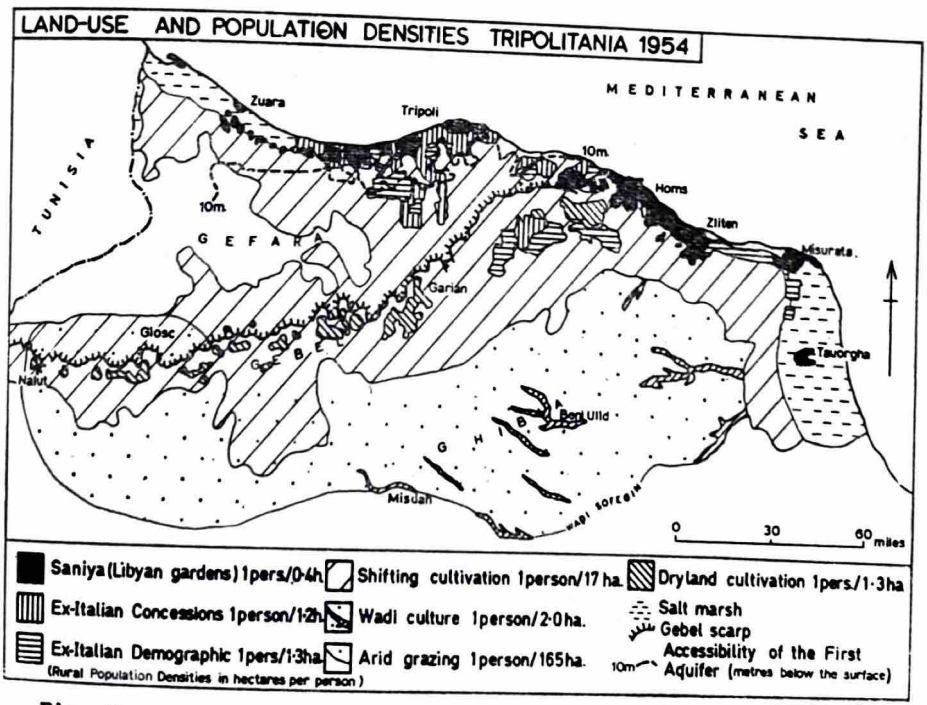

LAND-USE AND POPULATION DENSITIES TRIPOLITANIA 1954
MEDITERRANEAN SEA
Zuara
Tripoli
Homs
Zliten
Misurata
Tauorgha
Garian
Giosc
Nalut
TUNISIA
GEFARA
GEBEL
GHIBLA
Beni Ulid
Misdah
WADI SOFEGIN
10m.
0
30
60 miles
Saniya (Libyan gardens) 1pers./0·4h.
Shifting cultivation 1person/17 ha.
Dryland cultivation 1pers./1·3ha
Ex-Italian Concessions 1person/1·2h.
Wadi culture 1person/2·0ha.
Salt marsh
Gebel scarp
Ex-Italian Demographic 1pers./1·3ha.
Arid grazing 1person/165ha.
Accessibility of the First Aquifer (metres below the surface)
(Rural Population Densities in hectares per person)

Fig. 19

rainfall, however, a definite break appears in the density of vegetation. Between 150-200 mm. constant overgrazing prevents the growth of perennial forage grasses, and profitable non-irrigated farming is limited to grazing and forestry.

The Tripolitanian agricultural zone, bounded approximately by the 150 mm. isohyet, covers about 24,570 sq. kms., comprising 8 per cent of the provincial area. This land, all in one piece except for a small wedge of better watered land on the littoral at Sirte, is actually a coastal strip extending from Tunisia to Misurata. It averages about 30 kilometres wide at both eastern and western ends, with a 100 kilometre wide bulge in the central section, and with one projection or « tongue » extending westwards along the Gebel Nefusa from about Yefren to Nalut (Fig. 18).

The relationship between population density and the rainfall zones is tabulated in Table 5 and portrayed graphically in Figure 20. Rural population density, on both total and non-irrigated land, increased from zone to zone much more rapidly than annual rainfall. In other words, rather than varying in a straight-

Table 5. Rainfall Zones and Rural Population Density in Northern Tripolitania, 1954*

Rainfall Zone	Rural Population 1954		Area		Density
	No. persons	% total pop.	sq. kms.	% total	pers./sq.km.
300 mm.+	153,000	26.4	1,555	1.7	98
250 - 300	175,000	30.3	4,543	4.9	38
200 - 250	110,000	19.0	6,840	7.4	16
150 - 200	70,000	12.1	11,530	12.5	6.1
100 - 150	50,000	8.7	28,430	30.8	1.8
100	20,000	3.5	40,000	42.7	0.5
	578,000	100	92,898	100	5.8

* location of region in Figure 6.

Source:- Stewart, J. H. Land and Water Resources of Tripolitania, U.S. Technical Aid, Tripoli, (1958), p. 27.

line linear ratio with rainfall, population density increased in a so-called « geometric », or « exponential » rate as rainfall increased. Stewart [14] maintains that... « it indicates in general how productivity is controlled by rainfall ,and to some extent how population density responds to that productivity. There are undoubtedly other factors, some technical (such as ease of communication and transportation) and some sociological, that cause an even greater concentration of rural population in the higher rainfall zones than would be the result of prductivity alone ».

6.2 Sample Survey : Population Distribution and Rainfall Zones

A simple correlation statistical test related population density to the rainfall zones in an area of 20,000 square kilometres in western Tripolitania (Fig. 21). The results dispel the impression of uniform population densities within each rainfall zone and emphasize the importance of other physical influences on the distribution of population.

The average correlation for the sample area indicated a slight positive relationship between increasing population density and increasing rainfall. However, subdivision of the sample area into six rainfall zones indicated progressively significant correlations with increasing rainfall (Table 6).

The low absolute amount of rainfall below 150 mm. per annum, combined with the high evaporation loss (estimated by Stewart as 90 per cent of the total rainfall in interior regions), dictated the lack of association between the two variables. Variability of rainfall in time and space, together with the sparse vegetation, support the view that population distribution in this zone is associated with the availability of other water supplies. In regions receiving more than 150 mm. rainfall per annum there is an increasingly significant association; + 0.43 in the zone 150 mm. to 200 mm., to + 0.77 in the zone receiving over 250 mm. rainfall. The fact that only 12 per cent of the total cultivated land area is irrigated,[15] confined basically to the coastal zone, suggests the

Table 6. Results of the Population-Rainfall Correlations*

1.	Average for the sample area	+ 0.47
2.	Average for rainfall belts:-	
	(a) 0 to 50 mm	+ 0.25
	(b) 50 to 100 mm.	+ 0.23
	(c) 100 to 150 mm.	+ 0.13
	(d) 150 to 200 mm.	+ 0.43
	(e) 200 to 250 mm.	+ 0.56
	(f) over 250 mm.	+ 0.77
3.	Average for geographical regions:-	
	(a) Coastal belt (10 kms. from coast)	+ 0.17
	(b) Agricultural belt (20 kms. from coast)	+ 0.16
	(c) Gefara	+ 0.52
	(d) Gebel	+ 0.81
	(e) Interior plain (Ghibla)	+ 0.13
4.	Correlation of population distribution and number of wells	+ 0.70

*T-tests indicated that correlation co-efficients were accurate at 90% - 95% probability levels.

dependence on dry-farming techniques in the rest of the agricultural zone. In this area efficient utilization of available surface water and soil moisture ultimately dictates crop yields.

In order to cross check these correlation the sample area was again subdivided; this time on a physiographic basis (Fig. 21). The interior plain (Ghibla) corresponding with the rainfall zone below 150 mm. indicated little association. The Gebel ridge, however, showed the most significant correlation (+ 0.81) indicating that in the dry-farming areas, with little accessible underground water, agriculture and hence population distribution are determined primarily by the avaibility of rainfall. The Gefara, or inland plain between the coast and Gebel, showed a slight association between rainfall and population. This supports the principle that shifting cultivation depends partly on variability of rainfall, particularly in the 150-250 mm. rainfall zone. Suprisingly, the coastal belt, determined both as 10 km. and 20 km. from the sea, showed no correlation. The predominance of other factors would seem to be associated with the coastal concentration of population.

6.3 Distribution of Groundwater

The action of groundwater on the distribution of Tripolitania's rural population has a twofold influence. Within the agricultural zone, determined as the area receiving more than 150 mm. rainfall per annum, groundwater dictates local variations in the intensity of production and also determines the potential for agricultural expansion. Secondly, the supply of groundwater is the critical factor in determining population distribution outside the agricultural zone.

About 105,000 hectares of land are irrigated in northern Tripolitania representing about 13 per cent of the provincial cultivated land area (about four fifths of the national total) and supporting about 100,000 rural population in 1958. Like population density in the rainfall zones, the population supported on each hectare of irrigated land decrease in each rainfall zone, though not at the

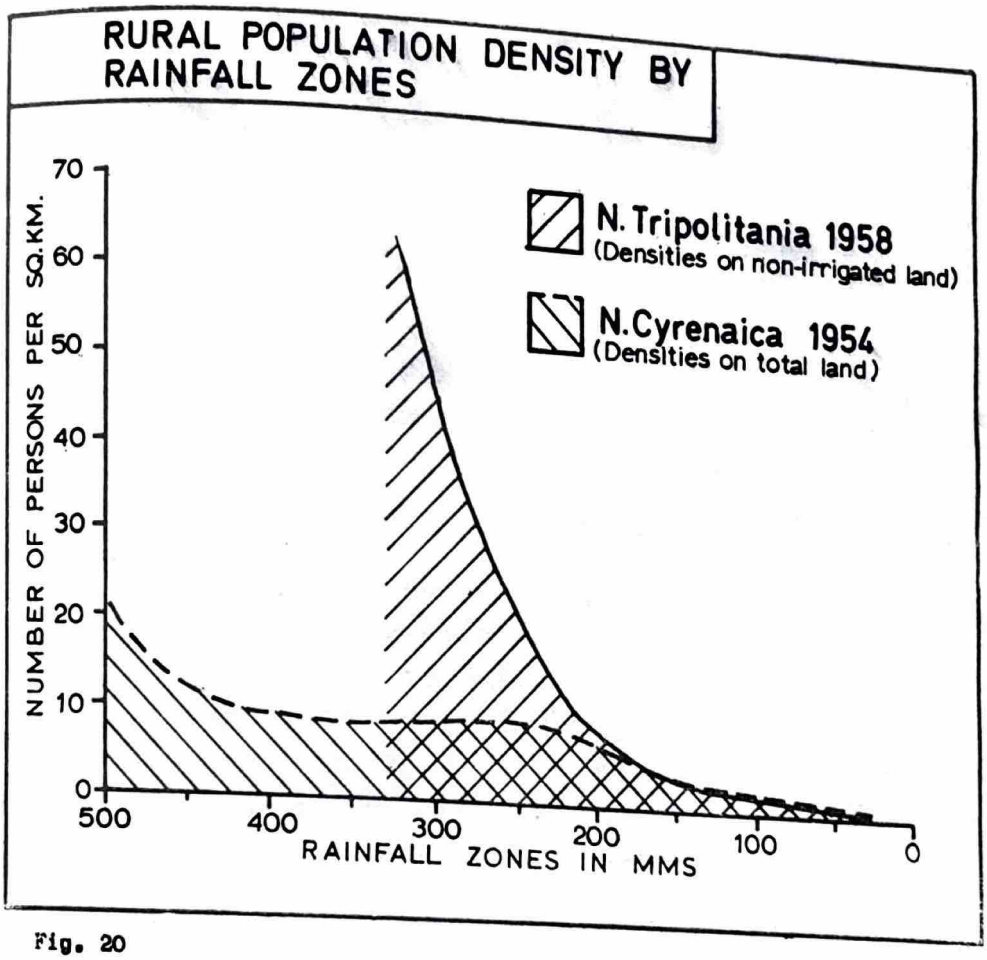

RURAL POPULATION DENSITY BY RAINFALL ZONES
NUMBER OF PERSONS PER SQ.KM.
70
60
50
40
30
20
10
0
500
400
300
200
100
0
RAINFALL ZONES IN MMS
N. Tripolitania 1958
(Densities on non-irrigated land)
N. Cyrenaica 1954
(Densities on total land)

