of these 2 widely separated populations showed that 90% of the Ohio site progeny were completely defoliated by 36 days of treatment to cool day and cold night temperatures while 81% of the Mississippi population maintained leaves up to 49 days under the same condition. Color changes of leaves were gradual in all individual plants to a light yellow a few days prior to the compound leaves being lost from the stem.

These phenological differences being expressed by different genotypes of the same species are indications of the physiological processes that are selected for in populations that must survive in habitats of a shorter growing season. Earlier cessation of growth and the biochemical changes leading to winter dormancy and hardiness would be expected to enhance the survival of more northern populations. In the absence of shorter growing seasons and earlier exposure to fall or winter conditions early leaf abscission and fall would have little adaptive or selective value in populations from the Mississippi River Valley as typified by the Greenville, Mississippi progeny used in this test.

A practical value is suggested by these findings if the search for similar patterns were to be expanded to include hardwood species that show foliage coloration characters of horticultural and landscaping use. Although boxelder has little commercial value (except for potential paper pulp and, of course, its as yet unknown niche or functional role in natural ecosystems) the patterns indicated in this simple study would seem to hold promise in landscaping public areas with genotypes from different areas that would survive in a selected habitat. It might be possible by judicious selection to arrange plantings of trees to expand the fall coloration and leaf dropping time and enhance the aesthetics of commercial, public or private park type areas. A contrary approach could also be made to reduce the labor involvement in gathering and disposal of leaves by selecting genotypes of several species that would show synchronized leaf fall making it possible to only contend with leaf disposal in a short span of time. Landscape architects and horticulturists might well profit from an examination of the evolutionary patterns inherent in ecotypes of endemic species.—**Joe E. Winstead**, Department of Biology, Western Kentucky University, Bowling Green, Kentucky 42101, and **Anthony M. Greco**, Department of Marine Science, University of South Florida, St. Petersburg, Florida 33701.

A Life-form Spectrum for Ohio—This paper presents a life-form analysis of the native spermatophytes of Ohio. The life-form classification we use is that of Raunkiaer (The Life Forms of Plants and Statistical Geography, Clarendon Press, Oxford, 1934), based on the position of the perennating buds or meristems relative to the surface of the substrate. A summary of Raunkiaer's classification and of the use of life-form data in phytoclimatic studies is given in Gibson (Amer. Midl. Naturalist 66:1–60, 1952), McDonald (Amer. Midl. Naturalist 18:687–733, 1937), and Thieret (Michigan Bot. 16:27–33, 1977) and need not be repeated in full here.

TABLE 1. The Normal Spectrum, the Ohio spectrum, and available spectra for other central states.

	Ph	Ch	H	Cr	Th
Normal Spectrum	46.0	9.0	26.0	6.0	13.0
Ohio	15.3	1.6	50.0	20.6	12.5
Michigan	14.2	2.2	51.6	22.1	9.2
Kentucky	17.6	1.4	52.6	16.6	11.8
Indiana	15.3	1.7	50.3	19.6	13.0
Illinois	15.5	1.6	50.2	19.8	12.9
Iowa	14.8	1.0	48.6	20.9	14.2
Minnesota	13.0	3.0	49.0	22.0	13.0

Raunkiaer recognizes 5 principal life-form classes. In order of increasing protection of the buds, these are: Class I. Phanerophytes (Ph): meristems 25 cm or more above the soil surface; almost all are trees and shrubs. Especially characteristic of humid tropical forests, phanerophytes decrease with increase in latitude. Class II. Chamaephytes (Ch): meristems above the soil surface but lower than 25 cm. The Ch percentage in a flora tends to increase with increasing latitude or elevation. This class is especially characteristic of arctic and alpine areas. Class III. Hemicryptophytes (H): buds in the surface layer of the soil. This class tends to be dominant in temperate floras, and often constitutes half or more of the flora in grasslands and deciduous forests. Class IV. Cryptophytes (Cr): buds beneath the surface of the soil, in water, or in the substratum under the water. Cryptophytes appear not to be the dominant life-form of any particular area. Class V. Therophytes (Th): annual plants, which perennate by seeds. They are especially abundant in desert floras and in weedy communities developing after native vegetation is disturbed.

