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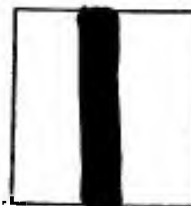
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TECHNICAL REPORT

EP-113

Canal Zone Analogs VIII

**ANALOGS OF CANAL ZONE CLIMATE
IN AUSTRALIA AND NEW GUINEA**



**QUARTERMASTER RESEARCH & ENGINEERING CENTER
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Natick, Massachusetts

ENVIRONMENTAL PROTECTION RESEARCH DIVISION

Technical Report
EP-113

Canal Zone Analogs VIII

ANALOGS OF CANAL ZONE CLIMATE IN AUSTRALIA AND NEW GUINEA

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ORIGINAL CONTAINS COLOR PLATES: ALL DDC
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FOREWORD

A successful research, development, or training program requires a knowledge of the degree of environmental representativeness of test sites and training areas. The Quartermaster Corps, at the request of the Corps of Engineers, Waterways Experiment Station, under a directive from the U.S. Army General Staff, is developing a generalized, comparative, climatic picture of the wet tropics throughout the world by a series of tropical analog studies. The series parallels two series already completed, comparing Yuma, Arizona, with the various desert regions of the Northern Hemisphere, and Fort Greely, Alaska, and Fort Churchill, Canada, with the subarctic regions of North America and Eurasia.

This is the eighth report of the tropical series. It compares the Canal Zone climate with that of Australia and New Guinea, and by so doing provides a climatic reference for military planners and test personnel.

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ABSTRACT

The climate of Australia and New Guinea is compared with that of two locations in the Canal Zone: Balboa Heights, representing the drier, leeward, Pacific side of the Isthmus of Panama, and Cristobal, representing the wetter, windward, Atlantic side. Areas of analogy of pertinent climatic elements and combinations of these elements are shown on maps.

Areas of complete climatic analogy to each Canal Zone station are found in certain portions of the lowlands of New Guinea. Climates in Australia are not analogous with either Canal Zone station but some climatic elements, such as mean temperature of the warmest month, are comparable. Areas below 2,000 feet in elevation either have analogy with Balboa Heights or Cristobal, or have wetter or hotter climates than these stations. Most of New Britain and the southern interior lowlands of New Guinea from the Gulf of Papua to the Arafura Sea, are high rainfall areas, usually receiving over 200 inches per year; this is much more than either Canal Zone station and therefore not analogous. The mountainous areas in New Guinea and in the neighboring islands are too cool for analogy with either Canal Zone station. Although there is scanty coverage of data for mean windspeed, mean cloudiness, and mean relative humidity for most of the area, stations which show analogy for temperature and precipitation criteria usually show at least local analogy for the other, less widely observed elements.

ANALOGS OF CANAL ZONE CLIMATE IN AUSTRALIA AND NEW GUINEA

1. Purpose and scope

This report is the eighth of a series comparing the climate of tropical regions with that of Cristobal and Balboa Heights, Canal Zone. These two stations were selected to represent the climates of the Atlantic and Pacific portions of the Canal Zone, respectively. The environment of Cristobal is described in a previous report (Wiley and others, 1955).

No attempt has been made to provide a regional climatology of Australia and New Guinea. Instead, the method has been to select certain climatic elements that are considered particularly significant and, for each of these, to map the areas within the region considered closely analogous to either Balboa Heights or Cristobal. Some of the information presented on these maps of single climatic elements has been consolidated into two composite maps, one for each of the two Canal Zone stations, showing areas where there is a coincidence of analogy for several climatic elements.

2. Delimitation and geography of Australia and New Guinea

The area covered by this report includes Queensland, Northern Territory, and part of Western Australia; New Guinea and neighboring islands; the Bismarck Archipelago; the Solomon Islands; and New Caledonia.

a. Topography

The continent of Australia is a large, compact, land mass without great local relief in most parts except for a low mountain range parallel to the eastern coastline. There are four physiographic regions in Australia that have wet-tropical climatic elements, and are, therefore, compared with the Canal Zone. These regions are: the Eastern Coastal Plain, Great Dividing Range, the Cape York Peninsula and the Great Artesian Basin (Fig. 2).

The Eastern Coastal Plain is only a narrow beach in many places, but in other places it is from 25 to 50 miles wide. This region extends from Cape York Peninsula to southern Australia. It receives heavy rainfall because of its location near the windward slope of the highlands. One outstanding physiographic feature of coastal Australia is the series of coral reefs that lie about 30 miles offshore and extend northward from latitude 24° S.

The Great Dividing Range, like the Eastern Coastal Plain, extends from Cape York Peninsula into southern Australia. Although the relief is

great in some areas, most of the region is characterized by low hills and plateaus. These coastal mountains are a barrier to the Southeast Trade Winds, and great amounts of precipitation fall on the steep eastern slopes. Just south of Cairns, on a tableland rising abruptly from the ocean, is the highest point in Queensland, Mount Bartle Fiere, 5,438 feet. The continental divide between the Coral Sea and the Gulf of Carpentaria is only 20 miles from the east coast at this point.

The Cape York Peninsula is the northernmost region of the continent and is a northern continuation of the Eastern Coastal Plain and the Great Dividing Range. The maritime influences of the Coral Sea and Gulf of Carpentaria and the nearness to the Equator give this region the most tropical environment in Australia. It is influenced by both summer and winter monsoons. Several large rivers, including the Archer, Holroyd, Coleman, and Mitchell, drain the eastern highlands of the peninsula, an area of heavy precipitation.

The Great Artesian Basin, the largest region of this study area, lies between the Great Dividing Range to the east and the deserts and tablelands to the west. This is the largest known artesian basin in the world, approximately 640,000 square miles. It is an area of rolling plains, most of which lie below 500 feet; only a few elevations are over 1,000 feet. The rivers are intermittent, but are quite wide after heavy rains in the wet season.

The other seven physiographic regions in northern Australia: the Kimberleys, Darwinia, Barkly Tableland, Great Sandy Desert, Great Victoria Desert, MacDonnell Range, and the Simpson Desert (Fig. 2), have very few wet-tropical elements. The Kimberleys, Darwinia, and Barkly Tableland regions emerge from the coastal and interior deserts to form hilly and rough terrain in the interior, rising to 2,800 feet at Mount Hann. The three great deserts of Western Australia: the Great Sandy Desert, Great Victoria Desert, and the Simpson Desert, consist of unusually level, stony or sandy surfaces broken only by isolated ranges of hills and the MacDonnell Range.

New Guinea and most of the other islands in this study area are volcanic, and have highland interiors, surrounded by coastal lowlands. The windward slopes of these interior highlands are rainy, and the lee slopes are relatively dry. In general, the drier lee slopes have higher temperatures. There are ten physiographic regions delineated in New Guinea. They are: the Southern Lowland, Vogel Kop, Bomderai, Northern Lowland, Intermontane Lowland, Central New Guinea Plateau, Bismarck Range, Owen Stanley Range, Cromwell Mountains, and the Northern Coastal Ranges.

The Southern Lowland covers approximately one-third of New Guinea. It is made up of a vast swampy area drained by the Fly, Digoel, Eilanden,

and other lesser rivers, and a southeastward extension along the coast. Local relief is small and the climate fairly uniform throughout the area.

The Vogel Kop and Bomderai are the arms of a double peninsula in northwestern New Guinea; their southern and western coasts are a continuation of the Southern Lowland. A plateau of over 3,000 feet elevation in the northern peninsula terminates in steep rocky headlands on the northern coast. Also in the north is the Northern Lowland, a rainy, narrow, swampy, coastal plain 30 to 40 miles wide.

The Intermontane Lowland begins in western New Guinea in the basin of the Mamberamo and Idenburg Rivers and extends almost without interruption to the northeast and southeast coasts. The elevation is less than 3,000 feet, and the drainage is so poor that during the wet season (December through April) lakes form between the Central Plateau and the Northern Coastal Ranges.

The Central New Guinea Plateau extends in a northwest-southeast direction nearly the entire length of New Guinea. The highest summits are over 15,000 feet: e.g., Juliana Gebergte, 15,420 feet; Wilhelmina Top, 15,584 feet; and Carstensch Toppen, 16,404 feet. In the west, the region, which is 75 to 100 miles wide, has many elevations above 9,000 feet; in the east, elevations generally range from 5,000 to 7,000 feet. All of the areas in this plateau above 7,000 feet are too cool to be analogous to the Canal Zone stations. The plateau terminates at the precipitous face of the Bismarck mountains in the south; in the north the descent is gradual and is interrupted by outlying ranges and piedments.

The Bismarck and Owen Stanley Ranges in the southeastern portion of the Central New Guinea Plateau are 3,000 to 9,000 feet high and have great local variations in climate and terrain. These mountains are the main feature of the narrow terminal peninsula of New Guinea. The highest elevation in the Owen Stanley Range is Mount Victoria, 13,363 feet. This range extends to the Coral Sea at the southeastern tip of the island. The Cromwell Mountains, eastern outliers of the Central Plateau, are surrounded by lowlands. Mount Salawaket, 13,454 feet, is the highest point, but most of the range is only slightly above 5,000 feet. Like the other areas above 7,000 feet elevation, the highest of these mountains are too cool to be analogous to the Canal Zone stations.

The Northern Coastal Ranges are highly dissected ridges paralleling the Central Plateau and the north coast of New Guinea. Peak elevations, varying between 4,000 and 7,000 feet, frequently are in clouds from December through April.

The Bismarck Archipelago, Solomon Islands, and New Caledonia are volcanic, and have highland interiors surrounded by narrow coastal lowlands.

The windward slopes of these interior highlands are rainy, and the lee slopes are relatively dry with higher temperatures.

b. Major climatic controls

The Australian and Asian Monsoons and the Southeast Trade Winds assert the greatest influences on the climate of the study area. In the Southern Hemisphere summer (December, January, and February) winds blow from the Asian high pressure system toward the Australian low pressure system, resulting in northwesterly or westerly winds over New Guinea and northern Australia. In the Southern Hemisphere winter (June, July, and August) the pressure systems are reversed, and the winds are southerly and southeasterly; the prevailing Southeast Trades in the Coral Sea are intensified during this season.

In Australia precipitation is seasonal due to the dry interior over which the winds travel in the winter, whereas in New Guinea and many of the lesser islands the rainy season is almost continuous throughout the year. Near the Equator, as in the Canal Zone, most of the annual rain occurs in the form of convectional thunderstorms during the summer season.

In Australia humid conditions decrease inland from the sea; even the low mountains are climatic divides. Most of the area west of the Great Dividing Range receives less than 10 inches of precipitation. Humid air penetrates to the interior only occasionally in the summer. Cloudiness, likewise, decreases inland from the coasts; on the average day in interior Australia less than 4 tenths of the sky is cloud covered. There is usually an increase in cloudiness in summer in the north and in winter in the south.

The lowlands of New Guinea and neighboring island groups exposed to the monsoons are cloudy, rainy, hot, and humid, while most of the highlands above 7,000 feet are cool and relatively dry. Also, the lee slopes below 7,000 feet in the island highlands may be relatively dry.

3. Climatic summary of the Canal Zone

The Pacific portion of the Canal Zone, represented by Balboa Heights, has a moderately humid tropical climate with a 4-month dry season (Fig. 1). The difference in mean monthly temperatures of the warmest and coldest months is only 2 F°, and the range from the highest mean daily maximum (March and April, 90° F) to the lowest mean daily minimum (February, 71° F) is only 19 F°. Precipitation, averaging 70 inches annually, is markedly seasonal. Two months, February and March, have less than 1 inch of rainfall, and five months have more than 8 inches. The dry season begins in December and ends in April. Rainfall in each of the remaining months is more than 7 inches; October and November both have more than 10 inches.

CRISTOBAL
(ATLANTIC SIDE)

BALBOA HEIGHTS
(PACIFIC SIDE)

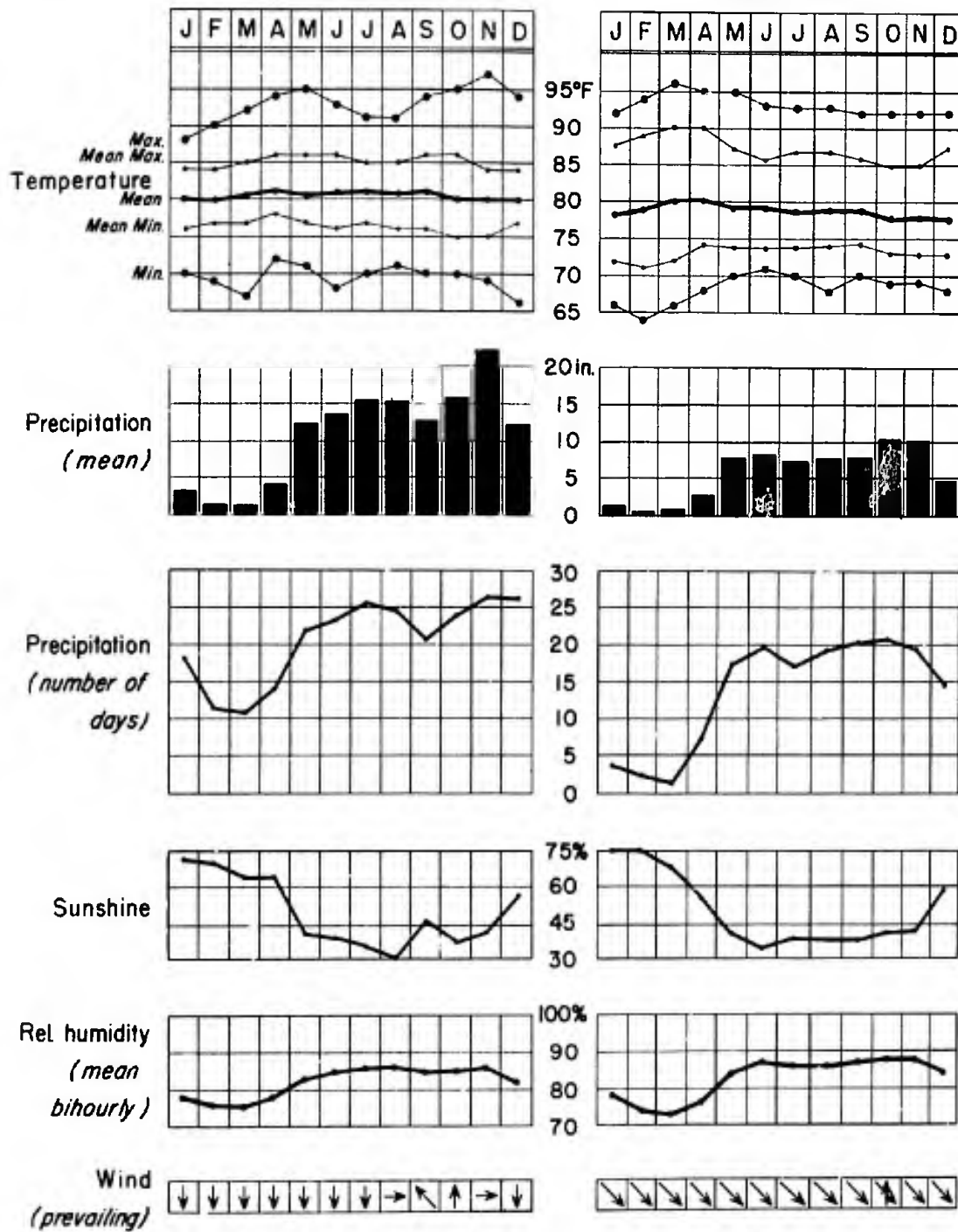


Figure 1. Climatic Summary of 2 Canal Zone stations

Relative humidity is high from June through November. Cloudiness is at a maximum from May through November, coinciding with the wet season; sky coverage averages about 8 tenths at Balboa Heights at that season. Wind speed, however, is greatest during the dry season; winds average 9 to 10 mph at Balboa Heights from January through April, but only about 5 to 6 mph during the remainder of the year. Southeastward toward the coast, there is a slight decrease in rainfall and an increase in temperature, as elevation drops to sea level from 118 feet at Balboa Heights. Rainfall increases to the northwest, averaging 88 inches at Gamboa, 117 inches at Monto Lirio, and more than 130 inches at Cristobal.

The Atlantic portion of the Canal Zone, represented by Cristobal, has a wet-tropical climate (Fig. 1). The difference in mean temperatures of the warmest and coolest months is only 2 F°, and the range from the highest mean daily maximum (April, May, June, September, and October, 86° F) to the lowest mean daily minimum (October and November, 75° F) is only 11 F°. The mean annual temperature of 81° F is typical of equatorial areas. Precipitation averages 130 inches a year, and the monthly distribution is uneven. Although no month can be considered really dry, two months have less than 2 inches of rainfall, while eight months have more than 11 inches. The drier season at Cristobal begins in January (3.4 inches) and ends in April (4.1 inches). During the remaining months, average rainfall ranges from about 12 to 22 inches. Mean relative humidity is high in all months; the lowest mean value, 77 percent, occurs in February and March. Cloud cover is greatest in July, 8 tenths, and least in February, 5.5 tenths. Mean wind speed is greatest in February and March (nearly 15 mph) and least in September (about 6 mph).

