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Properties and Distribution Patterns of Red-Yellow and Related Soils in the Philippines

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Abstract
Red-Yellow and related soils in the Philippines consisted of Red soils, Yellow soils, Dark Brown soils, Terra Rossa-like soils, Terra Fusca-like soils, Rendzina-like soils, Brown Upland soils, Pseudogley-like soils, Andosols, Vertisols, Brown Lowland soils, and Gray Lowland soils. The acidity tended to decrease in the order: Red soils > Yellow soils > Dark Brown soils > Terra Rossa-like soils > Terra Fusca-like soils > Rendzina-like soils. The acidity of other soil groups showed a wide range depending on the lime contents of parent materials and the duration of the dry period in the area. The factors that control the properties and the distribution patters of Red-Yellow and related soils in the Philippines were found to be: parent materials, land form, and types of climate based on the duration of the dry period.

Discipline: Agricultural environment/ Soils, fertilizers and plant nutrition
Additional key words: topography, parent material, climate type, soil genesis, soil classification

Introduction

The Philippines is a nation of islands extending from 4°N to 22°N. More than 7,000 islands are distributed in the Pacific Ocean from the South China Sea. The total land area is 300,000 km^2, and agricultural land accounts for 32% of the total land area.

Carandang[1] indicates that the constraints on fertility of Philippine soils include: 1) soil erosion, 2) soil acidity, 3) deficiency in nitrogen, phosphorus and potassium, and 4) deficiency in micro-nutrients. In addition, moisture deficiency of soils during the dry season is also an important problem.

The objectives of the study were: to analyze the physico-chemical and mineralogical properties of Red-Yellow and related soils in the Philippines; to determine their patterns of distribution in relation to parent material, topographic position and climate; and to classify these soils according to some soil classification systems. The results were reported in technical papers[3-6].

Such data and information could contribute to improving the knowledge on the soils in the Philippines as they were classified in relation to crop production and other land uses.

Materials and methods

Nine areas all over the Philippines were selected and soil samples from 48 pedons were collected and analyzed (Fig. 1). The selection of the sites and the pedons was mainly based on the following criteria: 1) Red-Yellow and related soils in the Philippines which were temporarily classified into some soil taxa depending on the kind of parent materials and land form, and 2) climate in the Philippines which was classified into 3 types based on the duration of the dry period, namely: more than 4 dry months (tropical monsoon climate), 2 to 4 dry months (tropical monsoon climate), and less than 2 dry months (tropical rain forest climate) whose soil moisture regimes in the Soil Taxonomy[8] roughly correspond to ustic, udic and perudic regions, respectively.

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Fig. 1. Research sites in the Philippines

Results and discussion

1) Soils of Bicol

The Pacific coast of the Bicol region is under tropical rain forest climate with less than 2 dry months. Eight (BC1-8) profiles derived from andesitic recent and old alluvium and tuffaceous rocks were examined in Camarines Norte and Sur of Bicol.

The cross-section shown in Fig. 2 illustrates the toposequence of the soils on terraces along the highway from Daet, Camarines Norte to Naga, Camarines Sur in Bicol. In this area, Brown Lowland soils are formed on flat recent alluvial terraces 6 to 8 m in elevation, Yellow soils on flat lower terraces 8 to 20 m in elevation and Red and Yellow soils on rolling middle terraces 20 to 50 m in elevation. Red and Yellow soils are also formed on hilly upper terraces 100 to 140 m in elevation. There are ironstone nodules on and in the surface layer of Yellow soils on the upper terraces.

The Brown Lowland, Red and Yellow soils on recent, lower and middle terraces are used for coconut plantations, and the Red and Yellow soils on upper terraces for shifting cultivation.

Table 1 shows some physico-chemical properties of the soils which were developed on different terraces in Bicol. Red and Yellow soils on old alluvial terraces in Bicol were characterized by a high clay content (54.7-90.5%), low CEC of less than 16 cmol (+) kg^{-1} clay except for two A horizons, low pH value (4.6-5.4) and low degree of base saturation (11.2-51.4%). On the other hand, Brown Lowland soils on recent alluvial terraces still showed high sand and silt contents and relatively high CEC (clay), pH value and degree of base saturation. Sand content, organic matter content, pH value, CEC (clay) and degree of base saturation tended to decrease toward the older soils on older terraces.

Similar toposequence of soils could also be found in Northern Leyte under tropical rain forest climate with less than 2 dry months.

2) Soils of Benguet

Fig. 3 shows the toposequence of soils in and around La Trinidad valley in Benguet. Benguet is located in the highlands of the Cordillera Central mountains 1,300 to 2,000 m in elevation and it is

