SOME ASPECTS OF FABRIC DYNAMICS IN A MOLER PROFILE (INVESTIGATED BY THE APPLICATION OF A GRAPHICAL SCHEME)

by

Ulrich Babel (1)

INTRODUCTION

Soil fabrics are complex formations of inherited and of newly formed units.

To investigate the dynanics of soil fabric, it is necessary to start with the description of fabric states. Some aspects of soil fabric can be described by means of a graphical scheme. The procedure is given by BABEL (in print).

The graphical scheme is an advanced stage of abstraction. The thin section is a first abstraction. Here the changing in time as well as the third dimension is excluded. These advantages make it possible to have repeated investigations and to apply stereological methods. A further level of abstraction is the schematical drawing, the value of which has been appreciated in soil micro - morphology already for a long time. It corresponds to the abstraction of a landscape in a topographical map (e.g. JONGERIUS, and JAGER, 1964). A next following level of abstraction is the graphical scheme, which is used in the present paper. In this scheme, each fabric unit., which normally occurs in numerous items, appears only once. The lines which combine the units demonstrate their association, that is the way in which they are neighbored.

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(1) Fachgebiet Bodenbiologie, Institut für Bodenkunde und Standortslehre, Universität Hohenheim, Stuttgart, Germany.

The purpose of all those abstractions is to pick out some precise characteristics from the multitude of in - formations which can be found in a soil by means of mor- phography. Such characteristics can be consolidated by terminology. They can be used in qualitative descrip - tions or in morphometric measurements. But it is not the main idea of the scheme to work out individual fabric units (e.g. in contrary to the approach which has been made by BABEL (1974), where relations between mor - phographic characteristics and ecological conditions are demonstrated). The graphical scheme is meant to indi - cate relations of neighborhood between the units and consequently to show the construction of higher fabric units out of lower ones. The lowest units are conside - red to be the basic units.[1] It is meant that all fabric units of all levels of organization are represented in the scheme. For simplification it is possible to summarize several similar types of units into one item only. (Here is a subjective element of this description method, which probably never can be excluded; for subjectivity see also BABEL, in print).

Thus the graphical sheme is an abstraction towards relations of neghborhood. (On the contrary, some other characteristics of relative (related) distribution as well as orientation and relative amounts are not represented in the scheme). The discussion of the graphical scheme may help to draw conclusions from the local relations to functional relations (genetics or dynamics). That is a frequent way of reasoning in micromorphology.

(1) During the working meeting, the author has shown posters of the most important types of tissue and cell residues as well as of frequent morphographical types of decomposition of tissues. A publication is in preparation (BABEL and JEANSON).

The main purpose of this paper, however, is to draw conclusions on processes from changings of the graphical schemes for subsequent stages of decomposition. To show this, two examples are chosen, the first one being three stages of decomposition of spruce needles, the second one representing four surface horizons of a moder profile which succeed each other in space as well as in time.

Examples

The items of basic units which are represented in the schematical drawings are the same as in the graphical schemes (leaf residues (l.r.), organic fine substance (f.s.), roots and root residues (r.r.), bark residues (b.r.). The higher levels which are indicated in the schemes often can not be delimited distinctly in the drawings, which follow closely the respective part of the thin section. In fact, they are types of association between which exist gradual transitions (e.g. between small aggregates (s.ag.) and dense areas of fine sub - stance (d.ar.): when the areas of fine substance are less dense it may be recognized that they are composed of small aggregates). It is not necessary to transform the types (with gradual transitions) into classes (with well defined boundaries) when a qualitative fabric descrip - tion is intended. This is necessary only in quantitative descriptions. In future, electronic image analysis may help in this difficult task.

Simple example: Decomposition of spruce needles by primary decomposers.

Description : Fig. 1 and 2 show 3 stages. In the first stage the needle is still intact, it is one fabric component only. (The internal differentiation of this organ residue is not taken into account by the soil scien-

tist as it is not due to soil forming processes.).

In the second stage the well known attack by oribatid mites can be recognized. The graphical scheme indicates: There is a plant residue (1.1) and particles of organic fine substance (1.2). The latter ones are associated to form oribatid mite droppings (2.1). Those are associated with the needle residue (1.1) to form the whole fabric (square symbol).

In the third stage a further differentiation is recognizable. The organic fine substance (1.2) does not form oribatid mite droppings (2.1) only, but dense fabric areas (2.2) as well. Indeed here we have 3 items of fabric units, which directly build up the whole fabric, one of first (1.1) and two of second level (2.1, 2.2).

Discussion: Thus the succession of graphical schemes shows an increasing differentiation of fabric in the course of decomposition. This corresponds with a differentiation in chemistry and biology. In stage 1, decomposition processes are largely restricted to solution and formation of browning substances. In the mite droppings the accessible surface has increased by the comminution. This provokes surther decomposition processes such as autoxidation as well as colonization and decomposition by microorganisms. The dense fine substance areas (2.2). have resulted from a falling apart of the droppings (2.1). Thus they represent a further decomposition stage (ageing, see Bal, 1973). (It is not intended to demonstrate this interpretation by the graphical scheme).