4. Criteria and methods

a. Climatic elements selected for study

As in the previous studies of this series, temperature, precipitation, humidity, cloud cover, and windspeed were the climatic elements considered most important to military activities. It was assumed that test authorities are more interested in stress periods (e.g., hottest and wettest) and in annual fluctuations than in the data for specific calendar months; accordingly, the warmest, coldest, wettest, and driest months of the year at each station were selected for study. The following specific climatic elements were studied:

- (1) Mean temperature of the warmest month
- (2) Mean daily maximum temperature of the warmest month
- (3) Mean temperature of the coldest month
- (4) Mean daily minimum temperature of the coldest month
- (5) Mean daily temperature range of the warmest month
- (6) Mean annual precipitation

- (7) Mean precipitation of the wettest month
- (8) Number of wet months
- (9) Relative humidity of the driest month
- (10) Mean cloud cover of the wettest month
- (11) Mean windspeed of the wettest month

b. "Analogous" and "semianalogous" ranges defined

Classes were established defining the ranges of values considered to be closely analogous to those for Balboa Heights and Cristobal. Fairly narrow limits of analogy were used in order to keep comparisons closely representative of the two reference stations. Table I* lists the classes of analogy and semianalogy selected for each element. For temperature, a departure of 4 degrees from the mean at the Canal Zone station was allowed for each analogy class (except where a mean was taken for the two reference stations), and an additional 4 degrees for semianalogy. As for precipitation: the mean annual rainfall of 70 inches at Balboa Heights is somewhat below that normally considered humid equatorial (supporting dense evergreen forest) for a locality with a dry season; therefore, in this tropical deciduous forest the limits of analogy were set at 55 to 85 inches, differentiating it from most of the evergreen rain forest areas, on the upper margin, and savanna areas, on the lower margin. Cristobal, which has a tropical evergreen rain forest type of climate, has a mean annual rainfall of 130 inches. A departure of up to 30 inches of mean annual rainfall was considered analogous to Cristobal, and an additional 30 inches was considered semianalogous. Departures of 5 percent in mean relative humidity, 1 tenth in amount of cloudiness, and 2 mph in windspeed were selected as ranges of analogy for these elements.

c. Explanation of maps

Values are shown for each station, with degree of analogy indicated by a symbol. Isoleths were drawn to show zones of close analogy, and these zones are shaded. Areas of semianalogy were not shaded but were indicated by placing the appropriate symbol on the map and legend for stations having semianalogous conditions. From the separate maps showing analogous areas for each element, two composite maps were prepared, one for Balboa Heights and one for Cristobal, indicating regions where the following four single elements are analogous: mean temperature of the warmest month, mean temperature of the coldest month, mean annual precipitation, and number of wet months.

* All tables are listed after par. 7

d. Limitations of data

The procedures as outlined have certain definite limitations in a climatic comparison of this sort. Foremost among these is the necessity, often encountered in climatology, of assuming climatic conditions in areas having few if any stations.

A second limitation is that some elements, such as dew point, solar radiation, and visibility, which would have proved valuable as indicators of climatic analogy, were not included in this study because of the limited amount of data available.

For certain elements the number of stations reporting does not provide a representative picture. Consequently, isopleths were not drawn for mean relative humidity for the driest month, mean cloudiness for the wettest month, or mean windspeed for the wettest month. The assumption has been made that Balboa Heights and Cristobal are representative of the Pacific and Atlantic portions of the Canal Zone.

Data from some stations are not given in a form directly comparable to that for the Balboa Heights or Cristobal records. Where period of record, hours of observation, or manner of observation differed, station records had to be interpolated in drawing the isopleths. Values outside the limits of analogy or semianalogy were not analyzed, nor were combinations of climatic elements other than those involved in computing number of wet months.

The method of recording temperatures varies from country to country. Mean temperatures are usually determined by averaging the daily maximum and minimum temperatures; however, at some stations the means are obtained by averaging bi-hourly temperature observations as at Balboa Heights and Cristobal. Experience has shown that the difference between mean temperatures derived by these different ways is seldom more than 1 F° (Contreras Arias, 1942). Hours of observation of relative humidity, windspeed, and cloudiness vary widely throughout the study area.

5. Analysis of single-element maps

Individual maps showing analogous areas have been prepared for the climatic elements listed in paragraph 4a above, numbers 1 through 8. Maps of elements 9, 10, and 11 have been prepared showing only the values for individual stations, since the data were considered inadequate for delimiting analogous areas.

a. Mean temperature, warmest month (Fig. 3)

As Table I* indicates, analogy for mean temperature of the warmest month for both Balboa Heights and Cristobal is 77° to 85° F. In Australia the principal analogous area extends from the Great Artesian Basin to the east coast. Three small mountainous areas within this eastern area are too cool for analogy. Toowoomba, just west of Brisbane, has the lowest mean temperature for the warmest month recorded for any station in the study area, 71° F in December. West of the Great Dividing Range the mean monthly temperature is too high for analogy except in the MacDonnell Range which is analogous. The hottest area, in the western part of the continent at Wyndham, records a November mean of 90° F. Except for mountain elevations in excess of 7,000 feet, all of New Guinea and nearly all the other islands of the region are within the range of analogy.

b. Mean daily maximum temperature, warmest month (Fig. 4)

At Balboa Heights the mean daily maximum temperature for the warmest month is 90° F; at Cristobal, 86° F. Analogy for the two stations is considered to be in the ranges 86° to 94° F and 82° to 90° F, respectively; areas with mean temperatures between 86° and 90° F are considered analogous to both stations. The entire eastern coast of Australia is in the latter category. Another strip, along the eastern coast and in the Great Dividing Range, is analogous to Balboa Heights. The extreme northern coastal area of Darwinia and the western coastal lowland of the Kimberleys are also analogous to Balboa Heights. Most of interior Australia has temperatures too high for analogy; the highest mean daily maximum temperature recorded is at Daly Waters, 102° F, in November and December. New Guinea and the Bismarck and Solomon island groups and New Caledonia are analogous except for the high mountain areas that have mean daily maximum temperatures too low for analogy, e.g., Sattelberg, 81° F in January.

c. Mean temperature, coldest month (Fig. 5)

The analogous temperature range for both Balboa Heights and Cristobal is 75° to 83° F for the mean temperature of the coldest month. In Australia only the northern part of Cape York Peninsula, Darwinia, and the Kimberleys are analogous in winter. To the south, temperatures are too low for analogy in the coldest months. Toowoomba records the lowest mean temperature for the coldest month, 47° F for July. New Guinea and the islands north of latitude 15° S are analogous except in the mountains.

*Tables are grouped after par. 7

New Caledonia is not analogous because mean temperatures are lower than the limits of analogy for Cristobal. The highest mean of the study area is at Fanning Island (north of the Solomons) with 82° F in January.

d. Mean daily minimum temperature, coldest month (Fig. 6)

Analogy with respect to mean daily minimum temperature for the coldest month is defined as 67° to 75° F for Balboa Heights and 71° to 79° F for Cristobal. The areas of analogy include most of the islands, except for the highlands, and a small part of northern Australia. The lowest and highest mean daily minimum temperatures, respectively, for this study area are at Alice Springs, Australia, 38° F in July, and at Kerema, New Guinea, 78° F in July and August.

e. Mean daily temperature range, warmest month (Fig. 7)

The mean daily temperature range for the warmest month is 16 F° at Balboa Heights and 8 F° at Cristobal. Temperature ranges within 4 degrees of each of the above mean ranges are considered closely analogous. All of the Australian coasts in the study area are analogous to one or the other of the Canal Zone stations, but most of this analogy is with Balboa Heights. The interior of the continent has larger temperature ranges (up to 30 F°) than the coastal areas. Double Island Point in southeast Australia has the smallest mean temperature range for the warmest month, 8 F° in January and February.

Of the stations in New Guinea, the Bismarck and Solomon Islands, and New Caledonia, all but two (Kerema, New Guinea, and Quitambo, New Caledonia) are analogous to Balboa Heights in terms of warmest month temperature range.

f. Mean annual precipitation (Fig. 8)

Mean annual precipitation analogy for Balboa Heights is 55 to 85 inches; for Cristobal, on the wetter Atlantic side, it is 100 to 160 inches. Only five small areas in Australia receive enough rain to be analogous to Balboa Heights; only one station (Innistail, 143 inches) is wet enough for analogy with Cristobal. Two of the areas, in Darwinia and on the Cape York Peninsula, receive their rain from the northwest winds. The other three areas are exposed eastern locations, influenced by the Southeast Trades and to a lesser extent by the Asian monsoon.

Most of New Guinea receives too much precipitation to be analogous to Balboa Heights, and a sizable area is even wetter than Cristobal. Because New Guinea is exposed to both the monsoon winds and the southeasterlies, there is an area where rainfall is too great for analogy; this area extends across the island from the Gulf of Papua to the Arafura Sea.

There is also a large area of greater-than-analogy rainfall on New Britain. The stations on the eastern shore of the Gulf of Papua are in a rainshadow and receive less than 55 inches. A similar rainshadow effect prevails on the western coast of New Caledonia.

The greatest mean annual rainfall recorded in the study area, 258 inches, is at Linden Hafen Plantation on the south coast of New Britain. The smallest mean annual rainfall for the study area is 5 inches at Charlotte Waters, Australia, and all of the interior of the continent is much drier than the Canal Zone.

g. Mean precipitation, wettest month (Fig. 9)

Analogy for mean monthly precipitation of the wettest month for Balboa Heights is 8 to 14 inches. For Cristobal the analogy is 15 to 19 inches. The amount of precipitation for the wettest month in Australia diminishes inland from the north coast. The interior of the continent is dry; Charlotte Waters, for example, has a mean precipitation of only 1 inch for January, the wettest month. In Darwinia and the Cape York Peninsula, there are small areas on the windward coasts which are analogous to Cristobal. The remainder of the whole north coastal area is analogous to Balboa Heights.

In New Caledonia the wettest area is on the northeast coast where a small area of Cristobal analogy prevails. Almost all of the remainder of New Caledonia is analogous to Balboa Heights.

Most of New Guinea and the neighboring island groups have rainfall analogous to either Balboa Heights or Cristobal or have too much rainfall for analogy. Some upper slopes of the highest mountains of New Guinea in the interior, however, have too little rainfall for analogy.

In most of the area, the wettest month occurs in the southern summer (around January or February) but on areas exposed to the Southeast Trades and monsoons, such as Kikori (New Guinea) and southern New Britain, the wettest month may come in the southern winter. Thus, in August, when the southeast monsoon winds strike the southern coast, New Britain receives the greatest average monthly rainfall of the study area; the stations at both Gasmata and Linden Hafen record an average of 47 inches in this month.

h. Number of wet months (Fig. 10)

In this series of analogs the term "wet month" is based on the Thornthwaite (1931) formula for precipitation effectiveness. According to this formula, a month is considered wet when the average rainfall is at least as high as that corresponding to the various temperatures shown on the sliding scale below. For example, a month is considered wet if the

average rainfall is 2.37 inches or greater and the mean temperature is 80° F. Wet months with mean temperatures below 68° F are excluded, being considered nontropical.

<u>Mean monthly temperatures (°F)</u>	<u>Mean monthly precipitation (in.)</u>
95	2.88
90	2.71
85	2.54
80	2.37
75	2.20
70	2.03
68	1.96

Analogy in terms of number of wet months is considered as 8 to 10 months for Balboa Heights and 9 to 11 months for Cristobal. In Australia, with a long dry season, only three small coastal areas are analogous to either or both Canal Zone stations. New Caledonia is analogous except for the leeward stations of Quitchambo and Paita. In New Guinea and the Bismarck and Solomon island groups, there are generally too many wet months for analogy, although there are some analogous areas in the mountains and along the southwest coasts of New Guinea.

i. Relative humidity, driest month (Fig. 11)

Mean relative humidities in the driest month of 70 to 80 percent and 72 to 82 percent are considered analogous for Balboa Heights and Cristobal, respectively. Isopleths for this map were not drawn because of the inconsistency of records for this element. Generally the east coasts of Australia and New Guinea have analogous areas. The interior of Australia has lower humidity than either station in the Canal Zone, and most of New Guinea has higher humidity.

j. Mean cloudiness, wettest month (Fig. 12)

Sky cover of 7 to 9 tenths is considered analogous for both Canal Zone stations in the wettest month. Because cloudiness data were available from only 51 stations, most of which are nonanalogous, there are no lines drawn on this map.

k. Mean windspeed, wettest month (Fig. 13)

Areas with mean windspeeds of 4 to 8 mph in the wettest month are considered analogous to Balboa Heights; 6 to 10 mph, analogous to Cristobal. Most of the 47 stations with available windspeed records are analogous to one or both of the Canal Zone stations.

6. Analysis of composite maps (Figs. 14 and 15)

Two maps have been prepared which show composite analogous areas for Balboa Heights (Fig. 14) and Cristobal (Fig. 15). These composites show areas of analogy for the following criteria for each Canal Zone station: mean temperature of the warmest month, mean temperature of the coldest month, and mean annual precipitation. Any area which is analogous with respect to these elements is then tested for "complete" or 4-way analogy by considering in addition the number of wet months.

The largest area of complete 4-way analogy with Balboa Heights is in southern New Guinea, bordering the Arafura Sea. A second less extensive area of analogy with Balboa Heights parallels the coast in the piedmont of the lower peninsula.

Complete Cristobal analogy (Fig. 15) is found in two areas of New Guinea. One very small area is in the piedmont northeast of the Gulf of Papua; another extends inland from Sorong to Momi in the Vogel Kop peninsula, following the southern slopes of the mountains.

Precipitation and number of wet months are too high for analogy in New Guinea, the Bismarck Archipelago, and the Solomon Islands. The high rainfall in the windward areas and in the islands, such as New Britain, and the interior lowlands of southern New Guinea, make vast areas too wet for analogy with Cristobal.

7. Tables of monthly values

Tables II through IX show the monthly and yearly means of the climatic elements for 23 key stations as well as for the two Canal Zone stations. The stations were selected for length of reliable record and representativeness. Key stations are not shown for the extreme southwestern part of the region, which is largely desert. In each table the mean values for the stations reveal certain characteristics of climatic analogy which are not manifest in the maps. For example, a more complete climatic picture is presented when one knows the length and intensity of the dry seasons.

The key stations and the regions they represent are listed below:

<u>Region</u>	<u>Key station</u>
<u>Australia</u> (11 key stations)	
Barkly Tableland	Tennant Creek
Cape York Peninsula	Mapoon

Australia (cont'd)

<u>Region</u>	<u>Key station</u>
Darwinia	Darwin
Eastern Coastal Plain	Cooktown Rockhampton
Great Artesian Basin	Normanton Richmond Windorah
Kimberleys	Derby Wyndham
MacDonnel Range	Alice Springs

New Guinea
(7 key stations)

Intermontane Lowlands	Bei Malu Hatzfeldthafen
Oriomo Plateau	Daru
Southern Lowland	Kikori Port Moresby Samarai
Vogel Kop	Manokwari

The Small Islands
(5 key stations)

New Britain	Rabaul
New Caledonia	Houailou Noumea
New Ireland	Kavieng
Solomon Islands	Kieta

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10. Maps

Figure

2	Station Locations
3	Mean Temperature, Warmest Month
4	Mean Daily Maximum Temperature, Warmest Month
5	Mean Temperature, Coldest Month
6	Mean Daily Minimum Temperature, Coldest Month
7	Mean Daily Temperature Range, Warmest Month
8	Mean Annual Precipitation
9	Mean Monthly Precipitation, Wettest Month
10	Number of Wet Months
11	Relative Humidity, Driest Month
12	Mean Cloudiness, Wettest Month
13	Mean Windspeed, Wettest Month
14	Composite of Analogous Areas - Balboa Heights
15	Composite of Analogous Areas - Cristobal

Note:

Fig. 2 Daru should be marked with a circle to indicate a key station

Fig. 3 Herberton should be 74° D not 94° D

TABLE I: CLIMATIC ELEMENTS AND CLASSES OF ANALOGY

Station index	Balboa Heights			Cristobal		
	Value at B.H. (mean)	Analogous (range)	Semianalogous (range)	Value at Cris. (mean)	Analogous (range)	Semianalogous (range)
TEMPERATURE (°F)						
Mean, warmest month*	80°F	77°-85°F	73°-76°F 86°-89°F	82°F	77°-85°F	73°-76°F 86°-89°F
Mean daily maximum, warmest month	90°F	86°-94°F	82°-85°F 95°-98°F	86°F	82°-90°F	79°-81°F 91°-94°F
Mean coldest month*	78°F	75°-83°F	71°-74°F 84°-87°F	80°F	75°-83°F	71°-74°F 84°-87°F
Mean daily minimum, coldest month	71°F	67°-75°F	63°-66°F 76°-79°F	75°F	71°-79°F	67°-70°F 80°-83°F
Mean daily range, warmest month	16°F	12°F-20°F	8°F-11°F 21°F-24°F	8°F	4°F-12°F	0°F-3°F 13°F-16°F
PRECIPITATION						
Mean annual (inches)	70	55-85	40-54 86-100	130	100-160	70-99 161-190
Mean, wettest month (inches)	11	8-14	5-7 15-17	22	15-29	8-14 30-36
Number of wet months	9	8-10	7 11	10	9-11	8 12
RELATIVE HUMIDITY (%)						
Mean, driest month	75%	70-80%	65-69% 81-85%	77%	72-82%	67-71% 83-87%
CLOUDINESS (tenths)						
Mean, wettest month	7.6	7.0-8.9	6.0-6.9 9.0-10.0	7.6	7.0-8.9	6.0-6.9 9.0-10.0
WIND SPEED (mph)						
Mean, wettest month	5.8	4-8	2-3 9-10	8	6-10	4-5 11-12

* See section 4b for explanation of ranges of analogy; sometimes a mean of the 2 reference stations is used.