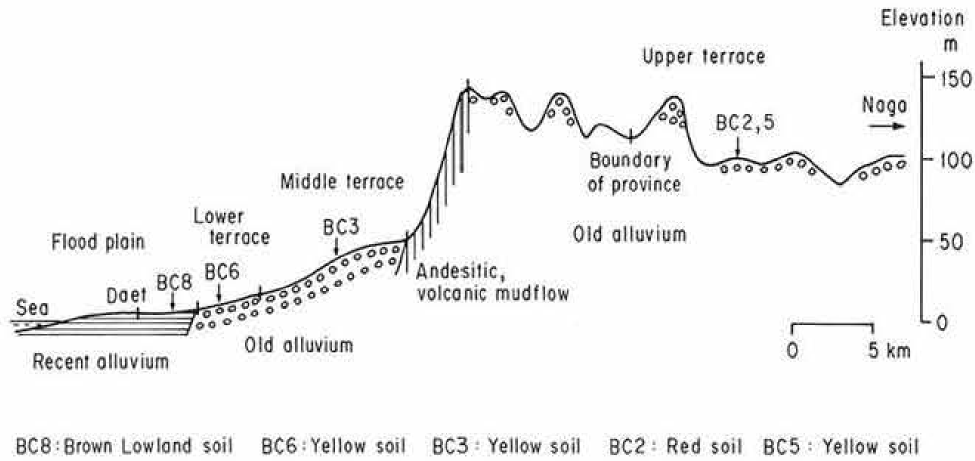

Fig. 2. Toposequence of soils on terraces along the highway from Daet to Naga in Bicol

Table 1. Physico-chemical properties of soils on different terraces in Bicol

Horizon	Depth (cm)	Soil color when moist	Particle size distribution: Co. sand 2–0.2	F. sand 0.2–0.02	Silt 0.02–0.002	Clay <0.002 mm	Texture	Organic matter (%)	pH H_2O (1:2.5)	CEC of the clay	ECEC of the clay	Base saturation NH_4OAc (%)
			(% of <2 mm)							(cmol (+) kg^{-1})		
BC8: Brown Lowland soil on recent terrace												
A	0–12	2.5Y5/1	18.2	27.5	39.9	14.4	L	8.3	5.2	123.2	49.7	35.0
Bw1	12–38	10YR5/4	16.1	20.1	32.5	31.3	LiC	4.2	5.4	47.1	17.7	34.0
Bw2	38–64	10YR6/3	14.9	19.3	49.6	16.2	SiCL	2.9	5.5	77.5	31.8	39.3
BC	64–93	10YR6/3	23.0	21.6	35.2	20.3	CL	1.8	5.8	49.8	21.4	40.4
2Cg	93–120+	5Y6/1	55.3	24.8	12.2	7.7	SL	1.1	5.8	66.7	23.6	33.6
BC6: Yellow soil on lower terrace												
A	0–12	10YR4/4	5.6	15.8	20.3	58.2	HC	5.7	5.0	17.3	8.2	30.5
Btcs1	12–29	10YR4/5	3.1	10.5	18.2	68.2	HC	3.2	5.0	13.3	6.5	33.5
Btcs2	29–52	10YR5/6	3.1	8.2	17.8	70.8	HC	1.9	5.4	9.5	5.1	42.6
Btg1	52–75	10YR4/6	1.5	7.4	18.1	73.0	HC	1.3	5.1	9.2	5.5	30.1
Btg2	75–115+	2.5Y6/4	0.9	7.6	19.8	71.7	HC	0.6	5.0	7.1	6.8	40.8
BC3: Yellow soil on middle terrace												
A	0–7	10YR4/4	2.6	14.6	21.4	61.5	HC	5.3	4.7	17.8	9.6	28.4
Bt1	7–21	10YR4/6	1.2	9.3	21.0	68.5	HC	2.7	4.8	12.7	8.4	29.9
Bt2	21–55	7.5YR5/6	0.6	5.8	22.8	70.8	HC	1.5	4.8	11.5	7.1	17.7
2Btg	55–90	8.7YR6/6	0.4	8.2	25.9	65.5	HC	1.1	4.7	12.6	8.6	15.5
2Bwg1	90–113	8.7YR6/6	0.3	8.9	32.6	58.3	HC	0.8	4.8	14.0	9.7	12.2
2Bwg2	113+	8.7YR6/6	0.4	9.5	35.3	54.7	HC	0.7	4.8	15.5	10.3	12.5
BC5: Yellow soil on upper terrace												
Acs	0–10	10YR4/6	6.0	7.0	11.0	76.0	HC	1.6	4.7	8.9	4.9	25.5
Btcs	10–25	1.2Y6/4	4.2	4.0	10.4	81.4	HC	1.2	4.7	8.1	4.5	18.3
Btcsg1	25–48	2.5Y4/6	2.5	2.9	8.0	86.5	HC	0.8	4.7	7.8	5.0	27.9
Btcsg2	48–70	2.6Y6/4	1.6	2.6	9.4	86.3	HC	0.8	4.8	7.7	5.2	26.2
Btcsg3	70–120	7.5Y6/4	0.5	3.6	5.3	90.5	HC	0.8	4.6	7.8	5.0	11.9
Bcswg	120–288	2.5Y6/4	0.4	4.6	9.4	85.5	HC	0.5	4.6	8.6	5.8	11.2
BC2: Red soil on upper terrace												
AB	0–7	2.5YR4/6	0.5	4.9	14.9	79.7	HC	2.9	4.6	9.4	7.1	51.4
Bt1	7–25	2.5YR4/8	0.5	5.2	6.3	88.0	HC	1.5	4.7	7.0	5.7	34.4
Bt2	25–58	10YR5/8	0.8	4.4	9.1	85.7	HC	1.0	4.7	7.6	5.4	23.6
Btg1	58–98	10YR7/3	0.1	5.8	7.1	87.0	HC	0.6	4.7	8.0	5.6	19.7
Btg2	98–150	10YR7/3	0.0	6.2	9.3	84.5	HC	0.4	4.6	8.3	6.3	18.6
Bwg	150+	10YR7/3	0.1	10.2	14.8	74.9	HC	0.3	4.7	9.1	7.0	16.7