As a standard of comparison with spectra of various regions, Raunkiaer developed the "Normal Spectrum." He determined the life-form for each of 1,000 species randomly selected from the world's flora. Every regional spectrum will have, he asserted, 1 class (excluding cryptophytes) whose percentage is notably higher than that of the Normal. This class can be taken as an indicator of what he called the "phytoclimate" of the region.

Ohio has ca. 1,730 species of native seed plants (Weishaupt, Vascular Plants of Ohio, 3rd ed., Kendall/Hunt, Dubuque, Iowa, 1971; T. Cooperrider and A. Cusick, pers. comm.). For each of these we determined the life-form through field, herbarium, and literature studies. Results are shown in Table 1, where the life-spectrum of Ohio is contrasted with the Normal Spectrum and with available spectra of other central states (see Thieret, Michigan Bot. 16:27–33, 1977).

The Ohio spectrum indicates that the state's phytoclimate is hemicryptophytic. The H percentage is about double that of the Normal.

According to Raunkiaer, the life-form values that would

be expected to show correlation with latitude are Ph, Ch, and Th. Our data for Ohio are mostly in line with Raunkiaer. Ohio Ph is greater than that of Michigan and less than that of Kentucky. Ohio Ch is intermediate between Michigan and Kentucky. Finally, Ohio Th is larger than that of Michigan; it is larger, also, than that of Kentucky, perhaps because a greater percentage of land in Ohio is under cultivation.

Life-form spectra have usually been compared along north–south gradients, Michigan vs. Kentucky, for example. But, with our Ohio spectrum, we can now compare 2 regions along an east–west line but separated by about 800 miles and in different biomes. Ohio lies in eastern deciduous forest; Iowa, largely in grassland. The 2 areas, however, have rather similar spectra. Remember that life-form data refer to *species* in a flora, rare species having just as much influence on a spectrum as do common or abundant ones. Such spectra are not meant to reflect differences in vegetation between 2 regions.

Comparison of Ohio's spectrum with that of Iowa shows, from the former to the latter, a decrease in Ph, a decrease in Ch, a decrease in H, and an increase in Th. Before we attempt some explanation of these differences, let us issue a disclaimer. The presence of small differences between spectra is a little understood—and little investigated—subject. We simply do not know what magnitude a difference must be to constitute an interpretable difference. Perhaps future students of life-forms will establish guidelines on this subject.

The slight decrease in Ph in Iowa doubtlessly reflects the less rich tree flora in that state. A quick check indicates that Iowa lacks at least 45 tree species found in Ohio, Indiana, and Illinois. We emphasize that the difference between forested areas and grasslands is not necessarily in the Ph percentage in the floras but in the dominance of trees in one and of grasses and forbs in the other. The decrease in Ch from Ohio to Iowa is attributable primarily to the scarcity in Iowa of Ericaceae and Pyrolaceae. The differences in H and Th between Ohio and Iowa are simply not explainable by us. In various spectra, one can see both small increases and small decreases in H and Th from forested areas to grasslands. Again, what is the significance of these differences? More study is required.

Lastly, it is clear that all of the life-form spectra presented here are dominated by H. Why such a large number of species with this life-form is present is open to hypothesis formulation and testing. Hemicryptophytes may be favored in environments with marked seasonality. The meristems in the soil surface may also be protected from extreme physical environment factors or grazers. Thermal advantages may also accrue in the soil surface because this is the microenvironment where solar radiation is most directly absorbed.—**James O. Luken** and **John W. Thieret**, Department of Biological Sciences, Northern Kentucky University, Highland Heights, Kentucky 41076.