TABLE II: STATIONS USED IN TABLES OF MONTHLY VALUES

Stations	Elev. (ft)	Lat. (S)	Long. (E)	Period of record (Years)		
				Temp.	Prec.	Other
Alice Springs (Australia)	1,901	23°38'	133°35'	52	57	20-30
BALBOA HEIGHTS (Canal Zone)	118	8°58' <u>N</u>	78°35' <u>W</u>	12-34	22-38	11-34
Bei Malu (New Guinea)	394	4°13'	142°53'	2	2	2
Cooktown (Australia)	17	15°28'	145°17'	29	62	5-30
CRISTOBAL (Canal Zone)	36	9°25' <u>N</u>	79°52' <u>W</u>	7-32	8-60	3-41
Daru (New Guinea)	25	9°04'	143°12'	24	39	5-27
Darwin (Australia)	97	12°28'	130°51'	58	61	5-30
Derby (Australia)	53	17°18'	123°40'	41	54	5-30
Hatzfeldthafen (New Guinea)	10	4°25'	145°25'	4	16	1- 3
Houailou (New Caledonia)	33	21°17'	165°38'	6	6	6
Kavieng (New Ireland)	25	2°34'	150°50'	11	18	5-13
Kieta (Solomon Islands)	240	6°10'	155°36'	9	19	5-11
Kikori (New Guinea)	806	7°24'	144°15'	20	24	5-21
Manokwari (New Guinea)	62	1°10'	134°20'	5	40	10-20
Mapoon (Australia)	20	12°04'	141°55'	18	38	5-17
Normanton (Australia)	31	17°39'	141°05'	20	68	5-22
Noumea (New Caledonia)	30	22°16'	166°27'	24	52	9-10
Port Moresby (New Guinea)	124	9°29'	147°09'	39	45	11-34
Rabaul (New Britain)	41	4°13'	152°12'	18	24	5-21
Richmond (Australia)	700	20°44'	143°10'	23	41	23
Rockhampton (Australia)	37	23°24'	150°30'	38	68	5-28
Samarai (New Guinea)	20	10°37'	150°40'	27	32	5-28
Tennant Creek (Australia)	1,075	19°34'	134°13'	21	57	20
Windorah (Australia)	390	25°26'	142°36'	24	43	22
Wyndham (Australia)	23	15°27'	128°07'	40	53	5-41

TABLE III: MEAN MONTHLY TEMPERATURE (°F)

<u>Stations</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Yr</u>
Alice Springs	84	82	77	68	60	54	52	58	66	73	79	82	70
BALBOA HEIGHTS	78	79	80	80	79	79	79	79	79	78	78	78	79
Bei Malu	83	83	84	83	83	82	81	81	82	84	83	82	83
Cooktown	82	82	80	79	76	74	72	74	76	79	81	82	76
CRISTOBAL	80	80	81	82	81	81	81	81	81	80	80	80	81
Daru	82	81	81	81	80	79	77	77	79	80	81	82	80
Darwin	84	84	84	84	82	78	77	80	82	85	86	85	82
Derby	87	86	86	84	78	73	72	74	80	84	88	88	82
Hatzfeldthafen	80	81	80	80	81	79	80	80	81	81	81	81	81
Houailou	77	78	77	76	72	69	69	67	69	71	74	76	73
Kavieng	82	81	82	81	81	81	80	80	81	82	82	82	81
Kieta	82	82	82	81	81	80	80	80	81	82	82	82	81
Kikori	82	81	81	80	79	78	76	76	78	80	80	81	79
Manokvari	79	79	79	80	80	79	79	80	80	80	81	80	80
Mapoon	84	84	84	83	81	78	78	78	81	84	86	86	82
Normanton	86	85	84	82	78	73	72	74	80	84	87	87	81
Noumea	79	79	78	76	73	70	69	68	70	72	76	78	74
Port Moresby	83	82	82	82	81	79	78	78	79	80	82	83	81
Rabaul	81	82	82	82	82	81	81	81	82	82	82	82	82
Richmond	86	84	82	76	69	64	63	67	74	80	84	86	76
Rockhampton	81	80	78	74	69	64	62	65	70	75	78	81	73
Samarai	83	83	82	81	80	78	78	77	78	79	80	82	80
Tennant Creek	87	86	83	78	70	64	64	68	75	82	86	87	78
Windorah	87	86	81	73	64	58	56	61	68	76	82	86	73
Wyndham	88	88	87	86	81	77	76	80	84	88	90	89	84

TABLE IV: MEAN DAILY MAXIMUM TEMPERATURE (°F)

<u>Stations</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Yr</u>
Alice Springs	97	96	91	82	73	68	67	74	81	88	94	96	84
BALBOA HEIGHTS	88	89	90	90	87	86	87	87	86	85	85	87	87
Bei Malu	91	92	93	91	91	90	89	89	90	93	92	91	91
Cooktown	89	88	86	85	82	80	79	80	82	85	88	89	84
CRISTOBAL	84	84	85	86	86	86	85	85	86	86	84	84	85
Daru	88	88	86	86	84	83	81	82	83	85	86	88	85
Darwin	90	90	91	92	91	88	87	89	91	93	94	92	91
Derby	95	95	95	95	90	85	85	88	93	96	97	97	93
Hatzfeldthafen	87	87	87	87	90	89	90	91	91	90	89	88	89
Houailou	85	86	86	85	82	80	79	79	80	82	84	85	83
Kavieng	88	88	89	88	88	88	88	88	89	90	90	89	89
Kieta	88	88	88	87	87	86	85	85	87	88	88	89	87
Kikori	90	89	89	87	84	82	81	81	83	86	88	89	86
Manokwari	85	85	85	85	86	85	85	86	86	87	87	86	86
Mapoon	92	91	91	90	88	86	86	87	90	93	95	94	90
Normanton	95	93	94	93	89	85	84	88	93	97	98	97	92
Noumea	86	85	85	83	79	77	76	76	78	80	83	86	81
Port Moresby	89	88	88	87	85	84	82	82	83	85	87	89	86
Rabaul	90	90	90	90	90	90	89	89	91	92	91	90	90
Richmond	98	96	95	91	84	79	79	84	81	97	100	100	91
Rockhampton	89	88	87	84	79	74	73	77	82	86	88	90	83
Samarai	89	89	88	86	84	83	82	81	83	85	86	88	85
Tennant Creek	98	96	94	89	82	76	76	81	89	95	98	99	89
Windorah	100	99	94	86	77	71	70	76	83	91	96	99	87
Wyndham	96	96	95	95	90	86	85	89	94	97	98	97	93

TABLE V: MEAN DAILY MINIMUM TEMPERATURE (°F)

<u>Stations</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Yr</u>
Alice Springs	70	69	63	54	46	41	38	43	50	58	64	68	55
BALBOA HEIGHTS	72	71	72	74	74	74	74	74	74	73	73	73	73
Bei Malu	74	74	74	74	75	74	74	73	73	74	74	73	74
Cooktown	75	75	75	73	70	68	66	67	70	73	75	75	72
CRISTOBAL	76	77	77	78	77	76	77	76	76	75	76	77	76
Daru	75	75	75	76	76	75	73	73	74	75	76	76	75
Darwin	77	77	77	76	73	69	67	70	74	77	78	78	74
Derby	79	79	78	72	66	61	58	61	66	73	78	79	71
Hatzfeldthafen	74	74	74	73	72	69	70	69	72	73	73	74	72
Houailou	69	69	69	68	62	59	58	55	58	60	63	66	63
Kavieng	75	75	75	74	74	74	73	73	73	73	74	74	74
Kieta	76	75	76	76	75	75	74	74	74	75	75	75	75
Kikori	74	73	72	73	74	73	72	72	73	73	73	74	73
Manokwari	73	73	74	74	74	74	74	74	74	74	74	74	74
Mapoon	77	77	77	76	74	70	69	70	72	74	76	77	74
Normanton	77	77	75	71	66	61	59	61	67	72	76	77	70
Noumea	72	73	72	70	66	64	62	61	63	65	68	79	67
Port Moresby	77	76	76	76	76	75	74	73	74	75	76	77	75
Rabaul	73	73	73	73	73	73	73	72	73	73	73	73	73
Richmond	73	72	69	62	54	49	47	50	57	64	69	72	62
Rockhampton	72	72	70	65	58	54	50	53	58	64	68	71	63
Samarai	77	76	76	75	75	74	73	73	74	74	74	76	75
Tennant Creek	76	75	72	67	59	53	51	54	61	68	73	75	65
Windorah	74	74	68	60	51	46	43	46	53	61	67	72	60
Wyndham	80	80	79	77	72	68	66	70	75	80	81	81	76

TABLE VI: MEAN MONTHLY PRECIPITATION (inches)

<u>Stations</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Yr</u>
Alice Springs	1.7	1.5	1.2	0.7	0.7	0.6	0.4	0.3	0.4	0.7	1.0	1.6	10.8
BALBOA HEIGHTS	1.0	0.6	0.7	2.9	8.0	8.4	7.3	7.8	8.2	10.2	10.5	4.7	70.3
Bei Malu	7.9	12.1	9.5	13.1	5.0	3.0	4.7	5.3	4.4	4.9	12.4	14.8	97.1
Cooktown	14.4	13.7	15.3	8.8	2.8	2.0	0.9	1.2	0.6	1.0	2.5	6.6	69.8
CRISTOBAL	3.4	1.5	1.5	4.1	12.5	13.9	15.6	15.3	12.8	15.8	22.3	11.7	130.4
Daru	11.9	11.4	12.7	13.1	9.6	3.9	4.0	2.0	1.6	2.0	4.1	7.6	84.1
Derwin	15.6	12.8	9.9	4.0	0.7	0.1	0.1	0.1	0.5	2.0	4.6	10.0	60.4
Derby	7.4	5.6	4.4	1.4	0.7	0.5	0.2	0.1	-	0.1	0.9	4.1	25.4
Hatzfeldthafen	15.9	14.6	9.9	14.8	4.9	3.2	7.0	3.5	4.7	6.2	12.2	11.6	107.9
Houailou	14.1	8.9	12.7	9.3	5.5	9.2	5.6	3.9	4.0	1.6	5.4	4.9	85.1
Kavieng	12.2	11.6	11.4	12.1	9.9	9.6	10.4	10.7	8.0	8.1	9.2	10.7	123.8
Kieta	10.7	10.6	10.9	11.4	9.6	9.2	11.2	9.7	8.0	10.1	9.6	9.2	120.4
Kikori	11.5	12.6	15.2	17.5	30.2	30.5	25.5	21.3	24.0	17.3	13.9	11.8	231.3
Manokwari	12.2	9.3	13.1	11.1	7.8	7.3	5.4	5.6	5.0	4.8	6.5	10.3	98.4
Mapoon	17.7	15.4	12.1	3.8	0.7	0.2	0.1	-	0.2	0.4	2.4	9.0	62.0
Normanton	10.9	10.0	6.1	1.5	0.4	0.4	0.2	0.1	0.1	0.4	1.8	5.6	37.5
Noumea	3.7	5.1	5.7	5.2	4.4	3.7	3.6	2.7	2.4	2.0	2.4	2.6	43.5
Port Moresby	7.0	7.9	6.8	4.1	2.6	1.2	1.2	0.9	1.2	1.2	1.9	4.3	40.1
Rabaul	14.8	10.4	10.2	10.0	5.1	3.3	5.4	4.7	3.5	5.1	7.1	10.1	89.7
Richmond	4.8	3.9	2.2	0.8	0.6	0.7	0.3	0.1	0.3	0.6	1.3	2.7	18.3
Reckhampton	7.5	7.6	4.4	2.6	1.6	2.6	1.8	0.8	1.3	1.8	2.4	4.7	39.1
Samarai	6.4	7.8	10.2	9.5	11.9	10.5	9.0	9.1	10.0	8.9	7.6	5.2	106.1
Tennant Creek	3.6	3.6	2.0	0.6	0.3	0.2	0.2	0.2	0.3	0.5	1.0	2.1	14.7
Windorah	1.5	1.7	1.7	1.0	0.8	0.8	0.6	0.4	0.5	0.7	1.0	1.5	12.2
Wyndham	7.3	6.0	4.6	0.8	0.2	0.2	0.2	-	0.1	0.4	2.0	4.1	25.9

TABLE VII: MEAN CLOUDINESS (tenths of sky covered)

<u>Stations</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Yr</u>
Alice Springs*	-	-	-	-	-	-	-	-	-	-	-	-	-
BALBOA HEIGHTS	4.8	4.8	5.0	6.3	7.6	8.0	7.6	7.7	7.7	7.7	7.6	6.3	6.8
Bei Malu	6.6	7.0	6.3	6.2	5.9	5.8	5.7	6.5	6.4	6.1	6.7	8.5	6.5
Cooktown	7.0	6.9	7.0	6.3	5.9	5.4	4.7	4.8	5.1	5.3	5.5	6.3	5.8
CRISTOBAL	5.9	5.5	5.8	6.4	7.8	7.9	8.0	7.6	7.1	7.4	7.6	6.8	7.0
Daru	6.7	6.9	7.1	7.2	7.0	7.0	7.0	6.8	6.8	6.6	6.2	6.1	6.8
Darwin	7.6	7.3	6.6	4.3	2.8	1.9	1.6	1.8	2.8	4.2	1.6	6.9	4.4
Derby	5.5	5.4	4.6	2.6	2.0	2.0	1.2	1.0	1.0	1.6	2.9	4.7	2.9
Hatzfeldthafen	7.3	8.3	7.3	6.8	5.7	5.9	5.6	6.8	6.0	5.8	7.1	7.3	6.7
Houailou*	-	-	-	-	-	-	-	-	-	-	-	-	-
Kavieng	7.1	6.6	6.6	6.4	5.7	5.6	5.9	5.6	5.4	5.7	5.8	6.2	6.0
Kieta	6.9	6.8	7.1	6.4	6.0	5.9	6.1	5.9	5.8	6.0	6.2	6.5	6.3
Kikori	5.7	5.6	5.4	5.6	6.5	8.0	7.8	8.3	7.8	7.1	6.2	5.4	6.6
Manokwari	7.9	7.1	7.2	7.0	5.2	6.2	6.5	6.4	5.7	5.3	5.1	7.7	6.4
Mapoon	6.1	6.2	5.8	4.9	4.1	3.5	3.5	3.3	3.5	3.6	4.5	5.7	4.6
Normanton	6.2	6.1	5.2	2.9	2.4	2.4	1.5	1.2	1.6	2.4	3.8	5.2	3.4
Noumea	4.4	4.3	4.0	4.4	4.4	4.6	4.3	4.2	4.2	4.0	4.4	3.8	4.2
Port Moresby	6.7	6.8	6.5	5.7	5.2	5.5	5.4	5.9	5.9	5.8	5.4	5.9	5.9
Rabaul	7.2	7.0	6.9	6.6	6.0	5.8	6.2	6.0	6.0	6.2	6.7	6.9	6.5
Richmond*	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockhampton	5.1	5.0	4.3	3.3	3.2	3.8	2.7	2.4	2.8	3.2	3.9	4.5	3.7
Samara	5.3	6.0	6.0	6.2	6.8	7.1	6.9	7.3	6.4	5.6	4.8	6.2	6.2
Tennant Creek*	-	-	-	-	-	-	-	-	-	-	-	-	-
Windorah*	-	-	-	-	-	-	-	-	-	-	-	-	-
Wyndham	5.4	5.4	4.6	2.7	3.0	1.6	0.9	0.9	1.2	2.4	3.6	5.0	3.1

* No data available

TABLE VIII: MEAN RELATIVE HUMIDITY (%)

<u>Stations</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Yr</u>
Alice Springs	31	34	36	40	47	53	49	38	30	27	26	29	37
BALBOA HEIGHTS	78	75	73	77	85	87	86	87	87	88	88	84	83
Bei Malu	84	82	82	84	85	88	83	84	84	82	85	85	84
Cooktown	74	76	77	75	74	74	72	69	68	67	68	70	72
CRISTOBAL	78	77	77	79	83	85	86	86	85	85	86	82	82
Daru	85	86	85	85	85	85	85	84	82	81	80	82	84
Darwin	75	76	71	61	55	54	52	54	57	59	63	69	62
Derby	64	63	60	47	44	43	44	42	43	47	53	59	51
Hatzfeldthafen	85	86	87	84	81	80	83	76	84	82	83	82	83
Houailou*	-	-	-	-	-	-	-	-	-	-	-	-	-
Kavieng	80	78	79	80	79	79	77	76	76	75	77	78	77
Kieta	78	77	78	80	80	81	80	80	79	76	78	76	78
Kikori	84	85	83	84	91	92	93	93	92	91	87	88	89
Manokwari	80	79	80	83	79	82	81	78	78	82	81	84	81
Mapoon	80	82	82	80	81	81	80	77	75	71	72	77	78
Normanton	64	65	58	44	45	50	44	41	38	39	44	52	49
Noumea	71	74	75	73	73	73	73	70	68	67	68	69	71
Port Moresby	71	72	73	74	77	78	78	77	77	76	73	71	74
Rabaul	77	76	76	77	75	74	74	72	69	70	73	75	74
Richmond	52	56	52	47	58	53	46	39	33	32	36	43	45
Rockhampton	62	62	63	60	60	62	59	55	53	52	53	57	59
Samarai	76	77	77	80	82	83	83	82	81	80	78	74	79
Tennant Creek	42	50	39	33	36	39	37	32	29	28	31	38	36
Windorah	37	41	40	41	50	57	55	43	34	33	32	34	41
Wyndham	67	69	65	46	42	42	40	43	44	51	56	55	52

* No data available

TABLE IX: MEAN WINDSPEED (mph)

