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Homoclimes within the British Commonwealth

G. MELVYN HOWE

Department of Geography and Anthropology,

University College of Wales, Aberystwyth

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1. Introduction

It is well known that the geographical distribution of crop plants is such as to indicate that climatic and soil conditions are sufficiently similar in widely scattered areas for the successful culture of these plants. The occurrence of nearly identical types of vegetation in different continents testifies also to similarities in climatic and soil conditions. Even so the majority of the cultivated plants of the eastern and western hemispheres are represented by totally different genera and, until comparatively modern times, very few such plants were common to both hemispheres. Many of the cereal and legume crops cultivated in the Old World before the time of Columbus were quite unknown in America, and the reverse was equally true. The introduction of rubber into Southeast Asia from the Amazon region, *via* Kew, is the classic example of plant introduction but of equal importance is that of sugar cane from the East into the West Indies, potatoes from South America into Europe, cinchona from South America into Indonesia, groundnuts from Brazil into Africa and India and, in more recent years, soybeans from Manchuria into America, U.S.S.R. and parts of Europe. Australia is unique among the continents in that, except for native grasses and forest trees, all plants of economic importance, particularly crop plants and fruit trees, all the clovers, many grasses and a variety of weeds have been introduced—possibly by accident—from other continents.

The Second World War witnessed, and to a certain extent was the cause of, increased number of plant introductions. This was especially so in the case of America where numerous new plants were introduced in an attempt to overcome war-time shortage of various plant products. But it is in the necessity for the fuller utilization of under-developed and undeveloped agricultural areas of the world in the face of rapidly increasing population that plant introduction assumes its greatest importance.

Two general procedures have been used to determine the suitability of different regions for various kinds of crops. The first is an outgrowth of the trial-and-error method employed by early man in domesticating wild plants. At first, information about the requirements of plants under cultivation must have been accumulated very slowly. Nowadays the general requirements of most plants regarding optimum conditions of temperature, moisture, soils etc are known from tests undertaken at agricultural experimental stations and wise selection from a sufficiency of plant material then follows.

The second procedure has been the collection of environmental data, followed by their evaluation to determine the suitability of specific area for the introduction of a new species or variety. Several classifications have been made of such accumulated data but one of the major difficulties in deriving

such classifications is the problem of selection, from a wide variety of environmental factors, of those that exert the greatest influence upon the important plants. In spite of imperfections, however, these classifications are valuable in indicating general similarities of regions. They are not completely adequate for showing the suitability of a specific locality for a praticular kind of plant that is not grown in that locality at the present time. More detailed data must be included in the comparisons if the suitability potentials of local environments of one region are to be evaluated in reference to those of another region (Whyte, Nilson-Leissner and Trumble 1953). For this purpose a full agro-geographical appraisal is essential.

Meanwhile there still exists the need for a better quantitative definition of climate if progress is to be made in the general spheres of crop distribution, plant introduction, plant breeding, the ecology of vegetation and the physiology of growth and reproduction in relation to the environment. Schemes and criteria proposed by such workers as Köppen (1931) and Thornthwaite (1933) are not applicable except in a general way, while the agro-climatic analogues of Nuttonson (1947) do not provide the full data required in planning and carrying out plant exploration and introduction. On the other hand an empirical scheme devised by Thornthwaite (1948), incorporating many new concepts and basic principles, may well mark an important step forward in agro-climatology. Not that the new classification is in any way complete or adequate from the agricultural point of view but it seems to offer a more rational approach to a classification of climate for the agriculturist and is worthy of consideration.

The main index of the classification is a climatic potential derived from the thermal regime, namely, 'potential evapo-transpiration'. This new element is defined as "the amount of water which would transpire and evaporate from a surface completely covered with vegetation under conditions of sufficient water supply in the root zone of the soil". Thornthwaite has evolved a formula,

$$e = 1{\cdot}6 \left(\frac{10\,t}{I}\right)^{a}$$

which expresses potential evapo-transpiration as a function of mean monthly temperature and length of day. From this formula, in which e = potential evapo-transpiration, t= temperature in degrees Centigrade, I=the sum of 12 monthly values of $(Tm/5)^{1{\cdot}514}$ where Tm is the monthly mean temperature in degrees Centigrade, and a=function of I, it is possibble to obtain unadjusted values of potential evapo-transpiration, *i.e.*, for a month of 30 days, each with 12 hours of possible daylight. Once the value of unadjusted potential evapo-transpiration have been obtained, corrections, involving multiplication by a series of factors, are applied for the duration of the month and the length of the day.

Using the procedure outlined by Thornthwaite (1948) it is possible to work out a water balance-sheet from climatic data alone, showing at all times the soil moisture condition and providing values of moisture surplus and deficiency. In regions where the water deficiency is large with respect to the potential evapo-transpiration, (*i.e*, water need), the climate is dry; when water surplus is large with respect to the potential evapotranspiration, the climate is moist. Where there is a water surplus and no water deficiency the relation between water surplus and water need constitutes an index of humidity. Similarly, where there is a water deficiency and no surplus, the relation between water deficiency and water need constitutes an index of aridity.

Water surplus and deficiency occur at different seasons in most places. Consequently both are taken into account in a moisture index, the one affecting it positively, the other negatively. Comparing the humidity index with the aridity index, making due allowance for soil moisture storage and utilization, a moisture index is obtained. Moist

climates have positive values of the moisture index while dry climates have negative values. This index is the basis for the division of the world into moisture provinces. The divisions suggested by Thornthwaite are—

Moisture Province		Moisture Index
A	Perhumid	100 and above
B_4	Humid	80 to 100
B_3	Humid	60 to 80
B_2	Humid	40 to 60
B_1	Humid	20 to 40
C_2	Moist sub-humid	0 to 20
C_1	Dry sub-humid	—20 to 0
D	Semi-arid	—40 to —20
E	Arid	—60 to —40

The moist and dry climates are separated by the moisture index of zero.

