Durham University

Durham E-Theses

A geographical study of the jebel tarhuna, Tripolitania

J. A. N. Brehony

How to cite:

Brehony, J. A. N. (1961) A geographical study of the jebel tarhuna, Tripolitania. Doctoral thesis, Durham University.

Use policy

The full-text may be used and/or reproduced, and given to third parties in any format or medium, without prior permission or charge, for personal research or study, educational, or not-for-profit purposes provided that:

- a full bibliographic reference is made to the original source
- a https://etheses.durham.ac.uk/id/eprint/8292/ is made to the metadata record in Durham E-Theses
- the full-text is not changed in any way

The full-text must not be sold in any format or medium without the formal permission of the copyright holders.

Please consult the full Durham E-Theses policy for further details.

Academic Support Office, The Palatine Centre, Durham University, Stockton Road, Durham, DH1 3LE
e-mail: e-theses.admin@durham.ac.uk Tel: +44 0191 334 6107
https://etheses.durham.ac.uk

A GEOGRAPHICAL STUDY OF THE JEBEL TARHUNA, TRIPOLITANIA.

J.A.N. BREHONY, B.A.

Ph. D. Thesis

Part 1. Text.
Part 2. Appendices and References.

The copyright of this thesis rests with the author. No quotation from it should be published without his prior written consent and information derived from it should be acknowledged.

DURHAM JUNE, 1961

PREFACE.

After graduating from Durham in June 1958, I was offered a grant to conduct geographical research in Libya. Libya was chosen because it was one of the least known countries in the Middle East or North Africa, because it was a relatively young and underdeveloped state and because it was politically fairly stable. In the six weeks between graduating and leaving for Libya, I chose to study the eastern part of the low plateau Jebel of northern Tripolitania. This region was called the Jebel Tarhuna by the Italians, and I chose to study it because it was little known and contained examples of semi-nomadic pastoralism, traditional Libyan agriculture and modern Italian cultivation, all within a small area. However, after reading the available literature in Libya and after visiting the region, I realised that the Jebel Tarhuna was only the western half of the area I intended to study, and that the local population referred to the eastern half as the Jebel Msellata. Therefore, I have adopted the name 'Eastern Jebel' to refer to the Italian Jebel Tarhuna. In the text, the name Jebel Tarhuna refers only to the area inhabited by the Tarhuna tribesmen.

In Libya, there were many difficulties to overcome. The amount of literature available was limited, and much of the Italian work had been lost during the Second World War or was in the hands of private Italian citizens. The

language barrier was a hindrance to a full appraisal of local conditions and made it difficult to establish contacts. This was partially overcome by an intensive study of 'Teach Yourself Italian' and by the fact that some of the younger members of the local population could speak some 'pidgin English'. Transport was another difficulty, and it was found that even a Landrover could not negotiate the trackless and broken northern areas of the Eastern Jebel.

I made two visits to Libya. During the first visit, which lasted from September 1st, 1958 to May 10th, 1959, I spent some time travelling in Libya and Tunisia, reading the available literature and making contacts with overseas experts working in Tripoli and with the tribesmen and Italian farmers living in the Eastern Jebel. The second visit took place in April and May, 1960, during which time I distributed some questionnaires and made some detailed field studies. The questionnaires were only a partial success, because very few tribesmen can read or write, but were of value in illustrating the main trends in agriculture.

There are many people both in Libya and Durham whom I wish to thank for helping me in my work. It is impossible to mention them all by name, but I am especially indebted to the following:

Brigadier Laing, army commander of the Tripoli District, for

affording me a Landrover and use of army petrol points.
Colonel Vaux and the officers and men of the 6th Royal Tank Regiment (now 3rd R.T.R.) for allowing me to stay with them and for being so hospitable to a civilian 'on a swan'.
Mr. E. M. Sicily, Director of Agriculture; Sadiq Sigiear, Assistant Director; Khiari Sgiar, Statistics Officer; and Said Sherriff, Extension Officer of the Nazarate of Agriculture, Sidi Mesri.
Abdusalamm Ayiisa and Mohammed Mgierbe of the Nazarate of Agriculture, Homs and Tarhuna Districts.
Sig. Vecchio of Ente per Colonizzazione della Libia at Al Khadra.
D. Davis, Range Management, L. Stewart, Water Conservation, and R. Vorrhis, Groundwater, officers of U.S.O.M., Tripoli.
Dr. Maggazzini of the Tripolitanian Meteorological Service.
Sig. Mazocchi, Horticulture, and Mr. Easton, Head, of F.A.O. Libya.
Mr. H. E. Causton, Head of Mission, Mr. H. Thomas and Mr. Corroy of the United Nations Mission to Libya.
Mr. Jerrom, Mr. Hopwood, Mr. Andrews and Mrs. Stephens of the British Council at Tripoli.
The librarians Ismail Sweiah of the Government Library; Beshir Giawab of the Agricultural Library, Sidi Mesri; Dr. T. Provasi of the Natural History Museum and Sig. Budri of

the Antiquities Library.

I am deeply indebted to many members of the local administration in the Eastern Jebel and especially to Mohammed Khalifa, Mayor of Cussabat, and Mohammed Ali Regiew of Beni Let, Cussabat. I wish to thank the many Libyans and Italians in Tarhuna and Cussabat for their generous hospitality and help in my work.

In Durham. I owe special thanks to my supervisor. Dr. did Roy Hill, who pioneered Libya for the Geography Department. Finally, I want to record my appreciation to Miss Jennifer Cox for reading and typing much of the text.

ERRATUM. Figures 2 and 4 have been reversed - figure 4 should follow figure 2. Figure 3 is enclosed in a folio at the back of Volume One.

ERRATUM. Pages 476 and 477 have been reversed - page 476 should follow page 477.

LIST OF CONTENTS.

Preface..... i
List of maps and diagrams..... v
List of tables..... viii
List of plates..... xii
List of appendices..... xiii
Chapter I. Introduction..... 1

Part One.

Section One. Geology and Morphology..... 12

Chapter II. Geology and structure..... 13
Chapter III. Morphology and evolution..... 44

Section Two. Physical Resources..... 66

Chapter IV. Climate, agriculture and pastoralism..... 67
Chapter V. Water resources and their uses..... 115
Chapter VI. Soil..... 150
Chapter VII. Vegetation and pasture..... 180

Section Three. Population and Settlement..... 202

Chapter VIII. Ethnic and social structure..... 203
Chapter IX. Population and emigration..... 231
Chapter X. Patterns of settlement..... 276

Section Four. Agriculture and Pastoralism..... 316

Chapter XI. Land use and land ownership..... 317
Chapter XII. Olive cultivation..... 351
Chapter XIII. Pastoralism..... 405
Chapter XIV. Barley and wheat - the supplementary crops 454
Chapter XV. Other crops..... 484
Conclusion..... 505
Chapter XVI. Conclusions and future development..... 506

Plates.....after 315

Part Two..... 517

Appendices..... 518
References..... 572

List of maps and diagrams.

Figure 1: Major administrative boundaries of the Eastern Jebel.

Figure 2: Location of settlements.

Figure 3: Tarhuna tribes: distribution and boundaries.

Figure 4: Cussabat and El Amamra tribes: distribution and boundaries.

Figure 5: Geology of Tarhuna and western Cussabat.

Figure 6: Geological sections across the Eastern Jebel.

Figure 7: Geology of the Jefara and Jebel.

Figure 8: Geolological section across the Jefara.

Figure 9: Relief of the Eastern Jebel.

Figure 10: Selected profiles across the Eastern Jebel.

Figure 11: Generalised contours of the Eastern Jebel and Jefara.

Figure 12: Wadi profiles.

Figure 13: Morphological regions.

Figure 14: a. Climatic regions.
b. Crop expectations of olives.

Figure 15: Rainfall in northern Tripolitania.

Figure 16: Rainfall in the Eastern Jebel.
a. Average.
b. 1946/7.
c. 1937/8.

Figure 17: a. Tripoli - total rainfall for agricultural years.
b. Frequency of rainfall.
c. Tarhuna - total rainfall for agricultural years.

Figure 18: Three year running means at Tarhuna.

Figure 19: Gaussen's formula.
a. Tarhuna.
b. Cussabat.

Figure 20: Potential evapo-transpiration at Hal Far and rainfall at Cussabat.

Figure 21: Distribution of wells and springs.

Figure 22: Distribution of cisterns.

Figure 23: Run-off and catchment areas in central Tarhuna.

Figure 24: a. Tarhuna: Arab cabile.
b. Tarhuna: Marabatin cabile.

Figure 25: Distribution of population, 1917.
a. Tarhuna.
b. Cussabat.

Figure 26: Age structure.
a. Tripolitania.
b. Tripoli City.
c. Beni Ulid.
d. Tarhuna.

Figure 27: Correlation of Net Reproduction Rates and Fertility Ratios for selected countries.

Figure 28: Cussabat: situation of the villages.

Figure 29: Cussabat: size of the villages.

Figure 30: The Cussabat house.

Figure 31: Land use and olive cultivation in Cussabat.

Figure 32: Distribution of farms in the Lahmat Aulad Brahim, Cabila Crarta, Cussabat.

Figure 33: Land use on concession farms.

Figure 34: Distribution of farms on Al Khadra.

Figure 35: a. Total number of olive trees in Tripolitania.
b. Italian and Libyan olive trees in Tripolitania.

Figure 36: Cussabat: olive/man ratios, 1910.

Figure 37: Production of olives, olive oil and sansa oil in Tripolitania.

Figure 38: Cussabat: distribution of olive presses.

Figure 39: Land use in Tarhuna.

Figure 40: Total number of sheep and goats in Tripolitania.

Figure 41: Monthly barley sales in the Eastern Jebel, 1958/9.

LIST OF TABLES.

Table I -	1.	Libya's balance of payments 1951-9 (£L000).
Table II -	1.	Table of formations.
Table II -	2.	Wealden and Cenomanian strata at Cussabat.
Table II -	3.	Geolological history of northern Tripolitania and southern Tunisia.
Table IV -	1.	Average frequency of wind readings at Tarhuna and Cussabat towns, 1925-35.
Table IV -	2.	Frequency of Ghibli winds, 1928-38.
Table IV -	3.	Monthly mean, maximum, extreme maximum, minimum and extreme minimum temperatures at Tarhuna and Cussabat.
Table IV -	4.	Monthly ranges inttemperature in degrees Fahrenheit.
Table IV -	5.	Monthly relative humidity.
Table IV -	6.	Rainfall averages (agricultural years) for selected stations.
Table IV -	7.	Rainfall distribution by month.
Table IV -	8.	Rainy days and rainfall intensity in the Jebel.
Table IV -	9.	Highest and lowest amounts of rainfall in agricultural years at stations in the Eastern Jebel.
Table IV -	10.	Monthly mean, maximum and minimum rainfall.
Table IV -	11.	Standard deviations and coefficients of deviation.
Table IV -	12.	Daily rainfall totals at Cussabat, 1925-1940.
Table IV -	13.	Highest daily totals of rainfall records at Cussabat, 1925-1940.
Table IV -	14.	Duration of dry and wet periods at Cussabat, 1925-1940.
Table IV -	15.	Monthly indices of aridity in the Eastern Jebel.
Table IV -	16.	Winter indices of aridity for selected Tripolitanian stations.
Table IV -	17.	Rainfall and crop yields in Tripolitania.
Table IV -	18.	Potential evapo-transpiration at Hal Far (Malta) and rainfall at Cussabat (in millimetres).
Table V -	1.	Infiltration rates in the Ard Hamra.
Table V -	2.	Variation of the water level at Well 5, Biar Fagghin, August 1st, 1957-August 1st, 1958.
Table V -	3.	Quality classification of underground water.
Table V -	4.	Quality of water from selected wells.
Table V -	5.	Water utilisation.
Table VI -	1.	Composition of sand at Gasr Tenzina.
Table VI -	2.	Physical composition of the Ard Hamra and Ard Hammari in percentages.

Table	VI	- 3.	Content of calcareous and siliceous materials in the Ard Hamra and Ard Hammari in percentages.
Table	VI	- 4.	Physical composition of the Ard Ten soils.
Table	VI	- 5.	Content of calcareous and siliceous materials in the Ard Ten.
Table	VI	- 6.	Percentage of nitrogen, potassium and phosphorus in the Intermediate soil type.
Table	VII	- 1.	Afforestation in the Eastern Jebel.
Table	VIII	- 1.	Distribution of population by ethnic groups in 1917.
Table	VIII	- 2.	Percentage of population in the main ethnic groups, 1904.
Table	IX	- 1.	Distribution of the population by mudiriat, Eastern Jebel, 1904.
Table	IX	- 2.	Population changes 1917-1954 in the Eastern Jebel.
Table	IX	- 3.	Land expropriated by the Italians.
Table	IX	- 4.	Density changes in the Eastern Jebel, 1917-1954.
Table	IX	- 5.	Density changes 1917-60 in eleven cabile, Cussabat.
Table	IX	- 6.	Density cha nges 1917-60 in ten selected cabile, Tarhuna.
Table	IX	- 7.	Sex structure in the Eastern Jebel, Tripolitania and selected Arab countries.
Table	IX	- 8.	Sex structure in ten selected cabile, Tarhuna, 1960.
Table	IX	- 9.	Age structure by sex in Tarhuna.
Table	IX	- 10.	Numbers of families and size of families in the Eastern Jebel.
Table	IX	- 11.	Household size in Tarhuna, 1954.
Table	IX	- 12.	Literacy by age and sex in Tarhuna, 1954.
Table	IX	- 13.	Libyans in Tunisia.
Table	X	- 1.	Households by type of dwelling, 1954.
Table	X	- 2.	Industrially active population resident in the urban areas, 1956.
Table	XI	- 1.	Land use in Tripolitania.
Table	XI	- 2.	Land use on Al Khadra.
Table	XI	- 3.	Olives on different types of land in Msellata (except Aulad el Aalem).
Table	XI	- 4.	Size of parcels in Beni Let.
Table	XI	- 5.	Size of land holdings in Beni Let, Cussabat.
Table	XI	- 6.	Tax on tree crops. Value/tree in millimes.

Table XII	1.	Distribution of olive trees by province, 1935 and 1956, in percentages.
Table XII	2.	Distribution of olive trees in the Eastern Jebel.
Table XII	3.	Distribution of olive trees in Cussabat, 1910.
Table XII	4.	Distribution of olives in the Italian zone.
Table XII	5.	Number of trees in ten selected cabile, Tarhuna, 1960.
Table XII	6.	Olive/man ratios in five Cussabat cabile, 1960.
Table XII	7.	Olive/man ratios in Beni Mislem.
Table XII	8.	Olives and people in Beni Let.
Table XII	9.	Tree/man ratio in ten selected cabile, Tarhuna, 1960.
Table XII	10.	Yields of dryland and irrigated olives on I.N.P.S. farms in the Jefara, 1956-7 (wet year). Kgs. per tree.
Table XII	11.	Olives and other plants on concession farms in Tarhuna, 1936.
Table XII	12.	Olives and other plants, Al Khadra, 1958.
Table XII	13.	Yields of olive oil in the Lahmat Orfella, Beni Let and other cabile, 1957-1958.
Table XII	14.	Yields of olives and olive oil in Tarhuna, 1958/9.
Table XII	15.	Distribution of types of olive presses in Tripolitania.
Table XII	16.	Quantity of olive oil sold at Cussabat market, September 1958-June 1959.
Table XII	17.	Exports of olive and sansa oil (yearly averages).
Table XII	18.	Olive oil producing countries in 1956.
Table XII	19.	Olive oil exports in 1957.
Table XII	20.	Income from olive cultivation in Beni Let.
Table XII	21.	Gross income from cultivation and pastoralism in Beni Let in £L.
Table XII	22.	Gross incomes in ten selected cabile, Tarhuna, 1959/60.
Table XIII	1.	Livestock numbers in Tripolitania, 1943-56.
Table XIII	2.	Provincial distribution of sheep and goats in Tripolitania, 1952.
Table XIII	3.	Distribution of sheep and goats in the Eastern Province, 1952.
Table XIII	4.	Numbers of sheep and goats in Tarhuna in selected years.
Table XIII	5.	Numbers of camels, cattle, horses, mules and donkeys in Tarhuna and Cussabat, 1958.

Table XIII -	6.	Distribution of animals in Tarhuna, 1959.
Table XIII -	7.	Density of sheep and goats in ten selected cabile, Tarhuna, 1960.
Table XIII -	8.	Man/animal ratios in ten selected cabile, Tarhuna, 1960.
Table XIII -	9.	Flock size in six lahma, Tarhuna, 1960.
Table XIII -	10.	Cistern water supplies and animal water demands.
Table XIII -	11.	Age structure of sheep and goat flocks in ten selected cabile, Tarhuna, 1960 (%).
Table XIII -	12.	Average annual production from livestock in Tripolitania, 1950-56 (metric tons).
Table XIII -	13.	Hides and skins flayed at Tarhuna and Cussabat and in Tripolitania during 1958.
Table XIII -	14.	Total gross income from sheep and goats in selected cabile, Tarhuna (£L).
Table XIV -	1.	Barley production in the Eastern Jebel, 1957/8.
Table XIV -	2.	Barley production in Tarhuna, 1958/9.
Table XIV -	3.	Barley production per hectare of total land area and per capita of the population, 1957/8 and 1958/9.
Table XIV -	4.	Barley production in ten selected cabile, Tarhuna, 1960 (qts.).
Table XIV -	5.	Barley production on 13 farms, Cabila Beni Let.
Table XIV -	6.	Return from seed on farms in Beni Let.
Table XV -	1.	Number of vines in Tripolitania for selected years.
Table XV -	2.	Distribution of vines in the Eastern Jebel, 1958.
Table XV -	3.	Vines in selected cabile, Tarhuna, 1960.

-oOo-

List of plates.

Plate 1. The Jebel Front.
Plate 2. The Wadi Taraglat in El Amamra.
Plate 3. The channel of the Wadi Gsea in El Amamra.
Plate 4. Northern edge of the dip slope near Sidi Essed.
Plate 5. Urginea maritima: the 'hedge' of the steppe.
Plate 6. Olives growing in dune-covered soil on a concession farm.
Plate 7. The Libyan plough: primitive but effective.
Plate 8. Harvesting the olive tree.
Plate 9. Terraced gardens in the Wadi Gherrim.
Plate 10. Excavation at the base of an olive tree.
Plate 11. An inundated olive tree after rainfall.
Plate 12. Terraced olives in the Wadi Gherrim.
Plate 13. Gmata: village expansion away from the ancient nucleus.
Plate 14. The Roman nucleus of Beni Let.
Plate 15. A street in Beni Let.
Plate 16. A street in Gmata.
Plate 17. A deserted house in Gmata.
Plate 18. A Marabout in Beni Let.
Plate 19. Uadna village among the olives in the Cussabat Plain.
Plate 20. Al Khadra.
Plate 21. The Cussabat Plain.
Plate 22. Recently reclaimed land in the Wadi Uaeni.
Plate 23. Partially cleared ginanat in the Wadi Gsea.
Plate 24. Swani near Gheleel.
Plate 25. The crowded ginanat.
Plate 26. An ancient olive tree in Cussabat.
Plate 27. The Rasli olive tree.
Plate 28. The Frantoio olive tree.
Plate 29. A carob tree in the Cussabat Plain.
Plate 30. Barbary sheep grazing the Asphodel Steppe in spring.

List of appendices.

Appendix I. Administrative units and boundaries in Tripolitania and the Eastern Jebel.

Appendix II. Table of equivalents.

Appendix IIIa. List of cabile and major lahma in Cussabat.
b. List of cabile and major lahma in El Amamra.
c. List of cabile and major lahma in Tarhuna with some remarks on origins.

Appendix IVa. Average number of rainy days at selected stations in the Eastern Jebel.
b. Rainfall totals by month and agricultural year for selected stations in the Eastern Jebel.
c. Rainfall totals for calendar years at selected stations in the Eastern Jebel.
d. Three year running means at Tarhuna.

Appendix V. Capacities of Roman cisterns in the Eastern Jebel.

Appendix VI. Quality of grazing in Tarhuna between March 31st and April 14th, 1913.

Appendix VIIa. Changes in the distribution of population in Tripolitania, 1917-1954.
b. Distribution of population in 1917.
c. Population density in the Eastern Jebel, 1917.
d. Population and dwellings in ten selected cabile, Tarhuna, April, 1960.
e. Density of population per square kilometre of agricultural land in ten selected cabile in Cussabat, 1917.
f. Marital status of the population of Tarhuna by age and sex, 1954.
g. Fertility ratios and Net Reproduction Rates for selected areas, 1954.

Appendix VIIIa. The number of olive trees in Tripolitania.
b. Number of olives and man/olive ratios in Msellata, 1910.
c. Production of olive oil by provinces 1943/4-1951/2, metric tons.
d. Production of olives, olive oil and sansa oil in Tripolitania.

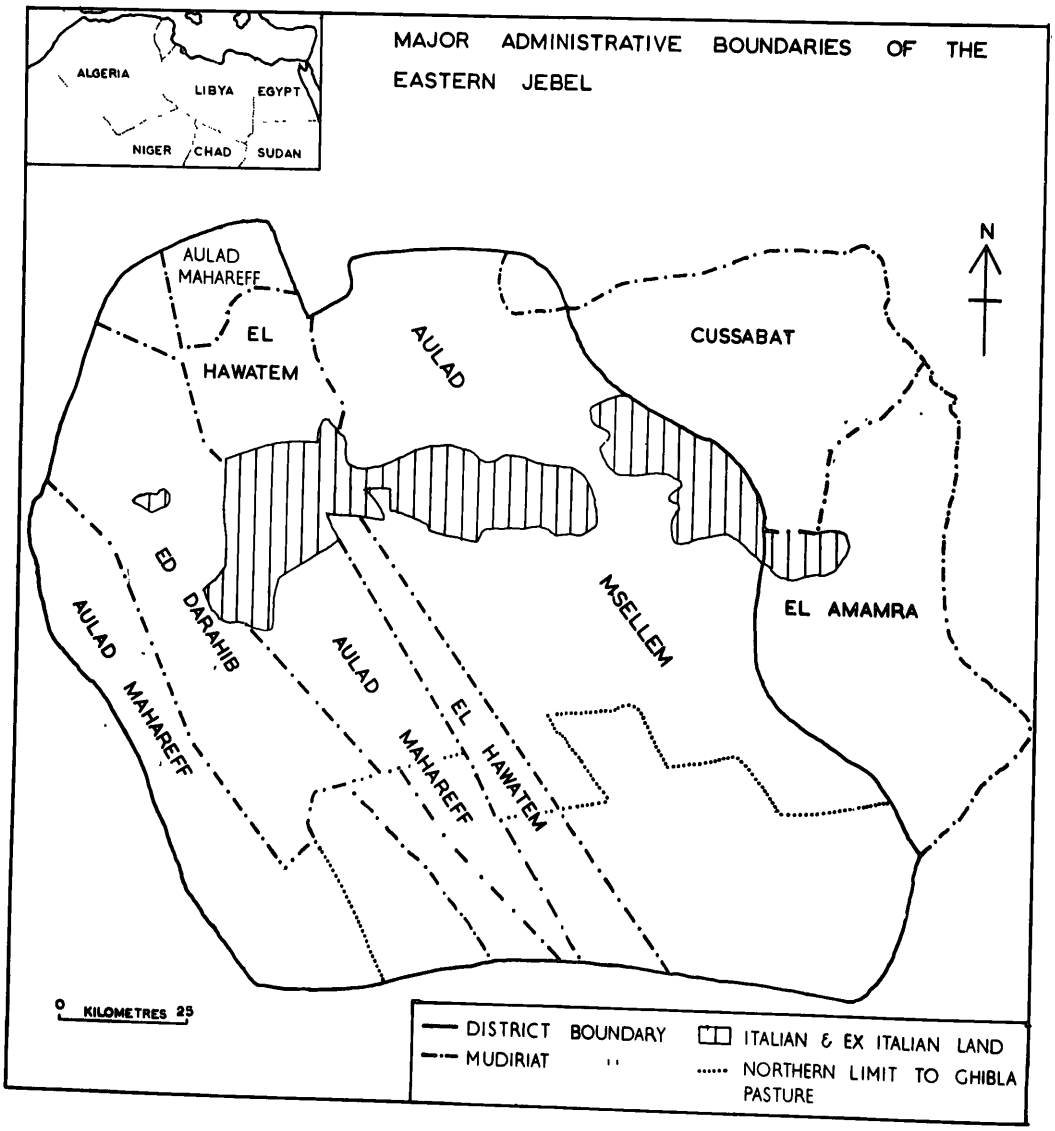
Appendix IX. Calcium phosphate content in a series of rock samples in the Eastern Jebel.

Appendix Xa. Estimates of livestock production in Tripolitania (metric tons).
b. Livestock numbers in ten selected cabile, Tarhuna, 1960.
c. Monthly sales of live animals at Tarhuna market, 1956-1959.
d. Monthly sales of meat at Tarhuna market.
e. Age structure of sheep and goat flocks in ten selected cabile, Tarhuna, 1960.

Appendix XIa. Production of barley in Tripolitania, 1930/1-1959/60.
b. Area sown in barley in Tripolitania for selected years.
c. Provincial distribution of barley production for selected years. (Metric tons).
d. Provincial distribution of area sown in barley for selected years. (Hectares).
e. Wheat production in Tripolitania. (Metric tons).
f. Area of wheat cultivated in Tripolitania. (Hectares).
g. Provincial distribution of wheat production for selected years. (Metric tons).
h. Provincial distribution of area in wheat for selected years. (Hectares).
i. Monthly barley sales in the Eastern Jebel, 1958-9.

-ooo-

Figure 1.


MAJOR ADMINISTRATIVE BOUNDARIES OF THE EASTERN JEBEL
ALGERIA
LIBYA
EGYPT
NIGER
CHAD
SUDAN
N
AULAD MAHAREFF
EL HAWATEM
AULAD
CUSSABAT
ED DARAHIB
AULAD MAHAREFF
AULAD
EL HAWATEM
MAHAREFF
MSELLEM
EL AMAMRA
0 KILOMETRES 25
DISTRICT BOUNDARY
MUDIRIAT
ITALIAN & EX ITALIAN LAND
NORTHERN LIMIT TO GHIBLA PASTURE

CHAPTER I.

INTRODUCTION.

Libya has an area of 680,000 sq. miles, is situated in North Africa and is compressed between the Maghreb to the west and Egypt to the east. Its northern littoral is Mediterranean, but about 90 per cent of the country lies in the Sahara. Most of Libya is underlain by the Archaean basement complex and belongs to the African tableland. In the north, sedimentaries of Secondary and Tertiary age are exposed and these were slightly buckled by the Alpine orogenesis to form the low plateau Jebels of east and west Libya. Climatically, there is a sharp transition between a semi-arid regime in the north and the aridity and temperature extremes of the Sahara.

Libya's predominantly Arab or Arabised Berber population, which numbered only 1,091,830 in 1954, is mainly concentrated in the semi-arid fringe north of latitude 32°N. The strategic position of Libya, across the main routes from Egypt to the Maghreb and from Europe to the lucrative trade of West and Central Africa, has meant that its people are used to foreign domination, and this is manifest in small racial minorities. The Romans arrived in the first century A.D. and extended the Phoenician olive and cereal cultivation over much of northern Tripolitania. They built up a thriving civilisation which was even more prosperous than that of the Greeks in Cyrenaica.

The area devoted to sedentary arboriculture was drastically reduced after the country was overrun by successive Arab invasions in the seventh and eleventh centuries. Cultivation stagnated under the Turks, whose loose control speeded the reversion of farmland to steppe and pasture. The Italians invaded the country in 1911, but conquest was not completed until the late 1920's. The area of sedentary cultivation was again extended as the Italians developed and colonised the country. The Libyans suffered directly from loss of land and watering points to the Italians and only indirectly benefited from economic development. When the Italians relinquished their sovereignty as a result of the Second World War, Libya was ruled by a British Military Administration until independence was granted by the United Nations in 1951.

Libya is made up of the three provinces of Cyrenaica, Tripolitania and the Fezzan, and is ruled by a monarch, Idris I, the former Emir of Cyrenaica and leader of the Senussi. The provinces differ considerably from each other and have separate 'personalities'. Cyrenaica, with an area of 330,000 sq. miles, is territorially the largest, but has a population of only 291,328, most of whom are semi-nomadic and nomadic pastoralists and tribal in outlook. Tripolitania is slightly smaller than Cyrenaica, but has a much larger population. The inhabitants have little in common with the

Cyrenaicans and are economically more advanced and sophisticated. They have many contacts with the peoples of southern Tunisia, which with Tripolitania forms a geological and morphological entity; the flat sandy plain of the Jefara and the escarpment of the Jebel are bisected by Libya's western boundary. The Fezzan was ruled by the French for a period and is Saharan. Most of its 55,000 inhabitants live in a few scattered oases.

When Libya became independent, few observers thought that it could survive, because of the dissimilarities between the provinces and the poverty and backwardness of the inhabitants. Libya was one of the world's poorest countries, with a per capita income only slightly above that of India and markedly lower than those of other Middle Eastern states (1). Political unity has been maintained, but economic independence has not been achieved. The following table shows Libya's balance of payments since independence.

Table 1 - 1. Libya's balance of payments 1951-59 (£L000).

	Imports	Exports and re-exports	Visible balance
1951	11,842	3,090	- 8,752
1952	11,566	4,363	- 7,203
1953	11,294	3,322	- 7,972
1954	11,286	3,479	- 7,807
1955	14,282	4,340	- 9,942
1956	16,487	3,961	-12,526
1957	28,076	5,415	-22,661
1958	34,501	5,075	-29,426
1959	40,585	4,300	-36,285

In every year there has been a marked deficit, which has grown steadily in recent years. The visible deficit has been wiped out by the invisible income accruing from the spending of British and American forces based in Libya and by official economic aid. Foreign spending in Libya varied from £L3,000,000 to £L5,600,000 between 1951 and 1956, and economic aid rose from £L1,460,000 to £L10,700,000 in the same period (2). The country experienced internal financial difficulties, so that both the Federal and Provincial Governments budgeted for a deficit. In 1956/7, for example, income was only £L8,709,620, of which £L3,000,000 was provided by the British Government as a direct budget grant; expenditure totalled £L9,174,620. Further, all economic development has been financed from external sources and in 1956/7 a total of £L20,532,000 was made available to the Libyan Government, mainly by the United States (3).

The position is, however, rapidly changing, as income from oil exploration and exploitation rights increases. In March 1959, there were 78 oil producing and 6 gas wells and oil was capable of flowing at the rate of 136,830 barrels per day. There were, moreover, 31 rigs in operation (4). In 1959 alone, foreign oil companies imported capital equipment valued at £L12,800,000, three times the value of Libya's exports for the same year. In 1960/61, the Libyan budget has been balanced

at the record figure of nearly £L16,000,000, and the Government claimed that the income was derived from within Libya.* To many Libyans, oil represents the final cure for all ills, and the cry of 'oil to the rescue' is often heard. They forget that a viable economy could be based on agriculture and that an oil boom may not last. The report of a World Bank Mission which examined the economic future of Libya sounded a warning note: the oil industry will not absorb more than 5% of Libya's economically active population.** It pointed out that revenues from oil must be carefully invested to extend and modernise agriculture, improve communications and eradicate poverty, disease and the 85% rate of illiteracy.

Agricultural expansion can be based on field and tree crops, dryland and irrigated cultivation. It must be associated with an improvement of animal husbandry, which, though animals are numerous and the area devoted to pasture very large, is still a subsistence industry making a small contribution to Libya's exports. Expansion can take place in all three provinces, especially in the Jefara of Tripolitania and in the low plateau Jebels of Cyrenaica and Tripolitania.

The Tripolitanian Jebel is part of a vast arcuate

---

* The Times.

** The Economist.

limestone escarpment which stretches from the Matmata in Tunisia to the Tripolitanian coast near Homs. In Tunisia, the escarpment is referred to as the Monts des Ksours, or simply the Jebel, and in Tripolitania it is divided into four sections: the Jebel Nefousa in the west, the Jebel Garian in the centre and the Jebels Tarhuna and Msellata in the east. The Jebels Tarhuna and Msellata, which is divided into Cussabat and El Amamra, form the Eastern Jebel, which is shown in black in figures 1 and 2. The escarpment is the remnant southerly limb of a dome-shaped Cretaceous anticline, the northern limb of which has been downfaulted to form the Jefara. The Jebel is composed of a broad dip slope plateau terminated northwards by a steep cliff scarp face called the Jebel Front or Jebel Scarp. The Eastern Jebel may be divided into a plateau zone and a northerly fringe, which has been deeply dissected. This is called the Scarp Zone, and in Tarhuna it is separated from the main plateau by an area of more undulating relief (Basin Zone) and a subsidiary scarp (Abanat Scarp). Altitude falls from over 650 metres above sea level in the south-west to about 100 metres along the eastern border.

Despite its inland position, the altitude of the Jebel induces a relatively high precipitation in the northern fringe, which contrasts with the aridity of the inner Jefara

to the north, and the Ghibla to the south. A mantle of Pleistocene aeolian and alluvial materials provide sandy calcareous soils which are the most fertile in Tripolitania. However, the region's limited groundwater reserves preclude large areas of irrigated agriculture.

In 1954, the population of the region numbered 60,000, three-quarters of whom were semi-nomadic pastoralists living in Tarhuna and El Amamra. Sedentary cultivation is confined to Cussabat, where olives have been grown since Roman times, and to seven privately-owned Italian concession farms and the Italian demographic estate of Al Khadra (Brevighliere) in Tarhuna. The sedentary element makes the greatest contribution to the Tripolitanian economy, producing olive oil, almonds, grapes, wine and cereals.

In recent years, emigration has become important and has changed the way of life in many areas and profoundly affected semi-nomadism and tribalism. During this period, agriculture slowly began to expand and the Libyan Government hopes to develop much of the region in arboriculture.

In studying the area, an attempt has been made to discover the potential of the physical resources in relation to the present and possible future methods and levels of resource use. This is based on a systematic treatment of the main natural resources and of the population, in whose hands the ultimate

development of the region lies. In many parts of Africa and Asia, Governments are faced with the problem of settling nomads and of encouraging them to turn cultivable steppe and pasture into farmland. It will be interesting to examine the differences in the Eastern Jebel between the semi-nomadic and sedentary patterns of settlement and economic activity. The Italian farms provide an opportunity to compare Libyan with Italian farming, and they are used as a foil to the main theme.

The thesis is presented in two parts: Part One consists of the text, maps, diagrams, tables and plates; Part Two of the references and appendices. The text is divided into four sections: Section 1 describes geology and relief; Section 2 studies the physical resources; Section 3 examines the population, social structure, emigration and settlement, and Section 4 land use, types of agriculture, the main crops and pastoralism. These are followed by a final chapter which summarises the text and draws some conclusions.

References are listed on a chapter basis. Those directly referred to in the text are given a number and are listed in order of appearance. A list of additional references is supplied for each chapter. Some references are given as footnotes, but these usually refer to personal communications made to the writer. The appendices are listed on page VIII and contain relevant statistical data, a list of the main tribes

and clans, an explanation of administrative boundaries and a table of equivalents relating to Arabic and metric units used in the text. The major place names are shown in figure 2 and the location of tribes in figures 3 and 4. Figure 3 is enclosed in a folio at the back of Volume One. Minor place names may be found on the G.S.G.S. 1:200,000 War Office Map Sheets 2 (Tripoli) and 3 (Misurata) and on the 1:100,000 War Office Map Sheets 1474 (Azzizia), 1475 (Tarhuna), 1476 (Homs) and 1574 (Gasr Garian). Place names are spelt as they appear on these maps, but tribal names are given their English equivalents. In the text, the terms cabila and lahmat refer to tribe and clan respectively. They are given their Arabic plurals - cabile and lahma - and have capital letters when referring to a specific tribe, as in Cabila Auasa and Lahmat Bu Galia.

figure 4.

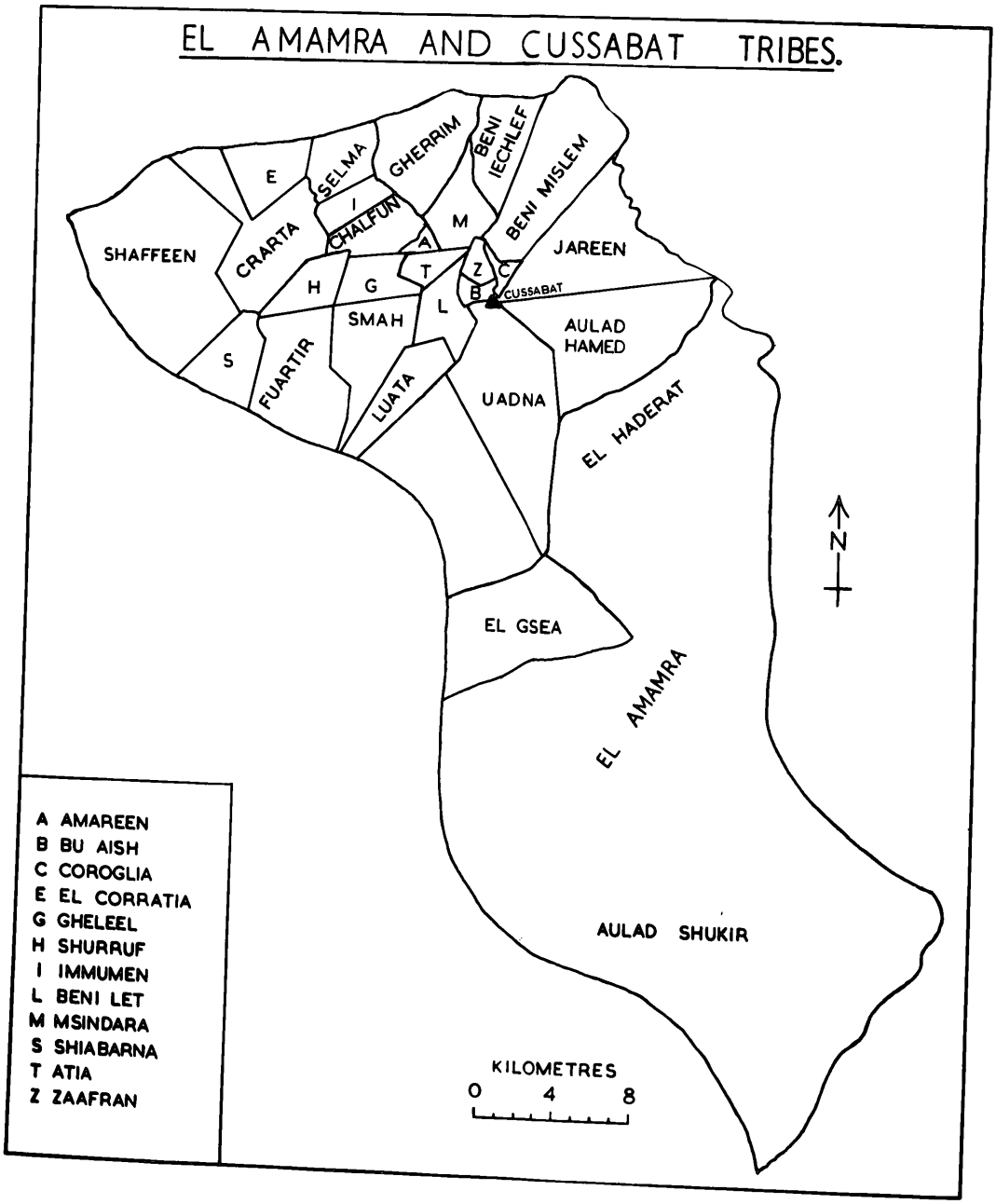
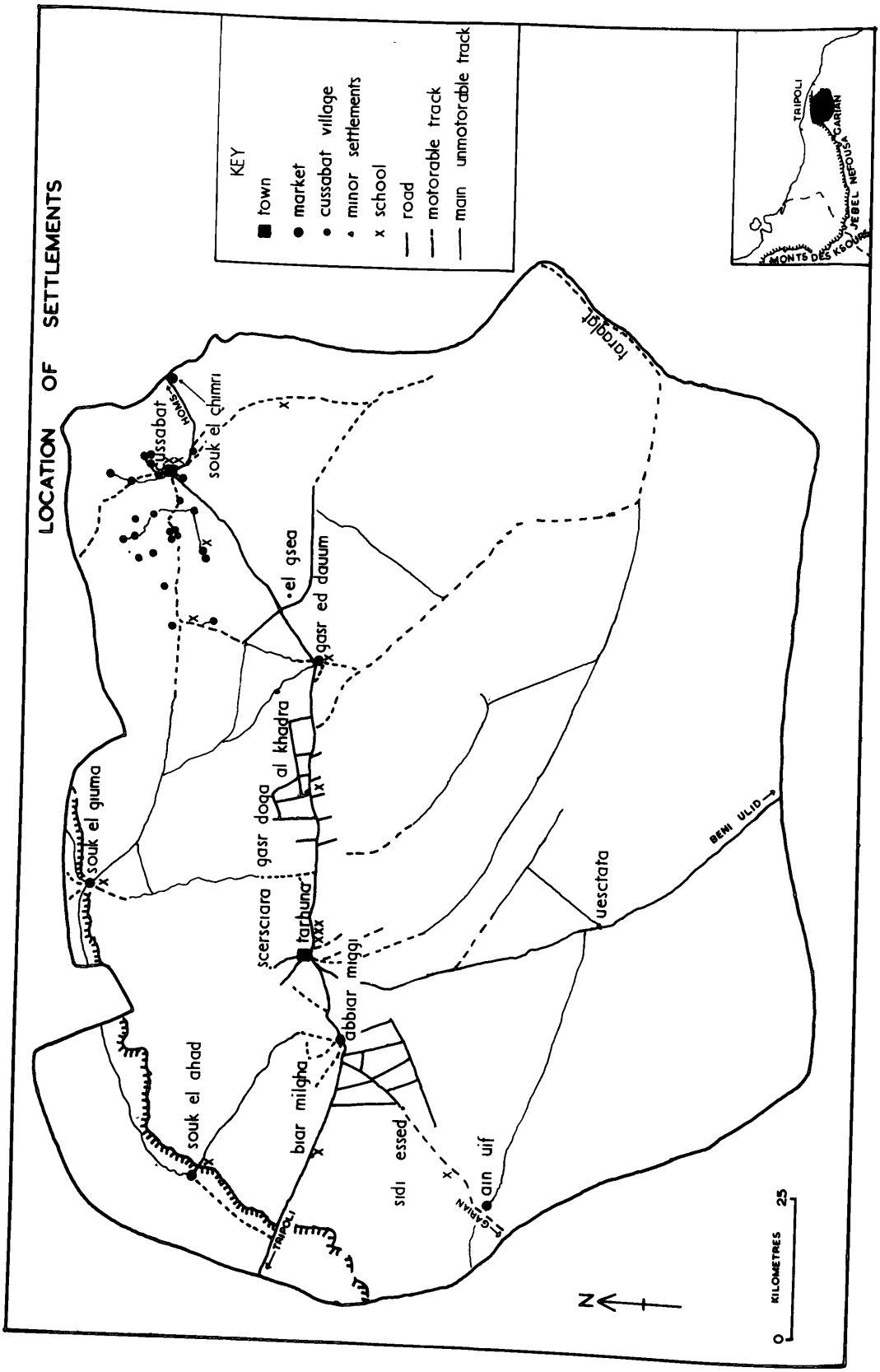

EL AMAMRA AND CUSSABAT TRIBES.
SHAFFEEN
CRARTA
E
SELMA
I
CHALFUN
GHERRIM
BENI IECHLEF
BENI MISLEM
M
A
T
Z
C
B
CUSSABAT
JAREEN
H
G
SMAH
L
AULAD HAMED
S
FUARTIR
LUATA
UADNA
EL HADERAT
N
EL GSEA
EL AMAMRA
AULAD SHUKIR
A AMAREEN
B BU AISH
C COROGLIA
E EL CORRATIA
G GHELEEL
H SHURRUF
I IMMUMEN
L BENI LET
M MSINDARA
S SHIABARNA
T ATIA
Z ZAAFRAN
KILOMETRES
0 4 8

figure 2.


LOCATION OF SETTLEMENTS
KEY
town
market
cussabat village
minor settlements
school
road
motorable track
main unmotorable track
TRIPOLI
GARIAN
JEBEL NEFOUSA
MONTS DES KSOUR
tarhuna
souk el giuma
souk el ahad
souk el chimri
cussabat
gasr ed dauum
el gsea
gasr doga
al khadra
scersciara
abbiar miggi
biar milgha
sidi essed
ain uif
uesctata
BENI ULID
TARGOLT
HOMS
TRIPOLI
GARIAN
N
0
KILOMETRES
25

SECTION ONE.

GEOLOGY AND MORPHOLOGY.

CHAPTER II

GEOLOGY

A. Introduction

Libya lies on the northern edge of the ancient African Tableland, which is formed by rocks of Archean age. This tableland was once part of Godwanaland, which was divided from the European land mass during the Secondary by the great Tethys sea. On the southern margins of the Tethys, a great thickness of Jurassic and Cretaceous strata was deposited. In the late Cretaceous, the Alpine orogenesis resulted in the formation of the Atlas mountains in the Magreb. Northern Libya, which lay beneath the Tethys, was only partially affected by the mountain building movements, so that only a major and relatively simple anticline was formed in northern Tripolitania and southern Tunisia. The northern limb of this anticline was either down faulted or eroded, so that in the early Tertiary only the southern limb was exposed. The area occupied by the northern limb was covered by a Miocene marine transgression, and a great thickness of limestones and marls were deposited. This was later covered by Pleistocene marine and continental depositions to form the Jefara. The southern limb, the Jebel, was only partially affected by the Miocene, but large areas of it were covered with aeolian and alluvial depositions dating from the Pleistocene and Recent periods.

The Jebel was also affected by volcanic intrusions and effusions, probably in the Pliocene.

The Eastern Jebel is thus formed mainly by Cretaceous strata, but there are limited exposures of Jurassic and Miocene strata with igneous outcrops in southern Tarhuna.

As yet, the geology of Tripolitania has not been accurately studied, though this is being remedied by the intensive work of oil company geologists. They have revised ideas on Libyan geology and have rejected some of the Italian work because of inaccuracies in both the location and age of important outcrops. Unfortunately, the oil companies cannot release the results of their work for some years, but both the Amoseas Oil Company and the D'Arcy Exploration Company provided the information on which this chapter is based. Their work was in turn based on Christie's pilot study of the neighbouring Garian area (1).

The chapter aims at describing the geology as a basis for examining groundwater resources, morphology and soils; the evolution of the region; and a brief description of its mineral resources.

B. Geology

The Eastern Jebel is composed of a series of strata of Jurassic, Cretaceous and Miocene age exposed to a total

thickness of 335 metres. The main formations are shown in Table II - 1 and figure 5.

Table II - 1 Table of formations

			Formation	Lithology
TERTIARY	MIOCENE	Tortonian	En Nab formations	Soft porous limestones and sandstones with flints
		Helvetian	Mergheb marls 100-110 m.	Sandy yellow marls with interbedded limestone
			Wadi Caam beds 40 m.	Metamorphosed limestone, sandstones and argillaceous limestones
SECONDARY	CRETACEOUS	Cenomanian - Turonian	Gasr Tigrinna formations 20-30 m.	Soft buff-grey marls
		Cenomanian	Garian limestones 70 m.	Massive white dolomitic crystalline limestones
			Jefren marls 90-100 m.	Soft yellow marls, clays, silts and marly limestone
			Ain Tobi limestones 100 m.	Light coloured argillaceous limestone with chert
		Wealden	Chicla formations	Clays and lignites
	JURASSIC	Upper	Bu Gheilan limestones 40 m.	Light coloured limestone commonly brecciated

Igneous rocks. Basalt, plagioclase and ankarite. Intrusive phonolite?

figure 5.

After D'Arcy Exploration Co..

1. The Jurassic

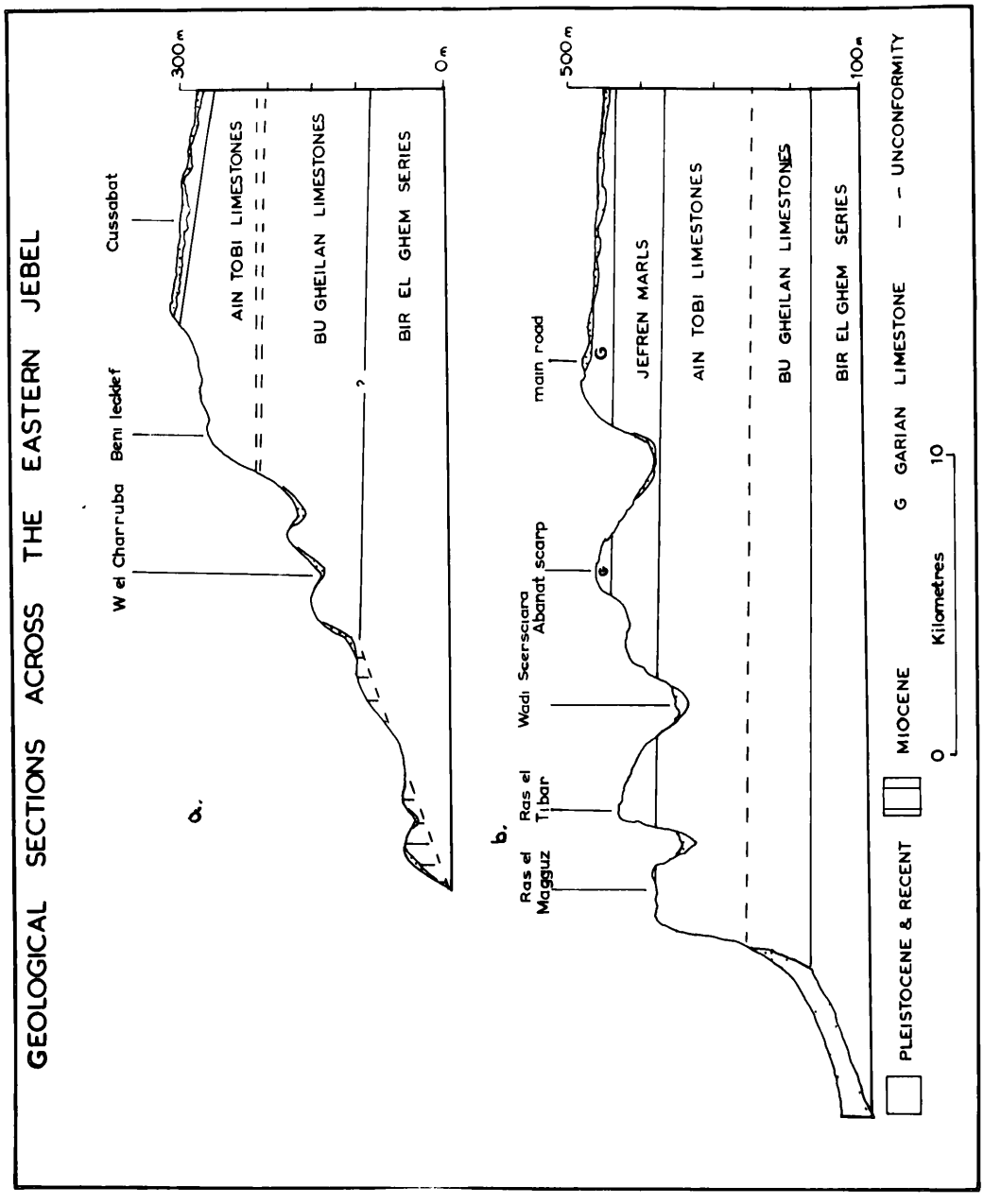
Jurassic rocks are exposed in three wadi channels along the Jebel Scarp. Maximum exposure occurs at the base of the Ras el Magguz, where 40 metres of light coloured carbonaceous limestones outcrop. These beds, together with those of Sidi el Heina and Turgut el Mergheb, resemble the Bu Gheilan limestones of Garian according to D'Arcy Exploration Company geologists.

Two bore holes were recently drilled by the H.T. Smith International Company in the Cussabat Plain between Cussabat and Zaafran villages. They passed through at least 200 metres of limestones which were overlain by clays and lignites of (probably) Wealden age. These limestones may be assigned to the Jurassic, because both Wealden and Albian beds in Tripolitania are thin and show continental facies. The lithology of the upper limestones resembles that of the Bu Gheilan limestones and the lower that of the Bir el Ghemn series of Garian (2). Because there is no further data, it is impossible to estimate the distribution of the Jurassic beneath Cussabat, but figure 6a shows a hypothetical section.

2. The Cretaceous

The Cretaceous found in the region under study may be divided into the Lower and Middle Cretaceous. The Upper

figure 6.