Complex example : Changings of fabric in the subsequent horizons of the surface layer of a moder profile

The figures 3 to 5 show schematic drawings from vertical thin sections of the horizons L_V, Fr, Fm, Hf of a moder profile (beech, acid brown earth, central

uplands of Germany : plot E1 of the Solling project of JBP; for photographs of the same details see BABEL ~~1972; for terminology of~~ horizons see BABEL, ~~1971~~).[1] Fig. 7 shows the respective graphical schemes.

Description : The basic units of the Lv are leaf residues (l.r.) and organic fine substance (f.s.). The latter is associated to form small aggregates (s.ag.), those, together with the leaf residues, form leaf bundles (lf.bd.), which build up the fabric of the horizon (square symbol).

The Fr contains roots and root residues (r.r.) as additional basic units, (they are put into the same item, as it is often impossible to distinguish them from each other in thin sections). The fine substance (f.s.) occurs not only in small aggregates (s.ag.). but in dense areas (d.ar.). also. The gradual transitions between (s.ag.). and(d.ar.) are not demonstrated in teh graphical scheme. A part of the leaf residues (l.r.) together with the small aggregates (s.ag.) forms leaf bundles (lf.bd.) just as in the Lv (from centre to upper right).

Several items contribute directly to the construction of the whole fabric: the basic units "leaf residues" (l.r.) and "roots with root residues" (r.r.), the second level units "small aggregates" (s.ag.) and "dense fine substance areas" (d.ar.), and the third level units "leaf bundles" (lf.bd.).

(1) Ln: (nearly)no fine substance, no visible decomposition; Lv: (nearly) no fine substance, visible decomposition of plant residues; Fr: organic fine substance but plant residues prevailing; Fm: high percentage of fine substance as well as of plant residues; Hr: organic fine substance prevailing but plant residues (from leaves or needles) still present; Hf: nearly only organic fine substance (roots or root residues may occur).

The Fm is built up very similar to the Fr in respect to the basic and higher fabric units. (The differences which are quite evident from the schematical drawings are those of orientation and of relative amounts; they are not demonstrated in the schemes.) The only difference which is recognizalble from the schemes is, that part of the dense areas (d. ar.) occurs in the leaf bundles (lf. bd.). (The whole horizontal belt which runs through the middle of the drawing is understood as a leaf bundle; this is in agreement with the separation of the material in the field.)

The fabric of the Hf is completely different. Leaf residues do not occur any longer, there are bark residues (b. r.) instead. The fine substance (f. s.) forms small aggregates (s. ag.) in some cases, which are similar to those of the preceding horizons. With this only exception all basic units are directly combined to form the whole fabric of the horizon, that is without forming special units.

Discussion: The graphical schemes show an increasing differentiation of the fabric from the Lv to the Fm. (This corresponds with the findings in the three stages os spruce needle decomposition, fig. 2). Apparently, there is a parallelism to the increasing differentiation in physico-chemical as well as in biological situation. Corresponding results are obtained by Anderson (1977) who calculated diversity indices for soil aminals as well as for simple fabric units such as leaf residues, droppings, small and large voids etc. Here, on the contrary, it is the differentiation of the fabric as a whole, the changings of which are found by the graphical scheme (fig. 7). In a still more abstracted way, the fabric differentiation can be expressed by a fabric formula (fig. 7, below the graphical schemes). This formula figures the sum of

units on each level. Additionally, the sum of all combining lines in the scheme can be quoted (fig. 7, in brackets on the right of the formulae).

After the increase from Lv to Fm, graphical schemes, fabric formulae and numbers of combining lines demonstrate a decrease from Fm to Hf. This represents once more a parallelism to biological activity and chemical processes, the Hf being a horizon of accumulation of substances which resist to further decomposition (BABEL, 1972).

The maximum of differentiation in Fr and Fm results firstly from the presence of both, inherited as well basic units (leaf residues as well as roots and root residues). Secondly, none of the basic or second level units dominate the whole fabric; this happens, however, in the Lv (leaf residues) as well as in the Hf (organic fine substance). Finally, the leaf bundles, which are inherited from the Lv, still occur in the F-horizons, but have disappeared in the Hf.

The graphical schemes of the 4 horizons may be discussed for some other details. In the Lv the position of the small aggregates (s.ag.) is due to their formation. Most of them are enchytraeid droppings. These animals have a high need of humidity and, therefore, live under the protection of the leaf bundles. On the other hand, the small aggregates contribute to the mechanical stabilization of the leaf bundles as they act as binding substances.

In the Fr roots appear for the first time. Here they find good humidity conditions by the protection of the overlying L-horizons. On the other hand, the increase in the amount of fine substance indicates increasing decomposition and thus mineralisation of plant nutrients. (The increased amount of fine substance causes the formation of dense fine substance areas (d.ar.), which is demonstrated in the graphical scheme. The decrease in

parallel orientation, which is not demonstrated in the scheme, is due to high activity of primary decomposer animals.)

In the Fm , the thick leaf bundles, which contain large dense areas (d.ar.), have been formed of the remnants of Lv-leaf bundles and from the increased amounts of organic fine substance. This happens after the decrease of activity of primary decomposers.

In the Hf , the fine substance includes all other fabric-units. It forms a coherent total fabric on the third level of the graphical scheme. (Therefore, it is no longer possible to enter dense areas of fine substance on the second level.) The dense fine substance is probable to prevent strong decomposition processes which are more difficult also because of the chemical properties of the accumulated material. It should be noted also, that the roots and root residues in the Hf are included in the dense fabric. Most of them are root residues. They have been packed up by the dense fabric exactly as the bark residues. (In the Fm, however, they are outside; in that horizon living roots prevail.) It is unknown, whether living roots are unable to penetrate into the dense areas because of lack of oxygen, or whether they can penetrate and thereby losen the dense areas.)