A second index used to define climatic provinces is annual potential evapo-transpiration itself. Evapo-transpiration—the change in state of water from liquid to vapour —represents not only an important mass transfer from ground to atmosphere but it is also an important agency of energy transfer since considerable heat is used in evapo-transpiration which is transferred to the air with the vapour as latent heat. Evapo-transpiration is thus more than the reverse of rainfall, it also serves as a reverse flow to the incoming radiaton. Thus a single index provides a picture of two of the principal exchanges between earth and atmosphere.

The thermal provinces defined by Thornthwaite by means of potential evapo-transpiration or available energy are as follows—

Thermal Province		Annual Potential Evapo-Transpiration (inches)
A′	Megathermal	41·2 and over
B'_4	Mesothermal	39·5 to 41·2
B'_3	Mesothermal	33·8 to 39·5
B'_2	Mesothermal	28·2 to 33·8
B'_1	Mesothermal	22·5 to 28·2
C'_2	Microthermal	16·8 to 22·5
C'_1	Microthermal	11·2 to 16·8
D′	Tundra	5·6 to 11·2
E′	Frost	0 to 5·6

These are the principal elements of the Thornthwaite (1948) classification. In addition indices of seasonal variation of the moisture and thermal indices are included. To express the seasonal variation of the moisture effectiveness Thornthwaite takes into account the size of the index of aridity in the moist climates (A, B, C_2) and that of the index of humidity in the dry climates (C_1, D, E) according to the following values and characteristics—

Moist Climates (A, B, C_2)		Aridity Index
r	Little or no water deficiency	0 to 16·7
s	Moderate deficiency of water in summer	16·7 to 33·3
w	Moderate deficiency of water in winter	16·7 to 33·3
s_2	Large deficiency of water in summer	Over 33·3
w_2	Large deficiency of water in winter	Over 33·3
Dry Climates (C_1, D, E)		**Humidity Index**
d	Little or no water surplus	0 to 10
s	Moderate surplus of water in winter	10 to 20
w	Moderate surplus of water in summer	10 to 20
s_2	Large surplus of water in winter	Over 20
w_2	Large surplus of water in summer	Over 20

The summer concentration of thermal efficiency includes the following types and their corresponding percentages of concentration—

Summer Concentration Percentage	Summer Concentration Type
48·0	a′
51·9	b'_4
56·3	b'_3
61·6	b'_2
68·0	b'_1
76·3	c'_2
88·0	c'_1

The factors described—a moisture factor, a heat factor and the seasonal variations of the two—furnish a complete picture of a climate according to the Thornthwaite (1948) classification. The classification as such is a useful yardstick of soil moisture-vegetation relationships and expresses significant features of the climates of the various areas of which the meteorological stations are considered representative. For this reason climatological data for over 1500 stations within the British Commonwealth have been classified into 4-cypher groups according to the scheme. A selection of the climatic types is mapped (Figs. 1-17) and certain of the stations with the same classification formula, *i.e.*, 'climatic analogues' or 'homoclimes' (areas having similar climatic controls) are listed in Appendix 1. Since the classification incorporates an elaborate assessment of the moisture factor affecting the needs and the use of water by growing crops, and the element 'potential evapo-transpiration' correlates with the growth of cultivated plants, those localities listed in Appendix 1 having the same climatic classification are considered agro-climatic analogues, *i.e.*, localities which are sufficiently alike with respect to their major climatic characteristics affecting crop production, particularly during the growing period, to offer a fair chance for the success of new plant material transplanted from one area to its climatic counterpart.

2. Conclusions

The introduction of the concept of potential evapo-transpiration into the coding of the complex facts of climate marks a step forward in the progress of agro-climatology. Unfortunately Thornthwaite has based his formula on somewhat limited observational data and expressed potential evapo-transpiration in terms of air temperature alone. While this did not seem unreasonable when the formula was introduced in 1948 (the more so since air temperature was also the most readily accessible element), it is now generally agreed that radiation plays a far more important role than air temperature in promoting evapo-transpiration. Doubts have been cast on the validity of the concept of potential evapo-transpiration and also the equation used to compute this quality. These and other criticisms will be found in Brooks (1948), Leeper (1950), Garnier (1951), Gentilli (1953), Guerinni (1953), Crowe (1954, 1957) and Chang (1959).

The Thornthwaite classification is based on average values or intensities of the climatic data and thus omits consideration of the variability of climatic features. The variability factor is critical in many parts of the world and variability within and between seasons is of great significance to the agricultural utilization of any given area. Nevertheless to include a measure of this factor into any classification would make it too complex for general application.

Finally, cognizance should be taken of plant variability expressing itself eventually as a strain or variety. This may well negate purely climatic considerations since the many strains and varieties of plants tend to extend the geographical areas within which a species can be utilized.

The present paper aims at providing, for the first time, easy reference to areas in the Commonwealth considered climatically analogous according to the Thornthwaite (1948) scheme. It accords pointers in the direction of comparative ecology, agronomy and agriculture generally, but until further information and experience is gained with the intricacies of vegetation, soil, hydrological, climatic and ecological conditions in the various parts of the world, the climatic classifications given in Appendix 1 and mapped in Figs. 1—17 must be considered preliminary and subject to revision. Meanwhile it remains a challenging task for climatologists, agriculturists and geographers to formulate and perfect a quantitative climatic classification like Köppen's (1931) or Thornthwaite's that will successfully portray the sophisticated facts required for these respective sciences.