GEOLOGICAL SECTIONS ACROSS THE EASTERN JEBEL
a.
W el Charruba
Beni Iecklef
Cussabat
300m
0m
AIN TOBI LIMESTONES
BU GHEILAN LIMESTONES
BIR EL GHEM SERIES
?
b.
Ras el Magguz
Ras el Tibar
Wadi Seersciara
Abanat scarp
main road
500m
100m
G
JEFREN MARLS
AIN TOBI LIMESTONES
BU GHEILAN LIMESTONES
BIR EL GHEM SERIES
PLEISTOCENE & RECENT
MIOCENE
G GARIAN LIMESTONE
- - UNCONFORMITY
0
Kilometres
10

Cretaceous (Turonian) of the Jebel Nefousa is not found in either Garian or the Eastern Jebel.

(a) The Lower Cretaceous

The Lower Cretaceous is represented by the Wealden and Albian in the Jebel Nefousa, and by the Wealden in Garian. Neither has been traced to exposures in the region under study, but Chiesa (3) found a thin series of lignites in a group of wells at Zaafran in Cussabat. These layers have also been traced in the H.T. Smith International Company boreholes. According to Chiesa, the lignites showed a lacustrine swamp facies characterised by the presence of fungi. They are clearly inferior to the Cenomanian. As the Wealden Chiela beds of Garian are continental and contain lignites, the Cussabat beds may be assigned to that group. The strata traced by Chiesa in the well and in the wadi bed above the well were as follows:-

Table II - 2. Wealden and Cenomanian strata at Cussabat

Stratum Nos.	Lithology	Thickness (metres)
1	Sub-crystalline covering limestone	3.5
2	Fossiliferous sandy marls (Cenomanian)	35.0
3	Light floury limestone	10.0
4	Light compact limestone	0.5
5	Clay, free from limestone, with fungi and trunks	0.08
6	Light coloured marls	1.6

Stratum Nos.	Lithology	Thickness (metres)
7	Ash grey clay with numerous trunks	0.04
8	Light grey clay	0.06
9	Lignite	0.08
10	Light grey clay	xxx

In Garian, the Wealden is underlain and overlain with unconformity by the Jurassic and Cenomanian respectively. Unconformity and the thinness of the Wealden may account for its absence above the Jurassic in northern Tarhuna.

(b) The Middle Cretaceous

Cenomanian strata, which account for most of the exposed rocks in the region, belong to the Middle Cretaceous and the Cenomanian - Turonian, are transitional between the Middle and Upper Cretaceous. In Garian, Christie divided the Cenomanian into three lithological groups: the Ain Tobi limestones, the Jefren marls and Garian limestones. Though D'Arcy Exploration Company geologists have accepted and used these divisions, neither Christie nor the geologists distinguished between the Ain Tobi and Jefren groups on their 1 : 100,000 maps. There are, however, important lithological differences between the hard compact Ain Tobi limestones and the soft clays, silts and marls of the Jefren group. The Cenomanian - Turonian strata are called the Gasr Tigrinna formation.

(i) The Ain Tobi limestones These rocks are extensively exposed in Northern Tarhuna and Msellata, the best exposures being in the Wadi Milgha in Tarhuna and the Wadi el Charruba in Cussabat. The zone between the Abanat and Jebel Scarps is dominated by the Jefren marls, but east of the Wadi Turgut the Ain Tobi limestones are preponderant. Of particular importance with regard to evolution is the hard siliceous band of limestone characterised by the presence of Ichthyosarcolites. This gives rise to a marked break in slope along the Tarhuna - Msellata confine.

The following bands may be recognised in the Ain Tobi limestones:-

1. White to buff marly limestone of chalky appearance. It is commonly porous with a small amount of argillaceous material. The series is inter-bedded with narrow sandy strata or white limestone with traces of wind-blown sand. This group is 14 - 20 metres thick and is best represented in the ridges and summits to the north and west of Cussabat village.

2. White to buff to light grey limestone similar to group 1, but with more argillaceous material. This group is strikingly represented in the el Galaa hill above Cussabat, where numerous fossils of the Cenomanian Exogyra flabellata Goldf. and Exogyra Columba Link have been collected.

3. Hard massive limestone that is one of the most conspicuous strata in the Eastern Jebel. It consists of an upper band of "reef limestone" formed by fragments of the rustistid Ichthyosarcolites and other organic remains. This group is about 5 metres thick and may be readily traced in the field. East of the Wadi Sret, it accounts for the precipitous slope of the Jebel Scarp.

4. White to buff grey marly limestone with rare nodules of flint and lenticles of dark chert. There are narrow argillaceous inter-beds and a conspicuous band of red coloured limestone near the top of the series. It is about 45 metres thick and is very prominent in Northern Msellata.

(ii) The Jefren marls. The Jefren marls are extensively exposed in Northern Tarhuna and parts of western Msellata. They appear to be fairly uniform in thickness, with a total exposure of about 90 metres. Well defined outcrops are rare and are restricted to the Abanat Scarp, particularly between the Wadis Masabha and Guman, and to the slopes of the Ras el Msid, Jebel Msid and Bu Tuil. In these areas, a hard and resistant capping of Garian limestone has preserved the soft marls. North-western Tarhuna is dominated by the Jefren marls, which elsewhere form residual corniches above the Ain Tobi limestones. The formation extends southwards along the Gsea basin and is exposed in parts of eastern El Amamra.

The Jefren marls are composed of soft yellow marls, marly and lesser limestones, clays and silts. In Garian, beds of gypsum were found in this series. These gypsum beds cannot be traced in the Eastern Jebel. The limestones are argillaceous in nature but occasionally grade into pure limestones. The clays and silts are found at all levels. Beds are thin and there is considerable horizontal diversity. The clays are varied in colour, blue and yellow strata being common. It is difficult to trace typical sections in this series since many of the strata are easily eroded.

(iii) <u>The Garian limestones</u> The Garian limestones are the most extensively exposed strata in the Eastern Jebel. These hard and resistant limestones underlie the greater part of the Ghibla and Tarhuna Plateau, though the section between the Tmasla and Tamamura Wadis is covered with the Turonian - Cenomanian Gasr Tigrinna formations. The Garian limestones cap the Abanat Scarp and its principal outliers at Bu Tuil, Jebel Msid and the Ras el Msid. The best exposures are found in these sections, but recent quarrying at Uesctata reveals the main beds, which correspond to those that Christie recognised in Garian. These are:-

1. White to yellow dolomitic limestone of massive structure. Throughout the lower sections there are numerous vugs and

veins filled with calcite or quartz crystals.. In the upper bands, the limestones become more siliceous. The Missione Sanfilippo estimated that the 40 metre thick series at Biar Miggi contained an average magnesium carbonate content of 27.8% (4).

2. Well bedded white limestone. It is compact and hard in western Tarhuna and contains aragonite. There are branches of coralliform throughout this member. In the upper section, there is a conspicuous band of red limestone with bands of white chert towards the base.

(iv) Gasr Tigrinna formations. These were recently found in the region by the D'Arcy Oil Company. They are confined to southern Tarhuna between the Tmasla and Tamamura Wadis. Their thickness has not been measured, though it is believed that the Tarhuna deposits are much thinner than those of Garian, where Christie traced at least 87 metres of this formation. According to the oil companies, the Tarhuna beds consist mainly of marls and clays. Their importance lies in the fact that they provide an impervious floor for some of the Taraglat tributaries and thus permit extensive wadi flows in parts of South-east Tarhuna. In this respect, they differ considerably from the highly permeable Garian limestones.

3. The Miocene

Miocene rocks have been found beneath the Jefara and a study of them reveals that, though the Langlian period shows continental facies, there was a major marine transgression during the Helvetian and Tortonian periods. In the Jefara, the thickness of the Miocene decreases from a maximum of about 700 metres in the north to a few metres in the south, and its depth below the surface declines as the thickness decreases. The Miocene is exposed in a few areas, the most important of which are along the Jebel Scarp in north-west Tarhuna in wadi channels to the north of Msellata and in a series of minor summits between Fondugh en Naggaza and Homs. Geologists from the Amoseas Oil Company told the writer that Miocene rocks outcropped in eastern Msellata and the Misuratino. This has not been finally demonstrated but several facts point to their existence. These are:-

1. The Miocene is exposed along the north-east 'corner' of the Eastern Jebel.

2. The Miocene is only exposed in areas with an altitude of less than 165 metres. Whilst the Miocene is very thick below the Jefara, it is absent in the Jebels Tarhuna, Garian and Nefousa.

3. The eastern margins of Msellata lie below 165 metres and altitude decreases from about 200 metres in the El Gattar

to less than 100 metres in parts of the El Amamra - Sahel el Ahamed border.

4. The exposed strata in the Misuratino were assigned by the Italians to minor Marine ingressions during the late Tertiary, especially the Pliocene. However, C.O.T.H.A. geologists recently found that supposedly Pliocene strata in the Wadi Caam basin belonged to the Helvetian period of the Miocene (5).

It is concluded that the Miocene is exposed in parts of the El Amamra and that its western boundary roughly coincides with the 165 metre contour. This cannot be finally proved until the Amoseas Oil Company release their map of this region. It must be emphasised, however, that the geologists have told the writer that Miocene has been found by them in the El Amamra.

The nature and age of the Miocene may be deduced from studies made of the Miocene rocks exposed in the Homs area; Earlier Italian authorities classed these strata as 'Langlian', but the strata which were described by Floridia (6) are all marine and therefore not Langlian. Silvestri (7) suggested that they belonged to the middle Miocene. A more accurate definition may be determined by comparing Floridia's strata with those found beneath the Jefara by Desio (8).

Floridia recognised the following nine groups:-

1. Soft porous light limestones. These are arenaceous and compact and are 25 metres thick.

2. Limestones and sandstones of varying colour and thickness with flint interbeds. They are 40 - 50 metres thick.

3. Clastiche limestones and sandstones with breccias of rhombic calcite. This series contains the fossil Nealveoline Melo Curdica. 18 - 20 metres thick.

4. Yellow marls with limestone interstratification. There are traces of the fossil Chamlys sub-Malvinae Blank. 22 metres thick.

5. White oolitic limestones with traces of Ostrea and Chamlys. 8 metres thick.

6. As strata 4 with traces of Scutella and Amphioben. 40 metres thick.

7. Compact arenaceous limestones. 30 metres thick.

8. Crystalline limestones passing to yellow limestones and sandstones. 5 - 8 metres thick.

9. Minute yellow areniette which is hard and micacious. 3 - 5 metres thick.

Desio found the following groups of strata beneath the Jefara:-

1. Yellow or white limestone with alveolines. The presence of alveolines means that this group was deposited during the Tortonian or upper Miocene.

2. Green or yellow marls with intercalated green sandstones. The presence of the fossil Chamlys sub - Malvinae Blank, confirms their Helvetian age.

3. Sandstones with gravels and Scutella. (Probably) Langlian.

Floridia's strata 4 is clearly Helvetian and strata 3 may be Tortonian. It seems unlikely that the Langlian occurs at Homs because the Wadi Caam beds belong, according to C.O.T.H.A., to the Helvetian and were 'much older than the Homs Miocene'.

The Eastern Jebel was thus partially affected by the Miocene marine ingression, so that the Miocene strata of eastern Msellata and northern El Amamra are probably composed of upper Helvetian or Tortonian limestones and marls.

4. Igneous rocks

There are extensive outcrops of igneous rocks in southern Tarhuna, especially in the Uesetata region. These are related to a narrow zone of volcanic exposures which stretch between the Azzizia - Garian area south-east to Beni Ulid. Three types of igneous rocks are found along this zone: extrusive basalts, intrusive basalts and intrusive phonolites. The intrusive rocks are found in the central part of the zone and the extrusives in the

lateral areas. The phonolite is exposed as small bosses which can cover an area of 3 - 4 sq. kilometres. Both the phonolite and the intrusive basalt produce local distortions in the strata and there are several fine examples of this near the settlement of Uesotata. The basaltic extrusions are similar to the much larger ones of Garian, and they have flowed along wadi channels to produce a shelving effect. They lie on top of the Cenomanian with traces of an ancient hardpan visible at the base of some exposures, which are generally about 10 metres thick. This indicates that they are of post - Cretaceous origin and Christie believed that the effusions took place in either the Pliocene or early Quaternary. He thought, however, that some were older.

C. <u>The Pleistocene and Recent mantle</u>.

As figure 5 shows, the Cretaceous, Jurassic and Miocene bed rock is masked over large areas of the Eastern Jebel by Pleistocene and Recent depositions composed of aeolian sands, gravels and alluvium. The nature of these depositions varies according to the admixture of alluvium and aeolian materials. Though this will be discussed in greater detail in Chapter VI, it is relevant to examine how composition varies according to region and altitude.

In the first place, Lipparini (9) has shown that the aeolian sand originated from source regions in the south, Stella (10) that the sand is mainly composed of quartz grains with a little calcite and felspar, but that 4% of it is made up from heavier minerals (tourmaline, epidote, rutile, magnetite, zircon and orthoclase) and Rathjens (11) that the sand was deposited during the Holocene about 12,000 years ago. The pure sand is limited to the mesa-like surfaces of the Ghibla and to the upper parts of the region, mainly above the 450 metre contour. It is typically developed in the Italian zone of northern Tarhuna, where it is sometimes between 20 - 35 metres thick, varying according to the topography of the Cretaceous surfaces it covers.

To the north of the Ghibla and below about 450 metres, the sand is mixed with alluvium. In the wide undulating upper basins of the Wadis Sret, Ramle, Masabha and Turgut, the amount of alluvium is small, but in the terraces of Pleistocene origin along the lower courses of the main wadis and their tributaries there are alternating layers of sand and alluvial materials, as the following sample from the Wadi Seersciara shows:-

Table II - 2. Stratification of the Pleistocene and Recent material in the Wadi Scersciara

Material	Thickness (Inches)
Sandy 'tin'	15
Gravel	2
Sand	10
Gravel and sand	5
Sand	2
Fine gravel and alluvium	2
Caliche and Conglomerate	?

Silt, gravels and alluvium are also found in the wadi courses, whilst at the feet of the steeper slopes and along the Jebel front coarse gravels and angular scree have been added to sand and alluvium.

The caliche and conglomerate occuring in the Wadi Scersciara section are found in the sandy areas and take the form of a hard compact layer lying at depths of a few centimetres to several metres below the surface.

D. Structure

The Jurassic rocks, which are the oldest exposed beds in the Eastern Jebel, are limited to three small areas in Tarhuna, but in the neighbouring Garian they are very thick. In this area, they thin and sink eastward as the altitude of the Jebel decreases. Their exposure in Tarhuna is probably related to the depth of erosion along the Jebel

front and the fact that there is unconformity between the Jurassic and Wealden and the Cenomanian and Wealden, which is not exposed in the Eastern Jebel. The Wealden thins quickly eastward in Garian and disappears completely about 15 kilometres west of the Garian - Tarhuna boundary. The occurrence of Wealden beneath Cussabat is related to the unconformity between the Wealden and Jurassic; its thinness and apparent discontinuity is also related to the unconformity.

The great mass of the Eastern Jebel is formed by the Cenomanian and Cenomanian-Turonian, which appear to be level bedded. The strata, however, vary lithologically both horizontally and vertically and dip gently to the south in Tarhuna and to the south-east in Cussabat. The angle of dip increases as direction changes from a maximum of 5° in western Tarhuna to about 10° in Msellata.

The Miocene is fairly uniform in composition and thickness, but individual strata are found at various altitudes because of the unconformity between the Miocene and Cretaceous. The intercalation of white limestones with Ostrea marls in stratum 5 may be related to faulting, which Floridia considered to be important in this area.

The structural uniformity has been complicated by vulcanicity in southern Tarhuna and by faulting or jointing in the northern parts of the Eastern Jebel. The occurrence of faults

has not been demonstrated. Lipparini traced a series of east/west and north-west/south-east fault lines across northern Tarhuna and Cussabat. According to him, the Abanat Scarp has been faulted. The lines of these 'faults' may be traced as dark lines on the aerial photographs, but there are no signs of faulting on the ground. The D'Arcy Oil Company geologists believe that these lines are joints and not faults. Nonetheless, they affect the direction and morphology of some wadi valleys, and the lines may be shallow faults related to the epierogenetic movement which led to the downfaulting of the northern limb of the Jebel.

E. Evolution: formation of the Jebel anticline and the Jebel Scarp

The evolution of the Eastern Jebel is related to the evolution of the vast area of northern Tripolitania and southern Tunisia covered by the arcuate plateau of the Jebel and the flat sandy plain of the Jefara. The many French and Italian authorities who have examined the evolution of this region agree that it was part of a vast dome-shaped Cretaceous anticline, but they disagree about its subsequent erosion and the formation of the Jebel Scarp.

The geology of this region is shown in figure 7 and the main formations and geological history are summarised

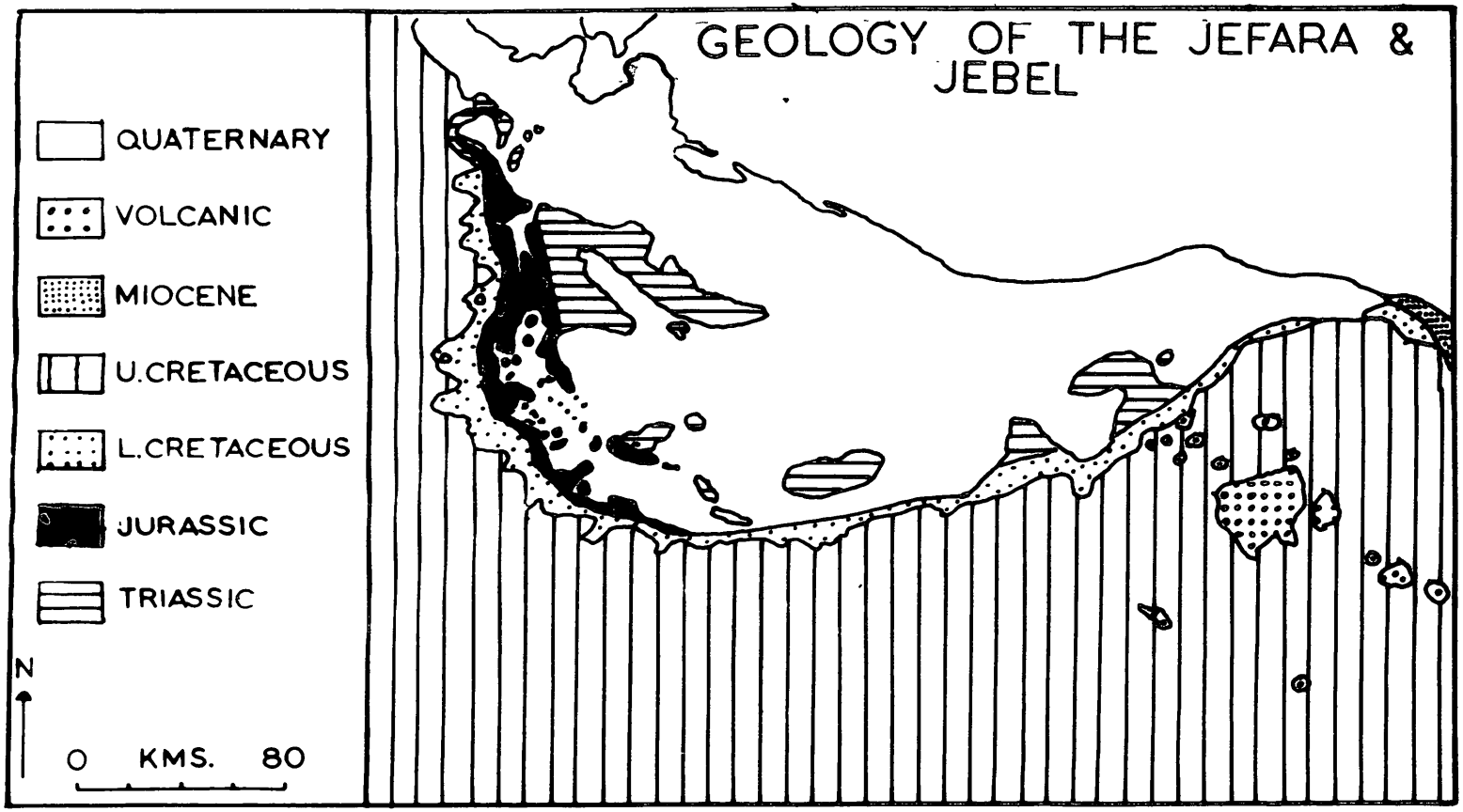

GEOLOGY OF THE JEFARA &
JEBEL
QUATERNARY
VOLCANIC
MIOCENE
U.CRETACEOUS
L.CRETACEOUS
JURASSIC
TRIASSIC
N
0 KMS. 80

figure 7.

in Table II - 3. Broadly, the Jebel is formed by Jurassic and Cretaceous rocks, the youngest beds being exposed in the Wadi Soffegin basin and the oldest along the Scarp itself. In the Jefara, there are a series of low hills lying 4 - 6 kilometres north of the Jebel. These are the Pre-Jebellic hills and are formed mainly by Triassic rocks (12). The Triassic, the oldest formation in the region, is also exposed at the foot of the Jebel at Garian, and a line of Triassic may be traced across the Jefara from Garian to the Matmata in Tunisia. These are aligned north-west/south-east in the same direction as the igeneous rocks which are exposed between Garian and Beni Ulid. Geologists have concluded that this region was once part of an anticline because of the arcuate shape of the Jebel, because the Triassic crosses the Jefara and touches the arc at its two highest points - Garian and the Matmata - and because the strata dip away to the south in Tripolitania and to the south-west in Tunisia. They believe that the nucleus of the anticline was formed by the Triassic so that the anticline was aligned north-west/south-east and its tectonic axis lay between southern Garian and the Matmata. Lipparini, who studied the Tripolitanian section of the Jebel, concluded that the tectonic axis of the Jebel corresponds laterally to the synclinal 'ditch' of the Wadi Soffegin which is compressed between the southern edge of the anticline

Table II - 3. Geological History.

SYSTEM	STAGE	DEPOSITS	NOTES
HOLOCENE	FLANDRIAN	Loess?	Continental conditions
PLEISTOCENE	WURM	Calcrete and loess.	Mainly Continental
	RISS	Sand.	Continental
	TYRRHENIAN	Thin clay layer.	Marine
	MINDEL	?	?
PLIOCENE	-	'Gefarico'	Continental marine regression
MIOCENE	PONTIAN	Sand and clay.	?
	TORTONIAN	White and yellowish limestones.	Marine
	HELVETIAN	Green fossiliferous clays and marls.	Marine
	LANGHIAN	Sandstones and gravels	Marine
OLIGOCENE	-	'Gefarico'	Continental
EOCENE	-	'Gefarico'	Continental
MIDDLE CRETACEOUS	DANIAN		Retreating sea
	SENONIAN	Soffegin limestones	Oscillating movements of the sea. Formation of anticline.
	TURONIAN	Nalut limestone, Tigrinna beds.	Marine
	CENOMANIAN	Garian limestone, Jefren Marls & Ain Tobi Limestone.	Total immersion of land by the sea
LOWER CRETACEOUS	ALBIAN	Conglomerates	Continental
	WEALDEN	Clays and lignites	Continental
JURASSIC	BAJOCIAN	Bu Gheilan limestone	Marine and lagoonar
	LIAS	Bu Sheba & Bir el Ghnem series	-
TRIASSIC	MUSCHELKALK	Compact limestone	Marine

and the Hamada el Homra, a vast featureless Senonian plateau. Depositions dating from the Danian and Maestrichtian are found in the eastern part of the Wadi Soffegin basin. Lipparini considered that, as these depositions were limited to the synclinal ditch, they must have been deposited after the formation of the anticline. As Turonian rocks are found in the Jebel, the anticline was formed in the late Turonian or Senonian periods of the Upper Cretaceous.

The Cretaceous rocks of northern Tripolitania and southern Tunisia were deposited in the Tethys and were folded and uplifted during the Alpine. Tripolitania, however, lay on the southern margins of the Tethys. Because of this, the fold movements were less severe, and were further mitigated by the relative nearness of the Archean mass of Gondwana land.

The Eastern Jebel lay to the east of the zone of orographic culmination at Garian and to the north-east of the tectonic axis of the anticline. The strata dipped south in response to the synclinal basin of the Ghibla, but the surface was sloped north-eastward towards the Mediterranean or Tethys sea. The sharp break in slope between Garian and Tarhuna is probably related to vulcanicity which took place in the Tertiary or early Quaternary.

(b) <u>The formation of the Scarp</u>

The many theories put forward to account for the

origin of the Jebel Scarp are based on one of three hypotheses: marine abrasion, continental erosion and faulting.

(i) Marine abrasion. Zaccagna (13) is the principal advocate of this theory, and though his views were rejected by most of the Italians they are favoured by geologists from the D'Arcy Exploration Company. The theory is based on the shape of the Jebel Scarp - its cliff-like face, its relative arcuate shape and on the estuarine appearance of the wadis which break through it. However, only two major post - Cretaceous transgressions have been traced: the Miocene and Tyrrhenian. The distribution of these depositions shows, that though marine abrasion may have been a factor in the formation of the Jebel Scarp it did not lead to its formation. The Miocene is over 700 metres thick in the Jefara and there are no traces of it south of a clearly marked fault line in the Azzizia and Maamura Triassic Pre-Jebellic hills.

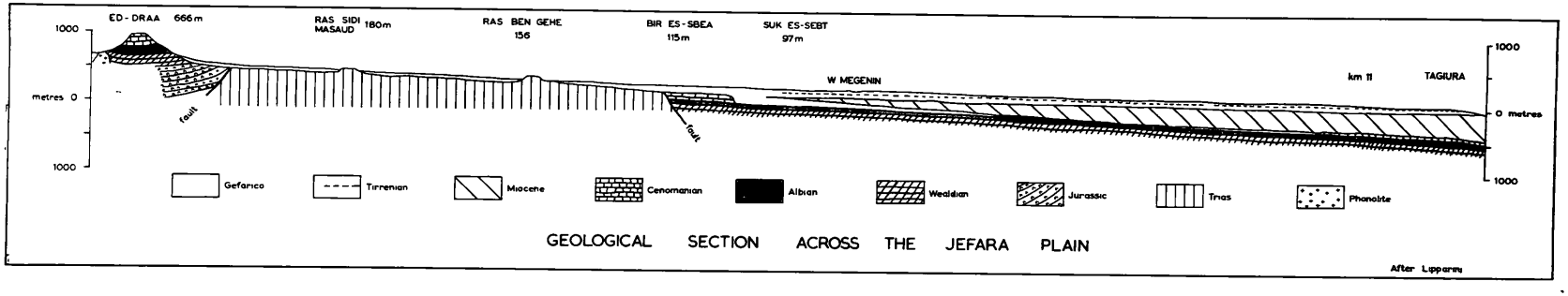
(ii) Continental erosion The advanced development of the Jebel wadis, plus the occurrence of small 'residual' hills in front of the Scarp, led Ahlmann (14) among others to conclude that the Scarp was formed by the processes of normal continental erosion. This theory does not explain the occurence of the fault line at Azzizia nor the great thickness of the Miocene in the Jefara. Continental erosion has been important in the regression of the Scarp to its present position and proportions,

but it did not give rise to it.

(iii) Faulting. Lipparini put forward the theory that the Jebel Scarp was formed by a series of faults, and that the northern limb of the Cretaceous anticline was down faulted. He stated that deep boring in the Jefara at Souk el Sebt and Biar es Sheba (Tunisia) had reached a series of sandstones and clays beneath the Miocene, and he assigned these to the Wealden. The French found similar evidence in other parts of Tunisia and they concluded that the Cretaceous underlaid the Miocene in the Jefara. Lipparini traced a series of faults at Azzizia and Maamura. These were aligned parallel to the Jebel Scarp. He concluded that a series of faults could be found by boring within 5 - 6 kilometres north of the Scarp. These have not been explored and their existence has not been proved. However, the theory that faulting gave rise to the scarp is the most feasible and most widely accepted of those put forward, and led Archambault to produce a hypothetical section across the Jefara (fig. 8).

Fracturing and downfaulting of the northern limb of the Jebel probably gave rise to the Scarp. Subsequently, the northern limb was covered by the Miocene and Pleistocene depositions to produce the present day Jefara. The Miocene was deposited on the eastern margins of the Jebel because the

figure 8.


ED-DRAA 666m
RAS SIDI MASAUD 180m
RAS BEN GEHE 156
BIR ES-SBEA 115m
SUK ES-SEBT 97m
W MEGENIN
km 11
TAGIURA
1000
metres 0
1000
1000
0 metres
1000
fault
fault
Gefarico
Tirrenian
Miocene
Cenomanian
Albian
Wealdian
Jurassic
Trias
Phonolite
GEOLOGICAL SECTION ACROSS THE JEFARA PLAIN
After Lipparini

degree of uplift in the anticline was weakest here whilst the downthrow of the northern limb was correspondingly weaker.

F. Mineral resources

The mineral resources of the Eastern Jebel have been examined by the Missione Sanfilippo in 1910 (4), Desio (8) in the 1930's and Brichant (15) in 1950. Their results showed that there were only four possible sources of mineral wealth: phosphates, lignite, oil and building stone.

The Missione Franchetti examined 27 samples of rock for phosphate content and the results are given in Appendix IX. It is clear that phosphates do not occur in exploitable quantities.

The Italians planned to quarry the lignite deposits at Cussabat, but their plans were based on the very optimistic report of Viezzer (16). Brichant and Chiesa (3) subsequently investigated the deposits and concluded that they were too thin for exploitation. In addition to the prohibitive costs, the fact that the deposits are lacustrine indicates that they are not very extensive.

Since early 1958, several major oil strikes have been made in Tripolitania, mainly in the Syrtica basin and the Hamada el Homra. Both the D'Arcy Exploration Company and

the Amoseas Company are continuing to explore the Eastern Jebel, but most geologists think that no oil will be found in the region.

There are good deposits of building stone in the region, associated with both the Garian and Ain Tobi limestones. There are two quarries at Uescetata and Al Khadra exploiting the Garian beds. As there is no building stone on the coast, where most of the rapidly expanding towns are situated, there should be a constant, if not increasing, demand for stone quarried in Tarhuna. If sedentarisation of the semi-nomadic tribes continues, then local demand will increase.

G. Summary and conclusions

The Eastern Jebel is the remnant southerly limb of a Cretaceous anticline, whose northern limb was down faulted in the late Cretaceous. Though Jurassic and Miocene strata are found, the region is dominated by the horizontally deposited beds of the Middle Cretaceous. The varying lithology of these strata is important from the viewpoint of continental erosion and groundwater resources. The solid base of the Eastern Jebel was affected by Pleistocene deposition, principally aeolian loess, but also by locally eroded alluvium. The deposition of the Pleistocene and Recent mantle has produced the soil cover and given rise to the most important group of aquifers.

The poor mineral resources of the region mean that the population must rely on soil, water and rainfall and that mining or quarrying cannot form an economic alternative to agriculture or pastoralism. The fact that building stone exists in exploitable quantities means that, if the semi-nomads are persuaded to lead a more sedentary existence, an abundant supply of building stone will be available.

CHAPTER III.

MORPHOLOGY AND EVOLUTION.

A. Introduction.

It is important to describe the relief of the region as a preliminary to studies of natural resources and agriculture. The structure of the Eastern Jebel has already been described, and it was noted that it is a relatively small part of a vast region extending over southern Tunisia and northern Tripolitania. The tectonic evolution has been described, but it remains to examine the process and stage of erosion. Morphological studies are greatly hampered by the poor cover of topographical maps, the most detailed of which is on a scale of 1:100,000. The maps preclude detailed studies, but they may be used to determine the broad features of the region and to describe relief. The chapter is divided into five main sections, which are:-

B. The major morphological units.

C. Surfaces.

D. Process and stage of erosion.

E. Wadis.

F. Morphological regions.

B. The major morphological units.

The Eastern Jebel is part of a much larger morphological region extending over most of southern Tunisia and northern

Tripolitania. This region consists of the escarpment and plateau of the Jebel and the Jefara Plain, in which Tertiary and Quaternary depositions cover the downfaulted northern limb of the anticline which produced the Jebel. The arcuate-shaped escarpment lies at an altitude of over 800 metres above sea level in parts of Garian, but falls to 400-500 metres in the Jebel Nefousa in the west, 300-500 metres in Tarhuna and 200-300 metres in Cussabat. Throughout its length, the Jebel is defined northwards by a steep scarp which overlooks the Jefara. The Jefara is a flat, fairly sandy plain and slopes gently to the sea. It is broken by the low monadnocks of the Pre-Jebellic hills at Azzizia and to the west, and its surface features vary from sand and sand dunes in the east to outcrops of the calcareous crust (caliche) in the west, and sebka, or dried salty marshes, in the north-west. Near the scarp, there is a well marked piedmont zone. North of Tarhuna, this zone has been colonised by tribesmen from the Jebel, and is thus part of the region under study.

1. The piedmont.

The piedmont lies at an altitude of 175-200 metres in north-western Tarhuna, but falls eastward to about 50-80 metres in the Homs area. Near the Wadi Milgha, (fig. 9), the piedmont is covered in detritus formed from the erosion of the Jebel and is highly ravined, being cut by a number of

large and incised wadis. Between the Wadis Labeter and Ramle, it slopes northward at an angle equivalent to 15 per thousand and it is broken by alluvial fans and scree from the Jebel (1). Towards Cussabat, the fans become larger and take the form of long narrow outwash ridges.

2. The Jebel.

Figure 9 shows the relief of the Eastern Jebel, and figure 10, seven selected profiles. Though the scarp is well marked, it is crenulate in appearance and is scalloped and broken by gullies and major wadis. It is roughly aligned east-west, but it is not straight, and there are frequent changes in alignment, especially in the west. The dip slope is defined northwards by a series of scarps and ridges roughly parallel to the Jebel Scarp and formed by homoclinal retreat of the water divide. The zone of scarp slope consequent drainage is deeply incised and broken by numerous wadis, and has an extremely rugged and highly accidented surface. Homoclinal shifting has given rise to a steep cliff scarp in central and western Tarhuna, and to the east and west, smaller but pronounced breaks in slope. Below the Abanat Scarp, the Wadis Turgut and Masabha have excavated an almost ditch-like trench in central Tarhuna. The dip slope undulates in the north, but further south is dissected into mesa-like surfaces by broad wadi channels. Altitude falls from over 600 metres

figure 9.

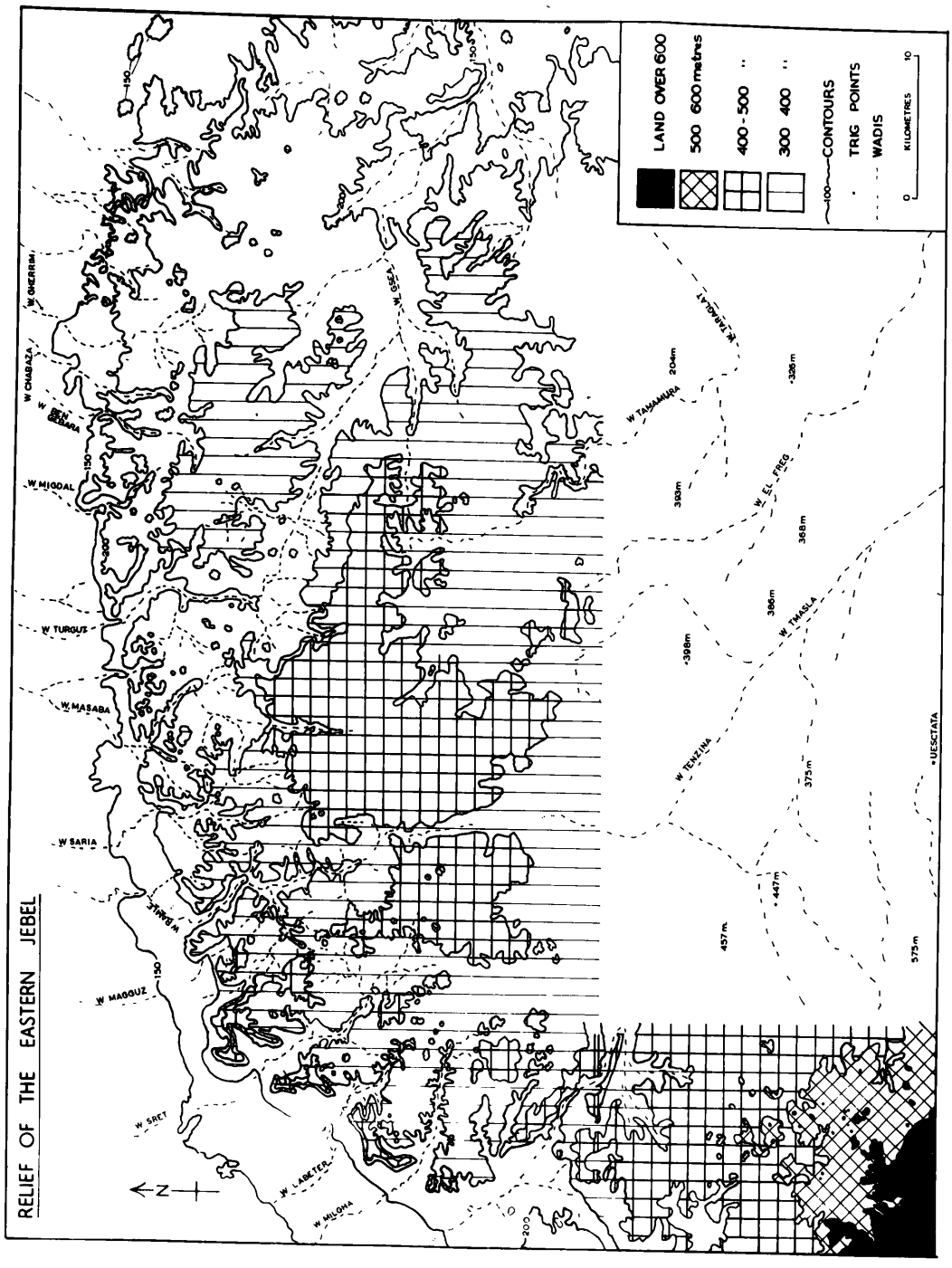
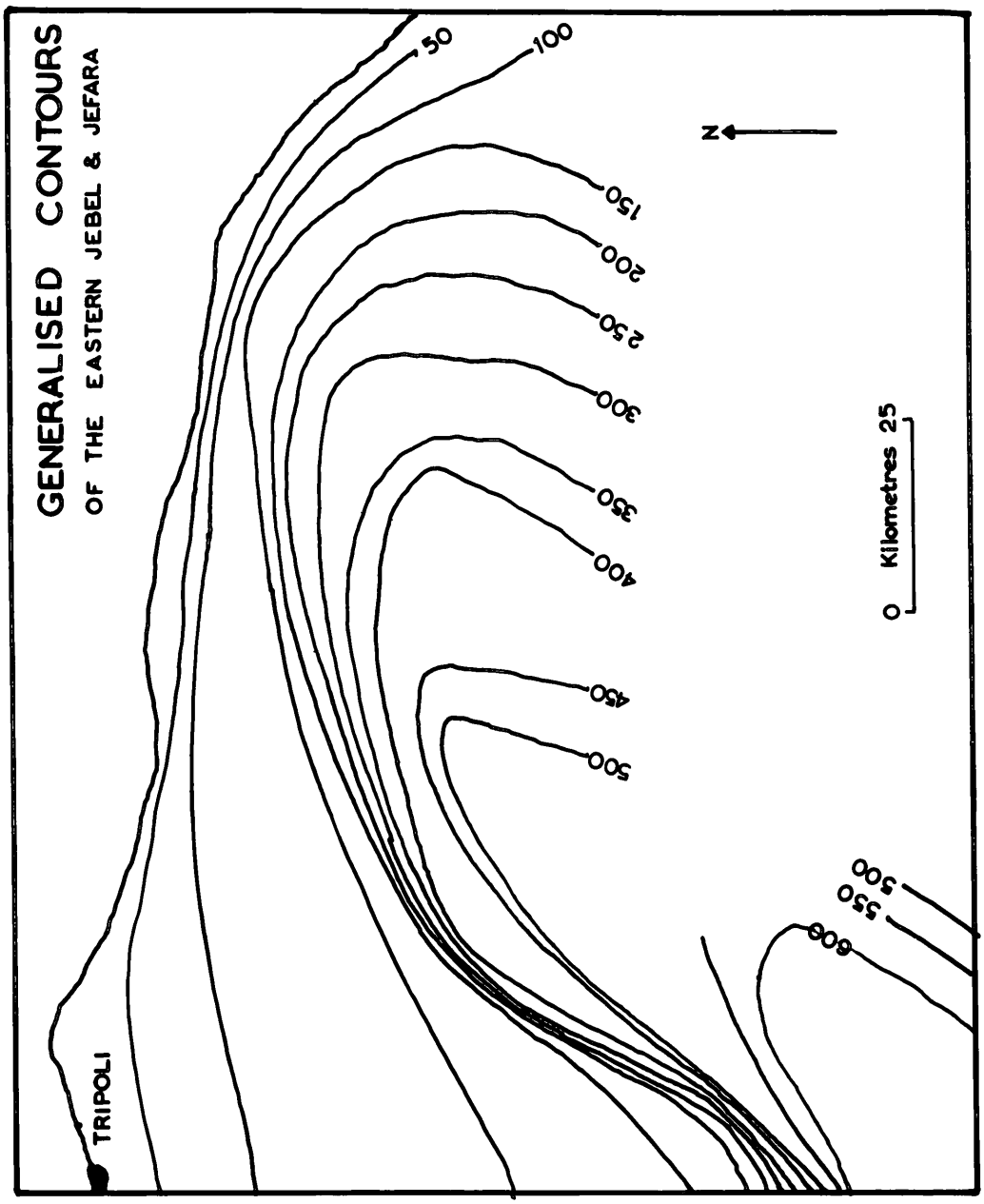

RELIEF OF THE EASTERN JEBEL
LAND OVER 600
500 600 metres
400 - 500 ..
300 400 ..
100 CONTOURS
TRIG POINTS
WADIS
0 KILOMETRES 10
W GHERRIM
W CHABAZA
W MIGDAL
W TURGUT
W MASABA
W SARIA
W MAGGUZ
W SRET
W LABKTER
W MILOHA
W TAMAMURA
W EL FEEG
W THASLA
W TENZINA
UESCTATA
204m
393m
368m
386m
398m
375m
447m
457m
575m

figure 11.


GENERALISED CONTOURS
OF THE EASTERN JEBEL & JEFARA
TRIPOLI
50
100
150
200
250
300
350
400
450
500
550
600
N
0 Kilometres 25

east in El Amamra and the north-east in Cussabat. These slopes have been partially obliterated by a wadi regime consequent to the scarp slope of the Jebel, and the ancient surfaces have been eroded by fluvial action. To determine the direction and importance of the ancient slopes and surfaces, their present morphology must be examined.

1. The highland zone.

The highland zone is well preserved, but is marked northwards by the steep cliff-like Abanat Scarp. North of the Scarp and the main watershed, there are a number of small outliers with altitudes of over 500 metres. These outliers and the Jebel Msid are capped with Garian limestone, which also underlies the main highland zone. The ancient surface has been preserved by this resistant formation, whilst north-flowing wadis have been deeply incised in the soft Jefren marls underlying the Garian limestones.

2. The Tarhuna dip slope.

The Tarhuna dip slope lies to the south-east of the highland zone and dips eastward in the extreme west and south-eastward over the rest of Tarhuna. In the north it has been covered in deep deposits of Pleistocene loess, and it is underlain throughout by Garian limestones and Tigrinna beds. In the north, the surface is gently undulating, but with increasing aridity, wadis are confined to broad but well

incised channels which cut the ancient surface into mesa-like formations. The surface has also been affected by vulcanicity and in places there are local inversions of relief (2).

3. The Msellata dip slope.

To the north-east and east of the highland zone, the surfaces dip to the east and north-east towards the coast near Homs and the Misuratino. The northern section lies at an altitude of 200-300 metres and is very broken, rugged and highly accidented. Wadis flow from the highland zone to the east, north-east and north, so that the hydrography is very complicated. Further south, however, wadis flow to the Misuratino coast, and the dip slope resembles that of Tarhuna. The transition from a south-eastern to a north-eastern direction of slope is sharp, and this is illustrated by the almost right angled change of course of the Wadi Taraglat on the Tarhuna-Msellata border (3).

This slope may be divided into the El Amamra dip slope and the Cussabat surface, the divide being the main watershed between scarp consequent flowing regimes and the south-east-flowing upper feeders of wadis flowing to the Misuratino.

D. Process and stage of erosion.

After the formation of the anticline, wadis consequent to its slopes developed, but the regimes were severely affected

by the fracturing of the anticline and the down faulting of the northern limb. The creation of the scarp gave rise to a series of streams consequent to it which cut back from rills to rivers under the processes of normal regressive erosion. However, the amplitude of relief near the scarp was marked, and the local base level of north-flowing streams was much lower and nearer than those of south-east and north-east-flowing consequents. The powerful north-flowing streams cut back to undermine and capture the headwaters of south-east-flowing talwegs. The evidence for this process of erosion is abundant within the present landscape. The full range of retrogressive fluvial erosion may be traced in the rills, gullies and steep graded streams cutting the Jebel Scarp. The north-flowing streams have large and well developed tributaries flowing south-eastward. Lipparini traced numerous elbows of wadi capture in the region (4). The process is continuing, and scarp slope consequents are cutting back more rapidly than dip slope wadis.

Lipparini has shown that these processes were active before the beginning of the Pleistocene, but that during the Pleistocene conditions were altered by the formation of one or more layers of <u>caliche</u> and the deposition of aeolian loess. (5). The deposition of the loess probably took place in the Holocene (6) and 'initiated a period of competition for

erosion between the loess and the intense rainfall, to the advantage of the former' (7). Wadi channels were occluded by the loess, which filled many of the hollows and depressions in the region. The result is that wadis in the northern Jebel now cut their beds in the Pleistocene, and only the deeper talwegs penetrate to the underlying bed rock. These features are marked in the ditch-like area of central Tarhuna occupied by the Wadis Gsea, Turgut and Masabha. Recent downcutting and erosion has produced the Pleistocene terraces of the Scarp Zone.

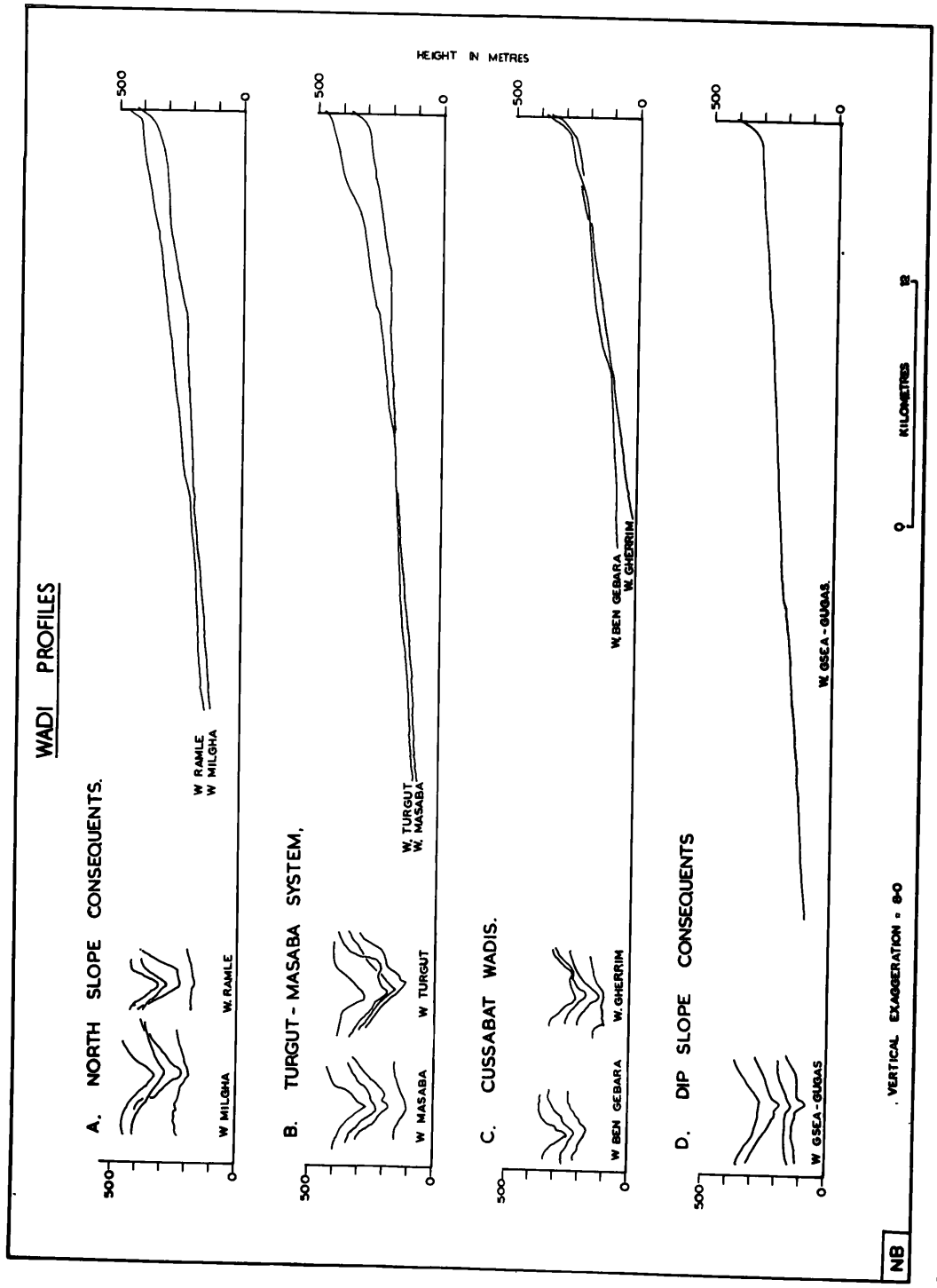
E. Wadis.

Wadis respond to the base levels of the Jefara, the Mediterranean and the Wadi Soffegin and are consequent to the scarp and dip slopes. Their stage in the cycle of erosion has been altered by capture, occlusion and faulting or jointing. The wadis may be divided into groups reflecting these characteristics: wadis of north-western Tarhuna, the Turgut-Masabha system, Cussabat wadis and the dip slope consequents flowing to the Wadi Soffegin and the Mediterranean.

1. Wadis of north-western Tarhuna.

These wadis flow to the west of the Wadi Masabha. Two wadis, the Milgha and Ramle, have been examined in detail and their profiles are shown in figure 12a. The wadis rise near

figure 12.


WADI PROFILES
HEIGHT IN METRES
A. NORTH SLOPE CONSEQUENTS.
W MILGHA
W. RAMLE
W RAMLE
W MILGHA
B. TURGUT - MASABA SYSTEM,
W MASABA
W TURGUT
W. TURGUT
W. MASABA
C. CUSSABAT WADIS.
W BEN GEBARA
W. GHERRIM
W BEN GEBARA
W. GHERRIM
D. DIP SLOPE CONSEQUENTS
W GSEA - GUBAS
W GSEA - GUBAS
500
0
VERTICAL EXAGGERATION = 8·0
KILOMETRES
NB

Tarhuna town and flow north-east and north to the Jefara, according to the alignment of the scarp. The Wadi Milgha is interesting because part of its middle course is occupied by a small Italian estate, whilst the Wadi Ramle is fed by the perennial spring of Scersciara. The upper feeders are incised in the Pleistocene and Garian limestone and are typical of youthful arid streams. They are steep-sided and steeply graded, and their boulder-strewn floors consist of a series of small tiers ranged in the wadi profile. The tiers are floored by limestone or caliche sills and are vigorously attacked by the wadi spate. The Wadi Ramle cuts a small aquifer at Scersciara and water flows along the bed for a few hundred yards, giving rise en route to Tripolitania's only perennial waterfall.

The middle courses have been filled by Pleistocene loess and the wadi channels are cut between terraces. The Pleistocene extends into the major tributary wadis, to soften the accidented surfaces and give rise to good sandy soils. Further down the profiles, the amplitude of relief is greater and the valleys are encased between cliff-like limestone and marl slopes. The wadi channels widen, and as the terraces disappear the spate overflows the channel to agrade the lit majeur. Near the scarp, the wadis are deeply incised between towering banks broken by overhanging immature feeders. As

the wadis break through the scarp, piles of alluvium are deposited by the spate. Neither the Milgha nor the Ramle drain to the sea, but flow to inland basins a few miles north of the scarp.

2. The Wadis Turgut and Masabha.

The Wadis Masabha and Turgut are considered together because they once formed a single system linked to the south-east-flowing Wadi Gsea. Lipparini gave the following evidence for this statement (8).

a. The Turgut and Masabha, which flow south-east to north-east in their central courses, appear to be excavated in a ditch-like depression bounded to the south-west by the Abanat Scarp and to the north-east by a detached section of the highland surface of Tarhuna. At the southern end of the depression a very low ridge serves as a water divide between the Turgut and Gsea.

b. The middle courses of both wadis are aligned in the same direction as the Gsea, but turn sharply northwards to flow into the Jefara.

c. Both the Turgut and Masabha are fed by well-developed south-flowing tributaries

It seems that powerful steeply graded scarp slope consequents worked back to capture a large south-east-flowing wadi and detached two sections of it. The Masabha and Turgut

and the Turgut and Gsea are divided by low ridges which contrast with the Abanat Scarp in the south-west.