The occurrence of small aggregates in ratios similar to those in the preceding horizons, does not necessarily mean a similar animal activity. Their amounts result from the difference between their formation and decomposition (BABEL, 1974). In accordance with other informations about processes in the Hf, a low formation ratio and in the beginning a still lower decomposition ratio must be assumed.

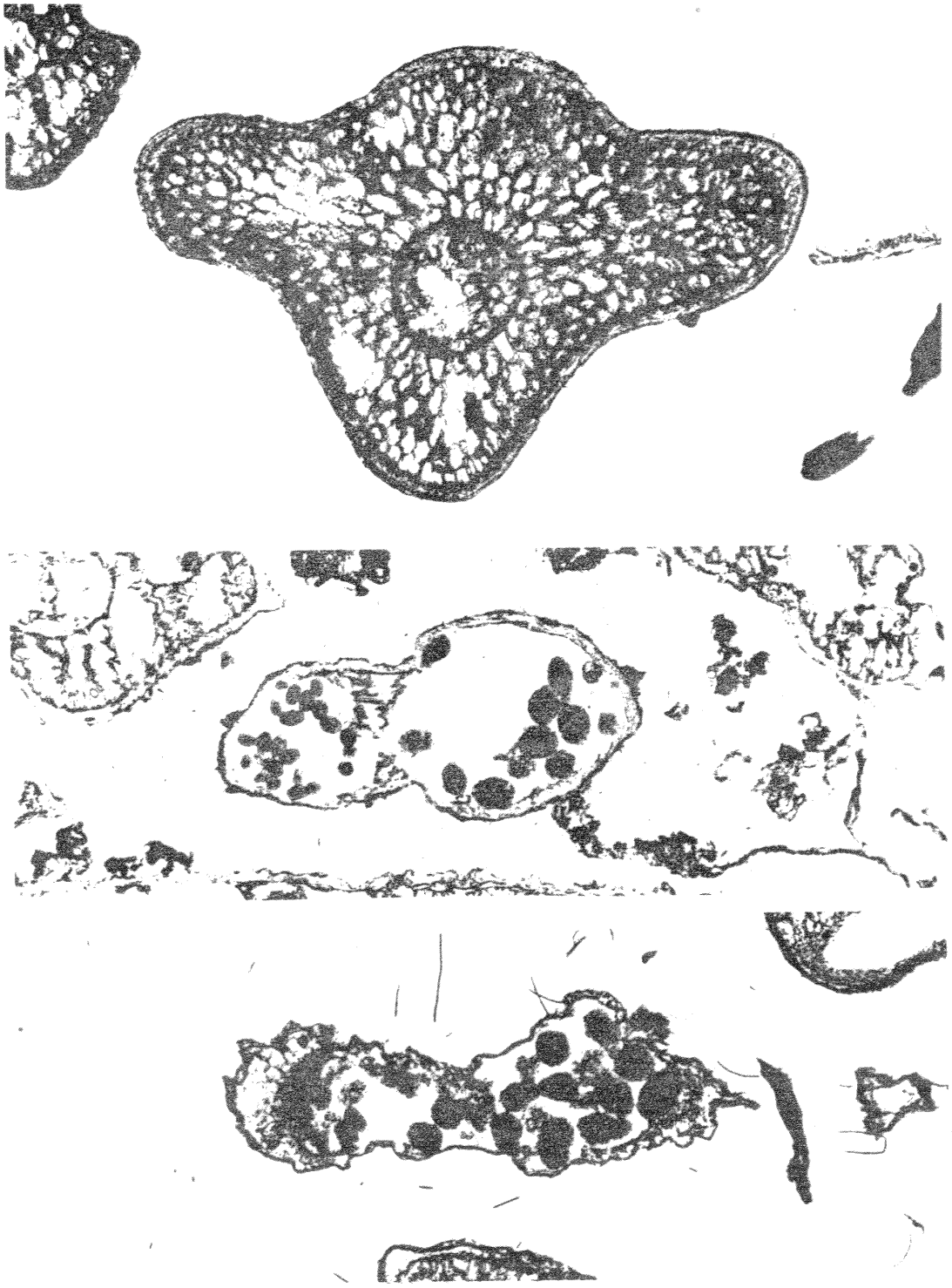


Fig. 1

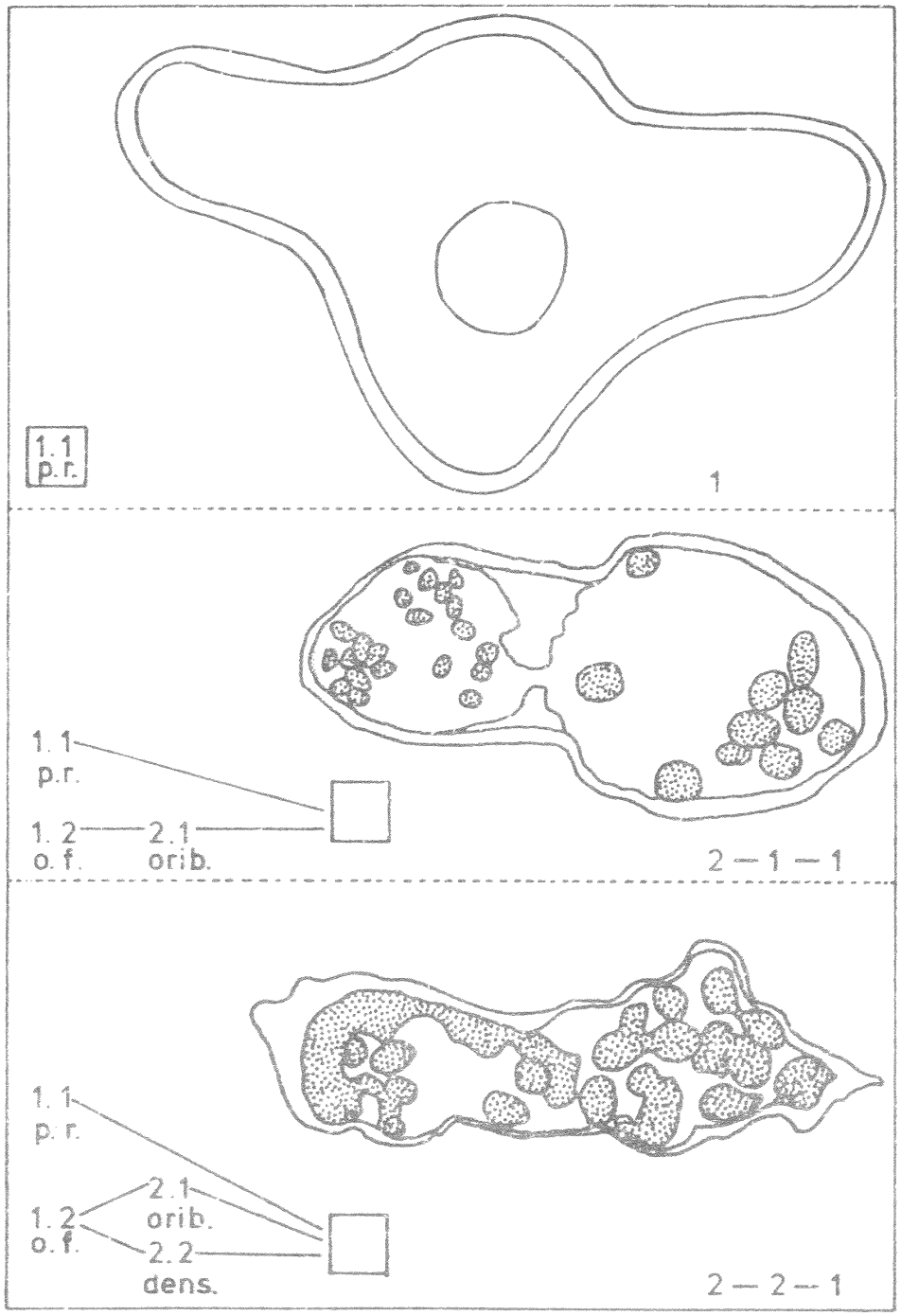