Fig. 20

Table 7. Distribution of Irrigated Land by Rainfall Zones in Northern Tripolitania, 1958

Rainfall Zone (annual average)	Irrigated Land (hectares)	Population Supported	Density persons/ha. irrigated land	Non-irrigated land
over 350 mm.	2,000	2,500	1.3)	98
300 - 350 mm.	19,000	25,000	1.3)	
250 - 300 mm.	44,000	50,000	1.1	38
200 - 250 mm.	20,000	20,000	1.0	16
150 - 200 mm.	5,000	5,000	1.0	6
	90,000	102,500	1.1	

Source:- Stewart, J. H. Land and Water Resources of Tripolitania, U.S. Operation Mission to Libya, (1958). p. 26.

same rate (Table 7). The bulk of the irrigated land is situated in the Gefara which, because of its Tertiary and Quaternary sediments, is the main area of percolation and accumulation of underground water. This occurs in two main aquifers.[16]

The first, or Phreatic, water-table has a south to north gradient, steep in the east of the Gefara plain and shallow in the west. A littoral extension occurs between Homs and Misurata. However, the most accessible non-brackish water occurs in the area south of Tripoli (Fig. 19). The fact that this was the only water-table used prior to the arrival of he Italians in the 1920's is a reflection of its accessibility by traditional « dalu » (leather bucket) irrigation techniques. Recently installed electric pumps have enabled greater exploitation of existing areas and an extension southwards to tap the deeper aquifer. Over two-thirds of the Tripolitanian irrigated area is fed by pumped water. However, the high density of wells in the Arab garden oases (saniya) has resulted in decreasing yields and salinity in coastal areas due to sea water infiltration. The accessibility of the first water-table decreases eastwards with increasing depth, and westwards with increasing evaporation and consequent salinity. Shifting sand from

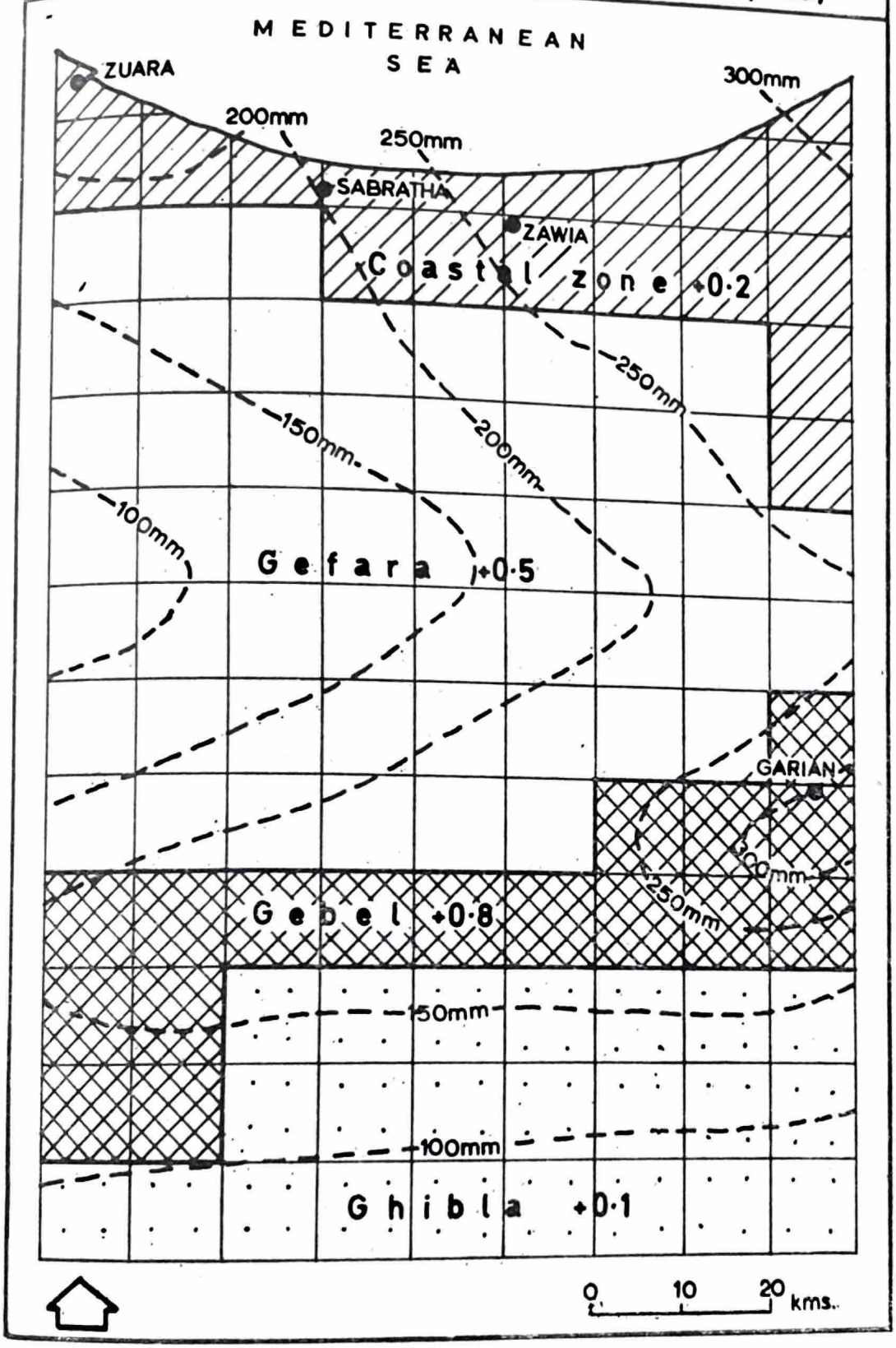
the Gefara has caused blockage of wells in the Tripoli area. However, exploitation of this water table has allowed population densities of 4 persons per hectare to be concentrated in saniya gardens along the coast (Fig. 19).

The second, or deep Quaternary aquifer, is confined to an area within thirty miles of Tripoli, but is important because of the high yields and good quality of the water. Being 20-25 meters below the first aquifer, it was inaccessible to the Arabs using traditional techniques. The introduction of the diesel, and recently electric, pumps enabled the Italian Demographic and Concession farms to expand southwards into previously unoccupied territory in the Gefara. Exploitation of deeper artesian water supported population densities of one person per hectare on large-scale commercial farming enterprises geared to supply growing urban needs. This concentration of accessible water resources around the Tripoli population complex has tended to reinforce the inertia of population growth in the centre of the Tripolitanian coastal plain.

In the vast pre-desert and desert areas of Tripolitania receiving less than 150 mm. rainfall per annum, there are numerous pockets of agriculture and population concentration. These scattered areas, limited in extent, depend essentially on two types of irrigation; controlled perennial irrigation from wells and springs, and uncontrolled flood-irrigation, defined by Stewart as « wadi culture ».[17] The extent of the water available and the methods of utilization form distinct paterns of population distribution, composing approximately 100,000 persons.

Controlled perennial irrigation dependent on well and spring water in the pre-desert and desert zone is concentrated chiefly in scattered oases. The largest is Tauorgha situated south of Misurata. It is nourished by a huge spring, though situated in « sebkha » (salt flats). The small populated areas totalling about 5,000 inhabitants are scattered over an area of about 100 sq. kms. The largest concentrated oasis is at Ghadames in south-west Tripolitania where nearly 3,000 inhabitants share an area of little more than four square kilometres. Smaller oases trend in an east-west

RAINFALL ZONES v RURAL POPULATION DISTRIBUTION
(correlation coefficients for sample area 20,000 sq.kms.)



direction, parallel to the Gebel, though at the foot of the southern dip slope. Other less important settlements occur along the northern spring line of the Gebel; for instance at Tiji and Giosc. The total population of the oases in 1964 was estimated at 10,000, remaining relatively stable since 1954.

The flood-irrigated areas, or the « wadi culture zone », support about 60,000 to 70,000 persons, mainly on the southern slopes of the Gebel and in the 100 to 150 mm. per annum rainfall zone. Flood flows occur in the watercourses of the large wadis on average 15 times in ten years. Frequency and reliability of wadi flooding increase with average annual rainfall. Most of the wadis exceed 100 metres in width and contain deep accumulation of alluvial soil (known as « gattis ») brought down by the floodwaters. Particular physical conditions necessary for irrigation limit the distribution of population to an area of approximately 23,000 sq. kms., although actual wadi cultivation and settlement cover no more than 500 sq. kms. (Fig. 19). The terrain yields considerable run-off from rainstroms of only moderate intensity, the location occurs in rainfall zones receiving at least one flood per annum, and local topographical conditions favour slight gradients and broad wadis.

The most spectacular example occurs around Beni Ulid in the central Ghibla. Efficient run-off and delivery of water, from the surrounding better-watered Gebel, converge at a point where the wadi is wide and flat. Flood-waters deposit silt allowing the water to penetrate the deep soil that has accumulated over centuries. Roman remains of rock dykes and dams further check the velocity of the bi-annual floodwater. At Beni Ulid five square kilometres support about 7,000 people and in addition 10,000 olive trees and date palms and several hundred hectares of mixed barley and bermuda grass. Thus, while the Wadis Tareglat, Mimum, Uestata, Merdum and Sofegin comprise the main productive areas, they depend on the water catchment of the whole Gebel dip-slope.

Other areas adjacent to the Gebel have less favourable conditions. Most of the Gebel scarp has wadi gradients too steep and floodflow velocities too high for the development of cultivation in

the wadis. To the west of Tripoli none of the northward flowing wadis reaches the sea, while those along the east coast support only minor population concentrations on narrow alluvial wadi patches. The effect of the wadis as local indicators of population distribution within the agricultural zone is indicated by Wadi Megenin situated south-west of Tripoli City. The fertility of this Wadi is emphasized by the intense development of vegetables and citrus fruits despite sporadic damage by flooding.[18]

The combination of well-water, flood-runoff and seasonal rainfall also forms the basis of pastoralism and shifting cultivation supporting about 200,000 Tripolitanians*. Shifting cultivation of barley, wheat and fodder crops on « tinn » lands (heavy alluvial soils) in the Gefara is supplemented by grazing lands in the Gefara and Ghibla. Tribal ownership of territory and wells, together with seasonal employment in the coastal saniya oases, dictate specific lines of population movements, though disputes over water rights still remain a source of tribal conflict. Primitive methods of farming are paralleled by ignorance of range management techniques; the consequent overgrazing hinders maximum utilization of scarce resources.[19] For these reasons population densities, ranging from 20-60 ha. per person, still cause excessive pressure on the land.

