# Actinomycetes Biomass in Forest Soils

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Actinomycetes are a physiologically important group of bacteria which decompose structurally more complex organic substances in nature. In addition to starch, they decompose cellulose, chitin, waxes, carbohydrates, humus substances, etc. They also take part in the decomposition of certain synthetic and waste materials, e.g. pesticides /HELLING et al., 1971/.

It has been found that in some soils actinomycetes account for as much as 50% of the total bacterial population in agar media /WEBLEY et al., 1952; GRAY and WILLIAMS, 1971; GRUNDA, 1973/. A microscopic determination of the soil fungi biomass showed that the soil suspension also contained thin fibres of actinomycetes. Therefore, the fibres were simultaneously measured and recorded.

## Materials and methods

The soils of two localities in Czechoslovakia /Lednice and Rájec/ and a locality in Hungary /Kerecsend/ were studied.

Lednice: plain, 165 m alt., mean annual precipitation 524 mm, mean annual temperature 9.0 °C. The soil, formed on the alluvium of the Dyje river, is a clay loam with a structural profile, the form of humus being moder-mull to mull. The soil is moderately acid to neutral. The forest stand exhibits the following species composition: Quercus robur /74%/, Fraxinus sp. /21%/, Tilia cordata, Carpinus betulus, Ulmus carpinifolia and Populus alba. The shrub and herb layers are rich in plant species.

Rájec: the Drahanská Uplands, 620 m alt., mean annual precipitation 683 mm, mean annual temperature 6.6 °C. Acid brown forest soil on granodiorite with a moderate accumulation of surface humus and a shortage of available mineral nutrients. A pure stand of Picea abies aged 80 years.

Kerecsend: hilly region at the northern edge of the Great Hungarian Plain at 150 m alt., mean annual precipitation 533 mm, mean annual tempera-

ture 9.9 °C. Grey soil to eutrophic brown forest soil on clay-sandy sediments with a thin layer of loess. It is a soil rich in minerals, with a moderately acid to neutral reaction. The forest stand is composed of Quercus pubescens with a smaller proportion of Q. cerris, Q. petraea and Q. robur; the lower storey is formed by Acer tataricum and A. campestre.

The number of colony forming units /CFU/ was determined by the usual method of dilution on starch agar with the addition of humic acids.

The actinomycetes fibres were measured in a soil-water suspension prepared by grinding fine earth in a mortar using a dilution of 1:100. One drop of the soil suspension was applied to the mesh of a Bürker heamocytometer. The length of hyphal fragments of less than 1.2 μm in diameter was determined, the measurements being made on 60 square fields of 1 $mm^2$ each.

The average length of the hyphes was converted to 1 g of dry soil and then, assuming the cross-section to be circular and using a hyphal diameter of 1 μm, it was converted to volume. The conversions and calculations can be expressed by the formula:

$$\text{Actinomycetes biomass} = \pi \cdot r^2 \cdot L \cdot da \cdot dm \cdot ds \cdot 10^4$$

where: r = radius of hyphae /0.5 μm/;
L = length of hyphae per g of dry soil /in μm/;
da = density of hyphae /1.1 $g.cm^{-3}$/;
dm = actinomycetes dry matter /0.1/;
ds = soil density /determined by soil physical analysis/.
The values obtained for individual soil horizons are as follows: Lednice: F - 0.3, $A_{mu}$ - 0.96, Btg - 1.3.
Rájec: L - 0.12, F - 0.15, H - 0.20, A - 1.27, /B/ - 1.48.
Kerecsend: A - 1.03, 1.06, 0.95, 1.08.
$10^4$ = conversion coefficient to 1 $m^2$.

The results obtained have to be further converted to the thickness of the particular soil layers /in cm/.

## Results and discussion

The length of actinomycetes fibres in 1 g of soil, as determined in the present analyses, is remarkably large /Table 1/. The 3.1 to 287.7 $m.g^{-1}$ averages which were used for the further calculation of actinomycetes biomass are, however, affected by a considerable error, their standard deviation and coefficient of variation being high. This is due to the fact that about one half of the microscoped square fields did not contain any fibres of actinomycetes, while other fields contained long fibres.

The biomass of actinomycetes calculated using the given formula is very low, due to the tininess of the actinomycetes fibres. A certain increase in the biomass, to perhaps twofold or fivefold values, could be achieved by including the weight of spores. However, the method does not make this possible. The actinomycetes biomass almost always amounts to less than 1% of the bacterial biomass.

## Summary

The length of actinomycetes fibres was determined by a microscopic method in a water suspension of soil prepared by grinding fine earth. Using constants, the actinomycetes biomass was calculated in 3 forest soils.

*Table 1*

Actinomycetes biomass at the experimental sites

| Horizon | Depth cm | CFU x $10^3.g^{-1}$ | L $m.g^{-1}$ | $s_x$ | v % | Biomass $g.m^{-2}$ | Biomass $kg.ha^{-1}$ | AB % |
|---|---|---|---|---|---|---|---|---|
| | | A. Floodplain forest soil, Lednice /n=36/ | | | | | | |
| F | 0-2 | 35 527 | 287.7 | 261.8 | 91 | 0.150 | 1.50 | 0.42 |
| Amu | 2-8 | 17 662 | 20.0 | 29.2 | 146 | 0.100 | 1.00 | 0.09 |
| Bg | 8-30 | 1 360 | 9.7 | 25.2 | 260 | 0.240 | 2.40 | 0.08 |
| Total | 0-30 | | | | | 0.490 | 4.90 | |
| | | B. Soil under a Norway spuce stand, Rajec /n=60/ | | | | | | |
| L | 0-2 | 17 | 28.8 | 39.7 | 138 | 0.013 | 0.13 | 7.93 |
| F | 2-4 | 107 | 62.4 | 75.4 | 121 | 0.016 | 0.16 | 1.54 |
| H | 4-5 | 229 | 83.0 | 68.7 | 83 | 0.014 | 0.14 | 1.00 |
| A | 5-8 | 55 | 9.3 | 12.3 | 133 | 0.051 | 0.51 | 0.33 |
| B | 8-30 | 9 | 3.1 | 5.8 | 187 | 0.080 | 0.80 | 0.94 |
| Total | 0-30 | | | | | 0.174 | 1.74 | |
| | | C. Forest reserve soil, Kerecsend /n=60/ | | | | | | |
| A | 2-20 | 2 083 | 14.8 | 31.5 | 213 | 0.265 | 2.65 | 0.29 |
| A | 2-20 | 2 753 | 20.1 | 34.6 | 172 | 0.371 | 3.71 | 0.31 |
| A | 2-20 | 10 022 | 18.1 | 32.9 | 182 | 0.298 | 2.98 | 0.14 |
| A | 2-20 | 3 091 | 16.7 | 28.4 | 170 | 0.313 | 3.13 | 0.12 |
| Mean | 2-20 | | 15.1 | | | 0.312 | 3.12 | |

Remarks: CFU = colony forming units; $s_x$ = standard deviation; L = length of fibres; v = coefficient of variation; AB = actinomycetes biomass in relation to bacterial biomass

The actinomycetes biomass was usually found to account for less than 1% of the total bacterial biomass. The standard deviations of the statistical population /length of hyphae, n=60/ are high. The method is not suitable for spore weight measurements.

## References


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