Fig. 2

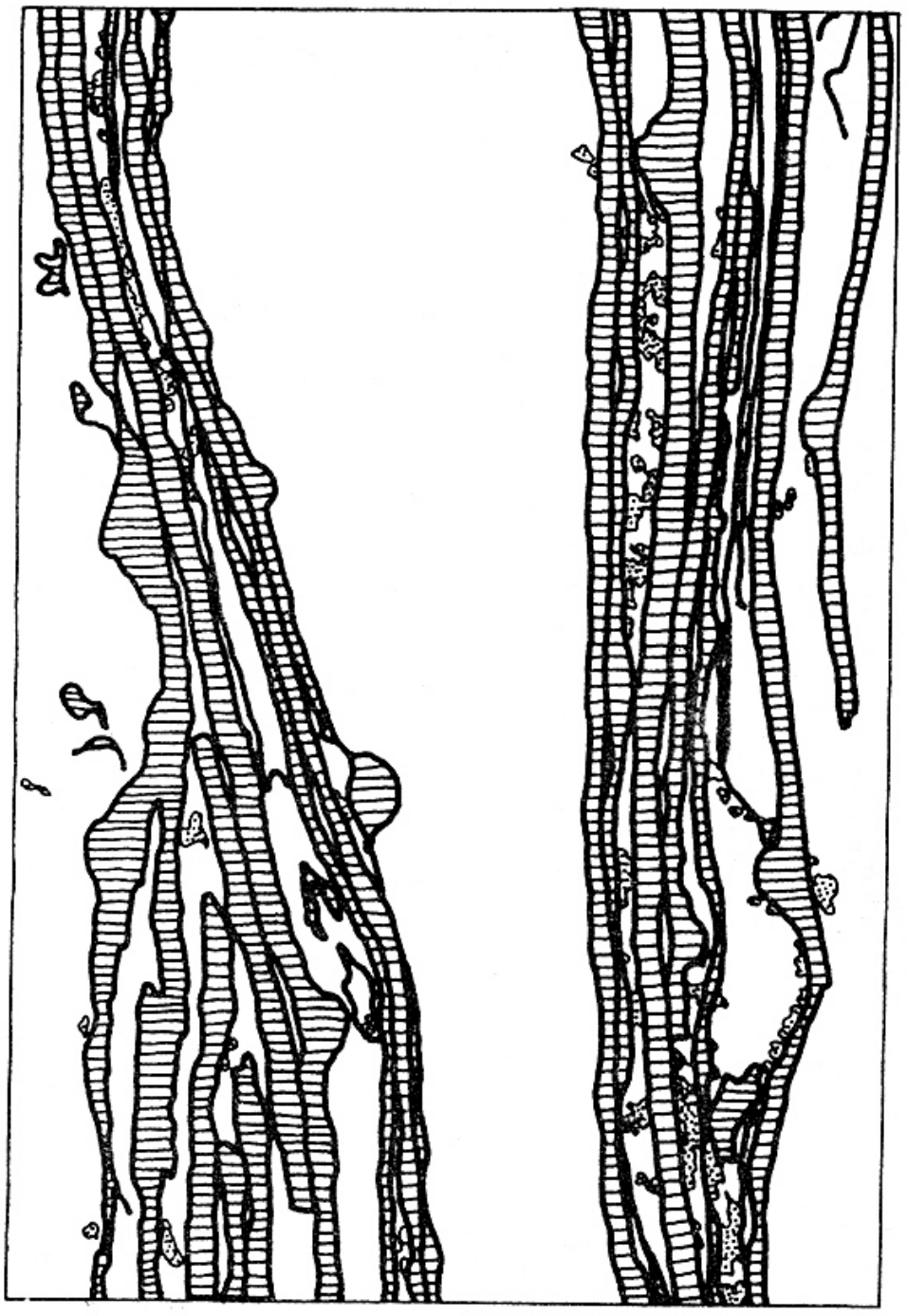


Fig. 3

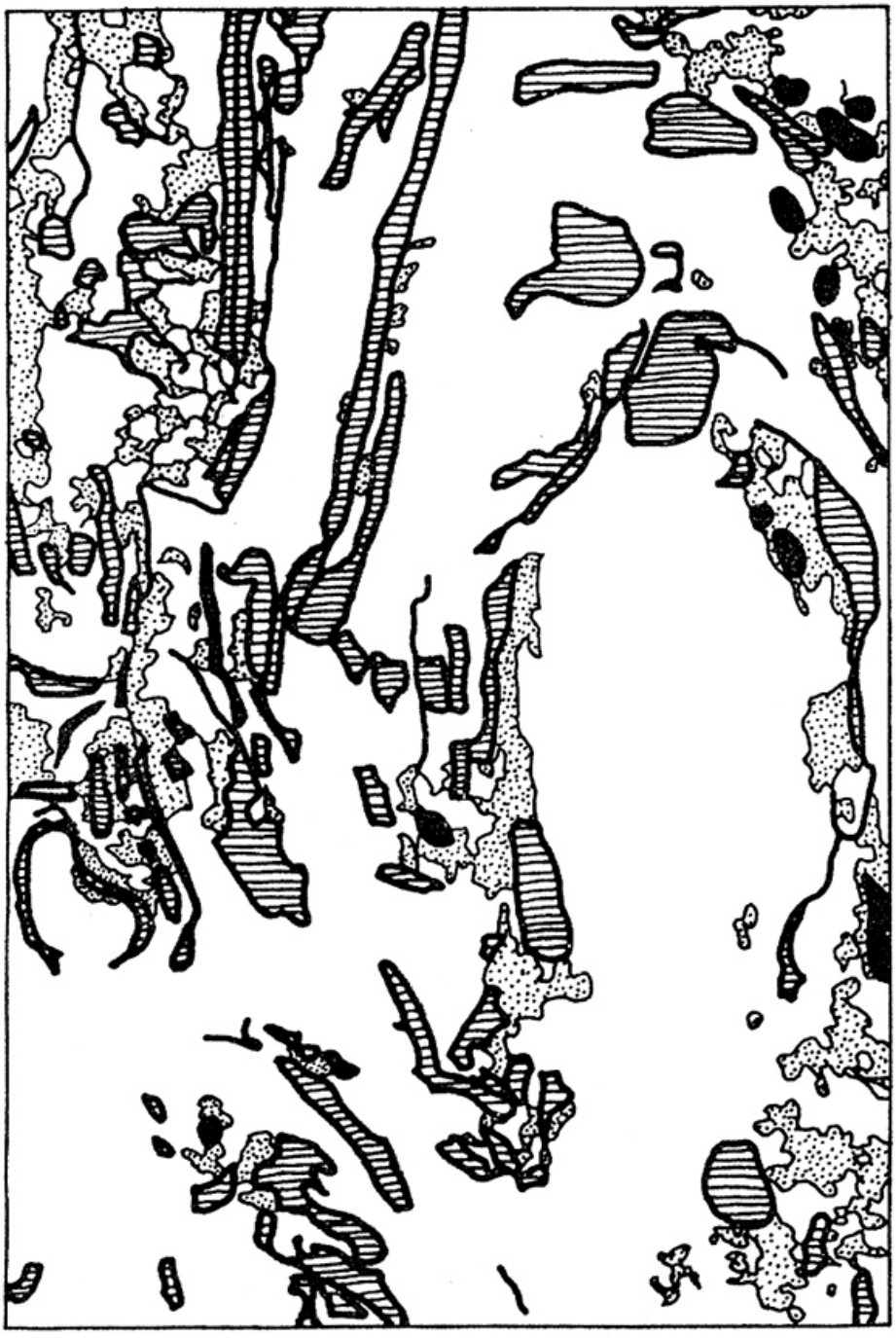
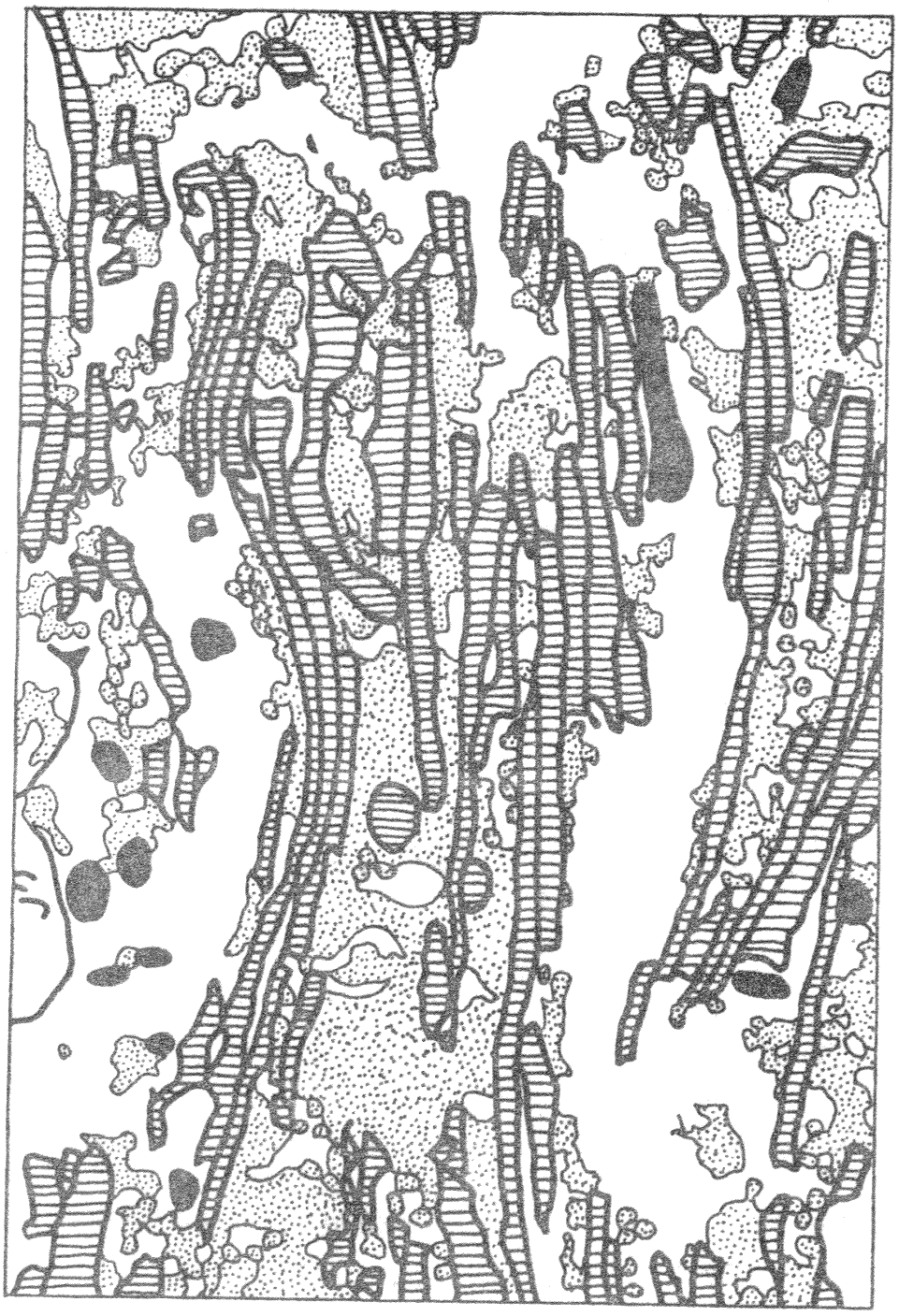


