Climatic Backgrounds in the Surveyed Countries in Africa

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Introduction

It is known that the climatic conditions as well as the topography and the soil condition affect the vegetation and agriculture, such as kind of crop, cropping pattern, cropping system and potential yield, etc. in that place [2-3, 6-8, 10-11]. It is naturally expected that climatic conditions also affect the distribution and ecotypic differentiation of wild and cultivated rice species in Africa. So authors are going to take up here the climatological backgrounds in the surveyed countries in Africa, that is, Senegal, Gambia, Liberia, Ivory Coast, Nigeria, Kenya, Tanzania and Madagascar.

The authors would like to express their deep gratitudes to the Government Officials of the African countries concerned. The authors must also express our thanks to the members of the Japanese Embassys in African countries, who helped them greatly in the travelling affairs and to the Ministry of Education, Science and Culture of the Japanese Government.

Materials and Methods

The basic informations on the climatic conditions were obtained from the literatures collected in proper countries and Japan [1, 3-9, 11]. And, the data on temperature, precipitation, duration of sunshine, and evaporation were mainly examined. Each climatic element provided a rough sketch as shown in the followings.

T_m, T_x and T_n ; average value of mean, maximum and minimum air temperatures throughout the observed periods, respectively, T_{mo} ; the revised temperature at sea level, Γ ; lapse rate of temperature, R_m and R_N ; average value of rainfall depth and the number of days with rain throughout the observed periods, respectively. Dv ; degree of variation for annual amount of precipitation calculated by Gherzi's method, S ; duration of sunshine, E_o ; evaporation.

Results and Discussion

1. Climate of West Africa

(1) Outlines

Most of the West Africa tends to show maximum values of air temperature twice a year, that is, just before and after the rainy season, because the sun goes through right above that place twice a year. However, maximum value of air temperature is higher just before, that after, the rainy season, because, in the former case, the land takes an intense insolation under arid condition and there are a few amounts of cloud. Thus, the hottest zone goes up northward in parallel with the northing of the sun (Fig. la), and the warmest period lies about in March in the South and about in July in the North. Annual T_m is between 25°C and 30°C in most of the West Africa excepting the western parts of Western Sahara, Senegal and Mauritania influenced by the Canaries current (cold current) and the highlands such as western and southeastern parts of Guinea and northern part of Nigeria. Furthermore, even in these exceptional areas, annual T_m is larger than 20°C (Fig. 1b).

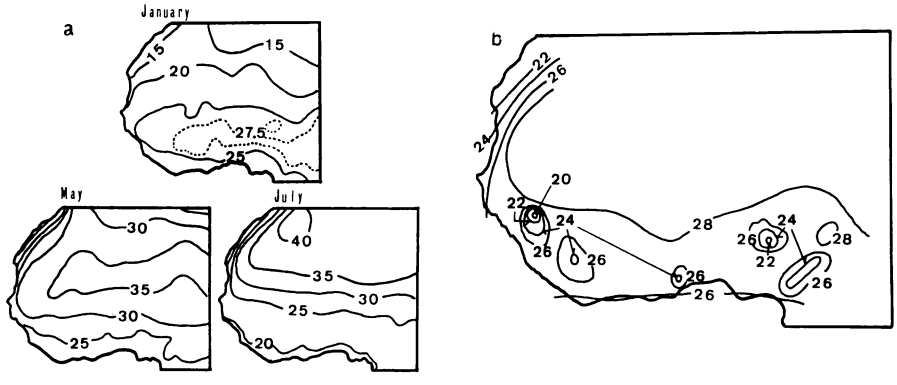


Fig. 1. Distribution-charts of the monthly average maximum air temperature (a) and the annual mean temperature (b) (°C) in West Africa.

Precipitation in January is restricted within the districts along the shore of Gulf of Guinea, with an arid condition covering the others. Through February into August, range of precipitation extends, monthly R_m increases gradually. And those come back again through September into January (Fig. 2a). It has been considered that such a systematic change of precipitation results from the migration of weather belt occurring simultaneously with the northward and southward movements of the intertropical convergence zone and from the topographical flatness in these areas[9]. Consequently, with the exception of the central district along the shore of Gulf of Guinea, annual R_m changes considerably and regularly from the count greater than 4,000 mm in west and east coastal districts to the one less than 100 mm in inland districts with the increasing in latitude (Fig. 2b). On the other hand, it has been deemed that the exceptionally light

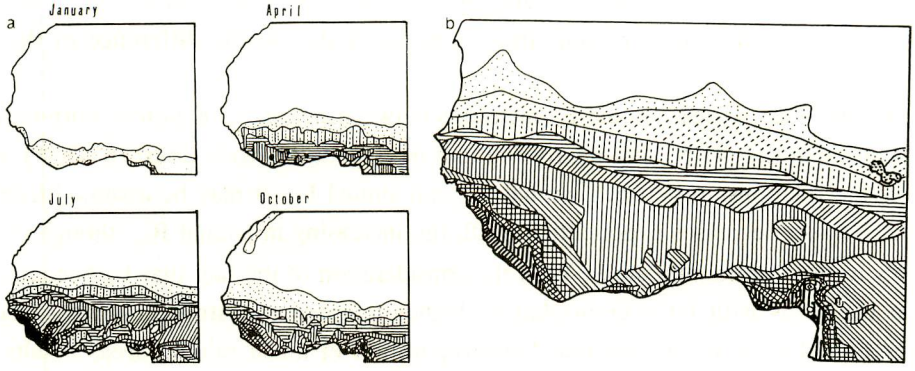
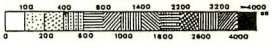


Fig. 2. Distribution–charts of the monthly rainfall depth (a) and the annual amount of precipitation (b) (mm) in West Africa.

Note 1 :  (a)

Note 2 :  (b)

rain in the central districts along the shore of Gulf of Guinea results from the ascent of cold water mass occasioned by the off–shore current[9].