6.4 Other Physical Determinants of Population Distribution

Apart from the major determinants of precipitation and underground water there are a variety of subsidiary physical influences. The peculiar topographical conditions of wadi culture, the role of alluvial soils and the dangers of shifting sand have been mentioned. The association of soil formation with climate, vegetation and landforms has resulted in three broad soil zones, corresponding with the three physiographic zones of the coast, Gefara and Gebel.[20]

The soils of the cultivated coastal belt are mainly brown pedocalic regosols. They are loose, friable and permeable, but are sus-

* Defined as «Nomads» and «Semi-Nomads» in 1964 population census

ceptible to wind erosion if no vegetation cover exists. The availability of plant nutrients and soil moisture are the controlling factors for crop production and yields. The increasing maturity and depth of soil profiles therefore tend to increase in the higher rainfall zones, or in areas where irrigation is commonly practised. Some soils also act as a deterrent to agricultural development. Accumulation and subsequent evaporation of saline water in depressions behind coastal dunes, combined with capillarity of shallow water-tables, result in the formation of solonchacks and saline soils. Occurrence of these soils around Tauorgha, in the east, and Zuara, in the west, tends to limit the coastal extension of agriculture.[21]

Similar soils are also found in the Gefara, though with a higher sand content than coastal areas. Brown pedocals and « tinn lands » form the basis for cultivation in the favoured patches, while coastal soils, characteristic of the arid western Gefara, limit cultivation and grazing. The third zone of the Gebel ridge marks the beginning of the immature and shallow soils typical of semi-desert regions, punctuated by the alluvial soils in the Ghibla wadis.

7. Non-Physical Factors influencing Tripolitania's Rural Population Distribution

The Tripolitanian rural population is particularly difficult to describe by settlement sizes because of the nature of the traditional agriculture. Outside the urban centre of Tripoli, the large rural settlements of Sukel Giuma, Misurata, Zawi, Homs and Zanzur are set in a matrix of densely populated agricultural land. The urban functions of the settlements merge with the agricultural holdings without a precise physical division either in terms of geographical situation or population density. The distribution and density of the rural population are more clearly differentiated by type of agriculture.

Within the agricultural zone defined by rainfall and irrigation potential, different types of agricultural settlement occur support-

ing different population densities. Basically, there are two distinct patterns of occupance set on a similar background of physical conditions; one related to a traditional system of agriculture reflecting a « natural » response to the physical environment, with a haphazard evolution and stagnant technology; the other related to a planned and predetermined agricultural organization, superimposed on the traditional agricultural system (Fig. 19 and Table 8).

7.1 Traditional Libyan Farms

Although many farms situated on the coast contain land in

Table 8 Land Use Zones and Rural Population Densities in Northern Tripolitania, 1954.*

Land Use Zones	Area in 000's ha.	Rural Population in 000's	Density (ha./person)
1. Saniya farms	50	140	0.4
2. Ex-Italian Concession Farms	127	110	1.2
3. Ex-Italian Demographic Farms	103	80	1.3
4. Dryland cultivation	120	94	1.3
5. Shifting cultivation	1,460	85	17.2
6. Wadi cultivation	50	25	2.0
7. Arid Grazing	7,240	44	165.0
	9,150	578	15.8
Urban population (Tripoli City)	-	130	-
Rest of province	15,850	30	-
Tripolitania	25,000	738	3.0

* Area relates to Figure 6

Sources:- (a) Rowland, F. and Robb, E. Survey of Land Resources in Tripolitania, British Military Administration, Tripoli, (1945).
(b) Stewart, J.H. Land and Water Resources of Tripolitania, U.S. Operations Mission to Libya, (1960).
(c) Ministry of National Economy, Libya. General Population Census 1954, Tripoli, (1959).

the Gefara, economic viability is determined primarily by the size and location of irrigated patches in the coastal saniya. Physical, economic and social factors have combined to produce small (usually about 2 hectares) and fragmented holdings. The patchiness of the sandy-loam to clay soils, and the accessibility of the first-water table by traditional « dalu » techniques have limited the extent of the saniya oases. Traditional methods of inheritance aggravate the segmentation of land in the irrigated patches, which usually form only a quarter of the holdings' hectarage. The average density of occupance for the 150,000 Tripolitanians involved in this type of agriculture varies from 3 to 10 persons per hectare, depending on the fragmentation of holdings. This high population density reflects not only the inherent fertility of the coastal areas, but also the subsistence nature of the traditional agricultural system.

Constraints on the expansion of irrigation in the coastal saniya are both physical and human. Insecurity of ownership, lack of initiative and, until recently, lack of capital have concentrated the population in existing areas. However, the first water-table has already been over-exploited. The average two wells per farm only irrigate an area of one hectare, and increasing salinity is common in coastal areas, particularly between Homs and Misurata. A sample survey in the 1950's indicated the subsistence nature of most farms; 40 per cent of the total value of crops were consumed by the families, and four-fifths of the gross earnings of each farm was less than £L200 per annum.

7.2 Ex-Italian Settlements

In contrast to the traditional farms there are two types of modern commercial undertakings; private Concessions and so-called Demographic settlements. These were implemented by the Italians in the 1930's, although many were farmed by Libyans after independence in 1951, particularly in Cyrenaica.

The Concession farms originated as grants of land by the Italian Government to private individuals. As private commercial

enterprises these farms were developed on some of the best remaining land, chiefly in the western coastal plain between the indigenous oases and, to a lesser extent, in the eastern Gefara and Gebel. Practically all the farms were located within the rainfall zones receiving more than 200 mm. rainfall per annum. Dry land tree cultivation of olives and almonds formed the basis of the farm economies, the plantations being suited to the undulating and lighter soils adjacent to the more fertile indigenous oases. Irrigated field crops of winter cereals and summer groundnuts developed with the exploitation of the second water-table. Stewart estimated that the Concessions covered 127,000 ha. in 1958, giving a population density of about one person per hectare : at least four times smaller than the density in the saniya oases. As only 17,000 Italian farmers remained on these farms in 1953,[23] it is likely that Libyan farmers formed the main settlers in 1964.

The second type of modern commercial undertaking is the ex-Italian Demographic holding, initiated after 1935. In large measure, these settlements were an experiment undertaken for political reasons without thought of strict financial return in the short run. Situated on slightly marginal land in the steppe zone of eastern Gefara and Gebel, the holdings attempted to reclaim land primarily by sand-dune fixation. The Demographic farms were smaller in size than the Concession holdings, and with a larger area under irrigation the Demographic farms were aimed at self-sufficiency. The cropping pattern conformed with available water supplies, so that the olive became the dominant crop on the non-irrigated Gebel farms. Inter-cropping of varied tree and ground crops was common in the better watered coastal areas. About 90,000 Libyans occupied the 103,000 ha. in 1958, giving a density of occupance similar to the Concession farms.

In contrast to the traditional saniya farms, the ex-Italian settlements are more regular and compact. Modernization is reflected in the lack of fragmentation of holdings and more efficient use of water resources. With the aid of diesel and electric pumps, for example, a single well irrigates twelve times the equivalent area on saniya farms. Specialization in groundnuts and olives,

together with numerous by-products, made the farms commercially orientated, (only 9 per cent of the produce being consumed locally in the sample of ex-Italian farms).[24] Although financial returns on ex-Italian farms are greater than on traditional farms, higher capital investment and paid labour offset excessive profit differentials.

Assuming that the area of ex-Italian farms was similar in 1940 and 1958, a marked re-distribution of rural population appears to have occurred within the higher rainfall zones. Estimates from various sources (Table 8) indicate that about 190,000 Libyans were settled on ex-Italian farms in 1954. This would have constituted a fourfold increase in the density of occupance since the 1930's. The Libyan settlers may have been composed of farmers previously occupying the saniya farms, thereby relieving some pressure of population and continuing a process of hired farm labour on ex-Italian farms.[25] It is also likely that Libyans returning from abroad were encouraged to settle on these settlements.[26] However, crude density comparisons between 1940-54 are not strictly accurate and actual rural population changes may not be so dramatic. Many of the 50,000 Italian farmers in 1940 were concentrated on only a small proportion of the total concession land because the olive plantations took about fifteen years to mature. Evidence from the Ministry of Housing Research Section suggests that nearly 23,000 farmsteads were operational on ex-Italian lands, supporting a Libyan population of about 130,000 in 1967.[27] This redistribution of Tripolitania's rural population, whether from local or foreign sources, has two implications. First, the erosion of the traditional agricultural system appears to have occurred through migration rather than through a change in type of farming practices and organization. Secondly, the local redistribution of population within the higher rainfall zone in part reflects a move towards land with a higher productive capacity. However, the type of land tenure, the state of agricultural technologies, the number of workers and dependents, and other non-physical determinants, have also influenced both the scale and direction of recent rural population redistributions.

8. Cyrenaica's Rural Population Distribution

8.1 Physical Determinants

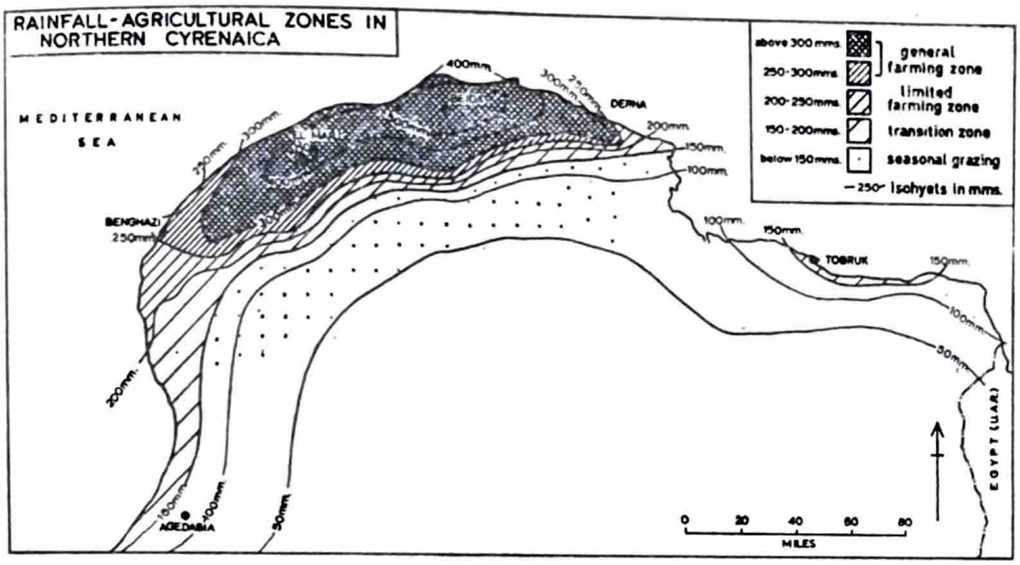
Cyrenaica displays the same three physiographic elements that influence Tripolitania's rural population distribution, though with differences in scale, location and structure. The abutment of the Gebel Akhdar against the northern coast wedges a coastal plain around Benghazi in the west, but only a thin coastal strip in the north and east. From the coast the Gebel rises in two tiers to a crest of 800 metres near Beida. The two scarp faces form a regular accurate boundary to the dissected limestone massif, though an intervening terrace between the two tiers occurs near Marj in the western Gebel.