The wadi profiles are similar to those of the Ramle and Turgut, but the upper feeders are extremely long and deeply dissected in the Abanat Scarp. The whole system was much affected by the deposition of aeolian loess, in which the broad wadi channels of the middle courses are deeply incised. The lits majeurs are extremely large, so that within the central part of Tarhuna there is a zone characterised by gently undulating relief. The ditch-like character of this region is clearly shown in the relief map. Towards the scarp, the profiles resemble those of the Milgha and Ramle, with towering cliff-like banks fringed with scree and rock detritus.

3. Cussabat wadis.

The amplitude of relief is lower in Cussabat than in Tarhuna, because of the relatively low altitude of the Jebel. The declivity of north-flowing scarp consequents is less marked and the wadis compete for erosion with steep dip slope consequents. Therefore, homoclinal shifting is reduced and the water divide swings northwards, then eastwards, as the direction of dip slope consequents changes from south-east to east and north-east. The scarp slope consequents are short but powerful, and the wadi spates normally empty into the sea.

The profiles of the Ben Gebara and Gherrim are given in

figure 12c. The valleys are similar to those of north-western Tarhuna, but they are less deeply incised and are fed by very short tributaries eating back into the small homoclinal scarp. Just below the scarp the valleys are wide and covered in loess, with small aggraded wadi channels. The rugged dissected area associated with the scarp slope is relatively nearer the water divide, so that the rounded contours of the middle courses are rapidly displaced by the narrow, confined, steep-sided valleys of the Scarp Zone. The course of the Wadi Gherrim changes direction rapidly twice near Gherrim village. This has been caused by faulting or jointing, to which the wadi valley has responded in the process of homoclinal shifting.

4. Dip slope consequents.

Study of the dip slope consequents is difficult, because there are no maps of southern Tarhuna. The wadis are consequent to the south-east dip slope in Tarhuna and consist of two principal systems: the Tenzina-Tmasla system flowing to the Wadi Soffegin, and the Taraglat system. The Tenzina-Tmasla system drains western Tarhuna and is fed by two groups of tributaries: a south-flowing group cut into the thick loess of the Sidi Essed area, and an east-flowing group associated with the volcanic effusions of Garian. The latter are steep-sided and narrow wadis which contrast with the broader, gently-graded, south-flowing feeders of the Sidi Essed area. The most

important confluence is at Uesctata, where the two groups of feeders join to form the Tmasla. Because of the importance of the confluence, there are floods every year at Uesctata. The Tmasla flows to join the Soffegin, which lies in the synclinal ditch of the ancient anticline. In southern Tarhuna and the Orfella, the Tmasla is very wide, with a valley floor nearly one kilometre broad sloping gently to the very shallow lit mineur. Vertical corrosion is at a minimum and the wadi is aggrading its banks.

The Taraglat drains most of Tarhuna and El Amamra and is fed by south-east-flowing tributaries, of which the most important are the Gsea-Gugas and the Ueeni. The Gsea-Gugas has been studied in detail and its profiles are given in figure 12d. The upper Gsea is well incised in Jefren marls and its middle valley is very broad, but defined by small cliff-like limestone banks. It flows south-east, but gradually turns eastward into the Gugas and then joins the Taraglat. The Taraglat flows north-east and it has cut the Tigrinna beds to form impressive but narrow canyons. Upper feeders of the Gsea, Ueani and Asal are cut in the Pleistocene of the northern part of the dip slope, but erosion is limited by the extensive olive cultivation of the Cussabat Plain.

North-east-flowing consequents like the Smara are short and deeply incised and flow to the Misuratino coast. Uniclinal

retreat has given rise to a minor scarp feature 2-3 kilometres inland from the coast.

F. Morphological regions.

From the foregoing description, the Eastern Jebel may be divided into morphological regions. (Fig. 13).

1. The Piedmont.

2. The Scarp Zone. This zone consists of the highly dissected area lying to the south of the Jebel Scarp.

3. The Basin Zone. The Basin Zone lies across the middle courses of the major wadis and is characterised by its undulating relief and deep deposits of aeolian loess and alluvial material. It is most clearly marked in the Turgut-Masabha trench.

4. Northern Dip Slope. This is comprised of the loess-covered undulating or flat parts of the northern dip slope, and is defined northwards by the main watershed and the homoclinal scarps. It may be subdivided into:-

   a. Tarhuna Plateau.

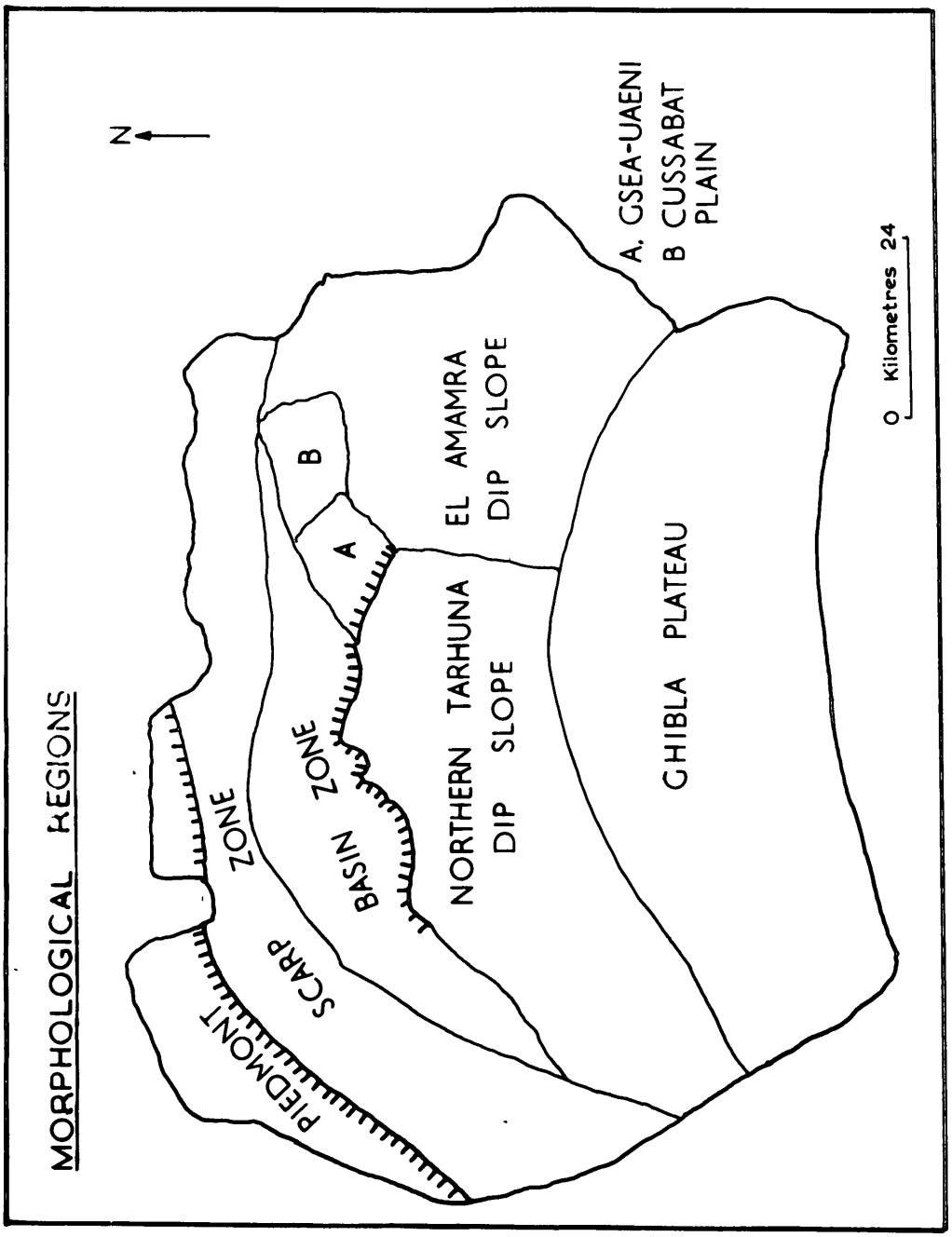
   b. The Gsea-Uaeni valleys.

   c. The Cussabat Plain.

5. The Ghibla Plateau. The Ghibla plateau is the area of south-east-flowing drainage and is dissected into mesas.

6. The El Amamra Dip Slope. This is similar in appearance to

figure 13.


MORPHOLOGICAL REGIONS
N
PIEDMONT ZONE
SCARP
BASIN ZONE
A
B
NORTHERN TARHUNA DIP SLOPE
EL AMAMRA DIP SLOPE
GHIBLA PLATEAU
A. GSEA-UAENI
B CUSSABAT PLAIN
0 Kilometres 24

the denuded Ghibla plateau, but is more humid and drains north-eastward.

G. Conclusions.

The relief of the Jebel has been determined by the alteration of the drainage pattern caused by the formation of the scarp slope. Retrogressive erosion, associated with a high amplitude of relief, led to rapid migration southward of the water divide, uniclinal retreat of the scarp slope and deep incision in the zone near the scarp. In Tarhuna, the effect of homoclinal shifting has been exaggerated by the exposure of Garian limestones, so that an important subsidiary scarp was produced. The wadi regimes were impeded by the deposition of aeolian loess, in which they are cutting their present courses.

Certain areas are of negative agricultural value. Slopes are too steep in the Scarp Zone for extensive cultivation, which must be restricted to Pleistocene terraces, residual plateau surfaces and to broader wadi channels. The Pleistocene has given rise to sandy soils along the northern edge of the dip slopes and in the Basin Zone, and these are potentially suited to agriculture. Sedentary cultivation is confined to small areas of these zones and could be extended. The Ghibla plateau has insufficient depositions of loess to maintain a

good soil material, so that agriculture should be limited to the wadi valleys.

Water is available from springs produced by the cutting of shallow aquifers, and this indicates that groundwater reserves could be exploited by drilling. Though the Ghibla and Jefara are arid, spates will naturally irrigate the wadi channels.

Lastly, the widespread influence of the Pleistocene means that soils will be of a sandy nature.

SECTION TWO.

PHYSICAL RESOURCES.

CHAPTER IV.

CLIMATE, AGRICULTURE AND PASTORALISM.

A. Introduction.

The climate of North Africa is profoundly influenced by its position between the Mediterranean in the north and the Sahara in the south. The northern litoral has a typically Mediterranean climate, with cool moist winters and hot dry summers, but the southern margins have little or no rainfall and a hot continental climate. Tripolitania lies on the southerly embayment of the North African coast, so that the Mediterranean and Sahara are closer together. This situation is reflected in the severity of summer drought in Tripolitania and its lower precipitation. There is no high barrier of mountains between the sea and the desert as in the Magreb, so in all seasons hot dry air may be drawn northwards to affect the Mediterranean litoral. Though the Eastern Jebel lies inland, its greater altitude means that rainfall is comparatively heavy and its temperature range less extreme. Such modification is restricted to the narrow northern margins of the region, and to the south climate rapidly becomes drier and more extreme.

In the region under study, both farmer and nomad are faced with a climate which is marginal for their activities, and which presents them with numerous problems. Because of this, the principal features of the climate will be examined

in detail with special emphasis on how these conditions affect cultivation and pastoralism. An essential preliminary to such an examination is a brief description of the air masses, pressure conditions and winds which give rise to the climatic characteristics. Throughout it must be borne in mind that data is available for only a few years. In the region, recordings of basic climatic data were initiated only in 1924 and they were interrupted by the Second World War. The principal sources of data are Fantoli's 'Le Pioggie della Libia' (1), and 'La Zona degli altipiani nord-orientale della Tripolitania' (2) and Maggazzini's Meteorological reports (3).

1. Winter conditions.

During the summer, eastward-moving depressions, which develop over the Atlantic, travel across Northern Europe. In winter, high pressure develops over the Russian land mass and this causes the depressions to follow a more southerly path to affect the Mediterranean from late September onwards. Those secondary depressions which move through the Mediterranean area enter by a number of "gaps", the more important of which are the Straits of Gibralter and the Gate of Casserone. Thence they follow one of two tracks: through the Adriatic towards southern Russia or along the northern coast of Africa, passing over Sicily to the eastern Mediterranean. Depressions following the more southerly track bring rainfall to

Tripolitania, especially when they pass over Tunisia and Sicily. The main rain-bearing winds are from the north-west, and the alignment of the Eastern Jebel perpendicular to these winds, together with its high altitudes, mean that rainfall is comparatively high. The northwesterly winds pass over the higher parts of the Eastern Jebel first, so that the lower-lying southern areas are in a rain shadow zone. Depressions following the more southerly track are weaker than those travelling over the Adriatic, and the frequency of depressions can vary highly from year to year. These are the fundamental causes of the fluctuating rainfall and high frequency of drought in the region under study.

The region is also affected by Ghibli depressions which form over north-west Africa and move eastwards along the litoral of Libya. These, like the depressions which follow the southerly track, draw in hot air from the Sahara so that in the front of them winds are from the south, veering to the north-west as the depressions pass. Ghibli depressions and shallow local depressions are most frequent in spring and early summer. The blast of hot Saharan air in front of the depressions are called Ghibli winds, and can also be associated with the widespread low pressure of autumn months. The Ghibli winds of the autumn are usually weak because the pressure gradient is not well marked, but in winter and spring they

can reach gale force if associated with deep and active depressions.

The depressions draw in air from Tropical maritime, Polar maritime, Tropical continental and Polar continental air masses. Because the depressions are usually weak, the intermixture of cold and warm air is not well marked, and rain is brought by the cold front and is associated with cold unstable air. As the depressions pass, there is usually a short period of intense rainfall followed by a longer showery period, the intensity of which depends upon the instability of the air. The intensity of the rainfall constrasts with the drizzle associated with the warm fronts of depressions passing over northern Europe. On the whole, depressions pass quickly, resulting in winter conditions characterised by long fine cloudless periods interspersed with brief rain periods.

2. Summer conditions.

In summer, Tripolitania lies between the semi-permanent high pressure zone of the sub-tropical Atlantic and the low pressure zones of the southern Sahara and Persia and north-west India. The Mediterranean region is an area of descending air, and pressure is high. The North-east Trade Winds which move southwards over Tripolitania to the thermal low of the Sahara are steady but light in force, and dry. Conditions are much more stable than those of winter, but temperatures

are very high. They are modified in the Eastern Jebel by its greater elevation in relation to the inner Jefara and Ghibla, where readings average over 85°F. Summer conditions are characterised by clear skies and bright sunshine, but temperatures can drop sharply at night because cloudless skies permit the maximum radiation of heat.

3. Winds.

Winds, particularly from the south and north-west, have important effects on agriculture and pastoralism and need close examination. The annual average frequency of wind readings at Tarhuna and Cussabat towns between 1925 and 1935 was as follows:-

Table IV - 1. Average frequency of wind readings at Tarhuna and Cussabat towns 1925-35 in percentages.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm
Tarhuna	20	18	5	10	20	6	5	16	-
Cussabat	16	7	6	9	22	10	18	11	1

Only 16% and 11% of winds come from the north-west, but most of these are associated with winter depressions. It is interesting to note that north-west winds are more frequent at Tarhuna than at Cussabat, despite the fact that the latter has a much higher rainfall. This happens because Cussabat lies further to the east and much nearer the coast than Tarhuna; this also means that westerly winds are more frequent

at Cussabat. Monthly figures are available for only four years, but in each year Tarhuna had more northwesterly winds than Cussabat in all winter months.

The most important winds from the viewpoint of crop production are the Ghiblis. Graif (4) calculated the frequency of Ghiblis for the period 1928-38 (Table IV - 2).

Table IV - 2. Frequency of Ghibli winds, 1928-1938.

	Tarhuna	Cussabat
October	2.2	1.3
November	1.0	0.1
December	0.3	0.0
January	0.0	0.0
February	0.5	0.1
March	1.1	0.3
April	2.6	1.0
May	3.2	1.3
Average	10.9	4.1

Ghiblis are more frequent at Tarhuna than at Cussabat because the former is much more exposed to the south. Cussabat has fewer Ghiblis than most parts of Tripolitania. Tripoli has 7.3, Azzizia 13.7 and Homs 6.2. Ghiblis are most important in the spring when they can be detrimental to the cereal harvests.

Figures for wind velocity are available for the period 1932-42, when 56% and 60% of winds at Tarhuna and Cussabat respectively were mild. Gale force winds are not common, but can occur on three to four days a year on average. Winds are usually not strong enough to do serious damage to crops and

plants.

B. Climatic regions.

The Eastern Jebel may be tentatively divided into climatic regions on the basis of temperature and rainfall readings from Tarhuna, Cussabat and stations bordering the Jebel. There are three regions: Humid Plateau, Semi-arid Plateau and Continental Steppe. (Fig. 14a).

1. The Humid Plateau.

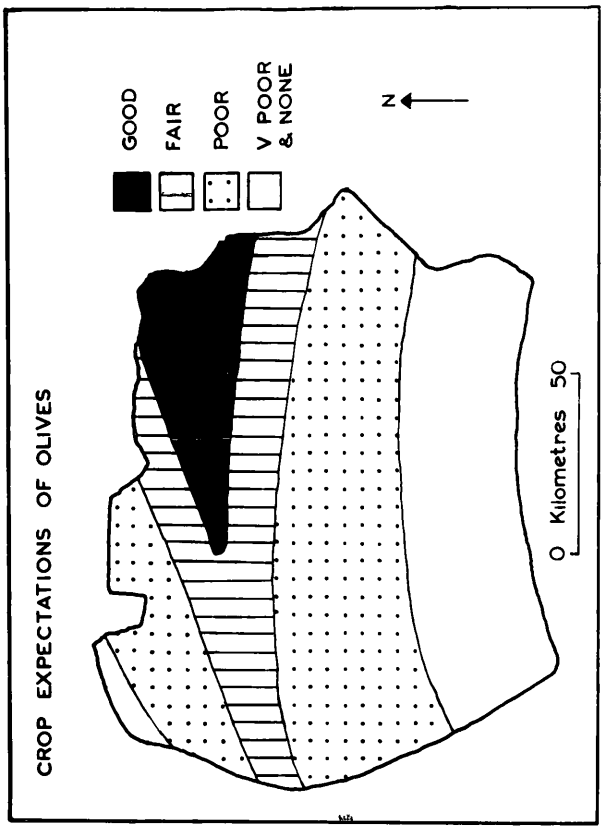
This zone is comprised of Cussabat and north-east Tarhuna. The mean annual temperature is about 68°F and the temperature curve closely resembles that of the Tripolitanian coast. Winter temperatures vary between 50 and 55°F, but frost can occasionally occur in January, which is the coldest month. Summer temperatures are relatively low - 77-80°F. The absolute maximum of 115°F was recorded during a spring Ghibli, though August is normally the hottest month. De Martonne's index of aridity is 12 in this region (5), but according to the index of Köppen (6), the region has a semi-arid steppe climate. Rainfall is comparatively high, exceeding 275 mms. per annum in all areas, but rising to over 300 mms. around Cussabat and the area to the north-west.

2. Semi-arid Plateau.

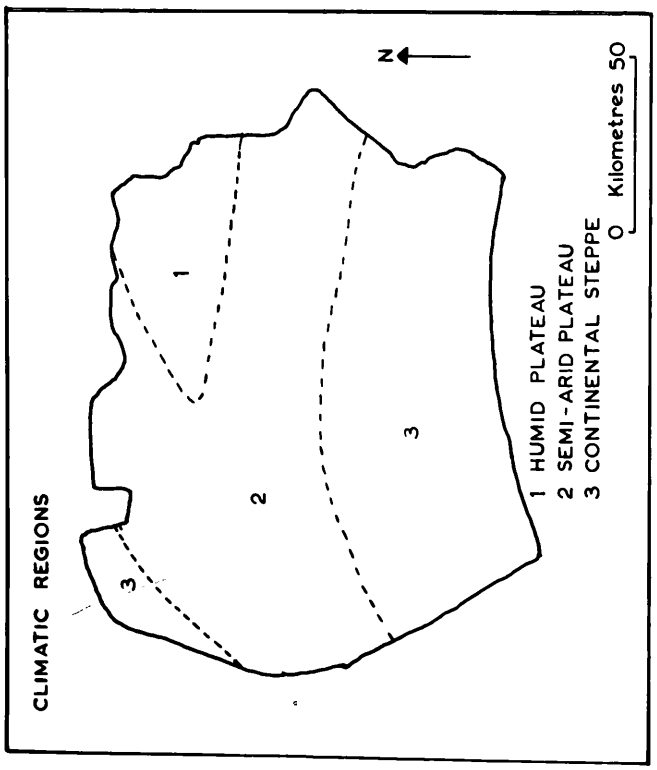
The Semi-arid Plateau includes most of northern Tarhuna

figure 14

(a)


CROP EXPECTATIONS OF OLIVES
GOOD
FAIR
POOR
V POOR & NONE
N
0 Kilometres 50

(b)


CLIMATIC REGIONS
N
1
2
3
3
1 HUMID PLATEAU
2 SEMI-ARID PLATEAU
3 CONTINENTAL STEPPE
0 Kilometres 50

and the El Amamra. Average temperatures are slightly higher than those of the Humid Plateau, but the range in mean monthly temperatures is greater. Frosts have occurred between December and February, whilst a Ghibli has sent June temperatures soaring to 123°F. Rainfall varies between 200-275 mms. and is less reliable than that of the Humid Plateau. De Martonne's index is 9 and Köppen's 22, showing that the region lies on the border of steppe and desert climates. The region may be subdivided as follows:-

a. A more humid northern zone with a rainfall of 250-275 mms..

b. A less humid dip slope with a rainfall of 200-250 mms., frequent Ghiblis and higher summer temperatures.

3. Continental Steppe.

This area is defined northwards by the 200 mms. isoyet and extends southward into the Wadi Soffegin basin and the desert. The mean annual temperature is 72-74°F with a summer average of 90-95°F, but with low winter temperatures which often fall below zero at night. The temperature range is pronounced and an extreme maximum of 132°F has been recorded at Beni Ulid. Rainfall is low and very unreliable, less than 75 mms. on the southern border of Tarhuna. That part of the Jefara Plain lying in northern Tarhuna also has a Continental Steppe climate.

These divisions are necessarily arbitrary, as the rain

factor can alter their boundaries by tens of kilometres in any year. That part of the Jefara Plain lying in northern Tarhuna also has a continental steppe climate.

C. Temperature.

The mean average temperature is very similar at Cussabat and Tarhuna, 66°F and 67°F respectively. Both are cooler than the coastal stations of Homs (68), Garabulli (69) and the steppe stations at Azzizia (70) and Beni Ulid (70), but warmer than the rest of the Jebel (Garian - 60°F).

The monthly means (Table IV - 3) show that the temperature regime is characterised by a rapid rise in temperature in spring and an equally rapid decline in autumn. These movements are much more marked than in the coastal stations.

Table IV - 3. Monthly mean, maximum, extreme maximum, minimum and extreme minimum temperatures at Tarhuna and Cussabat.

		Jan.	Feb.	Mar.	Apr.	May	June
T.	Mean	51	53.1	57	64.4	69.9	88
C.	"	52	52.8	58.8	63.8	69.7	86
T.	Max.	58.8	62.6	69.2	87.4	83.8	93.3
C.	"	60.2	61.9	69	85.1	83.6	90.8
T.	Min.	42	42.5	47.5	51.4	56.8	63.8
C.	"	44.1	45	48.2	52.2	57.6	64
T.	Ex. Max.	88	89.8	100.4	107.6	117	123.5
C.	"	90.6	92	95.4	114	110	119
T.	Ex. Min.	32	32	33.2	37.6	36	39.5
C.	"	32	35	33.4	39.2	37	40.2

		July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
T.	Mean	90	90.6	87	70.8	62.3	51.9	67
C.	"	89	88	87	70.8	63.2	54.2	66
T.	Max.	95	96	92	83	72	61.8	88
C.	"	92	92.5	90.6	92.8	73	62.8	86
T.	Min.	65.2	65.2	64.6	60	52.3	42.5	54
C.	"	66.4	66	65.4	60.8	54.2	47	63
T.	Ex. Max.	119.6	113	111.6	101	99.4	86.5	123
C.	"	113	115	113.1	110	98.5	91	119
T.	Ex. Min.	51	49	41.6	42	33.2	32.2	32
C.	"	54	53	51	40.2	37.3	35.6	32

The monthly means indicate small but significant differences between Tarhuna and Cussabat. In the cooler season, October-March, the mean monthly temperatures are higher at Cussabat (50-60°F) than Tarhuna. (The difference is more marked in the coldest months than in the spring or autumn). In summer, Cussabat is cooler than Tarhuna. The differences between the stations may be explained by the lower altitude and more northerly and maritime position of

Cussabat.

The hottest month in the Eastern Jebel is August, but the highest temperatures have been recorded in early summer during Ghiblis (Table IV - 3). Cold and hot spells may be studied from the figures for monthly maximum and minimum temperatures. At Tarhuna, the mean maximum averages between 90 and 95°F, whilst at Cussabat it rarely exceeds 90°F. Nonetheless, high temperatures have been recorded in every month and in January figures of 90°F and 88°F have occurred at Tarhuna and Cussabat respectively. Extreme maximum temperatures of over 100°F have been recorded in all months between March and October at Tarhuna, but the highest temperatures occur in May and June in association with Ghibli winds, which can send temperatures soaring by 30-40°F. Such a temperature rise reduces relative humidity by 50-55%, and increases the evaporating power of the atmosphere. This leads to a rapid loss of moisture from the soil, so that cereal crops can be ruined. Ghiblis are harmful if they occur during the pollinating stage of the olive or the milk stage of the almond. The only crop which benefits from Ghibli winds is the palm, which is not cultivated in the region.

Though the mean minima temperatures are 42°F and 44°F in Tarhuna and Cussabat respectively, extreme minima often fall below freezing point. Dr. Maggazzini, Head of the

Meteorological Service in Tripolitania, says that frosts can occur at Tarhuna from the last ten days of December to mid-March, and sometimes as late as mid-April. Frosts occur mainly in the numerous hollows and depressions of the Eastern Jebel, and Italian farmers say that localised ground frosts are common in January and February. Late frosts are detrimental to tree and cereal crops, and local farmers have discovered by trial and error that the air in depressions is often too cold for almond trees, even when there is no frost.

On the whole, however, winters are mild, particularly in the Humid Plateau area, but they become much more severe in the Continental Steppe, where summer temperatures are also higher. The mild winter temperatures induce a period of vegetation repose during the colder months, whilst hot summers restrict plant development (7). The period of winter repose is peculiar to the Eastern Jebel and precludes, for example, the production of early vegetables for the fast growing Libyan towns or foreign markets.

The ranges of temperature are also important. According to Fantoli, the mean annual range at Tarhuna is 24°F and only 21°F at Cussabat.

Table IV - 4. Monthly ranges in temperature in degrees Fahrenheit.

Station	Jan.	Feb.	Mar.	Apr.	May	June
Tarhuna	48.8	52.2	53	58	60.4	62.4
Cussabat	47.8	49.9	50	57	56.6	58.6

Station	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Tarhuna	63	62.8	60.8	54.4	51	49	56
Cussabat	58.2	54.2	54.8	51.6	49	47	53

The temperature ranges are well marked in all months and do not fall below 47.8°F anywhere in the region. The ranges at Tarhuna and Cussabat are about the same in the colder months, but in summer the diurnal variations of temperature are much more pronounced at Tarhuna than at Cussabat.

The Humid Plateau region has a milder climate than either of the other two regions. Higher temperatures in winter, which is the humid season, mean that the Humid Plateau is better suited to tree crop and cereal cultivation. This is particularly important in view of the fact that attempts are being made to introduce highly sensitive tree crops in both the Humid and Semi-arid Plateaus.

D. Relative Humidity and Mists.

1. Relative Humidity.

Relative humidity is important because it influences the

occurrence of mists and dew, and has a profound effect on rates of evaporation and evapo-transpiration. Relative humidity is also significant because it affects the effectiveness of precipitation. Unfortunately, it is impossible to assess relative humidity accurately because there are not enough readings. Readings are taken at 9 a.m. only at two stations in the Eastern Jebel - Tarhuna and Cussabat towns - and at Beni Ulid.

Table IV - 5. Monthly relative humidity.

	Jan.	Feb.	Mar.	Apr.	May	June
Cussabat	70	68	59	49	46	42
Tarhuna	64	61	58	49	46	37
Beni Ulid	64	61	57	48	43	35

	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Cussabat	41	49	53	54	60	63	55
Tarhuna	38	43	51	55	61	63	52
Beni Ulid	36	40	48	54	60	65	51

The figures are clearly influenced by the fact that Cussabat is nearer to the sea than Tarhuna and Beni Ulid, which is furthest away of the three. Proximity to the sea results in higher humidity, so that at Homs, for example, it never falls below 62. Humidity is lowest on the coast in April, but lowest in the Eastern Jebel in June or July. The most striking feature is the very low humidity of summer months. Even winter figures are low, especially at Beni Ulid. These

facts emphasise that the climate is comparatively arid and show that rain-bearing depressions are not very frequent. Nonetheless, relative humidity at Cussabat is higher than that of any other station in Tripolitania except Jefren.

The figures demonstrate that rates of evaporation are lowest in the rainy season and that summer air has a greatly increased capacity to absorb soil and plant moisture.

2. Mists.

Mists are common, especially in winter months. They are produced by cold humid air sinking into the hollows and depressions of the region. Mists, like frosts, thus tend to be localised, and few occur in the towns of Tarhuna and Cussabat, which do not lie in depressions. The writer observed that mists occurred morning after morning in Tarhuna from December to February, when it is common to see valleys shrouded in mist while visibility is good on the plateau surfaces. The mists, which can persist until early spring, disperse quickly as temperature rises, but they are a menace to crop production, for they can cause young olive blossoms to swell and fall off too quickly during the pollinating period. Mist can also produce the Cytope disease, and almonds and fruit trees are very sensitive to the cold humid air of the early morning mists. Though there are no figures, mists are much less frequent in Cussabat than in the higher and colder plateau

surfaces of the Semi-arid Plateau and Continental Steppe regions.

E. Precipitation.

Precipitation most commonly occurs as rainfall and dew in the region under study, but falls of hail and snow have been recorded.

1. Hail, snow and dew.

(a). Hail and snow.

Hail is infrequent and is expected only one day each year. However, it can be severe enough to flatten cereals and kill animals, which it did in 1955. Snow is expected, on average, once every 4-5 years. It is never heavy and quickly melts, though it lay on the ground for three days in Tarhuna in January, 1958.

(b). Dew.

The amount and frequency of dew forming in the region under study have never been recorded. Fantoli described dew as 'precipitazione occulte' and stated that it frequently occurs during the dry season, particularly on north-facing slopes. It can be observed on many mornings around Tarhuna town, where the vegetation is often soaked in dew. The writer's Landrover was covered in moisture morning after morning. Dew falls are more important in the late summer.

The upper limit of dew release during a night has been established at between 0.5 and 1.0 mms.[*] Went[**] has conducted a series of experiments in Israel, where he found that along the coast squash and corn grew almost twice as rapidly when they receive dew during the night. He found that 'some tenths of a millimetre' of dew fell per night in parts of the Negev and that annual dew falls were about 25 mms., and in favourable areas up to 250 mms.. Parts of the Negev are similar climatically to the Ghibla of the Eastern Jebel, where dew falls are probably high.

Dew is precipitated at night when plants are growing, and it is thus absorbed by leaves and foliage. However, the effectiveness of dew is impaired by the high evaporation rates, and when falls are heavy it drips from the leaves to the ground. Because the amount is so small, it does not percolate underground and is evaporated when the sun appears. Nonetheless, dew is a valuable supplement to rainfall, though unfortunately few attempts are made to trap it. In Cussabat, stones are piled round the feet of olive trees, or by themselves; in Tarhuna, the patchiness of cereal cultivation probably attracts dew. In an area where rainfall is low and unreliable, much greater efforts to trap dew are necessary.

---

[*] Vernet (19).

[**] Went ('Other references' No. 35)

Conditions are almost ideal for dew formation in the Eastern Jebel. Cloud cover averages 33% at Tarhuna and 31% at Cussabat, and in summer the sky is clear for very long periods.

2. Rainfall.

Water is the critical factor, and in a zone of dryland agriculture rainfall is of the most profound importance. In the Eastern Jebel, the groundwater resources are not sufficient to allow irrigation, and the distribution of wells and springs is such that most areas must rely on precipitation. As rainfall is so important, it must be examined in all its vagaries with special emphasis on its distribution, reliability and effectiveness. Effectiveness is influenced by the use made of the rainfall, but only the climatic influences will be considered in this chapter.

(a). Distribution.

Rainfall recordings are available from several stations along the Tarhuna plateau, but readings for the Humid Plateau are taken only at Cussabat town, so that occasionally it is necessary to refer to recordings taken at stations outside the Eastern Jebel. Rainfall averages by month and year for stations in the Eastern Jebel are given in Table IV - 6, and fig.15 shows the rainfall distribution.

Table IV - 6. Rainfall averages (agricultural years) for selected stations.

(MILLIMETRES)

Station	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Year
1. Eastern Jebel													
Cussabat (24) *	9.2	28.8	38.1	55.6	80.6	56.2	37.7	14.7	5.0	1.3	0.0	1.7	328.9
Tarhuna (34)	9.0	21.9	28.2	45.9	61.3	48.9	31.3	10.3	5.5	2.4	0.0	0.6	263.4
El Gsea (15)	9.8	17.8	30.4	47.0	58.5	51.0	25.7	11.4	6.6	1.5	0.2	1.4	261.3
Al Khadra (14)	6.5	26.7	24.3	40.3	59.4	44.9	22.8	13.9	8.1	0.0	0.1	4.4	251.4
" (18)	4.8	19.2	24.5	38.9	53.4	48.1	22.0	12.4	4.0	1.3	0.2	1.1	229.9
" (14)	4.7	21.7	31.8	36.5	54.2	48.0	29.3	10.8	5.6	0.0	0.5	4.8	247.9
Biar Miggi (24)	8.6	16.4	28.6	41.7	56.4	39.2	31.1	14.2	4.0	0.0	0.0	0.0	270.3
Sidi Essed (5)	4.5	12.2	23.4	40.2	43.4	56.4	16.7	13.6	4.0	0.0	0.0	0.0	245.0
2. Coast and western Jefara													
Homs (40)	7.3	29.9	48.9	52.3	57.1	39.2	19.6	9.3	5.7	1.3	0.0	0.8	271.4
Sciogran (6)	4.0	38.3	59.2	40.1	47.5	30.2	12.4	17.6	3.4	0.0	0.0	0.0	252.7
Gasr Chiar (12)	9.6	32.8	37.8	54.1	27.0	37.7	21.6	9.9	5.3	2.0	0.0	0.1	277.3
Garabulli (16)	11.3	42.5	26.1	72.2	78.8	47.5	29.2	8.4	3.1	1.8	0.0	0.0	320.9
Zliten (11)	12.3	28.3	38.3	52.5	43.2	29.0	19.1	6.4	3.4	0.1	0.0	0.0	232.6
3. Central Jebel													
Garian (32)	11.4	23.8	39.5	54.0	74.1	51.5	39.9	16.0	12.7	2.1	0.5	0.7	326.2
4. Ghibla													
Beni Ulid (25)	6.1	7.9	6.3	6.6	11.1	7.9	10.2	3.0	5.0	0.5	1.0	0.0	65.6

* Number of years for which readings exist.

The pattern is well marked. Rainfall is highest in the Humid Plateau, and Cussabat has a yearly average of 328 mms.. The figure exceeds 300 mms. over most of the Cussabat area and parts of north-east Tarhuna, declining to 260 mms. along the Jebel Scarp and 260-275 mms. along the northern edge of the Tarhuna plateau and northern El Amamra. Rainfall then decreases rapidly to the south and west, falling to 230 mms. at El Gsea, 245 mms. at Sidi Essed and below 75 mms. on the southern confines of Tarhuna. The pattern of distribution is clearly affected by changes in altitude, position and proximity to the sea. The main rain-bearing winds are most influential in the north-west, where the highland of Cussabat lies near the low-lying coastal plain. Cussabat town is surrounded by high summits which induce heavy precipitation. Orographically, the stations at Tarhuna town and Al Khadra are less favoured than that at Biar Miggi, which lies much nearer to the Jebel scarp. El Gsea lies furthest away from the scarp in the south-flowing Wadi Gsea and has a lower rainfall.

Rainfall distribution varies in time as well as space. The regime is typically Mediterranean, but is modified by the southerly situation of Tripolitania and the elevation of the Jebel. Rainfall begins in late September and finishes in eerly April. Short but intense showers are characteristic of the autumn rains, but the duration and volume of rainfall

increases to reach a maximum in late January. On the coast of Tripolitania, rainfall is higher in December than in February, but in the Eastern Jebel this is reversed, indicating that the region under study has a later maximum. 94% of the rainfall occurs between September and April, and of this, 21-22% occurs between September and November, 32-38% between March and May, the highest figures in both cases being at Nalhuna. The rainiest months in order are as follows:-

Table IV - 7. Rainfall distribution by month at three selected stations.

	Gussabat %	Tarhuna %	Bier Miggi %
January	24.5	23.5	20.6
February	17.3	18.5	12.7
December	16.7	17.4	15.4
March	11.8	10.7	11.3
November	11.5	10.1	10.5
October	6.7	6.3	6.1
April	4.4	3.9	5.3
September	2.7	2.4	2.2
May	1.4	1.8	1.0

The patterns are fairly similar, but it is interesting to note that Bier Miggi has an earlier maximum than Tarhuna and Gussabat. This may be caused by the relative nearness to the Jebel Scarp and distance from the sea of Bier Miggi, since the extension into the spring months of thermic conditions favourable to condensation produces the higher rain-

fall at the other stations. The annual distribution of rainfall is much more erratic in the Continental Steppe, where Beni Ulid has a double maximum in January and March.

(b). Number of rainy days.

An important aspect of rainfall distribution is the number of days on which it rains in a month and a year. (Appendix IVa). Rainfall is associated with the passage of cold fronts in not very frequent depressions. This means that rain is concentrated in short periods with long fine periods between. Rain falls on about 45 days per annum in the Eastern Jebel, but varies from 30 days on Al Khadra to 49 days at Cussabat.

Table IV - 8. Rainy days and rainfall intensity in the Jebel.

	Nos. of rainy days per annum	Average falls (mms.)
Cussabat	48.3	6.7
Tarhuna	44.4	5.8
El Gsea	38.2	6.6
Al Khadra 1	29.2	8.0
Al Khadra 2	35.0	6.5
Biar Miggi	34.6	7.7
Sidi Essed	37.9	6.5
Al Khadra 3	34.5	6.4

Fantoli found from his studies of daily totals at Cussabat town that rainy periods lasted from 3-5 days on average, but that rain could fall on ten days in succession. Rainfall is

intense (Table IV - 8), and between 5.8 and 8.0 mms. fall on every rainy day on average. Rainfall is more intense on the coast, where Tripoli and Homs average 7 mms. and 6.8 mms. respectively, than in the Continental Steppe, where Beni Ulid has an average rainfall of 3.8 mms. per rainy day. Fantoli calculated that 2-3 mms. of rain could fall in one hour on exceptionally rainy days.

If rain falls on only about 45 days per annum, then there are about 320 dry days. Detailed figures are incomplete so that it is not possible to study accurately the length of the dry periods. From Fantoli's recordings at Cussabat, the average length of a dry period is 45 days. (8)

(c). Reliability.

Rainfall in the Jebel is not only low, but also unreliable. In one year there is sufficient rain to give good olive and cereal crops, whilst in another there is severe drought. This variation is similarly manifest spatially.

The rainfall records show that in any one year there is considerable variation between the amounts received at the stations. Unfortunately, the stations are themselves distributed across the path of the rain-bearing winds and cannot show the contrast between north and south. For instance, rainfall in 1958-59 was above average for most

stations in the Jebel except Al Khadra 2. But in the lands of the Cabile Aulad Hamed and El Hamamla in the Wadi Taraglat, no rain fell between February and May. Thus the cereal harvest was ruined and the animals had to be sent to the north three weeks earlier than usual. Over the rest of the Jebel the season was regarded as being a good one. In the north, however, rainfall was high around Tarhuna and as far east as Al Khadra. The Italian farmers on the concession farms had a 'bumper' year, but on central Al Khadra rainfall was below average and only a fair crop was harvested. The north-south variation cannot be shown statistically, but both farmer and nomad are well aware of it.

The rainfall totals for a number of years at each of the Jebel stations are given in Appendix IVb and IVc. These tables have been constructed both for calendar and agricultural years, since statistics for the latter are not always available. In most years, Cussabat has more rain than Tarhuna, but in 1927-8 Cussabat's rainfall was 120 mms. below average, and that of Tarhuna 60 mms. above average. However, in 1936-7, Tarhuna's rainfall was only 230 mms., compared with 443 mms. at Cussabat. In some years, there are large differences between the rainfall of Tarhuna and the stations further east. The Al Khadra stations recorded rainfalls of 50-70 mms. below average in 1943-4, whilst at Tarhuna the rainfall was 295 mms.. These

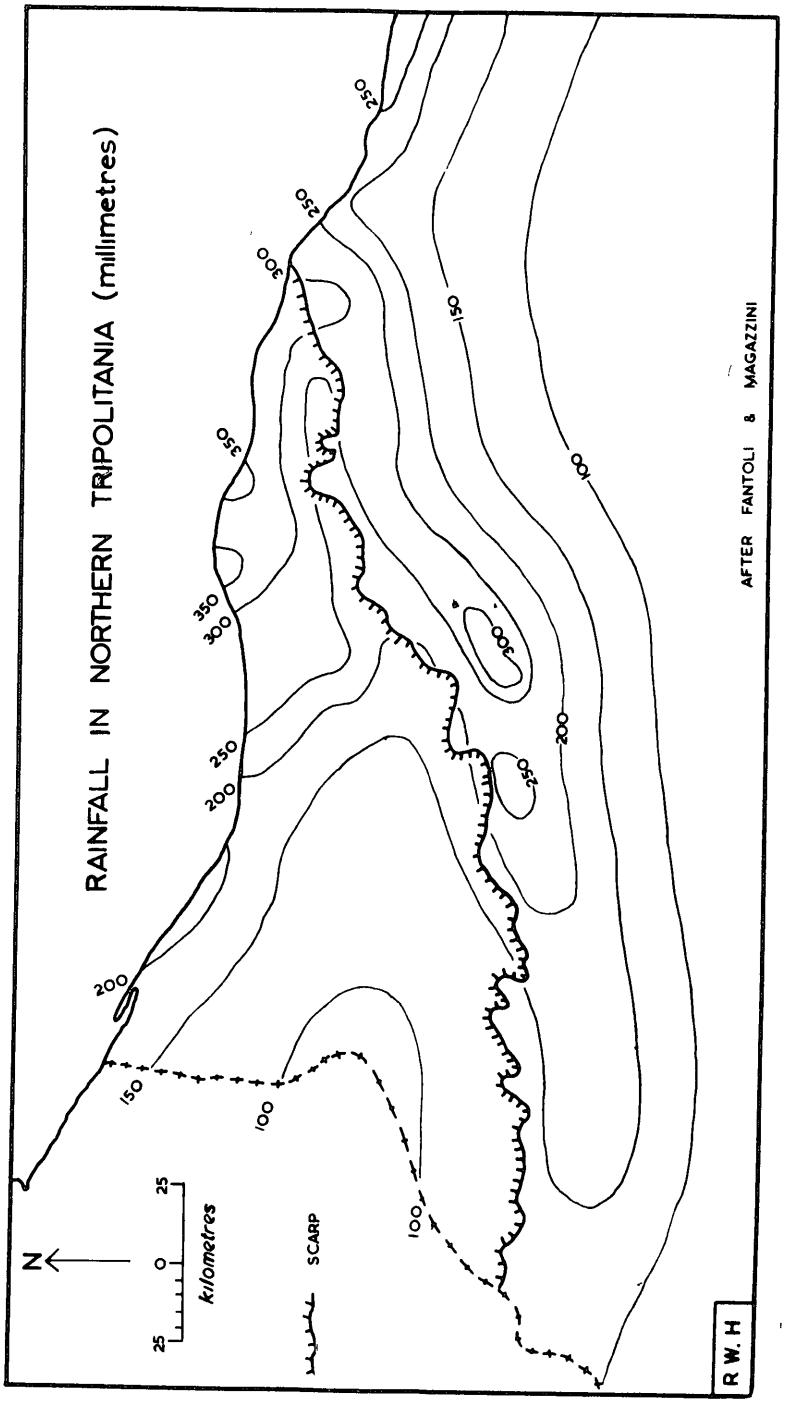
differences illustrate fully the unreliability of the distribution of rainfall and indicate that yields from cereals and trees vary greatly in some years.

If the isohyet pattern of a wet year (1937-38) is compared with that of a dry year, an interesting pattern emerges. In a dry year, Continental Steppe conditions can penetrate into the Humid Plateau, but in wet years even the southern margins of Tarhuna can have a rainfall of 100-150 mms.. (Fig. 16).

Annual rainfall has varied from 114 mms. to 498 mms. at Tarhuna and 112 mms. to 520 mms. at Cussabat, but it is the most frequently occurring amounts that are of most value, and these have been graphed in fig. 17b. Over the relatively short period of 15 years, at Tarhuna most years have had between 250 and 300 mms. of rainfall, or about the mean. At Cussabat, however, there are two peaks at 200-250 mms. and 300-350 mms.. At Cussabat, there are more years below the average, but in a wet year rainfall is often extremely heavy.

The fluctuating behaviour of Tarhuna's and Cussabat's rainfall is graphed in fig.17 c, and may be compared with fig.17 a, which gives the pattern for Tripoli and Azzizia, where figures for a much longer period are available. The stations generally have the same trend, but it can be seen that at Azzizia in the Jefara, the trend differs from that of

figure 15.



After Hill.

figure 16.

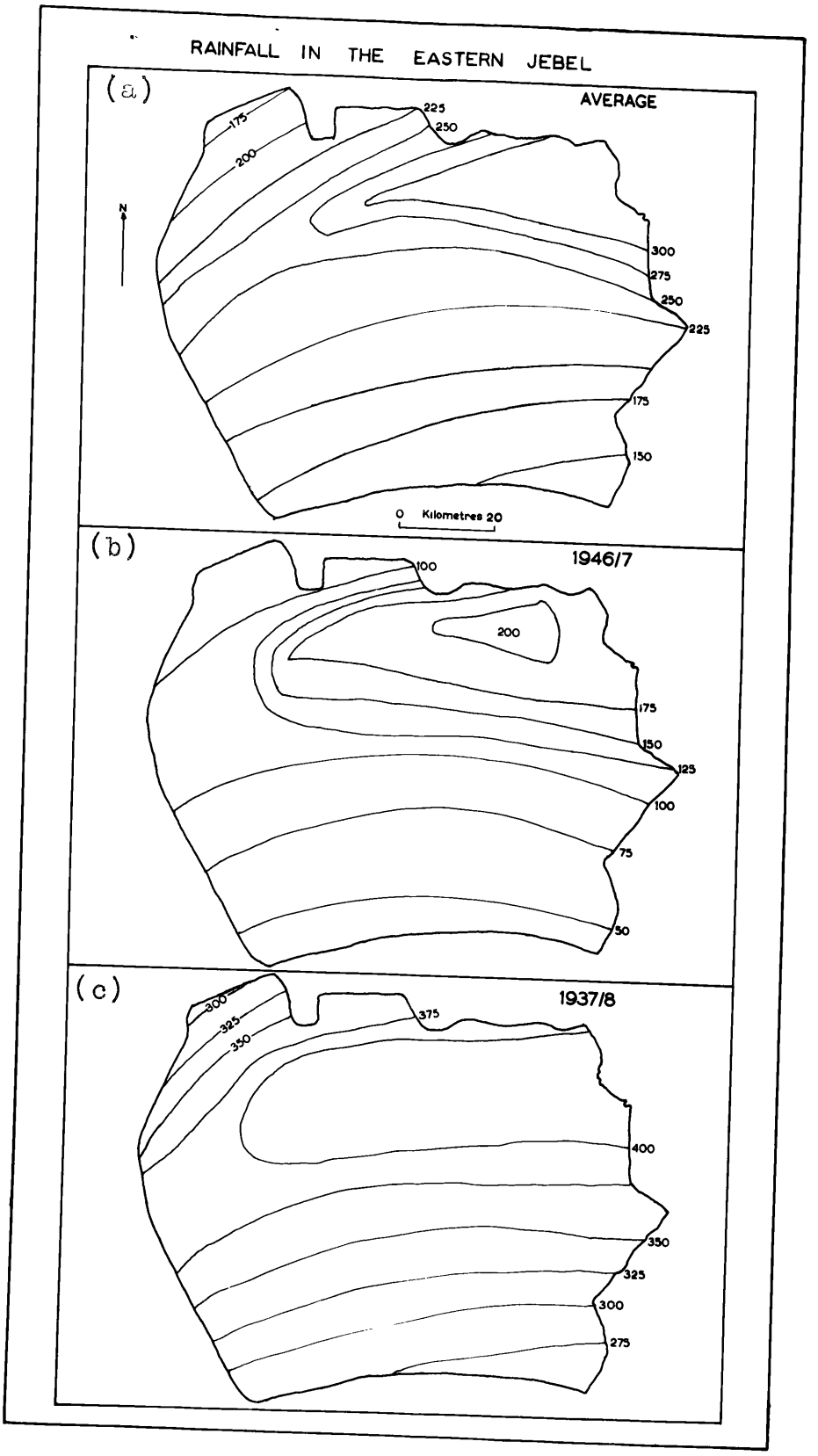
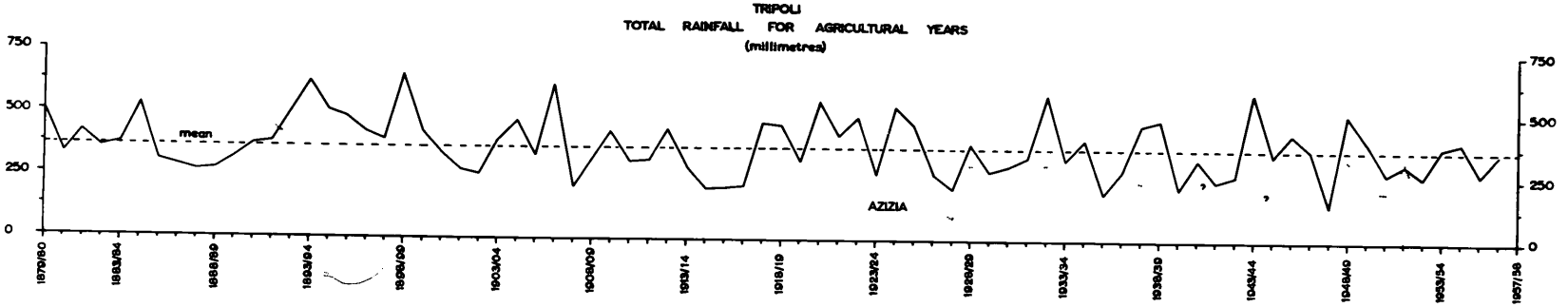
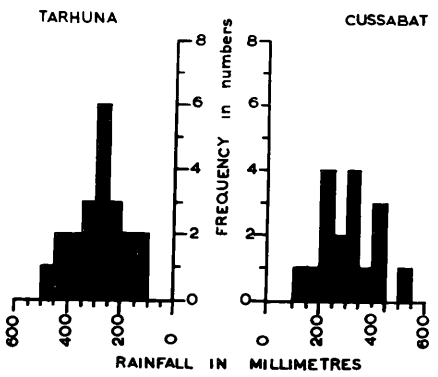

RAINFALL IN THE EASTERN JEBEL
(a)
AVERAGE
225
250
175
200
N
300
275
250
225
175
150
0 Kilometres 20
(b)
1946/7
100
200
175
150
125
100
75
50
(c)
1937/8
300
325
350
375
400
350
325
300
275

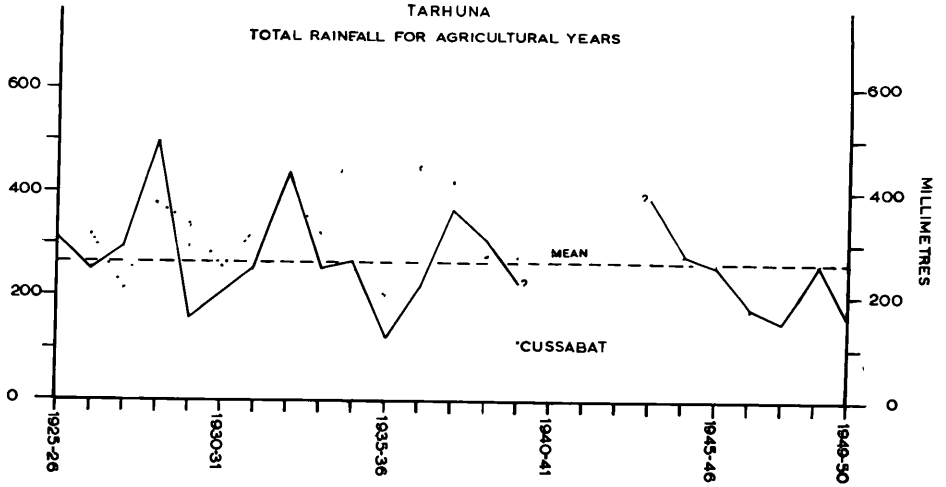
Figure 17.
a



b.



