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Summary

Due to the very favorable geographic location of the Swiss Center for Scientific Research in the Ivory Coast, it was possible to investigate the mineralization of nitrogen in various aspects of the country's vegetation.

This work is based on a method which enables one to measure the amount of mineral nitrogen (NH_3, NO_4) produced under field conditions. It is well known that only simple inorganic introgen compounds are accepted by the higher autotrophic green plants. The quantities of nitrogen, which are mineralized in the soil, are, therefore, very important to the vegetation but at the same time are related to its productivity, since the main supply of mineral nitrogen comes from the litter.

In the three types of tropical humid forests studied (Tropical humid evergreen forest on sandy soil: Turraeantho-Heisterietum; Tropical humid evergreen forest on clay soil: Diospyro-Mapanietum; Tropical humid semi-deciduous forest: Celtis forest), the mineralization of nitrogen was active everywhere. When the moisture content of the soil increases, it usually has a positive influence on the nitrogen mineralization; therefore, the largest accumulations were noted during the rainy season. The accumulations in the soil samples incubated for six weeks were mainly due to nitratic nitrogen, despite very low pli values. This can be explained by the climatic and microclimatic conditions, which are very conducive to the mineralization process. The amounts of nitrogen thus mineralized are high and should be related to the large litter production measured in these forests. This litter, in spite of the very acid condition prevailing in the soil, is rapidly broken down; and, as noticed by many scientists, big humus accumulations do not occur. In two experimental lots of the most productive station, figures slightly above 200 kg/ha/yr have been evaluated—a very impressive amount. The mean yearly production for the three forests has been estimated at 135, 170 and 165 kg/ha respectively.

In the Guinean and pre-laguna savannahs (pre-forest savannahs), by contrast, the quantities of mineral nitrogen have always been exceedingly low, to such an extent that in most cases the figures were too small to be measured accurately by this method; therefore, few graphic representations were given. In the savannah, traces of ammoniacal nitrogen were more common than those of nitratic nitrogen. Because of the very low figures, it was not possible to give a reliable estimation of the annual production. These savannahs are always burnt (experiments not included) once every year during the dry season.

In the native corplands and in the post-cultural formations of the forest area, a relatively high production of nitrogen was measured—not as great as in the climactic forest but much greater than in the savannah. After two years of traditional African cultivation (shifting cultivation), the production of mineral nitrogen does not seem to drop considerably. The annual production obtained varied between 71 and 91 kg/ha. It appears that, through the periodic clearing of new land, the African makes use of the explosive nitrogen mineralization which follows and lasts a short time after the first hoeing. Large amounts of mineral nitrogen can be freed and put to use by the crops. Although this high content of mineral nitrogen in the soil does not last long, a relatively high production of mineral nitrogen is maintained even after a fairly long period of cultivation.

This explains why the tropical rain forest, characterized by its rapid recycling of nitrogen, is still able to grow back quickly, at least in its secondary stages, following a clearing and a traditional cultivation. It is true, as other scientists have already pointed out, that in tropical forests the stock of biogenic elements are to be found above all in the vegetation itself and not in the soil; and that therefore, a large portion of the stock is depleted when the forest is cleared and cultivated. It seems, however, as far as nitrogen is concerned that this element is then replaced through the activity of nitrogen fixing micro-organisms (symbiotic and non-

symbiotic), which appear to be very prevalent in previously cultivated tropical soils. Thus in the Ivory Coast, as has now been clearly shown, and contrary to what was previously believed, the clearing and cultivation of forest areas do not cause the disappearance of the forest vegetation and its replacement by the savannah.

On the other hand, the results of this work have confirmed the very scant microbiological activity of the savannah's soil as well as why the savannahs have been able to subsist in a few places where the climate is suitable even for evergreen rain forests. It is very difficult for plants affiliated with the forest to invade such areas where the soil is extremely deficient in nitrogen resources; and this factor is believed to be equally important as the direct impact of fire on the plants. The presence of these very intriguing savannahs, located in a region where the climate should favor the forest, is usually interpreted nowadays by a paleoclimatic theory, which is supported by the above-mentioned facts. The origin of these savannahs can be traced back to an extended dry period, with the result that the dry, clear Sudanese forests reached the coast and divided the Western Guinean dense forest into two blocks. During this remote period these dry, clear Sudanese forests must have been transformed into grasslands (savannahs) and impoverished in nitrogen through the regular abuse of fire, still to be observed in the north. Maintained by man's interference despite a wetter climate, these savannahs were able to remain in a few areas of their former realm; but even there they are still being encroached upon by the forest, in spite of the fire. This last point has been actually proven by recent research.

Therefore, one should add to the direct impact of fire on the vegetation an indirect effect through the maintenance of a type of soil not conducive to mineral nitrogen production. The savannah graminaceae, burnable during the dry season, are dependent upon this type of soil and do not seem to be able to withstand competition from forest and non-combustible species in a richer medium. It has even been pointed out that the tall savannah graminaceae (Andropogonae) seem to contribute biologically to the soil's condition (by the secretion of antibiotic—antibacteria substances) and that their influence should be added to the action of fire, which burne nearly all the yearly litter, creating a very unfavorable environment for bacterial life.

This situation, nearly stable, cannot conceivably be created at the expense of the rain forest under the prevailing climatic conditions, at least by the traditional African methods of cultivation. In this case the soil always remains sufficiently active, biologically speaking, and, therefore, conducive to mineral nitrogen production, allowing the growth of weeds and pre-forest species, which would soon overwhelm any savannah plant.

Any afforestation of the savannah is linked with the formation of a more biologically active soil, the occurrence of a broad recycling of nitrogen (vegetation soil) and the production of nitrates. This has been clearly shown, especially in the supplementary experiments.

Interesting comparison can be drawn between communities of tropical vegetation and temperate vegetation, in which the soils have similar nitrsgen balances. Certain of the most productive temperate forests appear similar in this repect to tropical rain forests, whereas there are incontestable analogies between the very low mineral nitrogen production in the soil of certain stable litter producing meadows in a temperate climate (Molinietum, Brometum) and the Guinean savannah soil. In this last case it is interesting to note that factors governing these non-climactic vegetation communities are approximately the same; the mowing being equivalent to the fire. (Almost total destruction of the carbohydrates produced during the vegetation period, but nitrogen losses negligible. No litter accumulation and breakdown necessary for nitrogen exchanges between soil and vegetation.)

One can conclude from these observations that as in the temperate regions, the nitrogen factor plays an important role, maybe even more important, in the dynamism of the tropical plant communities and especially in the struggle between the dense forest and the savannah.