8. Acknowledgements

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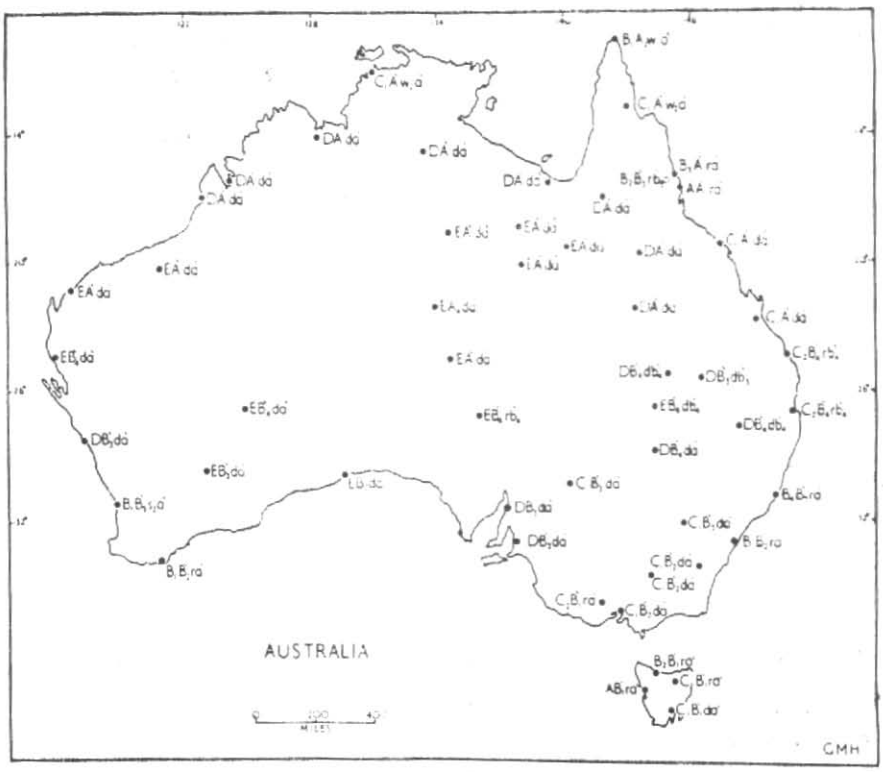
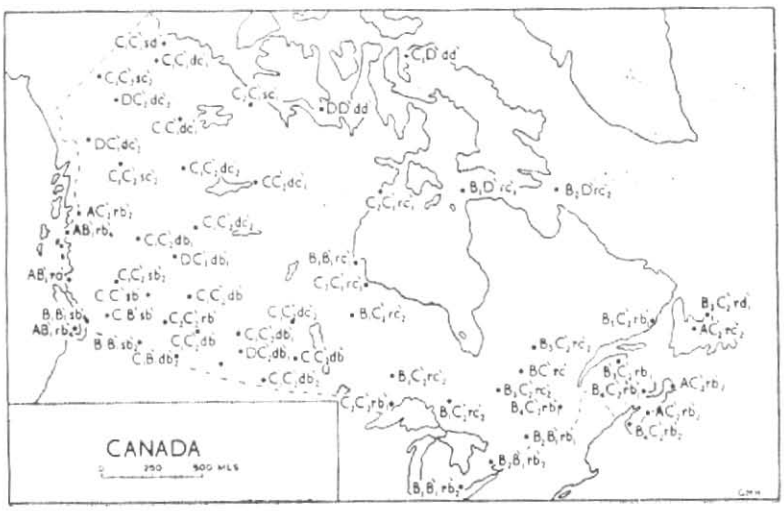


Fig. 1



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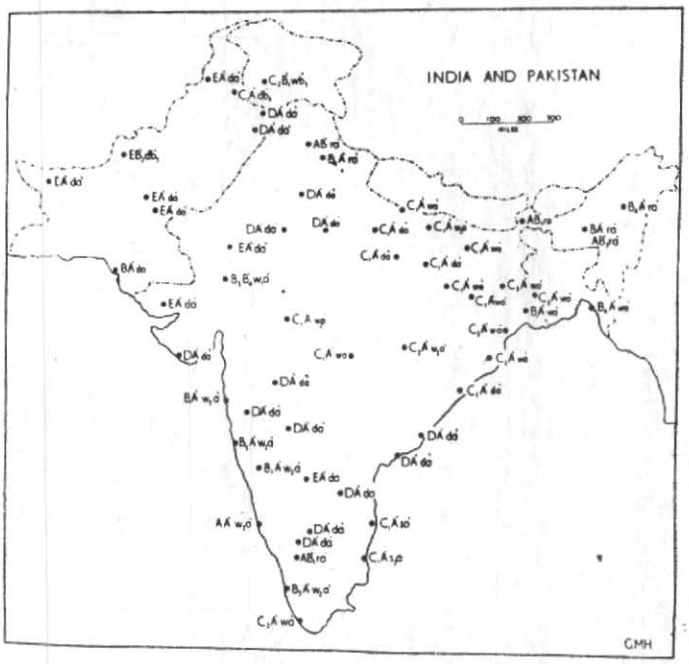
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miles
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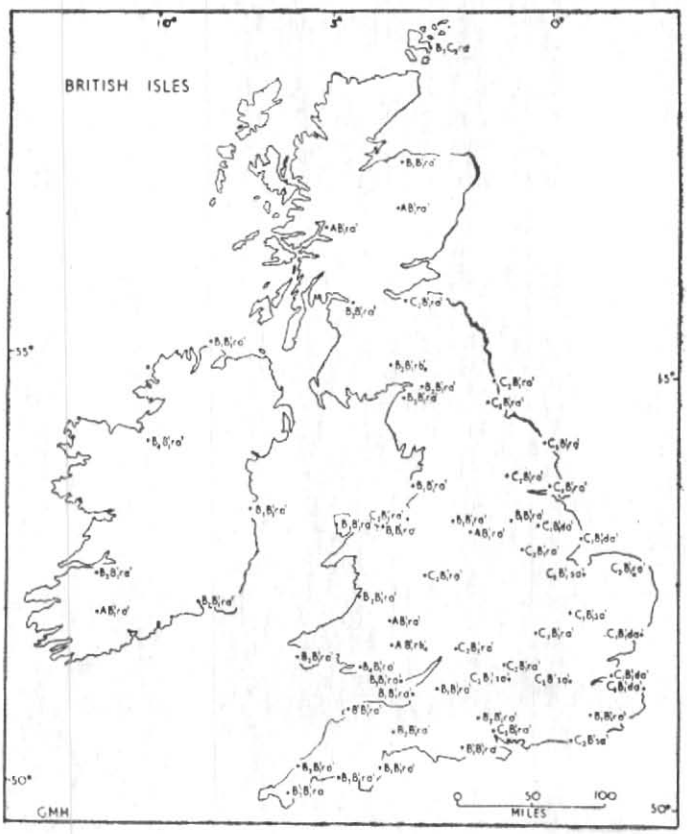
Fig. 3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10°
5°
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50°
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MILES
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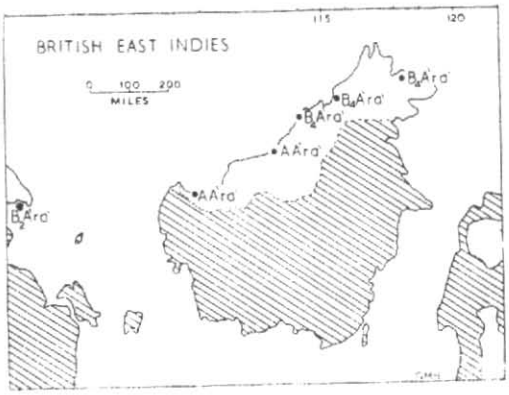
Fig. 4