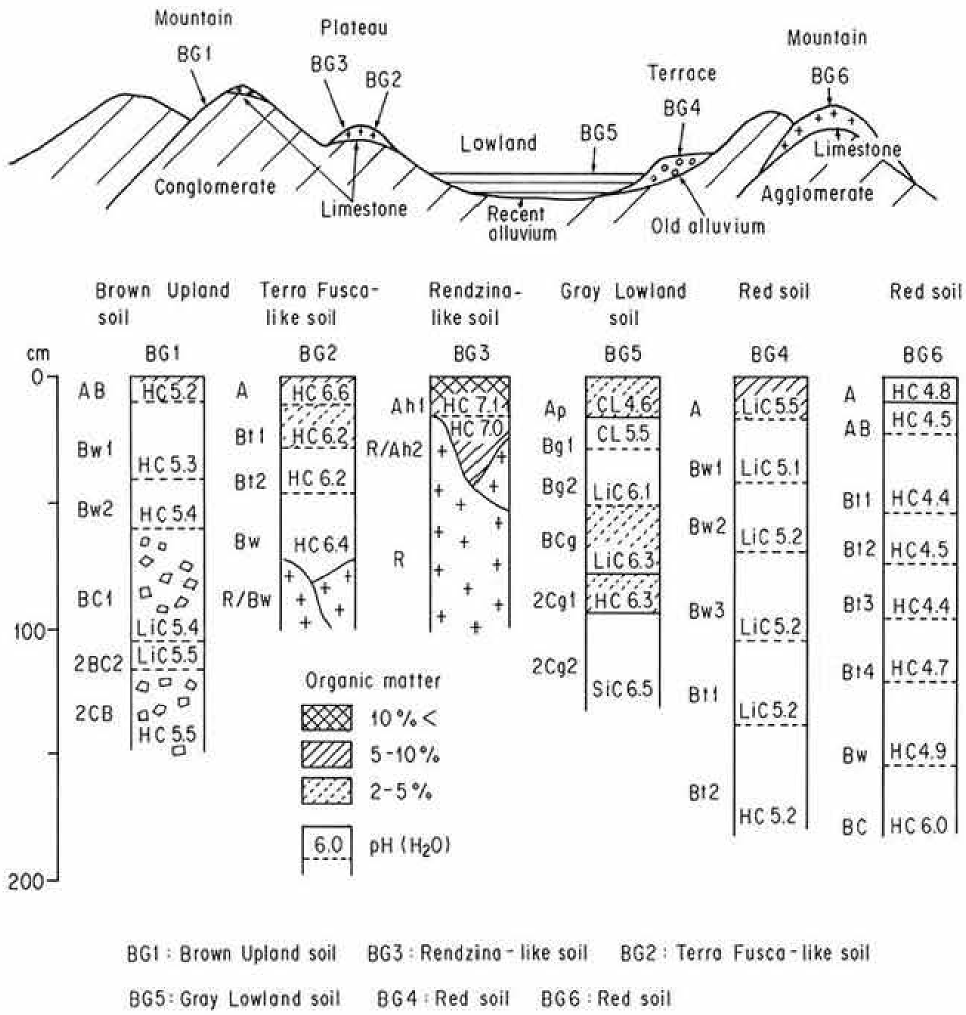

Fig. 3. Toposequence of soils in and around La Trinidad valley, Benguet

characterized by a tropical highland monsoon climate with 2 to 4 dry months. Six (BG1-6) profiles derived from various parent materials were examined here.

La Trinidad valley in Benguet is considered to be an ancient crater. The mountains around the valley consist of agglomerate, conglomerate, and shale and sandstone materials of tertiary system partially covered by coral limestone. Gray Lowland soils are formed on the plain of La Trinidad valley, Red soils on old alluvial terraces in the valley and acid Brown Upland soils on the slope of mountains consisting of conglomerate. Red soils are moderately acid and have a CEC of more than 16 cmol (+) kg^{-1} clay.

On the limestone plateaus, Rendzina-like soils, Terra Fusca-like soils and Red soils are developed. Rendzina-like soils are developed on the slope of the limestone plateaus and Terra Fusca-like soils on the relatively flat surface of the limestone plateaus. Red soils are also distributed on limestone plateaus with a limestone bed at about 2 m below the surface. However it is assumed that the parent materials were derived from not only limestone but also from marine and eolian deposits on limestone. The upper B horizons of the Red soils on limestone plateaus are strongly acid and the pH increases with increasing depth.

3) Soils of Ilocos Norte

The coast of the South China Sea in Ilocos Norte is under tropical monsoon climate with more than 6 severe dry months.