<u>Stations</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Yr</u>
Alice Springs*	-	-	-	-	-	-	-	-	-	-	-	-	-
BALBOA HEIGHTS	8.8	10.1	10.3	8.8	6.1	5.4	5.9	5.9	5.6	6.3	5.8	6.4	7.1
Bei Malu	3.0	1.4	2.1	1.4	1.2	1.2	1.2	1.2	2.2	1.4	1.3	1.7	1.5
Cooktown	6.0	6.0	7.0	9.0	8.0	9.0	9.0	9.0	8.0	8.0	7.0	6.0	8.0
CRISTOBAL	14.1	14.8	14.8	12.5	8.0	6.6	8.1	7.9	6.1	6.6	8.0	11.8	9.9
Daru	7.0	7.0	5.0	7.0	14.0	13.0	13.0	15.0	12.0	10.0	7.0	5.0	9.0
Darwin	8.0	9.0	7.0	7.0	8.0	9.0	8.0	8.0	9.0	8.0	7.0	7.0	8.0
Derby	9.0	9.0	8.0	9.0	9.0	12.0	9.0	12.0	13.0	14.0	13.0	9.0	12.0
Hatzfeldthafen	3.8	3.7	3.7	3.4	3.8	4.1	4.6	6.4	5.3	5.2	3.7	2.9	4.3
Houailou*	-	-	-	-	-	-	-	-	-	-	-	-	-
Kavieng	7.0	7.0	7.0	6.0	7.0	7.0	7.0	8.0	9.0	7.0	8.0	9.0	8.0
Kieta	3.0	2.0	2.0	2.0	3.0	6.0	5.0	5.0	3.0	3.0	2.0	2.0	3.0
Kikori	3.0	5.0	5.0	3.0	3.0	2.0	3.0	7.0	5.0	3.0	3.0	3.0	3.0
Manokwari*	-	-	-	-	-	-	-	-	-	-	-	-	-
Mapoon	12.0	9.0	14.0	16.0	18.0	16.0	16.0	20.0	17.0	16.0	13.0	8.0	15.0
Normanton	6.0	6.0	7.0	8.0	8.0	7.0	6.0	7.0	6.0	7.0	7.0	6.0	7.0
Noumea	3.8	3.8	3.4	3.8	2.8	2.8	4.1	3.8	4.5	4.5	3.8	4.1	3.8
Port Moresby	6.0	7.0	3.0	8.0	9.0	13.0	12.0	14.0	13.0	12.0	7.0	7.0	9.0
Rabaul	9.0	9.0	8.0	6.0	5.0	7.0	7.0	8.0	7.0	6.0	7.0	7.0	7.0
Richmond*	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockhampton	8.0	8.0	9.0	7.0	6.0	6.0	8.0	8.0	7.0	8.0	7.0	8.0	7.0
Samarai	3.0	3.0	3.0	5.0	5.0	3.0	5.0	5.0	3.0	3.0	3.0	5.0	3.0
Tennant Creek*	-	-	-	-	-	-	-	-	-	-	-	-	-
Windorah*	-	-	-	-	-	-	-	-	-	-	-	-	-
Wyndham	8.0	8.0	7.0	7.0	7.0	8.0	8.0	7.0	7.0	9.0	8.0	7.0	8.0

* No data available

PANAMA CANAL ZONE- AUSTRALIA AND NEW GUINEA

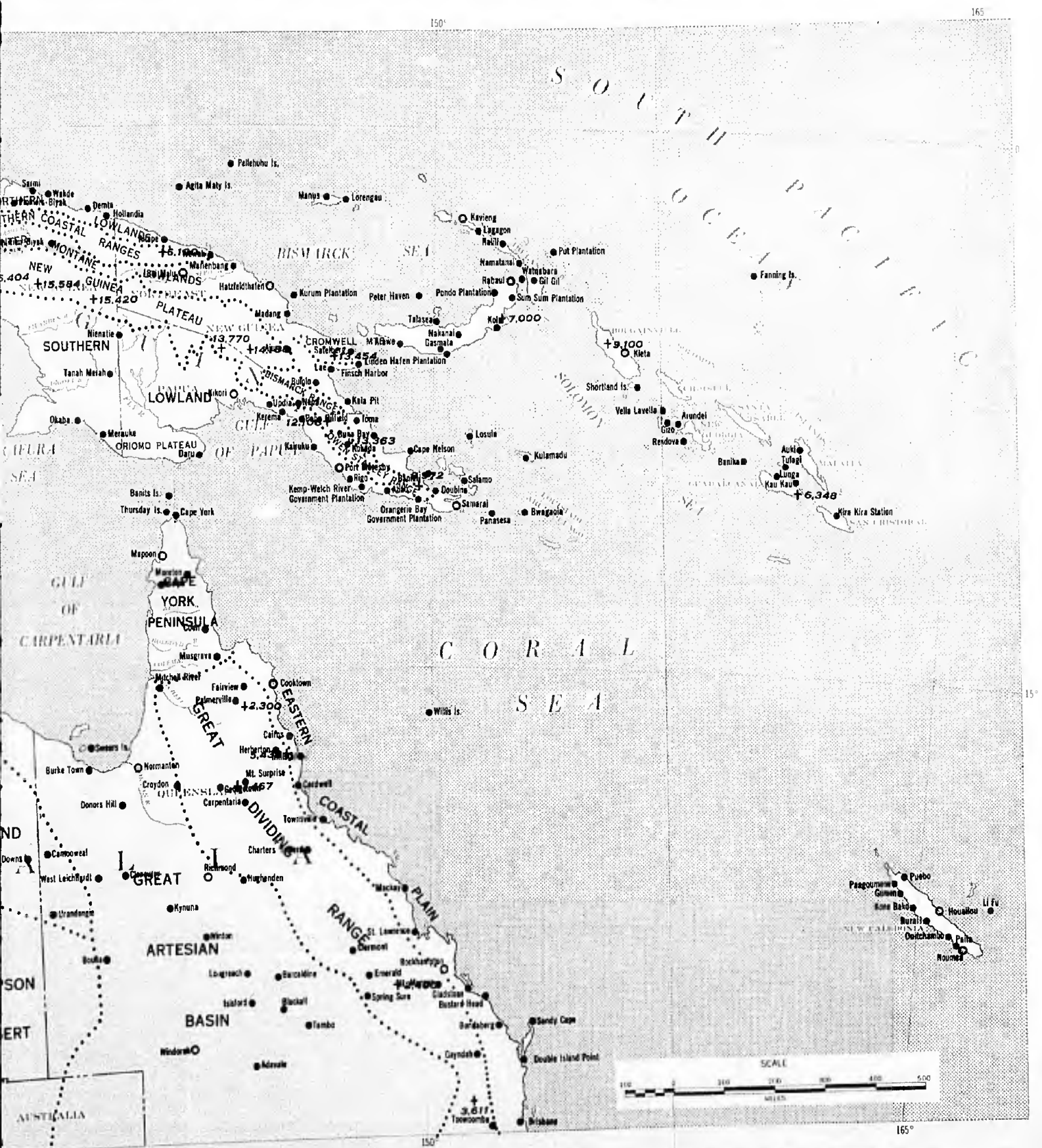
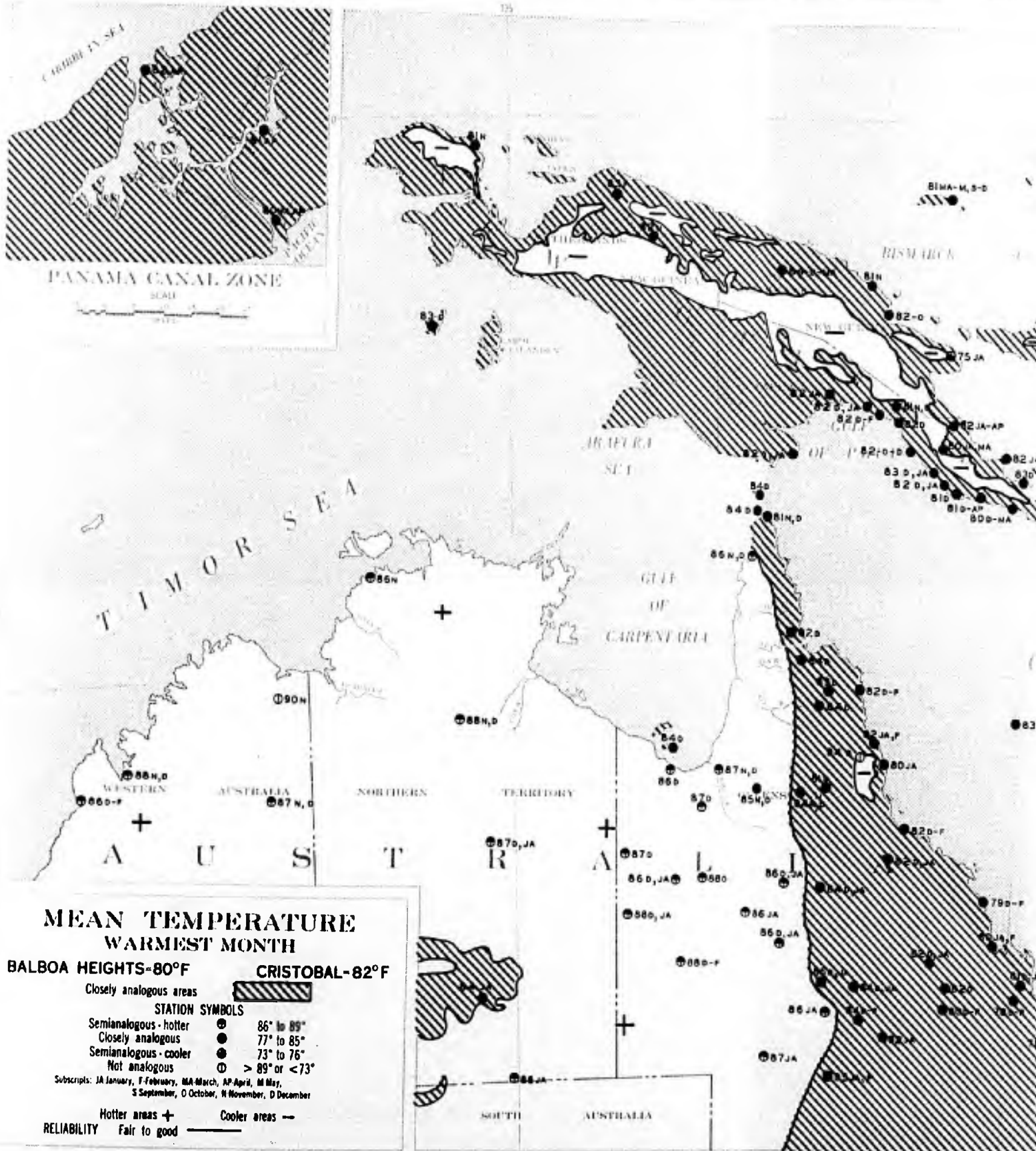


Figure 2

CLIMATIC ANALOGS OF PANAMA CANAL ZONE- AUSTRALIA



**MEAN TEMPERATURE
WARMEST MONTH**

BALBOA HEIGHTS-80°F CRISTOBAL-82°F

Closely analogous areas

STATION SYMBOLS

Semianalogous - hotter	⊙	86° to 89°
Closely analogous	●	77° to 85°
Semianalogous - cooler	⊙	73° to 76°
Not analogous	⊖	> 89° or < 73°

Subscripts: JA January, F February, MA March, AP April, M May, S September, O October, N November, D December

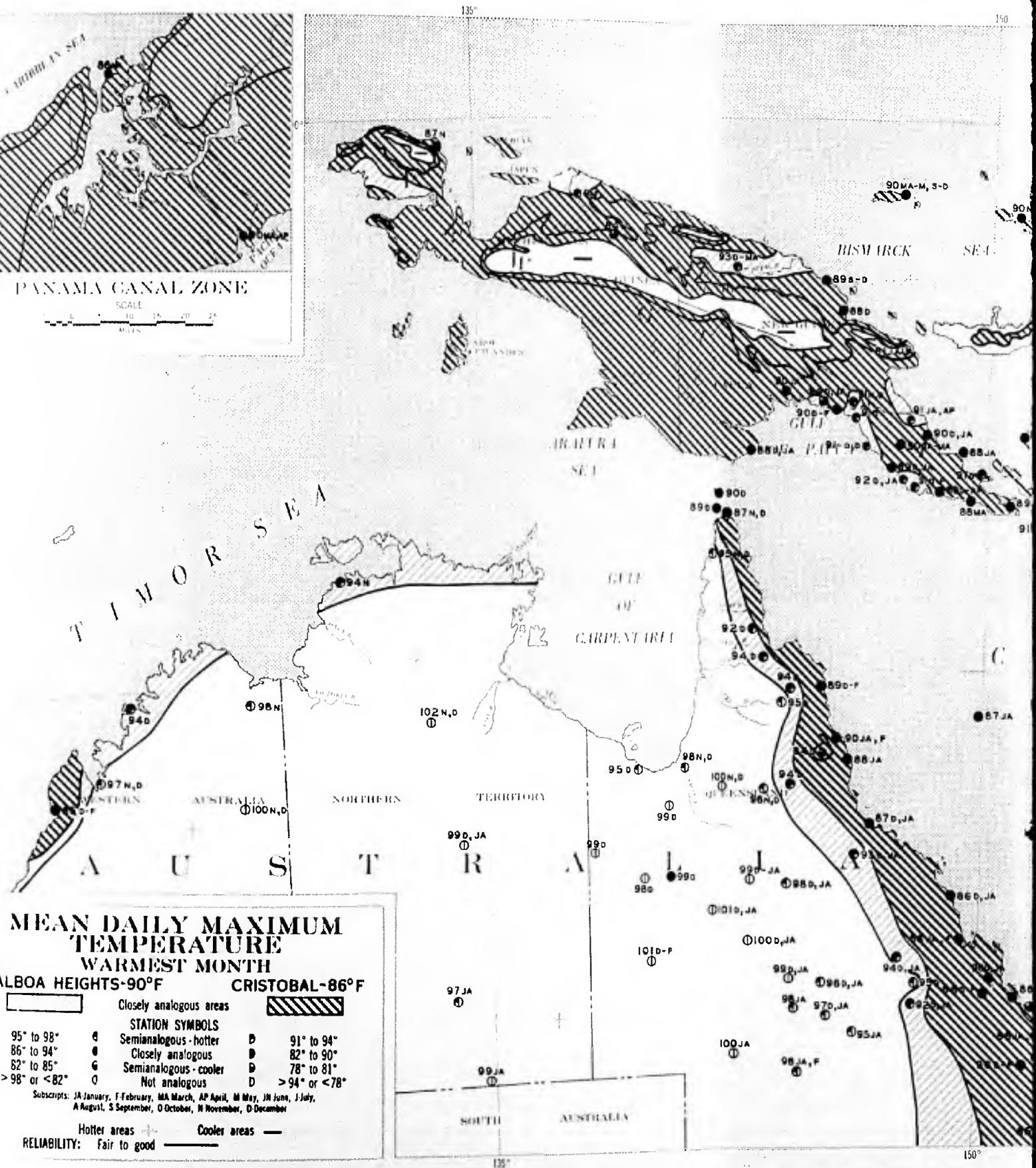
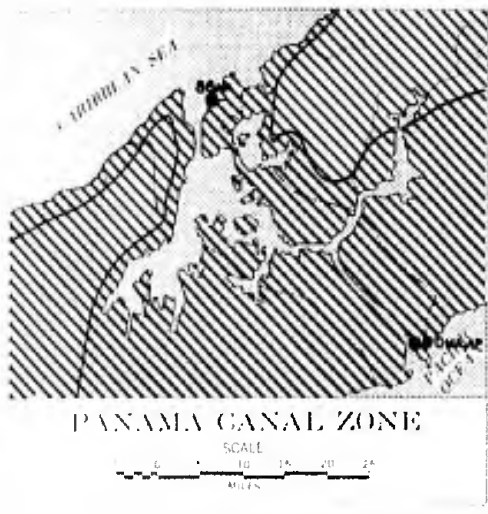
Hotter areas + Cooler areas -

RELIABILITY Fair to good

1

1

CLIMATIC ANALOGS OF PANAMA CANAL ZONE- AUSTRALIA



MEAN DAILY MAXIMUM TEMPERATURE WARMEST MONTH

BALBOA HEIGHTS-90°F CRISTOBAL-86°F

	Closely analogous areas	
95° to 98°	● Semianalogous - hotter	● 91° to 94°
86° to 94°	○ Closely analogous	○ 82° to 90°
82° to 85°	◐ Semianalogous - cooler	◐ 78° to 81°
>98° or <82°	○ Not analogous	○ >94° or <78°

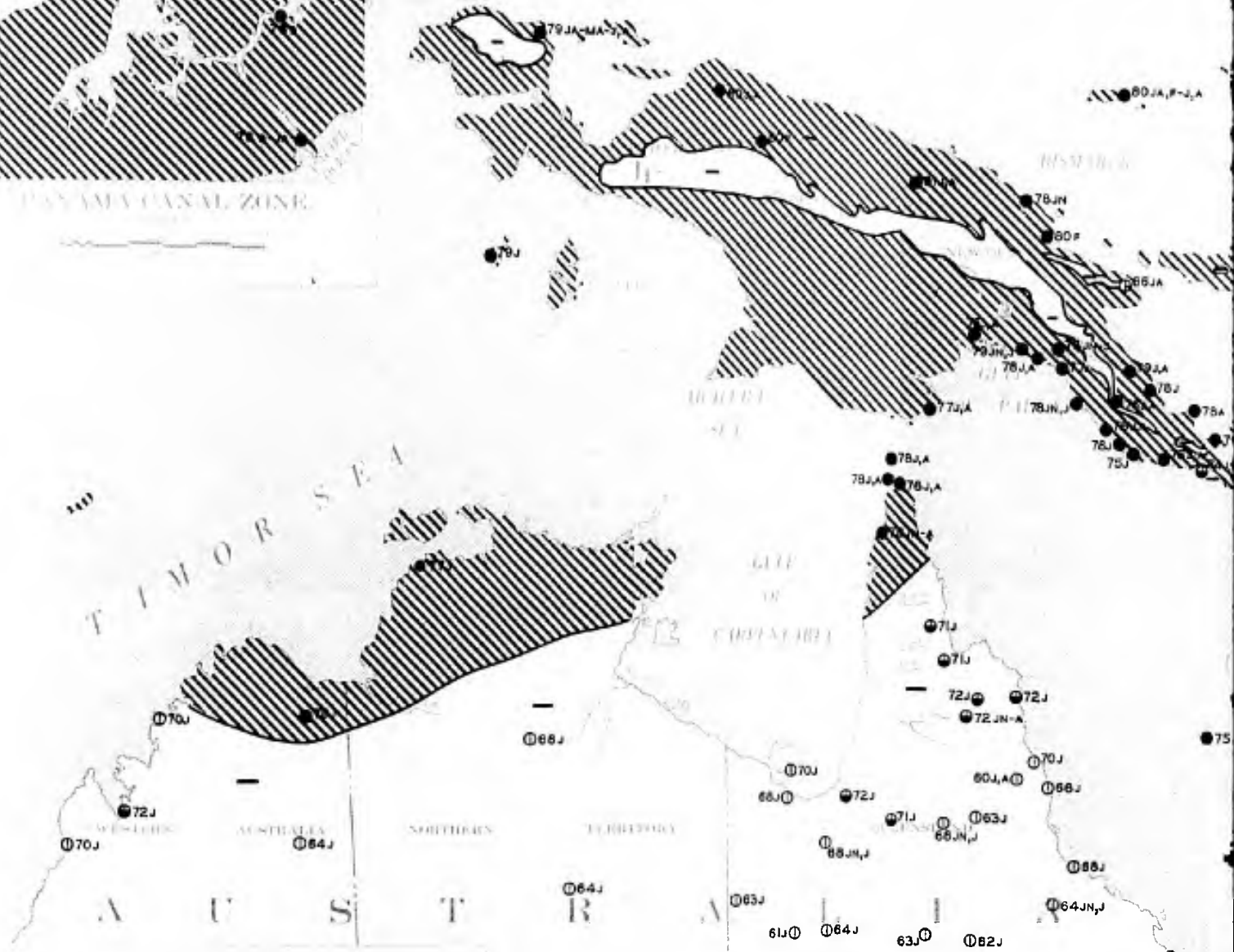
Subscripts: JA/January, F/February, MA/March, AP/April, M/May, JN/June, J/July, A/August, S/September, O/October, N/November, D/December

