

MICROCLIMATOLOGICAL FEATURES OF AN OLD FIELD AND AN OAK-HICKORY FOREST IN NEW JERSEY

On the Piedmont of New Jersey, there are many fields which are no longer cultivated and are in some stage of secondary succession. Bard (1952) has described various ones in this area which ranged from 1 to 60 years of abandonment. After 40 years of abandonment, the field can be described as a mosaic of scattered islands of herbs in a matrix of encroaching clumps of trees and shrubs. It is a mosaic of habitat extremes.

The mature forest in this vicinity is an oak-hickory community, one stand of which, Mettler's Woods, although at one time subject to fire, has remained as forest since Indian days (Buell, Buell, and Small 1954). Where its canopy is continuous, habitat extremes are at a minimum.

The objective of the present study was to measure temperature at several levels in what are apparently the most extreme habitats in a field 40 years after abandonment and to compare these temperature measurements with similar records from Mettler's Woods. Although it was obvious that there are large differences, the question to be answered was how large and what differences at various levels above the ground in relation to local vegetation structure.

The study area was located approximately one mile east of East Millstone, New Jersey (40°30'N, 74°34'W). The terrain here is gently rolling and the soil is quite uniform so that the sites were comparable as to both exposure and soil. Observations were made from August, 1951, through August, 1952.

One location in Mettler's Woods was selected. Data are also presented for two contrasting locations in a 40-year field, one under a small red maple tree in a thicket and the other in the center of a grassy opening surrounded by thickets of shrubs and young trees.

Air temperatures were measured at 2 m., 20 cm. and 5 cm. heights above the ground using standard maximum and minimum thermometers placed in double aluminum shields, the same equipment as described by Cantlon (1953). Soil temperatures were measured at a depth of 4 cm. below the surface by placing standard maximum and minimum thermometers in horizontal chambers supported by metal shields on top and sides. Temperatures were read weekly. All temperatures are given in degrees Fahrenheit.

The vegetation immediately surrounding the station in Mettler's Woods was relatively uniform. The oak canopy (consisting of *Quercus alba*¹ and *Q. rubra*) was about 60 per cent complete in all directions. The flowering dogwood (*Cornus florida*) was almost continuous, with 99 per cent measured cover. The shrub layer of maple-leaved viburnum (*Viburnum acerifolium*) afforded no cover over the instruments but did form a shield from wind movements. In the herb layer, the may-apple (*Podophyllum peltatum*) covered from 20 per cent to 30 per cent of the ground on the south and northwest of the instruments in spring, but during June the plant rapidly deteriorates so that by July it had lost its importance as a ground cover.

The field station in the grassy opening was located where the trees and larger shrubs were absent for a radius of about 6 m. The opening was surrounded by trees of red maple (*Acer rubrum*), eastern red cedar (*Juniperus virginiana*) and black cherry (*Prunus serotina*) of various sizes up to 15 to 30 feet high. Clumps

of bayberry (*Myrica pensylvanica*) were dispersed on the periphery, and tufts of little bluestem (*Andropogon scoparius*) occurred throughout the center.

The station under the maple was located just outside the southwestern boundary of the opening and about 20 m. from the location of the thermometers in the opening. The maple was about 3 inches DBH and about 15 feet high. It was in a group with other trees, red cedars and flowering dogwoods, as well as large shrubs of bayberry. The ground was covered with a thin leaf litter. Scattered shoots of poison ivy (*Rhus radicans*) dominated the lowest layer.

Air temperature extremes during the course of the year's study decreased in intensity from the grassy opening (−8° to 112° F.) to the thicket (−8° to 100° F.) to Mettler's Woods (−3° to 96° F.). As with the annual extremes, the weekly extremes were in general in the same order of difference for the three stations. However, at the various levels above ground, conspicuous differences appeared. At the field station in the grassy opening, the greatest variation in maximum temperature was noted in the spring, summer and fall. During this period when the sun was rising to, and falling from its zenith (73°), the warmest temperatures were found at the 5 cm. and 20 cm. levels. When the angle of inclination of the sun was lowest (26°) in winter, the variations in maximum temperatures at the 5 cm. and 20 cm. levels were least. The lowest minimum temperatures were found at the 20 cm. level throughout the year. During the spring, the highest minimum temperatures occurred at the 2 m. level. On several occasions during the winter, marked differences in minimum temperatures between the 20 cm. and the 5 cm. levels corresponded to periods of snow cover, the higher level having lower minimum temperatures at these times.

At the field station under the maple, the seasonal variation in maximum temperatures followed, in general, those conditions found in the grassy opening but the extremes were not so great. A striking departure from the temperature pattern found in the grassy opening could be observed in mid-May at the maple station. At this time, when the canopy closed, a reverse of the maximum temperature gradient of the opening was established. Instead of an increase in temperature toward the ground, the highest readings were observed at 2 m. and the lowest maximum temperatures were found at 5 cm. The differences of minimum temperature within the sampling levels were less pronounced under the maple during periods of snow cover than those found in the opening. Although the lowest minimum temperatures were generally found at 20 cm., as in the open, this occurrence was less consistent under the maple.