Fig. 4



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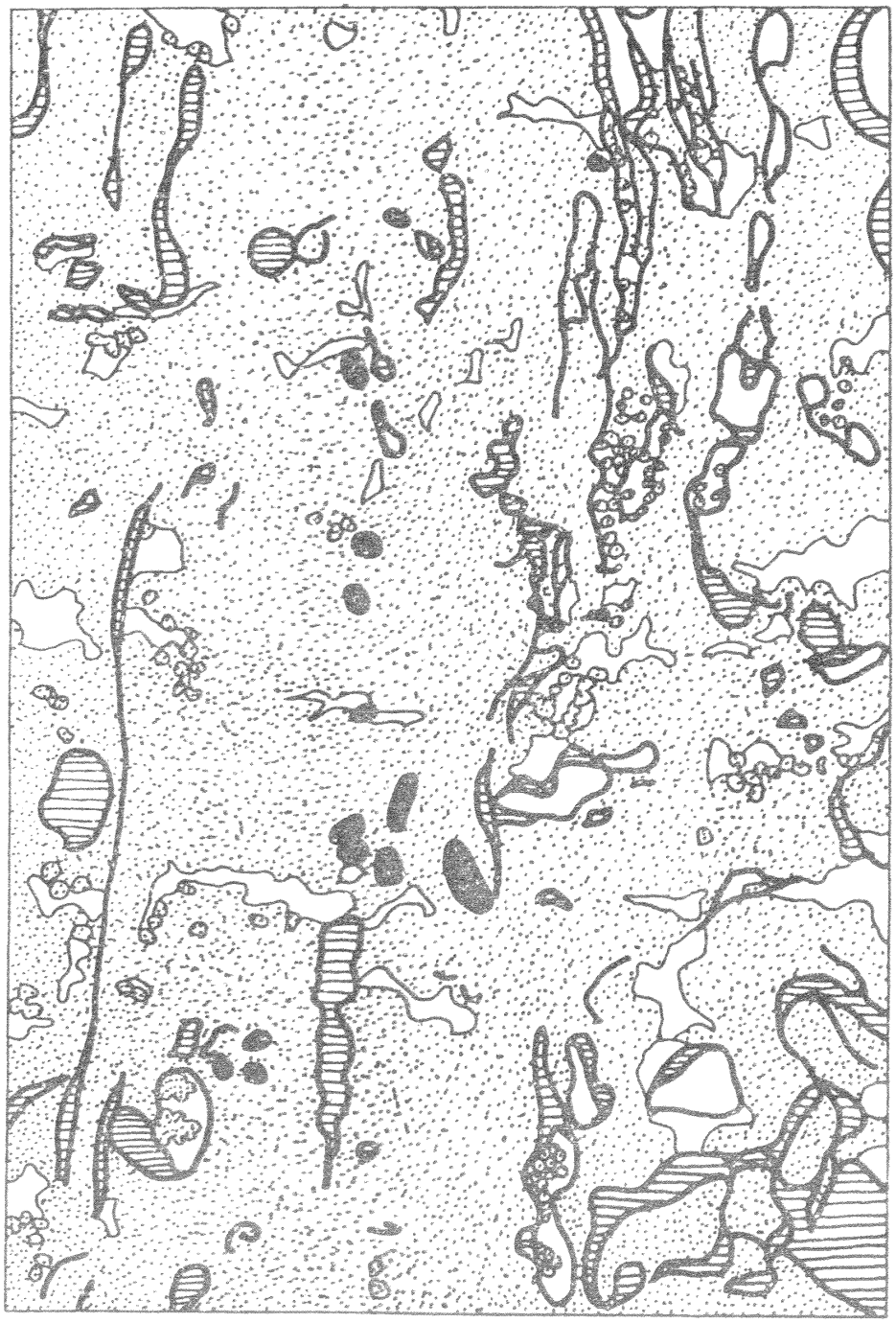

Fig. 6

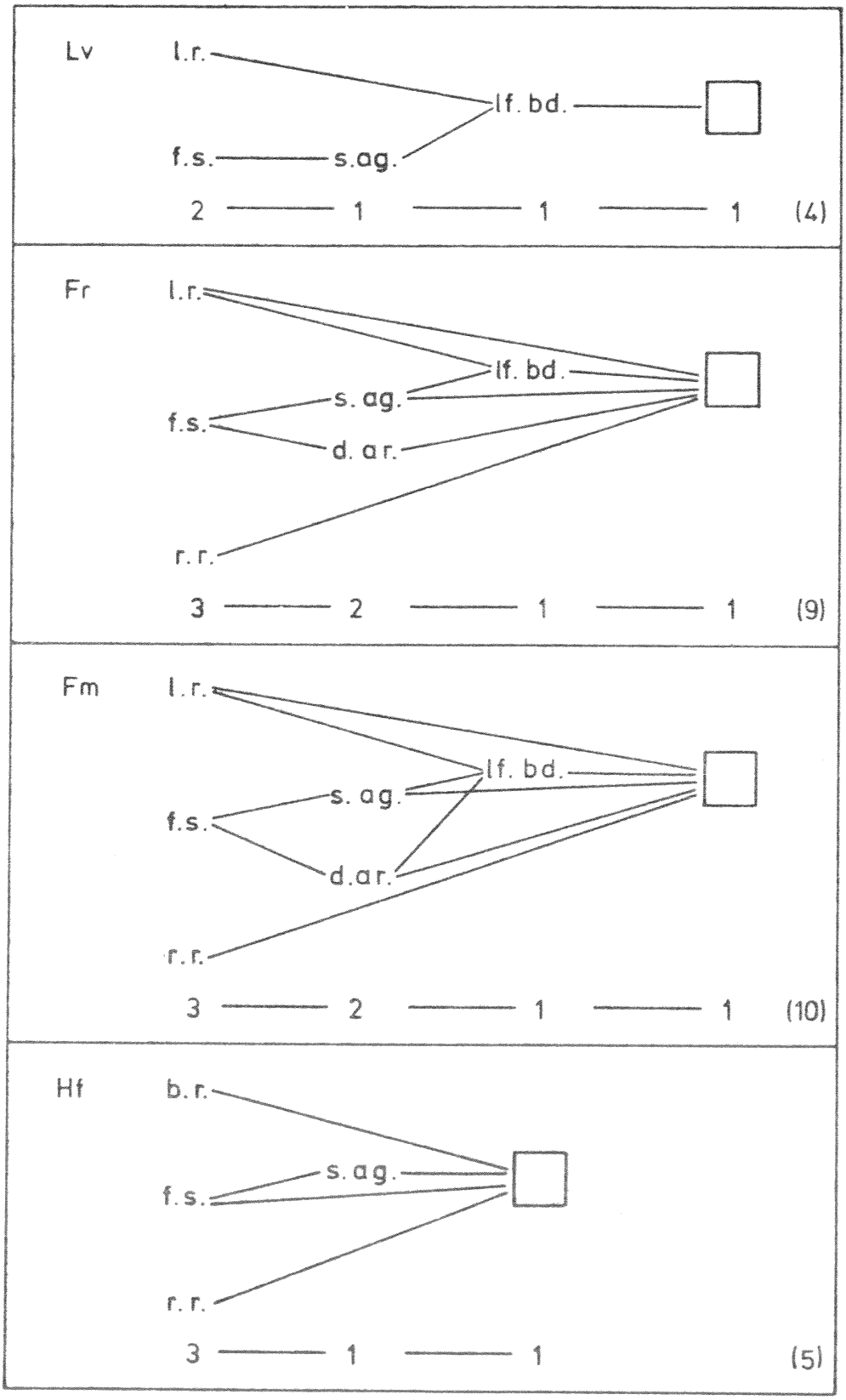
Lv
l.r.
lf. bd.
f.s.
s.ag.
2 1 1 1 (4)
Fr
l.r.
lf. bd.
s. ag.
f.s.
d. ar.
r. r.
3 2 1 1 (9)
Fm
l. r.
lf. bd.
s. ag.
f.s.
d.ar.
r. r.
3 2 1 1 (10)
Hf
b. r.
s. ag.
f. s.
r. r.
3 1 1 (5)