Because R_N and the cloud amount are more abundant in the South than in the North, annual S becomes considerably poorer in the South than in the North of West Africa. For instance, the annual S is only 1,500 hours in Abidjan of Ivory Coast (5° 15'N) as against about 3,600 hours in Agadez of Niger (18° 41'N). Fig. 3 shows the relationship between the annual S and the annual R_m. It may be assumed from Fig. 3 that

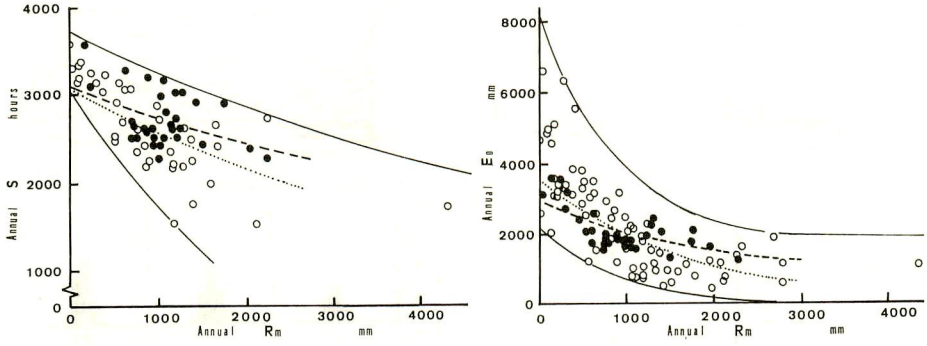


Fig. 3. Relationship between the annual duration of sunshine (annual S hours) and the annual amount of precipitation (annual R_m mm).

Note 1 : ○ ; West Africa, ····● ; East Africa

Note 2 : $S_{West\ Africa} = 3052\ e^{-0.000169R}$ $(r=0.672^{**})$

$S_{East\ Africa} = 3067\ e^{-0.000112R}$ $(r=0.441^{**})$

※※ $P<0.01$

Fig. 4. Relationship between the annual evaporation (annual E_o mm) and the annual amount of precipitation (annual R_m mm).

Note 1 : Symbols are the same as those in Fig. 3.

Note 2 : $E_{oWest\ Africa} = 3543\ e^{-0.000618R}$ $(r=0.719^{**})$

$E_{oEast\ Africa} = 2889\ e^{-0.000365R}$ $(r=0.694^{**})$

※※ $P<0.01$

annual S generally decreases exponentially with the increasing in annual R_m, though it varies widely in the much raining areas presumably due to the difference in the rainy pattern.

In the West Africa, annual E_o measures between nearly 6,500 mm in Fort-Gouraud of Mauritania (22° 41'N) and nearly 500 mm in Gagnoa of Ivory Coast (6° 08'N). Fig. 4 shows the relationship between annual R_m and annual E_o. It may be assumed from Fig. 4 that E_o also decreases exponentially with the increasing in annual R_m, though it varies widely in the thin raining areas. With the consideration of the fact that E_o becomes larger in the areas with intenser-insolation, higher-temperature, stronger-wind speed and lower-humidity, it is guessed that low-evaporation in much raining areas results from the poor insolation and the high-humidity, and that high-evaporation in thin raining areas results from the intense insolation, low-humidity and high-temperature.

Therefore, it may be admitted as a conclusion that climates of West Africa are to be characterized by water-excess and low-bright sunshine in the South, and by water-shortage and high-bright sunshine in the North, respectively.

(2) Senegal and Gambia

Fig. 5 shows the distribution-charts of annual T_m and annual R_m in Senegal and Gambia, and changes of monthly T_m and monthly R_m in the main cities[4, 6, 9].

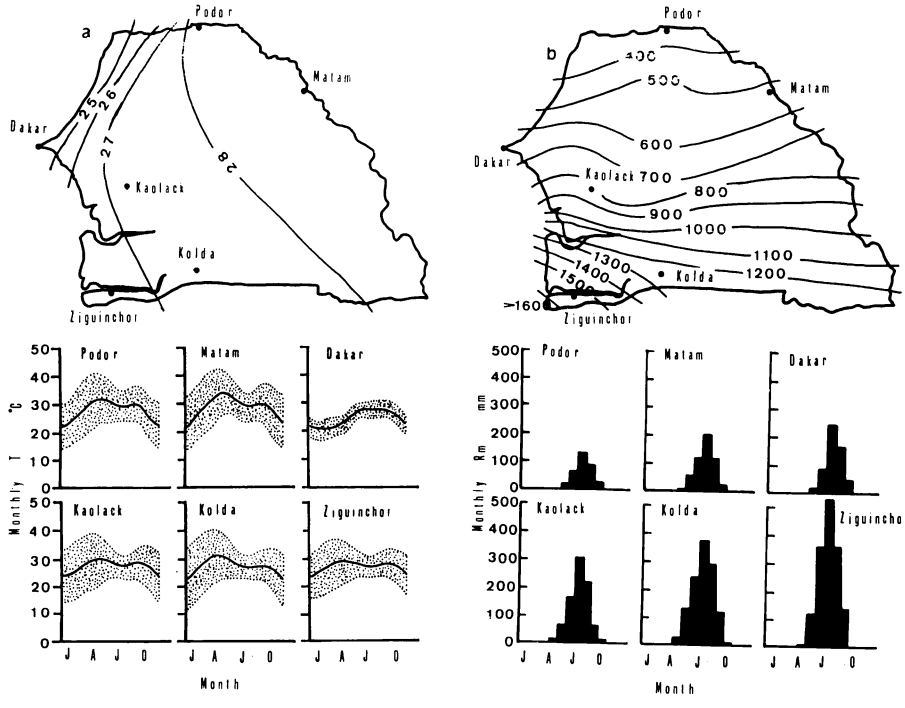


Fig. 5. Distribution-charts of the annual mean air temperature (a) (°C) and the annual amount of precipitation (b) (mm) in Senegal and Gambia, and the changes of monthly average maximum, mean and minimum air temperatures (a) (°C), and the monthly rainfall depth (b) (mm) in their main cities.

Note : Maximum temperature
Mean temperature
Minimum temperature

Annual T_m and annual R_m decrease gradually from the inland district to the coastal district, and from the South to the North, respectively.

A broad division of seasons in these countries is made between dry season and rainy season by the rainfall depth. There are few rainings in all the parts of these countries through November into March. For instance, the total R_ms within this period of time are only 13 mm, 3 mm and 30 mm in Dakar, Tambacounda and Banjul, respectively. Similarly, R_Ns are only 1.4, 1.5 and 1.5 days, respectively. Monthly R_m and R_N begin to increase gradually in the southeastern parts roughly in the month of April, reaching the climax roughly in August. And in the North those begin to decrease rapidly in October, and in the South, in November. Adding to the limited rainfall depth, precipitation in the North of Senegal is characterized by its uncertainty and irregularity. For instance, although annual R_ms in Matam and in Linguere average 520 mm and 533 mm, respectively, real annual amount of precipitation varies between 256 mm and 1,112 mm in Matam, and between 205 mm and 854 mm in Linguere, year by year, respectively. That is, Dvs reach 1.6 and 1.2 in Matam (15° 38'N) and in Linguere (15° 23'N), respectively.

