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The Relation Between Soil and Topography in a Small Area of Paddy Field

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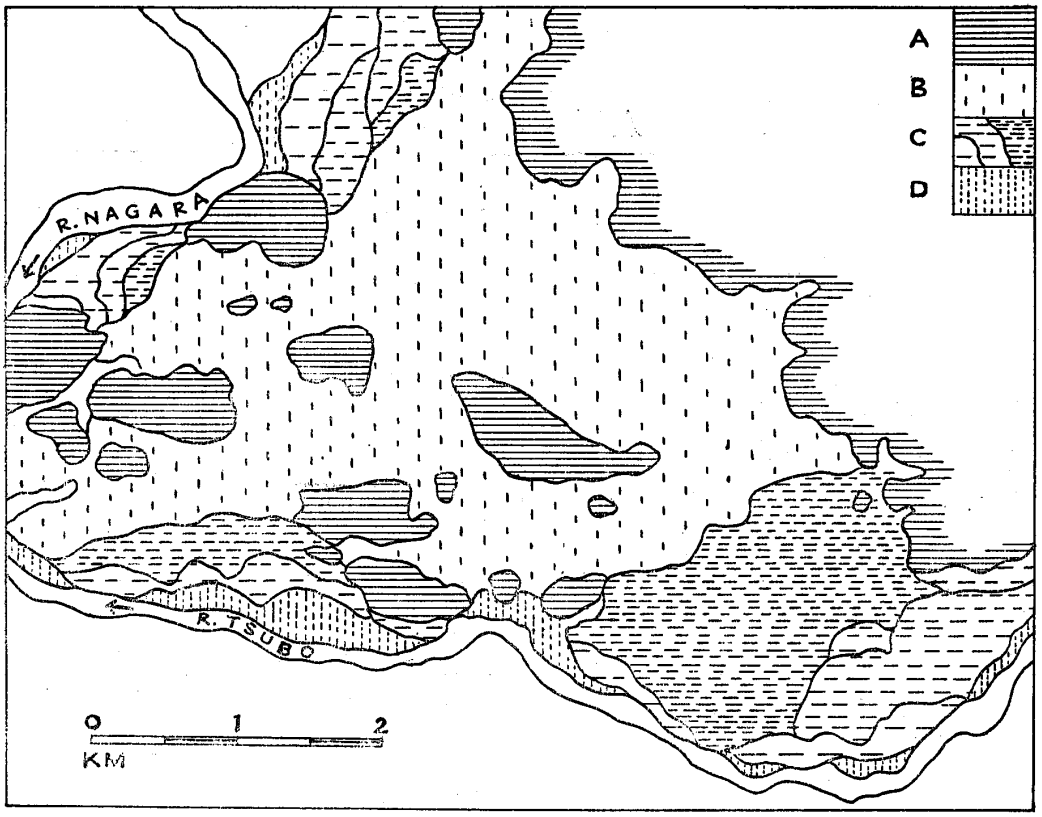
Introduction

Topography is one of the important pedogenic factors of soil formation. It affects the depth to water table, the moisture-air regime in soil and the amount of runoff through surface relief, relative elevation and other characteristics derived from its original formation. (1) Within some soil regions of various slopes can be found a group of soils, so-called catena, developed from similar paremt material. (2) However, on upland or lowland plains of quarternary formation, each topographic surface is mostly overlaid by such different superficial materials from which soils are derived, that topography often seems to have no close connection with soil. Nevertheless it is commonly accepted that topography is used conveniently as a basis for locating boundaries between different soil groups as well as for setting sampling sites. In reconnaissance survey, soil associations or soil families occur correlatively with major topographic divisions. (3), (4) But in detailed survey of larger scale, the relation between soil and topography will be much complicated. (5), (6), (7) It is necessary to investigate their relationship in various regions where soil survey has been made in detail. The writer has observed soil profile and topography in a small area of paddy field lying on young topography, together with soil survey staffs of the National Institute of Agricultural Sciences, and examined as follows. (8)

Topographic division of the surveyed area

The surveyed area extends around Seki-city in Gifu-prefecture, bounded in the north east by low mountains of palaeozoic rocks, to the north west by the river Nagara-gawa, and to the south by its tributary, the Tsubo-gawa. The grater part of the area consists of pleistocene upland, out of which low but steep hills of palaeozoic rocks rising. Narrow alluvial flood plain and terraces occupy the remaining part. Their distribution is illustrated in Fig. 1.