Fig. 5

Fig. 6



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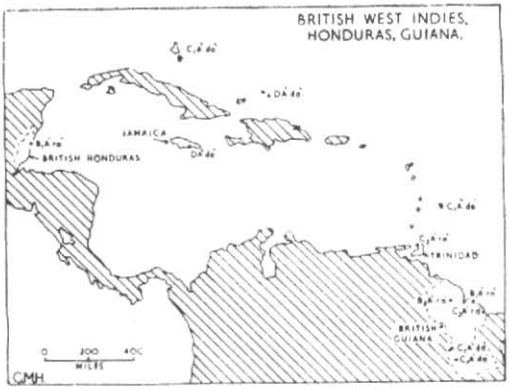

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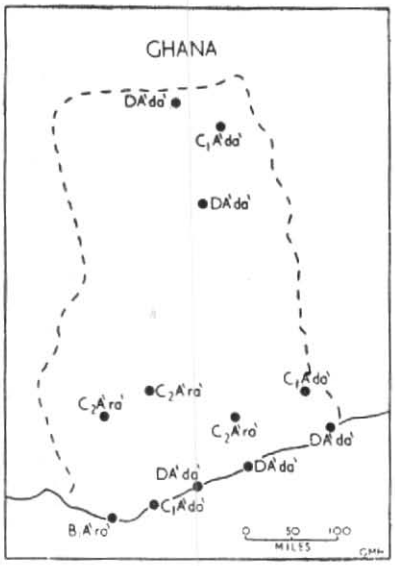

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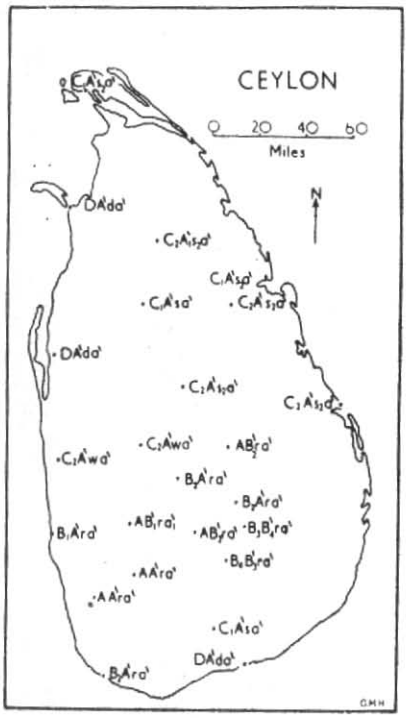
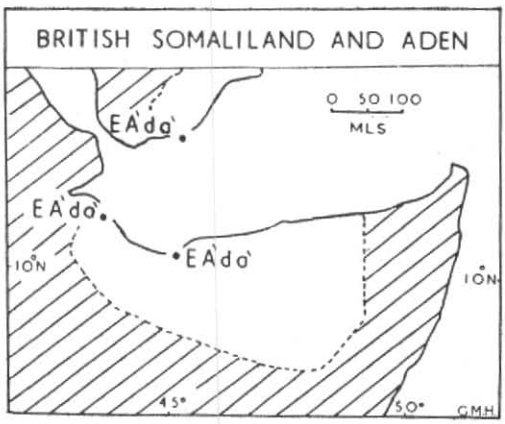


Fig. 10



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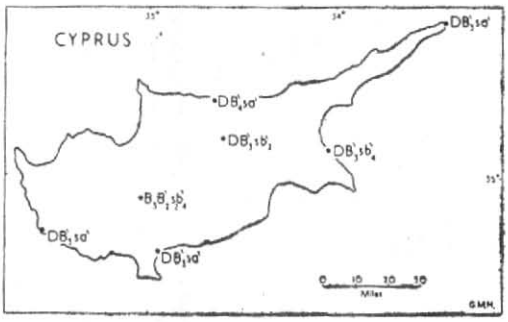