(3) Liberia

Figs. 6a and 6b show the distribution–charts of annual T_m and annual R_m in Liberia and changes of monthly T_m and monthly R_m in the main cities[5, 9]. The climate of this country is characterized by the general high–temperature and much moisture throughout

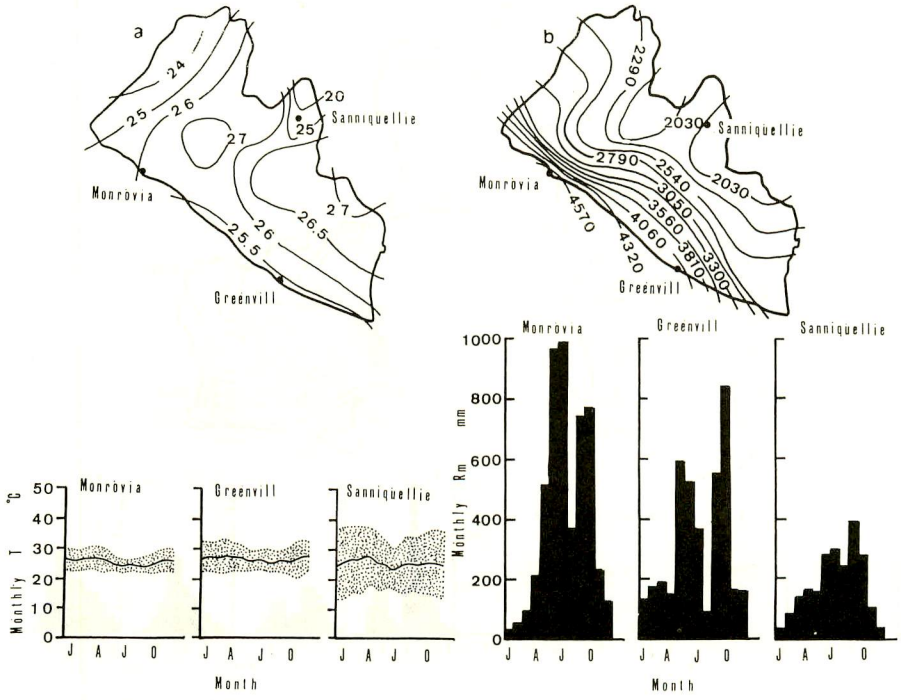


Fig. 6. Distribution–charts of the annual mean air temperature (a) (°C) and the annual amount of precipitation (b) (mm) in Liberia, and the changes of monthly average maximum, mean and minimum air temperatures (a) (°C), and the monthly rainfall depth (b) (mm) in its main cities.
Note : Symbols are the same as those in Fig. 5.

the year. That is, annual T_m in most of this country, excepting the peripheral region of Mt. Nimba, is 24 ~27°C, annual R_m reaching 2,000~4,800 mm.

Even the period through December into April when the northern countries have dry season, there is R_N counting more than five days and monthly R_m showing more than 50 mm on an average in all the parts of the country. R_m and R_N begin to be increasing rapidly in the coastal district roughly in May and in the northwestern hilly district roughly in June, and monthly R_N comes to be accounting for more than 2/3 of one month. Although monthly R_m and R_N decrease rapidly once roughly in August, this tendency isn't so conspicuous in the northern parts. Thereafter, those increase once again in September and October, beginning to come back again in the hilly district roughly in November, and in the coastal district roughly in December. Monthly T_m differs only a little from annual T_m throughout the year.

(4) Climate of Ivory Coast

Figs. 7a and 7b show distribution-charts of annual T_m and annual R_m in Ivory Coast, and changes of monthly T_m and monthly R_m in the main cities of each meso-climatic zone[3, 9]. Ivory Coast falls into the four meso-climatic zones as shown in Fig. 7c[3].

I) The South

This meso-climatic zone is characterized by high-temprature, much moisture and small ranges of temperature. That is, annual R_m is 1,600~2,200 mm, annual T_m is 26~

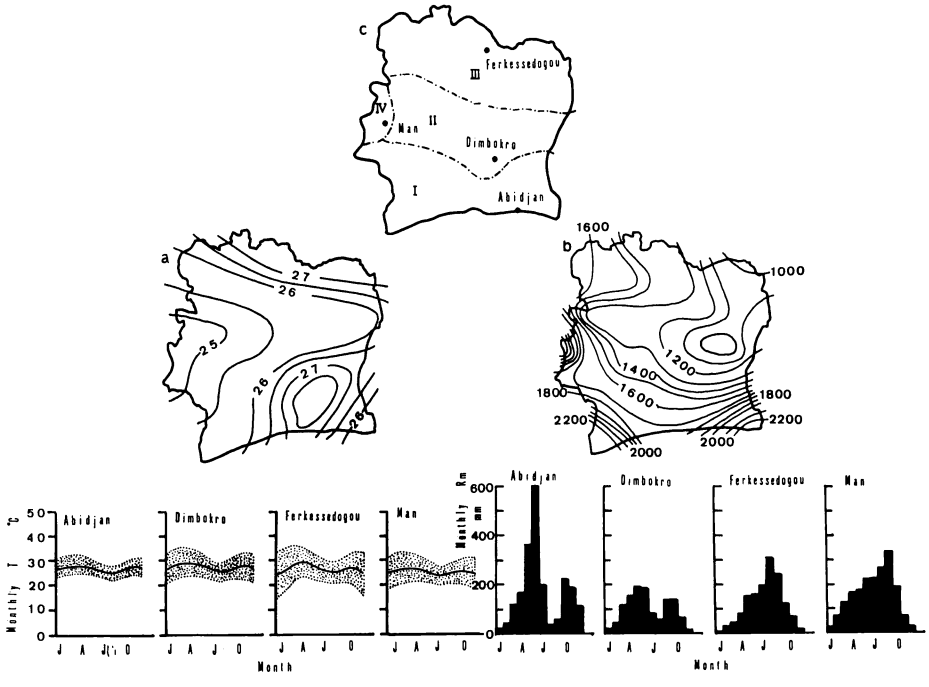


Fig. 7. Distribution-charts of the annual mean air temperature (a) (°C) and the annual amount of precipitation (b) (mm) in Ivory Coast, and the changes of monthly average maximum, mean and minimum air temperatures (a) (°C), and the monthly rainfall depth (b) (mm) in its main cities and climatic division (c) in Ivory Coast.
Note : Symbols are the same as those in Fig. 5.