Fig. 7

Captions to illustrations

Fig. 1 : Three stages of decomposition of spruce needles (compare fig. 2): 1.) Tissues preserved (Ln-horizon, moder). 2.) Most part of assimilation parenchyma and central cylinder eaten by oribatid mites and transformed into well confined droppings = (Lv-horizon, moder). 3.) As 2, but part of the droppings fallen in pieces (Lv-horizon, moder). Frame length: 2,2 mm.

Fig. 2 : Schematical drawings, graphical schemes for the fabric, and fabric formulae of three stages of spruce needle decomposition (compare fig. 1). Abbreviations : p.r.: plant residue; o.f.: organic fine substance; orib.: oribatid mite droppings ;dens.: dense areas of fine substance.

Fig. 3.: Lv-horizon (schematical drawing). - Beech, moder, acid brown earth, central uplands of Germany. - Vertical thin section, frame length 6,4 mm. - Strong contours: Leaf residues; dotted: organic fine substance; black: roots and root residues (compare photographs in BABEL, 1972). - For graphical scheme and short discussion of the fabric, compare fig. 7.

Fig. 4. : Fr-horizon (Schematical drawing). - Other data compare fig. 3.

Fig. 5.: Fm-horizon (Schematical drawing). - Other data compara fig. 3.

Fig. 6.: Hf-horizon (Schematical drawing). - Strong contours: bark residues. - Other data compare fig. 3.

Fig. 7.: graphical schemes for the fabrics of the 4 moder-horizons of fig. 3-6.

Lv : Simple fabric of 2 basic units, one of which is predominant (leaf residues), 1 item of 2nd level (small aggregates) and 1 item of 3rd level (leaf bundles). - Abiological and microbial processes result in the formation of leaf bundles.

Fr: More differentiated fabric than Lv: The same basic units as in Lv but in more ways of neighboring; additionally new units (roots). - Part of the leaf bundles is still present, another part is transformed by animals into organic fine substance, which forms dense areas as its amount increases. - Horizon of highest feeding activity of animals.

Fm: Neighborly relations very similar to Fr. The increasing amount of ine substance is not represented directly in the graphical scheme, the orientation neither. Somewhat decreasing activity of animals. - The most differentiated fabric in Fr and Fm corresponds to the highest diversity of animals and of biological processes in these horizons.

Hf: Simple fabric by predomination of 1 basic unit (organic fine substance). - The simpler fabric corresponds to the low biological activity.

Abbreviations :

basic units : l.r.: leaf residues
b.r.: bark residues
f.s.: organic fine substance
r.r.: roots and root residues
2nd level s.ag.: small aggregates of organic fine substance
d.ar.: dense areas of organic fine substance
3rd level lf.bd.: leaf bundles
total fabric: (square symbol).

FABRIC DINAMICS IN A MODER PROFILE

SUMMARY

On the basis of graphical schemes, which demonstrae neighborly relations between the fabric units, alterations, of the fabric during decomposition of two organic materials are discussed:

1). needles, which are attacked by oribatid mites

2). the surface horizons of a moder profile.

The fabric schemes show in a simple way the complex mixtures of inherited and of newly formed structures. Fabric schemes and fabric formulae demonstrate the increase of fabric differentiation form the L-to the F-horizon and its decrease to the H-horizon. These alterations correspond largely with the overall extent and differentiation of the biological processes. Moreover, the setting up of the fabric scheme encourages detailed observation on neighborly relations of the fabric units, which are discussed as cause or effect of processes.

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