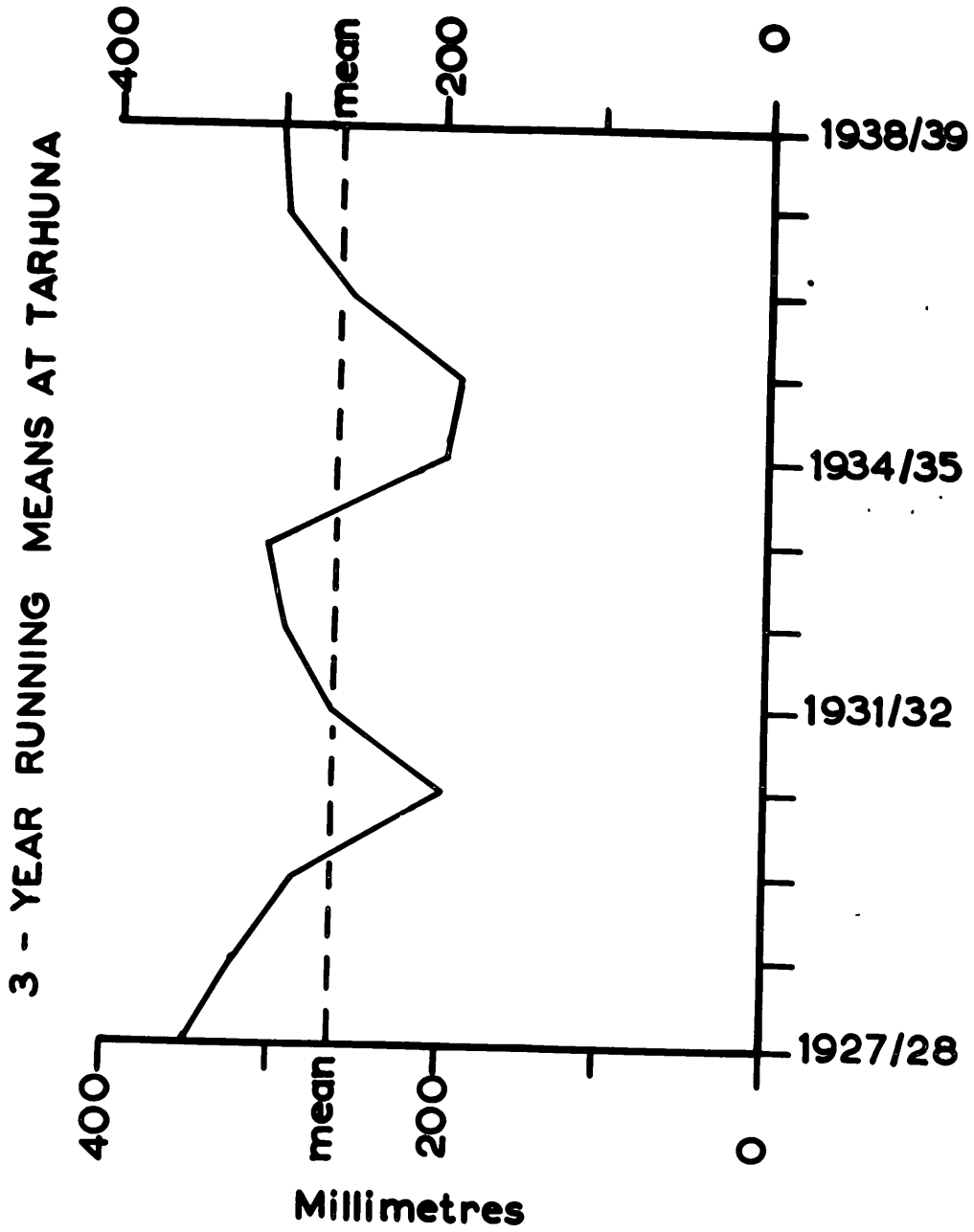
c.



Tripoli. This difference is probably paralleled by variations between the pattern of rainfall in the northern Jebel and the Ghibla. As the yields of dryland crops are bound to fluctuate in response to rainfall, an attempt was made to relate yields of cereals and olives and animal numbers in Tripolitania to Tripoli's rainfall. This was unsuccessful, because the rainfall at one coastal station cannot give a true picture of rainfall elsewhere, and many of the crop and animal figures relate to calendar and not agricultural years.

To smooth out the fluctuations in fig. 17c, a graph based on moving averages or running means was constructed for Tarhuna. The period covered by the rainfall statistics was too small to permit the use of five year means, so the less commonly used three year means were employed. The general trend of rainfall at Tarhuna gave the following sequence:- wet, dry, above average, dry, above average. At least two periods of drought will be experienced every 15 years. It would be interesting to construct cumulative graphs of rainfall for the Eastern Jebel to find out whether there is a moisture deficit or surplus which would affect the level of aquifers. A 15 year period is not long enough, however. Hill (9) discovered that over a period of 35 years at Tripoli, deficits below the mean were approximately balanced by water surpluses above the mean. This indicates that water levels

figure 18.


3 - YEAR RUNNING MEANS AT TARHUNA
400
mean
200
0
1938/39
1934/35
1931/32
1927/28
Millimetres

would remain static over this length of time.

Rainfall totals at other stations in the Eastern Jebel have not been as closely examined, but they fluctuate sharply.

Table IV - 9. Highest and lowest amounts of rainfall in agricultural years at stations in the Eastern Jebel.

	Highest	Lowest
El Gsea	398.0	113.6
Al Khadra 1	343.6	191.5
Al Khadra 2	303.0	189.5
Al Khadra 3	273.5	209.5
Biar Miggi	320.5	129.7

(d). Monthly variations.

The figures for monthly average rainfalls bear little relation to actual rainfall. Table IV - 10 compares the mean, maximum and minimum falls recorded in each month at Tarhuna and Cussabat.

Table IV - 10. Monthly mean, maximum and minimum rainfall. (10)

	Tarhuna			Cussabat		
	Mean	Max.	Min.	Mean	Max.	Min.
September	7.2	44.6	0.0	6.6	50.1	0.0
October	21.4	104.6	0.0	27.8	186.1	0.0
November	26.8	77.1	0.0	33.9	116.9	1.4
December	44.0	147.2	1.5	63.5	129.3	0.8
January	57.3	141.0	5.4	74.1	161.0	10.1
February	50.8	139.8	0.0	52.8	113.0	0.0
March	31.5	131.8	0.0	39.6	117.0	0.0
April	11.4	47.6	0.0	16.6	67.3	0.0
May	4.6	40.2	0.0	4.4	35.3	0.0
June	1.3	28.8	0.0	1.7	9.8	0.0
July	0.2	4.0	0.0	0.0	0.0	0.0
August	0.8	14.9	0.0	0.2	1.7	0.0

Every month except November, December and January at Cussabat and December and January at Tarhuna has at some time had no rainfall. In any year, there may be no rain in the critical months of November, March and April.

In a dry year, there may well be a heavy rainfall in two or three months, and in a wet year, there may be no rain at critical periods. The variation in monthly rainfall over a long period may be studied by calculating the standard deviation of rainfall. Standard deviations and the co-efficient of variability for both Tarhuna and Cussabat are given in Table IV - 11.

Table IV-11. Standard deviations and co-efficients of deviation.

	Cussabat			Tarhuna		
	Mean	Standard deviation	Co-efficient of standard deviation	Mean	Standard deviation	Co-efficient of standard deviation
Sep.	6.6	6.7	101.7	7.2	6.3	86.4
Oct.	27.8	24.2	87.2	21.4	22.2	103.4
Nov.	33.9	21.0	59.9	26.8	26.4	91.1
Dec.	63.5	32.1	50.2	44.0	30.7	69.8
Jan.	74.1	32.8	45.6	57.3	25.8	45.1
Feb.	52.8	25.3	47.9	50.8	25.2	49.9
Mar.	39.6	34.4	87.3	31.5	26.0	82.5
Apr.	16.6	11.5	69.9	11.4	11.3	99.0
May	4.4	5.5	125.0	4.6	5.9	128.3
June	1.7	2.1	123.4	1.3	2.2	169.0
July	0.0	0.0	0.0	0.2	0.2	100.0
Aug.	0.2	0.3	150.0	0.8	0.8	100.0

Rainfall can vary by about 50% in winter and 70-100% in autumn and spring, which are the most critical periods. However, there is rarely a complete failure of rainfall, so that a dry autumn may be offset by heavy winter and spring rain, and a dry spring by heavy winter rainfall which will help to maintain soil moisture. In the dry year of 1935-36, for instance, winter rains failed completely, but there was a fall in April which was 60% above the mean. In 1939-40, the winter rains again failed, but those of autumn and spring were well above average. The harvest of cereal and tree crops in the Eastern Jebel is closely related to the March rainfall. Yet in 20 years, there has been only one complete failure of

spring rain and this was in 1930-31 when only 1.3 mms. fell in March and April. The variability of monthly totals is partially offset by a varying distribution of rainfall between the months over a period of years. Shifting cultivators are aware of this, and usually own several widely scattered plots of land which they sow between September and January, according to when and where it rains, and then hope that at least 50% of their sowings will be harvested after the spring rains.

(e). Intensity, wet and dry periods.

Rainfall also varies in intensity, and a very intense rainfall impairs effectiveness because it increases run-off. Between 1925 and 1940, 60.43% of all rainy days had falls of between 0.1 and 5.0 mms..

Table IV - 12. Daily rainfall totals at Cussabat 1925-40. (11)

Amount	Nos. of days	Percentage
0.1-5.0	449	60.43
5.0-10.0	145	19.34
10.0-20.0	100	13.25
over 20.0	49	6.98

The maximum total of rain recorded in one day at Cussabat was 128.0 mms. (Table IV - 13) and the most intense rainfall occurs in October, November, March and April, so that the spring and autumn rains are more intense than winter rains.

Table IV - 13. Highest daily totals of rainfall recorded at Cussabat 1925-40. (12)

Month	Highest amount of rainfall in one day
October	128.0
November	92.3
April	67.0
March	56.0
January	48.0
February	45.0
December	34.0
May	24.2
September	12.5
June	6.0
August	1.2
July	0.0

Rainy periods average 3-5 days in length, but can last for 10 days, whilst dry periods average 20-30 days, but can be over 150 days in length.

Table IV - 14. Duration of dry and wet periods at Cussabat 1925-40. (13)

Rain periods		Dry periods	
Days	Frequency	Days	Frequency
3	53	13-20	21
4	23	20-30	24
5	11	30-40	9
6	3	40-50	4
7	4	50-60	5
8	2	60-70	1
9	2	70-80	2
10	2	80-90	1
		90-100	-
		100-150	8
		150-200	6

Unfortunately, it is not possible to examine figures for other stations, but they would show the same trends.

F. Correlation of climatic data: indices of aridity.

Rainfall itself is not an adequate guide to the aridity or humidity of an area, because rainfall effectiveness is influenced by other climatic data. This is particularly important in a zone of dryland agriculture. Unfortunately, there is no data on evaporation, evapo-transpiration or the volume of dew falls, so that rainfall can only be correlated with temperature. Several methods by which temperature and rainfall may be related have been calculated in the last fifty years. Of the formulae available, those of De Martonne (5), Emberger (14) and Köppen (6) are the most practical, since they do not require information other than rainfall and temperature, and because they have already been widely used and are thus useful in making comparisons between the region under study and other parts of the world.

Both Emberger's and De Martonne's formulae showed the same results, so that of De Martonne, which is more universally employed, was used. De Martonne bases his "index of aridity" on the formula P/T - 10, where P equals the precipitation in mms. and T the temperature in degrees centigrade. He classed the results he obtained from applying his formula

to various parts of the world, into the following three groups:

An index of over 20: Exoric, drainage flows to the sea.
An index of 10-20: Endoric, drainage flows to inland basins.
An index of below 10: Areic, no surface flow.

The index curve of 10 is normally regarded as the boundary between steppe and desert. The indices of Tarhuna and Cussabat are respectively 9.0 and 11.0, and thus there should be no surface flow from Tarhuna, which lies in the desert, and only drainage from Cussabat. However, rainfall is confined to the winter months in the Eastern Jebel, so that yearly indices of aridity do not give a true picture. It is far better to calculate the winter or semi-annual indices and monthly indices. Monthly indices for Tarhuna and Cussabat are given in Table IV - 15, and winter indices, as well as rainfall, for a number of Tripolitanian stations are given in Table IV - 16.

Table IV - 15. Monthly indices of aridity in the Eastern Jebel.

	Tarhuna		Cussabat
Sep.	3.1	areic	3.2
Oct.	8.2	areic	10.8
Nov.	12.8	endoric	16.6
Dec.	26.9	exoric	29.3
Jan.	31.5	exoric	46.1
Feb.	27.3	exoric	30.7
Mar.	16.0	endoric	16.9
Apr.	4.4	areic	6.3
May	2.1	areic	1.9
June	0.7	areic	0.4
July	0.3	areic	0.0
Aug.	0.1	areic	0.7

Table IV - 16. Winter indices of aridity for selected Tripolitanian stations.

Station	Index	Rainfall
Tripoli	26.8	347.9
Garian	25.6	391.8
Cussabat	23.4	328.9
Garabulli	22.6	296.3
Castel Beneto	20.9	269.1
Jefren	20.9	243.2
Zavia	19.2	251.1
Tarhuna	19.0	231.8
Misurata	17.4	235.8
Homs	17.2	239.1
Beni Ulid	3.5	45.6

The winter indices of aridity for Tarhuna and Cussabat are 19.0 and 23.4, but at Beni Ulid the index falls to 3.5. This indicates that in winter the Humid Plateau is exoric, the Semi-arid Steppe endoric and the Continental Steppe areic.

Between April and September and April and October at Cussabat and Tarhuna respectively, conditions are very arid and there is no surface water flow. November and March are endoric, but water flows to the sea in December, January and February. The fact that there will be a surface flow of water for at least five months of the year from Tarhuna means that flood water will enter the Ghibla and Jefara, where it may permit shifting cereal cultivation or water spreading schemes.

Index curves calculated from De Martonne's formula are used to delimit certain types of agricultural activity. Thus, areas with an index of more than 20 are considered to be favourable for dryland agriculture. The winter indices of the Eastern Jebel are close to this boundary and are marginal for dryland agriculture, though the Humid Plateau is better favoured than the Semi-arid Plateau. Dryland cultivation is obviously impossible in the summer months, and in the Continental Steppe it is excluded completely except in humid wadi valleys.

The world boundaries to both cereal and olive tree cultivation are assumed to coincide with the index curve of 10, and between the curves of 10 and 15 respectively. The zone of olive cultivation, which is at present restricted to Cussabat and the Italian zone, could be extended into other

parts of the Humid and Semi-arid Plateau regions. Winter cereal cultivation is possible in the whole of the El Amamra and most of Tarhuna, north of a line between Uesctata and the Wadi Taraglat. South of this zone, it is impossible outside humid wadi valleys.

Definitions based on De Martonne's index of aridity are somewhat arbitrary, since it excludes several important factors. A much more practical guide has been provided by Dr. Maggazzini, head of the Tripolitanian Meteorological Service. He has calculated from 30 years of research and experience of Tripolitanian conditions the minimum quantities of rainfall necessary to produce various yields from olive trees and cereals. They are as follows:-

Table IV - 17. Rainfall and crop yields in Tripolitania.

Crop	Nature of yield	Minimum amount of rainfall necessary
1. Olives	a. Good	300 mms.
	b. Fair	250 "
	c. Poor	180 "
	d. No crop	below 150 "
2. Cereals	a. Good	300 "
	b. Fair	250 "
	c. Poor	200 "
	d. No crop	below 200 "

Fig.14b shows the approximate boundaries of areas giving good, fair and poor crops. The area in which olive trees would give a good yield extends over the Humid Plateau area,

and fair yields could be expected in the Semi-arid Plateau. The Italiens get higher yields than Libyans, but this is due to differing agricultural techniques. Between 1924-25 and 1949-50, Cussabat should have had 8 good, 3 fair and 2 poor crops with one complete failure, compared to 5 good, 5 fair, 4 poor crops and 4 failures at Terhuna.

A good or fair cereal crop can be expected in most years, particularly when it is borne in mind that cereals are generally planted in wadis. The distribution of winter rainfall is more important when considering cereals, since the November rainfall usually decides which areas will be sown and the spring rain which shall be harvested.

Pastoralism is more important than agriculture over most of the region under study. Semi-nomadic and nomadic pastoralism is usually found in marginal steppe areas. The success of pastoralism will vary from year to year according to the capacity of the vegetation to fulfil animal needs. It is sufficient in winter, but in the summer months it is severely reduced by aridity. This means that grazing must be supplemented by watering every 2-3 days. The amount of moisture available depends not only on rainfall, but on rates of evaporation and evapo-transpiration, and these factors also affect agriculture.

1. Soil moisture, evaporation and evapo-transpiration.

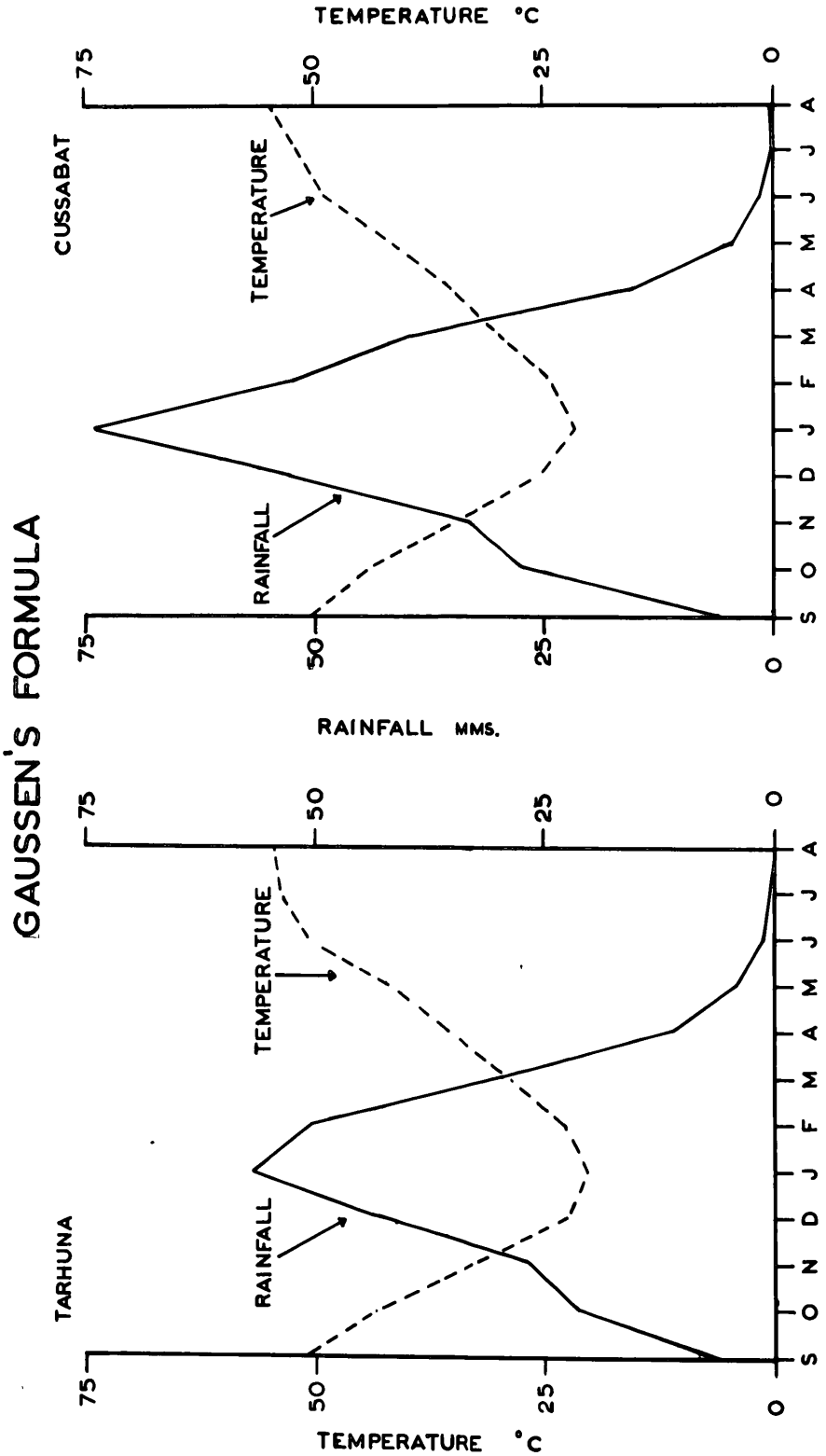
(a). Soil moisture.

Gaussen (15) states that drought may be deemed to exist when the total of monthly rainfall in millimetres is less than twice the mean temperature centigrade. This relationship has been plotted in fig. 19 for Tarhuna and Cussabat. There is a prolonged period of moisture deficiency in the summer months and the deficit is not neutralised until the beginning of November; then there is a period of moisture surplus until the beginning of March. This pattern manifestly rules out summer dryland agriculture and the development of spontaneous vegetation in the summer, and emphasises the importance of the March and November rains.

(b). Evaporation.

About 10% of the rain falling in the Wadi Megenine basin of Garian runs off and the rest either percolates or is lost by evaporation or evapo-transpiration. Willcts (16) has shown in Palestine that of the rain falling on lands draining to the Mediterranean, 70% is lost by evaporation and evapo-transpiration, 24% percolates underground and 6% flows to the sea. U.N.T.H.A. (17) quote a formula for calculating evaporation: evaporation equals 4.2 x temperature in degrees centigrade. Applying this formula to Cussabat and Tarhuna, evaporation is 972 and 980 mms. per annum, or three times the

figure 19.


GAUSSEN'S FORMULA
CUSSABAT
TEMPERATURE °C
TEMPERATURE
RAINFALL
RAINFALL MMS.
75
50
25
0
S O N D J F M A M J J A
TARHUNA
TEMPERATURE °C

rainfall. Clearly any efforts to conserve or store surface water must take into account the high rates of evaporation.

(c). Evapo-transpiration.

Evapo-transpiration is equivalent to the water needs of the plants. The spontaneous pattern of vegetation varies from year to year according to moisture availability, which depends upon the precipitation, soil texture and water holding capacity and the species of plants. When rainfall is low, vegetation is sparse, but it is dense when rainfall is high. After the first rains, vegetation rapidly develops on light soils, but if rainfall is low, heavy soils may remain devoid of plant cover for the whole rainy season. The water holding capacity of sands and sandy loams, which are widespread in the region under study, is about 60-70 mms. (18). However, Vernet (19) has shown that at least 10 mms. of infiltrated water is lost in the first 2-3 days after rainfall.

These factors also influence cultivated plants, but the farmer can take measures to ensure that his crops will give good yields. Some indication of the moisture surplus that it is necessary to make up can be determined by assessing the potential evapo-transpiration, which occurs under optimum soil and water conditions. Work on potential evapo-transpiration rates has been carried out in various parts of the world, but the nearest and most relevant to this study is that

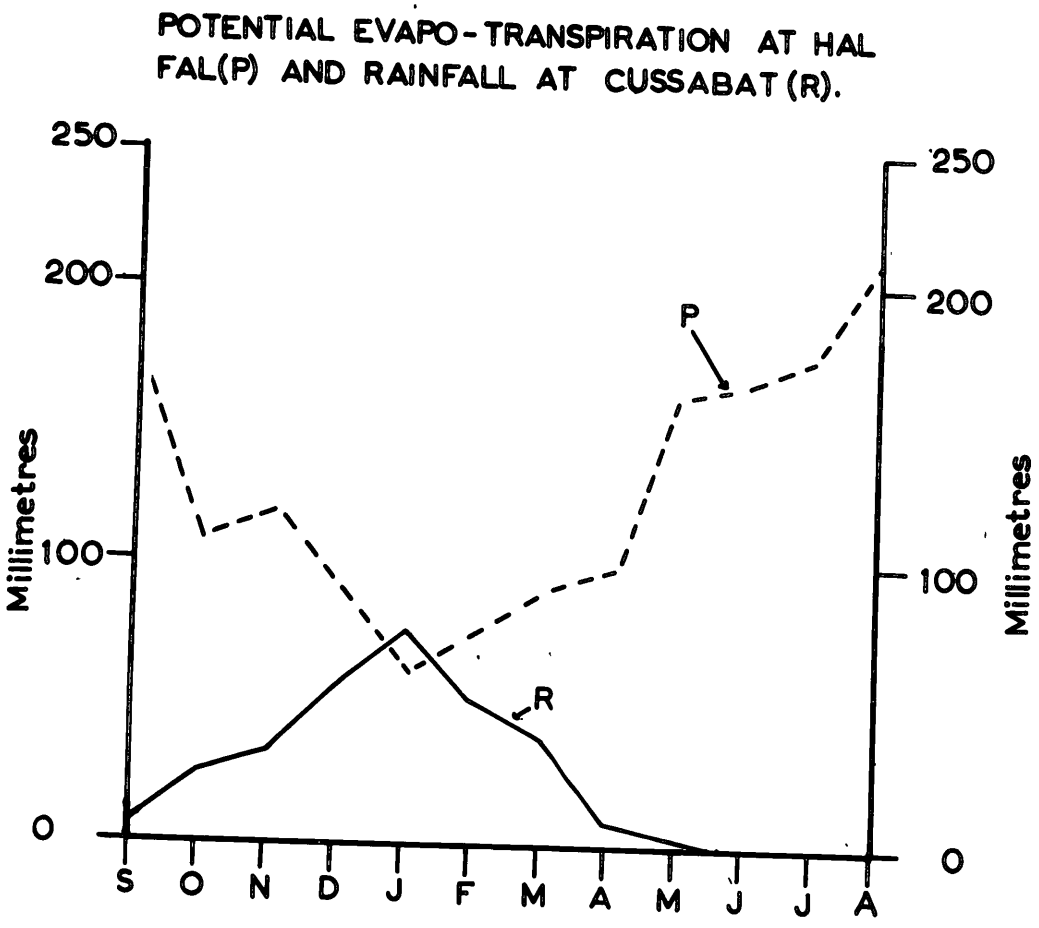
of Mitchell (20), who has taken measurements at Hal Far in Malta. Malta lies 250 miles north of Cussabat and has a slightly cooler and more humid climate. According to Hill (21), who used Mitchell's figures in his study of evapo-transpiration rates at Sidi Mesri, Mitchell over-read the figures for his station. Even so, his figures are minimal for Cussabat and must be treated with circumspection. They are given in Table IV - 18 and graphed with rainfall in fig. 19.

Table IV - 18. Potential evapo-transpiration at Hal Far (Malta) and rainfall at Cussabat (in millimetres).

Month	Potential evapo-transpiration Hal Far	Rainfall Cussabat
September	172.7	6.6
October	121.9	27.8
November	137.2	33.9
December	78.7	63.5
January	63.5	74.1
February	76.2	52.8
March	83.8	39.6
April	99.1	16.6
May	160.0	4.4
June	165.1	1.7
July	177.0	0.0
August	210.9	0.2
Year	1,546.1	321.2

Only December has a moisture surplus. Crops in the Eastern Jebel will give low yields unless the density of plantings are carefully restricted and water stored or conserved for use as irrigation at critical periods.

figure 20.


POTENTIAL EVAPO-TRANSPIRATION AT HAL FAL(P) AND RAINFALL AT CUSSABAT (R).
250
200
100
0
Millimetres
P
R
S
O
N
D
J
F
M
A
M
J
J
A

G. Conclusions.

Though the Eastern Jebel is climatically one of the most favoured areas in Tripolitania, both farmer and pastoralist are faced with great climatic difficulties. Rainfall is low and unreliable and is confined to the winter months; in any season or during the critical periods, the rain can fail. Evaporation and evapo-transpiration rates are high, and the availability of soil moisture is low. Rainfall quickly declines in the Jefara and Ghibla, and as it does so, its reliability decreases and temperatures rise. Conditions are aggravated by the extremes of hot spring Ghiblis and winter frosts and mists.

Under such climatic conditions, irrigation is essential to large scale and intensive cultivation, but in the Eastern Jebel groundwater reserves are limited and the few wells and springs are concentrated in several small areas. Therefore, summer cultivation is precluded, and only the hardy Mediterranean tree crops can withstand the aridity of the summer months. Winter cultivation of certain field crops is possible, but yields would be low and it would be necessary to leave land in fallow for long periods. In the more arid parts of the Eastern Jebel, pastoralism and shifting cultivation offer the only methods of gaining a living from the land, except where water spreading is practicable (Chapter V). Yields from

cultivated crops and the extent and development of spontaneous plants vary highly according to rainfall.

At present, arboriculture is confined to Cussabat and parts of the Tarhuna Plateau. Yet good and fair crops of olives can be obtained over much of the Humid and Semi-Arid Plateaus. Italians obtain higher yields from olives in the Semi-Arid Plateau than Libyans in the Humid Plateau. Olive cultivation can be extended and made more profitable and it could be associated with other drought-resisting tree crops like the almond, vine, fig, carob and pistachia vera. However, the extension of arboriculture must be controlled, because it is necessary for pastoralists to have access to summer pasture near the main wells, all of which lie in the Humid and Semi-Arid Plateaus.

The population should make every effort to conserve and use the little rainwater that is available. It should be channelled to terraces and gardens, trapped by dams and contour ridges and conserved in cisterns and behind dams. Actual and possible future methods of water conservation will be considered in Chapter V, but throughout it is important to bear in mind two factors: that rainfall is unreliable and that evaporation rates are high.

CHAPTER V.

WATER RESOURCES AND THEIR USES.

A. Introduction.

It was shown in Chapter IV that rainfall is low and unreliable and that much of it is lost by evaporation. In such conditions, the population must use groundwater. Groundwater supplies are inadequate because the reserves are small and are restricted to a few small areas. This inhibits economic activity and precludes the use of water in large quantities for agricultural purposes, since there is not enough water in many parts of the region for domestic purposes. Groundwater supplies must be supplemented by the collection, use and conservation of run-off, which accounts for nearly 10% of all rainfall. The methods employed by the population are often primitive, and only a fraction of run-off is used. A great quantity of surface water runs to waste and causes much damage, since it most typically flows in the form of the wadi spate (or flash-flood).

The chapter will be divided into two sections dealing respectively with groundwater and the collection and conservation of run-off. Examination will bear in mind that arboriculture is likely to extend into pastoral zones in the next few decades.

B. Groundwater resources.

The groundwater resources are inadequate, and evidence

indicates that most of the aquifers are already exploited. There may be untapped aquifers in the Ghibla. These facts are deduced from the following evidence:-

1. The geology and structure of the region are uniform and relatively simple. The Garian and Ain Tobi limestones are highly permeable, so that potential aquifers are restricted to the Jefren marls, the Tigrinna beds, which lie in the less humid zones, and the sparsely distributed Wealden and Miocene strata.

2. Deep borings at El Gsea, Cussabat and Tarhuna towns have demonstrated that there are no substantial reserves of water below 65 metres except for one small aquifer at the bottom of the Jurassic.

3. The strata dip to the south and south-east, so that infiltrated water is likely to flow towards the Taraglat and Soffegin basins. Karstic erosion in these areas points to such subterranean flow (1).

4. There are no wells or springs on the dip slope of the Eastern Jebel between the Garian-Tarhuna border in the west, Biar Dufan in Misurata, Al Khadra in the north and Beni Ulid in the south. As Berber well-diggers have never penetrated below 30 metres from the surface, aquifers, if they exist, lie below 30 metres in this zone.

5. Water flows from several springs at Taourgha at a daily

rate of three million m3. In 1959, a high-yielding artesian aquifer was found at Gioda, just north of Taourgha in the Wadi Soffegin basin. L.A.J.S. geologists assert that this water is derived from rainfall infiltrating into the Eastern Jebel.

The Eastern Jebel is probably a vast catchment area for groundwater found in the Misuratino and Wadi Soffegin basin. It is unlikely that large reserves will be found in the highly eroded northern Jebel, but if bores were put down in the Ghibla, water might be found. So far there has been no drilling south of Sidi Essed.

1. The aquifers.

Known aquifers are confined to the northern areas of Tarhuna and Msellata, where several have been traced. They do not show the same uniformity as those of the Jefara, but may be grouped into five classes, which are:-

(a). Pleistocene aquifers.

(b). Cenomanian aquifers.

(c). Wealden aquifers.

(d). Miocene aquifers.

(e). The Jurassic aquifer.

(a). Pleistocene aquifers.

Pleistocene aquifers lie at the junction of the aeolian loess and the Cretaceous bed-rock, where this is formed by Jefren marls or Tigrinna beds. Though the nature

of the aquifer varies, it is most commonly found in unconsolidated sands overlying impermeable clay and silt layers. The depth and accessibility of the aquifer also varies because the surface of the Cretaceous bed-rock was moulded by pre-Pleistocene continental erosion. The aquifer is rarely more than 30 metres below the surface, the maximum depth of penetration by Berber well-diggers. Because of this, most of the wells of Tarhuna are derived from Pleistocene aquifers. The depth and water level of most wells are not known, but a few are recorded on the Italian 1:100,000 maps. Figures show that well depth varies from about 4 metres to 25 metres, even over small areas. At Biar Miggi and Biar Milgha the aquifers are one metre below the surface, but at Tarhuna town they are 20 metres down. Most of the wells along the Tarhuna plateau are derived from Pleistocene aquifers, which also feed the springs of Seersciara and Gasr Doga. Judging from the depth of wells in the Basin Zone, most of them are fed from Pleistocene aquifers. Wells using these aquifers are grouped because the Cretaceous floor undulates. The most important groups are at Biar Miggi (3 wells), Biar Milgha (4 wells), Ain Uif, Tarhuna town (14 wells) and Gasr ed Dauum (19 wells).

(b). <u>The Cenomanian aquifers.</u>

There are several impermeable clay and silt levels in the Jefren marls, from which all Cretaceous wells are fed.

On the Tarhuna plateau, the aquifers lie between 40 and 60 metres below the surface, and are thus unexploited by Libyan-dug wells. The 40 wells found on Al Khadra exploit one or more aquifers in this group, and these aquifers are cut by wadis incised in the Abanat Scarp, the Basin and Scarp Zones. Here there are a number of indigenous wells and a line of springs stretching between Gasr Doga and Biar Damra. One well at Tarhuna town exploits three aquifers in the Jefren marls at depths of 25, 45 and 67 metres (2).

(c). Wealden aquifers.

These aquifers are found in limestone overlying impervious clays of Wealden origin. The important well groups of Biar Fagghin, Biar Zaafrania and Biar Fahrum exploit these aquifers to supply Cussabat's water. The aquifer is most accessible at Biar Fagghin, where 19 wells are between 8 and 10 metres deep, with water levels at 6-7 metres. The other wells are deeper, but little is known about them.

(d). Miocene aquifers.

These are associated with the restricted exposures of Miocene on the eastern boundary of El Amamra. A line of wells stretches from the El Gattar in the Gsea valley to the Sahel el Ahamed. The wells are only 4-6 metres deep, but they have never been explored.

(e). The Jurassic aquifer.

The Jurassic aquifer was found deep in the Jurassic by the H. T. Smith International Company in early 1959. It occurs in a cavernous limestone underlain by an impermeable sandstone. It is probably of limited extent because another drill made in 1960 only a few hundred metres from the original bore failed to find water.

Because the aquifers have hardly been investigated, several observers have questioned the origins of several groundwater levels. For instance, Amato (3) thought the wells of Gasr ed Dauum were of Pleistocene origin, but Lenfranc* suggests that the water comes from a fractured aquifer in the Jefren marls.

2. Potentiality and yield of the aquifers.

(a). Pleistocene aquifers.

The actual and potential yields from the Pleistocene aquifers depend on the nature of the underlying Cretaceous surfaces. These surfaces are extremely uneven, so that water tends to flow into numerous hollows and depressions. Hence, the flow from any well or spring depends on the point where it taps the underground basin, and on the size of the basin. These factors are reflected in the variation of flow over

---

* From Files of Correspondence 1956-7. L.P.D.S.A. Tripoli.
(L.P.D.S.A. IS LIBYAN PUBLIC DEVELOPMENT AND STABILISATION AGENCY)

small areas. For example, an Italian well drilled near Tarhuna reached at 10 metres an aquifer yielding 30 m3/hr., whilst another bore 100 metres to the west found nothing. The essential problem is to locate the main depressions in the Cretaceous surface and then to drill in the right places. The location of the basins may be determined by following the present courses of wadi beds, which, according to Lipparini (4) follow the courses of pre-Pleistocene talwegs. Good wells have been drilled into the ancient basins of the Wadis Ramle, Turgut, Mensci and Sret at Tarhuna town, Scersciara, Biar Um er Risok and Biar Miggi respectively. More reserves of the Pleistocene water lie in the great wadi basins of northern Tarhuna, where there are few wells, though many springs.

Amato (5) states that the average yield from Italian-drilled wells is about 30 m3/hr. from Pleistocene aquifers when a wind pump is used. Most Libyan wells yield less than 10 m3/hr. though it is difficult to calculate flow, because they are not used all the time. The spring at Scersciara flows at the constant rate of 60 m3/hr.. Because flow is so high and constant, Amato believes that the water may not be derived from a Pleistocene aquifer. More research is necessary because it seems to the observer that water flows from the junction of the Pleistocene and Cretaceous. Many of the wells and springs are non-perennial and some otherwise perennial wells dry up in

drought years. A recent draw down test was made on a number of wells in Tarhuna. It was found that it took 10-12 hours to pump most wells dry, whilst they took up to 150 hours to recover. These factors point to the essential relationship between rainfall and the rate of flow from Pleistocene wells and springs. A large proportion of them are merely subterranean reservoirs in which rainwater collects during the winter. Many run dry if the demand placed on them is too heavy. The drying up of wells is a very important problem in Cussabat, where their relative fewness imposes severe pressure on all wells.

If the wells are fed by winter rainfall, then their yields and potentialities depend not only on the size of the underground catchment, but also on the rates of infiltration. These rates are high in sand, as the following table shows:-

Table V - 1. Infiltration rates in the Ard Hamra.

Mms. of water absorbed before measurement	Time of infiltration of 8 mms. of water	Speed in cms. per hour
0	20 seconds	144
8	40 "	72
16	51 "	58
24	59 "	47
32	70 "	41

The average rate of infiltration in the Wadi Megenine basin is 7 % of rainfall.

Wells exploiting these aquifers are generally simple dug wells faced with limestone. Water is withdrawn manually, or sometimes by means of animal power. Italians have improved drawing arrangements on Sidi Essed with wind pumps and on Al Khadra with wind and electrically powered pumps.

(b). Cenomanian aquifers.

The yield and the potentiality of Cenomanian aquifers is highly variable. On Al Khadra 29 wells yield 28,800 m3/annum, which is sufficient to maintain a water allotment of 3.5 m3/ha./annum. Yields of individual wells are very low, and average less than 3 m3/day. However, extensive drilling at El Gsea (Marconi) found nothing. Wells on the concession farms give good yields and produce about 30 m3/hr. for 2-3 hours per day. A well drilled into the Jefren marls at Tarhuna gave a yield of 100 m3/hr.. This is now used to supply water to Tarhuna town and its barracks. The other principal source of Cenomanian water is at Gasr ed Dauum, where there is a constant flow of 60 m3/hr. from a spring in the Wadi el Me.

Very little is known about other wells and springs using Cenomanian aquifers. The Arab population say that the springs along the Abanat Scarp have a constant but low yield, which has fallen off since the foundation of Al Khadra. On Al

Khadra itself, water levels are falling* and this is being compensated by the extension of drilling on the eastern boundary, where a new aquifer was found in 1958. It seems that the reserves of water in the Cenomanian aquifers are not very great, and some of the wells may dry up within the next few years.

(c). Wealden aquifers.

The Wealden aquifers are exploited manually by simple dug wells faced with limestone. Most of them were cemented by the Italians to reduce loss by evaporation. The nature of these aquifers was shown in recent tests made by L.A.J.S.xx at Biar Fagghin, where there are 19 wells. Water levels declined up the wadi bed, indicating flow from the bed-rock. A draw down test was made at well number 4 (see Table V - 4). It took 23 hours to reduce the water level from 22 feet to 36 feet. At this point it ran dry, and it took 72 hours to recover. During the test, the water levels in the other wells fell by 3-4 feet. Water levels in the wells were found to vary at different times, and some occasionally dry up. Table V - 2 shows the variations at one of these wells.

---

* Personal communication from Ente official on Al Khadra.

xx LIBYAN-AMERICAN JOINT SERVICES

Table V - 2. Variation of the water level at Well 5, Biar Fagghin, August 1st, 1957 - August 1st, 1958.

Date	Water level (feet)
August 1st, 1957	19.25
September 1st, 1957	20.80
October 1st, 1957	20.20
November 1st, 1957	19.60
December 1st, 1957	18.48
January 1st, 1958	19.70
February 1st, 1958	19.47
March 1st, 1958	21.70
April 1st, 1958	21.34
May 1st, 1958	22.16
June 1st, 1958	20.10
July 1st, 1958	19.80
August 1st, 1958	19.00

It seems that the wells are fed by rainfall, and in a drought year the pressure on them is too great. At present, the wells at Biar Fagghin are used by the El Amamra and Hadida Cabile as well as by the settled villagers of Cussabat, Uadna and Luata.

The other main wells using Wealden aquifers are similar. Five wells which were drilled by the Italians four kilometres north of Biar Fagghin were affected by the draw down tests. These wells once provided tap water to Cussabat, but fell into disuse in the dry years of 1946-1948 and are now too small to meet requirements. Because of this, water has to be brought from Biar Fagghin to Cussabat, where it is sold to the inhabitants at 2 piastres per 4.5 gallons.

The Wealden aquifers are poor and are fed by rainfall. The Mayor of Cussabat believes that water levels have declined in the last 40 years, during which time the population of Msellata has increased by 20%.

(d). Miocene aquifers.

The Miocene aquifers yield about 5 m3/hr., and provide water for domestic and stock use in the Aulad Shukir and El Amamra. The pressure on them is not great and the yield is at present adequate.

(e). Jurassic aquifer.

The Jurassic aquifer gave an initial yield of 5 m3/hr., which may rise to 15 m3/hr. after the drill has been cleaned and cleared. It is to be developed as a source of tap water to Cussabat town. The water will be electrically pumped and piped to a reservoir built on the slopes of El Galaa, where a gravity tap supply will be set up.

3. Quality of the groundwater.

Underground water accumulates over a considerable period of time and therefore often collects a large mineral content which affects its quality. The most harmful minerals, in decreasing order of toxicity are:- magnesium sulphate, magnesium chloride and the carbonate, sulphate and chloride of sodium. To assess the quality of water it is necessary to know the total amount of dissolved salts present, particularly

sodium chloride. This fact, together with the specific conductance of water, which Thorne and Petersen (6) maintain is the best measure of toxicity of the salts present, may be used to classify the groundwater of the region. The following criteria are derived from Houk (7) and Marroni (8), who were interested in irrigated agriculture:-

Table V - 3. Quality classification of underground water.

Class of water	Specific conductance in microhms at 25 C	Dissolved salts parts/million	Sodium chloride parts/million
Good	Below 2,000	Below 1,400	Below 1,000
Fair	2,000 - 3,000	1,400 - 2,100	1,000 - 2,000
Poor	Above 3,000	Above 2,100	Above 2,000

The figures are applicable in the Eastern Jebel where water is used for irrigating young trees.

Table V - 4 summarises the quality of groundwater in the Eastern Jebel.

Table V - 4. Quality of water from selected wells.

Location		Specific conductance	Dissolved solids	NaCl.	Quality
Biar Fagghin	1	1,135	643	170	good
	2	1,033	615	266	"
	3	1,345	771	149	"
	4	1,318	891	313	"
	5	1,310	997	326	"
	6	1,872	1,110	354	"
	7	1,755	1,070	362	"
	8	2,227	1,317	450	fair
	9	1,661	976	319	good
	10	1,264	742	220	"
	11	1,404	852	262	"
	12	1,404	856	220	"
	13	3,276	3,144	291	poor
	14	1,665	1,167	209	good
Tarhuna Ain Uif	1	3,159	2,217	1,100	poor
	2	1,451	216	200	good
Tarhuna town		2,574	1,787	750	fair
Al Khadra	26	2,646	2,600	600	poor

Water is generally of good quality in both the Pleistocene and Wealden aquifers, where water is stored for only short periods. The Pleistocene water is slightly alkaline and hard, and its temperature varies from 68-72°F. Water from the Cenomanian wells appears to be poorer, but only one analysis is available. The salt content is high, but the young trees on Al Khadra, which have been irrigated with Cenomanian water do not show signs of salinity. This is because the soils are permeable, well-drained, devoid of chloride and rich in calcium carbonate (9).

4. Water utilisation.

Groundwater is used for household purposes, the watering of stock in the summer and the occasional irrigation of young trees. Irrigated agriculture is restricted to an area of less than 5 ha. dispersed in tiny plots near the wells of Gasr Doga, Scerscara, Biar Zaafrania and Biar Fagghin.

It is difficult to estimate total requirements, since there are no figures for water utilisation in the Eastern Jebel, and very few for Tripolitania as a whole. Three estimates of the probable per capita consumption of water may be deduced from information supplied by Pioger (10).

1. Zuara. Zuara, with a population of 8,000, uses water from two wells which supply 43,000 gallons per day. The daily and annual per capita consumption is thus 0.0224 and 9.0 m3 respectively.

2. Misurata. 9,000 people live in Misurata, and they use 234 m3 of water per day, so that the daily and annual per capita consumption is 0.026 and 9.46 m3 respectively.

3. Al Khadra. Ente allotted 3.6 m3 of groundwater per ha. per annum, or a total of 28,800 m3 per annum. Each farm received about 500 litres daily, which means that the daily and annual per capita consumption was about 0.0625 and 24 m3 respectively, since each household was composed of at least eight people.

Italian requirements would probably be higher than those of Libyans, so that the figures for Zuara and Misurata provide a fair estimate of total per capita consumption. However, both these areas are urban, whereas in Tarhuna and Cussabat there are large animal populations. According to Ducros (11), animals need watering every two to three days during the summer and should receive about two litres each time. Animals require water between May and September, and each sheep and goat would consume between 100 and 140 litres of water.

On the basis of these calculations, the estimated water consumption in the Eastern Jebel is as follows:-

Table V - 5. Water Utilisation.

Mudiriat	Population	Nos. of sheep and goats	Water consumption (m3)		
			Human	Animal	Total
Cussabat	14,157	18,000	127,800	2,160	129,960
El Amamra	4,500	12,000	40,500	1,440	41,940
Aulad Msellem	21,000	44,000	189,000	5,280	194,280
Aulad Mahareff	8,100	26,000	72,900	3,120	76,020
El Hawatem	5,500	10,000	49,500	1,200	50,700
Ed Darahib	3,900	15,000	35,100	1,800	36,900
Italians	1,500	-	36,000	-	36,000
	58,657	125,000	550,800	15,000	565,800

Adding to this total the demands of olive factories and those of the British forces who occasionally use Tarhuna as a base, total demand is around 700,000m3 per annum. Demand increases during the summer when evaporation rates are highest.

The present demand can be met by the wells and springs, because Gasr ed Dauum alone supplies about 400,000 m3 per annum. However, the wells are concentrated in well-defined zones, and the four largest wells are all found on the northern edge of the Tarhuna plateau (fig.21). There are no wells in the Ghibla, and in Cussabat they do not lie close to the main centres of population. In Tarhuna, the cabila lands are scattered over the northern Jebel, and several tribes have no wells or springs. This imposes severe restrictions on the movement of population and animals, which are reflected in overgrazing and the concentration of population near the wells in summer.

The groundwater resources are not inadequate in the quantity and quality of their yields, but they are badly distributed, so that the population must rely on means of conserving and storing rainwater and run-off for domestic, animal and agricultural purposes.

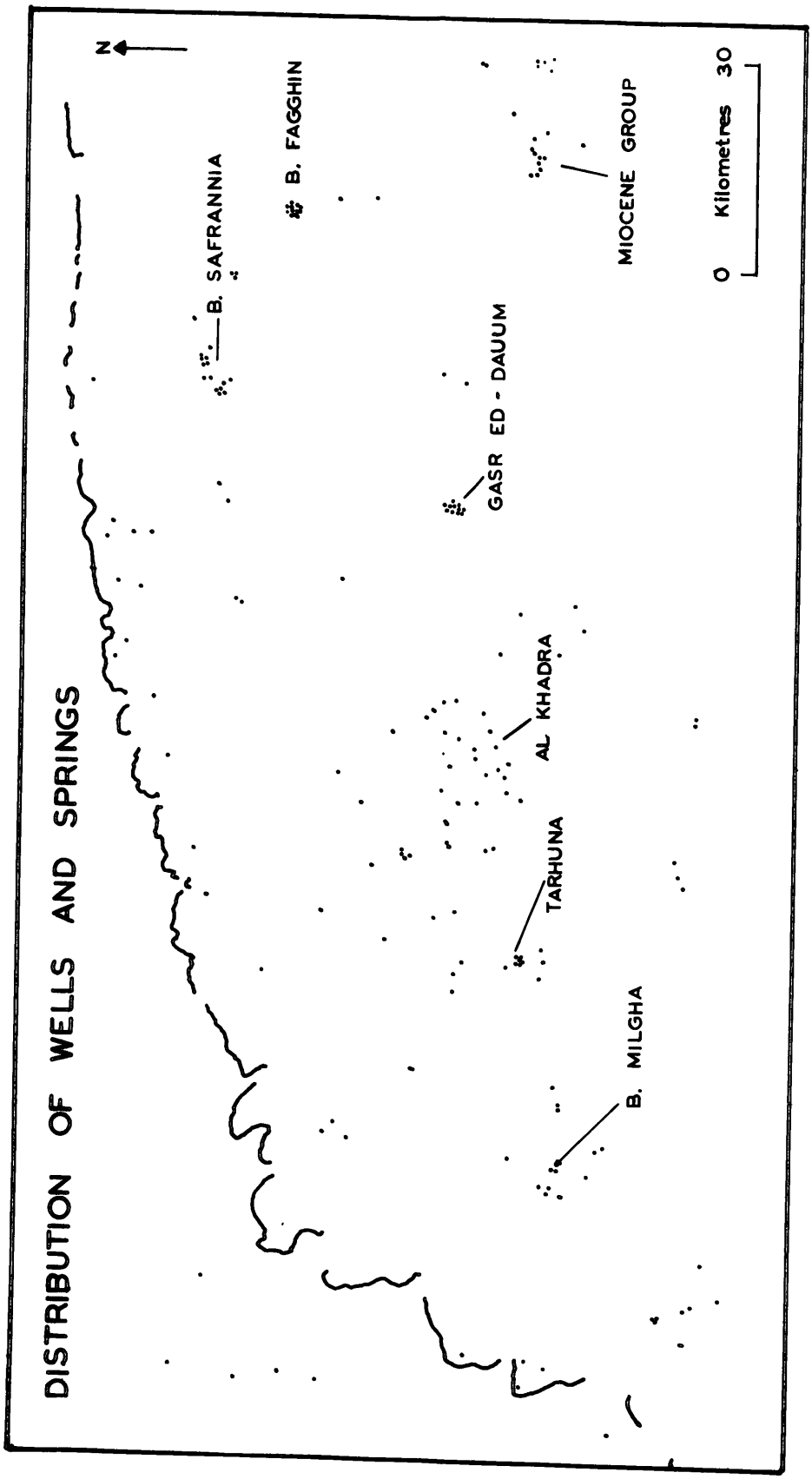
B. The collection and conservation of rainfall and run-off.

Rainfall and run-off are either collected in storage tanks or conserved behind small dams.

1. Collection of rainwater.

Rainwater is collected in cisterns, of which there are probably several thousand in the region under study. Though

figure 21.