27°C and both diurnal and annual ranges of temperature are less than, or equal to, 5°C. Monthly R_m and R_N through December into February are 50～100 mm and 2～3 days, respectively. Although these values are smaller than those in other months, those in this climatic zone are not so small as those in the others (major dry season). Precipitation reaches the first maximum roughly in May or June (major rainy season), after that it begins to be increasing gradually roughly in March. There is a minor dry season on the west side during the period through July into August, and on the east side through August into September. This season is distinguished from the main dry season by the facts that R_N and cloud amount are more than those in the latter. Precipitation increases again through September or October into November (minor rainy season), coming back again, thereafter.

Ⅱ) The central district

This meso–climatic zone is situated at the transition section between the South above–mentioned and the North described later. That is, annual R_m is 1,100～1,600 mm, annual T_m is 25～26°C, and both the diurnal and annual ranges of temperature become slightly wider than those in the South. The dry season is through November into March and the rainy season is through April into October, provided that monthly R_m keeps showing the two peaks in June and September because of the northing and southing of intertropical convergence zone.

Ⅲ) The North

Although annual T_m is 25～27°C, ranges of temperature are considerably larger than those of the above–mentioned other meso–climatic zones. Annual R_m is 900～1,100 mm, excepting 1,400～1,600 mm in the northwestern parts. There are few rainings through December into February, thereafter, precipitation begins to increase gradually roughly in March. Monthly R_m reaches the climax through July into September. Total R_m within this period of time 600～1,000 mm, and that accounts for more than half of the annual R_m. Precipitation begins to decrease gradually through October into November, thereafter coming back again.

Ⅳ) The western hilly districts

This meso–climatic zone is characterized by a relative coolness, large ranges of temperature, and much raining. That is, annual mean temperature is 24～25°C, rainy season is through March into October and annual R_m is 1,700～2,200 mm.

(5) Climate of Nigeria

Figs. 8a and 8b show the distribution–charts of annual T_m and annual R_m in Nigeria as well as the changes of monthly T_m and monthly R_m in the main cities of each meso–climatic zone[7, 9]. Nigeria falls into the four meso–climatic zones as shown in Fig. 8c[7].

Ⅰ) The South

This meso–climatic zone is characterized by the high–temperature, much moisture and small ranges of temperature. That is, annual T_m is about 26°C, monthly average diurnal range of temperature in each month is 5～8°C, and annual range of temperature is 2～4°C. Annual R_m is greater than 1,500 mm in either place, although it tends to become greater in the eastern parts than in the western parts. Monthly R_m even through

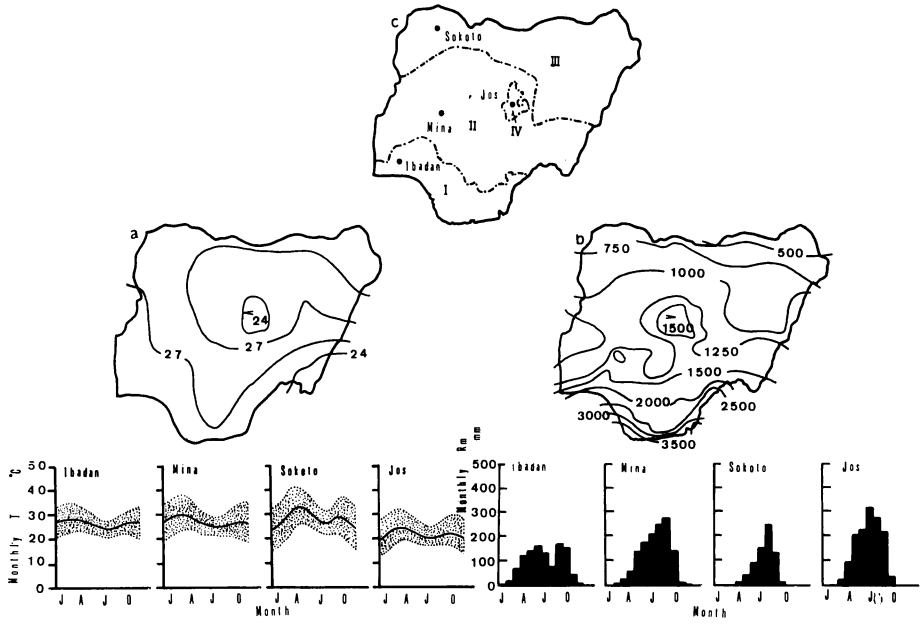


Fig. 8. Distribution–charts of the annual mean air temperature (a) (°C) and the annual amount of precipitation (b) (mm) in Nigeria, and the changes of monthly average maximum, mean and minimum air temperatures (a) (°C), and the monthly rainfall depth (b) (mm) in its main cities and climatic divisions (c) in Nigeria.
Note : Symbols are the same as those in Fig. 5.

December into January is about 50 mm on an average. Thereafter, it increases gradually into nearly June, and, the period from March to July forms the major rainy season. Although monthly R_m decreases once in August, it increases once again through September into October (minor rainy season), beginning to come back again in November.

II) The central district

This meso–climatic zone is situated in the transition districts between the above–mentioned South and the North that is going to be described later. Annual R_m is 1,000~1,500 mm. Monthly R_m and R_N through December into January are less than, or eqaul to, 10 mm and one day, respectively. Precipitation begins to be increasing gradually in either place roughly in February. And, the western part has two rainy seasons, that is, first rainy season lasting from May to June and the second one lasting from September to October, and the eastern part has one rainy season from May to September. Thereafter, precipitation begins to decrease through October into November.

III) The North

Annual R_m is 500~1,000 mm. There are few rainings through November into April. The rainy season is through June into September, and total R_m within this period of time accounts for about 80% of the whole.

IV) The central hilly district

This district is marked off from the others by the fact that annual T_m is lower than those, in the peripheral regions of this district, that is, less than, or equal to, 24°C. R_m is more slightly than those in the peripheral regions.

2. Climate of East Africa

(1) Outlines

Compared with the other African areas, East Africa lying on the Great Rift Valley has some intricate configurations of the ground, including high mountains such as Mt. Kenya (5,200 m), Mt. Kilimanjaro (5,895 m) and Mt. Ruwenzori (5,119 m) and some large lakes, such as Victoria, Tanganyika and Nyasa. Fig. 9 shows the transverse section diagrams of topography, annual R_m and annual T_m across the equatorial zone of Kenya from the Indian Ocean to the Lake Victoria. Annual T_m changes keeping very close connection with altitude, and annual R_m is greater on the east side of Mt. Kenya and the west side of Mau' mountainous district than in any other districts. Thus the complexity of the topography makes the climate of East Africa considerably complicated.