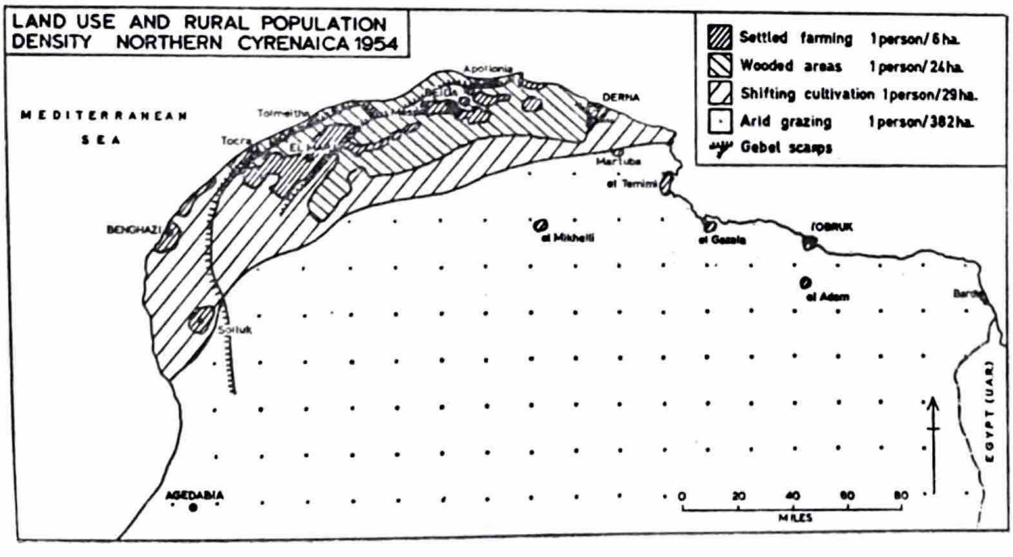
Westerly and north-westerly winds bring comparatively high winter rains to most of the Gebel Akhdar. The area receiving more than 300 mm. annual rainfall is about five times that in Tripolitania, while some of the central Gebel plateaus receive up to 600 mm. Like the relief, however, rainfall drops off on all sides of the Gebel and only a small portion of the coastal plain receives more than 200 mm. Most of the semi-desert and desert zones south of the Gebel receive less than 150 mm. rainfall per annum (Fig. 22).

In contrast to the Tripolitanian tendency for rural population density to increase in a geometric progression with increasing rainfall, Cyrenaica has more regular population densities in each rainfall zone (Fig. 20 and Table 9). Part of the reason lies in the smaller total population and larger area of rainfall zones, and part in the structure of the Gebel. Thus, nearly half of Cyrenaica's rural population lives in rainfall zones receiving more than 300 mm., almost twice the proportion that occurs in Tripolitania. Yet the rainfall zone is almost four times as large, resulting in lower total densities of occupance in each rainfall zone compared with the western province.

The structure of the Gebel indirectly acts as a deterrent to high population densities. The limestone Gebel encourages rapid

Fig. 22


RAINFALL - AGRICULTURAL ZONES IN NORTHERN CYRENAICA
above 300 mms.
250-300 mms.
general farming zone
200-250 mms.
limited farming zone
150-200 mms.
transition zone
below 150 mms.
seasonal grazing
—250— Isohyets in mms.
MEDITERRANEAN SEA
BENGHAZI
DERNA
TOBRUK
AGEDABIA
EGYPT (UAR)
MILES
0 20 40 60 80


LAND USE AND RURAL POPULATION DENSITY NORTHERN CYRENAICA 1954
Settled farming 1 person/6 ha.
Wooded areas 1 person/24 ha.
Shifting cultivation 1 person/29 ha.
Arid grazing 1 person/382 ha.
Gebel scarps
MEDITERRANEAN SEA
Apollonia
Tolmeitha
Tocra
DERNA
Martuba
el Temimi
BENGHAZI
el Mikhelli
el Gazala
TOBRUK
el Adem
Bardia
Soluk
AGEDABIA
EGYPT (UAR)
MILES
0 20 40 60 80

percolation of rainwater, whilst the dissection of the high Gebel limits animal movements across the region. The contradiction of high relief and high rainfall, with few perennial rivers (only five major wadis radiating from the Gebel crest reach the sea) has discouraged concentration of the rural population. From a water divide near the Gebel crest groundwater moves north and northwest towards the Mediterranean and south towards the Ghibla. Faulting and fracturing, which characterizes the karst topography of the Gebel, in part account for spring water along the bases of the scrap and dip slopes. Even so, the total estimated flow of Gebel spring would provide sufficient irrigation supply for only 4000 ha. of land, or partial irrigation for 10,000 ha. However, it is

Table 9 Rainfall Zones and Rural Population Density in Northern Cyrenaica, 1954*

Rainfall Zone	Rural Population 1954		Area		Density
	No. persons	% total pop.	sq. kms.	% total	pers./sq.km.
500 mm. +	17,000	11.3	1,400	1.5	12.1
450 - 500	12,600	8.4	1,000	1.1	12.6
400 - 450	10,000	6.7	1,100	1.2	9.1
350 - 400	14,000	9.3	1,700	1.9	8.2
300 - 350	16,600	11.1	1,700	1.9	9.8
(300 mm.+)	(70,200)	(46.8)	(6,900)	(7.6)	(10.2)
250 - 300	16,600	11.1	1,900	2.1	8.7
200 - 250	12,000	8.0	2,200	2.4	5.5
150 - 200	18,200	12.1	3,800	4.2	4.8
100 - 150	11,200	7.5	6,000	6.6	1.9
100	22,400	14.5	70,200	77.1	0.3
	150,000	100	91,000	100	1.6

* location of region in Figure 8

Sources: (a) Department of Regional Geography, Warsaw. 1954 Population Map of Libya, 1:1 million, Warsaw, (1964).
(b) I.B.R.D. The Economic Development of Libya, John Hopkins Press, Baltimore, (1960), p.104.

doubtful whether half the potential supply could be utilized for agriculture.[28]

Two areas contain the necessary physical conditions for irrigation. On the first escarpment in the western Gebel a wide, flat, saucer-shaped plain surrounds the town of Marj. This area of settled agriculture covers 28,000 ha. on land with a heavy terra rossa soil. Most of the 300-500 mm. annual rainfall is trapped on the plain, some of which percolates to a few perched water-tables first noted by the Italians in the 1930's.[20] While water for urban needs is accessible, lack of efficient recharge can cause overexploitation. Springs also offer potential irrigation water along the foot of the northern scarps, particularly when combined with the alluvial outwash soils on the coastal plain. However, between Tolmeitha and Benghazi and Apollonia and Derna overexploitation and poor recharge of spring water has led to salt water intrusion and brackish water. As such, there are only about 2,000 ha. of irrigated land in Cyrenaica; less than one per cent of the total area of settled agriculture (Table 10).

While perennial wadi flows are distinctly limited in the high Gebel, silting of courses does give rise to irregular flows. Wadis from the first escarpment emerge on to the coastal plain about three times each year depositing alluvium along the scarp foot. However, the combination of watercourse permeability, fast run-off and lack of capital works in the form of wadi dams, have precluded extensive spring line settlement, at least in the Benghazi Plain.

The fact that a quarter of Cyrenaica's rural population lives on land receiving less than 150 mm. rainfall per annum indicates the economic dependency on pastoralism. Much of this land occurring on the southern slopes of the Gebel Akhdar dip-slope wadis provides patches for seasonal grazing and harvesting, though not on the same scale as in Tripolitania. Perennial river flows are non-existent, catchment areas are small, and run-off velocity unfavourable for the growth of a wadi culture. Interior

able 10 Land Use Zones and Rural Population Densities in Northern Cyrenaica, 1954*

Land Use Zones	Area in ha.	1954 Rural Pop. (000's)	Density ha/person
1. Static Farming.	240,000	40	6.0
2. Shifting cultivation	2,140,000	73	29.3
3. Forested areas	480,000	20	24.0
4. Arid grazing	6,500,000	17	382.4
	9,360,000*	150	62.4
Urban population	-	111	-
Rest of province	76,100,000	30	-
Cyrenaica	85,500,000	291	0.3

* Area relates to Figure 9

Sources:- (a) I.B.R.D. The Economic Development of Libya, John Hopkins Press, Baltimore, (1960), p.104.

(b) Ministry of National Economy, Libya. General Population Census 1954, Tripoli, (1959).

(c) Department of Regional Geography, Warsaw. 1954 Population Map of Libya, 1:1 million, Warsaw, (1964).

oases at Jaghbub, Aujila and Kufra are only partly related to patterns of seasonal grazing on the Cyrenaican Ghibla.[30]

8.2 Non-Physical Determinants

While comparisons with Tripolitania's land use and population densities are difficult because of different classifications, it is apparent that Cyrenaica's densities of occupance are lower for each equivalent area (Tables 9 and 10). Settled, or static, farming in northern Cyrenaica is concentrated in the Barce Plain around the towns of Marj and Beida. Western coastal areas around Benghazi, Tolmeitha and Appolonia also support agriculture and settled farming (Fig. 23).

Despite the dissection of the high Gebel and the high annual rainfall, Cyrenaica has been geared to pastoralism with a subsidiary emphasis on shifting cultivation. Traditionally the Bedouin have been pastoralists first and cultivators second. For centuries the nomadic way of life has prevailed over most of the country except for the coastal towns, and it has been argued that pastorialism is well adapted to the physical environment.[31] While the Bedouin society has shown a great capacity for survival, neither its organization nor its values equip it to take advantage of the opportunities for economic advance opened up by the oil wealth.

The Italian colonization of Cyrenaica in the 1930's further offset the geometrical increase of population density in rainfall zones identified in Tripolitania. On the basis of an Anglo-Jewish commission in Cyrenaica in 1908 it was estimated that 300,000 colonists could be settled in addition to the existing indigenous population. [32] By 1940 the Italians had acquired about 120,000 ha. land, although only half was actually developed to support about 50,000 settlers. The bulk of the 2,000 Italian families were situated around Marj and Beida. These areas still remain the major settled parts, though with slightly lower densities of occupance than the Italians had originally planned. In the Mutas-

sarrifia of Marj, for instance, four-fifths of the sedentary agricultural holdings are composed of ex-Italian farms. [33]

The evacuation of the Italian colony in 1942 left an agricultural infrastructure, but also social disruption. Eviction of Bedouin tribes during acquisition of potential colonization land has caused conflicts concerning re-settlement. Attempts have been made by the government to deal with this problem. In 1952 the ex-Italian Demographic and Concession farms reverted to state ownership. More recently the National Agricultural Settlement Authority (NASA), established in 1964, attempted to mitigate the clash between evicted Bedouin groups. However, re-settlement schemes will not radically alter the present pattern of population distribution.