DISTRIBUTION OF WELLS AND SPRINGS
N
B. SAFRANNIA
B. FAGGHIN
GASR ED - DAUUM
AL KHADRA
TARHUNA
B. MILGHA
MIOCENE GROUP
0 Kilometres 30

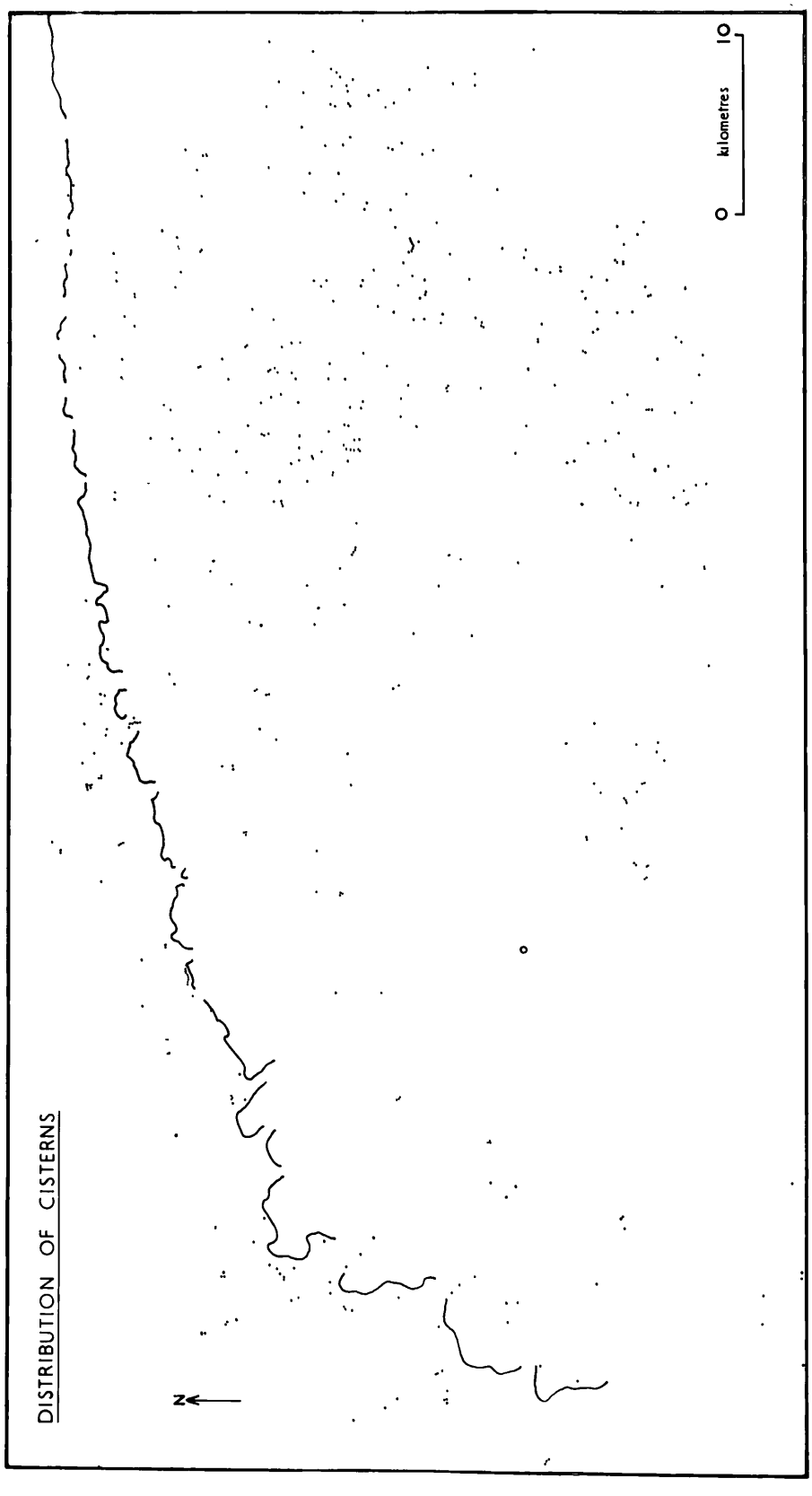
only about 1,200 appear on the Italian 1:100,000 maps, they are clearly widely dispersed (fig.22). Cisterns are most dense where rainfall is highest and groundwater supplies smallest. There are very few along the northern edge of the Tarhuna plateau, but they become more numerous to the north and north-east and less numerous towards the Ghibla and in the Jefara, where they are concentrated in wadi beds. Cisterns are densely distributed in Cussabat, where most households have their own cistern and each village is surrounded by small storage tanks.

The cisterns are of four types: faschia, or open tanks; maragnat, or small closed cisterns of Arab origin; Roman cisterns and small excavations cut in the wadi beds. The maragnat are the most numerous, but there are a large number of Roman cisterns in Cussabat, El Amamra and around Uesctata and the Wadi Taraglat.

Roman cisterns are normally either square rock-cut tanks, or large rectangular and vaulted tanks divided into several chambers. Lush (12) was able to trace 122 Roman cisterns, all still in use. However, many are in a bad state of repair, and are cracked and blocked with sand and fallen masonary. Some are very large, with capacities of over 400 m3, but most of them hold only 40-75 m3 of water (Appendix V).

Arab cisterns are smaller and simpler. They are dug into

figure 22.



slopes on which there is run-off after rainfall, and water is channelled into a sedimentation basin before entering the cistern. Most of them consist of a cylindrical tank made from limestone chippings and lined with concrete. They have a capacity of about 3-4 m3, and are usually partly cemented on top so that the cistern can be locked with an iron hatch or blocked with stone. Most cisterns are delapidated and need cleaning and repairing. The Government is making free grants of cement to cistern owners and so far 200 cisterns have been repaired, but there are still 1,000 outstanding applications.

The cisterns are a useful supplement to the main wells and enable the population to live in the Gabile. However, the water is quickly used up during the summer, which is the critical period. Thus, in practise, the cisterns sustain the population and animals only for the first few weeks of summer, after which the wells and springs must be used. Because of the restriction this places on population movement, the Government is experimenting with improved types of cistern with large capacities. Several very large "beehive" cisterns have been constructed in the Wadi Taraglat, and these have been sufficient to supply water for household and stock use to several families in the Gabila Aulad Hamed for the whole summer. The "beehive" cisterns may prove useful if no groundwater is found in the Ghibla, since they offer a means of dispersing

the animal population during the arid part of the year.

2. Run-off and the wadi spate.

Rainfall is so small and seasonal that there are no perennial flows of surface water except below the spring at Scersciara. Surface flow usually takes the form of a large flood called the spate. This water flows from the Eastern Jebel into the Jefara and Ghibla, where most of it is unused except for the natural irrigation provided by its passage. This water could be used in the Ghibla or inner Jefara, or it could also be trapped and used within the Eastern Jebel itself.

The volume and relative frequency of the spate depend on the intensity of the rainfall, the rate of run-off, the size of the catchment area and the nature of the wadi bed.

(a). Intensity of rainfall.

On average, rain falls on 45 days per annum in the Eastern Jebel. 77% of these have amounts of less than 10mms., and are not likely to cause floods; 14% have over 10 mms., and could produce a spate if the rains fell at night and over a large part of the catchment area; and 9% have over 20 mms., which should produce a flood. Rain is heaviest in late winter, but most intense in the early part of the rainy season, when it falls on land which is partially impermeable because of the heat and evaporation of summer.

(b). Run-off rates.

Run-off rates are lowest on flat sandy surfaces and highest on steep denuded slopes. Run-off rates have not been calculated for Tarhuna, but C.O.T.H.A. recently investigated them in the Wadi Megenine basin of Garian (13). Conditions here are similar to those found in northern Tarhuna. C.O.T.H.A. found that run-off varied from 5-55% of total rainfall and averaged 10%. Rates would fall on the sandy catchments of the dip slope, but would rise on the denuded and incised surfaces of western Tarhuna. In these two areas, run-off would equal about 5% and 15-20% of total rainfall respectively.

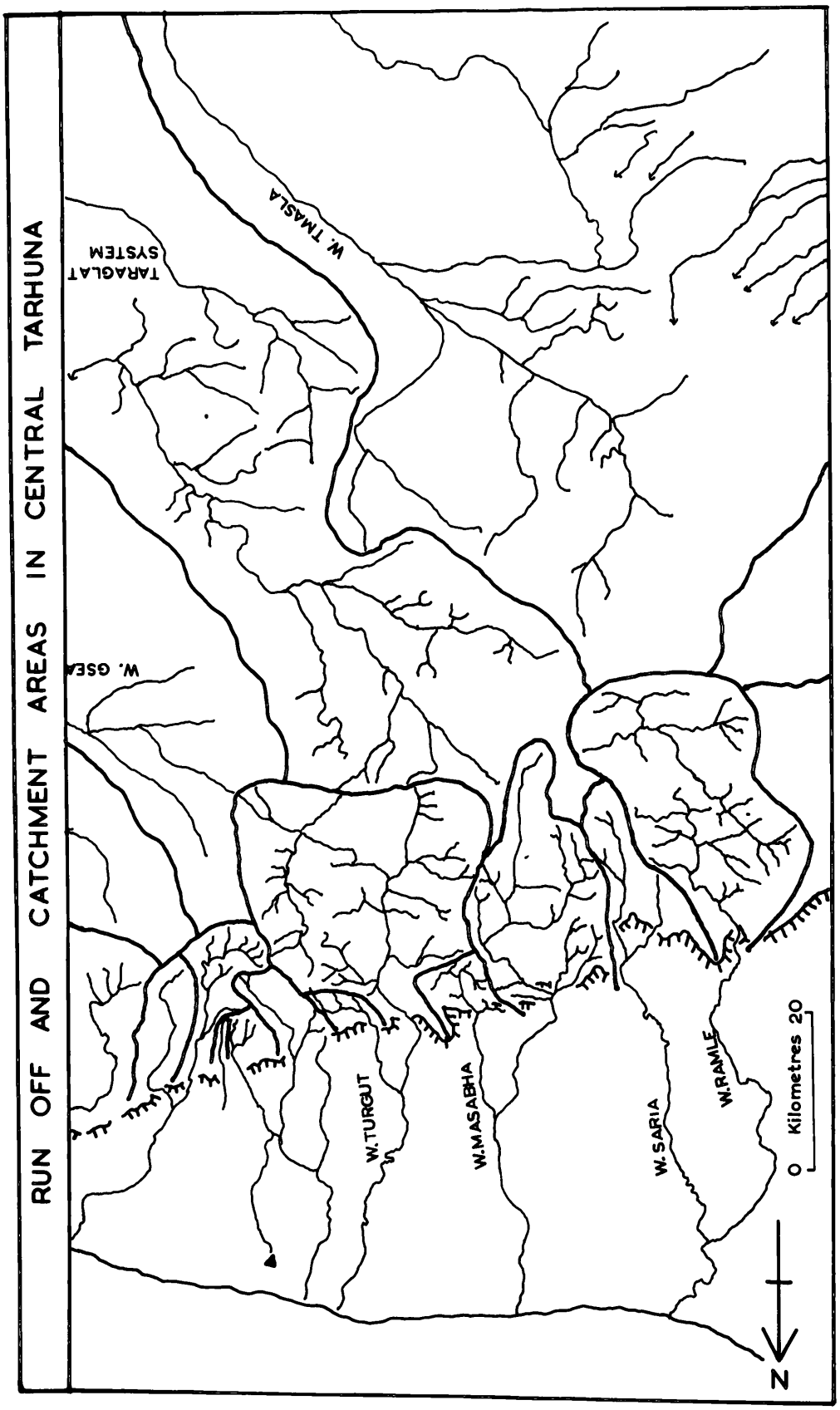
(c). The size of the catchment area.

The volume of the spate is controlled by the area in which run-off is collected and concentrated into the wadi channels. Some idea of the total surface flow in a wadi may be obtained by mapping the approximate boundaries of wadi catchments (fig.23). The potential total of water passing through the Jebel front and the northern Ghibla in the average year is very high, and millions of cubic metres of water are lost each year, even allowing for the fact that much of the water never reaches the Jefara or Ghibla.

(d). The nature of the wadi bed.

Water will flow further along channels which are cut in less permeable rocks. C.O.T.H.A. showed that the

figure 23.


RUN OFF AND CATCHMENT AREAS IN CENTRAL TARHUNA
TARAGLAT SYSTEM
W. TMASLA
W. GSEA
W.TURGUT
W.MASABHA
W. SARIA
W.RAMLE
0 Kilometres 20
N

volume of the spate was greater from wadis cut in the Jefren marls than from those cut in the Garian limestones in the Teraglat-Caam basin. In the Wadi Gsea, cut in the Jefren marls, the spates were greater in volume and flowed further along the channel than in the neighbouring Tamamura (14).

The spate is the dramatic form of surface flow. After rainfall, water may accumulate for a few days in the wadi bed, or flow may be no more than a movement of mud. Water from the spate is lost to the Jebel, where it is little used or conserved. Water conservation must be introduced, because conditions in the catchment areas are deteriorating. For example, floods in the Wadi Megenine are increasing in volume and are carrying more sediment. In 1935, 100 mms. of rainfall produced a flood of 7-8 mms. at Tripoli; today it produces 15 mms.. The Quaternary material which still clothes the middle basins of the larger wadis is gradually being stripped and carried downstream. A solution lies in the reintroduction of the Roman system of flood control, the extension of the Cussabat "dams", or the introduction of modern techniques of water conservation.

3. Water conservation.

(a). The Roman system.

The ruins of many Roman dams are scattered about the eastern section of the region. Few are mapped, but the main

concentrations appear to be along the wadis of Sciogran and eastern Cussabat. Westwards, they are more spasmodically distributed, but there are important groups in the Wadis Gherrim, Ben Gebara, Chabazza, Turgut and Wadi El Me, where there is a group of 60 dams. The dams are of two types: a broad, short, thick dam resembling a reservoir, and a long narrow wall set in the broader and flatter wadi bottoms. Oates (15) believes that both types served the same purpose and that the difference in structure was to suit different wadis. The dams in the Wadi El Me are about 16 metres long and 10 metres high. The downstream side is sloped as if to hold back water and protect the dam from the cascading overflow. The upstream faces of these and many of the other dams have been raised from time to time. These dams did not give rise to reservoirs, since the depth of water would have been too small and its surface area too great to avoid evaporation. Their main purpose was to build up soil and limit the damage which the spate could cause. Water could be obtained by digging in the soil behind the dam, since the groundwater level would be raised. These methods are still employed by the Berbers around Nalut and Giado in the Jebel Nefousa.

Oates believes that the dams were small local projects and not centralised works for water conservation, as some writers have contended. This is demonstrated by their sporadic

distribution. Nonetheless, the Roman dams provided an admirable method of conserving water.

(b). The Hawara inheritance.

The last days of the Roman empire witnessed a 'Berberisation' of agriculture, so that when the Romans withdrew, their techniques were conserved. However, continual invasions and devastations of arboriculture after the seventh century saw the destruction of Roman dams, which were eventually breached by the wadi spates.

The general principle of water conservation has been retained in Cussabat, however, where the Arabised Berber population construct small earth walls across slopes and wadi channels to conserve soil and moisture. The walls vary in height and breadth according to their position, and are usually composed of a walled nucleus covered with beaten earth. Run-off and sediment are trapped by the dams to form small terraces behind the walls. These terraces are normally constructed in a series, each having small feed channels cut in the slopes and small spillways on one side of the wall. Sometimes the terraces are constructed singly on steep slopes, whilst in the more undulating valleys of the Wadis Gsea and Uaeni groups of ginanat (dry gardens) are fed by run-off. Small excavations are made in the terraces and sometimes around the bases of olive trees on the Cussabat Plain. Channels are dug in the

earth to feed water into these small reservoirs, which maintain soil moisture for a few days after rainfall (for more details see ChapterXI). The Cussabat dams are primitive, but they are an important contribution to the use, if not the conservation of run-off. Their main faults are that they merely effect the transfer of soil from wadi slopes into the terraces, and do not conserve water for dry years or dry periods. They are merely an improved method of natural irrigation from the wadi spate used in Tarhuna for shifting cereal cultivation.

3. Other methods of water conservation.

The Government sees water conservation as a broad regional problem. The Eastern Jebel is the catchment area for the Jefara and Ghibla, where water spreading schemes are being initiated. The conditions in the catchment areas are deteriorating, so that it is essential that conservation be carried out in the Eastern Jebel. This can be done by afforesting slopes to protect them against erosion, or by the extension of the Cussabat dams into the upper basins of the main wadis. The dams, however, like the L.A.J.S. terraces (Chapter VI) use rainwater without storing it, so that cultivation is still dependent on the vagaries of rainfall. At present, two methods of conservation are being tried: water spreading in the Ghibla and the damming in the Jebel

itself.

(a). Water spreading.

Water spreading work, which has been carried out widely in the U.S.A., consists of a series of earth and rock dykes in the wadi channels, to slow down the flow of water, reduce erosion, spread diverted water over a large area and thus increase soil moisture. Experts from the United States Overseas Mission have been working on water spreading problems in Tripolitania for several years. One of them, Davis, (16) points out that during Roman times many wadis had their beds stabilised by rock dykes and terraces, and he considers that this network should be restored as soon as possible. He maintains that this would attract shifting cultivation to the wadi beds, so that the rest of the wadi basins could be managed and improved for grazing. At present, two types of water spreading are envisaged:-

Public work, involving earth and rock dykes in the major Ghibla wadis.

Self-help, comprising community dykes in the wadis, hillside terracing and cistern improvement.

The Government is hoping that the second method will be used in the Ghibla, but at the moment it is doubtful whether the tribesmen will co-operate. However, dykes were built by L.A.J.S. in the Wadi Soffegin at Beni Ulid. With water

spreading, at least two crops of Bermuda grass and one of barley are possible. In 1955/6, for instance, a good crop of grass was harvested after the first rains; in the colder months the Bermuda grass was dormant and the barley matured and was harvested; after the spring rains another crop of Bermuda grass was harvested. Further down the Megenine, two small oases have not received a spate since the dykes were built in 1955. This problem does not exist in the Wadi Taraglat, where five dykes have been constructed at 50 metre intervals. Here, the dykes, which are meant to bleed, increase the depth of moisture penetration from 18-36" and as long as penetration can be achieved to 24-40", cereals and forage can be grown. It is too early to judge the success of water spreading in the Wadi Taraglat, though two crops of Bermuda grass and cereals were harvested in 1958. In 1959, there was no flood after January, and the cereals dried out. If water spreading proves successful, it could be extended to Uesotata and the other wadis of the Ghibla.

(b). Damming in the Jebel.

Water conservation must go hand in hand with soil conservation. Re-afforestation, contour dykes and terraces, which will be discussed in Chapter VI, can be used to restrict soil erosion, and these methods would also slow down the flow of water. Small check dams must be built in the Jebel to

control the spate to the Jefara and to conserve water for stock, human and agricultural needs. Before damming, the slopes must be afforested or the dams will rapidly silt up. Silting will be an important problem, but local labour could be diverted into clearing after each flood. This would in itself limit emigration and probably lead to increasing arboriculture (Chapters IX & XII).

The question remains of the methods to be employed. Pioger pointed out that it was not possible to find suitable methods until hydraulic engineers have familiarised themselves with the lie of the land. One type of arrangement that he suggested is to dam up a valley by submersible barriers with a horizontal ridge. In this way, the bed is transformed into a series of benches on an incline, but with less of a slope than the regular slope of the valley. Barriers to delimit benches or terraces formed with alluvial deposits may be made of earth, but must have a stone facing. For heavy water flow, or where the slope is steep, the downstream facing of the dam should be inclined and made of different sized blocks, the idea being to reduce the speed of the water as it reaches the next lower level.

Another method is being tried out in the Wadi Gan of Garian in the Scarp Zone. Here, small but thick dykes are being built across the wadi bed. From the dykes, water is

diverted into a number of cisterns and a large open reservoir. The feasibility of the scheme, and its economic aspects, have yet to be calculated, but if it is successful it could be extended into Tarhuna. This method might best be applied in the upper courses of wadis whose Jefara sections are too incised to permit water spreading. The Wadi Ramle is one example cited by C.O.T.H.A. (17).

Other methods of conserving water, especially for stock needs, are "T" dams and "turkey nest" dams. The first type, which is widely used in the U.S.A., is excavated in the shape of a T to a depth of 10-15 feet, and can be over 150 feet long. "T" dams are usually built in shallow valleys high in the catchments and do not require solid foundations or extensive spillways. The "turkey nest" dams are circular excavations surrounded by earth banks to form the dam wall. Water is gathered from the spate, and in Australia they have proved to be a satisfactory method of storing water.

Because the population is reluctant to co-operate on communal projects (Chapter VII) and because soil and water conservation are intimately related, the most practicable methods of conservation lie in the improvement of cultural techniques and the extension of terracing, contour ridging and reafforestation in Tarhuna. The best way of achieving this is by education and demonstration, and by Government aid

to families attempting to conserve land resources. The conservation of water may be carried out by the extension of the cistern construction programme, particularly of the type found in the Wadi Gan; water spreading; and the construction of check dams in the upper courses of wadis in which water spreading will take place, and the conservation dams in the more deeply incised talwegs. Damming would have to be carried out by the Government, but the work would benefit the Eastern Jebel and Jefara.

C. Regions of water supply.

Regions of water supply sum up the information given in this chapter. There are six principal regions of water supply.

1. Zones of adequate groundwater resources.

(a). Northern Tarhuna plateau between Biar Milgha and Gasr ed Dauum.

(b). Wells and springs of north-west Tarhuna.

(c). The Miocene wells of El Amamra.

2. Zones of wells and cisterns.

(a). The Cussabat plain.

(b). The middle basins of Tarhuna.

(c). Western Tarhuna.

3. Cisterns and zones where water conservation is urgently needed.

(a). Northern Cussabat.

4. Cisterns and areas of natural irrigation.

(a). Scarp Zone of northern Tarhuna.

(b). Piedmont zone.

(c). Ghibla wadis.

5. Waterless zones.

(a). Central and south-west Ghibla.

D. Conclusions.

The Eastern Jebel is at present a vast catchment area, from which water flows on the surface to the Jefara and Ghibla, and underground to the Misuratino and Wadi Soffegin basins. As 70% of rainfall is lost by evaporation, the population is forced to live on only a fraction of its rainwater. If there are large groundwater reserves, they lie on the southern margins of the region, and not those parts climatically suited to agriculture. Present groundwater reserves are adequate to meet the demands of the population, but because wells and springs are relatively few, and concentrated in several small areas, the distribution of population and economic activity are restricted. To overcome these facts, the people attempt to conserve and collect run-off and rainfall. Their methods are poor and the results unsatisfactory. If tree cultivation is to be extended and improved, and pastoralism made more economic

in the marginal areas to which it will be forced, the present water supplies will have to be improved. They may be improved in the following ways:-

1. Exploration and exploitation of groundwater reserves in the Basin and Scarp Zones and the northern dip slope.

2. Deep drilling in the Ghibla near areas of karstic erosion.

3. Improvement of wells by cleaning, clearing and the construction of efficient drawing arrangements. As a first step, it will be necessary to bring up to date information on the distribution and depth of the wells, the nature of the aquifers and the quality of the water.

4. The construction of large and improved types of cisterns in all parts of the region, but particularly in the Ghibla. The cleaning, repairing and cementing of old cisterns.

5. The introduction of simple water conservation measures, especially those like terracing and contour ridging, which also help to conserve the soil.

6. Construction of conservation dams in the northern Jebel, particularly in the headwaters of wadis which are too incised to permit water spreading.

7. The construction of earth check dams in other wadis, to reduce the rate of run-off and conserve both soil and water for local use.

CHAPTER VI.

SOIL.

A. Introduction.

As Hill (1) has pointed out, we are confronted in Tripolitania with the problem of what is a true soil. Strictly speaking, soil is the medium in which plants grow, and must not be confused with weathered rock. Because of the aridity of the Tripolitanian climate and the over-grazing of the range, plant life has been severely reduced in parts of the Eastern Jebel. Nonetheless, there is a measure of vegetation cover even in the most arid parts of the Ghibla and the most degraded slopes of the scarp zone. In many areas, the deficient vegetation would develop if the density of grazing animals was lowered. It is not intended to enter into the polemics of soil definition in this chapter, but to concentrate on the distribution and characteristics of soils and soil material as they influence sedentary and shifting cultivation and grazing.

However, because the distribution of agriculture and pastoralism has been influenced by human rather than environmental factors, the land use systems are not always those most suited to the prevailing water and soil resources. Despite this, water can define the general boundaries of cultivation in Cussabat, it can influence the pastoral movements in Tarhuna and affect the distribution of population in both areas. Soil modifies the distribution still further, since it affects the development and extent of the

pasture, the areas used for shifting cultivation and the types and yield of crops grown in sedentary cultivation. The study of soil is also important because the traditional pattern is changing and the distribution and type of land use are beginning to be reshaped according to water and soil resources.

B. Soil classification.

W. M. Davies, the great geomorphologist, emphasised that landscape is a function of "structure, process and stage". This formula can be applied to soils, and pedacologists use this genetic approach to classify the major soil groups into zonal, intrazonal and azonal.

Zonal soils are closely related to climate and their profiles are an expression of this relationship. They are divided into two great orders, Pedalfers and Pedocals. In Pedalfers, the dominant direction of translocation is downwards with the leaching of bases etc. from the A to the B horizons. The reverse process takes place in Pedocals, which are found in arid zones.

Most of the soils found in the Eastern Jebel are Pedocals and should be intrinsically fertile. However, the upward leaching of salts, particularly calcium bicarbonate, is increased by high summer temperatures. This means that

the solution of calcium bicarbonate in the soil gives off carbon dioxide as it nears the surface, and deposits calcium carbonate. This process is known as calcification. It creates hard or soft layers in the soil and induces a granular structure. It is difficult to decide whether a true zonal Pedocal is found in the Eastern Jebel, but the Intermediate soil type, which will be discussed later, may be a pedocalic regosol. (2).

Intrazonal soils are those found in more than one climatic belt and their profiles have distinctive characteristics which are not those to be expected under the climatic conditions which prevail. The calcimorphic or crust soils of this group are found in the Eastern Jebel.

Azonal soils are those in which the parent material does not remain in situ long enough for true profile development. They are represented in the Eastern Jebel by sands, alluvial, detrital and eroded soils.

Thus, examples of all three major soil groups occur in the region under study. Parent material is derived from the weathering in situ of superficial Quaternary and Cretaceous formations, the aeolian sands transported from source regions in the south, and alluvium. Taking into account the Great Soil Groups classification indicated above, and the nature of the parent material, it is possible to class the region's

soils tentatively into the following groups:-

1. Sand dunes and sandy areas - Azonal regosols.
2. Alluvial soils of the wadis and Jefaran Piedmont - Azonal.
3. The Intermediate soil type - Zonal.
4. Calcimorphic crust soils - Intrazonal.
5. Eroded soils - Azonal.
6. Detrital soils: wadi and Piedmont lithosols - Azonal.

C. The main soil groups and their distribution.

1. Sand dunes and sandy areas.

The sand, making up the dunes and the ard ramla (sandy areas), is of continental origin, and the white marine sands of the Jefara are not found in the Eastern Jebel. The sand grains are reddish in colour if coated with haematite or brownish if covered with limonite. They are finely grained, and are composed mainly of quartz, with a minor amount of heavier minerals. The grains, which have been highly polished and rounded by attrition, form a homogeneous mass without any signs of stratification. As there is very little clay and calcareous material, most sands are unstable, and are devoid of vegetation and cultivation. They are of two types:-

(a). Dunes.

The loose sands have given rise to dune formations in a zone lying one to three kilometres south of the Italian

zone between Sidi Essed in the west, and Gasr ed Dauum in the east. The dunes are small, but the grains are easily blown by wind, so that sand is invading the southernmost farms of Al Khadra and Sidi Essed.

(b). Loose sands.

A thin and discontinuous layer of sand stretches over large areas of the Tarhuna plateau to the south of the sand dunes, and overlies heavier soils northwards. Occasionally, small dunes develop, and there are thicker accumulations of sand around the feet of some south-facing slopes.

2. Alluvial soils of the wadis and Jefaran Piedmont.

The main belt of Sandy soils lies east-west across Tarhuna, south of the main watershed. The Alluvial soils run north-south along the wadi courses, and are also found in two narrow and discontinuous belts running east-west across the northern and southern margins of Tarhuna. In the northern Jebel, Alluvial soils are found below the wadi terraces in the upper courses, but are most extensive after the terraces ha ve disappeared in the lower courses. The composition of the Alluvial soils is strongly influenced by the wadi spate. In the main wadi channel, where the traction load is deposited, the soils are formed from coarse gravels and pebbles, but on the margins of the valley floor finer alluviu m

from the suspension load produces the Limon of the Jefara and the Ard Ten of the Ghibla. The Alluvial soils are formed by an interstratified mass of sands, gravels and clays, so that profile development depends on the nature of the spate. Because of the greater clay content, the soils are much more compact and cohesive than the sand or the Intermediate soil type.

3. Intermediate Soil Type.

The Intermediate soil type is so called because it is formed partly of aeolian and partly of alluvial materials. It is very similar to the Intermediate soil of the Jefara and was called "terra rossa" by the Italians. Willimot (2) considered that the Jefaran soil was a pedocalic regosal, but because of the special conditions of slope and fluvial erosion in the Eastern Jebel this classification has been rejected. The soil reflects the nature of its parent materials which are:-

(a). Material produced by weathering in situ of the limestones and marls.

(b). Imported aeolian materials.

(c). Alluvial materials from Pleistocene and recent fluvial erosion.

The contribution of the parent materials to any sample of soil varies from area to area. Broadly, the sandiest soils

are found towards the south, but the Scarp Zone has important locally eroded materials, and alluvial materials are important near wadi channels. This diversity is recognised by the local population, who divide the Intermediate soil type into three main orders: the Ard Hamra, the Ard Hammari and the Ard Ten.

(a). Ard Hamra.

The Ard Hamra (the red soil) is the sandiest and most widespread of the Intermediate soil types. It consists mainly of coarse sand particles, with 90-92% of its grains between 0.1 mms. and 1.0 mms. in diameter, and a little clay and silt. Because it contains more clay and calcareous particles, it is more compact and cohesive than sand. There is no real stratification, but the calcareous elements have been leached to a depth of 0.8-1.4 metres below the surface, where they occasionally form a hardpan, whilst the clay particles are most abundant just below the surface.

The Ard Hamra covers most of the northern Tarhuna plateau between the sand dunes and the Abanat Scarp, and it extends northwards into the great wadi basins and on to the residual plateau surfaces of the Scarp Zone. It thins eastwards and changes in character to become the lighter Ard Seffir of the El Amamra.

(b). Ard Hammari.

The Ard Hammari (the pink soil) is lighter in colour

and more calcareous than the Ard Hamra. It is a thin soil, usually associated with areas of intense erosion or areas in which the Cretaceous bedrock rises towards the surface. It is not extensively distributed and it is found mainly on the slopes of the Scarp Zone in Tarhuna and Cussabat and occasionally on the margins of the wadi valleys in the Ghibla and Jefara.

(c). The Ard Ten.

The Ard Ten embraces several soil types characterised by particles derived from the bedrock and alluvial materials rather than aeolian sand. There are three main sub-types: the Ten Hamra, the Ten Safra and the Ten Cadra.

(i). Ten Hamra. This is a light red soil. It contains more clay and limestone than aeolian elements, and is therefore more compact and cohesive, less sandy, porous and permeable than the Ard Hamra and Ard Hammari. It is generally thin, and its higher clay content reflects the fact that it is normally found in areas where easily eroded Jefren marls outcrop. It is of limited distribution, and is most commonly found on the upper parts of wadi slopes in zones of deep incision. It thus lies in the Scarp Zone and forms the material on which the inundated gardens of Cussabat have been laid out.

(ii). Ten Safra. The Ten Safra is found on the lower wadi terraces, and is composed of interstratified zones of gravel,

silt, clay and sand deposited during Pleistocene and Recent periods. Its clay content is high, but again, its distribution is limited. The main areas of Ten Safra lie along the courses of the main north-flowing wadis and their tributaries.

(iii). Ten Cadra: The Ten Cadra is characterised by a greater amount of alluvial materials than other soils in the Ard Ten group. They were laid down by Pleistocene rivers in the Ghibla, and are only occasionally renewed by deposition associated with modern spates. They are not truly alluvial, because they have been mixed with aeolian sands, but Manetti (3) considered them to be colluvial. In character, the soils resemble the Ard Hammari, but have a higher clay and silt content.

4. Calcimorphic crust soils.

Though the processes of calcification are active throughout northern Tripolitania, crusts appear at the surface in very few areas. Various writers have referred to the caliche (or croute)which occurs at varying levels throughout the Ard Hamra. The caliche gives rise to a hard and compact stratum within the soil profile and resembles a concreted limestone which is broken with great difficulty. Sometimes the caliche is found near the surface, sometimes at depth. In some areas it is both overlain and underlain with conglomerates, whilst in others two or more separate layers

occur in the soil profile. Because of this variety, it is necessary to examine more closely the nature and distribution of the caliche.

(a). The main hardpan layer.

In the Ard Hamra, the amount of calcareous material increases down the soil profile to a depth of 0.8-1.0 metres. The greatest concentration of the calcareous elements appears to occur where equilibrium has been established between the downward leaching caused by winter rainfall and the upward leaching caused by summer drought. On the Tarhuna plateau, the caliche lies about one metre below the surface, but as aridity increases, particularly to the south-west, the hardpan rises in the soil profile and appears at the surface to the south of Sidi Essed and over a large stretch of the El Amamra around Biar Fagghin. It probably lies at a greater depth on the sand dunes of Tarhuna, where rapid deflation takes place. However, when the water table lies near the surface, the caliche is much higher, and actually outcrops near the wells of Biar Milgha, which exploit an aquifer lying only 2-3 metres below the surface.

(b). Wadi crust.

The caliche is also found along the wadi courses of the Jefara and the northern dip slope of Tarhuna. These crusts have been formed by the capillary upward movement of

water containing calcium carbonate after the winter floods. The run-off is heavily charged with calcium carbonate, and as the water sinks into the ground more is dissolved. In the summer, heat forces the water to rise to the surface and deposit its calcium carbonate.

(c). Deeper crusts.

Lipparini (4) has traced several hardpan layers in the valleys of the Turgut and Ramle of northern Tarhuna. He believes that these crusts were laid down during an arid Pleistocene period, probably the Wurm. They are important where fluvial erosion has stripped the covering of sands.

5. Eroded soils.

In the Scarp Zone, intense rainfall and high run-off rates have led to the stripping of the steeper slopes, so that even soil material is scarce. Here and there, however, small pockets of immature, coarse and shallow soils occur. These azonal soils are similar to those found in areas protected from wind erosion in the Ghibla. They are formed from the weathering in situ of limestones and marls, but are of little use for agriculture.

6. Detrital soils: Piedmont and wadi lithosols.

Detrital soils occur along the Jebel scarp and the main wadi courses. They are formed from the fans of coarse gravel and boulders to which angular scree and run-off alluvium have

been added. They are being continually built up and are thus permanently immature and of little value.

The soils of the Eastern Jebel are sandy and calcareous. The sandier soils, which are the most influenced by aeolian materials, are found to the south and generally above the 400 metre surface. Below this surface to the north, locally eroded and weathered material influences soil composition and changes its character.

D. Soils and Agriculture.

1. Physical characteristics of the soils.

Of the major soil groups above, only three - sands, alluvial soils and the Intermediate soil type - are used for agriculture. The other soils support a thin cover of plant life used for animal pasture. The agricultural and pastoral significance of the soil depends not only on its nutrient and organic status, but also on its physical structure.

(a). Sand and sand dunes.

The sands are mainly composed of coarse grains and differ from the Jefara sands, which are composed of finer grains. The following sample from Gasr Tenzina is typical:-

Table VI- 1. Composition of sand at Gasr Tenzina. (5)

Particle size	Percentage of dry earth
0.1 - 1.0 (coarse sand)	92.0
0.05 - 0.1 (fine sand)	5.0
0.01 - 0.05 (silt)	2.4
Under 0.1 (clay)	0.6

There is hardly any clay or silt, but as most sands have up to 8% calcareous grains (6) they have a certain measure of cohesion. They are extremely permeable and act as a gigantic water trap.

(b). Alluvial soils.

The alluvial soils closely resemble the Intermediate soil type except for limon, which is quite different. It has up to 30% clay, about 60% silt and only 5-10% sand in the Jefara. Because of its clay content it is less permeable, and it is necessary to plough this soil deeply to mix it with the underlying sands and Ard Hamra.

(c). Intermediate soils.

The Ard Hamra and Ard Hammari closely resemble the pure sand soils in particle size.

Table VI - 2. Physical composition of the Ard Hamra and Ard Hammari in percentages. (7)

Location	Coarse sand 0.1-1.0	Fine sand 0.05-0.1	Silt 0.01-0.05	Clay under 0.01	Calcareous materials
Ard Hamra					
Gasr Tenzina	96	2.4	0.47	1.1	15.7
Wadi Taraglat	88.4	5.2	4.4	2.9	15.0
Abbiar Miggi	89.7	9.2	0.5	0.6	11.1
Scersciara	61.0	27.9	6.6	4.4	6.6
Zaafran	92.8	4.1	1.6	1.5	14.7
Wadi Ramle	86.3	6.4	2.7	4.6	12.4
Gasr ed Dauum	95.0	1.0	0.5	3.6	15.5
Ard Hammari					
Cussabat	90.1	4.2	4.6	1.1	7.7
Saniet Miggi	83.6	9.4	4.9	2.1	9.0
Wadi Gsea	94.1	1.6	2.7	1.5	15.3

There is a little more clay and silt, but the main difference between the sand and Ard Hamra is the greater calcareous content of the latter. This makes the soil more cohesive and less permeable. Nonetheless, most of the soil is made up of siliceous particles, as the following three samples show:-

Table VI - 3. Content of calcareous and siliceous materials in the Ard Hamra and Ard Hammari in percentages. (8)

Location	Coarse sand		Fine sand		Silt		Clay
	Sil.	Cal.	Sil.	Cal.	Sil.	Cal.	
Tarhuna town	54.9	3.7	22.3	2.2	2.2	6.9	7.8
Tarhuna town	65.1	0.6	26.9	0.4	1.7	-	5.3
Al Khadra	54.3	5.4	17.8	4.1	2.5	6.2	9.7

The Ard Hamra and Ard Hammari are characterised by high rates of infiltration and porosity, but low powers of capillarity and absorption. The loose structure also enables plant roots to penetrate deeply into the soil, and this is very useful in an area of low rainfall and strong winds. The hardpan, which occurs in Ard Hamra, can favour agricultural development in places where it interferes with, but does not completely impede infiltration. The main disadvantages of these soils are the rapid dessication of the upper horizons in summer, and the rapid percolation and transportation of nutrients down the soil profile. However, they are easily worked, and thus are used by the Libyans for shifting cereal cultivation.

The clay content of the Ard Ten group is much higher, and the soils are more calcareous, compact and heavy.

Table VI - 4. Physical composition of the Ard Ten soils. (9)

	Coarse sand 0.1-1.0	Fine sand 0.05-0.1	Silt 0.01-0.05	Clay under 0.01
Hamra				
Guezi	67.5	23.7	6.4	2.3
Galaa	75.2	7.7	8.9	8.1
Safra				
Gherrim	59.5	22.0	6.1	12.4
Gheleel	64.6	5.4	4.4	25.7
Sidi Atia	69.3	6.2	8.0	16.5
Cadra				
Zaafran	86.4	1.6	0.9	11.1
Beni Let	85.5	1.1	5.3	8.4

Table VI- 5. Content of calcareous and siliceous materials in the Ard Ten. (10)

	Coarse sand		Fine sand		Silt		Clay
Cussabat	49.2	2.5	31.0	2.4	2.6	2.6	9.7
El Gsea	41.3	2.5	28.8	6.7	2.2	8.5	10.0

The hardpan does not occur in the Ard Ten, which is generally thinner and has less fine earth than the Ard Hamra or Ard Hammari. The Ard Ten soils are less easy to work, but otherwise are similar in character to the other Intermediate soils, from which they are a transition rather than a distinctive sub-group.

2. Organic and salt content; nutrient status.

The presence of organic matter and nutrients in the soil is essential for plant growth. For a full understanding of the agricultural merits and demerits of the soils, it is necessary to examine the elements which affect soil fertility.

(a). Organic content of the soil.

The colouring of Tripolitanian soils is determined by the coating of limonite and haematite on the sand grains. As there is no deep brown soil, it is evident that the organic content is low. Hill (11) states that the average organic content of soils in the Jefara is about 1%. The figure is higher in the Jebel, where Broc (12) found that it varied from 0.3% on sands to 3-4% on clays. The poorest soil

is the Ard Hamra, whilst the highest figures were recorded in the Ard Ten of Cussabat. Though the organic content of soils in the Eastern Jebel is higher than on the Jefara, they are still poor.

(b). Salt content.

The main toxic salts - the sulphates of sodium and magnesium and the chloride of magnesium - do not occur in dangerous quantities in the Jebel soils. This is evident in the absence of halyophytic vegetation. Broc (13) found that the average salt content on all types of soil in Tarhuna and Cussabat was less than 1%, which is not a toxic quantity. As there is little chance of irrigated agriculture extending to the Eastern Jebel, soil salinity is unlikely to develop.

(c). Nutrient status of the soil.

The elements which are necessary to plant growth may be divided into two groups: major nutrients and minor and trace nutrients.

Major nutrients.

(i). Nitrogen. Nitrogen is derived from the air and not the soil material. Though there is approximately 34,500 pounds of nitrogen over every land acre, it cannot be used directly by higher green plants (14). On virgin soils, nitrogen is usually combined with organic matter, and it can be maintained by adding manure or by the cultivation of

nitrogen-fixing legumes.

The nitrogen content of virgin soils in the United States varies from 0.1% to 1.0%. Because the vegetation cover is more continuous and dense in the Eastern Jebel, the nitrogen content should be higher in the Jefara, where it averages 0.04-0.01, compared to 0.04-0.04% on the Ard Hamra and 0.06-0.9% on the Ard Ten. (Manetti) (15).

Table VI - 6. Percentage of nitrogen, potassium and phosphorus in the Intermediate soil type.

	Location	Nitrogen	Potassium	Phosphorous
1.	Ard Hamra			
	Gasr Tenzina	0.05	trace	0.02
	Wadi Taraglat	0.08	0.02	0.06
	Abbiar Miggi	0.04	0.09	0.06
	Scersciara	0.09	0.09	0.03
	Zaafran	0.09	0.09	0.02
	Wadi Ramle	0.10	0.09	0.04
	Gasr ed Dauum	0.09	0.09	0.04
2.	Ard Hammari			
	Cussabat	0.04	0.17	0.03
	Saniet Miggi	0.06	0.13	0.04
	Wadi Gsea	0.07	0.08	0.06
3.	Ten Hamra			
	Guezi	0.07	0.13	0.03
	Sallaa	0.06	0.17	0.03
4.	Ten Safra			
	Gherrim	0.06	0.30	0.03
	Gheleel	0.09	0.25	0.06
	Sidi Atia	0.06	0.24	0.04
5.	Ten Cadra			
	Zaafran	0.08	0.11	0.04
	Beni Let	0.06	0.10	0.02

The soils are intrinsically low in nitrogen content, but may be improved by adding manure to cultivated gardens and by

planting legumes, which can fix about fifty pounds of nitrogen per acre.

(ii). Phosphorous. As most of the soils in the Eastern Jebel have pH values of over 7, phosphorous occurs as complex compounds of tri-calcium phosphate with calcium hydroxide or calcium carbonate, and organic phosphorous may be up to 10% of total phosphorous. According to Thorne and Petersen, the phosphorous content of soil varies from 0.4-0.02% and averages about 0.1%. In the Eastern Jebel Manetti (16) found that the phosphorous content ranged from 0.02-0.06 (Table VI - 6). The highest figures came from the Ten Safra and those Ard Ten soils in which the bed rock was nearest to the surface. The soils are thus low in phosphorous content, but the better endowed soils are those on which Libyan tree cultivation takes place.

(iii). Potassium. In arid areas the normal potash content is about 0.15% for sands, rising to 4% for clays. Manetti (17) found that the Ard Hamra had 0.09 potash content, falling to 0.04 on poorer soils near Tenzina and rising to 0.25 on the Ard Ten of the Cussabat area. Though these figures are low, there is no real potash deficiency because potassium is readily available as water-soluble salts salts and also as the potassium absorbed in exchangeable form in soil colloids. Soils showing low potassium responses have been farmed for

centuries in Asia Minor and for over one hundred years in the United States, so that it is unlikely that deficiencies will arise in the Eastern Jebel.

(iv). Calcium. Calcium, which is an essential ingredient in animal diet, is not deficient in the soils of the Eastern Jebel. Both Broc (18) and Manetti (19) say that there is an abundance of this element in all but the pure sand soils. The animals therefore absorb it through the pasture. The best endowed soils are the Ard Ten (Safra and Hamra) of Cussabat and the scarp and basin areas of Tarhuna. It is significant that until 1928 all indigenous tree cultivation was restricted to these areas, whilst the poorly endowed Ard Hamra soils were used for shifting cultivation. However, the Italians established their concession and demographic farms on the Ard Hamra, and so far no symptoms of nutrient deficiencies have been reflected in crop production.

Minor and trace nutrients.

Comel (20) has shown that sulphur, magnesium and iron are not deficient in the Ard Ten, and there is no evidence to indicate deficiencies of these elements in other soil types. Little research has been done on the trace nutrients, which are vital to plant growth. However, certain conclusions may be drawn from findings in other arid areas:-

(1). Copper. Copper is usually deficient on weathered

sandy soils, but it is most securely held in soils with a pH range of 7 to 8. However, in Florida copper deficiency has followed the planting of fruit trees.

(ii). Zinc. Zinc deficiencies are associated with calcareous soils if deep rooting trees like apricots or peaches are planted.

(iii). Boron. Boron deficiencies are not common in arid zones.

(iv). Molydenum. Little is known about this, but deficiencies have arisen on weathered sandy soils in Australia and California. Deficiencies may be made up by adding minute quantities of this nutrient or by spreading the ash of eucalyptus trees on the soil.

(v). Manganese. Manganese deficiencies have occurred on alkaline, calcareous and very sandy soils in the United States.

Trace nutrient deficiencies may occur in the Eastern Jebel, particularly after the planting of fruit trees. As it is planned to extend the cultivation of peaches and apricots, some research into the content of manganese, copper and zinc must be carried out.

(d). pH values and the chemical availability of plant nutrients.

Most of the soils in the region under study are

alkaline and often have pH values of over 8. Broc (21) quotes figures of 8.4 near Abbiar Miggi, 8.6 in two samples near Tarhuna town, on Al Khadra and El Gsea, and 8.7 in Cussabat. Samples taken by the writer gave pH values of 8 or more in localities as far apart as Uescata, Beni Let and Et Tella. Though values are high, they do not exceed 8.8 - the point at which alkalinity becomes toxic - since they are kept down by the very open and well aerated soil structure.

The solubility of a given element in a chemical solution is called its "chemical availability". At high pH values, the availability of plant nutrients is usually poor, and plants have difficulty in absorbing sufficient phosphate, iron and some trace elements. Though the quantity of iron in the soils is unknown, it is not likely to be available when pH values exceed 8.2; this arises particularly when an illuvial layer of calcium carbonate is within 12 inches of the surface (22). Plants may suffer from phosphate starvation in soils with a pH value of 8 or over, because the most insoluble range of this element is from 8.0 to 8.5.

E. Soil erosion and conservation.

1. Soil erosion.

Soil erosion is a very serious problem in the region under study. In a hot dry climate the cover of vegetation is usually sparse, and there is little to protect the soil

against erosion by wind or storm water. Any derangement of the soil cover by man or beast dangerously disturbs the balance. Soil is dried out during the long dry seasons and is left in a vulnerable condition, so that the first and most intense rains can strip the soil. In the Eastern Jebel, intense rainfall, powerful winds and steep slopes induce erosion, which is speeded by overgrazing and poor agricultural techniques. Soil erosion is unrecognised by the local population, who do nothing to prevent it. As a result, most of the forms of soil erosion found in arid areas occur in the Eastern Jebel.

(a). Types of soil erosion.

The soil is eroded by wind and water, and erosion may be classified according to the various forms it takes. Each type presents special problems.

(i). Sheet erosion. Sheet erosion is the removal of a thin layer of soil by run-off moving over the surface. It occurs over large areas and induces other types of erosion. It takes place where run-off is highest, and is severe on steep slopes. The soil cover over much of the Scarp Zone has already been removed, and sheet erosion is in action on the long gentle slopes of the great wadi basins.

(ii). Rill or finger erosion. The concentration of run-off in channels results in the loosening of the soil and the

gauging out of the soil material. Rill erosion is well-developed in the Basin Zone and is particularly extensive in the hills around the Cussabat Plain. It is usually caused by the cutting of small channels in the soil to feed terraced gardens or cisterns. It also develops when the soil is loosened by the pulling of Esparto grass and by ploughing along slopes.

(iii). Gully erosion. Gully erosion follows sheet erosion or develops from rills. Run-off becomes concentrated in gullies, which are progressively widened and deepened, and some old gullies branch out as fingers into surrounding areas. Gullying is extensive in Tarhuna, particularly in the Basin Zone and on the Tarhuna plateau. There are several very deep gullies north of the Italian zone, and these are being widened and deepened each year.

(iv). Wind erosion. Wind erosion is the removal of soil by wind, and is a significant problem in areas with a long dry period. It is serious in the northern Tarhuna plateau, where the wind also carries sand to the north to invade and cover the Ard Hamra and Ard Hammari.

Soil erosion is advanced and is accelerated rather than retarded by the primitive agricultural techniques. It has been caused by the stripping of the original forest climax and speeded by overgrazing, which reduces the plant cover to

expose the soil.

2. Soil conservation.

Soil may be conserved by biological, mechanical and cultural means. Mechanical conservation works are designed to control the movement of flood water by various structural devices. According to the laws of hydraulics, if the speed of water is doubled, then (a) its erosive power is increased four times, (b) the quantity of material of a given size which can be transported is increased thirty two times, and (c) the size of particle which can be transported is increased sixty four times (23). Mechanical conservation methods aim to reduce the speed of water. This may be done by damming, constructing drains to carry the water, contour ridges and benched terraces to slow up the rate of run-off. These methods are being applied in the Eastern Jebel on the experimental farms and at Al Khadra. Draining is being tried out in connection with tree cultivation, and involves the construction of concrete spillways, whilst contour ridging involves the building of small terraces which follow the true contours of undulating land. Trees are also being cultivated in these terraces, which offer a sound method of water conservation. Drains must be constructed in the Scarp Zone and ridges in the Basin Zone and on the Tarhuna plateau.

A type of soil conservation is practised in Cussabat,

where the farmers build small earth dams on hill slopes and in wadi channels. These dams trap run-off to build up soil in terraces formed behind the dams. This method effects soil conservation on a small scale, but earth-cut feeder channels are speeding erosion on the hill slopes, and earth-cut spillways are becoming gullies in the valleys. Nonetheless, the principle is sound, and the terraces could easily be built by tribesmen in Tarhuna.

Biological methods of soil conservation involve the use of living things to prevent erosion. In the Eastern Jebel, erosion could be reduced if animal densities were lowered. Animal numbers will probably decline as tree cultivation extends, but such extension must be associated with improved culture techniques and reafforestation. Closed forests usually provide complete protection of soil, since the floors of such forests are usually covered with a mass of decaying leaves and twigs, whilst beneath soil is held by the root systems. The forest canopy protects soil against the sun and lowers day temperatures, and trees have an important function in breaking the power of the wind. Therefore the Tripolitanian administration has established a Forestry Service which is seeking to afforest large areas of the Eastern Jebel. In the last five years, 76 ha. of trees have been planted, mainly in the Scersciara, Biar Miggi and Al Khadra areas. An attempt

was made to persuade tribesmen to afforest land communally near Ain Ulf. This failed, but a similar project has succeeded in the neighbouring Orban of Garian. Afforestation will cost tribesmen only £L3-4 per hectare, and should be a preliminary to tree cultivation. It is planned to increase the forest cover greatly within the next few decades, and this will help to counteract erosion. Afforestation is to be accompanied by the survey and conservation of Esparto grass reserves and the fixation of dunes.

Modern techniques of cultivation must be introduced. The ignorance of the local population, who aim to conserve their own ways of life rather than the environmental resources, can be overcome by education and demonstration. The desired improvements are often simple, as the following list shows:-

(i). Ploughing across instead of along slopes.

(ii). The cutting instead of pulling of Esparto grass.

(iii). Ending the practise of using earth-cut feeder channels for cisterns and terraces.

(iv). The building of small contour ridges, and the extension of the Guessabat type of terrace into Tarhuna.

(v). The improvement of vegetation cover by controlled grazing. (See Chapter VII).

(vi). The building of absorption terraces.

(vii). Reclamation of gullies by earth check dams, which

would help conserve water, headwater protection and the sloping of the sides.

(viii). The planting of wind breaks and the fixation of dunes by planting the Aristida pungens.

Education is extending and demonstration plots are being set up in various parts of the region. Recently, a Conservation Officer has been appointed to the region, and the Government hopes that active soil conservation will soon be initiated.

E. Conclusions.

All soils are deficient in certain vital nutrients, and have pH values at which these nutrients are not readily available. Soils are exposed to erosion, which is stripping the soil mantle. The richest and most compact soils are the Alluvial and Intermediate types, which are also the most widespread and which lie in the more humid parts of the region. At present, sedentary cultivation is confined to two small areas of these soils, and could be extended, particularly in the Scarp and Basin Zones and the northern edge of the Tarhuna plateau. We have seen that climatic conditions preclude agriculture in southern Tarhuna, which must remain a pastoral area using specially reserved areas of summer grazing near the main wells.