Fig. 10 shows the relationship between T_{mo}, Γ and annual range and annual average diurnal range of temperature, and latitude. It may be assumed from Fig. 10 that temperature conditions change considerably not only in accordance with altitude but also with latitude. For instance, it is seen from Fig. 10 that T_{mo} is the highest between 15° N and 10° N, that Γ tends to be decreasing with nearing to south, and that annual range and annual average diurnal range of temperature tend to be increasing with the increase in latitude, becoming about two times, in the northern hemisphere, as large as in the south-

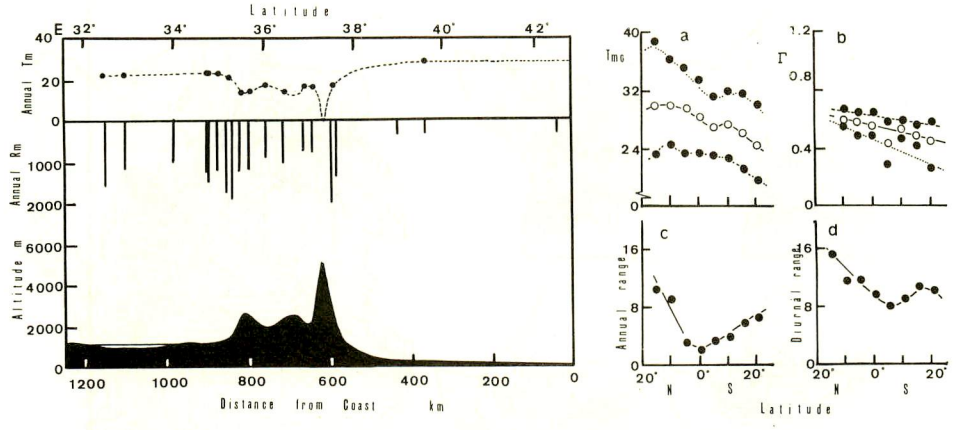


Fig. 9. Transverse section–diagrams of topography, the annual amount of precipitation (annual R_m) and the annual mean temperature (annual T_m) across equatorial zone of Kenya.
Note 1 : ● ; Observed values and ····· ; Calculated values (See Fig. 10).

Fig. 10. Relationships between latitude and the revised temperature at sea level (a) (T_{mo}, °C), lapse rate of temperature (b) (Γ, °C / 100 m), and the annual range (c) and the annual average diurnal range (d) of temperature (°C) in East Africa.
Note 1 : Annual $T_m = T_{mo} - \Gamma \times$(Altitude) (100 m)
Note 2 : ·····● ; Maximum temperature, —○ ; Mean temperature, ---● ; Minimum temperature (a and b).

ern hemisphere. Thus, different combinations of altitudes with latitudes tend to make the distribution of air temperature in East Africa considerably complicated.

Fig. 11 shows the changes of monthly R_m and the distribution–chart of annual R_m in the East Africa. Precipitations in January and in July are restricted within the southern and the northern hemispheres, respectively. And most of the East Africa are covered with raining in April and October. That is, in principle, the hemisphere of precipitation tends to be migrating in parallel with the northing and southing of the sun (Fig. 11a). However, in practice, a complexity of the topography in the East Africa makes the period of rainy season considerably complicated as described later. On the other hand, it may be fixed as a general rule that the annual R_m increases in the peripheral regions of high mountains such as Mt. Kenya and Mt. Kilimanjaro, where it is greater than 2,000 mm (Fig. 11b). However, compared with the much amount of rainfall in the same latitude of West African areas, R_m of the East Africa tends to become remarkably small. That is, the fact that most of the East Africa forms what is called the "equatorial dry zone" best characterizes the rainfall in the East Africa.

In Kenya, annual S measures between nearly 2,300 hours in Kimakia (Alt. 2,439 m) and almost 3,600 hours in Lodwar (Alt. 506 m). Generally speaking, annual S tends to become poorer in the higher lands on the whole. Perhaps this tendency may be connected with differences in R_N and with the cloud amount in each place (Fig. 3).

On the other hand, annual E_o in Kenya measures between nearly 1,250 mm in Kimakia and nearly 3,600 mm in Lodwar. Annual E_o as well as annual S tends to be de-

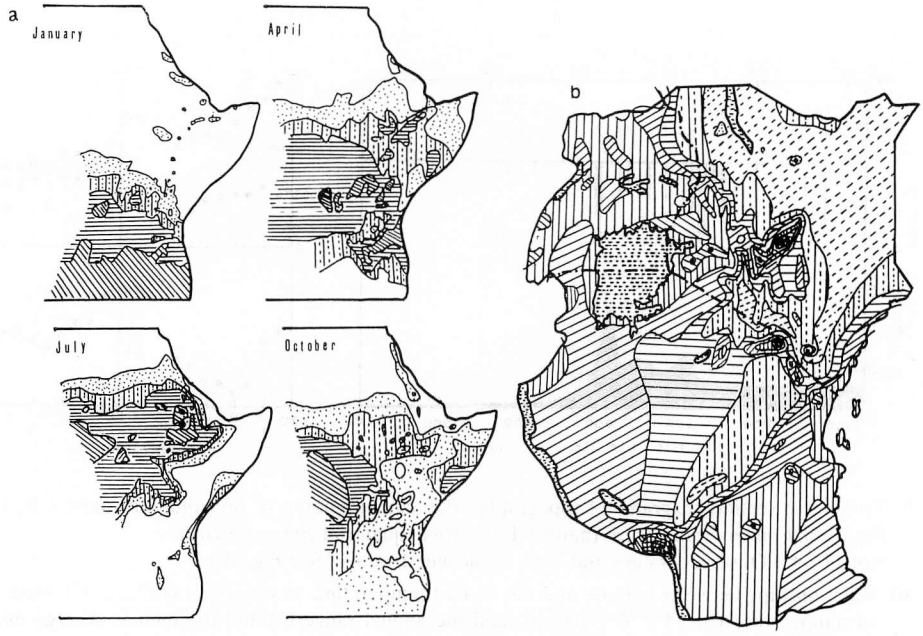
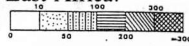
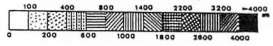


Fig. 11. Distribution–charts of the monthly rainfall depth (a) and the annual amount of precipitation (b) (mm) in East Africa.

Note 1 :  (a)

Note 2 :  (b)

creasing with altitude. This may be partly connected with lower temperature [8] and partly with less bright sunshine in higher lands (Fig. 4).

Therefore, it may be admitted as a conclusion that climates of East Africa are characterized by water–shortage, high temperature and high bright sunshine in the lowland, and by water–excess, low temperature and less bright sunshine in the highland.

Details are given as in the following.