Fig. 12

Fig. 13

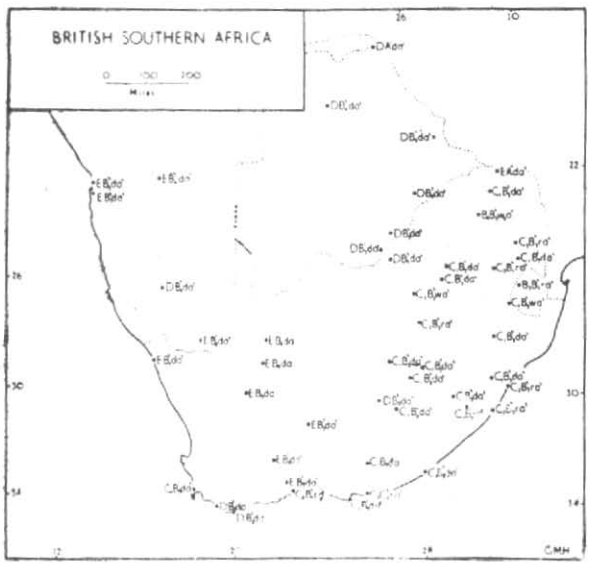
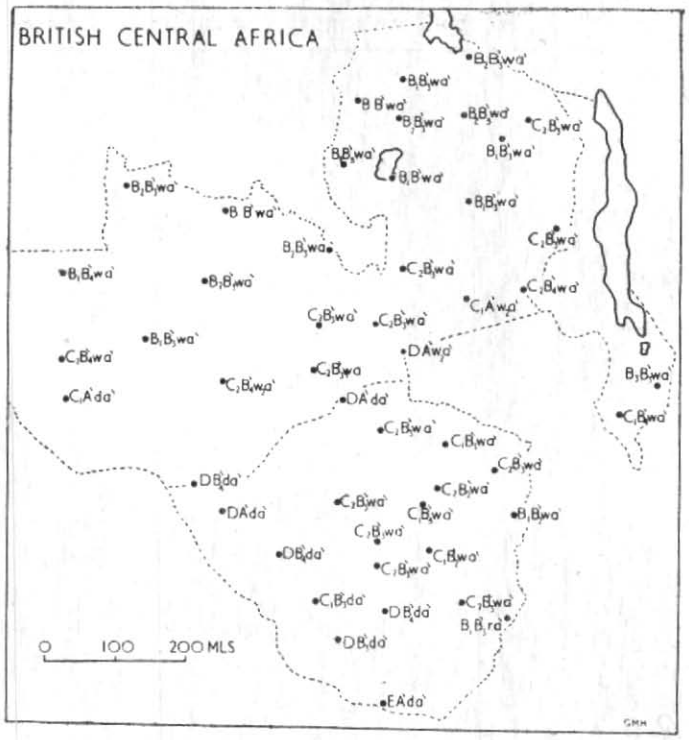


Fig. 14



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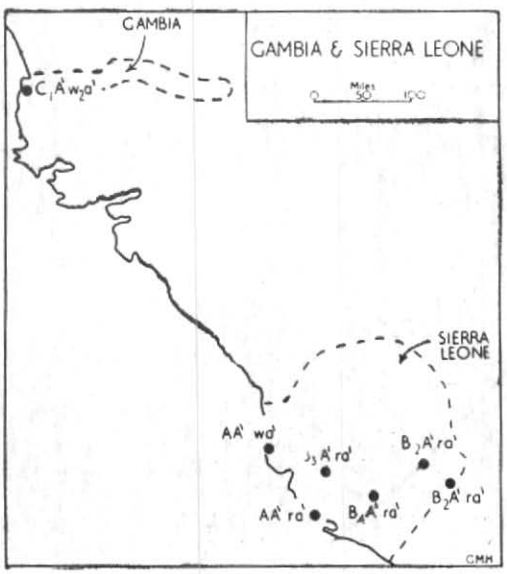

Fig. 16

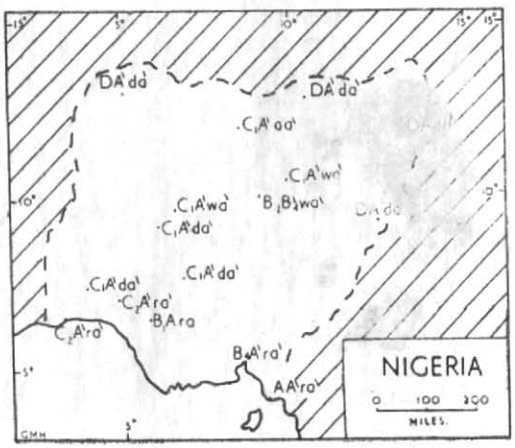

Fig. 17

APPENDIX 1

A selection of Homoclimes (Agro-Climatic analogues) within the British Commonwealth

'A' CLIMATES (PRE-HUMID)

Ar

Simla—India (B'_1 a')
Ootacamund—India (B'_1 a')
Port Blair—Andaman Is. (A' a')
Darjeeling—India (B'_1 a')
Kericho—Kenya (B'_2 a')
Bukoba—Tanganyika (B'_3 a')
Amani—Tanganyika (B'_3 a)
Waipoua—New Zealand (B'_1 a')
Karioi—New Zealand (B'_1 a')
Westport—New Zealand (B'_1 a')
Bonthe—S. Leone (A' a')
Victoria—Nigeria (A' a')
Tapah—Malaya (A' a')
Cameron Highlands—Malaya (A' a')
Maxwell's Hill—Malaya (A' a')
Penang Hill—Malaya (A' a')
Taiping—Malaya (A' a')
Frazer's Hill—Malaya (A' a')
Kuching—Sarawak (A' a')
Bintulu—Sarawak (A' a')
Waratah—Tasmania (B'_1 a')
Deloraine—Tasmania (B'_1 a')
Fort William—Scotland (B'_1 a')
Killarney—Eire (B'_1 a'_1)
Builth Wells—Wales (B'_1 a')
Agalwatta—Ceylon (A' a')
Ratnapura—Ceylon (A' a')
Nuara Elyia—Ceylon (B'_2 a')
Rangalla—Ceylon (B'_1 a')
Buxton—England (B'_1 a')
Clayoquot—Br. Columbia (B'_1 a')
Vancouver—Br. Columbia (B'_1 b'_4)
Prince Rupert—Br. Columbia (B'_1 b'_4)
Premier—Br. Columbia (C'_2 b'_2)
Natashkwan—Quebec (C'_2 C'_2)
Kedgewick—N. Brunswick (C'_2 b'_1)
Halifax—N. Scotia (B'_1 b'_2)
St. Johns—Newfoundland (C'_2 b'_2)
Crohamhurst—Australia (B'_3 b'_3)
Innisfail—Australia (A' a')

As

Cumberland—Br. Columbia (B'_1 b'_4)

Aw

Freetown—S. Leone (A' a')

As_2

Alberni—Br. Columbia (B'_1 b'_4)