Because the soils are poor and exposed to erosion, their use is restricted by the following facts:-

1. The soils need heavy additions of fertiliser to maintain their nutrient status and high yields. Fertiliser is expensive and beyond what most farmers can afford. For example, several cultivators in the Cabila Jareen say that they need fertiliser and because they cannot afford it their yields are declining. As revenue from oil increases, it should be possible for the Libyan Government to subsidise fertilisers, or encourage the spread of farming by making free grants of it.

2. In the absence of fertiliser and adequate groundwater supplies, tree cultivation must be controlled. The density of olives per hectare must not exceed a certain figure, and the trees must be carefully spaced, so that each receives the optimum amount of nutrients and moisture. Combrement (24) recommends that with a rainfall of 160-300 mms. trees should be planted 20-24 metres apart. Intercultivation should be avoided, especially after the trees are mature, and weeds must be regularly cleared.

3. The cultivation of cereals and field crops must be based on careful rotations or leaving land in fallow for one or more years between croppings.

4. The density of animal numbers, particularly that of the goat, must be reduced to prevent overgrazing, which is leading

to the degradation of the natural vegetation and to soil erosion. It will be necessary to improve methods of soil and water conservation and use, particularly in the Ghibla and Jefara where agriculture is impracticable.

5. Afforestation, the sowing of windbreaks, terracing and contour ridging of cultivated land and the control of storm water must be introduced to maintain and conserve the soil.

The spread of sedentary cultivation offers the best method of soil use and conservation, and it is therefore being encouraged by the Libyan Government. It is essential that agricultural and pastoral techniques be improved through education and demonstration.

CHAPTER VII.

VEGETATION AND PASTURE.

A. Introduction.

The natural vegetation is the most widely used of the Eastern Jebel's resources and it provides grazing, Esparto grass, fuel and charcoal. Because of its importance, and because the vegetation is not managed or improved over a large part of the region, it is important to study which plants exist, their characteristics and their distribution in space and time. It is also necessary to know how man may have altered the constitution of the plant communities by cultivation, deforestation or overgrazing and what, if anything, can be done to improve the state of the pasture and the number density and species of plants. The vegetation of the region has not been studied in detail by botanists or range management experts. Pampanini (1) collected samples of the dominant plant communities and made a rough classification of them. His work may be co-ordinated with that of Lang (2), who has made some useful studies of the climax vegetation in Garian, and examined the plant species in relation to their nutritional value.

B. Classification of vegetation.

Striking differences in vegetation are produced by the water factor in the environment. The differences are broadly

summed up in the division of plants into three groups: hydrophytes, mesophytes and xerophytes.

Hydrophytes grow in a water environment or in places where the air is so moist that a too rapid loss of water from the aerial organs is hindered. The mesophytes, or common land plants take an intermediate position between the hydrophytes and xerophytes and include most crop plants.

Xerophytes are found in arid and semi-arid environments, and are characterised by their physiological and morphological adaptation to drought. Xerophytic plants are of three types: ephemerals, succulents and non-succulent perennials.

Ephemerals or annuals complete their life cycle of seed germination, development and reproduction of the seed before the beginning of the dry season. They are characterised by their herbaceous stems and shallow root systems. Succulents store part of their absorbed water in special tissues of large cells either in roots, stems or leaves. They have a small transpiring surface, thick cuticles and few stomata. Non-succulent perennials endure wilting through a number of structural devices, the most important of which are elongated tap roots, extensive root systems, the drying up of vegetative matter above the ground and the partial or entire shedding of leaves during the dry season.

Most of Tripolitania's natural vegetation is xerophytic.

However, though the water factor is critical, other environmental factors influence the constitution of plant communities. Plant communities usually consist of the commonest species of non-succulent perennials and form the basis of vegetation mapping.

Xerophytes are normally divided into the Mediterranean and Desert types, which are roughly separated by the 200 mms. isohyet. These stages have been further subdivided in Tunisia on the basis of rainfall and soil types. They are as follows:-

1. Mediterranean stages. Vernet (3) recognised eight main series, of which four were found in areas with a rainfall of 400-600 mms.. These were:-

Olea Europa - Pistacia lentiscus series.

Callitris quadrivalvis series.

Juniperus phoenicea series.

Pinus halepsenis series.

2. Mediterranean Steppes. There are four main series, all of which lie in areas of between 200 and 400 mms. of rainfall. These are:-

Light soil Esparto grass steppes (Stipa tenacissima).

Heavy soil Esparto grass steppes.

Plateau (i.e. Jebel) silt steppes (Perfanum harmala).

Central sandy steppes (Artemnesia compestris, Zizyphus lotus).

3. Pre-Saharan Arid Steppes. There are four series found in

areas with a rainfall of 100-200 mms.. These are:-

Coastal sandy steppes (Stipa lagascae).

Hill crest steppes (Gymnocarpus decander).

Sandy steppes (Aristida obtusa).

Silt steppes (Artemnesia herba alba, Holoxylon tamariscifolium).

4. Saharan Steppes. Found in areas of less than 100 mms. of rainfall.

On the basis of rainfall, the Eastern Jebel falls into the Mediterranean Steppe and Pre-Saharan Arid Steppe stages. However, though climate and soil profoundly influence the constitution of plant communities, exposure and past and present land use are important factors. Under any series of conditions, the vegetation tends to form an ultimate association of species that is in equilibrium with the climate. This association is called the vegetation climax. The study of the climax is important, since it can provide clues to past changes in both environmental and land use conditions. In Tunisia, for example, some ecologists assert that the equilibrium between vegetation and climate has not been fully established because of climatic changes in the Neolithic period.

The climax stage of vegetation in the Tripolitanian Jebel is an association of Juniperus phoenicea, Pistacia atlantica and Olea europa, with a lower stratum of Stipa

tenacissima. Lang says that the forest climax of Juniperus phoenicea is "obvious everywhere in spite of intense cultivation" in Garian and the Jebel Nefousa. Specimens of the Pistachia atlantica (batum) are found scattered throughout the Eastern Jebel with notable concentrations in the humid wadi beds. Herodotus (4), the Greek writer, referred to the extensive forest cover of the Tripolitanian Jebel in the 5th century B.C.. The forest has been destroyed and is now found only in areas with over 400 mms. of rainfall. The vegetation of the Eastern Jebel has been degraded and Lang found three stages of degradation in Garian. These were:-

(a). An association of Stipa tenacissima (Esparto grass) and Artemnesia campestris.

(b). Associations of Artemnesia campestris and Asphodelus microcarpus.

(c). Stands of Asphodelus microcarpus on over grazed areas.

Pampanini (5) found that in the Eastern Jebel specimens of Artemnesia campestris were rare, and were found mainly in Cussabat. In the Scarp and Basin Zones, Stipa tenacissima was predominant, whilst to the south of the Abanat Scarp plant communities were composed of degraded associations of Asphodelus microcarpus and similar plants. He found that vegetation had degraded even further on the slopes of the northern Jebel where the Garrigue and Maquis associations

were dominant.

These associations show that the spontaneous vegetation of the Eastern Jebel has been very degraded. This is not surprising when it is recalled that pastoralism has been widely practised for at least 600 years. Thus the vegetation may be classed into the following groups:-

1. Esparto grass steppes of the northern Jebel.
2. The Asphodel steppe of Tarhuna.
3. Pre-Saharan Arid steppe of the Ghibla and Jefara.
4. Degraded communities of the northern Jebel.

C. Distribution and composition of the principal plant communities.

1. The Esparto grass steppes of the northern Jebel.

The Esparto grass steppes are dominated by the Stipa tenacissima. This is a non-succulent perennial which sheds its abundant feathery leaves at the beginning of summer. It is often over 0.5 metres in height, and is a rather bushy plant which grows in small clumps. It has an extensive compact root system that enables it to trap and store water. In Tripolitania its leaves are pressed to make high grade paper. There are 15 Esparto collecting centres in Tarhuna, and the local population pull the plant to supplement family income. Because it is pulled from the roots and exploited

rather than harvested, the Stipa tenacissima is disappearing from many parts of the northern Jebel.

Esparto grass is most commonly found on rocky thin soils on the wadi slopes. It prefers more humid sites and is found mainly on the lower parts of the north-facing slopes. It is nonetheless widely distributed between the 200 mms. and 300 mms. isohyets. The densest concentrations are found along the main watershed of the region from Biar Milgha - Fonmulgha in the west to the Sciogran in the east. There are important stretches of Esparto grass steppe in the western tributaries of the Wadi el Maader - Tenzina zone and in the wadi basins of the Scarp and Basin Zones. In these areas, the Esparto grass is confined to the valley bottoms, whilst the degraded Garrigue and Maquis lie on the upper slopes.

Esparto grass is usually associated with the following non-succulent perenniels:- (6)

Ranunculus asiaticus
Scilla
Salvia
Anagalis
Helianthemum
Biscutella
Rumex bucephalophorus.

The succulent species of the Helianthemum is also found. As in the Asphodel Steppe, the Stipa tenacissima is associated with numerous and colourful annuals, particularly in the protected areas.

2. The Asphodel Steppe of Tarhuna and El Amemra.

The Asphodelus microcarpus (Asphodel or King's Rod) is the commonest plant in the region. It is admirably adapted to aridity and is able to withstand the pressure of grazing so well that it has survived and flourished in places where the Stipa tenacissima has been removed. It is a non-succulent perennial with the following features:-

1. A dense, thickly bunched root system of a bulbous nature. The roots are longer than those of the Stipa tenacissima and thus penetrate further underground.
2. Elongated tap-roots that can penetrate to the nutrients.
3. Small thin leaves which are numerous and long in winter but are shed in summer.

The principal plants of the Asphodel community share these features. These plants are:- (7)

Scilla peruviana
Colchicum Ritchii
Muscari maritimum
Muscari cosmosum
Allium roseum
Polygonum equisetiform
Linaria fruticosa
Rumex tingitanus
Medicago
Astragalus baeticus
Viola sativa
Silene coloreto

The association varies according to soil conditions and exposure. The first four are found in abundance in all areas and the last four only in unexposed zones. These plants shed

their leaves in summer, leaving stunted woody stems above the ground.

Another perennial found amongst the Asphodel is the Urginea maritima. This plant is used by the local population to demarcate their lands, and Pampanini believes it to have been introduced from the coast for this purpose. It is amazing to see the steppe changed overnight in autumn from bare monotonous yellows and browns to a green checkerboard of Urginea maritima.

In spring, the Asphodel steppe is clothed by a large number of highly coloured ephemerals. The main annuals are:-

Anacyclus
Anthemis
Centaurea
Astragalus
Asnagallis
Sheradia
Calendula
Paronychia
Matthiola
Scleropa
Vulpia
Bromus
Lolium
Koeleria

The Asphodel steppe lies on the northern part of the dip slope between the main watershed and the belt of sand dunes in Tarhuna and the bare limestone slopes of southern El Amamra. It dominates the uncultivated sections of the Ard Hamra and Ard Hammari and appears in the fallow areas of the Cussabat Plain. It extends northwards into the Basin Zone of Tarhuna

and is found around the main wells in western Tarhuna. The Asphodel grades into communities which are transitional between the Esparto grass steppe to the north and the Pre-Saharan arid steppe to the south. It becomes associated with the Artemnesia campestris in northern Cussabat and the few undergrazed areas of the northern Jebel. On the Ard Ten, it gives way to the Retama retam or the Polygonum equiestiform; on loamy soils, the Artemnesia herba alba is important; on the sandy soils, Asphodel is associated with the Aristida pungens and occasionally the Stipa largascae.

3. The Pre-Saharan Arid Steppes of the Ghibla and Jefara.

The vegetation of the Ghibla has been little explored, but the following associations were found by Pampanini (8):-

(a). South of the Asphodel steppe, associations of Aristida pungens and Stipa largascae are found. The Aristida pungens is a remarkable plant with roots that extend horizontally in sand for distances of over 20 metres. It is thus found on zones of stable sand just south of the Italian zone.

(b). South of the sand dunes, plant communities are restricted to the few patches of sand and weathered material on which the Stipa largascae, which has no economic importance, and the Holoxylon salicornicum are associated.

(c). In the southern parts of the Ghibla and Jefara, where rainfall is very low, Pampanini found specimens of the

Holoxylon saliconicum associated with the Polygonum equisetiform. This is a desert border association and indicates the extreme aridity of the southern Ghibla.

These communities are associated with numerous annuals which provide the basis of the winter pasture.

4. The degraded communities of the northern Jebel.

The slopes of the northern Jebel have been overgrazed and badly cultivated so that much of the soil material has been stripped. The natural vegetation has been reduced to a thin and discontinuous cover of degraded plant associations. The Garrigue is the ultimate stage in degradation and is widespread on the slopes of northern Cussabat (Plate 12) where it contrasts with the luscious greens of olives cultivated in wadi bottoms. The plants are profoundly xerophytic, and as in the deserts of Australia and the south-west United States, perennial and aromatic succulents are dominant. The Thymus capitatus, which is characterised by globular leaves and thick robust roots, is the typical plant of the Garrigue, and it is rarely associated. Occasional associations with the Holoxylon do occur and the annuals of the Asphodel steppes appear in winter and spring.

The Maquis grows where soil conditions are better, and associations of the Calycotum, Periploca and Asparagus are typical. In parts of eastern Tarhuna, the Cistus anagyris and Silene inflata enter the communities.

D. Trees and the Zizyphus lotus.

Few spontaneous specimens of the original forest climax still remain, apart from the Pistachia atlantica, which the tribesmen try to preserve for shade. However, in several parts of the region, a plant which resembles a large green mound is found. This is the Zizyphus lotus, a plant which looks like a bush but is in fact a tree. It is often very large and can be several metres in diameter and over 1.5 metres high at the centre. Lang (9) maintains that the Zizyphus lotus is the only remnant of the once extensive arboriculture of Tarhuna. It thus indicates areas on which arboriculture has taken place, and it is interesting to examine its distribution.

The greatest concentrations of Zizyphus lotus are in the wadis of the northern Jebel. From the air, it appears that these areas are in tree cultivation. The trees thin to the west and south, but are again concentrated along the northern edge of the Tarhuna plateau and in the main wadi channels of the Ghibla. There are small stretches of Zizyphus lotus forests at Uescetata.

The areas covered with this plant were once under arboriculture, and both Broc (10) and Lang believe that this may be reintroduced.

E. Vegetation and pasture.

The spontaneous plants are grazed by animals who turn vegetation into meat, milk, wool and hair. The animals are rarely given extra forage, which is not cultivated in the region. The movements of animals and their nutritional status depend on the pasture, so that it is instructive to examine how grazing varies. Four distinct seasonal variations occur.

(i). September - December. Summer aridity dessicates the soil and reduces the plant cover to stunted woody stems and sparsely distributed evergreens. After the first autumn rains, soil moisture increases and the plants slowly come to life. The perennials renew their foliage for the winter and the first blades of grass come up. By late November, the steppes are green, though in the Ghibla plants are thinly distributed. Plant development starts in the north and moves southward as temperatures fall and rain increases. The animals follow this development to arrive in the Ghibla or Jefara by late November.

(ii). December - mid-February. Low winter temperatures arrest plant growth for a few weeks in winter. This process is more pronounced in the Jebel than in the Ghibla or Jefara. The animals remain in these areas, but must move constantly to find fresh pasture.

(iii). Mid-February - April. Rising spring temperatures regenerate plant life so that the ephemerals spring to life

to complete their short cycles of germination, development and reproduction. Vegetation is very dense and the steppes become bathed in colour. This process takes place earlier in the arid than in the humid zones, so that the animals move slowly back to the Jebel to benefit fully from the rich grazing.

(iv). April - September. The high temperatures and aridity of summer quickly kill the annuals and reduce the succulents and non-succulent perennials. Little pasture is available, and the coarse browse must be supplemented by regular watering of the stock. This confines the animals to the main watering points around which the vegetation has been seriously over-grazed.

The pattern is modified by the different nutritional requirements of the animals. Goats and camels are needed for milk and work and do not play as important a part in animal movements as sheep. Fortunately, goats and camels can graze the most unpromising pasture, even the degraded vegetation of the Garrigue-covered slopes.

The pattern is further altered by the variable quantity and distribution of the rainfall. If the rains fail, plant life is arrested and grazing reduced. This may happen over the whole region or only a part of it. When it occurs, animals must be moved to areas of good pasture or else they

must be sold or allowed to starve. Some idea of how vegetation can vary over quite small areas is shown in Appendix VI.

F. The state of the pasture and range management.

The evidence for continual and continuing degradation of the vegetation is formidable. In northern Tarhuna, it had reached an advanced state by 1911, and since that time 42,000 ha. of pasture have been turned over to cultivation by the Italians. Degradation has been caused by the destruction of the original forest climax and subsequent overgrazing, particularly in the last six centuries. The range is not only used for grazing, but must also provide charcoal, firewood, Esparto grass and land for shifting cereal cultivation. There must be enough sheep and goats for the population to live, but just as an equilibrium must be established between soils and climate to allow a climax vegetation to develop, so a balance must be maintained between animal and plant densities. If there are too many animals, the pasture degrades as the law of diminishing returns sets in. Animal yields decline, more are introduced, and this speeds degradation. Overgrazing also leads to soil erosion, which in turn results in a thinner plant cover.

Once again, it is necessary to introduce conservation methods. The improvement of water distribution would reduce the pressure on the pasture surrounding the important wells,

whilst greater cultivation and reafforestation would remove the problem of overgrazing from some areas. However, even if arboriculture is introduced, part of Tarhuna and El Amamra will have to be devoted to pastoralism. Thus, the main solutions lie in the reduction of animal numbers and the introduction of range management.

1. The reduction of animal numbers.

Though animal numbers have fallen in the last 50 years, the available range has also been reduced. In the same period, goats have become more numerous and now form 58-60% of total livestock, compared with 40-42% before 1930. The goat grazes the pasture very closely and is undoubtedly the chief cause of overgrazing. However, the goat is the tribesmen's cow, and it is kept even when a family's income is no longer derived from pastoralism. (For more details see Chapters IX and XIII). Ducros (11) believed that the optimum density of animals per hectare was 33, a figure which is surpassed over much of north-western Tarhuna. Elsewhere, density is lower, but the cabila lands are more arid.

The introduction of tree cultivation would lead to a reduction of pasture and therefore of animal numbers. In the south, where pastoralism must remain, sheep, which are the "commercial" animals, would become more important than goats, and so overgrazing would be reduced.

2. Range protection.

Range protection must begin with the isolation of areas on which para-climax communities could develop. This could be done on Government farms and State-owned land at Biar Miggi, Sidi Essed and El Gsea. A protected area exists just south of Nalut in the Jebel Nefousa, which has a rainfall of about 150 mms.. In that area, Lang found that the following associations offered the best pasture:-

1. Aristida pungens and Rumex tinginitatus.
2. Zizyphus lotus and Artemnesia campestris.
3. Rhantherium suaveolens and Stipa largessae.

Similar associations are found on the Tarhuna plateau, and the second would probably develop in a protected zone.

It is difficult to envisage how the range could be controlled. It is divided into many tiny allotments which are held in a form of private ownership. However, there will be increasing competition between pastoralism and arboriculture in Tarhuna, to the advantage of the latter. When this occurs, it may be possible to demarcate areas which will be reserved for either grazing or agriculture. Both Broo and Lang recommend that this be done in the Eastern Jefara, where the same problems are found. Tree cultivators could grow spineless cactus and forage crops for the pastoralists, who could sell cultivators meat and milk. This type of economy already exists

in Garian and parts of the Jebel Nefousa, and it could be extended to Tarhuna.

There are, however, numerous barriers to such development. Reports of range management officers are singularly vague about how range control can be implemented. The traditional way of life is still strong, and as the range is in private usufruct if not private ownership, it may be impossible to prevent the spread of tree cultivation to all areas from leaving only the barren and arid steppes of the Ghibla and Jefara to pastoralists. The solution may lie in the improvement of water supplies, but strict Government control of the range seems to offer the only possible answer to a difficult but important problem.

G. Afforestation.

The need for afforestation has been emphasised particularly as a method of controlling soil erosion and water waste. Forests are also needed to provide shade for animals and wood and twigs for fuel, charcoal and domestic requirements. The indigenous forest has been stripped from all parts of Tripolitania, not just from the region under study. Because of this, Italians started to reafforest land and had planted 2,000 ha. by 1940. The British continued to do this, and sowed 200,000 trees on 400 ha.. Since 1951, the Forestry Service has been

expanding its activities steadily and by early 1958, the Forest estate totalled 10,700 ha. including 3,800 ha. of fixed and planted sand dunes. (12)

Under the Italians, very little land was afforested in the region under study. However, Italian farms are usually surrounded by a double line of Eucalyptus trees, which act as windbreaks. Since 1955, 76 ha. has been afforested in the Eastern Jebel at the following localities:- (13)

Table VII - 1. Afforestation in the Eastern Jebel.

Locality	Area	Nos. of trees
Cussabat	10	4,000
Biar Miggi	11	4,500
Scersciara	37	15,100
Kurma-Khadra	18	7,500
Total	76	31,100

Most trees have been planted on state-owned land near former Italian farms. There are no privately owned forests, though farmers are beginning to demarcate their land with Eucalyptus trees. Most of the afforested land is covered in Acacia cynanophylla which, with the Eucalyptus gomphocelphala and the Eucalyptus camaldulensis account for most of Tripolitania's forest trees.

Afforestation is much cheaper than sand dune fixation, the respective costs being £L4.1 and £L32.5 per hectare. Because afforestation is inexpensive, the Libyan Government is

hoping to persuade tribesmen to afforest their land, communally or individually.

Two communal projects were started by L.A.J.S. and the Forestry Department at Ain Uif in Tarhuna and El Orban in Garian. The Tripolitanian Director of Agriculture persuaded tribal leaders to agree to both projects and trees were given to the tribesmen by L.A.J.S., who also built a small field office to deal with technical problems. At Ain Uif, however, the planted trees were torn up by owners of several large flocks who argued that the land was needed for grazing. This scheme failed, but at Orban everything has gone well and nearly 60,000 trees have been planted.[*] The failure at Ain Uif clearly indicates that further education is necessary and that development schemes must take into account local population as well as environmental conditions.

According to Marshall (12 p.108), Acacia forests are poor in Tripolitania. Hence, the Forestry Department is experimenting with other trees, which are being imported from other arid zones. The most successful have been the Acacia cyclops from Tunisia, the Holoxylon aphyllum from Uzbekistan and the Phytolacca dioca from Malta.

---

[*] Personal communication from Sadiq Siqiar, Assistant Director of Agriculture, Tripolitania.

The afforested area of the Eastern Jebel is small and must be enlarged if the soil mantle is to be preserved. Again, education and demonstration in the benefits and usefulness of forests are essential before projects like that of Ain Uif are undertaken. Forests will have to be protected from the demands of animals and charcoal burners, who are chiefly responsible for the present-day abuse of spontaneous trees.

H. Conclusions.

The Eastern Jebel was once clothed by forests composed of the Juniperus phoenicea, Pistachia atlantica and Olea europa. The forests have been cut down over a long period of time and are now found only in areas with over 400 mms. of rainfall. The destruction of the forest cover led to the gradual deterioration of soil conditions, which have been further undermined by overgrazing. At the present time, the natural vegetation provides two valuable resources, pasture and Esparto grass, to which forest trees could be added. Vegetational resources are being exploited rather than "farmed", so that Esparto grass is disappearing and pasture degrading. These processes are perpetuated because as resources decline in quality and quantity the rate of exploitation increases: more animals graze the pasture and more of the Esparto grass is harvested. Both resources are precious and their

exploitation influences the rate of soil erosion. They must be conserved by proper management in areas where pastoralism is more economic than arboriculture; animal numbers must be reduced, the range improved and the harvesting of Esparto grass controlled. These are "ideal" solutions which may not be practicable, as the L.A.J.S. afforestation scheme at Ain Uif demonstrated. But something must be done, and any schemes must take into consideration the population as well as environmental conditions in the Eastern Jebel.

SECTION THREE.

POPULATION AND SETTLEMENT.

CHAPTER VIII.

ETHNIC, SOCIAL AND TRIBAL STRUCTURE.

A. Introduction.

The present boundaries of resource use in the region are not related to the distribution of environmental resources. Pastoralism and tree cultivation could be interchanged. It has been contended that tree cultivation could be extended and that it would prove a more efficient and economic method of resource use than pastoralism. However, the boundary of cultivation has been long established, and it is necessary to examine how, when and why it was established and what has led to its perpetuation. These problems are related to the social, ethnic and tribal structure of the population and it is essential to examine the people from these viewpoints. This study is also preliminary to the analysis of the demographic characteristics of the population, as well as the patterns of settlement and economic activity. At the same time, it is necessary to know if the social structure is changing, as any changes will profoundly influence settlement and land use.

Hence the study will be divided into four main sections:

B. Ethnic structure.

C. Tribal structure.

D. Social organisation.

E. Changes in tribalism and social organisation.

B. Ethnic structure.

It has been contended by Chemlali (1) and others that the initial divisions of the Eastern Jebel are related to the ethnic structure of the population. His view was based on de Agostini's tables of tribes and their origins (2). However, Chemlali and his followers failed to distinguish between the ethnic origin and place of origin of the population.

1. Ethnic origins.

Until the present day, the population of Tripolitania has been divided into Arabs, Berbers, Arabised Berbers and Coroglia, based on de Agostini's definition of these ethnic groups. The cabile of the Eastern Jebel regard themselves as Arab, except for the Coroglia of Cussabat. However, de Agostini found that the population of the region was divided amongst the ethnic groups as follows:

Table VIII - 1. De Agostini's distribution of population by ethnic groups in 1917.

Mudiriats	Arabs	Berbers	Arabised Berbers	Marabatin
Cussabat	-	7,840	-	280
El Amamra	590	-	2,880	-
Aulad Msellem	8,730	2,250	8,010	5,550
Aulad Mahareff	7,050	450	2,350	2,100
El Hawatem	2,400	-	4,650	2,150
El Darahib	700	150	6,900	200
Total	19,470	10,690	24,790	10,280

cont.

Mudiriat	Sherriff	Coroglia	Jews
Cussabat	3,100	540	450
El Amamra	-	-	-
Aulad Msellem	2,400	-	-
Aulad Mahareff	750	-	-
El Hawatem	150	-	-
El Darahib	800	-	-
Total	7,200	540	450

Because of the conflicting evidence, it is necessary to define what constitutes these ethnic groups.

(a). Berber.

De Agostini (2 p.17) classed a tribe as Berber if its name could be traced to one of the Berber tribes described by Ibn Khaldun (3) in the 13th century. According to Ibn Khaldun, the Berbers were descended from two great confederations called the Madges and Branes. The Madges were composed of ten aggregates, of which the Nefousa, Addasa, Darisa and Luata, together with the Hawara, Sanghia and Cutuma of the Branes, were traced to cabile in Tripolitania by de Agostini. He found that the tribes of Cussabat belonged to either the Hawara or Luata, who lived in Msellata at the time of the Romans. Similarly, he found that eight cabile in Cussabat could be traced to the Addasa, who occupied Tarhuna and Orfella at the same period. He classed these cabile as Berber. However, Berber groups in Tripolitania - the Nefousa of the western Jebel and Zuara - may be distinguished from the rest

of the population by the following characteristics:

1. There are a number of fair-skinned, blue-eyed and blond-haired individuals among them.

2. Some still speak an ancient Berber language and the others speak a Berberised dialect of Arabic.

3. They belong to the Ibadite sect of Islam, whilst the rest of the population are Malakites.

4. They regard themselves as Berbers and are proud of their origins and traditions.

The supposedly Berber cabile of the Eastern Jebel are no different from the rest of the population in appearance, language or religion, and they firmly believe that they are Arabs. It is concluded that these cabile are of Berber origin, but that they are now completely Arabised.

(b). Arabs.

There were two distinct movements of Arabs into Tripolitania. The first took place in the 7th century, but was overwhelmed by Berber resistance so that no trace of the early invaders can be found today. The second - called the "Conquest" - occurred in the 11th century, when two warlike nomadic tribes were sent by the Fatamidi dynasty in Egypt to crush the power of North African Berber kingdoms. The tribes, the Beni Hilal and Beni Suleim, who came to Egypt from Arabia, drove through Tarhuna and the Jefara to Tunisia, but later

returned to settle in Tripolitania.

If the name of a cabila could be clearly related to either of these tribes, that cabila was considered Arab by de Agostini. This was a valid assumption, and is confirmed by the fact that Arab cabile trace their descent either to the Beni Hilal or the Beni Suleim and preserve their exploits in tribal traditions.

(c). Arabised Berbers.

Any tribe which was not clearly Arab or Berber was classed as being Arabised Berber by de Agostini. Again this was a valid assumption, since the bulk of the Tarhuna cabile, whom de Agostini included in this group, are probably Arabised descendents of the ancient Addasa groups.

(d). Coroglia.

The Coroglia are the descendents of Turkish Janissaries who married local Berber and Arab women. The Coroglia filled minor administrative posts in the Turkish government, and they form a separate cabila at Cussabat.

In addition to these groups, de Agostini recognised two groups of cabile whose origin was not always clear. These were the Marabatin and Sherriffs.

(e). Marabatin.

Marabatin cabile were of three types: Marabatin-bil-baraka, Marabatin al-fathin and Marabatin al-sadka. The

Marabatin bil-baraka (client tribes with the blessing) and the Marabatin al-fathin (client tribes of the prayer) were founded by the followers of one of the many saints and religious reformers of Islam who passed through Tripolitania on their way to, or return from Mecca. They attracted the poor and oppressed and probably small tribal groups gathered around the saint to form a new cabila or lahmat. Because of their supposedly sacred origins, the Marabatin were given the protection of stronger cabila. Today there are 26 Marabatin cabila in the Eastern Jebel (fig. 24b and Appendix III) and because of their mixed ethnic composition they were classed as Arabised Berbers by de Agostini.

The Marabatin al-sadka (client tribes who pay a fee) are different, because they have no sacred associations. They are small cabila who used to pay a fee for the protection of stronger cabila. They no longer exist in Tarhuna, and have been absorbed as lahma by the protecting cabila.

(f). Sherriffs.

The Sherriffs claim that they are descended from the Prophet Mohammed and thus should be Arab. However, de Agostini believed that several of the Sherriff cabila were impostors, and if he had any reasonable doubt about their origin he classed them as Arabised Berbers.

De Agostini also found 500 Jews living in Cussabat. They

left after the anti-Jewish riots in 1946 and the foundation of Israel in 1948. After 1923, Italians settled in the Eastern Jebel, mainly in Tarhuna. In 1937 there were 7,000 Italians in Tarhuna, most of them living on the three demographic estates at El Gsea, Al Khadra and Sidi Esseed, but in 1954 there were only 1,700 Italians and in 1960 less than 1,000.

Therefore, the population of the Eastern Jebel is distributed as shown in Table VIII - 2.

Table VIII - 2. Percentage of population in the main ethnic groups, 1954.

Mudiriat	Total population	Arabs		Arabised Berbers		Coroglia	Italians
		Arabs	Sherriff	Arabised Berbers	Merabatin		
Cussabat	14,157	-	16	75	7	2	-
El Amamra	4,462	35	-	65	-	-	-
Aulad Msellem	20,873	30	2	42	26	-	-
Aulad Maharef	8,036	54	-	23	23	-	-
Ed Tarahib	3,861	7	-	32	11	-	-
El Hawatem	5,434	30	-	54	16	-	-
Italian villages	1,983	-	-	-	-	-	100

It is concluded that some of de Agostini's ethnic divisions were based on false premises and that ethnic divisions do not explain why the Cussabat cabile are settled arboriculturalists and those of Tarhuna pastoralists, nor what are the reasons for the division of the Jebel into Tarhuna and Msellata and into the several tribal aggregates now forming the mudiriats.

2. Place of origin.

The answers to these questions do not lie, as de Agostini and Chemlali supposed, in ethnic differences, but in the fact that the tribes are derived from several places of origin and that they settled in the Eastern Jebel at different periods.

(a). Berbers.

According to local tradition and to de Agostini's tables, the Berber population was divided between the Addasa, who lived in Tarhuna and the Orfella, and the Hawara, who lived in Msellata. Nine of the original Hawara and Luata cabile still survive in Cussabat. They live in the Scarp Zone or defensible areas, and are the following:-

1. Imumen
2. Selma.
3. Gherrim, except for the Lahmat es-Sara.
4. Zaafran.
5. Bu Aish.
6. Chalfun, except for the Lahmat esc-Shiabarna.
7. Msindara, except for the Coroglia.
8. Luata.
9. Beni Mislem.

To the south of these cabile are found nine tribes of Addasa origin who immigrated to Cussabat between the 7th and 13th centuries. These are the:-

1. Esc-Shiabarna.
2. Esc-Shurruf.
3. El Gheleel.
4. Beni Let, except for three lahma from the Jareen, Coroglia and Tarhuna.
5. Lahmat Bu Ras of Msindara.
6. Zaviet Sidi Atia.
7. Zaviet Sidi Smah.
8. Esc-Shaffeen.
9. El Crarta.

The first five came from the Orfella and the last four from Tarhuna.

Between the 11th and 15th centuries, several Marabatin and Sherriff cabile settled in Cussabat. They were the:-

1. El Amareen. This cabila is related to the El Amareen of the Jefara and Tarhuna, but follow a different saint. They maintain their connections through a common Sheik, who lives in Tarhuna.
2. El Fuartir. Marabatin cabila from Zliten.
3. Beni Iechlef. This Marabatin cabila migrated from Tarhuna where they had split from the El Grarat, who follow a different saint.
4. El Coratia. This cabila is also called the Aulad el Aalem and they are Marabatin from Zliten.
5. El Jareen. Sherriffs from the Saghia el Homra in Morocco. They settled in Cussabat before 1450, since a famous sufi and writer - Jusef el Jareeni - lived among them at that time (2 p.71).
6. Shorfet Uadna, Aulad Hamed, ez-Zurgan, el Glasat, es Suadnia. Sherriffs from the Uaddan in the Fezzan.

In Tarhuna and the El Amamra, the Addasa Berber cabile were forced to become semi-nomadic before the 13th century. Most of the Tarhuna cabile except the Neffat and ez-Zurgan,

who migrated from Tunisia after the French conquests, are related to the Addasa.

(b). Arabs.

According to local tradition, arboriculture in Tarhuna was destroyed by the Aulad Hamed, a cabila derived from the Debbab of the Beni Suleim. They passed through the Eastern Jebel via the Wadi Taraglat, El Amamra and the northern dip slope to the Wadi Milgha and the Jefara. They did not settle, but continued to drive westwards into the Maghreb. Arab settlement of Tarhuna took place in later years, and according to local historians the Arabs came from three main areas: Morocco, Malta and the Njed.

(i). Morocco. Most of the cabile claim Moroccan origins. They probably left Morocco after the defeat of the Moorish kingdoms in Spain.

(ii). Malta. There is a strong tradition among the Aulad Mahareff that they originated from Malta. Local historians point out that there are several "lahma malte" in the Cabila Aulad Mahareff, and there is still a street in Valetta called the Trigh Mahareff. Arabs occupied Malta between 870 and 1091, when the island was taken by Count Roger the Norman.

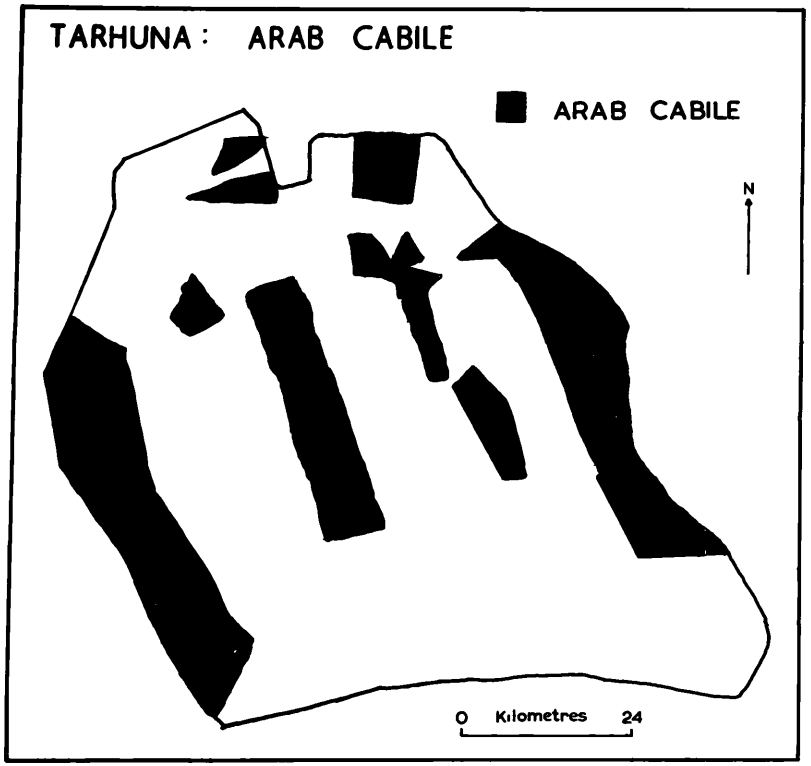
(iii). The Njed. The Masabha, the El Hawatem and the El Auasa claim that they immigrated from the Njed. They are not related to the Beni Hilal or the Beni Suleim, and may have

been client tribes who settled in the wake of the early invaders. Locally, they are believed to be the oldest tribal groups in the region.

It is most instructive to examine the distribution of the main ethnic groups according to their place of origin (see figs. 24 & 28). In Tarhuna, the Addasa cabile live in the central areas - mainly in the Scarp and Basin Zones. The Arabs, on the other hand, are found mainly on the peripheral areas around the main wells and in the areas of winter pasture. They occupied zones which were vital to the Addasa pastoralists. The Arabs were thus able to dominate the Berber cabile and this initiated the Arabisation of Tarhuna.

The influence of the Arabs is clear from the fact that the traditional leaders of the principal aggregates in Tarhuna are drawn from Arab cabile. Thus, the El Auasa supplied the leader of Aulad Msellem, the Aulad Jusef of the Darahib, and the Cabile Aulad Mahareff and El Hawatem of the aggregates of the same names. It is interesting to note that though the percentage of Arabs in the main aggregates varies from 7% in Darahib to 54% in the Aulad Mahareff, it is 30% in the Aulad Msellem and 30.3% in the combined populations of the remaining three aggregates. The Aulad Msellem occupy the whole of Eastern Tarhuna and have 50% of its population. The other three aggregates live in western Tarhuna and formed a

a.


TARHUNA : ARAB CABILE
ARAB CABILE
N
0 Kilometres 24

b.

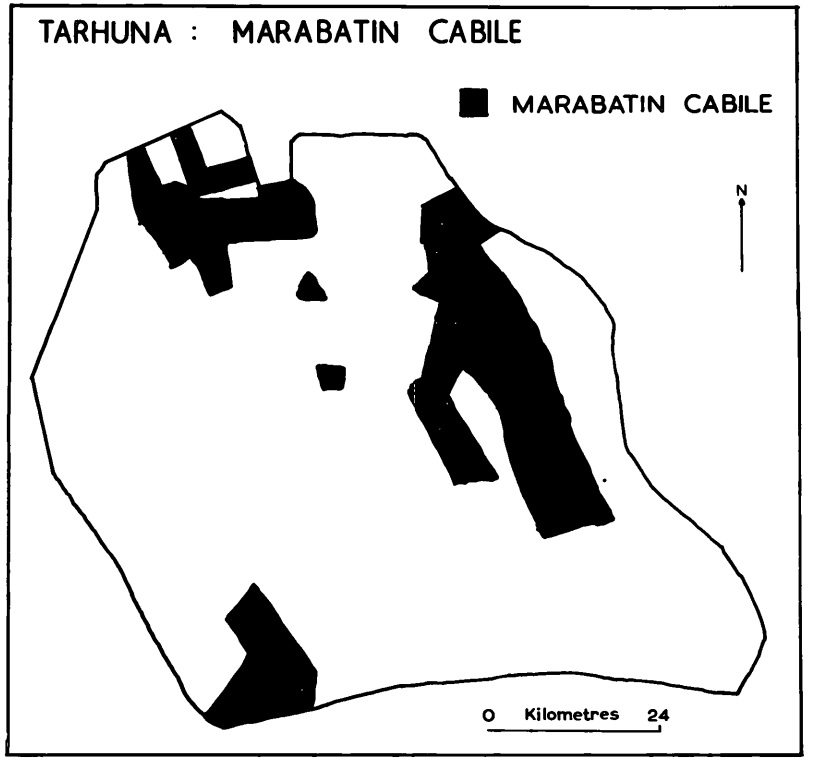

TARHUNA : MARABATIN CABILE
MARABATIN CABILE
N
0 Kilometres 24

figure 24.

traditional alliance called the sciбun to offset the influence of the Aulad Msellem within Tarhuna. The Arabs appear to have assumed the leadership of the main groups in Tarhuna, and thus completed the process of Arabisation. Later, Marabatin tribes settled in the peripheral areas of Tarhuna under the protection of Arab tribes.

In Cussabat, the Hawara cabile are found in the Scarp Zone, having retreated there during the Arab invasions. The Addasa cabile settled to the south and cultivated olives. Arboriculture survived despite the fact that Cussabat was surrounded by Arab or Arabised Berber peoples in Tarhuna, the Jefara, the Sciogran and the El Amamra. Its survival may have been due to the fact that as it was the only area of olive cultivation in Eastern Tripolitania the Arabs and pastoralists needed Cussabat as a source of olives and olive oil. This is demonstrated by the fact that in later years Marabatin and Sherriff groups settled in Cussabat without interference. After the Turkish conquest, a garrison was set up at Cussabat town, which became an important administrative centre, whilst Turkish landowners obtained large estates at Cussabat. Turkish influence, manifest in the survival to the present day of 500 Coroglia, maintained arboriculture.

Once the ethnic and tribal differences had been firmly established, they were perpetuated by the nature of social

organisation, which will now be examined.

C. Tribal structure.

The social organisation of the Eastern Jebel is based on tribalism, which differs little from that found elsewhere in North Africa and the Middle East. Hence, only the main aspects will be outlined, with special reference to settlement and economic activity. Tribalism implies fragmentation. Each social group within a tribal system is usually part of a larger group and is itself composed of smaller segments. In the Eastern Jebel, there are six main associations of social groups based on the family: Confederations, Aggregates, Cabile, Lahma (clans), Ailets and Beit.

1. Confederations.

The confederations are based on the ancient political divisions between the Addasa and Hawara. There is no "Eastern Jebel Confederation", but two separate groups: the Tarhuna and Msellata.

2. Aggregates.

The confederations are composed of aggregates of tribes which correspond to the present mudiriats. In Tarhuna, the three smaller aggregates were joined in the scibun, which existed only in opposition to the Aulad Msellem, which occupied nearly 50% of Tarhuna's land surface and contained

about 50% of its population. As in the case of each group within the tribal structure, the aggregates tended to oppose each other in internal Tarhuna affairs, but acted in unison when the interests of Tarhuna as a whole were involved. Thus, in the early part of the 19th century the soibun fought the Aulad Msellem at Soersciara in order to have the traditional market and seat of government transferred from Soersciara in the Aulad Msellem to El Ubberat (Tarhuna town) on the borders of three aggregates. However, when the Orfella, traditional enemies of the Tarhuna, attempted to take advantage of the conflict, the aggregates united under Ahmed el Moreid, the leader of the Aulad Msellem, to defeat them at Tenzina.

3. Cabile. (sing. cabila)

The aggregates are composed of cabile or tribal units, of which there are 28 in Cussabat, 8 in the El Amamra, 39 in the Aulad Msellem, 24 in the Aulad Mahareff, 8 in the Ed Darahib and 19 in the El Hawatem. Their distribution is shown in fig.3,4 and they are listed in Appendix III.

The importance of the tribe is that it is the largest of the homogeneous ethnic and social groups, and also the most convenient unit of local administration. In most cases, the members of a tribe share a common ancestor, whose name or more often nickname is retained in the tribal name. Each

cabila has its own special traditions, customs, lands and watering points. Its members are usually proud of these possessions, which are jealously guarded. A Sheik is chosen to be the head of each tribe. He is not a government appointed official, but a respected and usually wealthy member of the most influential family.

The cabila is a group through which its members and segments pursue common interests. However, it can only function properly if the balance between the population and resources is sufficient to maintain its members at an above subsistence level of returns. If a cabila becomes too large in population number for its resources, it splits and a section or sections move to find new lands. This has happened in the Cabila Duaim and Cabila Amareen. Both have split to form three new cabile, which retain something of their unity through a common Sheik. In recent years, some cabile have split because they have become too large to form an efficient administrative unit. The Fergian, for instance, has split into six new cabile based on sub-tribes.

In the same way, a cabila may become too small in population, so that its lands are annexed by more powerful neighbours. Hence, some smaller cabile used to join larger groups as "Marabatin al-sadka" or client tribes, who paid fees for protection of their interests. Under the Italians, the

smaller tribes were amalgamated for administrative purposes. These amalgamations account for the disappearance of a number of tribes since 1917. The el Glasat of Cussabat, for example, now form a lahmat of the Cabila Aulad Hamed (Appendix III).

The average size of the cabila is about 500 throughout the Jebel. However, it ranges in size from 150 at Gherrim to over 3,000 in the Aulad Ali of Mahareff.

4. Clans.

The clan, called locally the lahmat (pl. lahma), is a kinship group tracing its descent to a single male founder, who was normally the son or grandson of the cabila founder. A lahmat is like a smaller cabila. Its raison d'etre lies in the association of family groups to protect their interests against other clans. As with the cabila, the lahmat can split or unite with other lahma. Many have disappeared since 1917 and new ones have appeared. A clan loses its purpose when it consists of only a few members, and clans which were large in 1917 can now consist of perhaps one or two old people. Thus, clans rise and disappear and are no longer strictly related to the first one or two generations after the foundation of the tribe.

For instance, the Cabila Auasa consisted of the following lahma and lahma groups in 1917:-

Lahmat groups.	Lahmat 1917.
El Corma:	el Glelat Aulad esc-Sheik Ailet el Mored
Er-Risalia:	Aulad Bu Grara Aulad Abd el Mola el Helegat Aulad el Hadj

Today, there is a fifth lahmat in the er-Risalia, the Aulad aod el Crim, whilst the el Glelat has disappeared. Similarly, the Ailet el Mored rose to prominence in the 19th century through the influence of Ahmed el Moreid, who became the military leader of Tarhuna.

The er Risalia live in the Wadi Mensci, and the el Corma at Swintina. Both share land in the Wadi Taraglat. This feature is common. Each lahmat owns its own lands in the cabila, but pasture in their lands is available to other lahma in the cabila.

5. Ailets.

An ailet is a smaller reproduction of the clan, and is a kinship group often 10-12 generations in depth. The nature of the ailet is obscure, because there are several types. Some ailet are very large and old, whilst others are new and small; some clans are called ailets. In the Lahmat Abd el Mola of the Cabila Auasa there are three ailets - Ayissa, Abdusalelaam and Kader. Each consists of 2 or 3 family groups of 20-30 people, except the Ailet Ayissa, in which

there is a minor ailet called Decalia.

6. Beit (sing. biyut).

A biyut is a small kinship group composed of about 6-8 families. In turn, it breaks down into smaller family groups based on descent from one man, who may have lived three or more generations ago.

Thus, the society is composed of families organised in gradually larger groups based mainly on kinship.

D. Social organisation.

The family lies at the base of social and tribal structure, but it not the nuclear family, i.e. man, wife and children, of European society, but the extended family. The web of kinship submerges the nuclear family in a society which is essentially patriarchal. The position of the female is low, and the older males and the heads of families predominate. Society is also patrilineal and patrilocal. Ties between succeeding generations are thus stronger than those between members of the same generation. The emphasis is always on the past and on age. The family is literally the social unit which supports its members. In this, it is intimately related to land and property ownership. Thus, the father owns the land or the means of earning income from the land (e.g. animals, trees etc.). His sons must continue

continue to live with their father after marriage, since they lack the means of livelihood. The father in turn regards the child as his security in old age. A married son must support his father, even if the father is himself wealthy.

All this means that the family household will consist of at least the father and mother, married sons and their families, and unmarried children. Other relatives of the father may also belong to the family if they transfer their land and possessions to him.

This type of society works on the acceptance of certain rules and norms of conduct, and it is necessary to examine them briefly under the heads of communal activity, social divisions, segment-group relations and segment-segment relations. The recent changes in social organisation must also be examined in relation to changing land use and techniques.

1. Communal activities.

Ammar (4) found that in lower Egypt, village communities organised on a lahmat basis accepted three norms of communal behaviour. These were:

(a). Pride in belonging to a certain family. This pride was extended by the kinship system to include the lahmat and cabila.

(b). Respect to the person who plays the senior role in

the family and in the community.

(c). A feeling of fellowship between members of the same family and social groups.

These norms are also found in the Eastern Jebel. Pride in belonging to the family or segment is induced in early childhood, when education consists of learning the various segments and groups to which the child belongs. The creation of pride is also fostered by the constant discussions of the past deeds of the group and its famous leaders. For instance, every member of the Cabila Hamamla in Tarhuna is proud of the fact that one of its members is now Governor of Tripolitania. This pride is also expressed in the generosity of the family's hospitality to strangers.

The respect accorded to elders is a natural product of the society, based on the respect of the son for his father. The feeling of fellowship may be seen in the help once given to the sick and the poor in times of need.

2. Social divisions.

The population of the Jebel may be divided into the following age-sex groups:

(a). Males:
1. Boys under 12 years old.
2. Unmarried males over 12.
3. Adults.

(b). Females:
1. Unmarried girls under 12.
2. Women.
3. Old women.

There is almost complete social segregation of the sexes, and men and women each have their own duties to perform. In Cussabat, women take no part in agricultural activities, but in Tarhuna women work in the fields, since agriculture is regarded with a certain contempt by some of the nomadic tribes. The woman is bound by a number of conventions, such as the wearing of the veil, which reinforce her subordinate role in society.

The young boys are allowed to mix freely and are taught to respect the authority of the father. They are also taught to respect the authority of other adult males, referring to the men in their lahmat as "uncle". At the age of 12, the young men are given sleeping quarters away from the parents and young children. The boys are then discouraged from mixing with each other, and are gradually integrated into the family group through learning the techniques of agriculture and pastoralism. Individualism is not welcome, but great emphasis is placed on their contribution to the family needs and income. They are part of a team dominated by the household head.

Adults are responsible for family and tribal affairs. They meet together to discuss group policy in the dokkan (shops-cum-cafes) and at the weekly markets.

These social conventions within the family are projected

into the segments and social groups. On this level, there are two types of reaction: the first between the segment and the group and the second between the segments.

3. Relationships between social groups and their segments.

The relationship between segments and the group they form may be illustrated by the relationship between lahma and their cabila. The people of a cabila are descended from one man, so that all are part of him. The lands and animals and trees also belong to the cabila founder and thus to everyone. This unity is expressed in the communal ownership of property and the duty incumbent on tribal members to help each other in cases of sickness, drought or disability. If the cereal crop of a family fails, they must be given grain. If a man from the Cabila Hamamla murders a man from the Cabila Auasa, the whole of the Cabila Hamamla is held to be responsible by the Cabila Auasa. The tribe of the murderer is obliged to pay compensation collectively, and the murdered man's tribe share out the compensation. Before about 1892, no man could sell or dispose of tribal land to a man from another cabila without the permission of his own tribe.

4. Intra-group relationships.

Each group or segment has its own lands and possessions and pursues its own interests. This often leads to clashes between groups, which today are settled by arbitration, but

in the past by fighting. Each segment within a group is thus opposed to the others, and the segments must be large enough by themselves or in alliance to protect their interests. If these conditions are not fulfilled, the segments lose their raison d'etre. In the past this meant that their lands were annexed by more powerful neighbours or that the interests of the segment suffered within the larger social groups.

E. Changes in tribal and social organisation.

The tribal and social structure is designed to perpetuate the customs and traditions of the tribes. The system is exactly the same in every part of the Eastern Jebel, and differs from cabila to cabila only inasmuch as each seeks to perpetuate its own traditions and customs. In Cussabat, the system centres on arboriculture and in Tarhuna on pastoralism. Because the boundaries between pastoralism and sedentary arboriculture are defined by ancient tribal differences, and because economic activity is perpetuated by the tribal and social structure, it is difficult to envisage how changes in economic activity can take place without changes in tribalism. Therefore, changes in economic activity can only be effected by two methods:-

(a). An actual breakdown of tribalism itself.

(b). The adoption of new customs by the tribes. These

customs would in time become new traditions. Both processes are taking place.

The changes in tribal and social structure may be summed up as follows:-

1. During the 19th and early 20th centuries, the Moreid family of the Cabila Aussa established their leadership of Tarhuna. The need for such leadership was created by the growing conflicts between Tarhuna, the Orfella and the Misuratans, and later by the Italian invasions. The power of this family was based on the acceptance by the cabila of an all-powerful authority who led the population directly and dispensed with the "democratic" safeguard of balanced opposition between social groups. When the power of the Moreids was broken by the Italians, it was not reinvested in the cabila. The strength of the family group increased and that of the Sheik and the cabila declined.