Hotter areas Cooler areas

RELIABILITY: Fair to good

1

CLIMATIC ANALOGS OF PASSELY CANAL ZONE



MEAN TEMPERATURE COLDEST MONTH

BALBOA HEIGHTS-78°F CRISTOBAL-80°F

Closely analogous areas



STATION SYMBOLS

- Semianalogous - hotter ● 84° to 87°
- Closely analogous ● 75° to 83°
- Semianalogous - cooler ● 71° to 74°
- Not analogous ○ >87° or <71°

Subscripts: JA January, F February, MA March, AP April, M May, JN June, J July, A August, S September, O October, N November, D December

Cooler areas —

RELIABILITY: Fair to good

135°

150°

1

PANAMA CANAL ZONE- AUSTRALIA AND NEW GUINEA

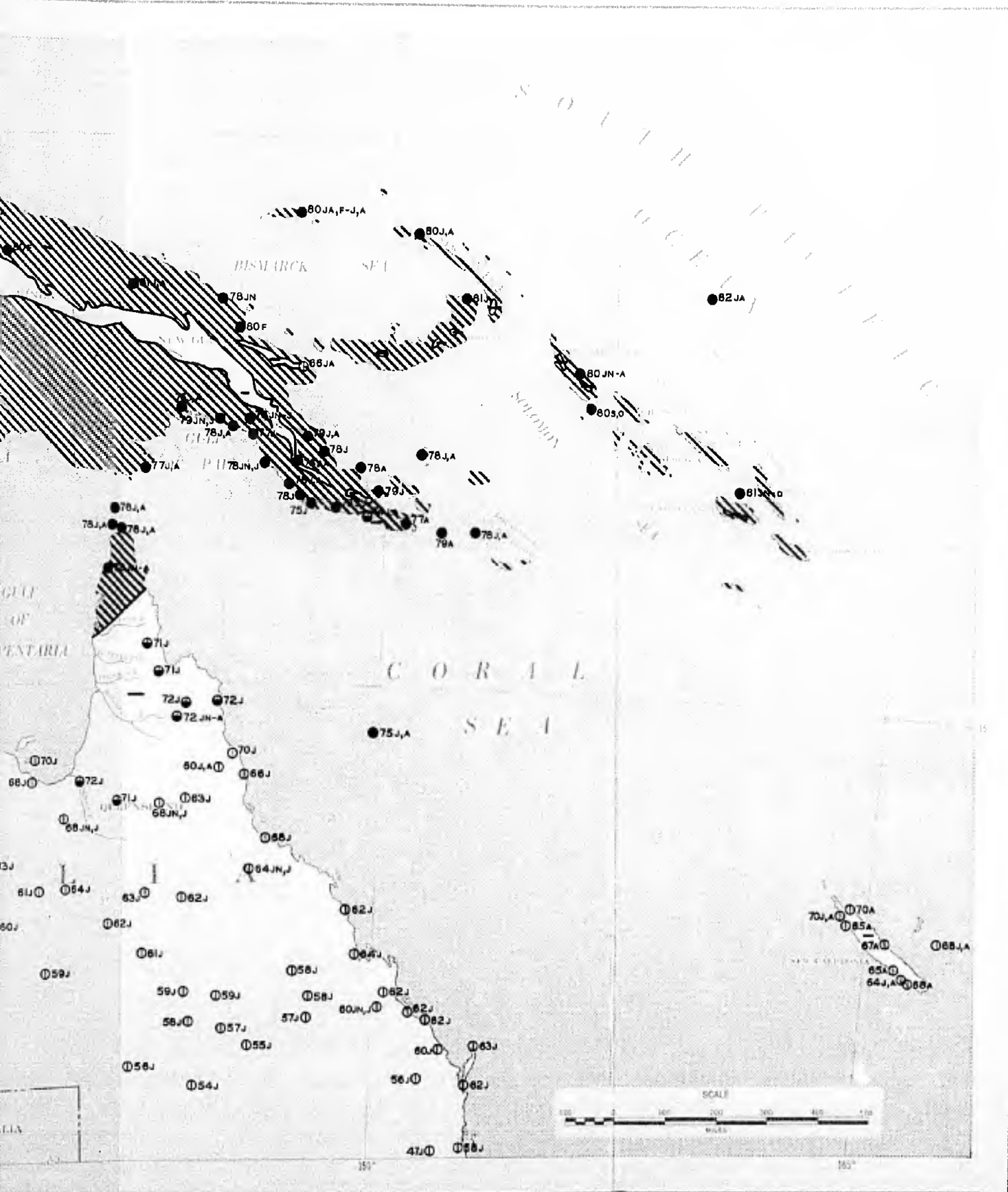
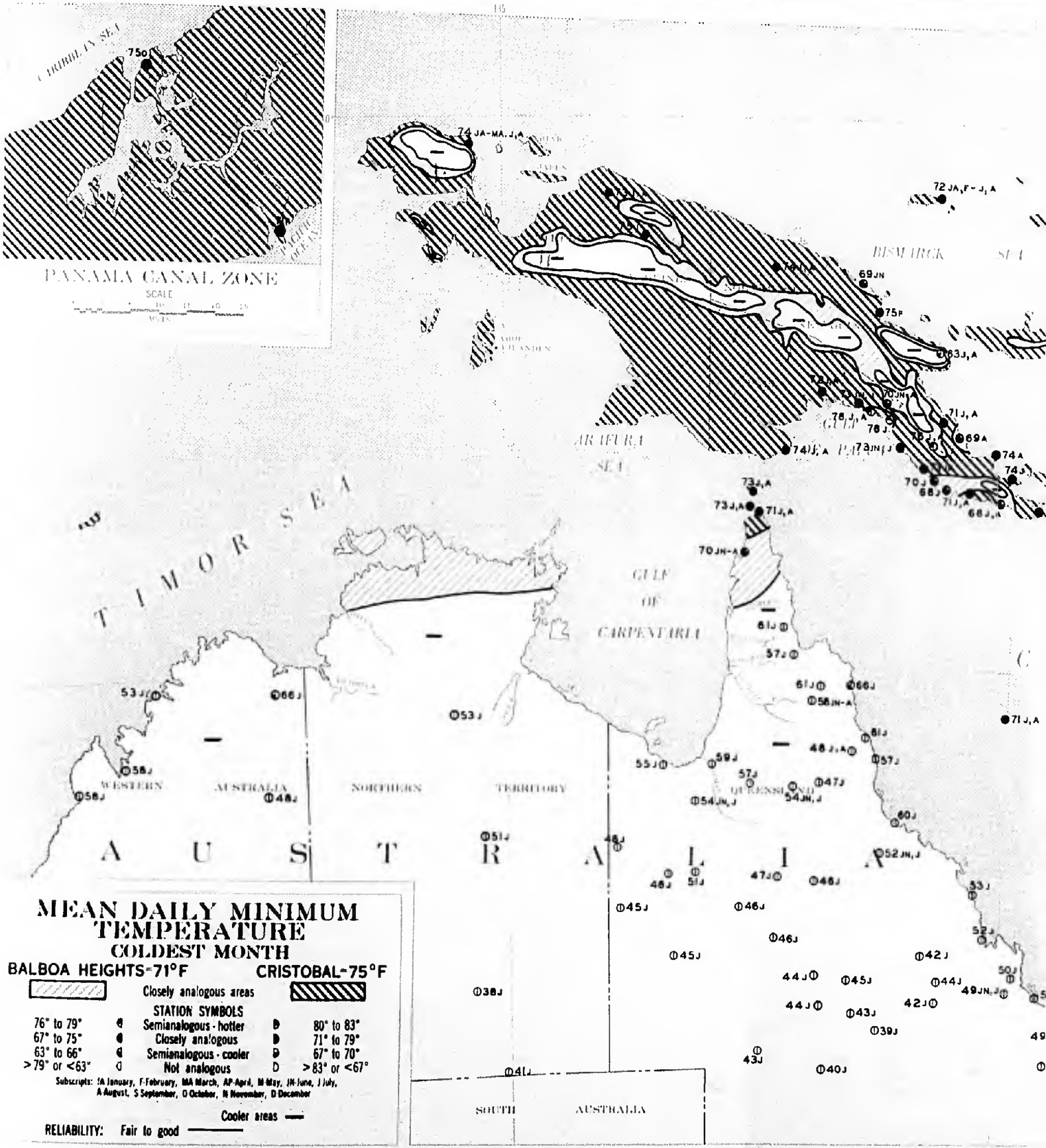
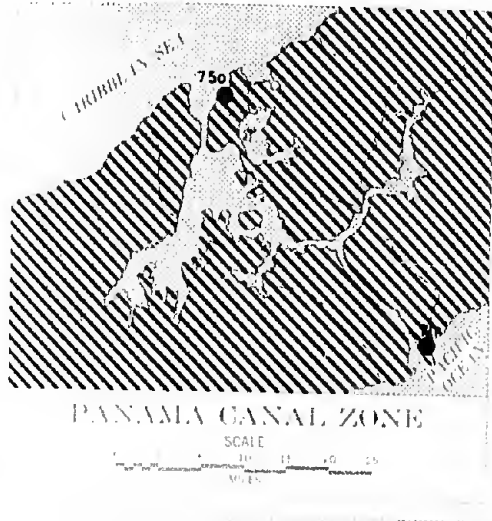


Figure 5

2

CLIMATIC ANALOGS OF PANAMA CANAL ZONE- AUSTRALIA



MEAN DAILY MINIMUM TEMPERATURE COLDEST MONTH

BALBOA HEIGHTS-71°F CRISTOBAL-75°F

	Closely analogous areas	
STATION SYMBOLS		
76° to 79°	⊙ Semianalogous - hotter	⊙ 80° to 83°
67° to 75°	⊙ Closely analogous	⊙ 71° to 79°
63° to 66°	⊙ Semianalogous - cooler	⊙ 67° to 70°
> 79° or < 63°	⊙ Not analogous	⊙ > 83° or < 67°

Subscripts: JA January, F February, MA March, AP April, M May, JN June, J July, A August, S September, O October, N November, D December

Cooler areas —

RELIABILITY: Fair to good

PANAMA CANAL ZONE- AUSTRALIA AND NEW GUINEA

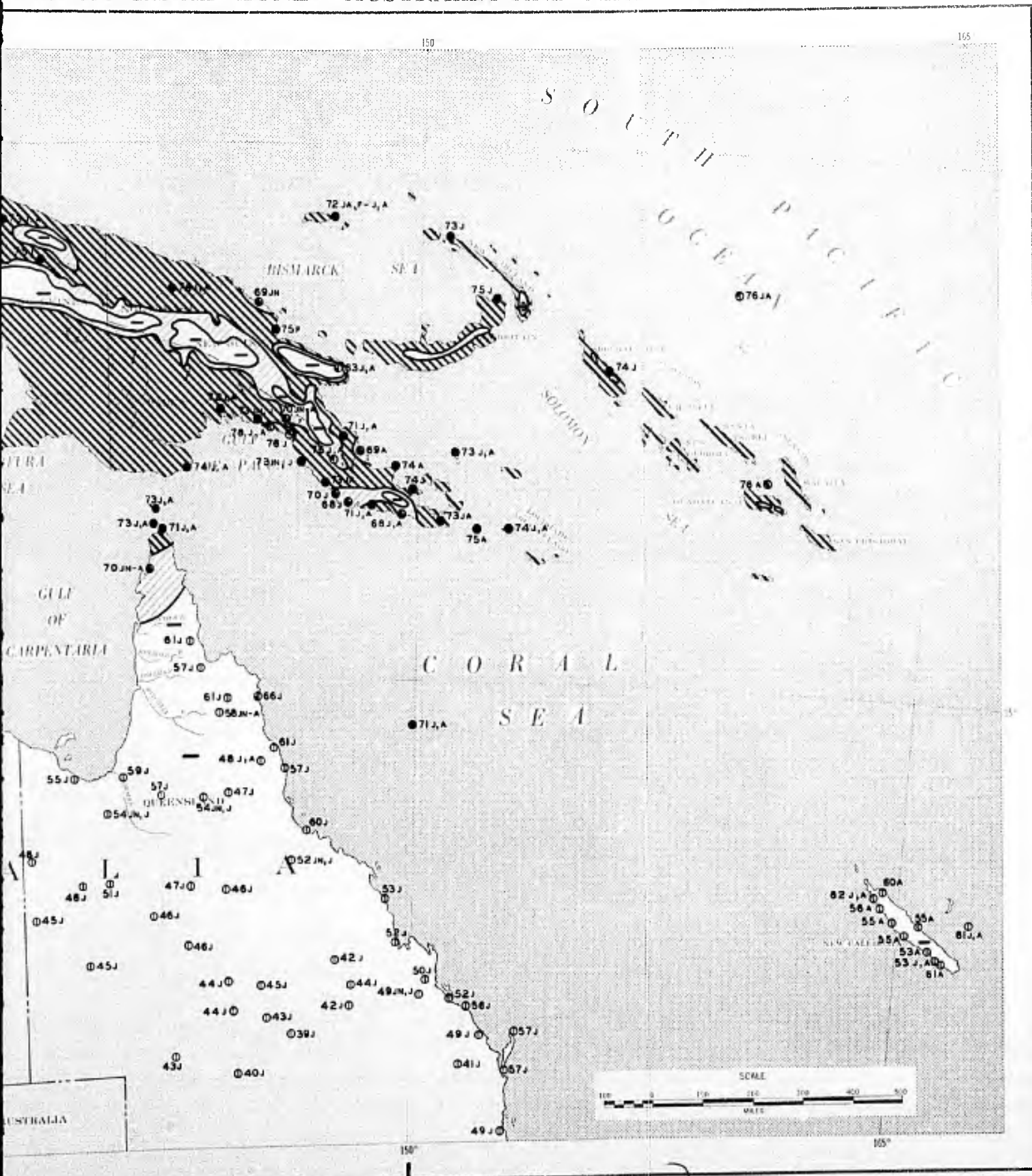
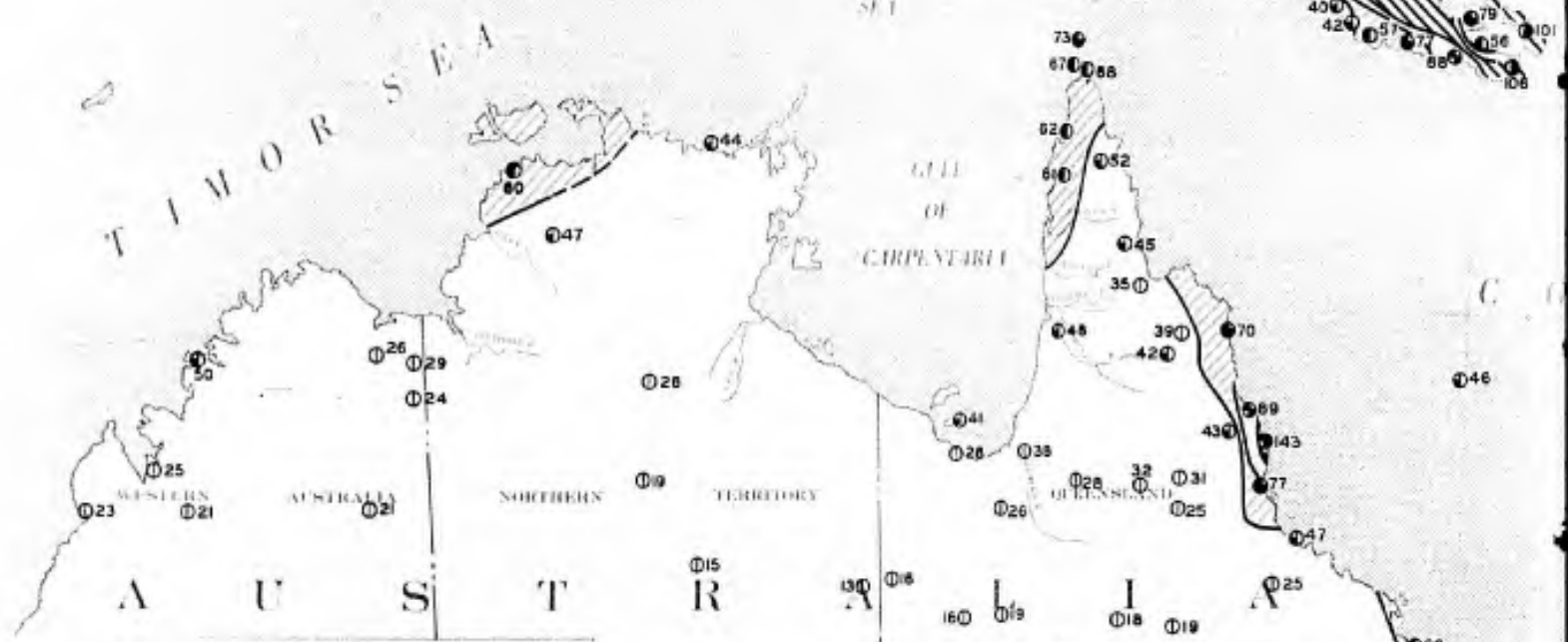
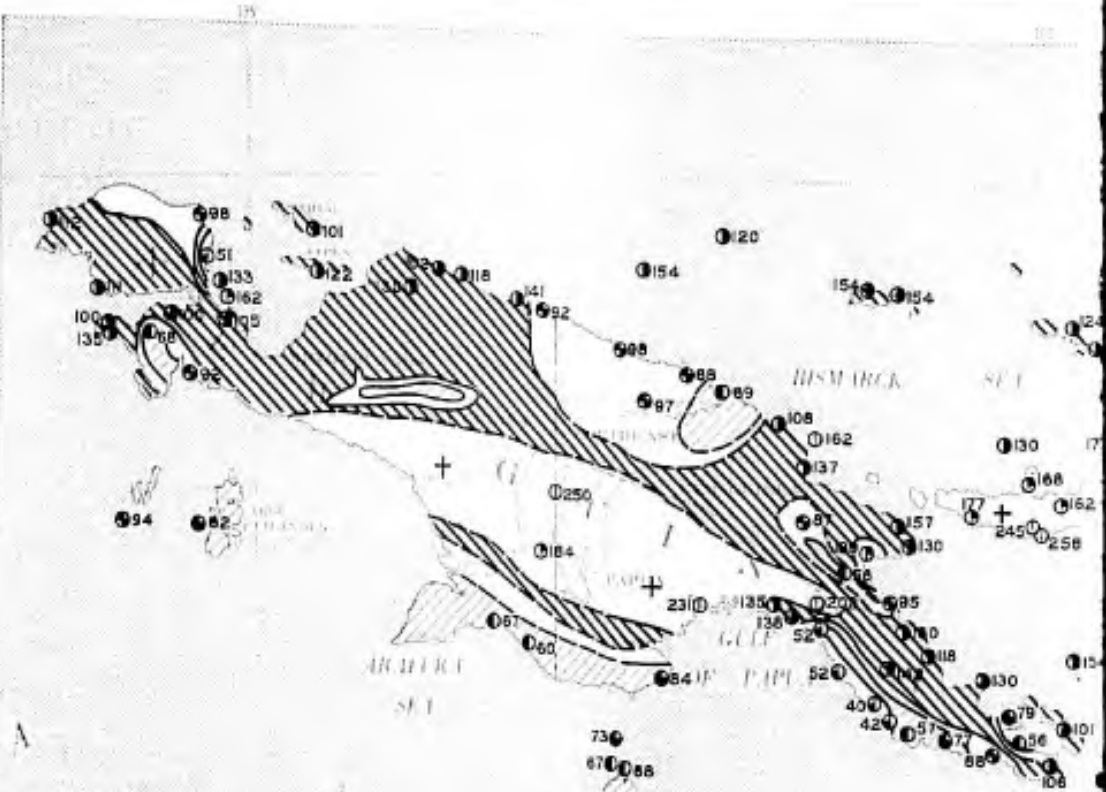
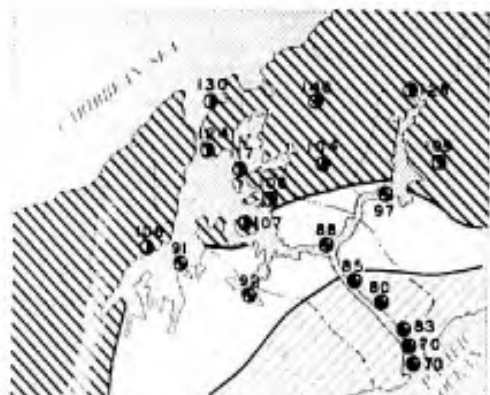