(2) Climate of Kenya

Kenya falls into the following seven meso–climatic zones as shown in Fig. 12[9].

Ⅰ) Peripheral region of the Lake Turkana

Annual R_m is less than 400 mm. Dv is about 0.8. There are two rainy seasons, that is, the first rainy season lasting from March to May and the second rainy season lasting from November to December. And the former is the main rainy season. Annual R_N is about 20 days. Monthly T_m changes from 28°C in August to 31°C in March. Diurnal

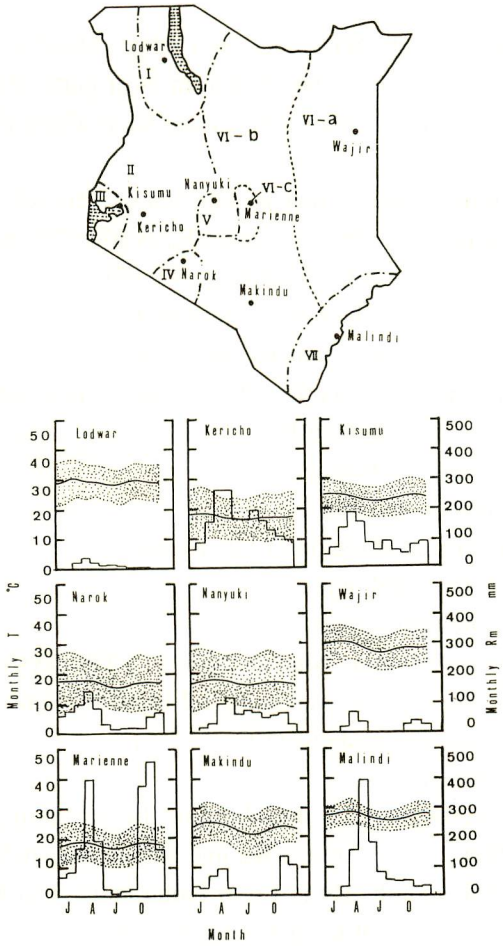


Fig. 12. Climatic division in Kenya and the changes of monthly average maximum, mean and minimum air temperatures (°C), and the monthly rainfall depth (mm) in its main cities.
Note : Symbols are the same as those in Fig. 5.

range of temperature is about 11°C.

Ⅱ) Kitale – Kericho – Kishi

There is one rainy season in the northern parts through April into September and in the southern parts through May into October. Monthly R_m in rainy season is greater than 125 mm. January is a relatively dry month, and R_m in January is less than 25 mm in the northern parts and greater than, or equal to, 50 mm in the southern parts. Annual R_m changes from 500 mm to 1,500 mm in the northern parts and from 1,200 to 2,400 mm in the southern parts. R_N is 100～150 days in the northern parts and about 200 days in the southern parts. Diurnal range of temperature is 10～15°C.

Ⅲ) The northern parts of the Lake Victoria

Although one period from March to June and the other period from October to November form the respective rainy seasons, there are no typical dry months (monthly $R_m < 25$ mm). Annual R_m is 1,150～1,520 mm and R_N is 125～155 days. Dv is about 0.4.

Ⅳ) Narok

Rainy season is through November into May. Monthly R_m during dry season through June into October is less than 25 mm in most parts of this zone. Annual R_m is 650～750 mm, and Dv is greater than 1.3. Annual R_N is about 100 days.

Ⅴ) Nanyuki

There are two rainy seasons, that is, one season through April into May and the other through August into November. Annual R_m is 650～750 mm, and Dv is about 0.8. Annual R_N is about 110 days. Diurnal range is 14～17°C.

Ⅵ) The central and the northeastern parts

There are two rainy seasons, that is, one season through March into May and the other through November into December. This meso–climatic zone is divided further into three sub–climatic zones according to R_m.

a) Garissa – Mandera

Annual R_m is less than 400 mm.

b) Peripheral region of Mt. Kenya

Annual R_m is 1,000～1,400 mm.

c) The central part

Annual R_m is 500～900 mm. Annual R_N is 70～130 days excepting about 130 days in Naivasha–Nakuru. Dv is 2.6 in Makindu, 1.2 in Nairobi and 0.8 in Voi, respectively. Diurnal range of temperature is about 11°C.

Ⅶ) Coastal regions

Rainy season is through April into June in the northern parts and through April into July in the southern parts. Annual R_m and annual R_N are 90～140 days, respectively, increasing toward the south. Dv is 1.6 in Lamu and 1.1 in Mombasa, decreasing toward the south. Diurnal range of temperatutre is 6～8°C.

(3) Climate of Tanzania

Tanzania falls generally into the following three meso–climatic zones as shown in Fig. 13[9].

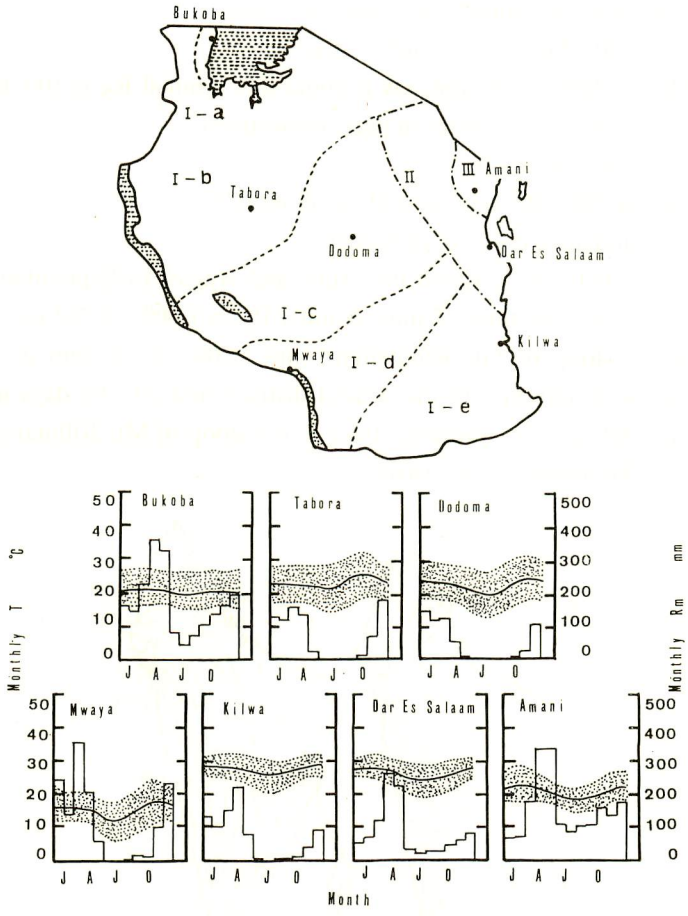


Fig. 13. Climatic division in Tanzania and the changes of monthly average maximum, mean and minimum air temperatures (°C) and the monthly rainfall depth (mm) in its main cities.
Note : Symbols are the same as those in Fig. 5.