Soil temperatures at 4 cm. depth showed slightly greater annual variation at the stations in the field (30° to 90° F. in the opening and 28° to 79° F. in the maple thicket) than in Mettler's Woods (29° to 73° F.). Conspicuous seasonal differences also occurred. In the opening, the greatest variation between maximum and minimum extremes occurred during the spring, summer and fall, paralleling the pattern of air temperatures. In Mettler's Woods the difference between them was uniformly less and was least in the late spring and summer when the forest canopy was closed. The thermal extremes were also less under the maple in the thicket than in the opening.

¹ Nomenclature for all plants follows Fernald (1950).

The nearest Weather Bureau station is located 8 miles east, on the agricultural campus of Rutgers University in New Brunswick. The records for the period corresponding with this study show the extremes during the year's period to be 3° F. minimum and 99° maximum. Compared with the grassy opening (—8° F. to 112° F.) the differences are large. Wolfe, *et al.* (1950) found similar pronounced differences between records which they took in the vegetation and those recorded at the nearest weather bureau station.

When the snow cover was deep enough to cover the lowest set of air thermometers at 5 cm., the insulating effect of snow cover was recorded. Relatively higher temperatures were maintained at this level ranging from 5° F. to 15° F. warmer. The refrigerated air passing over the snow, however, caused the 20 cm. level temperatures to drop to their lowest readings, the minimum reached at this time being —8° F.

The effect of the canopy on air temperatures could be observed in several respects. In Mettler's Woods and under the maple, the increase in temperature with height above the ground during summer and the decrease with height during the winter, appeared to be related to the presence or absence of canopy interference.

In the immediate vicinity of the instruments at the station in the opening, the dominant ground cover was little bluestem. This one-meter-high grass grows in bunches, and the dense fibrous roots eliminate all but the low-growing plants and lichens between the clumps. The woody vegetation surrounding the grassy opening allowed a maximum amount of insulation at and near the ground and an accompanying minimum of air movement. This would seem to account for the higher maximum observed at the 5 cm. and the 20 cm. levels during the spring, summer and fall. Lower winter differences in maximum temperatures were probably caused by the interception of the low winter sun by stems of surrounding trees and shrubs. Both the minimum temperatures found consistently at the 20 cm., and the maximum temperatures found at the lowest levels are in agreement

with Geiger's (1950) summary of incoming and outgoing radiation in vertical and horizontal types of plant cover.

SUMMARY

1. Weekly readings of maximum and minimum thermometers taken in a mature oak-hickory woods and in two habitats in an old field abandoned for 40 years, a grassy opening and a small thicket of young trees and large shrubs, show pronounced annual and seasonal temperature differences between themselves and between them and the local Weather Bureau station.

2. Records taken at 5 cm., 20 cm. and 2 m. levels as well as 4 cm. below ground show also that within these habitats, microclimatic structure from season to season is very different from one to another.

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NOTES ON THE FOOD OF *CRASPEDACUSTA SOWERBII* IN CRYSTAL LAKE, RAVENNA, OHIO

Medusae of the fresh-water jellyfish, *Craspedacusta sowerbii* Lankester have been recorded from many localities in Europe, Asia, Australia, North America, Central America and South America. Perhaps they are cosmopolitan in temperate and tropical regions. Usually they occur in artificial or natural ponds, sometimes in rivers, and occasionally in lakes as large as Pymatuning Reservoir (Jackson 1953).

Ordinarily the medusae occur sporadically in small numbers only, but sometimes they swarm by the thousands. In spite of their occasional availability, there have been few published reports on their food, and apparently no published quantitative studies. The earliest qualitative report of the food of this interesting animal was given by Lankester (1880a, 1880b, 1880c), who stated that both he and Mr. Sowerby had observed them feeding upon *Daphnia*. The same author (1881) described intracellular digestion, and mentioned the presence of algae in the endodermal cells.

Subsequently, qualitative descriptions of the food were given by Boecker (1905), who observed Infusoria, filamentous algae, *Amoeba*, etc. in the stomach; by Boulenger and Flower (1928), who said that young medusae fed upon plankton organisms; by Dejdar (1934), who found *Bosmina* and *Keratella* (= *Anuraea*) *cochlearis* in those rare cases where he encountered anything in the stomach of his specimens; by D. W. Dunham (in an unpublished Ph.D. dissertation at Ohio State University, 1941), who found that young medusae fed upon rotifers, and that adults consumed *Daphnia*, *Bosmina*, *Cyclops* and *Diaptomus*; by Dexter *et al.* (1949), who reported that "cladocerans and copepods were found entangled in the tentacles"; by Thomas (1950), who reported that his Australian specimens fed in the laboratory upon daphnids, cyprids and small mosquito larvae; and by Syncoens (1953), who stated that the nourishment consists chiefly of rotifers and larval copepods.

In addition to published studies, M. K. Linscheid (in an unpublished M.S. thesis at Western Reserve Univer-