1. Upland. Very flat surface, the relative height of which from



A: Mountain land.
B: Upland.
C: Terraces at two or three levels.
D: Flood plain.

Fig. 1. Topographical division of the area.

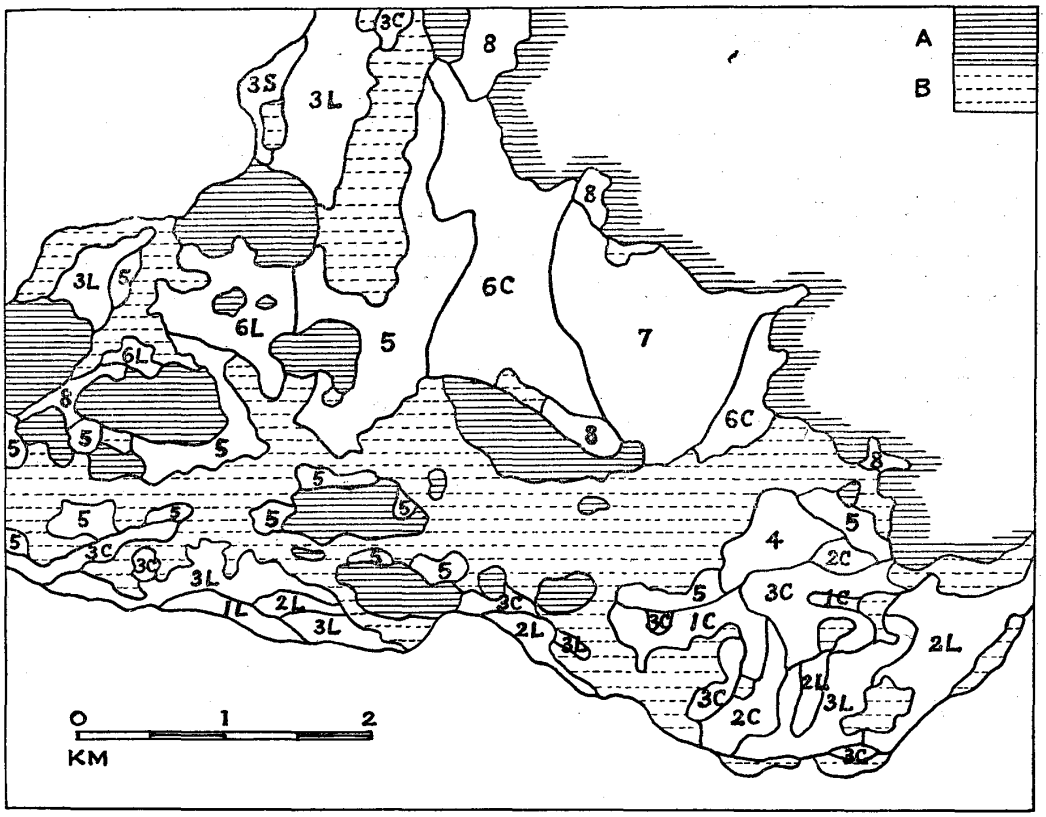
the present river bed is about 10 m. at the northern and south-eastern margins and about 5 m. at the western. The eastern half of this upland surface is nearly level, 55–57 m. in elevation, the central part of which is occupied by poorly drained paddy fields. The western half is slightly inclined towards west, under moderately well drained condition. This upland consists of stream depositions such as gravel and sand layers, overlaid by clay layer derived from lacustrine deposit and volcanic ashy material locally covering the clay.

2. Terraces. There exists a series of river terraces formed by the rejuvenation of post-pleistocene. Each surface of these terraces is nearly flat to undulating or gently inclined to the alluvial plain, and is fringed by about 2 to 3 m. cliffs; its surface material is largely gravel deposited on ancient stream courses.