The Italian colonization weakened the tribal structure, but at present there is a reversion to mixed farming of shifting cultivation and pastoralism. By 1960, a third of the farm holdings and one-half of the total agricultural area was under tribal ownership. This land use manifests many of the weaknesses inherent in communual ownership; overgrazing, little grassland improvement, afforestation or soil conservation, resulting in poor yields and low population densities. Thus, large tracts of land in the higher rainfall zones well suited to the cultivation of crops are being downgraded.

Physical determinants still influence Cyrenaica's distribution of population, but density of occupance is not necessarily correlated with water resource location. Two human elements have cut across the tendency for population to concentrate in the higher rainfall zones. Pastoralism, associated with the Bedouin tribes, has thrived in areas outside the dissected and thickly wooded high Gebel plateaus. Inevitably this form of land use has supported population densities lower than the potential of the land. The growth of planned settlement, thought of initially by the Jews, partially implemented by the Italians, and developed by the Libyans, is also cutting across «the grains» imposed by the physical environment. Economic development may also weaken

these physical determinants. For instance, the development of a water pipeline from springs in the eastern Gebel to settled farming areas on the central plateaus will tend to preserve the existing population distribution. The achievements of the Romans serve as an indication of what might still be done in this respect. By an energetic application of capital works — the construction of numerous cisterns, dykes, dams and aquaducts — the Romans were able to establish a thriving agricultural society which supported a population two or three times the size of the present population. [34] Moreover, there is no conclusive evidence that the rainfall in the coastal zone was any heavier in those days than now, nor was the population distribution concentrated in high rainfall zones.

9. Population Distribution in the Fezzan

The Fezzan is the least densely populated of Libya's three provinces, containing an estimated 86,000 persons in 1966 in an area of about one million square kilometres. Extremes of climate have set distinct limits to human habitation; average rainfall over a five year period at Sebha being 68 mm., though many aras receive no rain over several consecutive years. Consequently, irrigation water is the main determinant of agriculture and hence population distribution, for pastoralism is of small importance in the province.

Until recently, agriculture was limited to oases where water tables lay near the surface. Thus, the three parallel wadis of El Shati, Ajal and Hofra developed as the main population concentrations. The extent of population distribution depended on the traditional techniques of irrigation, while density of occupance was influenced by the scale of land fragmentation. New techniques of exploiting deeper artesian water, particularly in Wadi Hofra, have only partly extended the Fezzanese œcumene. On the other hand, difficult drainage, high water-tables, over exploitation and intense evaporation have caused much potentially fertile land in the oases to become saline. The net balance of ex-

tension and contraction of agricultural land probably showed a deficit between 1936-66.

The Fezzan economy has always been predominantly a subsistence one. In past centuries its population used to derive a subsidiary income from the caravan trade, and when this declined in the 19th century foreign garrisons moved in and provided the oases with a new source of income and employment. The withdrawal of the foreign garrisons has been replaced by external aid and oil revenues. The impact of this wealth has not been as marked as in the two northern provinces, but a measure of economic duality is now apparent. The population of Sebha, the provincial capital under the Federal government, rose from about 2,000 in the 1930's to 17,000 in 1966. New employment opportunities in the service sector and the urba neconomy, particularly government administration, have attracted people from other parts of Libya.

The urban growth of Sebha, in part a response to the completion of the Fezzan road to he Tripoli-Benghazi highway, has brought about changes in the socio-economic system of the province. The traditional feudal system is being undermined. An acute shortage of agricultural labour has resulted in large tracts of land going out of cultivation. It has been estimated for instance, that the area under cultivation has been reduced by fifty per cent since 1900.[35] With greater ease of communication to Tripoli and Benghazi, an increasing proportion of food is imported, further retarding agricultural developments.

10. Summary and Conclusion.

Basically, the coastal concentration, provincial proportions and physiographic influences upon the population distribution have remained significant and stable since the Italian colonization of the 1930's. Yet within well defined limits set by the physical environment the fine balance between determining factors and population distribution has been disturbed, though not in equal degrees in the three provinces. Occupation by foreigners and eco-

nomic wealth from oil revenues have strengthened the influences of the non-physical environment. The sum of these forces, or controls, has been to produce two tendencies. One is the inertia of the present population distribution, itself a product of physical and human determinants interacting in a complex temporal framework. The other tendency is the growth of population around urban nuclei. Numerically, the Libyan towns are achieving a dominance and primacy out of proportion to the size of the country's total population. Chapter II elaborates and analyses this urban growth.

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II. — CHAPTER

URBANIZATION AND POPULATION DISTRIBUTION

Libya is now the eighth most urbanized country in the Middle East containing over one-fifth of its total population in cities with over 100,000 inhabitants. Its level of urbanization is similar to the neighbouring countries of Egypt (U.A.R.) and Tunisia (Table 2.1). The pace of Libyan urbanization shows no sign of slackening and the major towns are beginning to dominate most forms of political and economic life. Between 1954 and 1966 the percentage of the population living in settlements of more than 20,000 inhabitants increased from 18 to 25 per cent. Four-fifths of the increase in total urban population occurred in the two major cities of Tripoli and Benghazi. In 1966, both cities accounted for nearly two-thirds of the total urban population, officially defined as agglomerations of more than 2,000 persons. About one-half of the total population lived in settlements containing more than 500 inhabitants. Yet the total number of settlements above this size showed remarkably little increase between 1954 and 1966. Thus, while the overall pace of urbanization has increased rapidly, the process of settlement multiplication has gained little momentum.

Some of the implications of these phenomena have already been hinted at; the urban-rural gradient was identified as the most important element differentiating Libyan regions; the major towns in all three provinces are exerting an increasing dominance

Table 2.1 Level of Urbanization in Selected Middle East Countries, 1960's

Country	Date	Total population in 000's persons	Total population in cities over 100,000 persons	Percent. of pop. in cities over 100,000 persons
Kuwait	1965	467	299	64.0
Iraq	1965	8,261	3,603	43.6
Bahrain	1965	182	79	43.4
Israel	1964	2,476	883	35.6
Lebanon	1963	2,230	615	27.5
Syria	1964	5,200	1,424	27.3
U.A.R.	1962	27,244	7,124	26.1
Libya	1964	1,564	351	22.4
Tunisia	1966	4,785	1,014	21.1
Iran	1966	25,781	5,090	19.7

Sources:- (a) Fullard, H. The Geographical Digest 1968, George Philip and Son Ltd., London, (1968).

(b) United Nations. Demographic Yearbook 1965, New York, (1966).

over all aspects of the population ; and the towns were probably the main lines of penetration of a modern economic sector into a traditional socio-economic system.

It is hypothesized in this chapter that Libya's settlement-size distributions are not determined by the level of economic development or the degree of urbanization; rather, the distribution is determined by the nature of the development processes operating in the country. Thus, the marked duality of socio-economic conditions pertaining in Libya, reflect the nature and type of economic development. The simplicity and strength of the forces which determine this economic development are reflected in the urban structure. The peculiarities of Libya's settlement-size distributions are, marked concentration in two cities, a regular ranking of small towns, and distinct provincial sub-systems of settlements.

In order to explain the grafting of Libya's provincial « primate » cities on to log-normal distributions of smaller settlements two theories of setlement-size distributions must be mentioned — the index of primacy and rank-sizes of Libyan settlements. By identifying Libya's deviations from theoretical and empirical evidence, and noting the settlement spacings and patterns, it is possible to note some of the prime determinants influencing Libya's patterns of urbanization.

2.1 Population Clusters; the Size Continuum

Although it is convenient to regard Libya's population as distributed in a series of discrete and isolated clusters, it must be realized that this settlement concept is artificial. In Cyrenaica, and the Fezzan, settlements are distinct and well-defined, but in Tripolitania dense rural settlement along the coast precludes acurate sub-division of urban units.[1] Despite the arbitrary definition and classification of Libyan settlements, forty of the largest settlements were identified in 1966.[2]

Examination of the available information on Libyan settlement sizes suggests a regularity similar to a linear pattern on a double logarithmic graph (Fig. 2.1). The Libyan pattern in 1966 was similar to that in Britain in 1961, though at a lower absolute level of population and with a more uneven distribution. It is, in fact, the degree of regularity in the relationship between the size and rank of towns (expressed formally as the «rank-size rule»*) which helps to generalize about Libya's population distribution. The distribution of Libyan settlement seems to follow Zipf's theory that rank-size distributions conform more closely to a theoretical S-shape than to a linear log-normal distribution. [3] However, Berry has interpreted these irregularities empirically by studying a selection of 38 city-size distributions. [4] The Libyan pattern appears

* Pn = Pl (n)-1 where Pn is the populaton of ithenth town in the series 1,2,3... n in which all towns in a region are arranged in descending order by population, and Pl is the population of the largest town (1. e. the *primate* town).

similar to the primate settlement-size distributions of Ceylon; log-normally-distributed lesser settlement sizes are followed by a gap because settlements of intermediate size are absent, and then by a rapid cumulation to a dual «primate» peak. Libya, for example, has log-normally-distributed settlements up to a settlement population of 15,000, and then a considerable gap followed by the two cities of Tripoli and Benghazi. On a provincial basis primacy dominates the sttlement-size distributions, particularly in Tripolitania and Cyrenaica, though also, significantly in the Fezzan. In both the northern provinces a gap in towns of 9,000 to 20,000 inhabitants is apparent.

Data for the higher levels of the urban hierarchy are more readily available and attention has been concentrated on the application of the rank-size rule for large cities. Stewart [5] examined the relationship between the primate city (P^1) and the second largest city (P^2) in a cross-section of seventy-two countries. Libyan evidence of the changing proportion between Tripoli and Benghazi supports Stewart's main finding that the larger countries tended to have high primate/secondary settlement ratios, but that internal provincial settlement patterns showed a strong dominance by large urban centres. Changes in the Libyan ratios between 1917 and 1966 indicated that the two largest cities most closely resembled the theoretical rank-size ratio of 2.0 in 1917 (2.1) and 1954 (1.9). Since post-war reconstruction, federation, and Cyrenaican oilfinds, Benghazi has grown to rival Tripoli as a major urban centre (1968, 1.6).

Median town rank-sizes in Libya tend to confirm other empirical evidence that a slightly concave settlement distribution is common below the primate city. Table 2.2 expresses the median sizes of the eight largest settlements in Libya between 1917 and 1966, expressed as a fraction of the largest settlement. Libya appears to have been closest to the theoretical rank-size conditions in 1954, although conditions have remained similar over 50 years, despite population changes in the country.