Figure 6

CLIMATIC ANALOGS OF PANAMA CANAL ZONE- AUSTRALIA



MEAN ANNUAL PRECIPITATION

BALBOA HEIGHTS 70 INCHES	STATION SYMBOLS	CRISTOBAL 130 INCHES
86 to 100	☉	161 to 190
55 to 85	●	100 to 160
40 to 54	⊖	70 to 99
>100 or <40	⊙	>190 or <70
	☉	

Wetter areas + Drier areas

RELIABILITY: Fair to good ——— Poor - - - -

PANAMA CANAL ZONE- AUSTRALIA AND NEW GUINEA

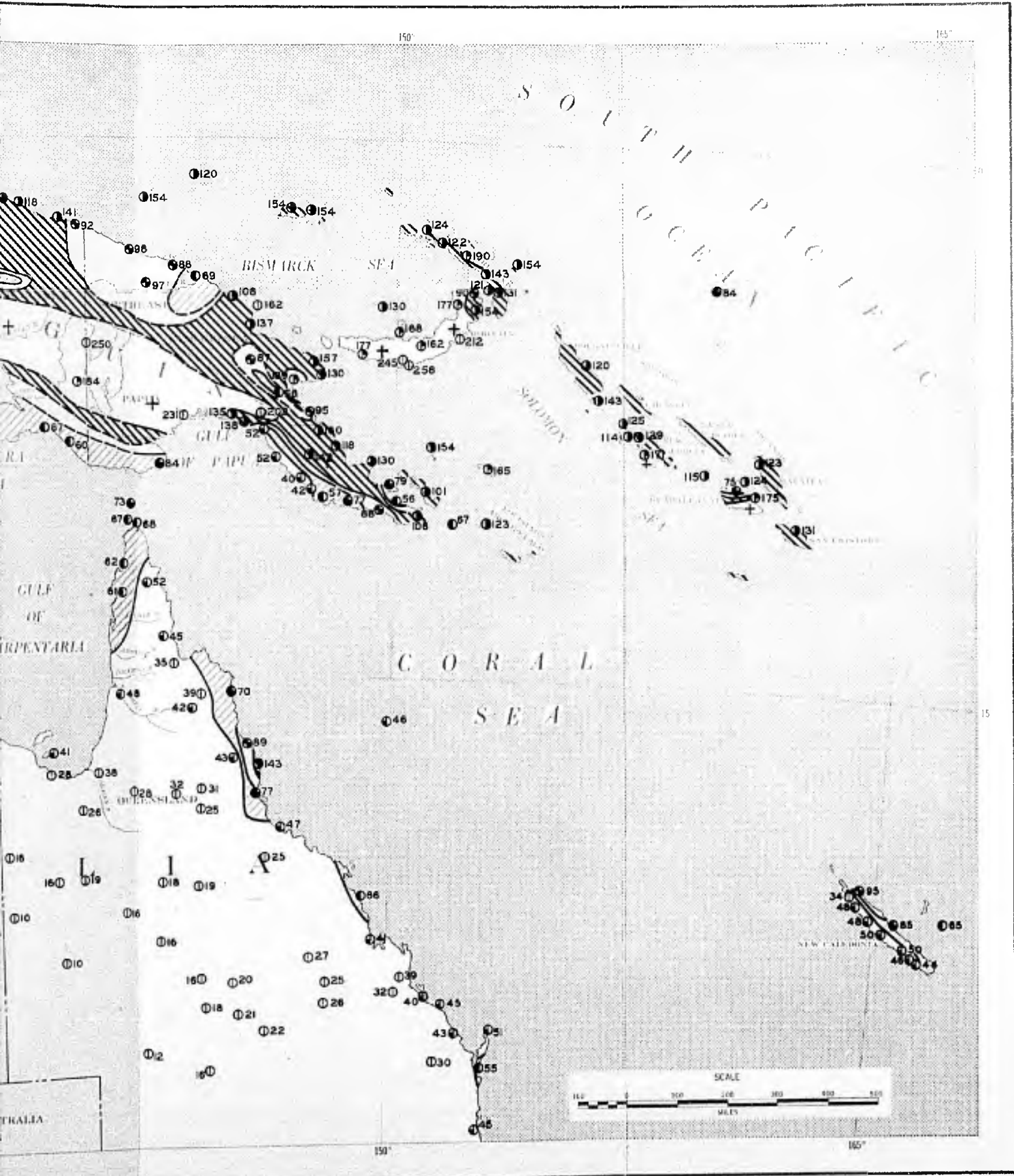
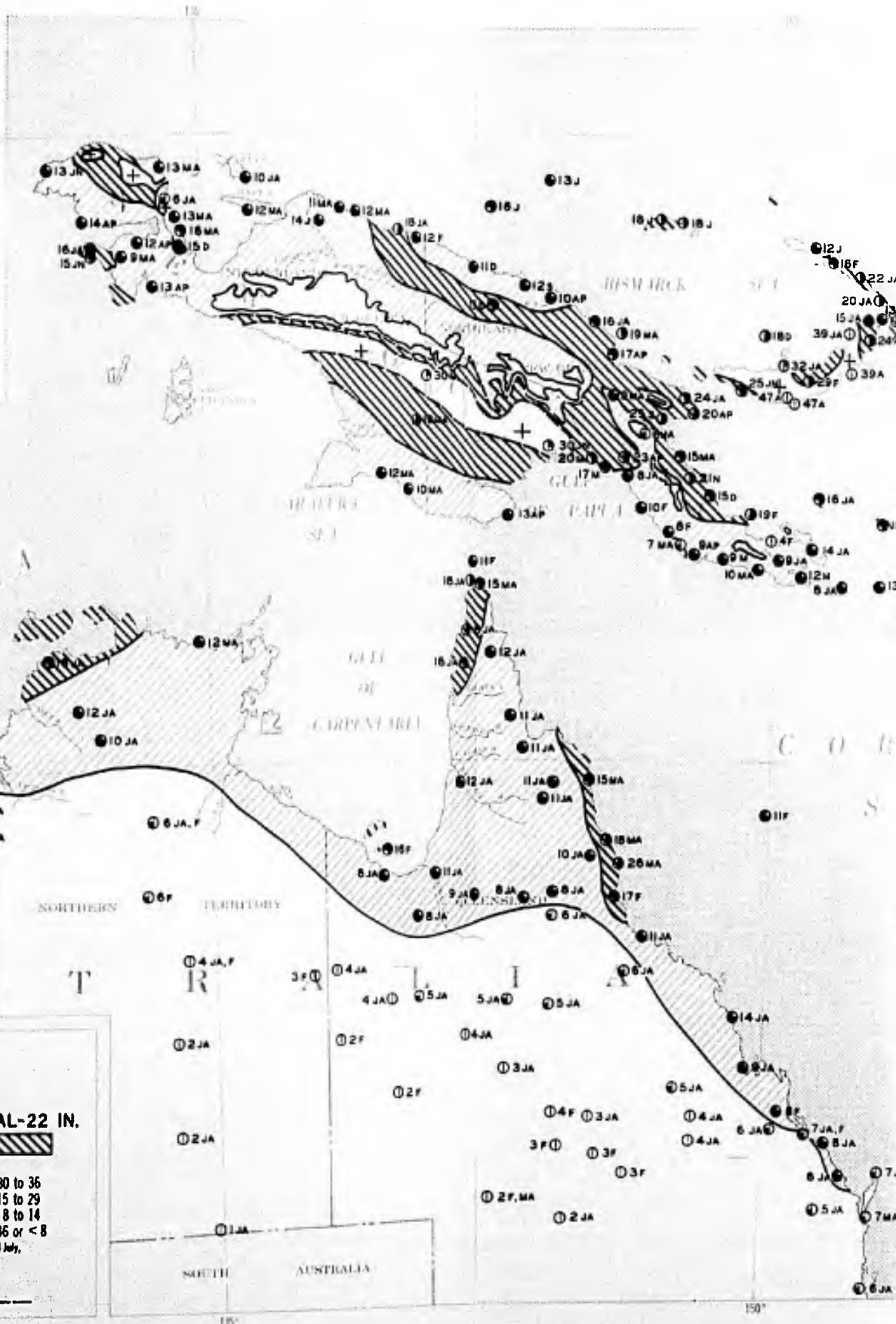


Figure 8

2

CLIMATIC ANALOGS OF PANAMA CANAL ZONE- AUSTRALIA



MEAN MONTHLY PRECIPITATION WETTEST MONTH

BALBOA HEIGHTS-11 IN. CRISTOBAL-22 IN.

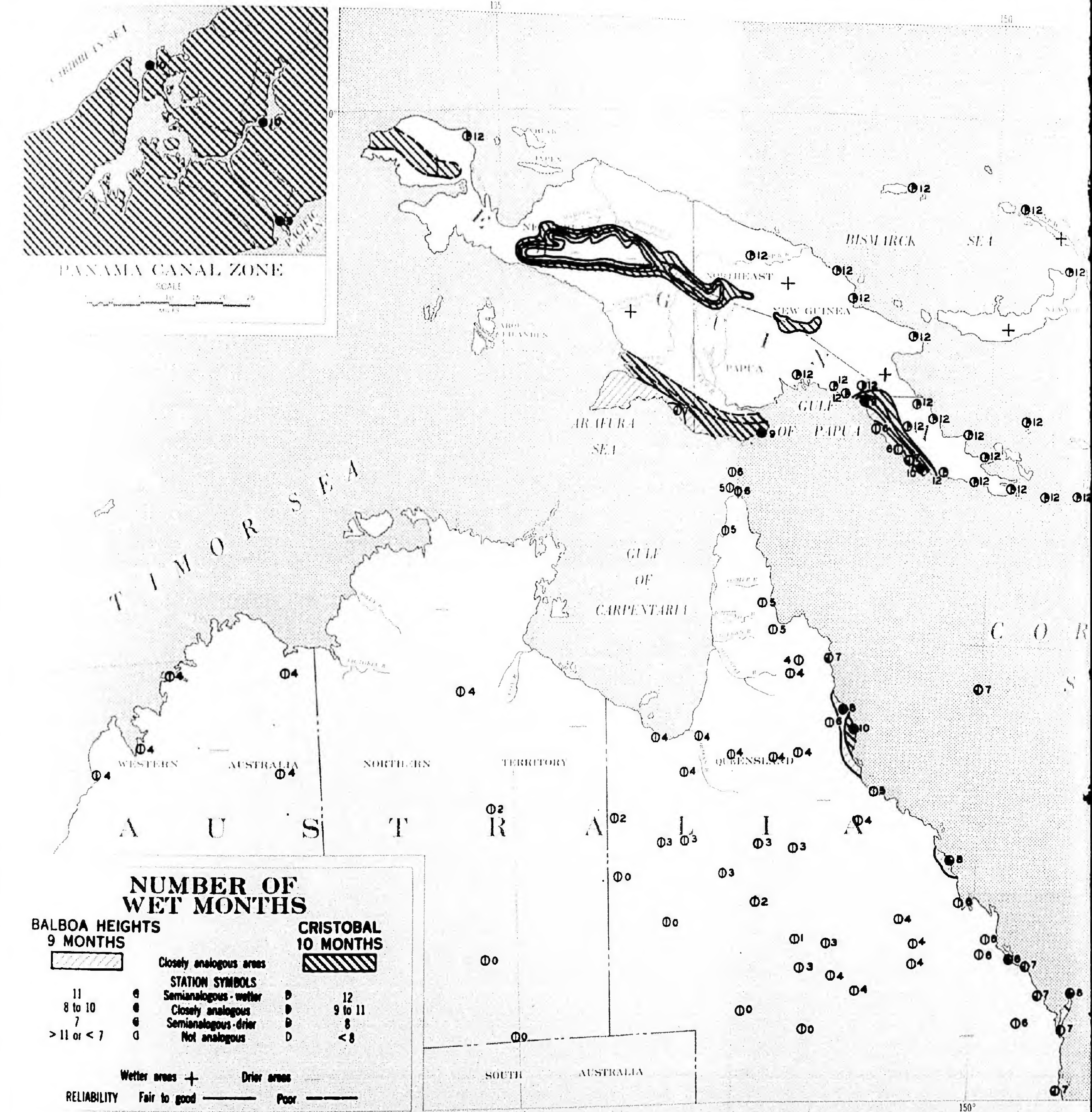
<p>15 to 17 ●</p> <p>8 to 14 ○</p> <p>5 to 7 □</p> <p>> 17 or < 5 ⊕</p>	<p>30 to 36 ●</p> <p>15 to 29 ○</p> <p>8 to 14 □</p> <p>> 36 or < 8 ⊕</p>
--	--

Subscripts: JA January, F February, MA March, AP April, M May, J June, J July, A August, S September, O October, N November, D December

Wetter areas ⊕ Drier areas ⊖

RELIABILITY: Fair to good ———— Poor - - - -

CLIMATIC ANALOGS OF PANAMA CANAL ZONE- AUSTRALIA



NUMBER OF WET MONTHS

**BALBOA HEIGHTS
9 MONTHS**



11
8 to 10
7
> 11 or < 7

Closely analogous areas

STATION SYMBOLS
 Ⓟ Semianalogous - wetter
 Ⓢ Closely analogous
 Ⓣ Semianalogous - drier
 Ⓞ Not analogous

