Woodhead and Woodhead, then we would expect that the main increase in osmolarity could be ascribed to an increase in sodium chloride, the major sea-water salt. However, sodium chloride explained only a part of the difference in osmotic pressure, and the proportion of the total osmotic pressure due to sodium chloride decreased in the winter (see Fig. 2). Therefore the theory of osmotic imbalance does not appear to offer a complete explanation of the results of all these studies. As suggested by Scholander *et al.*, the high osmotic pressure may have some adaptive significance as a protection against freezing for fishes inhabiting cold, shallow waters (*5*).

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First-Year Breakdown of Leaf Litter in Southern Appalachian Forests

Abstract. Breakdown of organic matter, an important step in the ecological circulation of chemical elements, was measured in Great Smoky Mountain and Oak Ridge forests. Greatest variation in first-year weight loss of leaves in nylon net bags was due to species (*Fagus grandifolia* 21 percent, *Acer saccharum* 32 percent, *Quercus shumardii* 34 percent, *Quercus alba* 39 percent, *Morus rubra* 64 percent). At elevations of 5200, 3400, and 850 ft, losses for all five species averaged, respectively, 29, 34, and 40 percent for leaves placed in spruce, hemlock, and pine stands, and 35, 40, and 46 percent for leaves placed in beech, cove hardwood, and whiteoak stands.

The Southern Appalachian forests have long attracted attention for their floristic diversity and complexity of vegetation pattern (*1*), but the opportunities which they offer for the study of ecological processes in contrasting natural environments deserve at least as much attention. The first-year results in a long-term experiment show remarkably systematic effects of contrasting climate, forest cover (evergreen versus deciduous), and species of leaf on the rates of breakdown of leaves on the forest floor. Such differences influence the release of nutrients to the soil and their availability to growing plants. The rate of this cycling of chemical elements from plants to litter to soil and back to plants is important in relation to the metabolism of the ecological system and to the movement through this system of radioactive isotopes originating from fallout and radioactive waste disposal operations (*2–5*).

Forests in the Great Smoky Mountains and at Oak Ridge have already been shown to exhibit a great range in accumulation of litter and humus (*6*). The differences are presumably due more to contrasting rates of breakdown than to variations in productivity (*3, 4, 7*). Differences in breakdown are influenced by both the litter species and the environment in which the litter is decomposing—factors which are confounded under natural conditions. The present study was designed to isolate the effects of these factors. Weighed samples of recently fallen leaves of five deciduous tree species were placed in bags of nylon net in paired deciduous and evergreen forest stands typical of three contrasting altitudinal climatic belts of the Southern Appalachian region (*1, 8*).

Of the field procedures previously used (*9–11*), that of Bocock and Gilbert (*10*) was most similar to ours, but we used larger samples in bags of smaller mesh size. The nylon net with 2.3-mm holes was fine enough to restrict loss of leaf fragments, yet coarse enough to admit a rich litter fauna (*12*). Rectangular net bags, 45 by 60 cm, were loaded with 50-g samples of leaves from large air-dried homogeneous supplies collected, soon after falling, at Oak Ridge (mulberry, *Morus rubra* L.; sugar maple, *Acer saccharum* Marsh.; Shumard red oak, *Quercus shumardii* Buckley), at Knoxville (white oak, *Quercus alba* L.), or at the beech stand where one set of litter bags was placed (beech, *Fagus grandifolia* Ehrh.). A safety pin closed the bag and attached it to a stainless steel nail anchored in the forest floor. The 50 g of leaves were well distributed initially over approximately 40 by 50 cm, but slow downhill creep tended to reduce this area by the end of the year.

In mid-December 1958, five bags

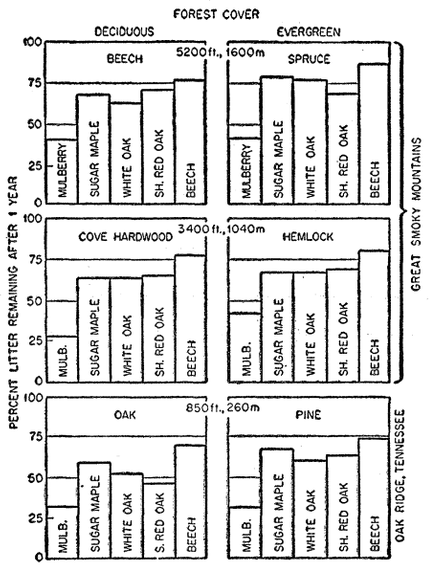


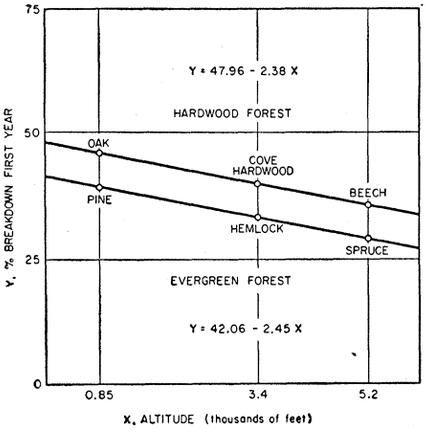
Fig. 1. Leaf litter from five tree species at end of first year, in six Southern Appalachian forests (evergreen versus deciduous stands at three elevations).

