LEAF-CUTTING ANTS AND THE SOIL PROFILE IN SURINAM

PARASOLMIEREN EN HUN INVLOED OP HET BODEMPROFIEL IN SURINAME

by/*door*

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A certain family of ants, the *Attinae*, is limited to the tropical and subtropical parts of America. These ants utilise the leaves of different trees and shrubs to build up their fungus gardens. These gardens are laid out in a highly complex structure of cavities, and holes, sometimes 500–1000 separate cavities are formed in which a great mass of fungus is cultivated (fig. 1). The life habits of the ants and the kind of way they work the pieces of leaves into their fungus gardens have been investigated and described in great detail by Stahel and Geyskes (1938, 1939, 1940, 1943). For readers not acquainted with these matters a short review is given of the subject first.

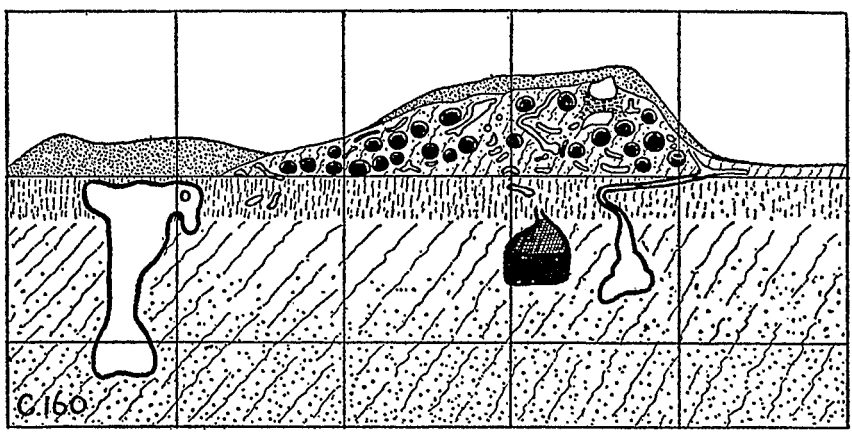

Fig. 1.
Cross-section of an ant-hill near Onverwacht. Right on top in the hill the termites nest with fungus gardens. To the left and right: cavities for water supply. In centre, cross-hatched: waste pit (Stahel und Geyskes, 1939).
Doorsnede door een termietenheuvel bij Onverwacht. Rechts boven in de heuvel: het termietennest met schimmeltuinen. Links en rechts: holten voor watertoevoer. In het midden, gearceerd: afvalput.

The two kinds of leaf-cutting ants occurring in Surinam are *Atta sexdens* and *A. cephalotes*. The first lives on open areas, not thickly covered by trees and shrubs, on drier soils of the interior of the country, where the groundwater table is low in general. *Atta cephalotes* is found more in the coastal plains of Surinam, where the groundwater table is higher in general, but occurs scattered in the interior too, if the groundwater is more proximate. More forested areas, for shadow on the nest, are preferred.

The faunatical differences between both species will not be mentioned now, nor the differences between soldiers, workers, cleaners etc. More im-

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portant are the differences between *Atta cephalotes* and *A. sexdens* regarding the methods of cutting the leaves and the method of nest-building. Ants of *A. cephalotes* of the lowland climb the three, cut the pieces of leaves and go down along the trunk of the tree with the piece of leaf held between their mandibles like a flag. Long distances, some tens of meters, the pieces of leaf are carried over cleaned paths to the nest (fig. 2 and 3).

The *A. sexdens* of the interior likes maniok leaves mostly, cuts the leaf-stalks on the plant so that the leaf drops on the ground. There it is divided by other ants into smaller pieces which are carried over short distances to entrancies of tunnels leading to the nest. These tunnels may be tens of meters long.

From these leaf-pieces, after thorough cleaning in the nest and even on the leaf-pieces when they are transported, the fungus gardens are build up. The interested reader should read the descriptions of all the measures taken by the ants to keep the gardens growing continuously, to keep them clean and to prevent the growth of an unwanted development of the fungus: *Rosites gongylophora* (Stahel, 1943). The protein and sugar-rich globular sponge-like structures in the fungus gardens represent the only food for the ants.