Libya's rank-size settlement hierarchy is therefore charac-

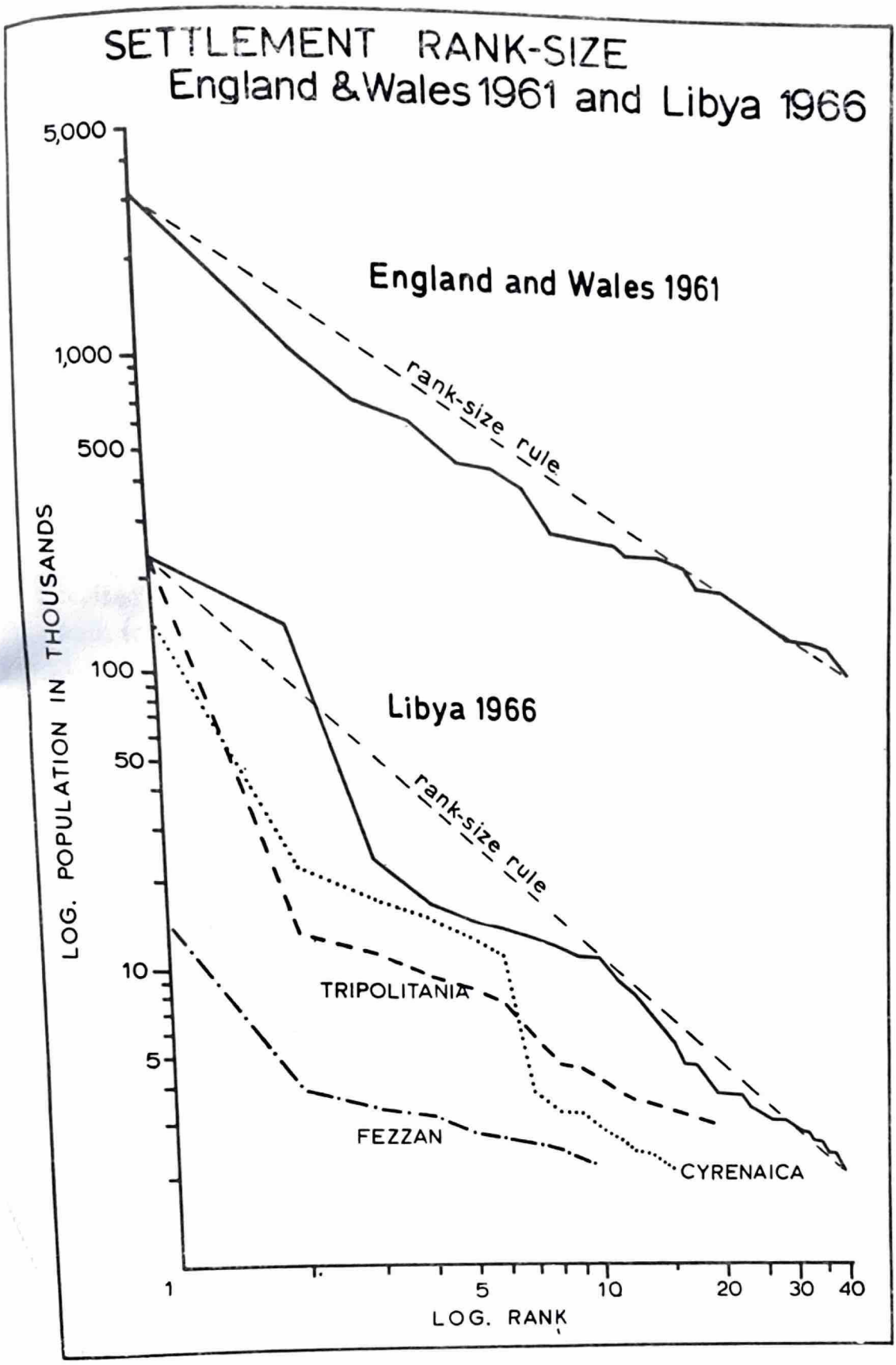

SETTLEMENT RANK-SIZE
England & Wales 1961 and Libya 1966
5,000
1,000
500
100
50
10
5
LOG. POPULATION IN THOUSANDS
England and Wales 1961
rank-size rule
Libya 1966
rank-size rule
TRIPOLITANIA
FEZZAN
CYRENAICA
1
5
10
20
30
40
LOG. RANK

Fig. 2.1

Table 2.2 Median Sizes of Libya's Eight Largest Settlements as a Fraction of Tripoli, 1917 to 1966

Libya	1st	2nd	3rd	4th	5th	6th	7th	8th
1917	1	0.47	0.13	0.09	0.08	0.07	0.06	0.05
1954	1	0.54	0.14	0.12	0.11	0.09	0.08	0.08
1966	1	0.64	0.10	0.08	0.07	0.06	0.06	0.05
72 countries*	1	0.32	0.20	0.14	0.12	-	-	-
Rank-size rule	1	0.50	0.33	0.25	0.20	0.17	0.14	0.13

* Stewart, C. T. "The size and spacing of cities", Geographical Review, Vol. 48, (1958), p. 228.

terized by (a) dual «primacy» (b) a lack of middle ranking towns, and (c) rank-sized small towns (Fig. 2.1). While the growth of two large cities developed between 1954-1964, the pattern has remained essentially the same since 1917. The stability of the Libyan rank-size settlement distributions over space and time suggests that it might be viewed as a steady-state phenomenon. Simon [6] has defined this condition as one of «entropy» in which the distribution is affected by a myriad of small random forces. However, Berry [7] has produced empirical evidence indicating that entropy is associated with log-normal city-size distributions, and not with well developed primacy. Neither theoretical nor empirical evidence would appear to explain Libya's peculiar condition.

Two groups of hypotheses are suggested to explain settlement size-numbr patterns. [8] The first group of hypothese contains ideas which seem logical in the abstract, but are not confirmed by empirical observation. It has been hypothesized that settlement-size distributions are related to the degree of urbanization. Between 1917 and 1966, for example, the proportion of the total Libyan population living in towns over 20,000 persons rose from about 10 to to 25 per cent, yet the settlement-size distribution remained relatively stable. This lack of cross-relation between degree of urba-

nization and settlement-size distribution was also emphasized by Berry's sample survey. [0]

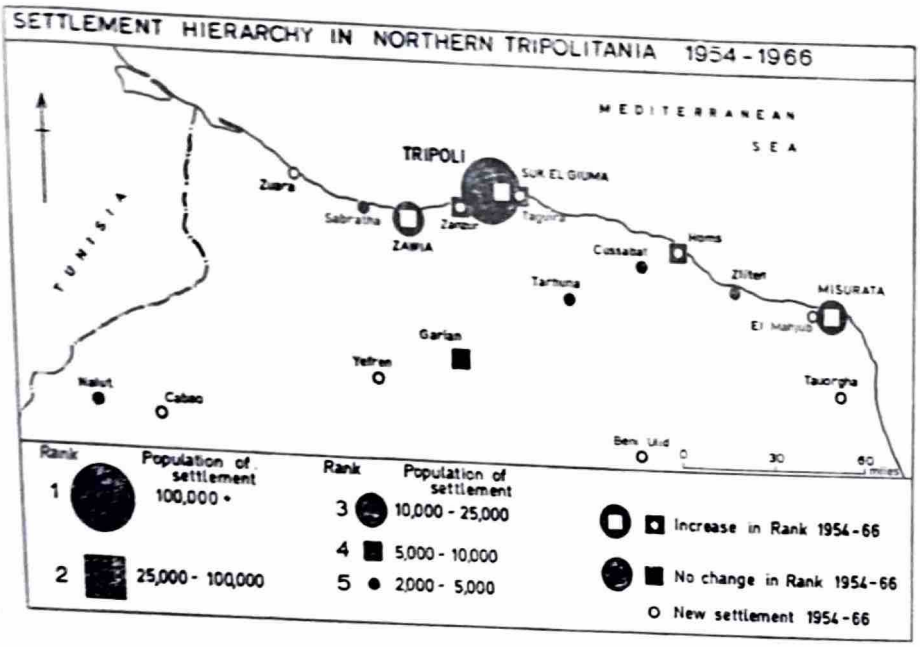
Nor does level of economic development appear highly correlated with size-number forms of settlements on a world-wide basis. Settlement pattern was related to the degree of economic development as measured on a scale derived by Berry from forty-three proposed indices of economic development. The pattern was essentially random, primate and log-normal countries being irregularly arranged with no preferential grouping at any point in the development spectrum.

The second group of hypotheses suggest that primate patterns are the products of city developments in countries which are (a) smaller than average, (b) have a short history of urbanization, and (c) are economically or politically simple. Libya would seem to fulfil these conditions. The settled area supporting about four-fifths of the population is small (about 50,000 sq. km.). Rapid urbanization is essentially a post-independence phenomenon. Finally, the impact of a few strong forces has operated, particularly the superimposition of a commercial export sector on a peasant agricultural system. While the type and degree of this duality has changed between 1917 and 1966, essentially the towns have remaines orientated outside Libya. As such, the grafting of Libyan «primate» cities on top of a lower log-normal distribution of settlements emphasizes the nature, rather than the level, of the country's economic development.

2.2 Size and Spacing of Settlements

If the rank-size rule, uncomplicated by the primacy of the largest cities, were to operate, then the spacing of settlements should be largely governed by their size. Large settlements would be widely spaced, smaller settlements more closely spaced. Different levels of regional urban dominance, together with a complex of physical and human influences, have determined contrasting patterns of settlement size and spacing throughout Libya.

Fig. 2.2


SETTLEMENT HIERARCHY IN NORTHERN TRIPOLITANIA 1954 - 1966
MEDITERRANEAN SEA
TUNISIA
TRIPOLI
SUK EL GUMA
Zuara
Sabratha
ZAWIA
Zanzur
Tagiura
Homs
Cussabat
Zliten
MISURATA
Tarhuna
El Hanjus
Garian
Yefren
Nalut
Cabao
Tauorgha
Beni Ulid
0
30
60
miles
Rank
Population of settlement
1
100,000 +
2
25,000 - 100,000
Rank
Population of settlement
3
10,000 - 25,000
4
5,000 - 10,000
5
2,000 - 5,000
Increase in Rank 1954-66
No change in Rank 1954-66
New settlement 1954-66

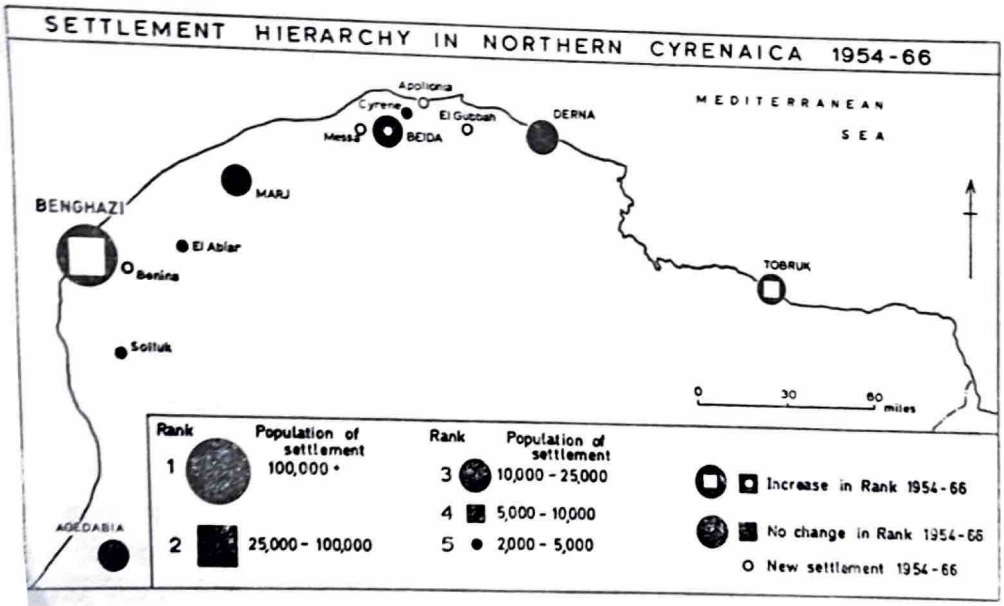

SETTLEMENT HIERARCHY IN NORTHERN CYRENAICA 1954-66
Apollonia
Cyrene
El Gubbah
DERNA
Messa
BEIDA
MEDITERRANEAN SEA
BENGHAZI
MARJ
El Abiar
Benina
TOBRUK
Solluk
AGEDABIA
0
30
60
miles
Rank
Population of settlement
1
100,000 +
2
25,000 - 100,000
Rank
Population of settlement
3
10,000 - 25,000
4
5,000 - 10,000
5
2,000 - 5,000
Increase in Rank 1954-66
No change in Rank 1954-66
New settlement 1954-66

