Respiration and Transformation of Nitrogen in the Floodplain Forest Soil at Lednice na Morave

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The extent of changes in the CO_2 production and in the contents of mineral nitrogen forms as a function of time and soil humidity was studied in laboratory experiments on soil samples from typical soil horizons of the floodplain forest at Lednice na Morave.

Materials and methods

The floodplain forest "Horni les" at Lednice na Morave /48°48'22''N, 16°46'32''E, 161 m a.s.l./ is characterized as a Fraxino-Ulmetum. The average yearly temperature is 9 °C and the average yearly precipitation 524 mm.

The A_o horizon /0-1 cm/ of the soil profile consists of litter and mull, the A horizon /1-8 cm/ is dark grey clayey earth with granular structure. The horizon A//B/ /8-50 cm/ consists of grayish brown clayey soil with patches showing a ferrous tint /KLIMO and PRAX, 1985/.

Soil samples were collected from three soil horizons in April 1987. The water holding capacity /WHC/ was estimated by weighing soaked samples: A_o=75.3%, A=38.9% and A/B/=25.0%. The samples were then stored in air-dried condition. The production of carbon dioxide by air-dried soil samples re-moistened to 30, 60 and 100% WHC of A_o, A and A/B/ was measured at daily intervals using the absorption method of FIEDLER and MAI /1973/. The extent of the changes in ammonium and nitrate nitrogen in A_o, A and A/B/ soil samples at the above soil moisture conditions was estimated conducting model incubation experiments. Ammonium ions were determined colorimetrically using the Nessler reagent /JAVORSKY et al., 1987/ and the nitrate ions with sodium salicylate /HORÁKOVÁ et al., 1986/, total carbon and nitrogen by using "Carlo Erba" analyzer.

Results and discussion

Experimental data on the CO_2 production by soil samples from individual soil horizons incubated at different soil moisture levels are summarized in Fig. 1. It is evident, that CO_2 production was higher by an order in the

litter and mull of the A_o horizon than in the humic and mineral soil from the A and A/B/ horizons respectively. The highest CO_2 production from the A_o horizon corresponding to 133.2 mg per 100 g dry soil per day took place at 60% WHC. The highest CO_2 production by the A and A/B/ horizons occurred at 30% WHC and was 6.7 and 6.4 mg CO_2 per 100 g dry soil per day.

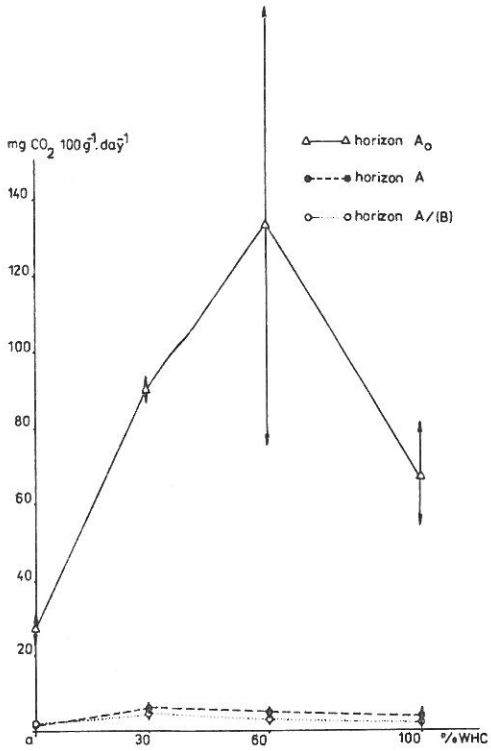

Fig. 1
CO_2 outputs of soil by respiration

The CO_2 production was stoichiometrically converted to the respective carbon production and further, on the basis of soil bulk density and soil layer thickness, to the carbon output of individual soil horizons, which was expressed in kg $ha^{-1}day^{-1}$. At different soil moisture levels, the litter layer A_o can thus theoretically produce 0.6-2.9 kg C $ha^{-1}day^{-1}$, the humic A horizon 1.4-12.5 kg C $ha^{-1}day^{-1}$ and the mineral A/B/ horizon 1.6-35.3 kg C $ha^{-1}day^{-1}$. The results are used for modelling the carbon output of the soil surface in the forest based on actual soil moisture data measured daily at the experimental station at Lednice.

The data of carbon output and carbon content were used for estimating the carbon turnover times for individual soil horizons. The results for different soil moisture levels are given in Table 1.