2. The system of redistribution of tribal land annually between the family groups ceased around 1870, and the family gained full rights of use and disposal of its land. The result was the accumulation of land by the rich, whilst the poor were forced to live off less and less land (Chapter XI). The need for members of a cabila to associate together was thus replaced by greater individualism and the cabila lost part of its function.

3. By 1911, the power of the individual was growing and that of the cabila falling, and a new and large "poor class" had been created. The Italians aggravated this situation by expropriating tribal land on the one hand and on the other by providing work for the poor, who were forced to emigrate to find it.

4. Emigration has grown steadily, and by 1960 nearly every family had one of its members working in Tripoli. Growing contact with European society, fostered by the development of communications and the emergence of Libya as an independent state, has resulted not only in increased individual freedom, but also in the gradual introduction of new ideas and new standards. The evidence is abundant. Many families possess the portable radio; pictures of Nasser and other Arab and Afro-Asian leaders are found in every tent and house; many of the younger people have some European clothes and speak some form of "pidgin" English; the writer became involved in discussions on the merits of British foreign policy on numerous occasions.

5. Since 1954, eight new schools have been built in the Eastern Jebel, and though the present capacity of the primary schools is equivalent to only 40% of all children of school age in Tarhuna, education is extending.

It is difficult to pinpoint the changes which are taking

place within the tribe because they vary greatly. In Tarhuna, a tribesman can name every lahmat in his cabila; in Cussabat, a tribesman usually knows the name of his own lahmat but few others. The cabila is no longer an important influence in the economic sphere, since it has little control over the disposal of land and no longer provides security in cases of drought and sickness. This is more marked in Cussabat, where "the poor will starve if the rains fail", than in Tarhuna, where an individual will no longer be given grain, but may be given land on which to sow his seed. Generally, a family must depend on its resources and its own initiative economically, but socially tribalism is still strong. An educated son of a very rich farmer in Beni Let was forced to support his parents, even though his own salary was meagre. The young men, who have been to the towns, complain about the social system, but do not actively rebel against it.

Nonetheless, tribalism is breaking down, even though it is not being replaced by urban or educated values. The fact that it is breaking down means that the traditional patterns of settlement and resource use are no longer under the strict control of the cabila, and new patterns are emerging.

F. Summary and conclusions.

Though the bulk of the population are of Berber origin,

they have been almost completely Arabised. Arabisation was achieved partly through the destruction of the Roman system of sedentary agriculture and partly by the power and distribution of later Arab settlers. The present day divisions within the Eastern Jebel are not due to ethnic differences as had previously been supposed, but to ancient divisions among the Berber and Arab cabile. Once these divisions had been established they were perpetuated by the system of social and tribal organisation, which was essentially the same in all parts of the region. The whole emphasis of social structure is placed on the continuity of tribal traditions by an "establishment" based on age and the distribution of population and wealth.

However, tribalism is breaking down, and is losing its economic if not its social function. It is being replaced by individualism, which must either rely on the social organisation for its sense of values or adopt those learned by emigrants in the towns and by literates from books. These changes are of profound importance, but before examining their effects it is necessary to consider the composition, movements and structure of the population which is emerging from the hitherto all-embracing grasp of tribalism.

CHAPTER IX.

POPULATION AND EMIGRATION.

A. Introduction.

Population is not a static but a dynamic force, and it is therefore essential to examine the demographic characteristics of the population, because they not only reflect what has happened in the past, but also indicate the future relationships between resources and economic activity. Though the tribal and social structure of the population has been affected by the growth of private property and increasing contact between the tribesmen and the outside world, the forces of traditionalism remain strong. The population is thus still in the primitive stage of the population cycle, and its movement is affected by high birth and death rates and a youthful age structure. The population is approaching "take-off"[*] and this is being speeded by the high emigration rates. Emigration, which is a reaction to population pressure on resources, has been happening for a long time, but it was precipitated by the Italians, who on one hand increased the need for it by expropriating native land, and on the other provided labour opportunities for migrants. Despite this, population will probably increase in the next few decades. In many other parts of the world, the movement of population emerging from

---

[*] Rostow, "Anti-Communist Manifesto", The Economist, 1959.

the primitive stage has been affected by a decline in death rates which preceded a fall in birth rates and produced a great surge in population numbers.

To illustrate these trends fully in the region under study, it is essential to examine the population under the following headings:-

B. The Censuses and reliability of the data.

C. Population number and changes 1911-1954.

D. Density and distribution of the population.

E. Population structure.

F. Vital rates.

G. Emigration.

B. The Censuses and reliability of the data.

Four censuses have been made in Tripolitania during this century, the first in 1911, two during the Italian period in 1931 and 1936, and one in 1954.

1. The census of 1911.

The Turkish census was based on a count of total resident population by tribe. Its results were refined and adapted by Col. de Agostini, who published his work in 1917 (1). His tables give the total population by cabile, but very little else. Their accuracy can be questioned on several grounds: the count seems to have been based on the estimates of tribal

Sheiks, all figures are in round numbers, and de Agostini himself says that the figures for Cussabat, for example, are an under-statement.

2. The Italian censuses of 1931 (2) and 1936 (3).

Both censuses were made by the Italian "Istituto Centrale di Statistica", the first on a de facto or "present" population method, and the second on a de jure or "resident" population method. The tables are unobtainable outside Florence, so that the only material available from these censuses is the tables for provincial populations quoted by Pan (4). He dealt with total population, age and sex structure and the type of settlements.

3. United Nations census of 1954 (5).

This census combined both the de jure and de facto methods, and is undoubtedly the most accurate count made of the Libyan population. The enumerators were well trained and the census well publicised. The information covered the following aspects:-

(a). Total population by mudiriat.

(b). Sex composition by mudiriat.

(c). Sex and age composition by district.

(d). Marital status by sex and age for districts.

(e). Literacy by sex and age for districts.

(f). Household and family size for districts.

(g). Type of house by household size for districts.

(h). Type of settled or nomadic life by household size for districts.

(i). Economically active population by age and sex.

(j). Occupations by age and sex.

The tables cover both resident and alien populations. The accuracy of the census can be questioned, because in some of the tables there are large numbers of "unknowns", whilst figures for age composition, for instance, vary between tables. The bulk of the population is illiterate and is still suspicious of Government-organised censuses.

It should be borne in mind throughout the chapter that the census figures are not always accurate.

C. Population number and changes 1911-1954.

In 1954, the population of the Eastern Jebel was 60,789, and is about 62,000 at the present time. Of this total, 40,187 lived in Tarhuna and 18,619 in Cussabat.

Table IX - 1. Distribution of the population by mudiriat, Eastern Jebel 1954.

Mudiriat	Population Number	%
Cussabat	14,157	24.1
El Amamra	4,462	7.7
Msellata	18,619	31.8
Aulad Msellem	20,873	35.2
Aulad Mahareff	8,036	14.2
El Hawatem	5,434	8.8
Ed Darahib	3,861	6.6
Tarhuna	40,187	64.8
Italian villages	1,983	3.4
Total Eastern Jebel	60,789	100.0

The Eastern Jebel contained one third of the population of the Jebel, 22% and 7% of the populations of the Eastern Province and Tripolitania respectively.

In 1917, de Agostini (1 p.74) calculated that the population of the Eastern Jebel was 73,000 (Table IX - 2) and that of Tripolitania 538,000.

Table IX - 2. Population changes 1917-1954 in the Eastern Jebel.

Mudiriat	Population 1917	Percentage change 1917-1954
Cussabat	12,030	+ 20%
El Amamra	4,560	- 2%
Aulad Msellem	26,240	- 19%
Aulad Mahareff	12,700	- 37%
El Hawatem	9,200	- 48%
Ed Darahib	8,750	- 57%
Eastern Jebel	73,480	- 19%

Between 1917 and 1954, the population of Tripolitania rose by 37% to reach a total of 738,300, while that of the Eastern Jebel declined by 19%. The decline in the Eastern Jebel is related to similar population losses in most nomadic and semi-nomadic regions of Tripolitania (Appendix VIIa). On the other hand, the areas of sedentary agriculture show population increases of 20-35%, and the coastal areas have made extensive population gains associated with the development of the urban areas. In 1917, Tripoli had a population of 30,000, but this had risen to 130,000 by 1954. This vast redistribution of population is related to two main factors: Italian colonisation and emigration.

1. Italian colonisation.

The Italians conquered northern Tripolitania in 1911, and reconquered it between 1922 and 1925. The military campaigns were bloody and the indigenous population suffered heavy losses in battle, and tribal economies were so severely disrupted that many tribesmen emigrated to Tunisia or Cyrenaica. Resistance to the Italians was greatest in districts farthest away from Tripoli, and far fiercer in nomadic than in sedentary zones.

Tarhuna suffered most at the hands of the Italians. The tribes had been organised into a powerful and semi-autonomous group by Ahmed el Moreid. He had divided his forces into two

parts, those from the scibun defending the entrance into western Tarhuna via the Wadi Milgha, and those from the Aulad Msellem guarding the eastern entrance near Gasr ed Dauum. The only decisive battle of the campaign was fought in the scibun, where the Italians killed 1,500 tribesmen (6) and massacred 4,000 others (7). The forces of the Aulad Msellem capitulated. The mudiriats of the scibun lost 18% of their populations.

2. Emigration.

The Italian military campaigns initiated emigration and the expropriation of native land increased it. Italian development created new labour opportunities for the already impoverished local population. Consequently, emigration increased to a high level, at which it has been maintained by post-Italian development work. Emigration was more important from nomadic than from sedentary zones, because Italian expropriations were limited to uncultivated land, and because pastoralism is less economic than cultivation (Chapter XII).

Hence, emigration from Cussabat was low before 1943, but high from Tarhuna, where the Italians expropriated 41,000 ha. of tribal land. This land lay on the northern edge of the dip slope around the main wells, which are vital to pastoralism in this region of poor groundwater resources. Hence, the great decline in population, particularly in western Tarhuna.

Table IX - 3. Land expropriated by the Italians.

Mudiriat	Area (ha.)	%	Remarks
Aulad Msellem	25,000	21	South of the Abanat scarp around the main wells.
Aulad Mahareff	6,000	7	Mainly from the densely populated areas around Tarhuna and Soerseiara.
El Hawatem	4,000	20	Northern area of dip slope from Souk el Khemis to Wadi Milgha and Tenzina.
Ed Darahib	6,000	19	

In Cussabat, emigration has been a post-war development, and the area was unaffected by Italian colonisation. Therefore, in common with other sedentary zones, population has increased. El Amamra was little affected by the Italians, but emigration has been very important.

D. Density and distribution of the population.

Statistics for the populations of cabile have not been released by the Libyan Government. However, some idea of the situation may be obtained from the figures for 1917 and from figures based on a sample survey of 20 cabile made by the writer in 1960.

1. Density distribution in 1917.

In 1917, the average density of population in the region was 27/sq. kilometre, varying from 7-90/sq. kilometre.

Broadly, the highest densities were found in areas of high

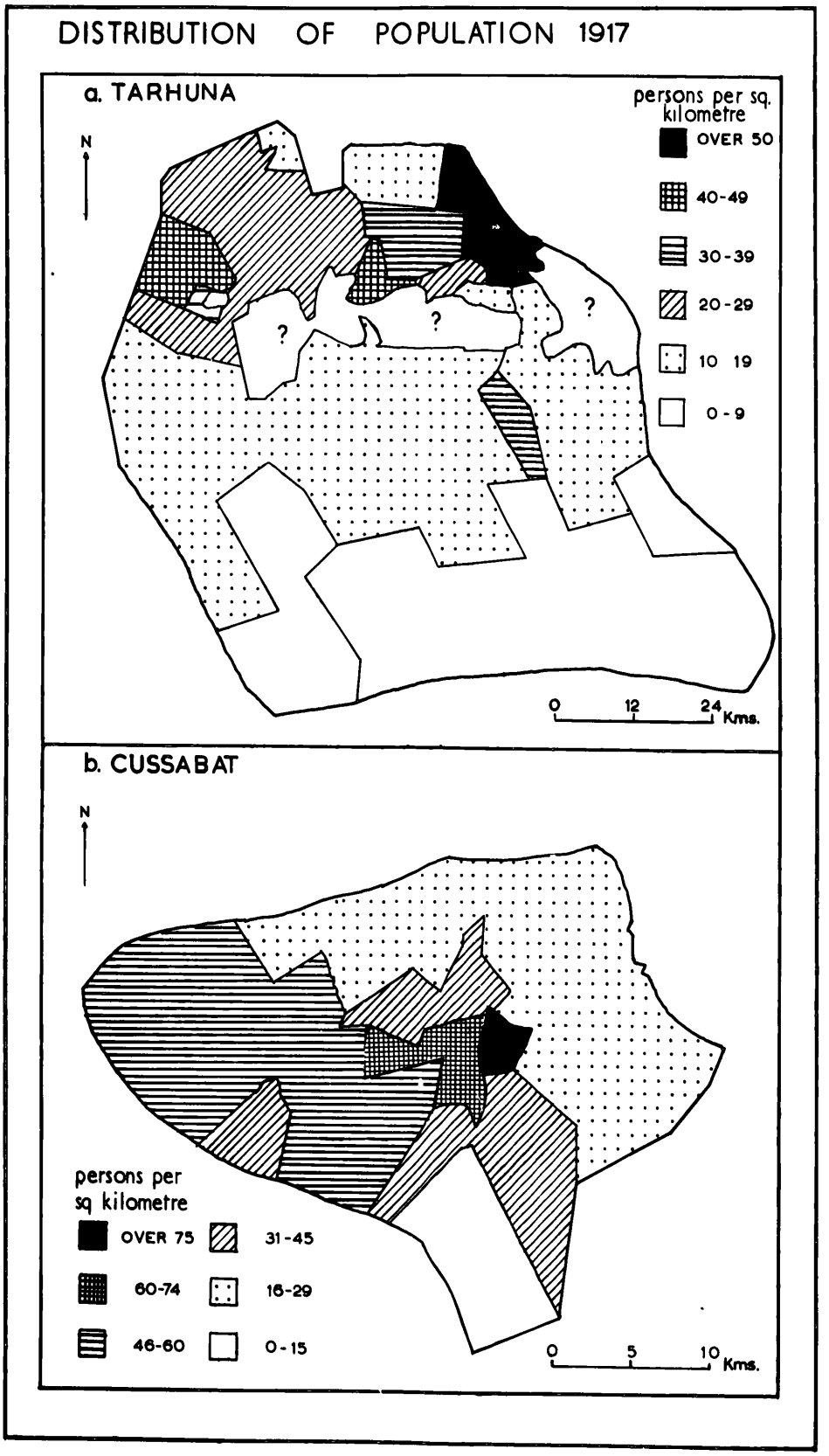
rainfall, and as rainfall decreased in volume and reliability, population was lower (fig.25). It is clear that density was much higher in Cussabat than in Tarhuna or the El Amamra, the respective figures being 40, 27 and 12/sq. kilometre.

(a). Cussabat.

The figures for population in Cussabat cabile in 1917 are given in Appendix VII and are mapped in Fig. 25a. Density varied from 17/sq. kilometre in Gherrim to 97 in Zaafran. A zone of high density ranging from 60-80/sq. kilometre ran from the Tarhuna border between the Jebel Msid and Sidi el Fasi to Cussabat town. South of this strip, which was defined northwards by the main watershed of Msellata, density fell to 30-35/sq. kilometre in the esc-Shiabarna and Uadna Cabile. To the east and north-east it averaged about 25/sq. kilometre, whilst the lowest densities were found in the Hawara Cabile of the Scarp Zone, particularly in the Cabile Gherrim, Imumen and Selma, where it averaged less than 20/sq. kilometre.

In Cussabat, the highest densities coincided with the areas of more extensive stretches of soil, and the lowest with the limited patches of Ard Ten in the Scarp Zone. However, when density is considered in terms of agricultural land (fig. 31 and Appendix VII) it ranged from 60-100/sq. kilometre in most areas.

figure 25.


DISTRIBUTION OF POPULATION 1917
a. TARHUNA
N
persons per sq. kilometre
OVER 50
40-49
30-39
20-29
10 19
0-9
?
?
?
0 12 24 Kms.
b. CUSSABAT
N
persons per sq kilometre
OVER 75
60-74
46-60
31-45
16-29
0-15
0 5 10 Kms.

(b). Tarhuna and El Amamra.

The highest densities in Tarhuna were found in the humid north-west, where they exceeded 50/sq. kilometre in the Grarat Loteen, Grarat Fogghin, Auamer, Hawatem Bu Ras and the Abanat Aburu. Densities fell to the west and south-west, to reach 7/sq. kilometre in the Fergian Grara and Burcat Ibedi and 6/sq. kilometre in the Fergian Remetat. Though the close relationship between rainfall and density was apparent, there were two anomalies: around the main wells, and in north-west Tarhuna. The main wells attracted some form of permanent settlement, and it is interesting to note that small cabile and unattached lahma were found settled near the wells. Densities are higher in north-west Tarhuna, because the Cabile Darahib, Hamadat Labeter and Hamadat Sret possess within their tribal boundaries land stretching from the dip slope to the Jefara, and thus have winter and summer pasture and wells within one tribal unit.

It is clear that the differences between Tarhuna and Cussabat are not related wholly to rainfall. The differences in density coincide with land use differences, and it is evident from the distribution of the population that tree cultivation can support a higher density of settlement. This contention is further demonstrated by the fact that in a nomadic and pastoral zone nearly every type of soil and slope

can be used to some economic purpose. Tree cultivation, on the other hand, uses certain types of soil and slope, and thus supports its population from a smaller exploited area than pastoralism.

2. Density changes 1917-1954-1960.

The 1954 figures are based on the mudiriats, which are too large to form an accurate basis for comperison with the 1917 figures. However, the pattern imposed by Italian land expropriation is clear (Table IX - 4), but the more humid areas suffered less.

Table IX - 4. Density changes in the Eastern Jebel, 1917-1954.

Mudiriat	Density 1917 (per square kilometre of land)	Density 1954 (per square kilometre of land)	Change
Cussabat	40	47	7
El Amamra	12	12	-
Aulad Msellem	20.8	20.4	- 0.4
Aulad Mahareff	15.2	11.8	- 3.4
El Hawatem	46	34.0	-12.0
Ed Darahib	29.2	15.5	-13.7

(a). Cussabat.

The rise in density in Cussabat is very unevenly distributed. Some cabile show density declines, others show rises of over 70%. (Table IX - 5.)

Table IX - 5. Density changes 1917-1960 in eleven cabile, Cussabat.

Cabile	Density per sq. kilometre 1917	1960	Percentage change
Gherrim	17	24	43
Imumen	19	24	26
Beni Iechlef	25	26	4
Jareen	23	40	74
Uadna	35	37	6
Beni Let	80	72	- 10
Crarta	47	57	22
Gheleel	65	67	3
Atia	36	40	11
Zaafran	88	75	- 15
Beni Mislem	16	22	34

The degree of increase is higher in the Scarp Zone, particularly in north-east Cussabat. The cabile on the Cussabat Plain are less densely settled than in 1917, and increases have been small in the zone of high densities.

Almost the whole cultivable area of the Cussabat Plain was under cultivation by 1917, so that arboriculture has not been extended since. Increasing population has meant that pressure on resource use has been aggravated, and falling per capita returns have encouraged emigration. In the Scarp Zone, there was still a large area of uncultivated land in 1917, so agriculture has increased with population. This is clearly demonstrated if the figures for Beni Mislem are broken down. The populations of the Lahma Gmata and Morad, who own land in

the Cussabat Plain, have declined by 10 and 200 respectively, whilst that of the Razagna and Megatata, who live in the Scarp Zone, has risen by 250. The extension of cultivation is only a temporary expedient, since it is clear that the only solution to falling per capita returns lies in the improvement and intensification of cultivation.

(b). Tarhuna.

The populations of ten selected cabile containing 30% of Tarhuna's population were examined by the writer in 1960.

Table IX - 6. Density changes 1917-1960 in ten selected cabile, Tarhuna.

Cabile	Density per sq. kilometre 1917	1960	Percentage change
Auasa	20	34	70
Hamamla	30	50	66
Msellem	40	60	50
Masabha	12	18	50
Nahagia	15	18	11
Fergian	16	22	20
Auled Ali	15	13	- 7
Et Tella	34	22	- 27
Darahib	30	20	- 33
Terscian	62	30	- 53

Each cabile had lost between 2% and 52% of its people, except for the Cabile Masabha and Msellem. The greatest declines were in the Tella, Darahib and Terscian (Appendix VIId). Despite the general decline in population, density has risen

in six cabile. The highest densities are now found on the Tarhuna plateau to the north and east of the Italian farms. They range from 34 to 60/sq. kilometre in the Auasa, Msellem and Hamamla, which also show the highest degree of increase. This is due to the fact that each cabila suffered heavily from the Italians, but, living in a humid zone, they have intensified their economies by extending tree cultivation in the Auasa and Msellem and by increasing the number of sheep - the commercial animal - in the Hamamla. The Masahha, like most cabile in the Scarp Zone, have been unaffected by land expropriation, but have been influenced by the extension of sedentary agriculture among the Gmata in the Jefara to the north. The lowest densities, except for the Masahha, are found on the more arid dip slope of western Tarhuna, where the cabile lost a large percentage of their land to the Italians. Densities have declined to about 13-23/sq. kilometre. In the Basin Zone of Central Tarhuna, densities are still fairly high - 22-30/sq. kilometre - but they have fallen sharply since 1917. The Et Tella and Terscian of this area were prevented from migrating to their winter pastures by the Italians, and have been forced either to keep more goats (Table XIII-7)or, latterly, to adopt tree cultivation. This may initiate a period of population increase to reverse the present trend induced by dependence on cereal cultivation and

goat husbandry, both of which are non-commercial.

The very low population increases and the changes in density illustrate the effects of Italian colonisation and emigration. However, it seems that if tree cultivation or a more profitable means of resource use were introduced, the density of settlement would increase.

E. Composition and structure of the population.

The examination of population structure and composition is hampered by the fact that figures are available only for districts. Except in a few cases, there are no figures for mudiriats, so that analysis must concentrate on revealing the important factors and trends within the population.

The population itself is rural, and though about 3,000 people live in Cussabat and 1,000 in Tarhuna towns, most are farmers or pastoralists. In Cussabat, all but 2% of the population is settled, but in Tarhuna 81% of the population is semi-nomadic and 7% nomadic.

1. Sex structure.

The most usual method of examining the sex structure of a population group is to calculate the sex ratio, which may be expressed as the number of males per thousand females. There were 16,000 more males than females in Tripolitania in 1954, and thus the sex ratio was 1,074 males/1,000 females. The

average figure in both Tarhuna and Cussabat was 1,075 and 1,074/1,000 females respectively.

Table IX - 7. Sex structure in the Eastern Jebel, Tripolitania and selected Arab countries.

Country	Area	Males	Females	Sex ratio
Libya	Tripolitania	382,209	356,129	1,074
	Eastern Jebel			
	Cussabat	7,331	6,826	1,075
	El Amamra	2,229	2,233	1,070
	Aulad Msellem	10,731	10,142	1,058
	Aulad Mahareff	4,168	3,878	1,072
	El Hawatem	2,735	2,699	1,013
	Ed Darahib	3,861	2,029	1,107
Tunisia				1,072
Algeria				1,016
Morocco				984
Sudan				1,030
Jordan				1,030

The excess of males over females is common to all Arab countries except Morocco, and is probably the result of higher female death rates, aggravated by the low position of the women. In all Arab countries, however, under-enumeration of the female population is likely. Only Tunisia reaches the high sex ratio of Tripolitania, and this may be due to the presence of a large number of Algerian refugees. There is a definite deficiency of females, and it is recognised by the tribesmen, who complain about it.

The ratio varied highly in the soibun and hence it is interesting to see whether or not it varies very much between

individual cabile.

Table IX - 8. Sex structure in ten selected cabile, Tarhuna, 1960.

Cabila	Males	Females	Sex ratio (per 100 females)*
Auasa	257	250	102
Msellem	500	495	101
Hamamla	756	714	106
Aulad Ali	1,548	1,351	115
Masabha	495	425	116
Fergian	1,545	1,320	117
Tella	520	436	119
Nahagie	875	654	134
Darahib	544	402	135
Terscian	207	187	91

In the cabile with high densities and large density increases, the sexes were the most evenly balanced; where density was low the excess of males was highest; and cabile which were unaffected by Italian expropriations had ratios of about 115-117 males/100 females.

2. Age structure.

The age structure of a population is determined by a number of factors, the most important of which are the birth, death and emigration rates operating over a period of time. The age structure of population in under-developed countries is normally determined by high birth and death rates, with a

* Reducing the ratio to 100 is more useful when considering the small tribal populations.

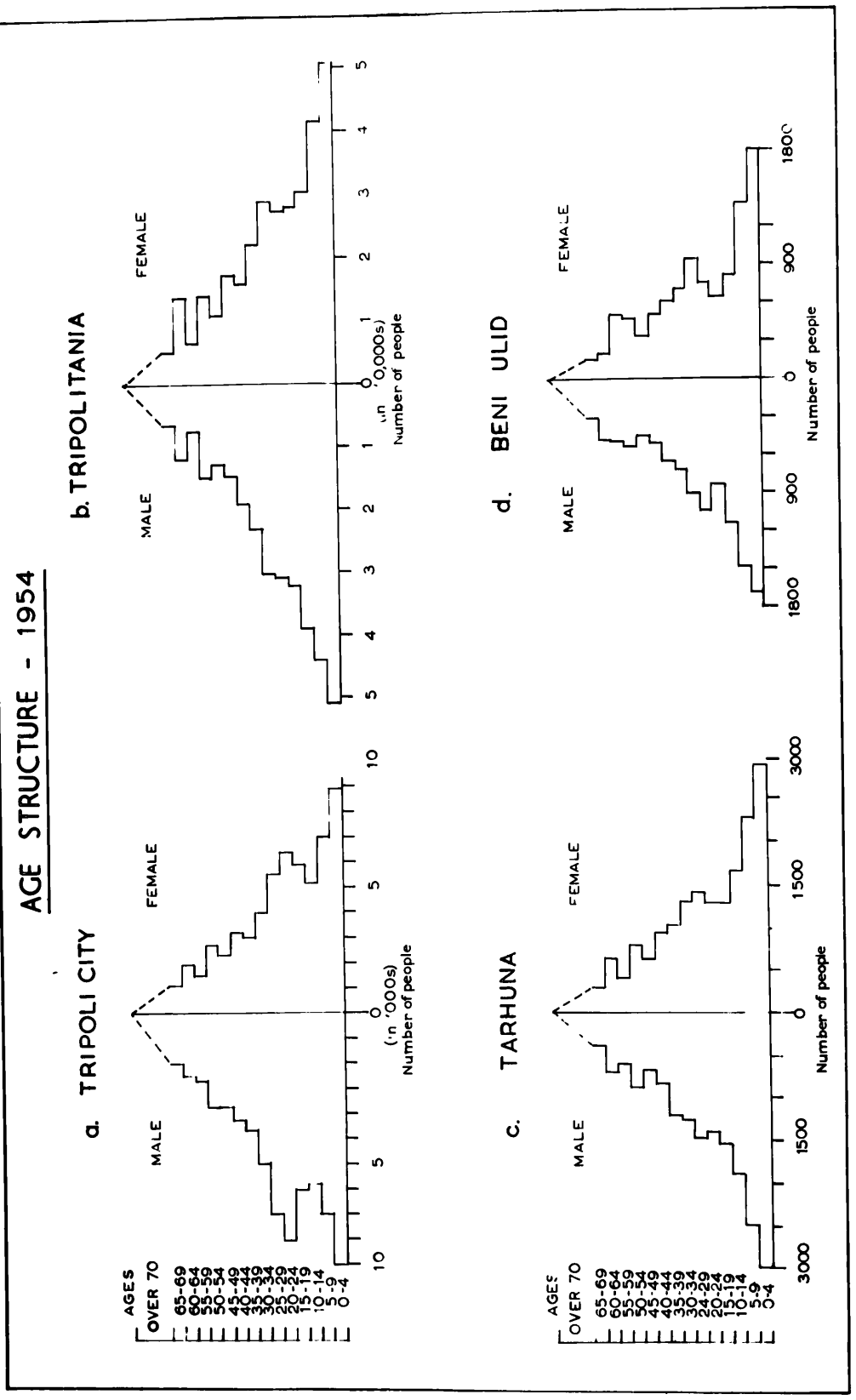
large proportion of the population aged 15 and under, and few old people. In Tripolitania, 38% of the population is aged under 15, compared to 5% over 65.

Internal or international migration is a common feature of most Mediterranean countries, and this produces significant differences between the rural and urban areas in the proportion of people in the younger sections of the economically active population. In Tripoli, 21% of the population is aged between 20 and 29, compared to 12% in Tarhuna (fig. 26a,b,c,d and Table IX - 9).

Table IX - 9. Age structure by sex in Tarhuna.

Age group	Males	Females
Under 1 year	429	407
1	478	465
2	778	796
3	670	666
4	622	630
5	597	539
6	542	588
7	469	381
8	601	576
9	219	187
10-14	2,018	1,648
15-19	1,564	1,329
20-24	1,364	1,312
25-29	1,426	1,418
30-34	1,213	1,338
35-39	1,206	1,047
40-44	885	960
45-49	715	657
50-54	888	829
55-59	603	437
60-64	719	660
65-69	416	313
70+	1,108	1,099
Unknown	16	20

figure 26.


AGE STRUCTURE - 1954
a. TRIPOLI CITY
b. TRIPOLITANIA
c. TARHUNA
d. BENI ULID
MALE
FEMALE
AGES
OVER 70
65-69
60-64
55-59
50-54
45-49
40-44
35-39
30-34
25-29
20-24
15-19
10-14
5-9
0-4
(in '000s)
Number of people

Figures for age structure have been used to construct the population "pyramids" of figs. 26a,b,c,d. It can be seen that in several parts of Tripolitania there are indentations in the following age groups: 30-34, 45-49 and 55-59.

(a). 55-59.

People in this age group were born between 1895 and 1899. In the following decade, there was considerable emigration from Tripolitania because of the dissension within the Ottoman Empire caused by the "Young Turk" movement and the Balkan conflicts. This age group was between 24 and 29 during the Italian reconquest, and would thus have been involved in the fighting.

(b). 45-49.

Born in the period 1905-1909, this group may have been affected by the emigration of this period and by the much more extensive emigration of the late 1920's, when this age group had just entered the economically active section of the population.

(c). 30-34.

This group was born during the Italian reconquest, when tribal life was severely disrupted.

The very large percentage of the population in the young age groups indicates that as education and standards of hygiene are improved, and as tribalism grows weaker, death

rates will fall to release the tremendous potential for population increase.

3. Marital status.

The study of the marital status is important because it affects the fertility rates of a population group. Figures for the marital status of the population of Tarhuna are given in Appendix VIIf. Three main factors emerge: that very few people remain single, that the age of marriage is fairly late, and that polygamy is very rare.

(a). Percentage married.

Though only 22% of the men and 26% of the women are married before they are 20 years old, 81.6% and 86% are married before they are 35. Only 50 men and 23 women over the age of 40 are single.

(b). The late age of marriage.

The average age of marriage is about 20-23 for females and 25-27 for males. Only 28% of the female population is married before the age of 20 in Tarhuna compared to 48% in Egypt, 62% in Jordan, 40-50% in Latin America and 20% in the United Kingdom. Most men marry fairly late because of the expense involved. In the region, marriage costs between £L50 and £L300. As the means of income are controlled by the parents and not the son, he must either wait or emigrate before he can afford marriage. The fecundity

of the population is affected by this, but as opportunities for paid labour increase and wages rise, people may marry younger in the next few decades. If this occurs, fertility will probably increase.

(c). The myth of polygamy.

3% of the male population have more than one wife, and only 16 men have three or more wives. These figures may be an under-statement, but they show that polygamy is rare. It is rare because of high marriage costs, the shortage of females and the common practise of re-marriage after divorce. Divorce is apparently common, and some people prefer to divorce their wives rather than marry two. In 1959, 1% of the male and female populations were divorced.

4. Family and household size.

It has been shown that the extended family is more important than the nuclear family in tribal life. The Census of 1954 did not define these differences, but distinguished between the nuclear family and the household, which consisted of "people who lived and slept as a group". This would include some extended families, but not all. According to the Census, there were 13,440 families (Table IX - 10) in the region living in 12,796 households, and 419 Italian families living in 419 households.

Table IX - 10. Numbers of families and size of families in the Eastern Jebel.

Mudiriat	Nos. of families	Average size of families
Cussabat	3,056	4.65
El Amamra	934	4.90
Aulad Msellem	5,295	4.03
Aulad Mahareff	1,917	4.28
El Hawatem	1,283	4.30
Ed Darahib	955	4.06
Italian villages	419	4.73

The average size of the family is thus between 4 and 5 people, and is lowest in size in Tarhuna. In Tarhuna, the number of families is equal to the number of households, so that the distribution of population between households is the same as that of families.

Table IX - 11. Household size in Tarhuna, June 30th, 1954.

Size of household	Nos. of households
1	456
2	1,600
3	2,129
4	1,986
5	1,521
6	1,002
7	684
8	252
9	132
10	58
11	22
12	7
13	2
14	2
15	1
over 16	1
	9,663

In Cussabat, there are 632 more families than households, so that the average size of a household is about 6 persons. The nuclear family appears to live in a separate household in Tarhuna, even if the households remain near or move with each other, but in Cussabat the extended families live under the same roof.

5. Literacy.

The accuracy of literacy statistics may be disputed on the following grounds:-

(1). There was no test to verify statements.

(2). The number of unknowns is very high.

(3). Some of the people who claimed they could read were educated at Zavia schools, where the Koran is memorised.

Even taking these factors into consideration, 88% of the males and 99% of the females were illiterate in 1954. (Table IX - 12). Though literacy rates are low throughout Libya, they are higher in sedentary than nomadic areas. Thus, the literacy rate is higher in Cussabat than in Tarhuna, but only very slightly. The position has certainly improved since 1954, but there is still less than one school for every 4,000 people in Tarhuna and for every 3,000 in Cussabat.

Table IX - 12. Literacy by age and sex in Tarhuna, 1954.

Age group	Illiterate	Read only	Read and write
Males			
5-9	1,746	2	147
10-14	1,380	-	329
15-19	1,173	1	279
20-24	1,055	-	205
25-29	988	2	171
30-34	972	-	172
35-39	699	-	163
40-44	577	1	129
45-49	738	-	104
50-54	498	-	92
55-59	629	-	71
over 60	1,323	-	53
Females			
5-9	1,969	1	66
10-14	1,362	-	14
15-19	1,190	-	18
20-24	1,177	-	16
25-29	1,323	-	4
30-34	1,271	-	3
35-39	983	-	-
40-44	922	-	-
45-49	604	-	-
50-54	803	-	-
55-59	374	-	1
over 60	1,918	1	-

Unknowns: 1,735 males and 1,438 females.

F. Vital rates.

1. Birth and death rates.

There are no statistics for births, deaths or marriages in Tripolitania. Registration began in 1958, but is incomplete. In Cussabat, for example, the crude birth and death rates

based on municipal statistics are ridiculously low - 9 and 4 per thousand respectively. Because of this, it is necessary to estimate the vital rates from three main sources: estimates by experts working in Tripolitania, estimates by hospitals and medical authorities, and the comparison and extrapolation of known data for Tarhuna and Tripolitania with data from demographically similar areas.

(a). Estimates by experts.

Three experts have made estimates of Libyan birth and death rates from small sample surveys. Lindberg (8), who studied three "typical" cabile, concluded that "birth rates among rural Arabs are 50 per thousand or more, and death rates 40 per thousand or more". In 1956, Higgins (9) quoted birth rates of 53 and death rates of 42 per thousand, whilst Sherwani (10) gave figures of 53.2 and 42.3 per thousand. All three experts agree that the death rate reflects the very high infant mortality rate, which Lindberg thought was about 300 per thousand live births.

(b). Estimates by hospitals.

The only medical data available relates to morbidity in the Cyrenaican hospitals during 1956 (11). The information covered 20,309 patients (7% of Cyrenaica's population), of which 49% were male. The mortality rate was 41 per thousand for males and 33 per thousand for females, excluding in the

case of the latter a large number of delivery cases with a fatality rate of 5 per thousand. Of the deaths, 21% occurred before the age of one year, and over 50% before ten years. The death rates derived from this data are applicable, because the inherently high death rates in the sample group would be balanced by inadequate medical facilities in rural areas like Tarhuna.

(c). Comparison and extrapolation of known data.

Studies of birth and death rates in countries at different stages of development led to the theory of the population cycle. According to this, countries were divided into four main stages of population growth according to their vital rates. Countries in the first or primitive stage have high birth and death rates, and population expands slowly. As standards of living are improved, the death rate begins to fall and the country enters the second or early expanding stage. Death rates usually continue to decline rapidly, but birth rates remain fairly high. As society begins to change with development, education and higher standards of living, the birth rate falls, but its decline is much less rapid than that of the death rate. In the final stage of the cycle, birth and death rates are low, but fairly steady, the birth rate being higher than the death rate. Countries like Libya are still at the primitive stage. Education and medicine have

recently been introduced, but only a minority of the population have been affected. Therefore, birth and death rates are high.

The rate of population increase may be determined by calculating the fertility ratio[M] for Tripolitania and Tarhuna and for a number of other countries at various stages of the popula tion cycle. If the Net Reproduction Rates for these countries are calculated and plotted on a graph against the fertility ratios, an approximate value for the Net Reproduction Rate of Tarhuna can be established (Appendix VII and fig.27). The fertility ratio for Tarhuna is 769 and for Tripolitania about 722. The Net Reproduction Rate for Tarhuna is roughly 1.9 and natural increase about 1.9%. If death rates are about 40 per thousand, then birth rates are 59 per thousand.

2. Factors affecting mortality rates.

The vital rates are high. It is important to know what factors maintain these rates at the present level in order to assess future demographic developments.

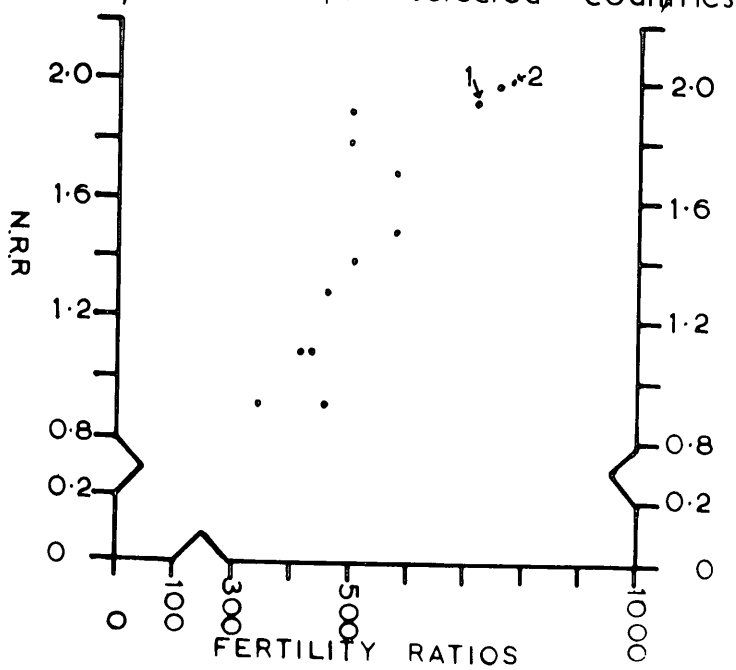
Libya is basically a healthy country and is not exposed to the major debilitating diseases which cause so much illness in other parts of the Middle East. According to Lindberg, "Raising the standard of living would result in a great

---

M The fertility ratio is calculated by dividing the number of children under the age of 5 by the number of females aged between 15 and 44.

figure 27.

Correlation of Net Reproduction Rates & Fertility Ratios for selected countries



1. Tarhuna.
2. Tripolitania.

improvement in the general health without any expansion of medical facilities. In launching the attacks on illness in Libya, it is food rather than drugs which is the most effective ammunition". (8 p.28).

The major causes of death in Tripolitania are gastro-enteritis, trachoma, tuberculosis and dysentery. Gastro-enteritis is the main cause of infant deaths, and kills 5,000 babies per annum (8 p.26). It is caused by the under-nourishment of the mother and the feeding of the child with contaminated or adult foods. About 90% of the population of rural Tripolitania have signs of past or active eye infection[H]. This infection, which is called trachoma, is caused by under-nourishment, which also gives rise to tuberculosis. Dysentery is the most common illness, and could be stamped out by practices of basic hygiene.

Illness and death result from poverty, malnutrition, ignorance and dirt. The low living standards can only be improved if the pattern of resource use is changed and better agricultural techniques introduced. The Government is trying to improve health standards through education in basic hygiene, which now appears in the school syllabus. The

---

[H] Personal communication from R. A. Black, M.D., R.A.M.C., who studied the incidence of trachoma in rural Tripolitania.

Department of Public Health is trying to improve the water supply at Cussabat by building a tap system. However, poverty can only be eradicated if agriculture and pastoralism are made more productive. But this and education will lead to a decline in the death rate, which may mean that the greater productivity will be absorbed by the increase in population. It is therefore essential that the population be taught to make the greatest possible use of their environmental resources.

3. Factors affecting birth rates.

In a society like that of the Eastern Jebel, fertility is kept below the level of fecundity by natural ~~rather than~~ BOTH AND socio-economic factors. The position of the female is low; sons are regarded as symbols of security and continuity, and many must be born if one is to survive. After marriage, a woman normally produces to her biological maximum, because birth control is not practised. Fertility is kept below fecundity by the deficiency of females, the late age of marriage and high female death rates caused by the ignorance and superstition surrounding birth.

Though the social organisation is changing, Libya remains one of the most strict and backward Islamic countries, and therefore it will not be simple to reduce the birth rate through education in birth control. Fertility is likely to

remain high, but death rates will soon begin to fall. As they fall, population will increase at a rate faster than at any other period in Libyan history.

G. Emigration.

The rate of emigration from the Eastern Jebel is very high, but its development has been an evolutionary, not a revolutionary process, and it began long before the 20th century. In the last hundred years, emigration has changed in volume, nature and orientation. Four periods may be distinguished: emigration before 1850, emigration between 1850 and 1925, between 1925 and 1940, and between 1940 and 1960.

1. Emigration before 1850.

The distribution of the population in Tripolitania was not stable until the late 19th century, and there were constant if small movements of tribal groups and refugees from area to area. As late as 1881, for instance, several small tribes migrated from Tunisia to Tarhuna (e.g. the Giauda of the Aulad Msellem). Emigration was restricted to Tarhuna, whilst Cussabat was an area of periodic immigration. Drought and inter-tribal fighting produced highly fluctuating numbers of emigrants, most of whom, however, did not leave the Eastern Jebel permanently. They sought pasture in the Orfella and

Jefara, work in the olive gardens of Cussabat and areas of irrigated agriculture on the coast and even in Tunisia.

2. Emigration between 1850 and 1925.

In this period, four events led to an increase in emigration and to its re-orientation.

(a). The growth of private ownership.

In the second half of the 19th century, rights of usufruct, if not ownership, of land passed from the cabila to the family (Chapter XI). As a result, the poor were forced to live off less and less land, and the rich amassed large land holdings. The security against drought and sickness provided by communal ownership disappeared. Emigration increased, migrants stayed away from the Jebel for longer periods and emigration spread to Cussabat.

(b). Turkish conscription and tax reforms.

After the Ottoman Empire had been strengthened by reforms following the Young Turk movement, the power of the state grew within Tripolitania. The Turks wanted man-power for their armies and money to pay for them, and therefore introduced conscription and new taxes. According to Bryant (12), Tripolitanian tribesmen reacted by emigrating in large numbers to Tunisia.

(c). French colonisation in Tunisia.

In 1881, the French established their protectorate

in Tunisia, which they subsequently colonised and developed. They set up large farms, particularly in the humid north, and initiated industrial, mining and commercial activities. A large number of Europeans emigrated, to settle mainly in the towns. Colonisation gave rise to numerous opportunities for the impoverished local population to find paid labour. Tripolitanians, who had many tribal contacts with the Tunisians, were also attracted, so that many temporary migrants were added to the refugees fleeing from the Turkish and Italian rule in Tripolitania. At the turn of the century, there were 57 trabelsi (Tripolitanian) tribes in Tunisia, and when the first census was made in 1921, there were over 20,000 Libyans in Tunisia (13). Later Tunisian censuses showed that the number of Libyans did not fluctuate much, except in 1931, after several thousand refugees left Tripolitania following Italian land expropriations (Table IX - 13). As emigration

Table IX - 13. Libyans in Tunisia (14).

Year	Number
1921	20,546
1926	20,305
1931	28,157
1936	23,907
1946	22,000
1956	18,900 (Random sample)

is characterised by its fluctuating, periodic nature, it is unlikely that after 1921 temporary emigration to Tunisia was

important. After 1931 the Italians discouraged emigration from Tripolitania.

(d). The Italian invasion and reconquest.

The disruption of tribal life caused by the Italian invasion in 1911 and the reconquest between 1921 and 1925 led to extensive emigration from rural Tripolitania to Tunisia and Cyrenaica. Many families left their tribes to settle in different parts of Tripolitania.

3. Emigration between 1925 and 1940.

The Italians did not initiate the present large scale emigration from rural Tripolitania, but they created the need for it. Italian colonisation was predominantly agricultural in nature, and unlike the French in Tunisia, they did not set up large concentrations of Europeans in urban or industrial areas. Tripolitania's only resource was its agricultural potential; there were no known mineral deposits and no local industries. The Italians established large concession* and demographic farms* in most parts of northern Tripolitania, except the Ghibla and western Jefara, which were too arid, and the Jebel Nefousa and Cussabat, which were already covered in arboriculture. They built roads within the colonised areas, and roads joining these areas to Tripoli, the main point of entry. Apart from this, they established small administrative and garrison centres adjoining small Libyan markets, and a

* CHAPTER XI

more skeleton of industry dealing with Italian agricultural products. Little was done for the Libyans, who, however, were affected by the loss of land and other side effects of Italian development.

The Italians weakened the balance between population and resources in tribal areas, but also created within these areas opportunities for paid labour on Italian farms. In Tarhuna the tribesmen did not have to emigrate, because work was available on local Italian farms. If they did emigrate, they usually went to other rural areas, and rarely to towns. "Economic emigration" - the migration from one economy to another - was more important than "geographical emigration" - the movement from one area to another. Before 1940, most tribesmen in Tarhuna were involved in economic emigration.

4. Emigration between 1940 and 1960.

The Italian system disintegrated after the British conquered Tripolitania in 1943 and established the military administration which lasted until 1951. The Italians based their colonisation on tree crops, particularly the olive, which takes 10 to 15 years to mature. As many of the trees were planted in the late 1930's, few were in production by 1943 and many farmers were forced to abandon their land. Though the British military administration tried to prevent this, there were few opportunities for work in many Italian

areas. Since the tribesmen had become accustomed to supplementing their income by such work, and since they had been impoverished by the war, they had to emigrate to centres of European population, where they found jobs as labourers or in domestic service. They flocked to Tripoli, the small administrative centres and the military bases near Tripoli, Homs, Sabratha, Ben Gashir, Kassala, Tarhuna town and later Wheelus Field. Since independence, a large sum of foreign aid has been invested in Libya, and this has been accompanied by the entry of many European and American nationals and companies. Industry and the Europeans are concentrated in Tripoli, and hence most labour opportunities are found here. No other town is as important as Tripoli, except for Bengazi, which dominates Cyrenaica as Tripoli dominates Tripolitania. As tribalism is much stronger in Cyrenaica, emigration is not as important as in Tripolitania, and many Tripolitanians have found work in Bengazi. In 1959, several important oil strikes were made in the Syrtica, and as exploitation is beginning, migrants from Tripolitania are seeking work there.

5. Characteristics of present-day emigration from the Eastern Jebel.

Migrants still aim to find pasture, temporary work on Italian and Libyan farms, and work in urban or industrial areas. Migrants seeking pasture are few in number, and usually

go to the Orfella, but during the drought of 1946-1948 some went to Cyrenaica. Though tribesmen still work on Al Khadra, the concession farms and in the olive harvest in Cussabat, most now go to the towns, oilfields, military bases and development areas.

It is difficult to calculate the volume of emigration, but it must be great, for the following reasons:-

1. The population of Tarhuna declined by 13,400 between 1917 and 1954, even allowing for the fact that about 5,500 were killed by the Italians. Thus, emigration resulted in this population decline plus natural increase. In Cussabat, population has increased at the rate of 20%, which is well below the Tripolitanian average.

2. There is a marked deficiency of young people of both sexes, particularly in the 20-30 age group. If the potential number of people in this age group is compared with the actual numbers in this and younger and older age groups, then there are at least 3-4,000 emigrants.

3. The Mayor of Cussabat estimates that at least "one thousand people" have emigrated to Cyrenaica in the last few years; more must have gone to Tripoli. The Sheik of Beni Mislem says that about 140 people have left the cabila to work or live elsewhere. This represents about 12% of the total cabila population.

4. Almost every family interviewed in the field by the writer had at least one or two of its members working outside the region.

The total per capita income from pastoralism is approximately £L10 per annum.* This is evidently too low, even in a subsistence economy. Some tribesmen are obviously supplementing their income from other sources.

It is more difficult to determine how long migrants spend outside the region. Some are more like commuters than migrants and return to the region at weekends; others spend part of the year in Tripoli and part in Tarhuna or Cussabat. The Italian farms can still absorb 1,500 temporary workers during the olive harvests, and men are needed for the sowing and harvesting and for moving animals. Some migrants no longer live in the area, but return occasionally. Several people from the Ailet el Moreid of the Cabila Auasa occupy important Government posts by virtue of their resistance to the Italians. They visit their cabila at every opportunity and some still own land in the region.

Judging from the age pyramid, migrants leave the Eastern Jebel before they are 20 and return after they are 30. In this period, they probably spend more time working in Tripoli than in Tarhuna. Migrants may stay away for longer periods. In Tunisia, for example, migrants do not return to their

* SEE CHAPTER XIII

tribes until they are 40-45 years of age. In the Eastern Jebel, large scale permanent and semi-permanent emigration is only 15-20 years old. Even elderly tribesmen asked the writer to find them jobs in Tripoli or Homs.

The migrants take up many different types of work, and do not appear to specialise, as some do in Tunisia, in any one particular occupation. The opportunities are diverse, and consist mainly of labouring jobs with oil companies, and domestic service with Europeans or military personnel. A number of migrants join the army or police, which are recruited from the rural and not the urban population.

Whatever they do, the aim is either to save money for marriage, or to send money back to their families in the Jebel. This is usually done personally, as the migrants frequently return to their tribes, most of which are only 2-3 hours and 30 piastres from Tripoli by thrice daily buses.

6. Causes of emigration and future developments.

The basic cause of emigration from the Eastern Jebel is population pressure on resources. Income and the standard of living have declined, both absolutely and relatively to the rest of Tripolitania. Population pressure on resources, which can be termed over-population, involves several factors, which are: (a) size of the population, (b) organisation and technical ability of the population, (c) size of the land area and (d)

level of income. The size of the land area is related to the type of resources that are exploited in a particular region, and the way in which they are exploited. In Tarhuna, for instance, the people integrate arid and semi-arid zones through pastoralism and semi-nomadism. They are interested in finding grazing and water for their animals, and water and land for shifting cultivation for themselves. In Cussabat, tribesmen live by cultivating olives and cereals, and they are interested in certain types of land where soils and rainfall permit agriculture and where there is enough water for the people to live on. Formerly, the population was divided into tribal groups, and the resources were communally exploited to maintain the whole group at or above the level of subsistence. The strong social organisation emphasised the need for co-operation and ostracised individualists. It also meant that the techniques and manner of resource use did not change and life was very much the same in the 19th as in the 13th century. Occasionally, drought resulted in a temporary decline in the area which could successfully be used, so that the level of income dropped and people had to find work outside the tribal area in order to live.

Since about 1890, many changes began to take place. Tribalism lost some of its meaning as rights of land use passed from the cabila to the family. Later, the Italians

expropriated land in Tarhuna, so that about 10% of the better grazing areas and some of the important wells were lost to the population. In both Tarhuna and Cussabat population increased, though in Tarhuna it may have been balanced by population losses in battle or flight. Increases in population were not compensated by changing patterns of resource use in the smaller area of land left, or by an increase in the technical ability of the people. Income and the standard of living thus declined, and emigration developed.

The Eastern Jebel is not an isolated area, but part of a modern state. Industrial, agricultural and commercial development on the coast, and the influx of a large European population have led to the creation of work for unskilled people, who receive comparatively high cash wages (£15-20 per month). The European and urban standa rds of living are higher than that of rural areas. At the same time, a large amount of foreign capital has been invested in Libya, either as direct grants for development or as investment in oil exploration and exploitation and other industrial and commercial enterprises. In 1959, for example, the Government balanced Libya's budget at £L16,000,000. £L9,000,000 of Libya's income came from foreign aid (15). With such large flows of capital into the country, the cost of living index has increased by 34% since 1955, and inflation has developed.