The cross-section shown in Fig. 4 illustrates the toposequence of soils in and around Batac, Ilocos Norte. Eight (IL1-8) profiles derived from various parent materials were examined in this area. There are new and old tertiary hills between the South China Sea and the Cordillera Central mountains, old

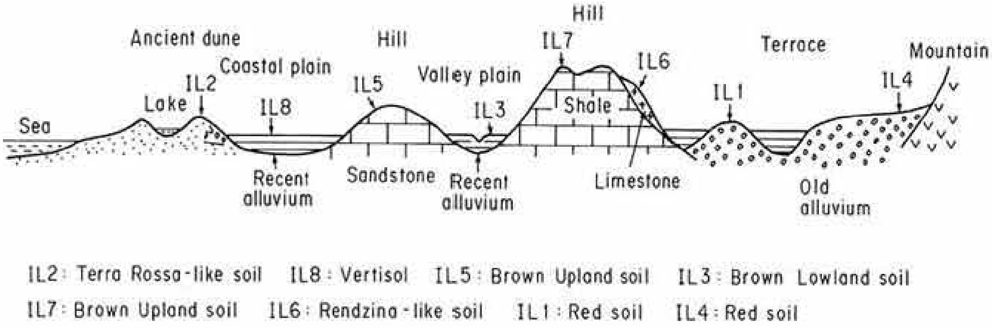

Fig. 4. Toposequence of soils in and around Batac, Ilocos Norte

alluvial terraces between the mountains and the hills, and ancient sand dunes between the sea and the hills. Recent alluvial plains are distributed among the hills, terraces and sand dunes.

The mountains mostly consist of igneous rocks, the older tertiary hills of calcareous shale and limestone, the younger tertiary hills of calcareous shale and sandstone and the recent plains of calcareous alluvium.

Red soils are developed on the rolling and hilly old alluvial terraces, Brown Upland soils and Rendzina-like soils on the tertiary hills, Terra Rossa-like soils on the ancient dunes, Calcareous Brown Lowland soils on the valley plains and Vertisols on the coastal plains. The width of cracks of Vertisols exceeds 7 cm at the surface, and there are 2 or 3 open cracks at least 1 cm wide at the depth of 50 cm. Soft powdery lime can be found in Brown Upland soils and Vertisols. Yellow soils could not be found in this area.

Table 2 shows some physico-chemical properties of the soils derived from various parent materials in and around Batac, Ilocos Norte. Rendzina-like soils, Brown Upland soils, Brown Lowland soils and Vertisols in this area contain a certain amount of free carbonates and exhibit high pH values of more than 7 and a high degree of base saturation. Red soils on the old alluvial terraces have relatively low pH values, low soil CEC and a low degree of base saturation, but the values are higher than those of the Red and Yellow soils in Bicol. Red-colored soils with argillic horizons on ancient sand dunes are classified as Terra Rossa-like soils because they display relatively high pH values and a high degree of base saturation of more than 70%.

4) Soils of Pangasinan

Pangasinan along the South China Sea is under a tropical monsoon climate with more than 4 severe dry months.

Fig. 5 shows the toposequence of soils on limestone terraces in Bolinao, Pangasinan. Four (PN1–4) profiles were examined in this area where there are several steps of terraces consisting of coral limestone. Terra Rossa-like soils are developed on the flat surface of higher terraces and Terra Fusca-like soils on the flat surface of relatively lower terraces. On the other hand, Rendzina-like soils are formed on recently raised coral limestone, slopes of rolling limestone terraces and edges of flat limestone terraces.

Similar toposequence of soils on limestone terraces could also be found in Panglao island, Bohol and Samal island, Davao.

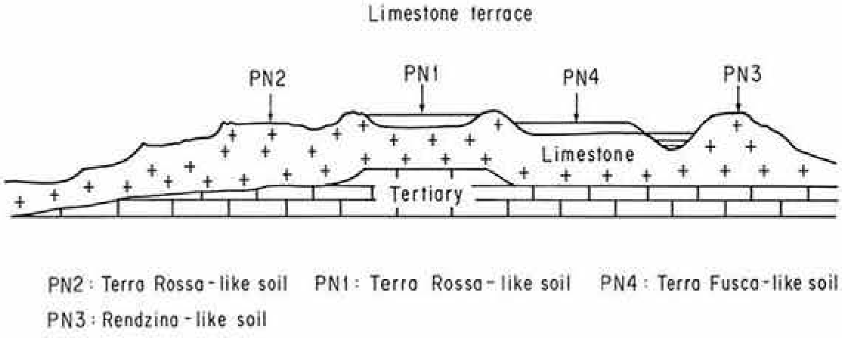

Fig. 5 Toposequence of soils on limestone terraces in Bolinao, Pangasinan

Table 2. Physico-chemical properties of soils derived from various parent materials in and around Batac, Ilocos Norte