**CRISTOBAL
10 MONTHS**



12
9 to 11
8
< 8

Wetter areas + Drier areas

RELIABILITY Fair to good ———— Poor ————

PANAMA CANAL ZONE- AUSTRALIA AND NEW GUINEA

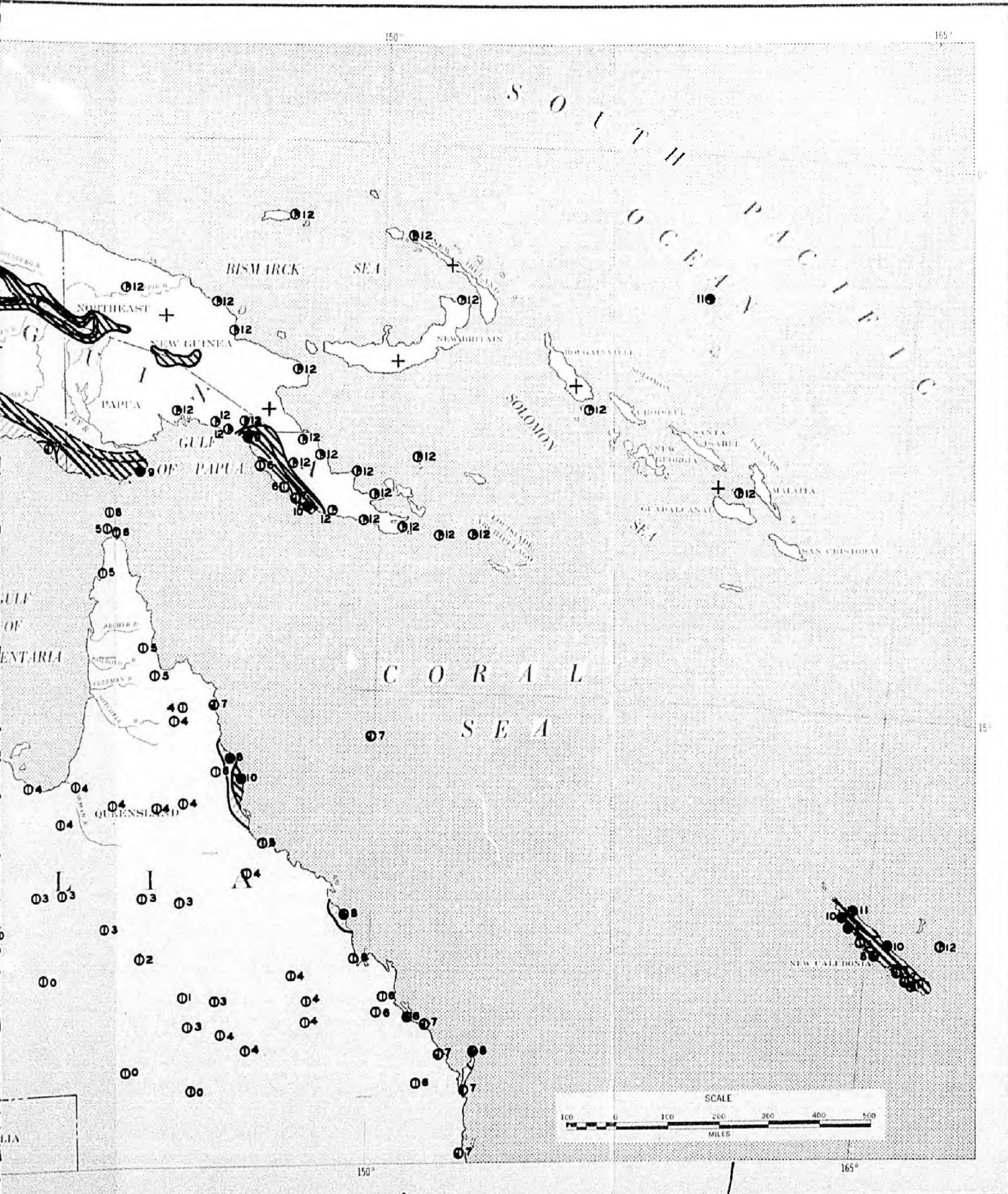
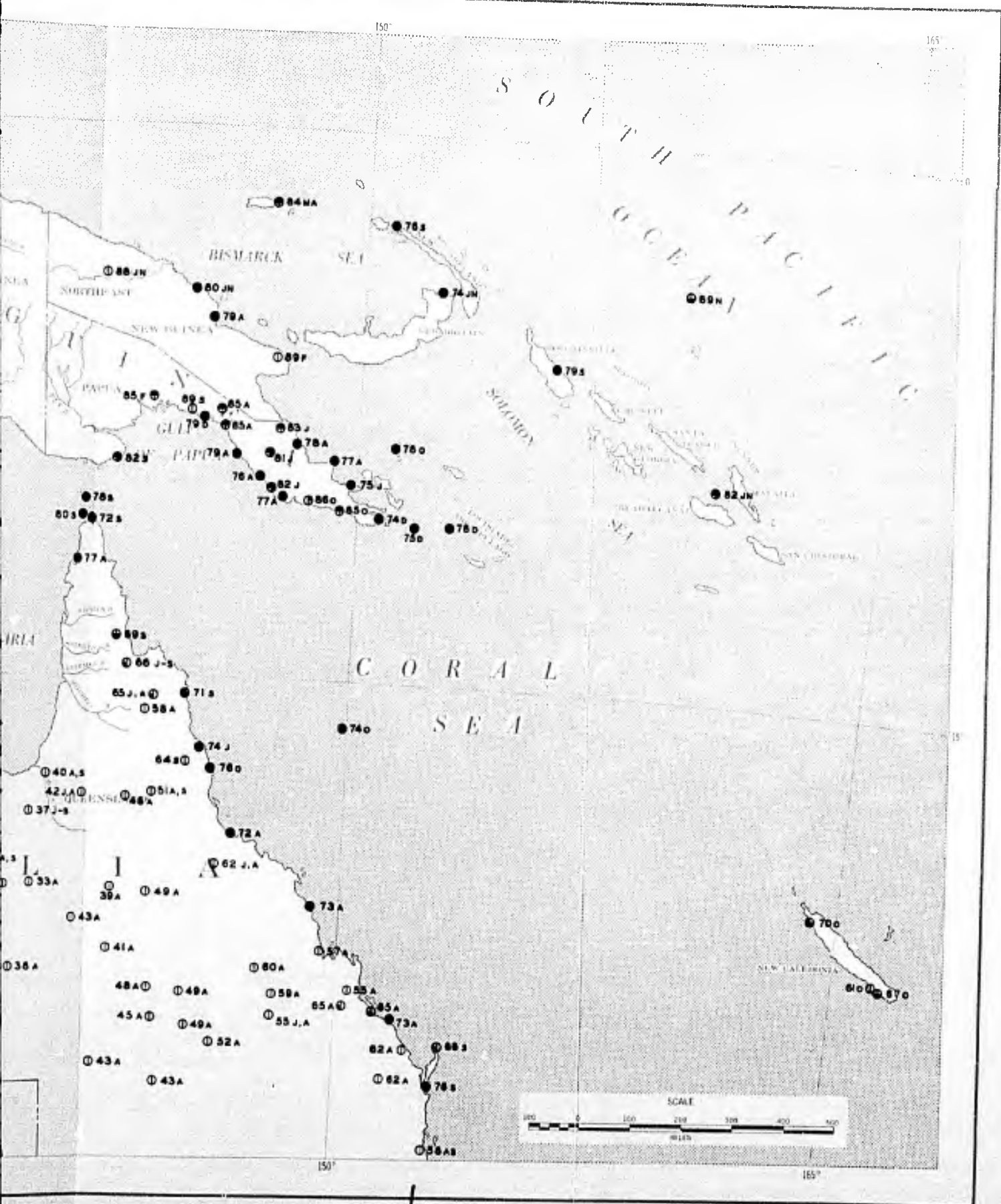


Figure 10

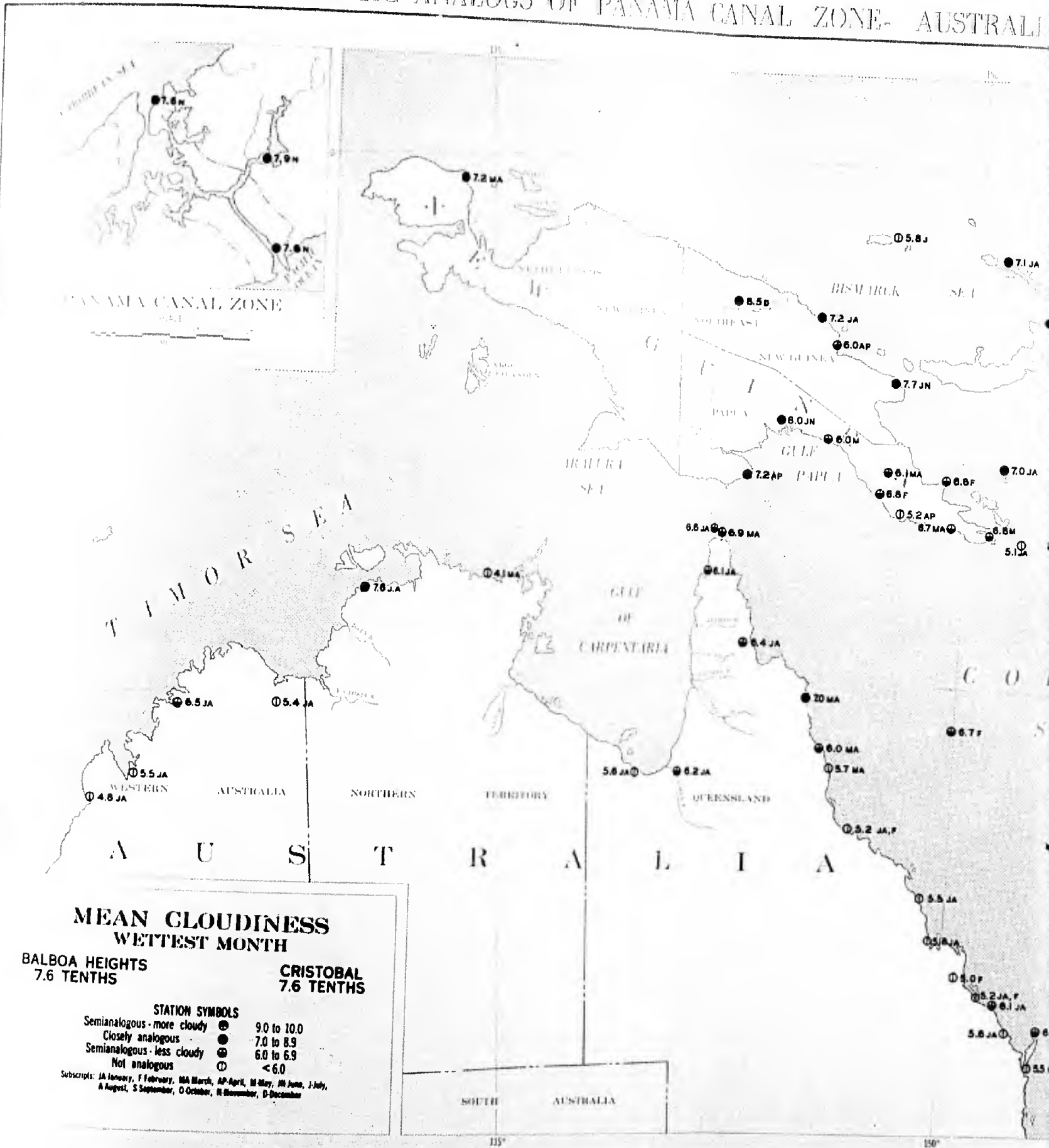
PANAMA CANAL ZONE- AUSTRALIA AND NEW GUINEA