Aw_2

Mangalore—India (A' a')

'B' CLIMATES (HUMID)—B_4

B_4r

Tauranga—New Zealand (B'_1a')
Wellington—New Zealand (B'_1 a')
Invercargill—New Zealand (B'_1 a')
Kapsabet—Kenya (B' a')
Calabar—Nigeria (A' a')
Pekan—Malaya (A' a')
Miri—Brunei (A' a')
Labuan—B.N. Borneo (A' a')
Chittagong—Pakistan (A' a')
Fernie—Br. Columbia (C'_2 b'_1)
Quebec—Quebec (C'_2 b'_1)
Frederikton—N. Bruns. (C'_2 b')
Hamilton—P. Ed. Is. (C'_2 b'_1)
Windsor—N. Scotland (C'_2 b'_2)
Howley—Newfoundland (C'_2 b'_1)
Bo—S. Leone (A' a')
Sandakan—B.N. Borneo (A' a')
Madeng—N. Guinea (A' a')
Cape Sorell—Tasmania (B'_1 a')
Markree Castle—Ireland (B'_1 a')
Diyatalawa—Ceylon (B'_3 a')
Cardwell—Australia (A' a')
Hong Kong (A' a')
Port Macquarie—Australia (B'_3 a')

B_4s

Shawnigan Lake—Br. Columbia (B'_1 b'_4)

B_4w

None

B_4s_2

None

B_4w_2

None

'B' CLIMATES (HUMID)—B_3

B_3r

Auckland—New Zealand (B'_2 a')
Onawe—New Zealand (B'_1 a')
Gisborne—New Zealand (B'_1 a')
Subukia—Kenya (B'_2 a')
Fort Ross—N.W. Territ. (D' d')
Montreal—Quebec (B'_1 b'_1)
Harrington Hbr.—Quebec (C'_2 b'_1)
Woodstock—N. Bruns. (C'_2 b'_1)
Kentville—N. Scotland (C'_2 b'_2)
Fogo—Newfoundland (C'_2 b'_1)

APPENDIX 1 (*contd*)

London—Ontario ($B'_1\ b'_2$)
Cardiff—Wales ($B'_1\ a'$)
Badulla—Ceylon ($B'_4\ a'$)
Mazaruni—B. Guinea ($A'\ a'$)
Moyamna—S. Leone ($A'\ a'$)
Dungun Highlands—Malaya ($A'\ a'$)
Kuala Krai—Malaya ($A'\ a'$)
Deerness—Scotland ($C_2\ a'$)
Paisley—Scotland ($B'_1\ a'$)
Foynes—Ireland ($B'_1\ a'$)
Cairns—Australia ($A'\ a'$)
Cape Moretown—Australia ($B'_3 b'_3$)
Mazaruni—Br. Guiana ($A'\ a'$)

B_3s

Salt Spring Is.—Br. Columbia ($B'_1\ b'_4$)
White Rock—Br. Columbia ($B'_1\ b'_4$)
Port Harrison—Quebec ($C'_1\ C'_1$)

B_3w

Zomba—Nyasaland ($B'_3\ a'$)

$B_3\ s_2$

Pemberton Meadows—Br. Columbia ($B'_1\ b'_2$)
Amiandos—Cyprus ($B'_2\ b'_4$)

$B_3\ w_2$

None

'B' CLIMATES (HUMID)—B_2

B_2r

Albanel—Quebec ($C'_2\ C'_2$)
Manousam—Quebec ($C'_2\ b'_1$)
Sorel—Quebec ($B'_1\ b'_1$)
Chelsea Falls—Quebec ($B'_2\ b'_1$)
Entebbe—Uganda ($B'_4\ a'$)
Njoro—Kenya ($B'_2\ a'$)
Dunedin—New Zealand ($B'_1\ a'$)
Masterton—New Zealand ($B'_1\ a'$)
Tengema—S. Leone ($A'\ a'$)
Daru—S. Leone ($A'\ a'$)
Jos—Nigeria ($B'_4\ a'$)
Johore Bharu—Malaya ($A'\ a'$)
Telok—Malaya ($A'\ a'$)
Singapore—Malaya ($A'\ a'$)
Kota Bharu—Malaya ($A'\ a'$)
Burnie—Tasmania ($B'_1\ a'$)
Deloraine—Tasmania ($B'_1\ a'$)
Dumfries—Scotland ($B'_1\ b'_4$)
Waterford—Ireland ($B'_1\ a'$)
Salisbury—England ($B'_1\ a'$)
Aberystwyth—Wales ($B'_1\ a'$)
Kandy—Ceylon ($A'\ a'$)
Minipe—Ceylon ($A'\ a'$)
Galle—Ceylon ($A'\ a'$)
Atherton—Anstralia ($B'_3\ b'_3$)
Port Douglas—Australia ($A'\ a'$)

B_2s

Duncan—Br. Columbia ($B'_1\ b'_4$)
Vanada—Br. Columbia ($B'_1\ b'_4$)
L. Louise—Alberta ($C'_2\ c'_2$)

B_2w

Abercorn—N. Rhodesia ($B'_3\ a'$)
Kasama—N. Rhodesia ($B'_3\ a'$)
Ndola—N. Rhodesia ($B'_3\ a'$)