Horizon	Depth (cm)	Soil color when moist	Particle size distribution Co. sand 2–0.2	F. sand 0.2–0.02	Silt 0.02–0.002	Clay <0.002 mm	Texture	Organic matter (%)	Carbonate as $CaCO_3$ (%)	pH H_2O (1:2.5)	CEC of soil (cmol (+)kg^{-1})	Base saturation NH_4OAc (%)
			······ (% of <2 mm) ······									
IL1: Red soil derived from old alluvium												
A	0–9	5YR4/4	11.8	29.1	31.5	27.7	LiC	5.6	—	5.3	20.7	60.7
Bt1	9–21	5YR4/4	7.7	20.9	27.8	43.5	LiC	3.7	—	5.4	20.9	53.2
Bt2	21–37/42	7.5YR4/8	6.7	24.7	26.5	42.1	LiC	2.3	—	5.7	19.8	43.9
Bt3	37/42–61	2.5YR4/8	11.8	31.0	25.8	31.4	LiC	1.3	—	5.5	15.8	45.1
Bt4	61–89	2.5YR4/6	15.2	25.6	28.5	30.8	LiC	1.0	—	5.5	15.2	55.1
2BC	89–150+	2.5YR4/6	13.7	30.6	30.3	25.4	LiC	0.6	—	5.7	13.7	68.9
IL2: Terra Rossa-like soil derived from ancient dune												
Ah	0–2	5YR2/2	23.0	35.4	23.8	17.8	CL	10.8	—	5.8	22.9	86.7
AE	2–11/15	5YR3/1	22.6	41.1	19.9	16.4	SCL	4.0	—	6.1	16.2	78.9
Bt1	11/15–22	2.5YR4/3	22.4	34.5	19.7	23.4	SCL	1.8	—	6.1	9.5	85.1
Bt2	22–35/40	2.5YR4/4	8.8	16.7	29.7	44.8	LiC	1.4	—	6.0	12.7	96.4
Bt3	35/40–70	2.5YR4/4	15.3	28.0	20.5	36.2	LiC	0.7	—	5.9	9.7	97.9
Bw1	70–104	2.5YR4/6	17.9	26.2	26.1	29.8	LiC	0.5	—	6.0	13.5	101.5
Bw2	104–200	2.5YR5/6	17.9	26.9	24.9	30.4	LiC	0.4	—	5.9	14.9	102.2
C	200+	10YR7/3	29.1	38.7	21.0	11.3	L	0.2	1.1	6.3	16.8	117.3
IL6: Rendzina-like soil derived from limestone												
Ah	0–10/12	10YR2/2	2.9	10.7	22.7	63.6	HC	4.9	6.1	7.7	71.1	108.8
C	10/12–43	10YR7/2	15.1	22.3	42.4	20.2	CL	1.8	53.3	7.8	35.8	159.7
R	43+	10YR7/2	21.6	24.6	38.9	15.0	CL	1.2	63.2	8.1	28.9	170.4
IL7: Brown Upland soil derived from calcareous shale												
O/A	0–2	10YR4/3	3.5	42.6	30.1	23.7	CL	3.0	4.3	7.2	50.6	109.6
Bw1	2–20	10YR4/3	3.3	42.0	34.6	20.2	CL	1.6	5.2	7.1	51.1	103.4
Bw2	20–45	10YR5/3	3.7	40.3	35.1	20.8	CL	1.3	5.5	7.2	52.0	107.4
C	45+	10YR5/4	2.8	47.1	31.8	18.3	CL	0.8	5.9	7.1	54.3	109.9
IL3: Brown Lowland soil derived from clacareous recent alluvium												
Ap	0–15	2.5Y5/3	0.3	68.2	22.2	9.3	L	1.4	12.9	7.2	43.0	172.5
Bw1	15–21	10YR4/3	0.2	34.8	42.5	22.5	CL	1.4	9.4	7.8	52.2	166.8
Bw2	21–45	10YR5/4	0.4	42.5	40.9	16.1	CL	0.9	10.6	8.2	51.1	162.7
Bw3	45–70	10YR5/4	0.1	48.8	38.2	12.9	L	0.5	12.0	8.2	46.5	173.2
C1	70–92	10YR5/4	0.0	70.3	21.8	7.8	SL	0.6	13.9	8.2	44.0	176.8
2C2	92–110+	10YR5/3	0.3	74.5	18.2	7.0	SL	0.5	12.6	8.3	40.6	186.6
IL8: Vertisol derived from calcareous recent alluvium												
Apg	0–18	2.5Y4/1	0.5	7.5	40.5	51.5	HC	2.4	10.4	7.2	61.2	145.0
Ak1	18–53	2.5Y3.5/1	0.7	9.5	43.7	46.2	HC	1.4	8.3	7.8	63.2	138.8
Ak2	53–88	2.5Y4/1	0.7	18.3	34.3	46.7	HC	0.9	6.2	7.9	58.3	123.8
AB	88–128	2.5Y3.5/1	0.4	23.9	37.8	37.9	LiC	0.9	5.8	7.9	58.2	114.3
BC	128–150+	2.5Y5/4	0.7	34.3	35.7	29.2	LiC	0.5	5.9	8.0	56.4	113.9