The prices of consumer goods sold in the Eastern Jebel are rising. Because of this, the standard of living has declined relatively in the region under study.

Thus, emigrants are forced to leave the region because of declining standards of living brought about by population pressure, and are going elsewhere to get a higher income. This cannot go on. The World Bank Report on Libya (16), published in 1961, sounds a warning note. It says that only 5% of the population can be employed in the oil industry, and that investment and development must concentrate on agriculture because of the poverty of Libya's resources and its small internal market. We have seen that population is likely to increase still further in the next few decades and that the rate of increase is likely to grow. Part of this increase, but not all of it, can be absorbed by emigration. If the present means of resource use are not changed or improved, living standards will decline further

7. The future.

It has been shown that population will increase at a faster rate than ever before in the region under study. This is indicated by the following factors:

(a). The population is youthful, with nearly 40% of the people under the age of 15. The capacity for growth is tremendous.

(b). The age of marriage is fairly late even compared WITH more developed Arab countries. It is likely to fall, so that the level of fertility will tend to increase towards the level of fecundity.

(c). Birth rates and death rates are high. The causes of the high birth rate are social, those of the high death rate ignorance and poverty. The latter are more likely to be removed before the former. This has occurred time and time again in all parts of the world.

At the same time, population pressure on resources is growing and living standards are declining both relatively and absolutely. The evidence for this is in the high emigration rate and the expansion of the cultivated area in Cussabat. Emigration cannot continue indefinitely, because of Libya's poor resources and lack of industry.

Because of these facts, something must be done. The expansion of the cultivated area in Cussabat is a temporary cure to a long term problem, since the yields of tree cultivation must first be improved. This can only be done by improving the techniques and means of cultivation.

Arboriculture supports a higher density than pastoralism in similar environments. Tree cultivation can be extended to Tarhuna to improve total yields per hectare, but it cannot extend to every part of Tarhuna, so that the techniques of

pastoralism must also be improved.

Thus, overpopulation must be neutralised by a change in the type of resource use in Tarhuna and El Amamra and by a general improvement in the technical ability of the population in all parts of the Eastern Jebel.

CHAPTER X.

THE PATTERNS OF SETTLEMENT.

A. Introduction.

This chapter will consider the patterns of Libyan settlement; Italian settlement is closely related to Ente's rigid system of organised resource use and is best considered in its agricultural context. The patterns of Libyan settlement closely reflect economic activity, but are affected by the ethnic origins, places of origin and social organisation of the population. On one hand, there are the semi-nomadic peoples of Tarhuna and El Amamra, and on the other, the settled village dwellers of Cussabat. The settlement pattern of Cussabat is the heritage of Roman arboriculture and settlement, which has disappeared from other parts of the Eastern Jebel as a direct result of the destruction of tree cultivation by the Aulad Hamed. Since 1911, the region has been influenced by the outside world, so that a veneer of modern settlement has been superimposed in some areas. In both the semi-nomadic and sedentary areas, changes in the traditional form and pattern of settlement are taking place. These changes reflect on one hand changes in social organisation, and on the other economic activity, so that their study provides an important link between the people and their economic activities. To deal with the relevant factors, the chapter will be divided as follows:-

B. Evolution of the settlement pattern.

C. The settled villages of Cussabat.

D. Recent changes in Cussabat.

E. Semi-nomadism in Tarhuna and El Amamra.

F. Sedentarisation.

G. Communications, towns and services.

B. Evolution of the settlement pattern.

Though the Jebel was undoubtedly affected by Phoenician and more ancient settlement, the present pattern is largely a reflection of Roman and post-Roman settlement.

1. Roman settlement.

Though effective Roman control of Tripolitania did not begin until 27 B.C. (1), the Eastern Jebel was already under settled cultivation by that time. This area was part of the hinterland of Leptis Magna, which had been an important trading city under both the Carthaginians and the Numidians. As Leptis Magna expanded under the Romans, so the area under cultivation gradually extended westwards in the Jebel to reach central Tarhuna in the second century A.D.. The culmination of Roman activity came in the third and fourth centuries, when Septimus Severus had reorganised the defence system of northern Tripolitania. He established three zones of defence: the limes Tripolitanus based on the three great isolated forts of

Bu Ngem, El Gheria el Garbia and Ghadames; a zone of limitanei settlements in the Soffegin-Zemzem basin (i.e. southern Tarhuna and the Orfella); and an inner zone formed by the "strategic road" which ran from Leptis Magna to Tunisia along the crest of the Jebel, north of the agricultural land (2).

The limitanei were settled by Libyan veterans, who in return for tax-free land and slaves, undertook to defend the areas they occupied. This system was based on a series of fortified farmsteads, some of which are still well preserved. In the northern part of the Jebel, small self-contained olive farms were characteristic, with homesteads of a para-military type. These farms consisted of a fortified farmhouse with olive presses, cisterns and occasionally small dams. Goodchild (3) believes that the existence of this type of farm proves that there was not a depressed class of "coloni" in the Jebel. Among these farmsteads, there were a number of small villages in which there was normally a small garrison, a church and a few shops. The principal villages were at Gasr ed Dauum, Gasr Doga, Soersciara (where there was a large pottery industry) and Ain Uif.

At the zenith of Roman rule, this type of settlement extended over the whole of modern Cussabat, the northern part of the Tarhuna plateau and parts of El Amamra. Towards the close of Roman rule, the population of these farms and villages

was almost entirely native, whilst the system of defence became "Berberised" as the Romans left Leptis Magna.

2. Post-Roman settlement.

Goodchild (4) and Oates (5) maintain that the withdrawal of the Romans made little difference to the way of life in the Eastern Jebel. Barbaric invasions probably reduced the settled zone, but did not radically alter the settlement pattern. There was, however, a definite decline in agricultural techniques with the decay of Roman soil and water conservation works.

After the Arab invasion of the 7th century, there was almost continual fighting between the Arabs and the settled Berbers. As a result, the stability necessary for tree cultivation disappeared and nomadic tribes encroached on the marginal areas of the Eastern Jebel. This process was accelerated in the 10th century after the invasions of the Beni Hilal and Beni Suleim. At first, these tribes were interested in Tunisia rather than Tripolitania, but they destroyed the old olive trees of Tarhuna and southern Msellata. Only northern Cussabat, which lay in a remote and inaccessible zone, was left intact. The Beni Hilal and Beni Suleim delivered the coup de grace to tree cultivation and the settled way of life in Tarhuna. In the 13th century, Ibn Khaldun referred to the Berber tribes of Tarhuna as nomadic.

Later, as Arab tribes returned from the west in search of land and water, the change to patoralism was completed.

The Turks maintained the status quo. They left the population alone, provided the Sheiks were able to produce the tribute demanded by the Porte. There were no significant changes in the Eastern Jebel beyond the creation of central administrative points at Cussabat town and Scersciara. The capital of Tarhuna was moved to the wells of El Ubberat in the early 19th century. Cowper (6) noted in 1898 that there was only one tree in the whole of northern Tarhuna, and this was given a sacred character by the nomads.

3. Italian period.

After the Italians had reconquered the Jebel, they laid out seven private agricultural estates around Tarhuna town and three large demographic estates at Sidi Essed, Al Khadra and El Gsea. They created the modern towns of Tarhuna and Cussabat and built the main roads of the Eastern Jebel. The combined effects of this activity and the expropriation of indigenous land have led to a modification of the native settlement pattern which will be discussed in a later section.

Thus, in the Jebel today, there are three distinctive settlement patterns: the settled villages of Cussabat, semi-nomadism in Tarhuna and the El Amamra, and the modern towns and communications.

C. Settled villages of Cussabat.

The Roman pattern of settled arboriculture has been maintained in Cussabat, but the social organisation has profoundly influenced the distribution of population within the villages. Each village, except Gheleel and Amareen, is composed of small house groups in which the families belonging to a biyut or an ailet dwell. The village is also divided into quarters occupied by lahma. Most villages house a complete cabila, but in the Cabile Shaffeen, Crarta, Fuartir and Beni Mislem the lahma live in dispersed house groups. In Crarta, for example, there is not one but seven villages. Cussabat, on the other hand, is a multi-tribal village which is divided into five quarters occupied by the Cabile Jareen, Aulad Hamed, Aulad ez Zurgan, Coroglia and Bu Aish. Thus tribalism is crystallised in the structure of settlement, and this has had an important influence on the preservation of traditional patterns in Cussabat.

The villages differ in site, morphology and evolution, and their distribution must be examined in relation to these factors.

1. Distribution of the villages.

(a). Site and situation.

If the villages are examined according to the origin of their population, a definite and interesting

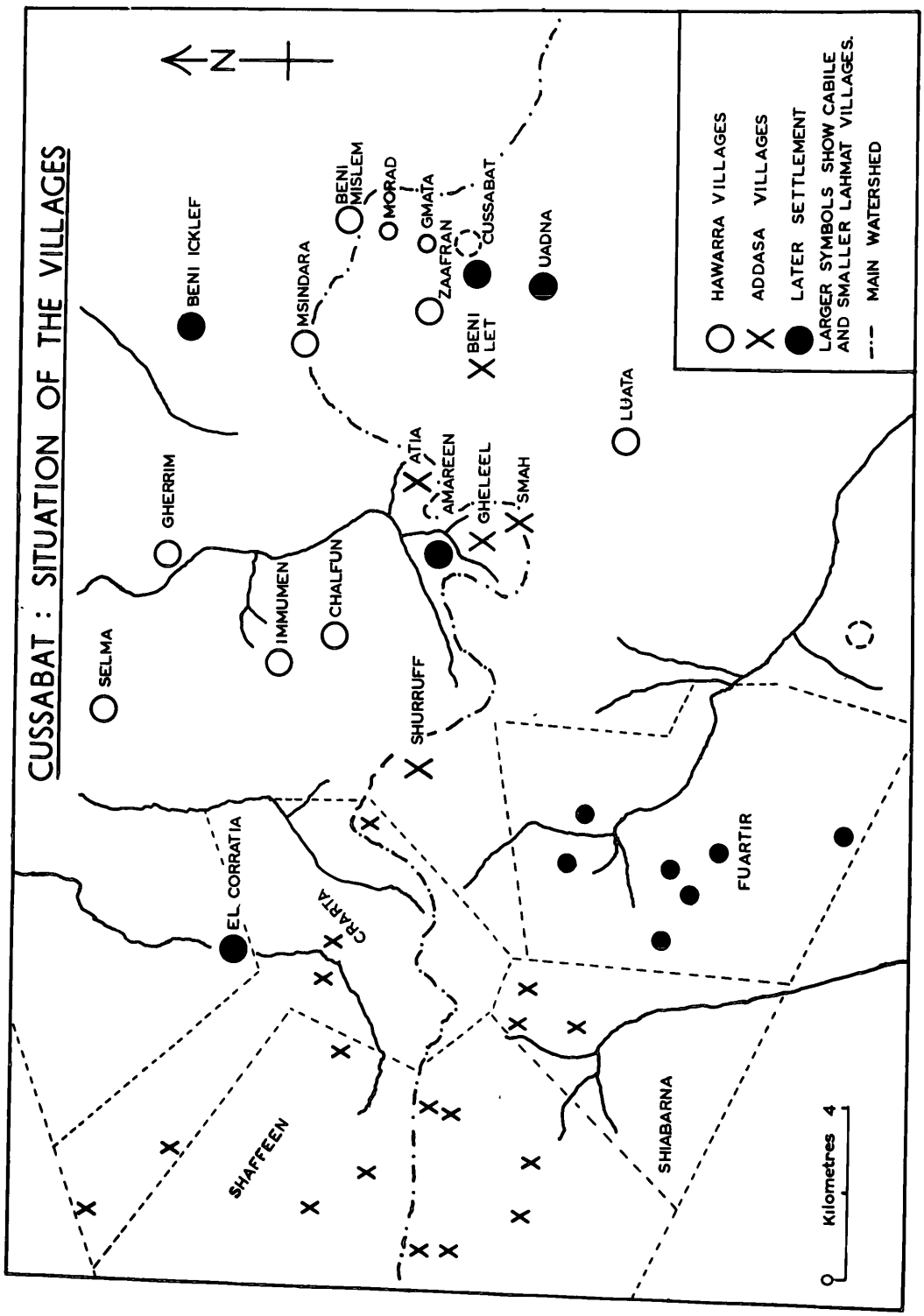
pattern emerges (fig. 28). Each group of villages is settled in a different morphological zone, and the following groups may be recognised:-

(i). The ancient Hawara and Luata Cabile villages. Nine of these villages lie in the Scarp Zone and two in the Cussabat Plain.

Those lying in the Scarp Zone are situated on the main watershed of Msellata or on the interfluves of the Wadi Gherrim. Each has a defensive site and is situated at an elevation of 250-320 metres above sea level. Gherrim, for instance, is sited on the summit of a narrow steeply sloped spur overlooking the Wadi Gherrim, 80 metres below the village. The spur has been cut back by a small wadi so that its summit and the village are almost detached from the base of the spur. Selma, Imumen and Ghalfun are similarly sited and all four villages lie near the ruins of Roman dams and houses. Msindara and the three villages of Beni Mislem occupy spurs projecting into the Scarp Zone from the Cussabat Plain. Behind each village a ruined fort is found, which once protected the inhabitants from marauders moving north-west across the Cussabat Plain.

Though Luata and the Bu Aish (Cussabat) no longer occupy defensive sites, the ruins of a once-inhabited village lie within their cabile boundaries. The Bu Aish lived on the

figure 28.


CUSSABAT : SITUATION OF THE VILLAGES
N
BENI ICKLEF
MSINDARA
BENI MISLEM
MORAD
GMATA
ZAAFRAN
CUSSABAT
UADNA
BENI LET
LUATA
ATIA
AMAREEN
GHELEEL
SMAH
GHERRIM
IMMUMEN
CHALFUN
SELMA
SHURRUFF
EL CORRATIA
CRARTA
FUARTIR
SHIABARNA
SHAFFEEN
HAWARRA VILLAGES
ADDASA VILLAGES
LATER SETTLEMENT
LARGER SYMBOLS SHOW CABILE AND SMALLER LAHMAT VILLAGES.
MAIN WATERSHED
Kilometres 4

summit of El Galaa, which lies 100 metres above the 260-275 metre surface of the Cussabat Plain, whilst the Luata formerly lived on the Jebel Msid, the highest summit in Msellata.

(ii). The Addasa immigrants. The Addasa villages lie to the south and west of the Hawara cabile and form an arc of a circle between Beni Let and Migdal. The cabile villages of this group are sited around the ruins of Roman and Berber forts, and the principal lahma villages of the Shaffeen, Crarta and Shiabarna are similarly sited. The only exceptions to this pattern are the villages of Gheleel, Sidi Atia and Sidi Smah, which are grouped around the wells of Biar Zaafrania, but lie on defensible sites overlooking the Wadi Zaafrania. The villages lie between 270 and 350 metres and none lies in the Scarp Zone.

(iii). The later immigrants. The later immigrants settled to the south of the Addasa villages in the Cussabat Plain and the valleys of the Gsea and Uaeni. Each village is inhabited by a Marabatin or Sherriff cabila, and they differ from the other villages because they are not sited for defensive purposes. The Sherriffs from Morocco and the Uaddan settled at Cussabat and Uadna, where uncultivated land was available, and the El Fuartir settled in the Wadi Uaeni. The exceptions to this pattern are the Marabatin Aulad el Aalem, El Amareen and Beni Iechlef, who live in the Scarp Zone. However, all

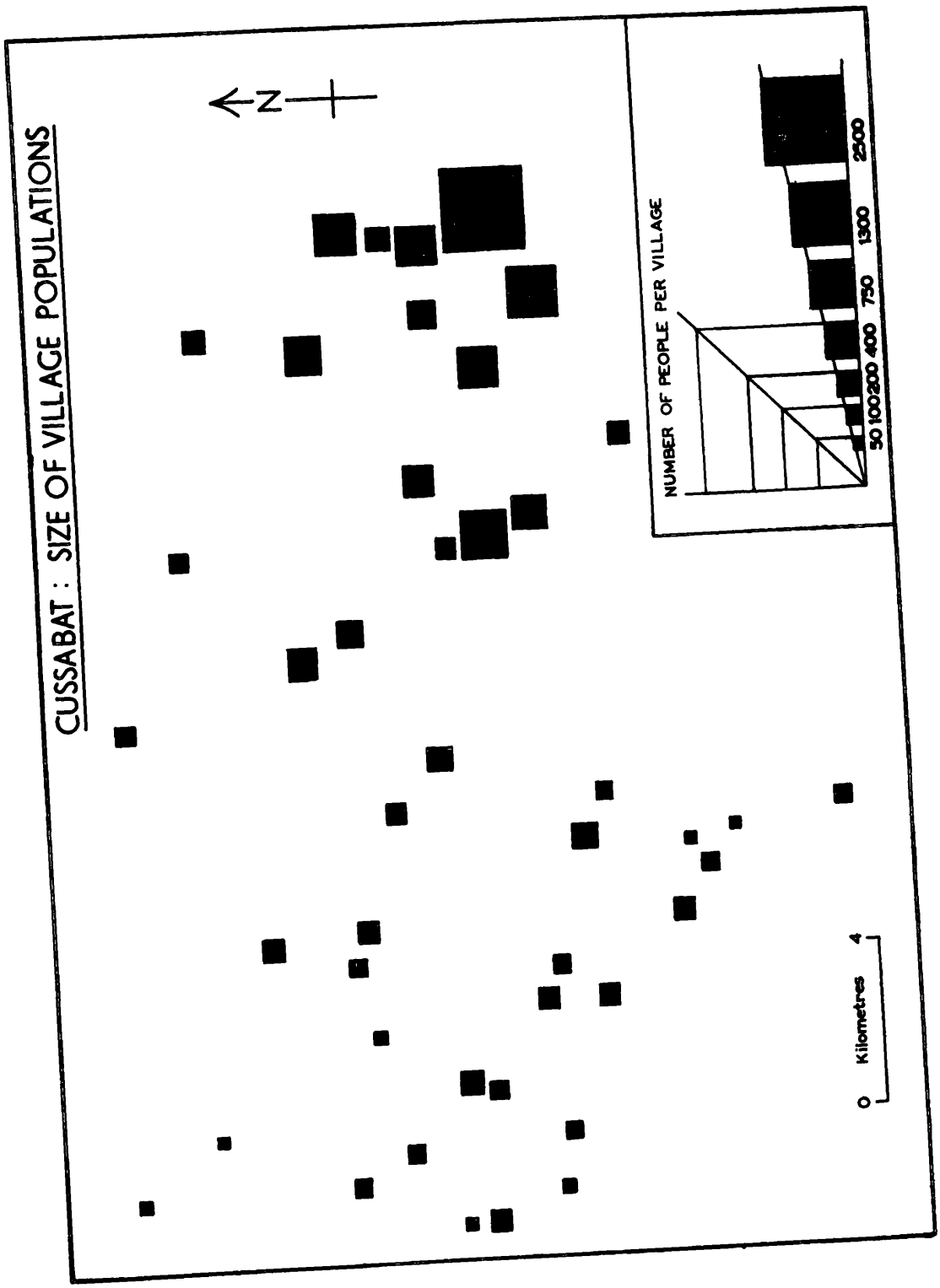
these cabile have a special relationship with either the Addasa or Hawara villages and it may be concluded that they were allowed to settle in the lands of the Msindara (Beni Iechlef), El Crarta (Aulad el Aalem) and El Gheleel (Amareen). None is sited for defence, and both the Beni Iechlef and the Aulad el Aalem are situated in wadi valleys.

It is clear that the Hawara cabile were forced to move into the Scarp Zone or survived because they lay in the Scarp Zone during the Arab invasions. The Addasa immigrants were less conscious of defence, but nonetheless occupied fortified sites either near good groundwater resources or cultivable land. The Marabatin and Sherriff cabile occupied the marginal zones of Cussabat or areas where no other cabile had settled. The exceptions are Zaafran and the Gheleel, Sidi Atia and Smah who settled near the main well groups.

(b). Village size.

Though the population of the cabile villages varies from 150 to 900, over 40% of the villages have populations of between 100 and 200 people (fig. 29). The twelve villages with more than 200 inhabitants lie to the south of the main watershed of Msellata, except for Chalfun and Imumen, in which 220 and 340 people live respectively. Four villages have more than 400 inhabitants and three of these - Beni Let (600), Uadna (900) and Beni Mislem (800) - own land in the Cussabat

figure 29.


CUSSABAT : SIZE OF VILLAGE POPULATIONS
N
NUMBER OF PEOPLE PER VILLAGE
50 100 200 400 750 1300 2500
0 Kilometres 4

Plain. It was noted that the density of settlement in terms of the cultivated area was constant in Cussabat and reached about 80/square kilometre. It seems that the size of the cultivable area has had a profound effect on the siting and evolution of the villages. Those least densely populated lie on the peripheries of Cussabat where land is still uncultivated.

The distribution of cultivable land has also led to the separation of the village quarters in western Cussabat, and the same process is beginning in eastern Cussabat. As population increased in western Cussabat, the cultivable area expanded until it became uneconomic or inconvenient for a part of the population to be separated so far from its land. This may be demonstrated by the following facts:-

(1). Aulad Brahim in the El Crarta was formerly the main cabila village, but it split to form the El Acarit and Breber lahma villages.

(2). This has happened again in the case of the Breber and El Acarit and today the lahmat Subuq, Migdal, Gargaresh and Ziann live separately. However, each occupies either caves or tents, which are typically temporary dwellings in Cussabat. In recent years several houses have been constructed in these areas. It seems that the population of a principal village moved temporarily to their land during the times of harvest

and sowing, but as time passed they remained at the temporary dwellings for longer and longer periods until they finally abandoned the village altogether.

(c). Morphology and evolution.

With the exception of the lahwat villages of recent foundation, the villages are remarkably alike in appearance. Once the site and area of habitation has been established by the first settlers, their descendants attempted to build and live within the initial confines. Each generation has built its houses on the ruins of those of the previous generation and the resulting inertia is expressed in the crowded housing, narrow twisting alleys, the great number of ruined dwellings and the amorphous compactness of village morphology. Each village stands out, even on the flat or undulating slopes of the Cussabat Plain, because each is built on the mounds created by continual building on one small site. As the population grew, the village was also forced to grow, but it expanded in a slow unwilling creep away from the original nucleus. Though every village follows this pattern, they differ in aspect according to the nature of the original site.

In the Scarp Zone, the Hawara villages are built on restricted areas of land on which there was little room for expansion. At Gherrim, 180 people live in an area of about 80 sq. metres and the houses are piled together and built on

an enormous mound of rubble. The village has not been able to expand, so that in recent years new houses have been built in the wadi terrace below the village.

The Addasa villages are usually dominated by the ruins of a Roman or Berber fort around which the houses are concentrated. In Beni Let, the Roman fort is well preserved and stands out from the rest of the village by virtue of its height and architecture. Beni Let is less crowded than Gherrim and differs from the latter in its clear divisions into lahmat quarters. The Lahmat Orfella live in the central part of the village and their houses are perched on the rubble and ruins of the centuries. The other lahma lie around the Orfella quarter, from which they are separated by broad alleys. In each quarter, there are many ruins amongst the inhabited buildings, which are reached by twisting, steep and rutted alleys. Centuries of wear have stripped the soil around the village so that the calcareous crust is exposed. The village cisterns, olive presses, gusbat (granaries) and the houses of the poor are dug beneath the crust. As in most of the other villages, recent dwellings and the new olive presses lie outside the main cluster of houses on the crust or some way from the village. (Plates 14-19).

Most of the Addasa villages resemble Beni Let, but Gheleel, Atia and Smah, together with Beni Mislem, Morad and

Gmata differ because their ancient nuclei lay on small summits. As population grew, the boundary of the village crept down the slopes, so that the modern villages appear to be built on the slopes.

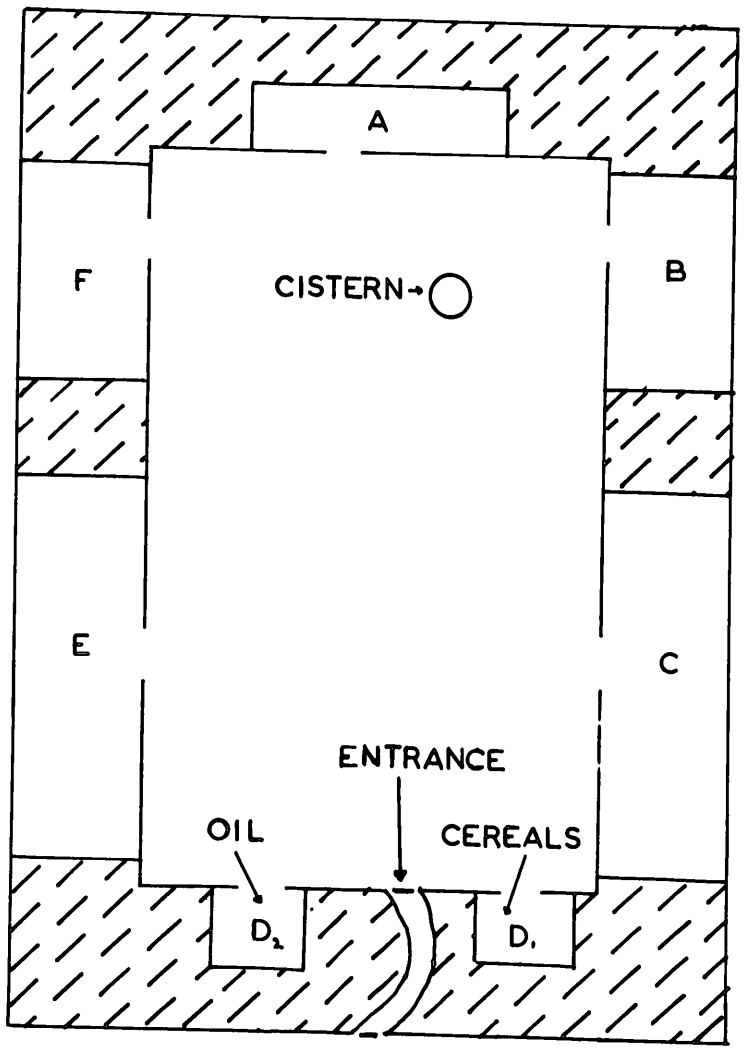
Villages built by the Marabatin and Sherriffs differ because defence was not an important influence on site. Uadna and Cussabat are much less compact than other villages and housing has expanded outward rather than upward (Plate 19). Beni Iechlef and El Corratia are similar, but extend across wadi floors above the level of the normal spate.

Perhaps the most important influence on the morphology of the villages is the type of terraced house, variants of which account for over 90% of all dwellings in Cussabat. It consists of a small courtyard with five or six rooms built around it (Fig. 30). Some houses have an external courtyard joined to an internal one by a covered passage. The walls are made from limestone chippings cemented together with the calcareous mud. The flat terraced roofs are constructed from olive and pistachia branches held together by mud. The wooden doors are set in arched or square doorways. The use of the rooms is governed by the social divisions within the family. The father and mother, married sons and all children over 12 years of age occupy separate rooms, and others are reserved for cooking, the family donkey and for storing

figure 30.

THE CUSSABAT HOUSE

MOHAMMED MIGIEBI'S HOUSE, BENI LET



A STABLE B KITCHEN

C MOHAMMED'S PARENTS

D_1, D_2 STORES

E MOHAMMED & FAMILY

F MOHAMMED'S BROTHER

grain and oil. Many houses also have a cistern in the courtyard. Formerly animals were kept in the courtyard, but now they are kept communally in stockades near the villages.

Modern houses are usually found outside the village and are box-shaped stone-built constructions. In addition, a few cave dwellings are found around most villages, but these constructions resemble the tent rather than the troglodite dwellings of Garian. Most are simple excavations dug beneath the crust, and, like the tent, are divided into two compartments separated by a goatskin cloth.

The striking feature about the Cussabat houses is their uniformity. The only differences are to be found in the embellishments rather than in the basic structure. The houses of the rich are often highly decorated with carvings or paintings, whilst those of the poor are small, plain and often tumbledown.

2. <u>The function of the villages</u>.

It has been seen that society is organised into a series of small social groups which are strikingly reflected in the organisation of housing within the village. These groups are self-contained, and their needs for additional services are few. This, combined with the low standard of living and the primitive agricultural techniques, means that few houses are devoted to providing services to the agricultural population.

those which exist may be divided into two groups:-

(a). Dokkan, Marabout, looms and olive presses.

These are different from the second group in that they are found in every village, and therefore may be discussed with reference to Beni Let. A dokkan is a small shop which also serves coffee and tea. The owner is usually a farmer, and he carries a small stock of tea, sugar, salt, tobacco and a few household goods. He draws his clientele from his own lahmat or filet. There are six dokkan in Beni Let, one in each lahmat and one larger shop on the village border which carries a greater range of goods. The dokkan are important as social centres and they are crowded in the evenings and on Fridays.

The Marabout are the tombs of saints and holy men, and serve as mosques and zavia, where the children learn the Koran from the village imam (lay priest paid by the cabila). There are three Marabout in Beni Let, one of which is very large.

There is usually one loom to each village, but there are three in Beni Let. The looms, which are singularly primitive, are operated by family labourers and weave baracan and clothes for a clientele drawn from the lahma. Commercially, they are of little importance, but they continue to provide an essential service, despite growing competition from imported

materials.

Olive presses will be discussed later, but it is relevant to indicate that there is at least one to every cabile (see fig.38). Formerly, the olive presses were operated by hand or by animal power and were situated in excavations dug beneath the calcrete (caliche) on the village borders. These have been replaced by mechanical presses which lie outside the village. The more modern presses also mill flour, but the bulk of the population, especially in the Scarp Zone, continue to use mill stones.

(b). Potteries and carpet weavers.

There are only four small potteries and three carpet makers in Cussabat. The potteries, which produce small household utensils, e.g. jugs, vases and water bottles, are situated in Cussabat, El Acarit, Beni Let and Imumen. They work clay found in the Wadis Gherrim and Ben Gebara. The carpet makers are found at Beni Let, Msindara and Cussabat and use local wool to make carpets for a purely local market. They are slow, and are unable to meet the demand placed on them.

Thus, few houses in any village are given over to special functions, and the main purpose of the village is to house the farmers and to maintain by close contact the influence of tribal and social organisation on the individual family.

D. Recent changes in Cussabat.

Emigration and the extension of tree cultivation to hitherto uncultivated zones is resulting in a greater dispersion of settlement in Cussabat. The evidence centres on the abandonment of dwellings within the village and the construction of new houses outside the village.

1. House abandonment.

Almost every village in Cussabat contains a number of houses which have recently been abandoned. In Morad, for instance, 25% of the houses have been deserted within the last ten years. This is the result of increasing emigration, the break-down of the traditional social structure and the overcrowded conditions of the villages.

2. New houses.

New houses are being built outside the main villages. In the Scarp Zone, recently built houses are sited in the valley bottoms or some way from the village near the new olive gardens. Olive cultivation is extending towards the tribal boundaries, and as the confines of cultivation move away from the village they attract permanent settlers. This process is most marked in the Cabile Jareen and Aulad Hamed, where two ailets have recently set up separate house groups near Souk el Chimri. Even on the Cussabat Plain, newer housing lies on the cultivated land and not in the village. The new house

type is much more solid than the traditional terrace house, and it requires firmer foundations. In the Cussabat Plain, the changing pattern is being emphasised by the construction of new olive presses on the borders of several cabile. Instead of relying on a cabila for its customers, the new olive presses, which have large capacities, are trying to attract a larger market.

These factors indicate that the old pattern is changing and that in the next few decades the population of Cussabat is likely to be much more dispersed over the cabila lands.

E. Semi-nomads in Tarhuna and El Amamra.

Semi-nomadism embraces so many different shades of population movement that it is necessary to define what it means. In Tarhuna and the El Amamra, the population consists of pastoralists who also cultivate cereals. However, the low and unreliable rainfall and the poor water resources mean that animals must be moved from winter pasture in the Ghibla and Jefara to wells and summer pasture in the Jebel. They must be moved not only between these zones but also within them. To avoid the risks of drought, the pastoralists cultivate cereals on a number of plots in both zones, so that a family owns several widely scattered parcels of sowing land. This particular type of resource use in a semi-arid environment

demands that the population must also move. This movement is referred to as nomadism, and it becomes semi-nomadism when the population movements are confined within the boundaries of tribal territories. Semi-nomads also differ from nomads in that they usually have a normal place of residence to which they return for a few months every year. When the population remains settled at one locality for most of the year, it is referred to as "sedentary" even though it may leave the locality for a few weeks at a time. In Tarhuna and the El Amamra, the degree of nomadism varies from cabila to cabila, and ranges from almost pure nomadism to a completely sedentary existence. Thus, the divisions defined by the Census of 1954 are arbitrary, but it showed that in Tarhuna 83% of the population was semi-nomadic, 12% settled and 7% nomadic.

However, the character of semi-nomadism is changing rapidly in Tarhuna, and those changes are having an important effect on the settlement pattern. Before considering them, it is necessary to examine the population movements which took place in the recent past.

1. Population and settlement before 1936.

In 1936, the people were much more nomadic then they are today, and only 4% of them were settled. At the end of the summer, the population was clustered around the main wells and areas of numerous wells. In September and October the people

dispersed and took part in one of three movements: to emigrate and seek work in the olive harvests, to take their flocks to the areas of winter pasture, or to seek land for cereal cultivation.

(a). Emigration.

The poorer families used to emigrate to Cussabat or occasionally to the coastal zone to seek work in the olive and date harvests. In 1911, large numbers left Tarhuna in early September to join groups from the other nomadic and semi-nomadic areas at Cussabat, where they were paid in kind for their labour. The creation of Italian demographic and concession farms has diverted much of this emigration to Tarhuna itself. About 3,000 labourers of all ages are taken on at Al Khadra each September, and the whole Italian zone is surrounded by small black tents until early October.

(b). Winter pasture.

When the emigration to areas of sedentary agriculture began, animals were collected in large numbers around the heads of the main tracks into the Ghibla. This usually began after the first rains and continued until November. It took various forms. The larger flock owners gave their animals to professional shepherds, whilst the owners of smaller flocks usually accompanied their animals to the Ghibla or gave them to family shepherds. The men and animals moved slowly south

to the main wadis, where small family encampments were set up. A family group was normally found in a small group of tents with other members of their ailet or lahmet in the vicinity. In winter, the families tended to remain in one area, and moved to another only when pasture was bad or when they were unable to find a full time shepherd.

(c). Sowing.

Sowing was generally carried out by hired labourers or family members, but whole families did move to the sowing areas. They moved about from parcel to parcel and ploughed and sowed when it rained. Normally, the northern area was sown first and the Ghibla and Jefara afterwards, so that the cultivators rejoined their families in the zones of winter pasture.

These movements varied from cabila to cabila and took place simultaneously or in any order according to family and cabila. By January, most of the population were in the areas of winter pasture, but a large proportion was forced to remain in the Jebel because of the inadequate water resources of the Ghibla and Jefara. After January, there was some further temporary emigration either to the Italian estates or the coastal gardens, or later to Tripoli. The migrants returned by April, when the population again dispersed to harvest the cereals and return with the animals to the Jebel. In May and

early June, the population was well distributed over the northern Jebel, but as grazing became poorer they were forced to concentrate around the main wells. Families with large cisterns remained near them, and others would visit the wells to replenish their water every few days.

In summer, the families either abandoned their tents or changed to lighter but more permanent tents. Cowper noted that many people were living in wattle huts in 1898.

Movement took the form of transhumance, but the population also moved within the zones of summer and winter pasture. The winter and summer settlement was fairly stable, and the population was clustered in groups according to kinship divisions within the tribal system.

These movements have been changed, and it is contended that the population is becoming more sedentary.

F. Sedentarisation.

The contention that the tribes are becoming more sedentary is based on the following evidence:-

1. In 1936, only 4% of the population was classed as being "settled", but the proportion had increased to 12% by 1954.

2. Emigration means that the semi-nomads are depending to a greater extent than before on cash remittances sent by migrants. For instance, despite the fact that Tarhuna is a

pastoral area, there were never more than one sheep and two goats per head of the population, even in a wet year such as 1956-57. A sheep can earn about £L5 per annum and a goat about £L2.25, which means that the average per capita income from livestock is only £L9.5 annually. This is supplemented by cereal produce which brings in less than 10 piastres per head. Though these figures are based simply on gross totals, it is evident that a large section of the population is living on income derived from other sources.

3. The goat has become more important than the sheep. In the local economy, the sheep are the commercial animals, and their products are sold. The goat, on the other hand, produces milk and meat for domestic consumption. In recent years, the number of goats has increased and that of sheep declined.

4. In 1911, Bertolini (7) stated that there was an abundant supply of agricultural labourers for the sowing and harvesting of cereals. Today there is a shortage. This shortage has been created by increasing demand and decreasing supply. The labourers now work in Tripoli or on the Italian farms, and emigration is robbing the family of its own labour. This has paradoxically resulted in an increasing demand for shepherds, whilst the household head now concentrates on sowing cereals or cultivating trees (Chapter XII). Instead of accompanying their animals, the owners of medium sized flocks are collecting

their sheep and goats in communal flocks which are given to the charge of a family or professional shepherd paid jointly by the animal owners. The decline in sheep numbers demonstrates that animal movement is becoming less important, because most of the goats, who are the family "larders", remain with the population in the north.

5. Tree cultivation is increasing. This will be discussed in detail later, but in 1935 there were only 4,000 olives on cabila land in Tarhuna. In 1958, there were 20,000 and in 1960, 25,000. Tree cultivation is not expanding at the same rates in each cabila, and it is most rapid in those cabile affected by Italian land expropriation and least rapid in the large cabile of western Tarhuna. (Chapter XII).

6. In 1959 and 1960, a large number of small houses were being constructed in many parts of Tarhuna, especially between the Italian farms and the Abanat scarp, but also in the Wadi Taraglat and at Uesctata.

It is concluded that the settlement pattern is being changed and the population becoming more sedentary. However, the number of people who have abandoned pastoralism completely is still low. Elsewhere in Africa, emigration has meant that the family depends to a greater extent on direct cash income, but it has not resulted in basic changes of resource use. The land, the goats and the plough are still retained as security

against the loss of a cash income. The family thus abandons pastoralism temporarily, but does not turn to other forms of land use. This may be deduced from the following factors:-

1. Both the Italian farmers and the urban employers complain that the labour force is shifting, and that the most frequent reason for dismissal is continual absence. This indicates that emigrants still return to Tarhuna for the harvest and animal movements.

2. Nearly 87% of the population continue to live in tents, even when they are in their habitual place of residence.

Table X - 1. Households by type of dwelling, Tarhuna, 1954.

Type of dwelling	Nos. of households
Shanties	524
Houses	714
Caves	61
Tents	8,545
Total	9,844

In the spring of 1960, 98% of the population of ten cabile (30% of Tarhuna's population) were living in tents (Appendix VIII).

Thus, the basic pastoral and semi-nomadic influence remains strong, but an increasingly large proportion of the population are no longer depending on pastoralism as the only source of income. This is resulting in greater sedentarisation, which will increase as arboriculture extends. The

reasons why this will occur will be examined in the sections dealing with economic activities.

C. Communications, towns and services.

Until 1911, the animals were the main form of transport, and the small markets the only points of contact between the Eastern Jebel and the outside world. Hence, communications consisted of a network of donkey and camel tracks linking the cabile to the markets, and cultivable and pastoral zones to one another. The tracks linking the region to the coastal towns were the widest and best, and it was the main track from Homs to Tripoli via the markets of Tarhuna, Cussabat and Abbiar Miggi that the Italians subsequently made into a motorable road. The position is very much the same today. Apart from the main road, a smaller road links Beni Ulid to Tarhuna town, and a few motorable tracks link Tarhuna to the Wadi Taraglat and Cussabat to Gasr Chiar and the villages south of the main watershed of Msellata. The northern part of the Jebel remains inaccessible from the dip slope by wheeled transport, and the Abanat scarp forms a considerable barrier to improvement. Apart from the Italian zone, which is covered by a network of good tracks, the donkey and camel tracks are still the most important links between the population and the markets.

The markets grew up either at the most accessible points over a large region, or at the borders of the Eastern Jebel. The first group, which included the markets at Tarhuna (serving the Jebel Tarhuna), Souk el Khemis (serving the sciban) and Cussabat, lay on the main routes to coastal towns and were thus visited by urban merchants. The second group served as points of exchange between Tarhuna and Garian (Souk el Giuma, Ain Uif), Garabulli (Souk el Giuma, Masabha), the Jefara (Souk el Ahad, Sret) and Cussabat (Gasr ed Dauum), and between Cussabat and the Sciogran (Souk el Chimri). Because of the regional importance of the two principal markets, they were chosen as administrative and garrison centres by both the Italians and the Turks.

1. Urban development.

The Italians created small towns at Cussabat and Tarhuna adjacent to the main markets. The towns consisted of barracks, offices and a few shops and stores which served the Italian population. The Italians established neither new industries nor opportunities for permanent employment which might have generated large urban populations. When the Italians left in 1951, their legacy was empty buildings which have since been filled by Libyan officials and shop keepers. The truly urban population of the Jebel is less than 1% of the total population. The other people living in the towns are farmers and

pastoralists. This situation is common to all parts of Tripolitania.

Tripoli contains one sixth of Tripolitania's total population and 86.6% of its industrially active population.

Table X - 2. Industrially active populations resident in urban areas, 1956. (8)

Municipality	Persons employed		Average number of workers/establishment
	Numbers	%	
Tripoli	41,157	86.60	6.1
Misurata	1,609	3.30	2.1
Homs	870	1.80	4.2
Garian	846	1.70	4.3
Zliten	654	1.41	1.5
Zavia	488	1.01	3.8
Souk el Giuma	453	0.91	4.6
Sirte	407	0.82	2.8
Tarhuna	394	0.79	2.1
Zuara	322	0.64	2.5
Jefren	231	0.57	1.1
Nalut	217	0.45	2.2

Both the greatest proportion of industrial workers and the largest units of industry are found in Tripoli. The distribution of industry in Tripolitania is unbalanced, and Tripoli's share too great. No other town approaches Tripoli, nor is one likely to, until some effort is made to decentralise industrial and commercial life. Tripoli is creating the phenomonon of 'geographical inertia'. Even the Development Agencies are centred in Tripoli and have little contact with the rural areas which are the principal objectives of development schemes.

Perhaps decentralisation could be started by transferring the headquarters of the Development Agencies to the smaller municipalities. This would result in (a) the creation of new work in these towns (b) larger urban populations (c) less emigration and (d) greater appreciation of the human as well as the environmental problems involved in development projects.

The chief drawbacks to any attempt at greater dispersion of the urban population and the decentralisation of its services are the poor communications, the high rates of illiteracy and the lack of skilled labour. It is therefore essential for the Government to improve roads and schools and to create smaller regional centres. It is trying to do this in some areas, and Tarhuna town is destined to become an important inland centre, serving both the Eastern Jebel and the Orfella to the south. The dilemma facing the Government is that even if urban services are decentralised from Tripoli, this may not be enough, because the population is so scattered and thinly distributed in rural areas. One answer to this problem would be the creation of small village centres like that at Al Khadra at convenient centres in the region, such as the markets.

To examine the present situation, it is necessary to discuss briefly the two towns and the distribution and nature of rural and urban services.

1. The towns.

(a). Cussabat.

Cussabat town lies at the foot of the El Galaa hill on the watershed between the Wadis Belsum, Zorgba and Ben Naal. It commands the eastern entrance to the Cussabat Plain. The original town was sited on the summit of the El Galaa, the highest point in Cussabat, but the present town lies on the north-eastern slope. Cussabat consists of an old and a modern town. The old town is composed of the five quarters occupied by the Cabile Bu Aish, El Jareen, Aulad Hamed, Ez Zurgan and the Coroglia. It is similar to the tribal villages of the rest of Cussabat, except that the shops are concentrated along the main road, and are more numerous. The early importance of the town sprang from its position as a convenient route centre accessible from the coast, El Amamra and the rest of Cussabat. Hence a market was established here. Because it was an important market, the Turks and Italians made the town the administrative centre of Msellata.

The modern town lies to the east of the old town, and is separated from it by the market place. It was built by the Italians and only consists of a few offices and shops, a hotel, a school and a dispensary. The Italians also built a small covered market adjacent to the old town. Few people live in the modern town, and the hotel was closed in 1960.

(b). Tarhuna.

Like Cussabat, Tarhuna consists of an old and a new town, separated by the market place. The old town is situated in a depression lying near the watershed between the Wadis Tenzina and Ramle. It rose to importance when the market of the Jebel Tarhuna was transferred to it from Soersciara in the early 19th century. It is easily accessible from all parts of the Eastern Jebel, and it lies at the junction of the Tripoli-Homs and Tripoli-Beni Ulid roads. In 1910, the town consisted of a large market place surrounded by a number of small shops and a Turkish fort. The Italians built the new town on the eastern summit of the depression. It consists of a barracks, a school, a small hospital, a hotel, shops, houses and an administrative centre, occupying three sides of a square, the fourth side of which is formed by the old town. The Italians planned to build a church in the centre of the square. They completed the steps, but a mosque now surmounts them. Around the mosque, the Russians are building a hospital, the Americans a teachers' training college and the English a public lavatory!

2. Rural and urban services.

(a). Markets and shops.

Cussabat is the central and only market in Msellata, whilst Tarhuna serves the Orfella as well as the Jebel. The Tarhuna market takes place every Monday, and that of Cussabat

on Thursday. Each household tries to send at least one member, usually its head, who buys the extra family necessities for the following week. Merchants from inside and outside the region attend the markets, selling food, agricultural implements and, more recently, small consumer goods, and buying animals, cereals and olives. However, the markets are losing some of their economic importance, as a number of local merchants are by-passing them, and buying goods direct from the producers. The markets retain their significance socially. The smaller markets are visited regularly by merchants from Tripoli, who travel round by lorry and bus, buying and selling en route. The markets consist of a small market place, surrounded by a few stone houses, tents and shanties. The houses are shops, and are usually open only on market day. There is usually an artisan or a flour miller at each of the markets. The markets are supplemented by small shops scattered over the countryside in Tarhuna, especially in the Ghibla near important areas of winter pasture. Fifteen Esparto presses are also found in Tarhuna.

(b). Administrative functions.

Tripolitania is divided into three provinces, which are sub-divided into a number of districts. Each district is administered by a District Commissioner responsible to the Governor of Tripolitania. Tarhuna forms a separate district,

and is divided into four mudiriats headed by Mudirs. Cussabat and the El Amamra are separate mudiriats in the Homs district, and are administered by a Kaimakan responsible to a joint Mudir living in Homs. However, part of the Kaimakan's duties are delegated to the Mayor of Cussabat. In the region, administrators deal directly with the Sheiks of the cabile, who must come to the towns. The Sheik is responsible for all matters affecting his cabila.

(c). Education.

Until about 1950, there were only four schools in the Eastern Jebel, and these were in the towns. Since then, ten new schools have been built, and seven of these are in Tarhuna. They are all primary schools, open to children of over five years of age and also to adults. They consist of a senior and a junior class, and the average size of the schools is about one hundred in Tarhuna and two hundred in Cussabat. They are well distributed (fig. 2), and in Tarhuna the sons of nomadic parents may board at the schools. There is only one school for girls - in Cussabat town. At present, the schools can only accommodate 40% and 20% of the children of school age in Tarhuna and Cussabat respectively. Secondary schools are located only in the chief towns of districts in Tripolitania. There is one small secondary school in Tarhuna, but boys from Cussabat must board at Homs, Misurata or Tripoli.

Facilities for advanced or technical education are restricted to Tripoli and Bengazi, but a teachers' training college will be opened in Tarhuna in 1961.

(d). Health.

With two small dispensaries, one in each town, and only five doctors, medical facilities are desperately inadequate, especially when it is remembered that the poor living standards lead to endemic lack of resistance to disease. The sick either go without medical aid or are sent to the modern but overcrowded coastal hospitals. However, the dispensaries play an important role in preventive medicine, whilst a public health programme is being launched in Cussabat. The situation is worse still as far as veterinary medicine is concerned, as there are only two veterinary surgeons for the whole region.

Other services do not exist. This is owing to the poverty of the Libyan Government, the low literacy rate and the dispersion of the population, whose social organisation is introverted.

H. Conclusions.

The patterns of settlement have been profoundly influenced by the perpetuation of Roman arboriculture in Cussabat and its replacement by pastoralism in Tarhuna and the El Amamra. The

boundary between settlement and semi-nomadism is defined by economic activity, and has remained unchanged since the 13th century. This was due to the rigid social organisation manifest in tribalism, which has deeply influenced the structure of settlement in both semi-nomadic and sedentary areas.

In recent years, changes have taken place in the forms of economic activity because of Italian colonisation, population pressure on resources and emigration. In Cussabat, the boundary of arboriculture is extending and people are leaving the villages to settle on the newly cultivated land. Emigration has produced labour shortages and dependence on external sources of income. In Tarhuna, people are finding agriculture more profitable than pastoralism. These factors are weakening tribalism and releasing the population from the time-honoured forms of settlement; in Cussabat, population is dispersing; in Tarhuna, the tribesmen are becoming more sedentary.

Though these trends are clear, they are not reflected in the type and distribution of rural services. Urban population is extremely small and the functions of the towns limited. The towns cannot offer the rural population the type of employment they need to supplement their income. Therefore they must emigrate, and so aggravate the lack of equilibrium in size and functions between Tripoli and other Tripolitanian

towns. The Tripolitanian administration is encouraging changes in the forms of economic activity, but it seems to be unprepared for the accompanying changes in the form of settlement. It is doing nothing to encourage, direct or rationalise the emerging settlement patterns.

Plate 1. The Jebel Front.

Plate 2. The Wadi Taraglat in El Amamra.

Plate 3. The channel of the Wadi Gsea in El Amamra.

Plate 4. Northern edge of the dip slope near Sidi Essed.

Plate 5. Urginea maritima: the 'hedge' of the steppe.

Plate 6. Olives growing in dune-covered soil on a concession farm.

Plate 7. The Libyan plough: primitive but effective.

Figure 8. Harvesting the olive tree.

Plate 9. Terraced gardens in the Wadi Gherrim.

Plate 10. Excavation at the base of an olive tree.

Plate 11. An inundated olive tree after rainfall.

Plate 12. Terraced olives in the Wadi Gherrim.

Plate 13. Gmata: village expansion away from the ancient nucleus.

Plate 14. The Roman nucleus of Beni Let.

Plate 15. A street in Beni Let.

Plate 16. A street in Gmata.

Plate 17. A deserted house in Gmata.

Plate 18. A Marabout in Beni Let.

Plate 19. Uadna village among the olives in the Cussabat Plain.

Plate 20. Al Khadra.

Plate 21. The Cussabat Plain.

Plate 22. Recently reclaimed land in the Wadi Uaeni.

Plate 23. Partially cleared ginanat in the Wadi Gsea.

Plate 24. Swani near Gheleel.

Plate 25. The crowded ginanat.

Plate 26. An ancient olive tree in Cussabat.

Plate 27. The Rasli olive tree.

Plate 28. The Frantoio olive tree.

Plate 29. A carob tree in the Cussabat Plain.

Plate 30. Barbary sheep grazing the Asphodel Steppe in spring.

TARHUNA TRIBES

DISTRIBUTION AND BOUNDARIES

NEFFAT
JUNES
SHEMASHIA
ABADSA
AMAREEN
RAS EL AIN
CHREGI
AULAD BU ZED
URSHEFFANA
AMAREEN
HAMADAT SRET
HAMADAT LABETER
SHUBEEN
JUSEF
ARIASC
REGAGIA
SUALAH
DARAHIB
Milgha
Essed
Sidi
M. SIEDA
S'MUMAT
ZACADNA
SHUBEEN
AULAD ALI
ABANAT MIGGI
MEGAGRA
BURCAT IBADI
FERGIAN GRARAT
AULAD MAHAREFF
MARAGNAT RAS EL AIN
DUAIM GUASSAM
GRAGTA
MASABHA
ABANAT ABURA
SELMA
FOGGHIN
ARABEEN
ET TELLA
TERSCIAN
LOTEEN
AULAD TARHU
CUANIN
RAHAMIA
ABADLA
RAHAMIA
SIDI MAMAR
SHIAFAFTI
SM'MAT
AUASA
MSELLEM
HAMAMLA
Al Khadra
El Gsea
GUAN
FERGIAN REMETAT
NAHAGIA AULAD CHALAFA
CUANIN
GELAS
AUASA
HAMAMLA
AULAD HAMED
NAHAGIA GIABARNA
EL AZIB
NAHAGIA MUANA
FERGIAN TUAFGA
MAHADI KELEBAT
MAHADI SHEREDAT
AULAD MAHAREFF
ED DARAHIB
AULAD MAHAREFF
EL HAWATEM
AULAD MSELLEM

AA SUMMER PASTURE
AA TRIBE - CABILA
Aa ITALIAN & STATE LAND

N

Kilometres
0 4 8

JANB