$B_2\ s_2$

None

$B_2\ w_2$

None

'B' CLIMATES (HUMID)—B_1

B_1r

Wanganui—New Zealand ($B'_1\ a'$)
Nelson—New Zealand ($B'\ a'$)
Queenstown—New Zealand ($B'_1\ a'$)
Hastings—New Zealand ($B'_1\ a'$)
Ashburton—New Zealand ($B'_1\ a'$)
Lushoto—Tanganyika ($B'_2\ a'$)
Mubende—Uganda ($B'_3\ a'$)
Tororo—Uganda ($B'_4\ a'$)
Kabale—Uganda ($B'_2\ a'$)
Kitale—Kenya ($B'_3\ a'$)
Eldoret—Kenya ($B'_2\ a'$)
Arusha—Tanganyika ($B'_3\ a'$)
Arua—Uganda ($A'\ a'$)
Gulu—Uganda ($A'\ a'$)
Wete—Pemba Is. ($A'\ a'$)
Kizimbani—Zanzibar ($A'\ a'$)
Gauhati—India ($A'\ a'$)
Karachi—Pakistan ($A'\ a'$)
Belize—Br. Honduras ($A'\ a'$)
Georgetown—Br. Guiana ($A'\ a'$)
Axim—Ghana ($A'\ a'$)
Benin City—Nigeria ($A'\ a'$)
Port Dickson—Malaya ($A'\ a'$)
Malacca Town—Malaya ($A'\ a'$)
Kuala Lumpur—Malaya ($A'\ a'$)
Currie—Tasmania ($B'_1\ a'$)
Stanley—Tasmania ($B'_1\ a'$)
St. Helens—Tasmania ($B'_1\ a'$)
Gordon Castle—Scotland ($B'_1\ a'$)
Malin Head—Ireland ($B'_1\ a'$)
Dublin—Ireland ($B'_1\ a'$)
Chipinga—S. Rhodesia ($B'_3\ a'$)

APPENDIX 1 (*contd*)

Sheffield—England (B'_1 a')
Torquay—England (B'_1 a')
Bath—England (B'_1 a')
Holyhead—Wales (B'_1 a')
Blackpool—England (B'_1 a')
Colombo—Ceylon (A' a')
Sydney—Australia (B'_2 a')

B_1s

Sao Hill—Tanganyika (B'_2 a')
Mbeya—Tanganyika (B'_2 a')

B_1w

Sao Hill—Tanganyika (B'_2 a')
Mbeya—Tanganyika (B'_2 a')
Calcutta—India (A' a')
Inynga—S. Rhodesia (B'_2 a')
Chilubi—N. Rhodesia (B'_4 a')
Cooktown—Australia (A' a')
Herberton—Australia (B'_3 b'_3)

B_1s_2

Trikoukkia—Cyprus (B'_2 b'_3)
Perth—Australia (B'_3 a')

B_1w_2

Songea—Tanganyika (B'_3 a')
Bombay—India (A' a')
Maka—N. Rhodesia (B'_3 a')
Cape York—Australia (A' a')

'C' CLIMATES (SUB-HUMID)—C_2

C_2r

Balmoral—New Zealand (B'_1 a')
Christchurch—New Zealand (B'_1 a')
Fairlie—New Zealand (B'_1 a')
Tekapo—New Zealand (B'_1 a')
Napier—New Zealand (B'_2 a')
New Amsterdam—Br. Guiana (A' a')
Kumasi—Ghana (A' a')
Bibianai—Ghana (A' a')
Tafo—Ghana (A' a')
Ondo—Nigeria (A' a')
Lagos—Nigeria (A' a')
Kuala Sehangor—Malaya (A' a')
Kuala Kangsar—Malaya (A' a')
Kangor—Malaya (A' a')
Temerloh—Malaya (A' a')
Fanning Island (A' a')
Ocean Island (A' a')
Nauru (A' a')
Eddystone Pt.—Tasmania (B'_1 a')
Launceston—Tasmania (B'_1 a')
Edinburgh—Scotland (B'_1 a')
Brisbane—Australia (B'_4 b'_4)
Toowomba—Australia (B'_2 b'_2)
Mackay—Australia (A' a')
Port of Spain—Trinidad (A' a')
Port Elizabeth—S. Africa (B'_2 a')
Pietersburg—S. Africa (B'_2 a')
Potchefstroom—S. Africa (B'_2 a')
Durban—S. Africa (B'_3 a')
Port Shepstone—S. Africa (B'_3 a')

C_2s

Kitui—Kenya (B'_3 a')
Kitgum—Uganda (A' a')
Soroti—Uganda (A' a')
Victoria Gardens—Zanzibar (A' a')
Hereford—England (B'_1 a')
Greenwich—England (B'_1 a')
Brighton—England (B'_1 a')

C_2w

Srinagar—Kashmir (B'_1 b'_2)
Cuttack—India (A' a')
Trivandrum—India (A' a')
Kitui—Kenya (B'_3 a')
Kitgum—Uganda (A' a')
Victoria Gardens—Zanzibar (A' a')
Mtoko—S. Rhodesia (B'_3 a')
Que-Que—S. Rhodesia (B'_3 a')
Salisbury—S. Rhodesia (B'_2 a')
Sipolilo—S. Rhodesia (B'_3 a')
Lunawila—Ceylon (A' a')
Kurunegala—Ceylon (A' a')

C_2s_2

Dambulla—Ceylon (A' a')
Vavunyia—Ceylon (A' a')
Batticaloa—Ceylon (A' a')

APPENDIX 1 (*contd*)

$C_2 w_2$

Broken Hill—N. Rhodesia (B'_3 a')
Fort Jameson—N. Rhodesia (B'_4 a')
Kusaka—N. Rhodesia (B'_3 a')
Mongu—N. Rhodesia (B'_4 a')
Miami—S. Rhodesia (B'_3 a')