The transformations of mineral nitrogen forms in the A_o horizon in the course of laboratory incubation at 60% WHC are shown in Fig. 2. The concentration of bound NH_4-N in this horizon was the highest on the 6th day

Table 1
C turnover times in years in characteristic soil horizons

Horizon	Soil moisture				
	air-dried	30%	60%	100%	WHC
A_o	30.8	9.3	6.3	12.6	
A	281.5	31.9	36.2	48.8	
A/B/	465.4	18.9	32.3	49.4	

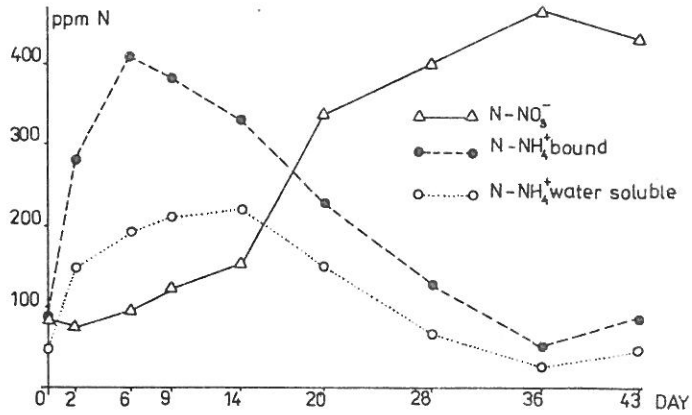

Fig. 2
Transformations of mineral nitrogen forms in the A_o horizon

of incubation /406 ppm/ and surpassed that of the water soluble NH_4-N throughout the whole experiment. The concentration of water soluble NH_4-N reached the maximum of 218 ppm on the 14th day, while that of NO_3-N /462 ppm/ on the 36th day. The distinct production of nitrates set in no sooner than a few days after the maximum concentration of bound NH_4-N had been attained. Analogous changes in A and A/B/ horizons were significantly lower. The maximum concentrations in the A/B/ horizon were 31 ppm for bound NH_4-N, 7 ppm for water soluble NH_4-N and 16 ppm for NO_3-N.

From the concentration changes, the rates of mineral nitrogen from transformations were calculated. The highest daily production was 94.0 ppm day^{-1} of the bound and 42 ppm day^{-1} of the water soluble NH_4-N, in the A_o horizon samples during the first days of incubation. The highest daily production of NO_3-N, i.e. 30.6 ppm day^{-1}, was also measured in the A_o horizon, but between the 14th and 20th day. Concurrently, the fastest decrease of both bound and water soluble NH_4-N, i.e. -17.4 and -11.7 ppm day^{-1}, respectively, was observed. This points to the interdependence of the mineral nitrogen transformations /i.e. ammonification and nitrification/ in the A_o horizon.

The rates of mineral nitrogen transformations were considerably slower in the A horizon than in the A_o. No decrease of NO_3 was observed. Ammonifica-

tion was highest during the first two days, and nitrification up to the 9th and 14th day of incubation. In contrast to the A_o horizon, the decrease of water soluble NH_4-N preceded that of the bound NH_4-N. The greatest decrease of the bound NH_4-N took place at the same time when the greatest increment of NO_3-N. The changes in the A/B/ horizon were by far the smallest.

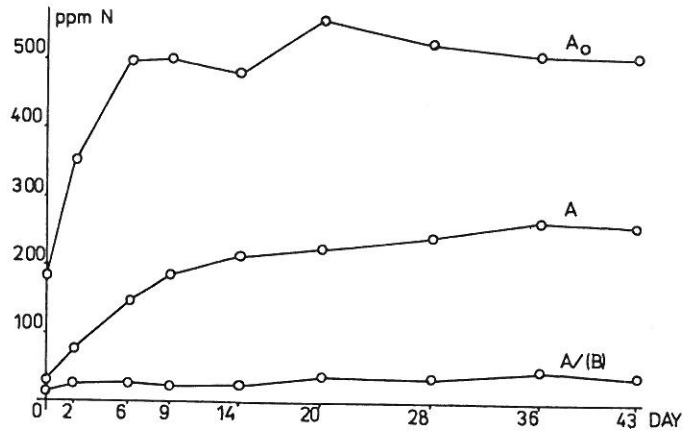

Fig. 3

Changes in the /NH_4-N + NO_3-N/ contents of individual soil horizons during incubation

Fig. 3 shows the increase of total mineral nitrogen /NH_4-N+NO_3-N/ in the individual horizons in the course of the incubation experiment. The amounts of total and mineral nitrogen and mineral nitrogen production in the soil, expressed in units of mass per hectare are given in Table 2. The last column of the Table presents the production of mineral nitrogen in soil samples from individual horizons during the incubation period of 43 days. With respect to mineral nitrogen production and the nutrition of forest stands, horizon A is the most important one. The stands of the

Table 2

Amounts of total and mineral nitrogen and mineral nitrogen production in the soil of a floodplain forest

Horizon	Amount of soil $t\ ha^{-1}$	Amount of total nitrogen $t\ ha^{-1}$	Amount of mineral nitrogen $kg\ ha^{-1}$	Production of mineral N during incubation $kg\ ha^{-1}t^{-1}$
A_o	8	0.084	1.23	2.62
A	728	4.120	21.01	172.63
A/B/	2261	9.157	23.81	83.33
Total	2997	13.361	46.05	258.58

floodplain forest at Lednice na Morave take up, according to KLIMO /1985/, about 224 kg ha^{-1} $year^{-1}$ of nitrogen, of which 178 kg are taken up by trees, 24 kg by shrubs and 22 kg by forbs.

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