I) Western Tanganyika

This meso–climatic zone has one rainy season in common. And this is divided further into the following five sub–climatic zones according to a little difference of rainfall depth and the period of rainy season.

a) Bukoba

It rains through December into May, and annual R_m is 1,300～2,000 mm. Dv is about 0.5, and annual R_N is more numerous than 150 days.

b) The northern district

Rainy season is through December into May, and annual R_N is 100～120 days. The number of months in which monthly R_m is less than 25 mm is about 4 months, centering around June–August. Dv is about 1.0 in Tabora and about 0.6 in Kigoma.

c) The central district

It rains largely through December into April, and annual R_N is about 60 days. The period through June into October forms a dry season. Annual R_m is 500～750 mm and

Dv is 1.4 in Dodoma and about 0.6 around Dodoma.

d) The southern hilly district

Annual R_m is 900～2,900 mm, Dv is about 0.8. Annual R_N is 100 days in the northern part and 170 days in the southern part, respectively.

e) The South

Annual R_m is 750～900 mm, and Dv is about 0.7.

Ⅱ) Kilimanjaro – Dar es Salaam

Rainy season is through March into May, and August or September is a dry month, monthly R_m counting less than 25 mm. Annual R_m is 1,000～1,200 mm excepting about 1,800 mm in the sloop of Mt. Kilimanjaro and 1,200～2,200 mm in Island of Mafia. Annual R_N is about 130 days in the coastal districts and 70～90 days in the inland districts excepting 160 days in Lyamungu lying in the sloop of Mt. Kilimanjaro.

Ⅲ) The northeastern district

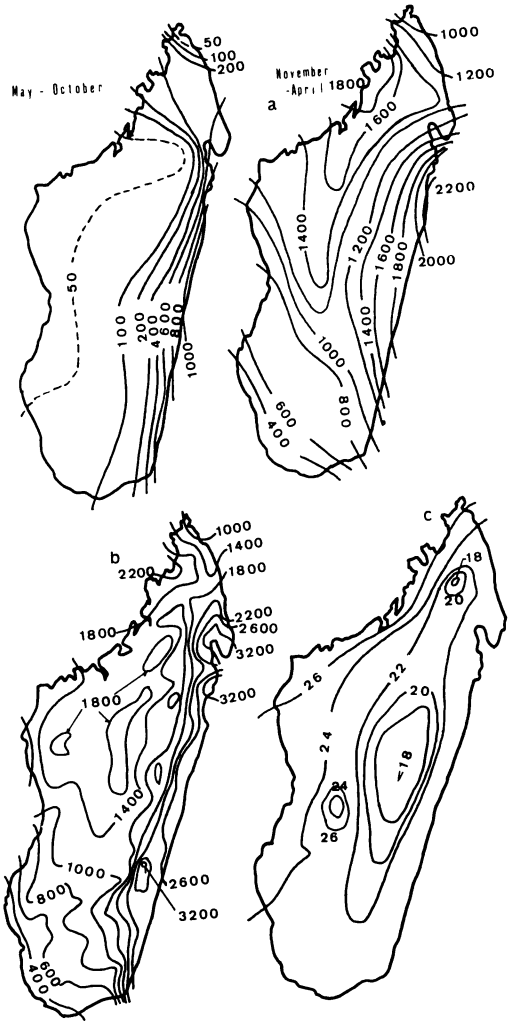


Fig. 14. Distribution–charts of the semi–annual amount of precipitation (a) (mm), the annual amount of precipitation (b) (mm), and the annual mean air temperature (c) (°C) in Madagascar.

There are two rainy seasons, that is, major rainy season through March into May and minor rainy season through November into December. Annual R_m is 1,500～2,000 mm, and annual R_N is 150～200 days. Dv changes from 0.4 to 0.7 place by place.

3. Climate of Madagascar

In Madagascar, the mountain range running through the central eastern side divides clearly the distribution of precipitation in this large island into the East and the West. That is, the east coastal district has all–year–round high–rain because of orographic precipitation with the forced ascending current, though the precipitation in its west side is restricted within the rainy season through November into April (Fig. 14a). Therefore, annual R_m also is considerably greater in the East than in the West (see Fig. 14b).

Air temperature is higher in coastal lowlands than in inland highlands, and higher in the west coast with dry season than in the east coast without dry season. For instance, annual T_m is 23.7°C in Tamatave lying to the east coast, 16.8°C in Antananarivo lying to the central hilly district and 26.6°C in Mahajanga lying to the west coast (Fig. 14c).

In Madagascar, annual S measures between about 3,700 hours in Tulear and about 2,400 hours in Tamatave. Annual E_o measures between about 1,700 mm in Mahajanga and about 700 mm in Antalaha. That is, those tend to be higher in the area with thinner raining and higher temperature.

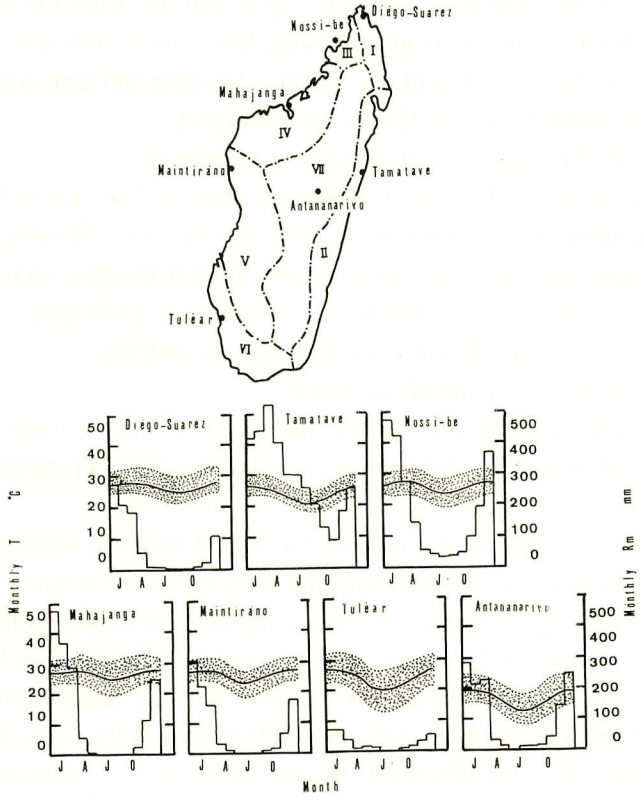


Fig. 15. Climatic division in Madagascar and the changes of monthly average maximum, mean and minimum air temperatures (°C), and the monthly rainfall depth in its main cities.
Note : Symbols are the same as those in Fig. 5.