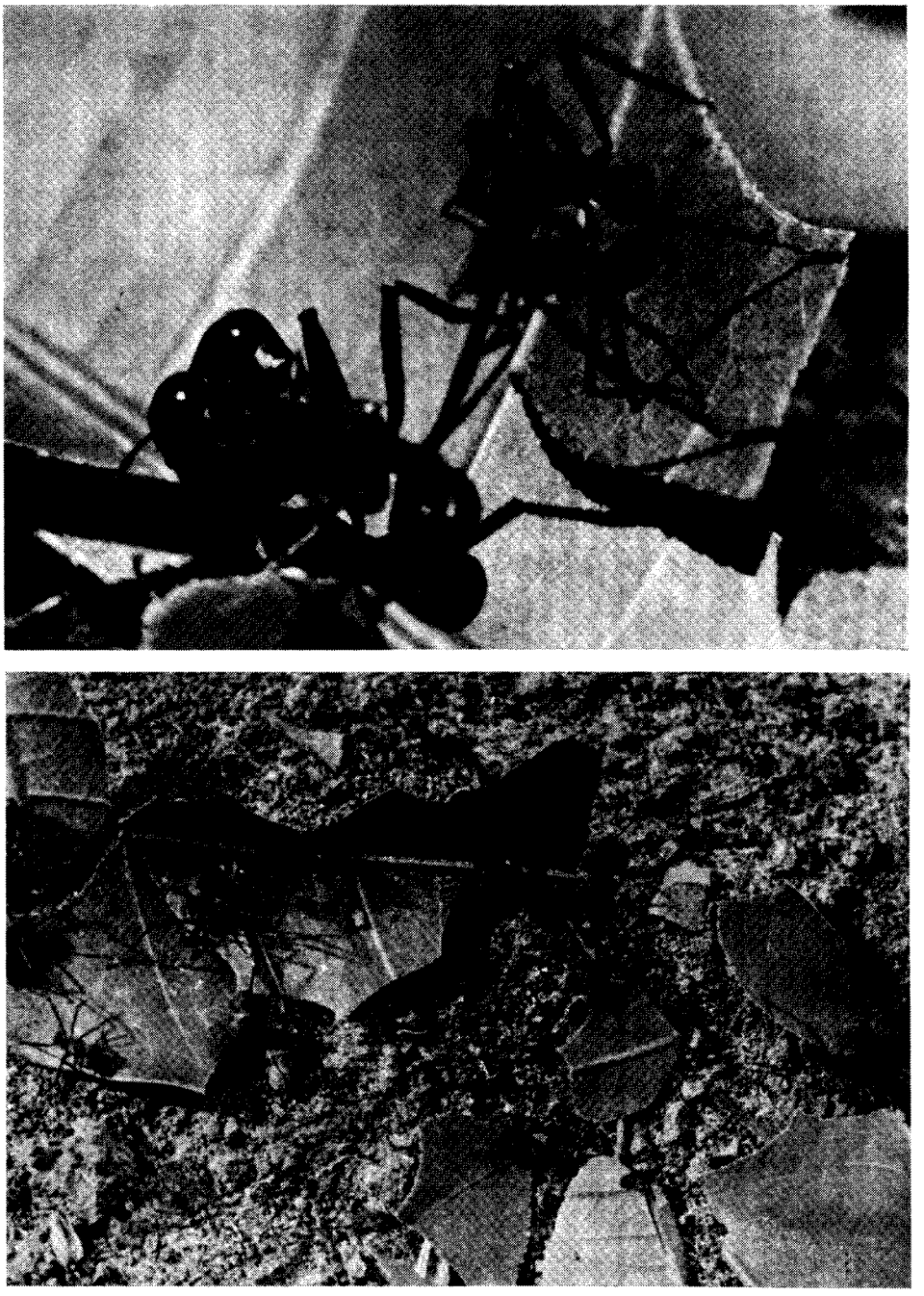
The result of the leaf-cutting by *Atta species* may be disastereous to tropical agriculture as the preference goes to leaves of maniok, vegetables, oranges, cocoa, mango etc. In fact the occurrence of *Atta sexdens* in the interior is one of the reasons, apart from exhaustion of the soil fertility by shifting agriculture, that the Amerindians and Bush negroes have to change their gardens so often.

Destruction of the nests may be carried out by applying carbondisulphide or methylbromide to several entrances of the nest, while closing the remainder of the entrances. The death of the fungus means the end of the nest but the death of the ants must be controlled after some days, otherwise a second treatment must be carried out.

As the ants need to dispose of the exhausted parts of the fungus gardens on one hand and have to keep these gardens moist on the other hand, beside the fungus-gardens cavities a number of subterranean cavities are dug-out to dispose their waste and nearly vertical tunnels are excavate to reach the groundwater. These cavities or tunnels may be more than 30 cm wide and more than one meter deep (fig. 1).

Even in non-cohaerent sand the soil to be excavated in first apparently cemented in some way or another before the ants take the aggregates of 2–3 mm diameter in their mandibles. There are no appreciable differences in organic matter content between the undisturbed and the excavated soil. Yet the aggregates can withstand somewhat the impact of light showers. After heavy rains the structure is lost and the soil is washed down the nest area, on which it was deposited. *Atta cephalotes* forms gently sloping funnel-shaped walls around the openings; *A. sexdens* has sharp edges on the funnel-shaped walls.