Table 3. Physico-chemical properties of soils developed on limestone

Horizon	Depth (cm)	Soil color when moist	Particle size distribution: Co. sand 2–0.2	F. sand 0.2–0.02	Silt 0.02–0.002	Clay <0.002 mm	Texture	Organic matter (%)	Carbonate as $CaCO_3$ (%)	pH H_2O (1:2.5)	CEC of soil (cmol(+)kg^{-1})	Base saturation NH_4OAc (%)
			(% of <2 mm)									
PN3: Rendzina-like soil												
Ah	0–8	5YR2/1	2.2	13.5	21.3	63.0	HC	15.8	6.6	7.0	62.5	122.7
C/Ah	8–21	5YR3/1	8.0	13.9	16.6	61.4	HC	4.3	19.0	7.5	44.6	143.7
R/C	21+	10YR7/2	12.1	17.5	39.5	30.9	LiC	1.4	45.2	7.9	28.0	168.3
BG2: Terra Fusca-like soil												
A	0–10	10YR3/2	1.4	4.5	15.1	78.9	HC	8.6	2.0	6.0	40.5	92.9
Bt1	10–27	10YR4/6	0.3	3.3	10.3	86.2	HC	2.0	2.0	6.2	38.1	92.6
Bt2	27–46	8.75YR5/6	0.4	4.1	6.2	89.3	HC	1.2	3.1	6.2	45.5	102.2
Bw	46–76	8.75YR5/6	0.2	3.2	21.9	74.8	HC	0.9	3.3	6.4	43.4	104.9
PN2: Terra Rossa-like soil												
Ah	0–12	5YR4/2	1.8	12.2	22.6	63.3	HC	2.5	0.7	6.0	33.8	88.0
Bt1	12–26	5YR3/2	1.1	6.3	10.3	82.2	HC	1.8	0.9	6.4	34.6	92.1
Bt2	26–44	5YR3/3	0.7	4.4	9.6	85.3	HC	1.5	1.2	6.3	37.0	89.4
C	44+		1.3	11.0	29.5	58.2	HC	1.4	5.3	6.7	39.2	155.8
PN1: Terra Rossa-like soil												
Ap	0–13	2.5YR3/2	0.9	42.6	15.2	41.3	LiC	2.7	1.7	5.7	14.4	51.1
Bt1	13–24	2.5YR4/2	0.7	15.9	18.6	64.8	HC	2.2	0.7	5.9	13.4	64.8
Bt2	24–58	2.5YR4/3.5	0.4	23.3	26.0	50.3	HC	1.2	1.3	6.1	11.6	83.2
Bt3	58–100	2.5YR4/4	0.5	18.4	27.7	53.4	HC	0.9	1.8	6.3	11.1	82.6
Bt4	100–200+	2.5YR4/4	0.4	16.3	29.6	53.8	HC	0.7	1.4	6.4	12.0	76.9
BG6: Red soil												
A	0–7/10	7.5YR4/3	2.0	11.2	14.6	72.2	HC	10.9	—	4.8	27.6	53.6
AB	7/10–20/23	5YR4/6	1.3	11.2	16.2	71.2	HC	3.5	—	4.5	14.9	40.1
Bt1	20/23–50/55	5YR5/8	0.7	4.1	8.9	86.3	HC	1.6	—	4.4	16.4	14.9
Bt2	50/55–70/75	2.5YR5/8	0.2	1.4	6.1	92.3	HC	1.4	—	4.5	23.6	12.2
Bt3	70/75–95	5YR6/8	1.2	3.4	7.7	87.7	HC	0.9	—	4.4	44.2	12.9
Bt4	95–120	7.5YR5/8	0.3	3.5	11.9	84.4	HC	0.7	—	4.7	31.2	19.0
Bw	120–153	5YR4/6	0.6	3.2	25.9	70.3	HC	1.0	—	4.9	45.2	60.3
BC	153+	10YR5/4	0.3	7.4	38.6	53.7	HC	1.3	—	6.0	52.6	94.5

5) Soils on limestone terraces and plateaus

As already mentioned, the soil sequence of Rendzina-like soils, Terra Fusca-like soils, Terra Rossa-like soils and Red soils can be found on limestone terraces and plateaus.

Table 3 shows the physico-chemical properties of the soils. The maximum clay content of each profile exceeded 60%. Rendzina-like soils and Terra Fusca-like soils still contained a considerable amount of free carbonates while Terra Rossa-like soils and Red soils contained hardly any free carbonate in the A and B horizons. The pH values and the degree of base saturation tended to decrease in the order: Rendzina-like soils > Terra Fusca-like soils > Terra Rossa-like soils > Red soils.

6) Other soils

In the Philippines, in addition to the soils already described there are other important soils. Soils with a dark brown argillic horizon and a relatively high base saturation except for Ap horizons are located on the undulating middle terraces in Negros Occidental. These soils which are referred to as Gimbalaon series in Negros were classified as Eutric Dark Brown soils. On the other hand, on the piedmont of Mt. Apo in Davao, there are soils referred to as Togbok series in Davao which have similar morphological features to those of the Gimbalaon series but a relatively low base saturation throughout the profile. These soils were classified as Eutric Dark Brown soils.

Some soils in Bohol are derived from old alluvial deposits and have a horizon with a low level of permeability showing hydromorphic properties immediately below the A horizon and argillic horizons. These soils were classified as Eutric or Dystric Pseudogley-like soils.

Though Volcanic ash soils were not investigated in this study, soils derived from recent alluvial fan deposits of Mt. Labo in Bicol displayed a low bulk density, high phosphate retention ability and high contents of acid oxalate soluble aluminum and iron. Therefore, these soils were classified as Andosols.