Madagascar falls generally into the following seven meso–climatic zones as shown in Fig. 15[9].

Ⅰ) The northeastern district

This meso–climatic zone has typical two seasons, that is, a dry season through April into September and a rainy season through October into March. Annual R_m and R_N are 1,400～3,000 mm and 170～200 days excepting less than 1,000 mm and 100 days around Diego–Suarez, respectively.

Ⅱ) The east coast

This meso–climatic zone has all–year–round much raining, though rainfall depth is the deepest in the summer. For instance, annual R_N is 200～250 days excepting 150 days around Fort–Dauphin lying in south, R_m is greater than 1,500 mm. Annual T_m is about 23±1°C, annual range of temperature is 5～6°C and diurnal range of temperature is 5～8°C.

Ⅲ) Nossi Be

This meso–climatic zone has rainfall even in winter in spite of being situated along the west coast. Monthly R_N in dry season through May into October is more than 5 days, and there are no dry months counting less than 25mm.

Ⅳ) The northwerstern district

Rainy season is through December into April, and dry season is through May into November. The number of dry months showing less than 25 mm is less than, or equal to, 6 months, and semi–annual R_m in dry season is less than 100 mm. Annual T_m is greater than 26°C in the coastal part and 22°C in the inland part.

Ⅴ) and Ⅵ) The south and southwestern districts

Rainy season in these climatic zones become shorter than that in the northwestren district above–mentioned, and monthly R_m also decreases considerably. The number of dry months showing less than 25 mm is greater than 6 months, and semi–annual R_m through November into April is less than, or equal to, 1,000 mm. Annual range of temperature is slightly larger than that in other climatic districts.

Ⅶ) The central mountainous district

Because of being highland, air temperature in this district is lower than that in the other districts, and annual T_m is less than, or equal to, 22°C. Precipitation tends to be concentrated in the rainy season.

As we have seen, the climatic condition is full of varieties according to the differences of the surveyed region and country, and even within the boundaries of a country. Fig. 16 shows annual T_m and annual R_m in a lump in the surveyed points and their outskirts. The range of annual T_m reaches 12.6°C ranging from 28.3°C in Matam (Senegal) and Sokoto (Nigeria) to 15.7°C in Kericho (Kenya), and the range of annual R_m reaches more than 4,400 mm ranging from 4,800 mm in Monrovia (Liberia) to less than 350 mm in Podor (Senegal) (Fig. 16). Provided that the differences of frequency and length of rainy season, annual and diurnal ranges of temperature, humidity, duration of sunshine, solar radiation and evaporation etc. were added to large differences of annual R_m and annual T_m, the climatic differences in the surveyed points would expand further. It may

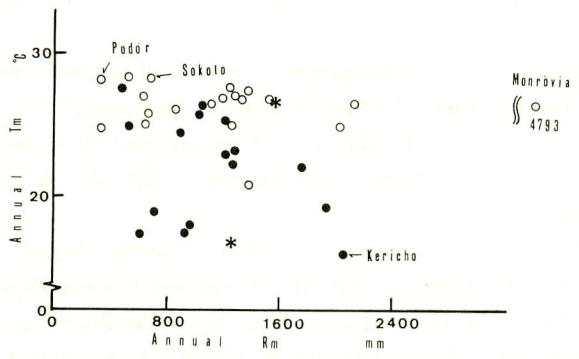


Fig. 16. Annual mean temperature and annual amount of precipitation in the surveyed points and their outskirts.
Note : ○ ; West Africa, ● ; East Africa and ＊ ; Madagascar

readily be imagined that each wild and cultivated rice collected in the various points bearing different climatological backgrounds shows its own reaction to the different climatic conditions. This is the reason why adaptability of wild and cultivated rice species collected on the trips to different climatic conditions must be examined in future and why authers give an absorbing interest to that result.

Summary

Climatological backgrounds in the surveyed countries were discussed in this report. The results obtained are summarized as follows:

1. Climatic conditions in West African area, East African area and Madagascar island changed considerably in accordance with principally latitude, altitude and longitude, respectively.
2. The ranges of annual T_m and annual R_m in the surveyed points and their outskirts reached 12.6°C and more than 4,400 mm, respectively.
3. On the bases of the results obtained in this report, the reaction of the wild and cultivated rice collected on the trips under different climatic conditions will have to be examined in the future.

References

1) East African Meteorological Department : Climatological statistics for East Africa. I. Kenya. p. 1–92, Nairobi (1975)
2) Fujii, H. : Ecosystem and Agriculture in Africa. AICAF, **7**(2), 42–51 (1984)
3) ———: Ivory Coast – The present situation and the problems of development –. AICAF ; A National Research Paper **25**, pp. 86 (1985)

4) GIFFARD, P. L. : L'arbre dans le paysage Sénégalais. pp. 431, Centre Technique Forestier Tropical, Dakar (1974)

5) HASSELMAN, K. H. : Liberia – Geographical mosaics of the land and the people. pp. 278, Ministry of Information, Cultural Affairs & Tourism, Monrovia (1979)

6) KATSUMATA, M., N. MAEDA, E. MASUI, Y. YAMASAKI and M. KATSUMATA : Senegal – The present situation and the problems of development –. AICAF ; A National Research Paper **24**, pp. 118 (1985)

7) NAKAMURA, M., Y. MUROI, S. SHIMADA and J. YAMAGUCHI : Nigeria – The present situation and the problems of development–. AICAF ; A National Research Paper **16**, pp. 156 (1982)

8) SOMBROEK, W. G., H. M. H. BRAUN and B. J. A. van der POUW : Exploratory soil map and agro–climatic zone map of Kenya 1980. pp. 56, Exploratory Soil Survey Report No. El, Kenya Soil Survey, Nairobi (1982)

9) TSUCHIYA, I., S. AOKI, M. OCHIAI, T. KAWAMURA and A. KURASHIMA : Climate of Africa. pp. 636, Kokon–Shoin, Tokyo (1972)

10) TSUNO, Y. : Food Problems and Production in Africa. AICAF **7**(3), 2–13 (1984)

11) YOSHIDA, M., A. EBATO, K. HANZAWA and M. YAMASHITA : Kenya – The present situation and problems of development –. AICAF ; A National Research Paper **20**, pp. 151 (1984)