Fig. 2.3

The distribution of urban centres in Tripolitania is similar to the distribution of rural population (Fig. 2.2). Tripoli City dominates the central coast and is flanked by medium sized towns. While the greatest amount of urban growth has taken place in and around Tripoli, the six new settlements since 1954 have evolved independently of the established pattern. Cyrenaica, in contrast, has a more regular pattern, the larger towns being evenly spaced along the coast and Gebel Akhdar (Fig. 2.3). There is also less gradation in settlement sizes than Tripolitania. New settlements since 1954 tended to cluster around Beida, the new capital, and Benghazi, situated off-centre in relation to other settlements.

Nearest neighbour analysis of similar sized settlements tended to conform to a log-normal distribution in both northern Tripolitania and Cyrenaica (Fig. 2.4). Tripolitania's rank 5 settlements (2,000 to 5,000 inhabitants) are slightly more widely spaced than those in Cyrenaica, while rank 3 settlements (10,000 to 25,000 inhabitants) are more clustered. Cyrenaica has no settlements containing populations between 5,000 and 10,000 (Table 2.3). In Tripolitania, settlements of all ranks are slightly nearer their neighbours in the densely populated coastal area compared with the inland Gebel (12 miles and 20 miles respectively). In contrast. Cyrenaican coastal towns have an average nearest neighbour of 48 miles, while the Gebel settlements are located only 16 miles apart. In both provinces the densest agricultural areas have settlements more closely spaced than areas with extensive shifting cultivation. While Libyan evidence is too scanty to weigh for or against theoretical models of settlement spacing, other empirical evidence suggests that Libya's pattern may not be atypical.

Losch's evidence for Iowa [10] and Brush and Bracey's data for Wisconsin and Southern England [11] both confirm the tendency of increasing distance between larger settlements. Plotting the same data, Libyan information indicates that lowest-order Libyan settlements are spaced similar to the high-order Wisconsin and southern England towns, both being similar sized settlements. While this information relates to widely differing areas with varied

Table 2.3 Settlement Spacing by Three Size Groupings, Libya 1966

Rank	Settlement Size	Distance between settlements of similar size		
		Tripolitania	Cyrenaica	Northern Libya
5	2,000 - 5,000	29 miles	15 miles	24 miles
4	5,000 -10,000	35 miles	-	35 miles
3	10,000 -25,000	57 miles	72 miles	66 miles

Source: Figures 2.2 and 2.3

population densities, certain tentative conclusions can be drawn. Firstly, settlements in both northern Tripolitania and Cyrenaica are generally more dispersed per size group than examples in Britain and America. This is probably determined in part by the physical environment. On the one hand, the agriculturally favoured areas on the Tripolitania coast both encourage and enable large concentrations of population to be supported. In contrast, localization of water and soil resources outside the agricultural zones determine the situation of the settlement. The physical conditions discussed in Chapter I, explain why Cyrenaican settlements are on average 23 miles from their nearest neighbour, compared with only 15 miles in Tripolitania.

Secondly, as Brush and Bracey noted in southern England and Wisconsin the settlement pattern shows a tendency to perpetuate itself; the pattern was well established 150 years ago when the basic distance factor was the time and effort required to get to any trade centre by foot or on cart. Agostini [12] suggested that the settlement pattern in Libya was established at least 50 years ago, while Roman remains indicate that the basic structure may have operated 1,800 years ago. [13]

Thirdly, the location of the primary cities in each province appears to have influenced surrounding settlements. Figure 2.5 shows the size and spacing of settlements containing between 2,000 and 25,000 inhabitants around Tripoli and Benghazi in 1954

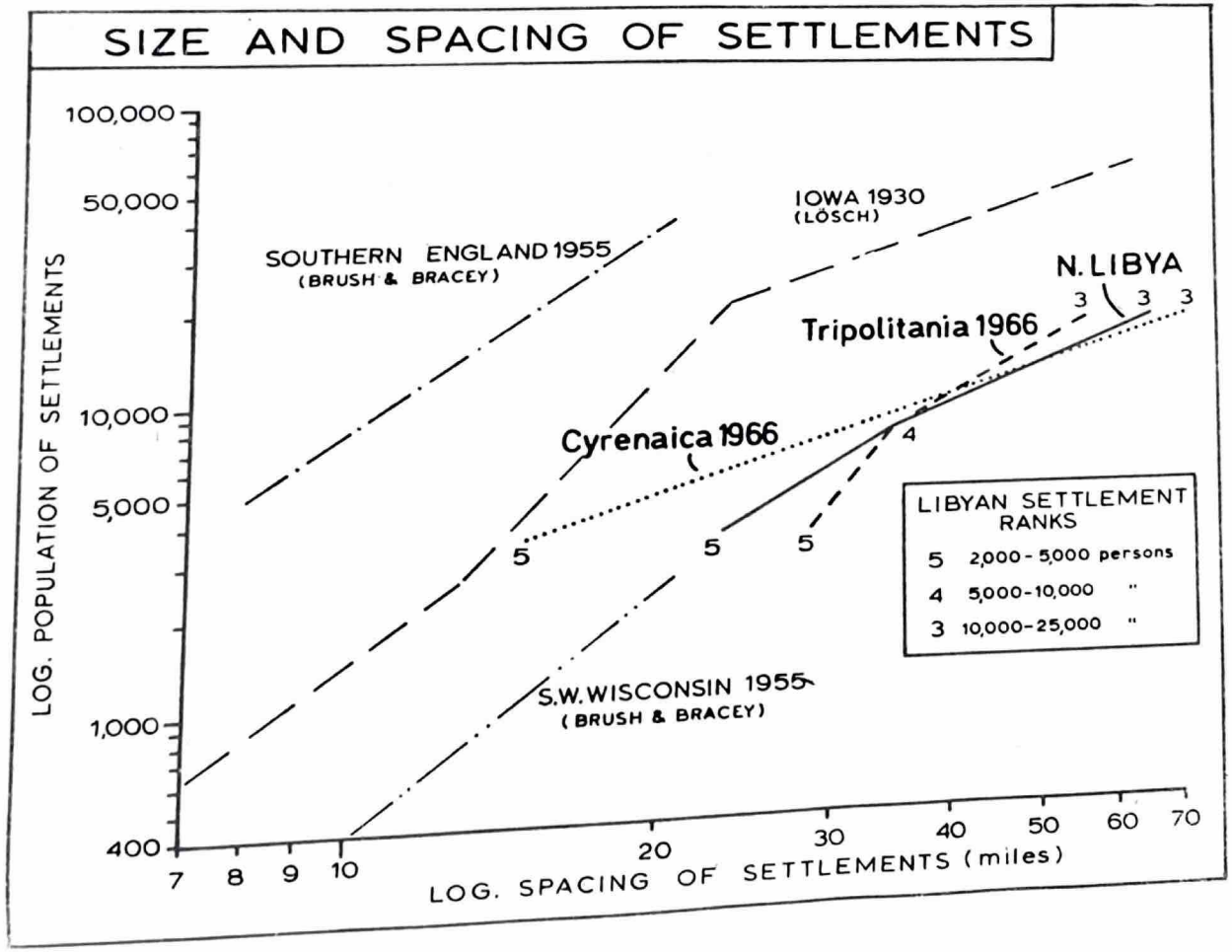

SIZE AND SPACING OF SETTLEMENTS
LOG. POPULATION OF SETTLEMENTS
100,000
50,000
10,000
5,000
1,000
400
7
8
9
10
20
30
40
50
60
70
LOG. SPACING OF SETTLEMENTS (miles)
SOUTHERN ENGLAND 1955
(BRUSH & BRACEY)
IOWA 1930
(LÖSCH)
N. LIBYA
Tripolitania 1966
Cyrenaica 1966
S.W. WISCONSIN 1955
(BRUSH & BRACEY)
LIBYAN SETTLEMENT RANKS
5 2,000 - 5,000 persons
4 5,000-10,000 "
3 10,000-25,000 "

Fig. 2.4

and 1966. The rank 5 settlements (2,000 to 5,000 inhabitants) show a gradation between 40 to 150 miles from Tripoli, while those in Cyrenaica have two distinct groupings, one near Benghazi, the other near Beida. It is the higher order settlements which account for the higher urban densities near Tripoli; four rank 3 and 4 settlements are located within 50 miles of Tripoli, contrasting with none near Benghazi. Instead, Cyrenaica has two large settlements (10,00-25,000 inhabitants) more than 150 miles from Benghazi. The resultant graphs of total urban populations in the two provinces indicate (a) the greater concentration of urban population nearer Tripoli, (b) the higher proportion Tripoli City has of its total provincial population, and (c) the decrease in primate concentration around Tripoli and the increase around Benghazi between 1954 and 1964. This may indicate a levelling-off of the influence of primacy in Tripolitania and the more youthful stage of urban development in Cyrenaica.

2.3 Determinants of Settlement Size and Spacing.

Stewart [14] maintains that the more urban the functions, the closer are the spacings of setlements, but that the size of the settlement is incidental to its function. Libyan evidence indicated the opposite.

The economic activities most closely related to urban areas were transport, commerce, construction and manufacturing. The proportion of economically active males in these four activities were calculated for a sample of sixteen Libyan towns of different sizes (Table 2.4). Spacing between settlements was calculated on the basis of number of settlements within a radius of twenty miles of each town. Correlation between urban functions and settlement spacing indicated an association of +0.325 for the sample of sixteen towns. It would seem, therefore, that degree of urban functions (by this definition at least did not necessarily indicate greater settlement cluster.

Also contrasting with Stewart's findings was the positive association between settlement size and function. A correlation co-

efficient between the size of settlements and the proportion of economically active males in urban functions (Table 2.4) revealed a positive association (+0.671). Although the two elements did not necessarily have a causal relationship, the larger the size of Libyan settlements, the more likelihood there was that urban functions would dominate the economic structure. Conversely, settlements with significant agricultural functions showed a high negative correlation with settlement size (-0.874).

Two processes may have operated. Firstly, there would appear to have been a transfer of processing and manufacturing activities from household and village handicrafts to the larger settlements. Secondly, the introduction of new economic activities associated with the recent economic expansion diversified the urban functions of large settlements.