'C' CLIMATES (SUB-HUMID)—C_1

$C_1 d$

Blenheim—New Zealand (B'_1 a')
Timaru—New Zealand (B'_1 a')
Waipiata—New Zealand (B'_1 a')
Rumuruti—Kenya (B'_2 a')
Maralal—Kenya (B'_3 a')
Nanyuki—Kenya (B'_2 a')
Naivasha—Kenya (B'_2 a')
Shinyanga—Tanganyika (A' a')
Kandoc—Tanganyika (B'_4 a')
Morogoro—Tanganyika (A' a')
Mbarara—Uganda (B'_3 a')
Marsabit—Kenya (B'_3 a')
Thika—Kenya (B'_3 a')
Allahabad—India (A' a')
Lucknow—India (A' a')
Dadanawa—Br. Guiana (A' a')
Eupukari—Br. Guiana (A' a')
Bathurst—Gambia (A' a')
Gambaga—Ghana (A' a')
Ho—Ghana (A' a')
Takoradi—Ghana (A' a')
Kano—Nigeria (A' a')
Bauchi—Nigeria (A' a')
Minna—Nigeria (A' a')
Ibadan—Nigeria (A' a')
New Province—Bahamas (A' a')
Oatlands—Tasmania (B'_1 a')
Hobart—Tasmania (B'_1 a')
Enkeldoorn—S. Rhodesia (B'_2 a')
Gatooma—S. Rhodesia (B'_3 a')
Bulawayo—S. Rhodesia (B'_3 a')
Chileke—Nyasaland (B'_4 a')
Shoeburyness—England (B'_1 a')
Lincoln—England (B'_1 a')
Mt. Surprise—Australia (A' a')
Ayr—Australia (A' a')
Bowen—Australia (A' a')
Broken Hill—Australia (B'_2 a')
Canberra—Australia (B'_2 a')
Melbourne—Australia (B'_2 a')
Bridgetown—Barbados (A' a')
Cape Town—S. Africa (B'_3 a')
East London—S. Africa (B'_3 a')
Pietermaritzburg—S. Africa (B'_2 a')
Bloemfontein—S. Africa (B'_2 a')
Johannesburg—S. Africa (B'_2 a')
Adelaide—Australia (B'_2 a')

$C_1 s$

Chukwani—Zanzibar (A' a')
Madras—India (A' a')
Cambridge—England (B'_1 a')

$C_1 w$

Chukwani—Zanzibar (A' a')
Patna—India (A' a')
Nagpur—India (A' a')
Normanton—Australia (A' a')
Rockhampton—Asutralia (A' a')

$C_1 s_2$

Trincomalee—Ceylon (A' a')
Jaffna—Ceylon (A' a')
Anuradhapura—Ceylon (A' a')
Halfeka—Cyprus (B'_3 b'_4)

$C_1 w_2$

Darwin—Australia (A' a')

'D' CIMATES (SEMI-ARID)

Dd

Agra—India (A' a')
Delhi—India (A' a')
Lahore—Pakistan (A' a')
Veraval—India (A' a')
Bangalore—India (A' a')
Cuddapah—India (A' a')
Poona—India (A' a')
Peshawar—Pakistan (A' a')
Navrongo—Ghana (A' a')
Tamale—Ghana (A' a')

APPENDIX 1 *(contd)*

Keta—Ghana (A′ a′)
Accra—Ghana (A′ a′)
Sokoto—Nigeria (A′ a′)
Nguru—Nigeria (A′ a′)
Maiduguri—Nigeria (A′ a′)
Yola—Nigeria (A′ a′)
Bethanie—S.W. Africa (B'_4 a′)
Lobatsi—Bechuanaland (B'_3 a′)
Gaberones—Bechuanaland (B'_3 a′)
Mahalapie—Bechuanaland (B'_4 a′)
Francistown—Bechuanaland (B'_3 a′)
Maun—Bechuanaland (B'_4 a′)
Kasane—Bechuanaland (A′ a′)
Valetta—Malta (B'_2 a′)
Grand Turk—Bahamas (A′ a′)
Chirunda—S. Rhodesia (A′ a′)
Gwaai—S. Rhodesia (B'_4 a′)
Gwanda—S. Rhodesia (B'_3 a′)
Kezi—S. Rhodesia (B'_3 a′)
Shabani—S. Rhodesia (B'_4 a′)
Wankie—S. Rhodesia (A′ a′)
Livingstone—N. Rhodesia (B'_4 a′)
Hambantota—Ceylon (A′ a′)
Puttaham—Ceylon (A′ a′)
Manar—Ceylon (A′ a′)
Morphou—Cyprus (B'_3 a′)
Alexandra—New Zealand (B'_1 a′)
Charters Towers—Australia (A′ a′)
Charleville—Australia (B'_4 b'_4)
Kingston—Jamaica (A′ a′)
Geraldton—Australia (B'_3 a′)
Broome—Australia (A′ a′)
Wyndham—Australia (A′ a′)
Croydon—Australia (A′ a′)
Cape L'Agulhas—S. Africa (B'_2 a′)
Bethulie—S. Africa (B'_2 a′)
Zeerust—S. Africa (B'_3 a′)
Mahalapye—S. Africa (B'_4 a′)

Ds

Nicosia—Cyprus (B'_3 b'_2)
Kyrenia—Cyprus (B'_4 a′)
Famagusta—Cyprus (B'_3 b'_4)
Lanarca—Cyprus (B'_3 b'_4)
Limassol—Cyprus (B'_3 a′)

Dw

None

Ds_2

Saittas—Cyprus (B'_3 b'_4)

Dw_2

None

'E' CLIMATES (ARID)

Ed

Lodwar—Kenya (A′ a′)
Mandera—Kenya (A′ a′)
Wajir—Kenya (A′ a′)
Garissa—Kenya (A′ a′)
Magadi—Kenya (A′ a′)
Peshawar—Pakistan (A′ a′)
Jodhpur—India (A′ a′)
Beitbridge—S. Rhodesia (A′ a′)
Windhoek—S. W. Africa (B'_4 a′)
Swakopmund—S. W. Africa (B'_3 a′)
Walvis Bay—S. W. Africa (B'_3 a′)
Berbera—Br. Somaliland (A′ a′)
Selia—Br. Somaliland (A′ a′)
Aden—Aden (A′ a′)
Camooweal—Australia (A′ a′)
Winton—Australia (A′ a′)
Onslow—Australia (A′ a′)
Eucla—Australia (B'_2 a′)
Coolgardie—Australia (B'_3 a′)
Cloncurry—Australia (A′ a′)
Alice Springs—Australia (B'_4 a′)
Upington—S. Africa (B'_4 a′)
Oudtshoorn—S. Africa (B'_3 a′)
Frazerburg—S. Africa (B'_2 a′)
Port Nolloth—S. Africa (B'_4 a′)

Es

None

Ew

None

Es_2

None

Ew_2

None