7) pH of soils in the Philippines

Fig. 6 shows the frequency of pH (H_2O) values depending on the soil groups. The pH values tended to increase in the order: Red soils < Yellow soils < Dark Brown soils < Terra Rossa-like soils < Terra Fusca-like soils < Rendzina-like soils. The pH values of the other soil groups showed wide ranges presumably associated with the lime contents of the parent materials and types of climate.

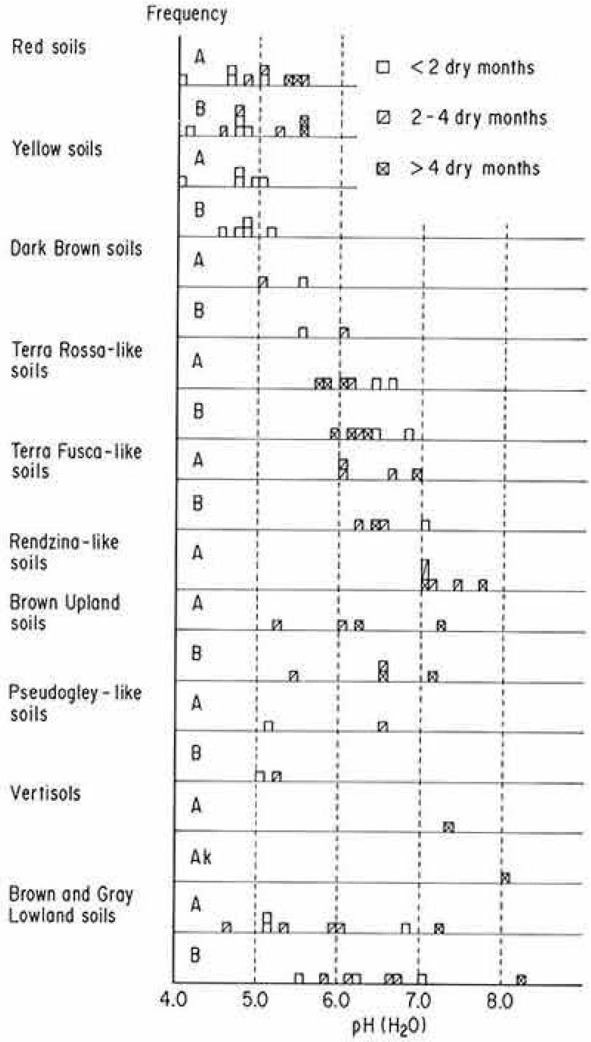

Fig. 6. Histogram for pH (H_2O) of A and B horizons of different soils in the Philippines

Conclusion

Table 4 summarizes the studies on the properties, classification and distribution patterns of Red-Yellow and related soils in the Philippines with the relationships among parent materials, land form, types of climate and kinds of soils.

(1) Main Red-Yellow and related soils in the Philippines consisted of Red soils, Yellow soils, Dark Brown soils, Terra Rossa-like soils, Terra Fusca-like soils, Rendzina-like soils, Brown Upland soils, Pseudogley-like soils, Andosols, Vertisols, Brown Lowland soils, and Gray Lowland soils.

(2) From residual, old alluvial and volcanic mud-

Table 4. Relationships among parent materials, land form, types of climate and soil groups of Red-Yellow and related soils in the Philippines

Parent material	Land form	Soil group	Changes in soil properties* with type of climate			Name of soils at surveyed sites	
			<2	2–4	>4 dry months	Soil taxonomy (1992)	FAO/UNESCO (1990)
Andesite and basalt [residual and old alluvial deposits, and volcanic mud-flow]	Hills, upper and middle terraces	Red soils	Strongly acid Low activity	Strongly to moderately acid Low activity	Moderately acid	Kandihumults Haplohumults Palehumults Kandiudults Kanhapludults	Haplic Nitosols Haplic Alisols Stagnic Acrisols Ferric Acrisols
		Yellow soils	Strongly acid Low activity	(Strongly to moderately acid)			
	Lower terraces	Yellow soils	Moderately acid Low activity	(Moderately acid)	(Moderately acid)		
	Piedmont of volcano and terraces	Dark Brown soils	Moderately acid	Moderately to slightly acid	(Slightly acid)	Paleudults Paleudalfs	Haplic Nitosols
Tuffaceous rocks [residual deposits]	Hills	Red soils	Strongly acid	Strongly to moderately acid	(Moderately acid)	Palehumults	Stagnic Alisols Haplic Nitosols
		Brown Upland soils	(Moderately acid)	Moderately acid	(Slightly acid)	Dystropepts	Dystric Cambisols
Limestone [residual, aquatic and/or eolian deposits on limestone]	Limestone hills and terraces	Red soils	(Strongly acid)	Strongly to moderately acid	(Moderately acid)	Haplohumults	Haplic Alisols
		Terra Rossa-like soils		Slightly acid		Paleustalfs Haplustalfs Paleudalfs Hapludalfs	Eutric Leptosols Haplic Nitosols Gleyic Luvisols Vertic Luvisols Chromic Luvisols
		Terra Fusca-like soils		Slightly acid to neutral			
		Rendzina-like soils		Neutral to slightly alkaline		Rendolls Haplustolls	Rendzic Leptosols
		Lithosols		Neutral		Tropothents	Eutric Leptosols
Calcareous sand stone and shale [residual and old alluvial deposits, and ancient dunes]	Terraces and ancient dune	Terra Rossa-like soils		Slightly acid		Haplustalfs Paleudalfs	Ferric Luvisols
	Hills	Brown Upland soils	(Slightly acid)	Slightly acid	Neutral	Ustropepts Eutropepts	Vertic Cambisols Calcaric Cambisols
Non-calcareous sandstone and shale	Terraces	Red soils	(Strongly acid)	Strongly to moderately acid	(Moderately acid)	Paleudults	Haplic Nitosols
		Pseudogley-like soils	(Moderately acid)	Moderately to slightly acid	(Slightly acid)	Epiaquults Albaqualfs	Dystric Planosols
	Hills	Brown Upland soils	(Moderately acid)	(Moderately acid)	(Slightly acid)		
Calcareous alluvial deposits [recent alluvial]	Alluvial lowland	Brown Lowland soils	Neutral	(Neutral to slightly alkaline)	Slightly to moderately alkaline	Ustropepts Eutropepts	Calcaric Cambisols
		Vertisols		(Neutral to slightly alkaline)	Slightly to moderately alkaline	Calciaquerts	Calcic Vertisols
Non-calcareous alluvial deposits [recent alluvial]	Alluvial lowland	Andosols	Moderately acid	(Moderately to slightly acid)	(Slightly acid)	Fulvudands Hapludands	Umbric Andosols Haplic Andosols
		Brown Lowland soils	Moderately acid	Moderately to slightly acid	(Slightly acid)	Dystropepts	Gleyic Cambisols
		Gray Lowland soils	Slightly acid	Slightly acid	(Slightly acid)	Tropaquepts	Eutric Gleysols