Table 2.4 indicates certain distinct changes in economic activities associated with size of settlement. Measured as more than ten per cent of the economically active male citizens, agriculture ceased to be a « significant » activity in settlements with more than 20,000 inhabitants. Manufacturing, commerce and transport activities were predominantly large town functions, although towns over 10,000 inhabitants had similar functions, though at a lower level of significance. Mining activities had no association with size of settlement, while construction functions were of small proportions only in settlements with under 5,000 inhabitants. Services remained the dominant activities in all settlements, except those with 5,000 to 10,000 inhabitants.

The location of the settlements (Figs. 2.2 and 2.3) appeared to be as important as size in determining the nature and importance of different economic activities. Suk el Giuma had a variety of functions, despite its rural orientation; a structure similar to that of Tripoli. All middle-sized Tripolitanian towns had distinct rural service sectors with a large number of agricultural workers. This may be attributed to the poor definition of the urban areas, and also to their location in intensively cultivated and settled agricultural areas. In contrast, Cyrenaican towns were more specialized.

Table 2.4 Economic Activities in Libyan Settlements, 1964

(Percentage of economically active male citizens aged 6 years and over by economic activities)

	Economic Activity	Settlement Sizes (number of inhabitants) A over 25,000	B 20,000 to 25,000	C 10,000 to 20,000	D 5,000 to 10,000	E 2,000 to 5,000
0	Agriculture	3.2	5.3	13.4	44.7	34.8
1	Mining	4.8	1.3	3.1	1.7	2.6
2-3	Manufacturing	11.3	6.4	7.4	3.3	1.5
4	Construction	10.6	12.7	11.6	9.3	3.7
5	Electricity, water and gas	3.4	4.0	2.4	1.2	1.8
6	Commerce	12.3	11.0	8.4	5.2	4.7
7	Transport	12.1	10.8	7.3	5.0	4.8
8	Services	34.0	41.5	32.4	17.7	34.6
9	Others	8.2	7.2	12.9	13.0	10.0
	Urban Functions (2, 3, 4, 6, 7)	49.7	44.9	37.1	24.0	16.5

Settlements: A - Tripoli, Benghazi; B - Derna; C - Agedabia, Beida, Sebha, Marj, Misurata, Suk el Giuma, Tobruk, Zawia; D - Homs, Nalut, Cussabat; E - Benina, Cyrene.

Source: Ministry of Economy and Trade, Libya. General Population Census 1964, Tripoli, (1966)

Tobruk, as an isolated settlement, had a small agricultural sector, but a variety of urban functions. Beida, the new capital, showed a large proportion of the economically active males in construction, while Agedaiba, one of the main oilfield settlements, had a significant number of persons engaged in mining activities. However, it was the number of « significant » functions which tended to characterize the larger settlements. The largest settlements had more than five functions containing more than ten per cent of the economically active male citizens (not including « other » economic activities), while small settlements had only two. Specialization appeared to be a middle-size settlement characteristic.

2.4 Conclusion

In general terms, Libya's « primate » urban structure appears to conform to other empirical evidence. Urban structure does not appear to be a function of the level of economic development, industrialization or urbanization. To some extent, Libya's urban structure was similar to other countries which are smaller than average (in terms of oecumene), have a short history of urbanization, and are economically or politically simple.[15] Thus, the « primate » structure grafted onto a lognormal distribution of smaller settlements is indicative of Libya's type of urban growth.

The spacing of Libyan settlements also tends to form a pattern that is empirically valid, though at a different level to other countries (Fig. 2.4). Evidence of the spacing of 200 American towns emphasizes some of the possible reasons for settlement density in Libya.[16] Thus, towns of a given size are likely to be more widely spaced where (a) rural population density is low, (b) farming is extensive, (c) agricultural production is low, (d) where the overall population density is low, and (e) where the town itself has a low proportion of workers in manufacturing. The wider spacing of Cyrenaican settlements vis-à-vis Tripolitanian settlements, is certainly partly attributed to the nature of the region's agriculture.

However, two elements are particularly relevant to Libya's settlement spacing and nature of agriculture. Firstly, regression

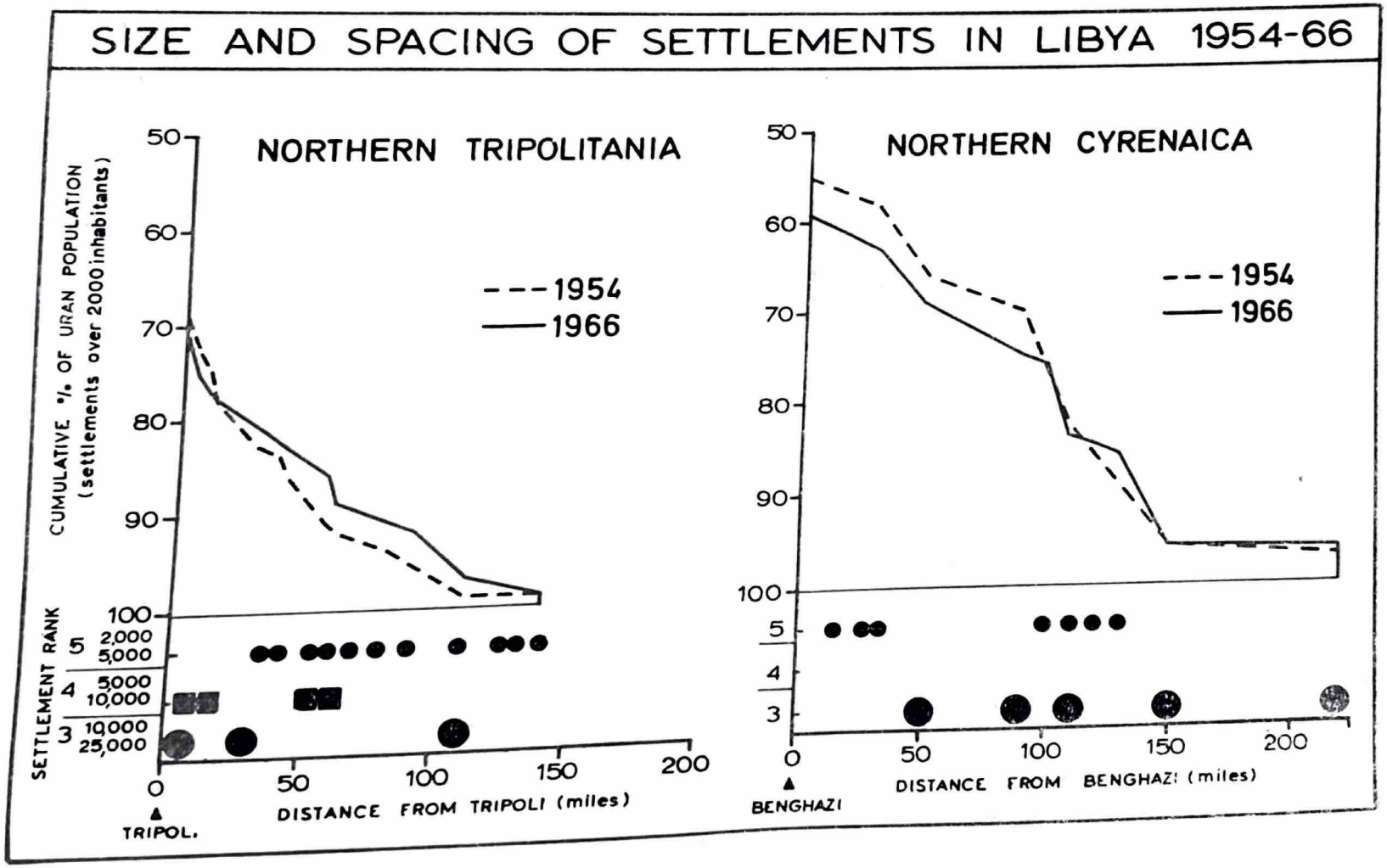

SIZE AND SPACING OF SETTLEMENTS IN LIBYA 1954-66
NORTHERN TRIPOLITANIA
NORTHERN CYRENAICA
CUMULATIVE % OF URAN POPULATION
(settlements over 2000 inhabitants)
1954
1966
SETTLEMENT RANK
5 2,000 5,000
4 5,000 10,000
3 10,000 25,000
50
60
70
80
90
100
0
50
100
150
200
TRIPOL.
DISTANCE FROM TRIPOLI (miles)
BENGHAZI
DISTANCE FROM BENGHAZI (miles)

Fig. 2.5

analysis of the American sample towns[17] showed that while all five features were slightly more valuable than town size in predicting spacing, only one, overall population density, could explain more than 10 per cent of variation. Indeed, all six hypotheses working together could only explain one-quarter of the variation in spacing. The question of settlement spacing is therefore complex in its causal roots.

Secondly, in general, the Libyan example is particularly difficult to analyse because of the contact between modern and traditional economies. In 1965, for instance, £L 15 million of food was imported, mainly through Tripoli and Benghazi. In contrast, only £L 25 million of food was produced in the country itself. Consequently, the equilibrium of functional dependency between towns and villages has become disturbed. In effect, the largest urban centres have become source areas for agricultural produce thereby usurping the functions of the small settlements.

The relationship between size and economic function of Libyan settlements appeared to differ from empirical evidence produced by Stewart.[18] The range of urban functions, whether specialized, dual or varied, was more closely associated with the location, than with the particular size, of settlements. However, the fact that specialization and dual economic functions predominated in Cyrenaican and Tripolitanian middle-sized towns respectively, indicated the particular stage of urban growth which Libyan regions are experiencing. Stewart[19] maintained that «in pre-industrial subsistence economies villages are orientated to the countryside and the agricultural population; the towns face one another only». In contrast, increasing contact between urban and rural areas appeared to be taking place in Libya. Thus, in Tripolitanian towns at least, the process of erosion of the traditional Libyan economy was reflected in the dual economic functions of their urban structures.

Two contrasting processes appear to influence Libya's urban structure. First, the pattern, and possibly the hierarchy, of settlements is being preserved. Historical inertia and water supply have dictated the coastal and Gebel concentration in both Tripolitania

and Cyrenaica, although local determinants have influenced particular distributions. For instance, an old but recently revived water pipeline from Ain Marra, near Derna, to Beida and Marj, in the Gebel Akhdar, will maintain the settlement structure of western Gebel despite lack of adequate ground water. On a national scale, it would seem that some limit must exist to the number of settlements and towns that a population of one and a half million inhabitants can support. Notably, few new settlements have been created between 1954 and 1966, and this would seem to suggest that Libya has reached an optimum. Continued government expenditure on schools, hospitals and houses on the basis of the present distribution of population will tend to preserve the existing settlement pattern.

While the pattern of settlement spacing has remained relatively stable, the sizes of settlements have been more susceptible to change. Governmental expenditure has itself disturbed the pattern delimeted by physical and historical factors. A fourth regional capital, Beida, has been established in a hitherto lightly urbanized area. Sebha, the Fezzan urban centre, has grown rapidly since the construction of the 700 mile Fezzan Road. The extension of the transport network will inevitably influence patterns of supply and demand, while the nature of Libya's economic growth will influence the economic functions of the urban centres.

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