The continuous excavation and later on the washing-down of the soil on the nest area give rise to a gradual increase in height (fig. 1). The area may be some 30–50 m^2 (fig. 3), with a mean height of half a meter above the surrounding terrain. Per average nest something in the order of 15–25 m^3 of soil are displaced by the ants. That this has a considerable effect on the soil by mixing and therefore by homogenisation (Hoeksema, 1953) will be ob-



Shell-photographes

Fig. 2.

Cutting of leaves (photo at the top) and transportation (photo below) by *Atta sexdens*. These leave pieces are used for preparing the subtratum on which a fungus is grown providing their only food.

Verdeling en verkleining van de bladeren (bovenste foto) en transport van de bladstukken (onderste foto) door Atta sexdens. *Dit bladmateriaal wordt gebruikt voor het bereiden van de voedingsbodem, waarop een schimmel „geteeld" wordt, die de dieren van voedsel voorziet.*

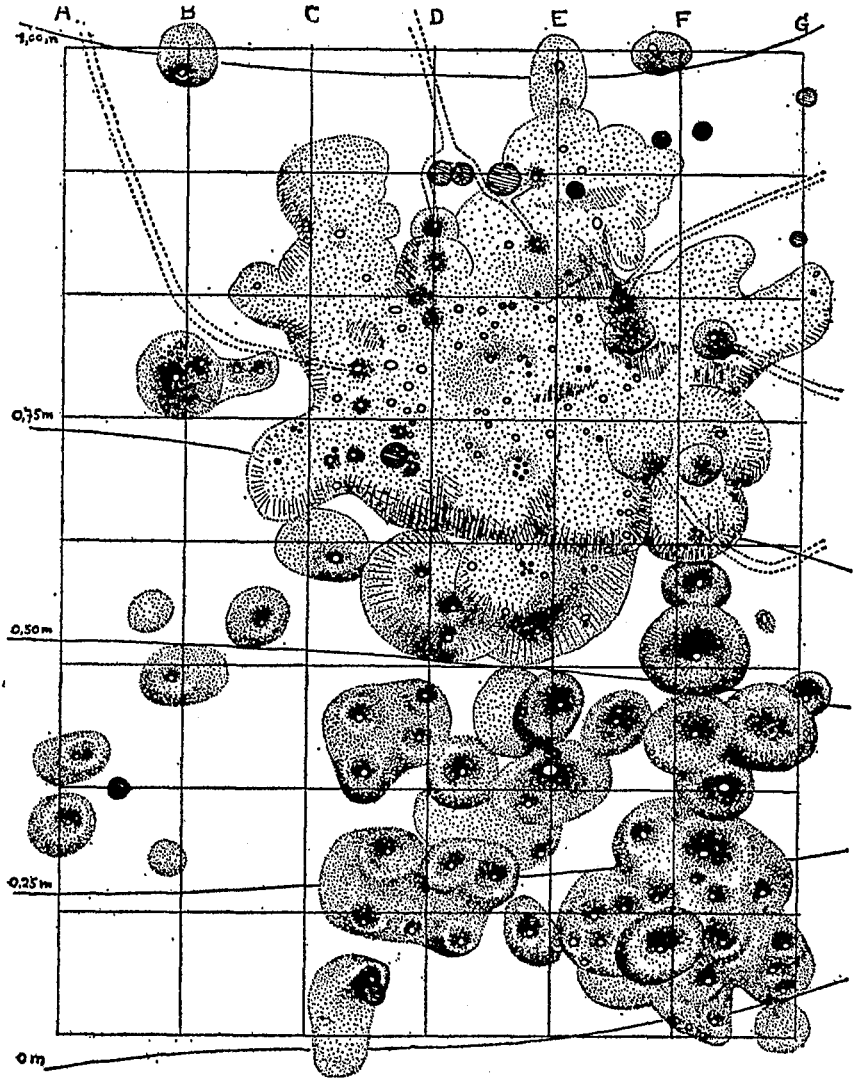


Fig. 3.

Nest area of *Atta cephalotes* on the sand ridge of Charlesburg. On top: some cleaned towing paths to the ant-hill. Right below: sand hills, recent removals. The darker shaded stains present tree-trunks. (Stahel und Geyskes, 1939).