3. Flood plain. Narrow alluvial lowland, formed by recent stream floods, consisting of similar gravel beds.

Characteristic description of paddy soils

Paddy soils of surveyed area have been classified into the following 8 types*, the distribution of which is shown in Fig. 2.



A: Mountain land.
B: Upland field or forrest land.
Fig. 2. Distribution of soil types.

Type 1. Very shallow solum about 15 to 20 cm. thick, underlaid by a gravel layer; two subtypes can be distinguished, the one is of coarser texture (1L), and the other, of finer (1C). Strong leaching by good drainage condition causes appearently iron and manganese to accumulate in reddish brown mottles, throughout the horizons between the lower part of plowed layer and the upper part of underlying gravel. The mottles can occasionally form a hard pan. Remarkably aged paddy soils (severely leached soils) predominate in the area of this tipe.

Type 2. Shallow solum, 30 to 40 cm. in depth, underlaid by gravel layer; divided into 2L and 2C according to its surface texture.

* The term type used here does not mean the subdivision of the soil series used in U.S. system of classification.

Soils of this type are also well drained and their subsoils show rusty iron staining and also manganese accumulation as results of downward flow of soil water, but not so remarkable as in type 1.

Type 3. Thick solum, followed by underlying gravel layer at about 1 m. or more of depth. Owing to the surface soils of varing texture, the following three subdivisions are distinguished; 3S, of coarse texture, 3L of medium, and 3C of fine. Soils of this type are rather well drained and rusty mottles can be seen through the whole profile with some exceptions. More or less aged soils are found also in two areas of type 2 and 3.

Type 4. Very shallow, 10 to 20 cm. of depth, underlaid by a gravel layer. As the profile has a distinct surface soil of rather dark brown light clay considerably rich in humus, it is likely to have developed from the terrace deposit mixed with the material transfered from the surface layer of Ando soil at the neighbouring upland. Despite of its shallow phase, this type shows the evidence of leaching and accumulation more slightly than the three types above discribed.

Type 5. Ando soil, so called 'Kuroboku'. Surface soil is well drained, light clay, dark colored rich in humus, 40 to 50 cm. thick. Subsoil is of brown clay, rich in volcanic glass material, more than 50 cm. in thickness. These horizons seem to be underlaid by compact white clay, the same material as in type 6 and 7. Although no distinct accumulating horizon is recognized through the profile, rusty mottles are found faintly below the plowed layer, and dark mottles in subsoil from upper humic horizon. The features of these mottles seem to give the evidence of slight downward leaching.

Type 6. Rather thick surface soil of dark brown light clay loam in 6L, or clay in 6C, resembling to that of Ando soil, followed by the subsoil of white heavy clay. This clay forms a compact impermeable layer that causes the soil to be poorly drained.

Type 7. Very heavy clay through the whole profile. Its subsoil, called 'Kawaratsuchi' (meaning the earth like a tile), is very sticky when wet and extremely hard when dry. Owing to the presence of this subsoil with such an extreme consistence, soil water cannot be drained after rain. In both types, 6 and 7, no distinct accumulation horizon as well as leaching horizon exists.

Type 8. Soils with waterlogged glei horizon. Below humic clay surface soil, pale clay subsoil suffered from gleization is developed owing to high water table.

Relation between soil types and topographic surfaces

Soils of the first three types characterized by distinct leaching and accumulation occur on the terraces and the flood plain; those of

the type 1 and 2 are restricted to the terraces along the Tsubo-gawa. On each surface of the terraces and flood plain various soils appear scatteringly, the distribution of which seems to have governed by superficial material, because of the fact that in the area occupied by aged soils the extent of leaching and consequently the decrease in rice-yield are affected by the depth and the textural nature of soil profile.

Soils of type 5 to 7 with general characteristic of indistinct leaching and accumulation occur on the upland surface. Type 5, Ando soil, extends to the marginal part of the upland, type 7 of heavy clay to the inner part, and type 6 lies between the above two. They are governed appearently by the differential parent materials of volcanic ash and clay, the formation process of which, however, could not be explained in this survey.

Type 8, of high water table, is found also on the upland, but is restricted to the foot of mountains in small patches, where water table is likely to be raised by spring water at the mountain-side.

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