1
2

Figure 11

CLIMATIC ANALOGS OF PANAMA CANAL ZONE- AUSTRALIA



PANAMA CANAL ZONE- AUSTRALIA AND NEW GUINEA

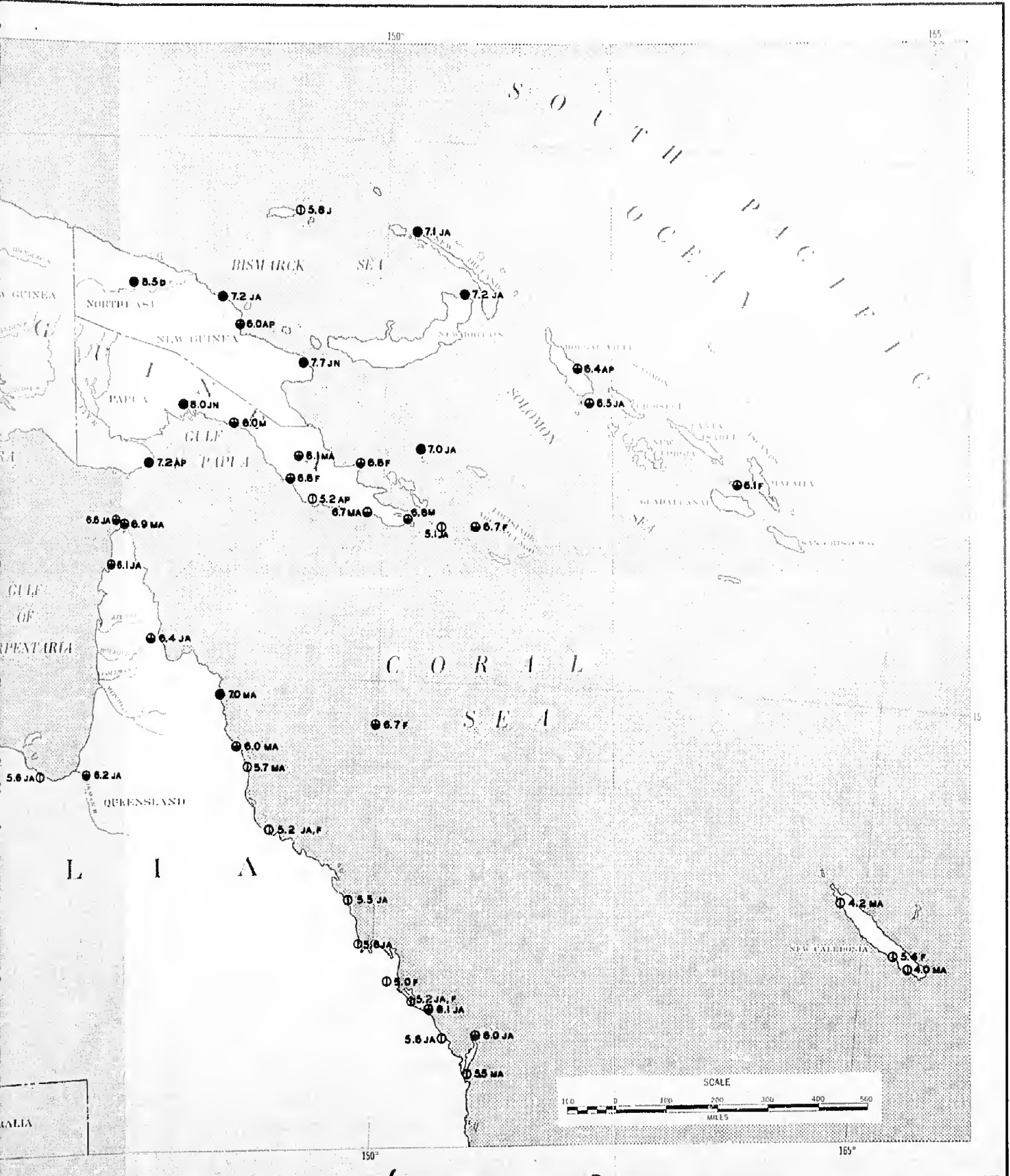


Figure 12

12

PACIFIC CANAL ZONE- AUSTRALIA AND NEW GUINEA

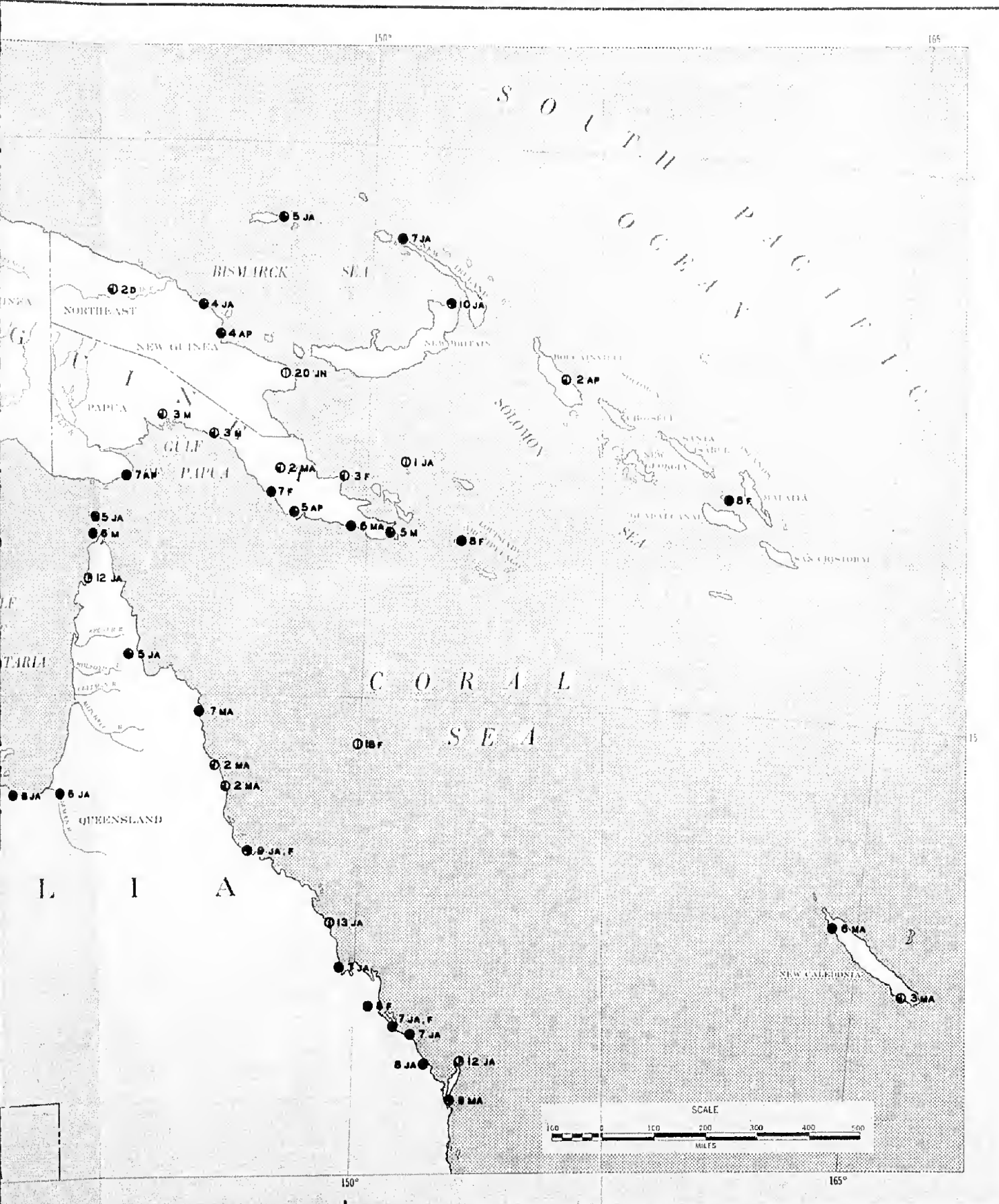
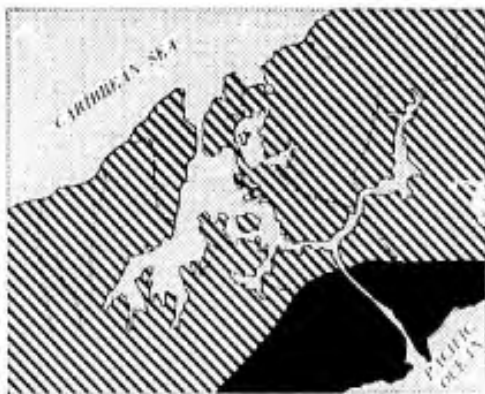
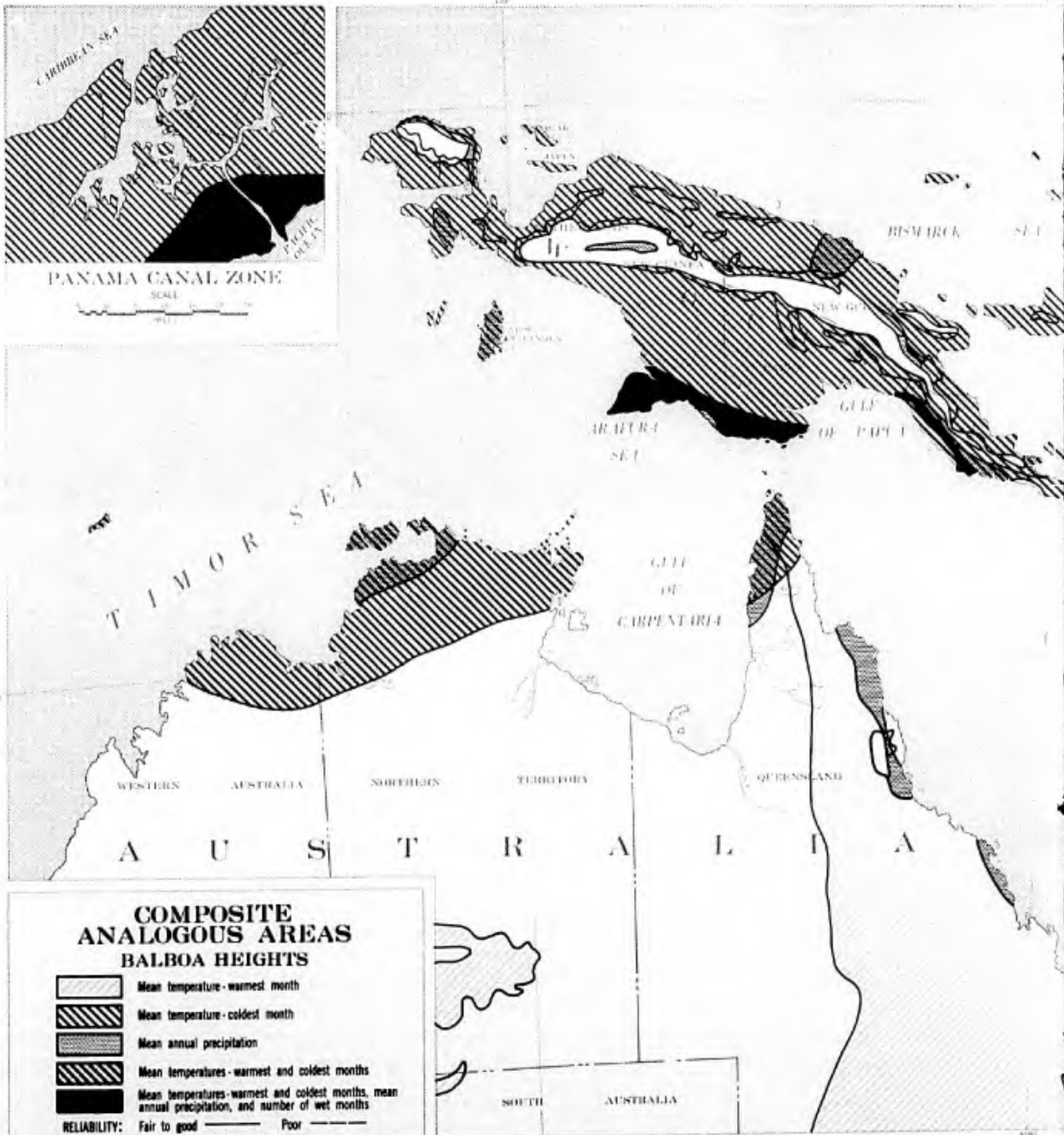
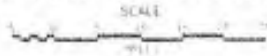


Figure 13

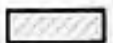




CLIMATIC ANALOGS OF PANAMA CANAL ZONE- AUSTR



PANAMA CANAL ZONE



COMPOSITE ANALOGOUS AREAS BALBOA HEIGHTS

-  Mean temperature - warmest month
-  Mean temperature - coldest month
-  Mean annual precipitation
-  Mean temperatures - warmest and coldest months
-  Mean temperatures - warmest and coldest months, mean annual precipitation, and number of wet months

RELIABILITY: Fair to good ———— Poor - - - - -

MA CANAL ZONE- AUSTRALIA AND NEW GUINEA

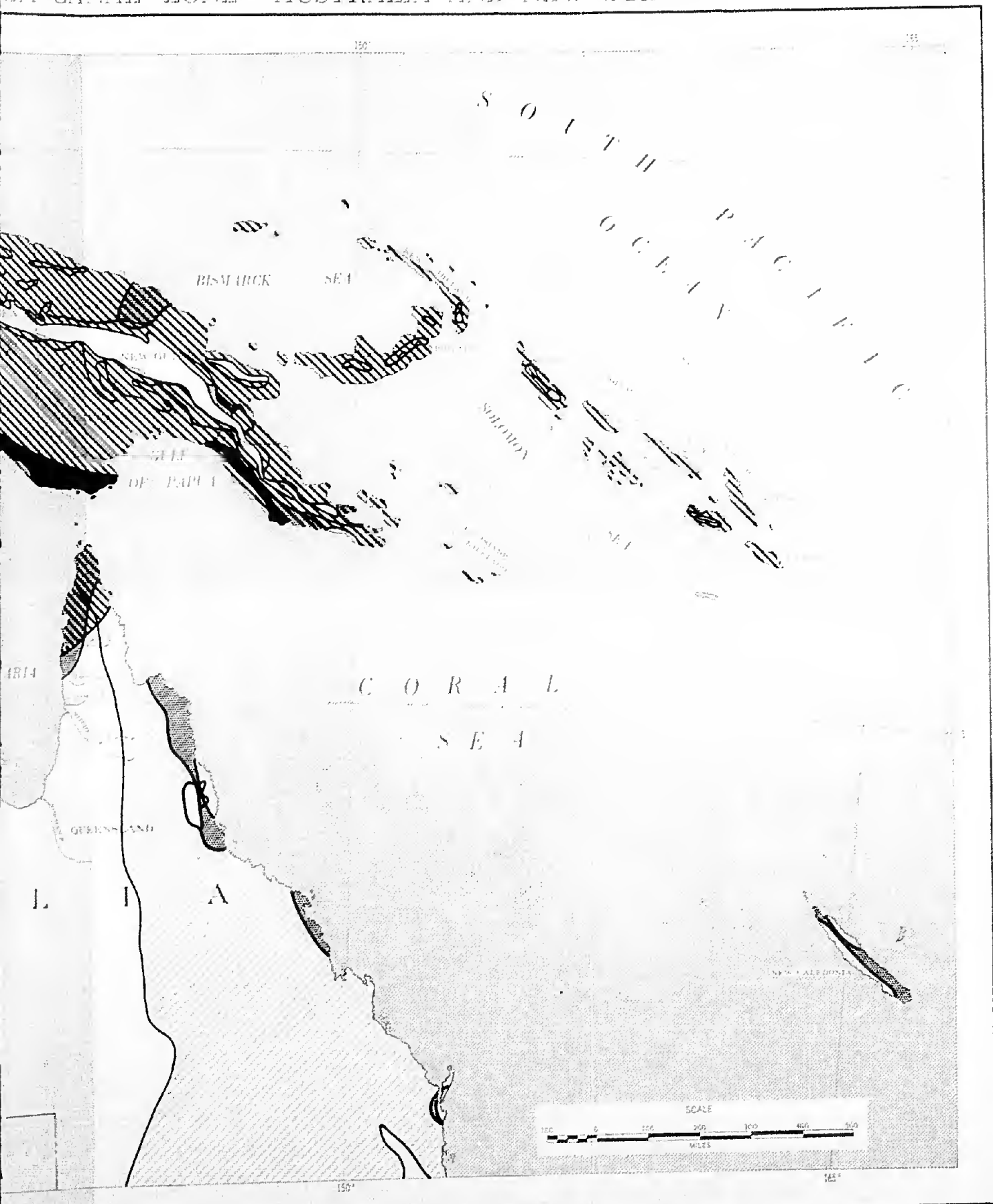


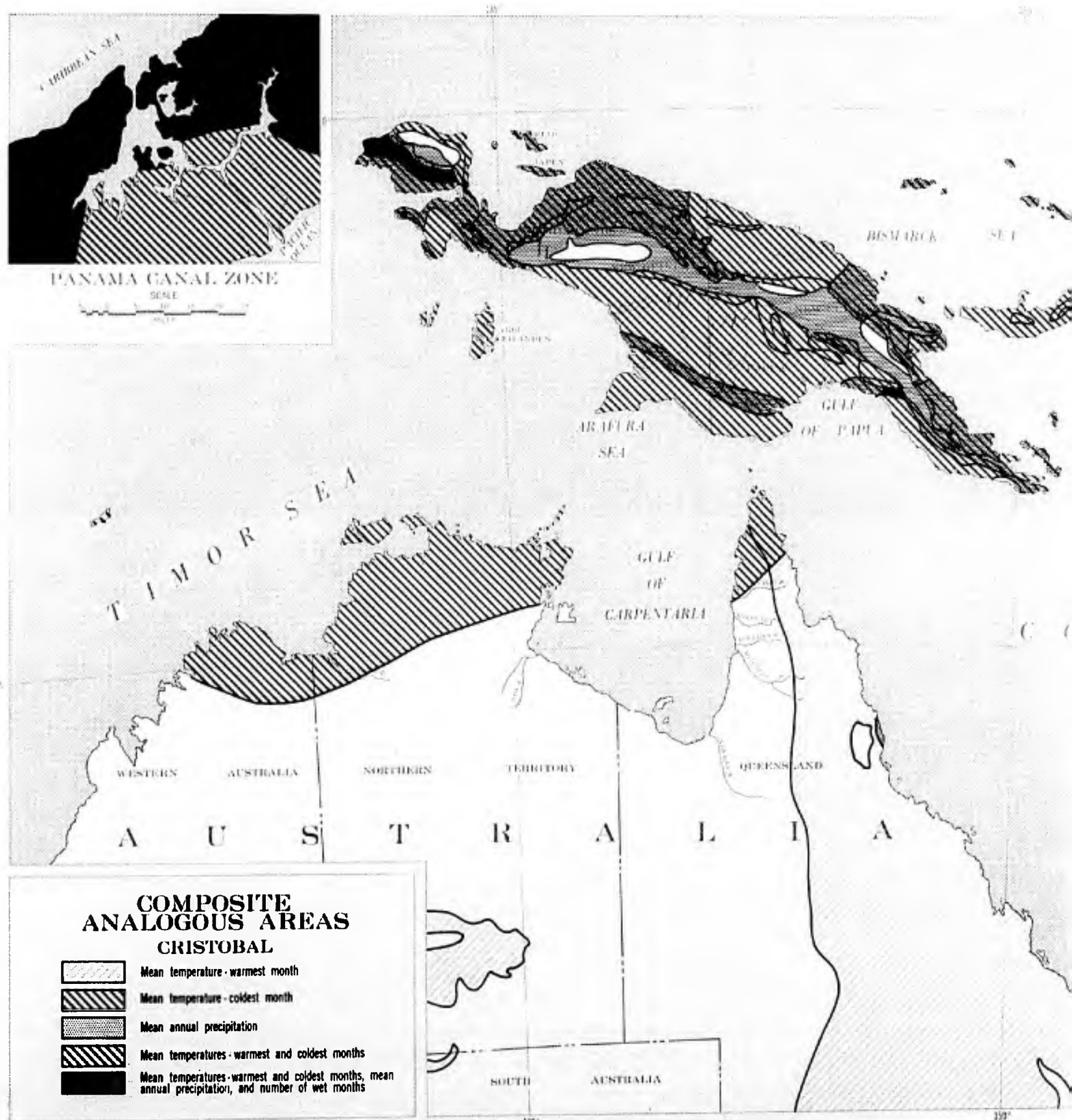
Figure 14

CLIMATIC ANALOGS OF PANAMA CANAL ZONE- AUSTRALIA








PANAMA CANAL ZONE

SCALE
0 10 20
MILES



COMPOSITE ANALOGOUS AREAS CRISTOBAL

-  Mean temperature - warmest month
-  Mean temperature - coldest month
-  Mean annual precipitation
-  Mean temperatures - warmest and coldest months
-  Mean temperatures - warmest and coldest months, mean annual precipitation, and number of wet months

PANAMA CANAL ZONE AUSTRALIA AND NEW GUINEA

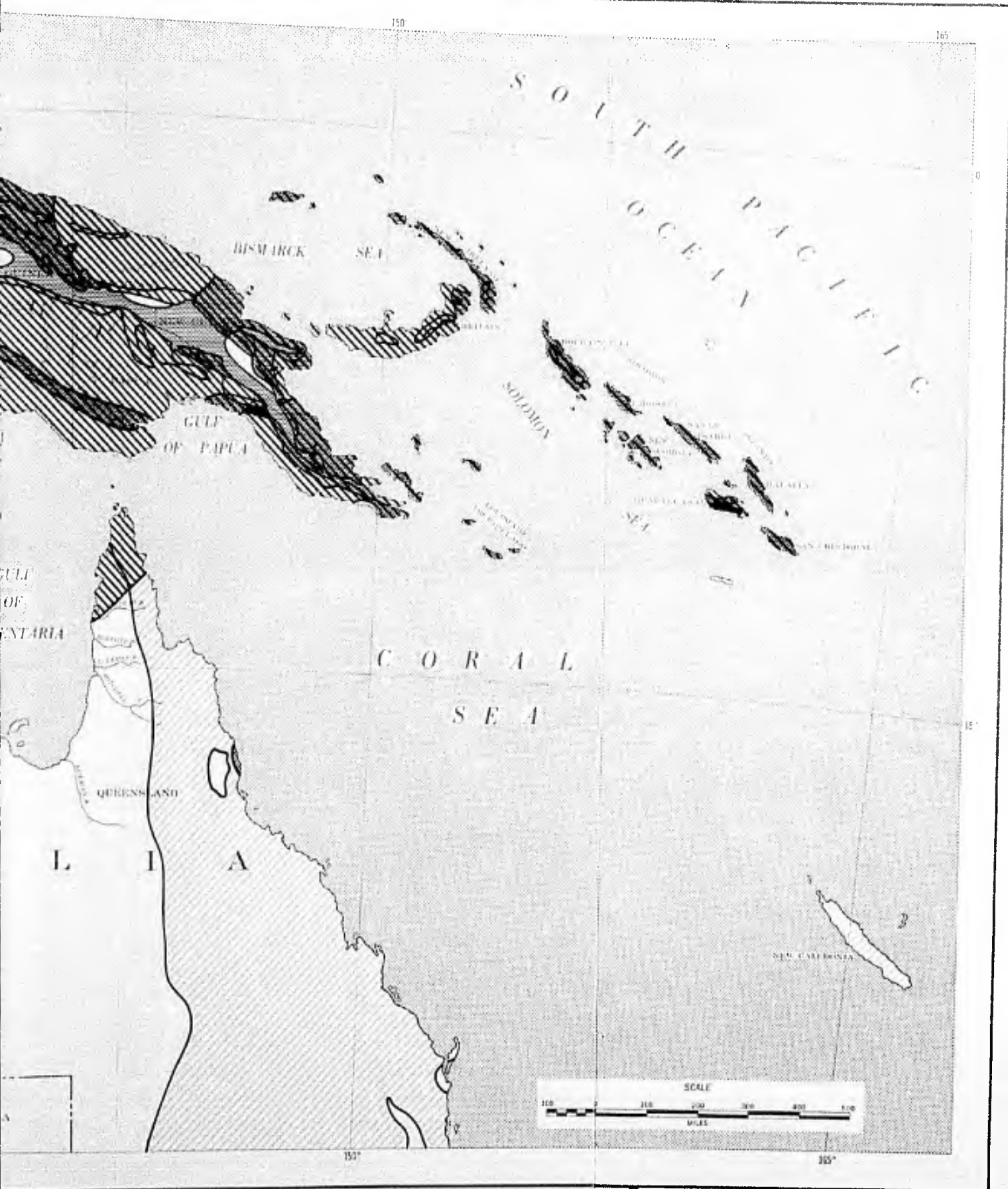


Figure 15