were distributed in each of four ramdomized blocks in each of the six forest stands, only one block being used in the study here reported. During early inspections at approximately monthly intervals, most herbs (*Claytonia, Oxalis, Stellaria*) growing into the bags were gently pulled out; any remaining herbs or other extraneous materials (spruce or hemlock needles) were removed before final weighing. After 5½ mo, one set of bags was dried on Tullgren funnels for extraction of the soil fauna (*12*), weighed air dry (30 percent relative humidity), and returned to the field in less than 2 wk (*4*). Extraction of the fauna, removal of extraneous materials, and final weighing were carried out at the end of 12 mo on a full set of 30 samples (Fig. 1), and the samples were retained for chemical analysis. Other blocks were left for future collection and comparison with additional bags installed in 1959.

Analysis of variance and regression (Fig. 2) shows the main effects of all three variables to be highly significant. In the split plot analysis of variance in Fig. 2, "error I" (for effects between stands) happens to be smaller than "error II" (for comparisons of leaf species within stands), but the main effects are highly significant with respect to either estimate of error. Interactions of altitude and forest cover, leaf species and cover, and species and altitude are not statistically significant ($F < 1$) and are far smaller than the main effects.

Effect of altitude is linear (2.4 percent difference in rate of breakdown per 1000 ft elevation or approximately 1 percent per degree Fahrenheit) with nonsignificant difference in regression slope between deciduous and evergreen forests. This compares closely with Mikola's differences of 1.75 percent per degree centigrade in first-year breakdown of pine needles in pine and spruce forests of northern and southern Finland, but is slightly less than the difference of 2.4 percent per degree centigrade for birch leaves (*13*). The consistent difference in percentage breakdown between evergreen and deciduous forests is about 6 percent, a difference slightly greater than would be expected from the microclimatic temperature records (*14*). It remains to be seen to what degree the differences between these contrasting adjacent stands are due to their microclimate and to what degree due to differences in microbiology.

Species differences were highly significant (Fig. 2) and consistent (Fig. 1). Most beech leaves remained unfragmented for the full year, with their degree of discoloration and perforation correlated with their weight losses (ranging from 12 percent under spruce to 29 percent under oak). Mulberry not only lost far more weight (57 to 68 percent), but the material remaining in the bags was rapidly darkening and losing form in only 4 mo. Aggregates of leaves had been changed by the end of the year to black masses of humus, which would have moved into the *H* or A_1 layer of the soil if not confined in the bags. White oak, Shumard red oak, and sugar maple were intermediate between mulberry and beech in weight loss, discoloration, and fragmentation. Similar several-fold species differences in rates of breakdown have been shown in laboratory experiments and have been related to organic and inorganic chemistry of the leaves (*15*).



ANALYSIS OF VARIANCE

SOURCE	d.f.	M.S.
COVER	1	282.1**
ALTITUDE	2	
LINEAR	1	556.0**
RESIDUAL	1	5.8
ERROR I	2	0.65
SPECIES	4	1471.7**
SP. x COVER	4	5.55
SP. x ALT.	8	5.57
ERROR II	8	20.54

**HIGHLY SIGNIFICANT WITH RESPECT TO EITHER ERROR I OR ERROR II.

Fig. 2. Regression of percentage breakdown, averaged for five species of leaves, on altitude of three evergreen and three deciduous forest stands in which leaves were exposed for 1 yr; split plot analysis of variance showing highly significant effects of evergreen versus deciduous cover, altitude, and species. Deviations of plot means (circles) from fitted regression slopes are not significant. Error II may include high order interactions, but these are small compared with main effects.

The surprisingly small difference between oak and sugar maple in litter bags, compared with more rapid disappearance of maple in certain natural forests, might be due to the absence or exclusion of large earthworms (*10*) which apparently select sugar maple when present in mixture with oak (*11*). Because of confinement of the leaves and their fragments, and restricted access of the larger forest floor fauna, the present results are not absolute measurements of breakdown of forest litter under natural conditions, but provide for estimates of relative rates under standardized conditions.

It remains to be seen whether losses in later years will show approximately constant percentage breakdown so that they fit theoretical models assuming linear differential equations with constant coefficients (*4*, *5*, *7*), or whether quantitative models for the development of forest floor material, the cycling of nutrients, and the dispersal of radioactive contamination will have to employ differential equations with variable coefficients (*16*).

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A New Thiamine Derivative, S-Benzoylthiamine O-Monophosphate

Abstract. S-Benzoylthiamine O-monophosphate has been synthesized, and its physicochemical and biological properties have been investigated. It is a stable crystalline substance, it exerts thiamine activity approximately equivalent to that of thiamine hydrochloride in thiamine-requiring microorganisms, and it is easily absorbed in organisms, particularly by oral administration.

Recently, Fujiwara and others (*1*) reported on thiamine alkyldisulfides, including thiamine propyldisulfide, which were absorbed in organisms more easily than thiamine hydrochloride. In the course of studies on phosphoric acid derivatives of thiamine, we found that a new derivative of thiamine monophosphate, S-benzoylthiamine O-monophosphate (BTMP), exhibited similar ease in absorbability in organisms by oral administration.

S-Benzoylthiamine O-monophosphate,