* Low activity: CEC of <16 cmol(+) kg^{-1} clay, Strongly acid: <pH (H_2O) 5.0, Moderately acid: pH 5.0–6.0, Slightly acid: pH 6.0–6.6, Neutral: pH 6.6–7.4, Slightly alkaline: pH 7.4–8.0, Moderately alkaline: pH 8.0–9.0.
( ): Assumption.

flow, andesite and basalt materials, Red soils and Yellow soils were formed on hills, and upper and middle terraces. The Red soils were strongly acid with low activity clays[7] under climatic conditions characterized by less than 2 dry months, strongly to moderately acid with low activity clays under climatic conditions characterized by 2 to 4 dry months, and moderately acid under climatic conditions characterized by more than 4 dry months. The Yellow soils were strongly acid with low activity clays under climatic conditions characterized by less than 2 dry months, strongly to moderately acid under climatic conditions characterized by 2 to 4 dry months, and were hardly formed under climatic conditions characterized by more than 4 dry months. On lower terraces, only Yellow soils were formed. The Yellow soils were moderately acid with low activity clays under climatic conditions characterized by less than 2 dry months, and moderately acid under climatic conditions characterized by 2 or more dry months. These Red-Yellow soils were classified as Kandihumults, Haplohumults, Palehumults, Kandiudults, Kanhapludults, or probably Haplustults in the Soil Taxonomy[8] or as Haplic Nitosols, Haplic Alisols, Stagnic Acrisols or Ferric Acrisols in the FAO-UNESCO System[2].

(3) From residual, aquatic and/or eolian materials on limestone, Red soils were formed on hills, Terra Rossa-like soils on flat higher terraces, Terra Fusca-like soils on flat lower terraces and gentle slopes of hills, and Rendzina-like soils on recently raised coral terraces and slopes of rolling terraces and hills. Red soils were strongly to moderately acid, Terra Rossa-like soils slightly acid, Terra Fusca-like soils slightly acid to neutral, and Rendzina-like soils neutral to slightly alkaline. Terra Rossa-like soils and Terra Fusca-like soils were classified as Paleustalfs, Haplustalfs, Paleudalfs or Hapludalfs in the Soil Taxonomy, or as Haplic Nitosols, Gleyic Luvisols, Vertic Luvisols, Chromic Luvisols or Eutric Leptosols in FAO-UNESCO System and Rendzina-like soils as Rendolls or Haplustolls, or as Rendic Leptosols.

(4) Under climatic conditions characterized by more than 4 dry months, Brown Upland soils with soft powdery lime (Ustropepts or Calcaric Cambisols) developed from residual material of calcareous shale and sandstone on hills, and Vertisols with soft powdery lime (Calciaquerts or Calcic Vertisols) and Calcareous Brown Lowland soils (Ustropepts or Calcaric Cambisols) from calcareous alluvial deposits on recent plains.

(5) Red soils, Terra Rossa-like soils, Brown Upland soils and Pseudogley-like soils were formed from residual and old alluvial materials of sandstone and shale and Vertisols, Andosols, Brown Lowland soils, and Gray Lowland soils from recent alluvial deposits. Such a difference in the soil characteristics was due to the difference in the pedogenic process depending on the nature of parent materials, land form, and the duration of the dry period in the area.

(6) As mentioned above, the factors that control the properties and the distribution patterns of Red-Yellow and related soils in the Philippines are: parent materials, land form, and types of climate based on the duration of the dry period.

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