Bovenaanzicht van het nest van Atta cephalotes *op de zandrug van Charlesburg. Boven: enkele geschoonde sleeppaden naar de nestheuvel. Rechts beneden: recent uitgeworpen zandheuvels. De gearceerde donkere schijven zijn boomstammen.*

vious. This process of homogenisation can be observed best when the soil-forming process gives rise to different layers in the profile as e.g. in a podsol profile. Van der Voorde (1957) described the effect that this mixing of soil has on the Rijsdijk very fine sand, found in the old coastal plain of Surinam. There in depressions of the old ridges-system a groundwater podsol is formed. Depending on the topography of the terrain the Rijsdijk serie may obtain a considerable area. In these uniform stretches of soil some spots with a totally

different soil can be observed. Upon close observation the soil on these spots appears to be a thorough mixture of the A_1, A_2, B_{2h}, B_{2ir} and C-layers of the podsol profile. This mixing has been obtained by the *Atta* ants, building their nest and excavating the subsoil and mixing it with topsoil (fig. 3). After leaving their nest the soil collaps and the mixture may be found back by a soil survey. Colour and humus content are nearly uniform.

In the young coastal plain, on the sand ridges, the sandy profiles are sometimes underlain by thinner or thicker clay layers, due to differences in sedimentational circumstances during the deposition of the sediments. These clay layers are penetrated by the ants when in the dry season the lowering watertable must be followed to supply the fungus gardens with water. The mixture of sand and clay on the nest area results in the ultimate homogenisation of the soil.

In more uniformly textured soil types, the work of the leaf-cutting ants cannot be observed so easily; nevertheless the effect must be the same.

It is safe to assume that the leaf-cutting ants have an enormous effect in the long run on the process of the homogenisation of tropical soils.

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SAMENVATTING

In Suriname komen twee soorten draagmieren voor (*Atta sexdens* en *A. cephalotes*) die leven van schimmeltuinen. Als materiaal waarop de schimmels groeien gebruiken zij de bladeren van verschillende bomen en struiken.

Atta sexdens komt voor op drogere terreinen in het binnenland, waarbij voor de nestplaats minder zwaar begroeide gedeelten worden uitgekozen. De bladeren voor de schimmeltuinen worden in de bomen aan de bladstelen doorgebeten; het op de grond gevallen blad wordt dáár verkleind en vervolgens over korte afstanden bovengronds vervoerd naar de ingangen van tunnels, die naar het nest voeren.

Atta cephalotes wordt vooral aangetroffen in de kustvlakten. De nesten zijn beschaduwd en liggen ook op gronden met een hogere grondwaterstand. Deze soort mieren bijt stukjes blad uit de bladeren in de bomen en draagt de stukjes langs de stam omlaag. De bladstukjes worden vervolgens over meerdere tientallen meters gedragen over schoongemaakte paden, die naar het nest leiden.

In de nesten van beide soorten worden de bladstukjes verwerkt tot een voedingsbodem waarop schimmels in onderaardse holten worden gekweekt. Van deze schimmelmassa leven de mieren. Deze levenswijze kan rampzalige gevolgen hebben voor cultures van cassave, groenten, citrus, cacao enz. Het voorkomen van *Atta sexdens* in het binnenland is één van de redenen dat Indianen en Boscreolen hun kostgronden moeten verlaten. Bestrijding is mogelijk. De bodemkundige betekenis van de draagmieren ligt op het terrein van de homogenisatie van de grond. Door het graven van schimmeltuinen, afvalputten, waterputten en gangen wordt een vermenging van de grond bereikt. Vaak zien we in een gebied vele nesten.

Het nestoppervlak van 30 à 50 m^2 ligt gemiddeld een halve meter hoger dan de omgeving. Zodoende wordt 15 à 25 m^3 grond per nest verplaatst.

De homogeniserende werking valt duidelijk op bij bodemprofielen met sterk verschillende lagen, doch is overal aanwezig. Zo zijn in een podzol-

gebied van de oude kustvlakte plaatsen gevonden waar alle bodemlagen volledig vermengd waren. In het zandritsengebied brengen de mieren vaak klei uit de diepere ondergrond naar boven.

LITERATURE

Hoeksema, K. J., 1953. De natuurlijke homogenisatie van het bodemprofiel in Nederland. Boor en Spade VI, pp. 24–30.

Stahel, G., 1943. The fungus gardens of the leaf cutting ants. Journ. New York Botanical Garden, Vol. 44, pp. 245–253.

Stahel, G. & *D. C. Geyskes*, 1938. Sobre o fungo cultivado pela formiga *Atta cephalotes* (Ueber den Pilz der Gärten von *Atta cephalotes*); Anais Primeira Reuniao Sul-Americana de Botanica, Rio de Janeiro, I, pp. 199–213.

Stahel, G. & *D. C. Geyskes*, 1939. Ueber den Bau der Nester von *Atta cephalotes* L. und *Atta sexdens* L.; Revista de Entomologia, X, pp. 27–78.

Stahel, G. and D. C. Geyskes, 1940. De parasolmieren en hunne bestrijding; Bull. Dept. Landbouwproefstation Suriname, 56, pp. 28.

Voorde, P. K. J. van der, 1957. De bodemgesteldheid van het ritsenlandschap en van de Oude Kustvlakte in Suriname, Amsterdam.