Introduction to Lightning Ecology

E. V. KOMAREK
Tall Timbers Research Station
Tallahassee, Florida

THE constant bombardment by lightning of the earth's surface and atmosphere, of water, land and air, and ranging from the far reaches of the North and South to the hot and humid regions of the equator, and even at times into the interior of deserts, such as the Sahara, is certainly deserving of attention and study. Lightning is the most obvious manifestation to us of the electrical field and other electrical components of our earth. It may not be, however, the most important aspect, even though the most evident, of what can be termed electrical field ecology or perhaps more inclusive as "electrical ecology"—the relationship of living things to electricity.

Living organisms evolved, not only in an environment and habitat dominated by certain spectrums of temperature, water, and air, but also to the various spectrums of the many electrical aspects of our earth and universe. Life is limited on earth not only to certain ranges of tolerance of the three most commonly studied aspects, but also by cretain limiting effects of the electrical components of the earth and its surroundings. The study of lightning is a good beginning into the investigation of "electrical ecology" because of the dramatic reactions and behavior of the human race to lightning and thunder.

The effect of lightning as an ignition agent for setting forest and

grassland fires has been covered in much detail throughout our past 12 Conferences as well as elsewhere. A considerable volume of literature has developed and many investigations are being conducted by various agencies and organizations. The aspect of "natural fires" by lightning, particularly in Wilderness Areas, is now the subject of much discussion. Terms such as "natural fires," "let burn" policy, and "loose herding" a fire have become of general usage. This session has been developed to stimulate and encourage interest and investigations in the other aspects of lightning and has been organized to emphasize the relationships of lightning and living organisms.

That lightning can effect trees in diverse ways has been recorded for a long time and in fact, also occurs in the early mythology of man. However, the serious scientific study of these effects on various plants and animals has been very sporadic and scattered in many publications, largely in the past 75 years. The attached bibliography contains most of the existing information, at least in the English language journals. There is reason, however, to believe that there is also a considerable amount of information in the journals and publications of other languages unavailable to us for one reason or another. It is our hope that this paper may lead us to much of this knowledge.

PRIMARY ECOLOGICAL EFFECTS OF LIGHTNING

On Trees and Shrubs

The many diverse physical effects on trees of many species and in many parts of the world have been summarized by Komarek (1964, 1965, 1968, 1972) and Taylor (1969, 1971). They have also reported on their own studies. Taylor in particular has studied the detailed effects of the lightning strike on Douglas fir (*Pseudotsuga menziesii* var. *glayca.*) It is apparent that the effect of lightning on trees, however, can vary from examples where the trees are literally burst apart or a lightning streak that is usually but not always spiral to only internal injury with no immediate outward signs. The latter appears to be the more usual case in tropical species such as palms, (*Sabal palmetto*, *Cocos nucifera*, *Washington filifera*), rubber (*Hevea brasiliensis*), tea (*Thea sinensis*), and *Gravilleas* although lightning streaks are occasionally seen in some other tropical species

of trees. Lightning has been reported as one of the major predators in western ponderosa pine (*Pinus ponderosa*) and in southern pine forests (*Pinus palustris*, *P. elliottii*, and *P. taeda*). It is, therefore, not only of considerable importance economically but ecologically as well and in certain kinds of forests may be a primary regenerative force in both replacement and in tree succession.

On Soils, Soil Fauna and Flora

I have been unable to find any references to the effect of lightning on soils, soil fauna and flora except for the short reference I made to soil tests following a lightning strike in 1965 which were rather crude tests and inconclusive. It is rather striking that there are several records of lightning striking replicated plots and destroying the vegetation on Agricultural Experiment Stations and yet no interest was ever shown in what the effects consisted of, even though observers found that some such areas could not be used for experimental studies for sometime afterward.

SECONDARY ECOLOGICAL EFFECTS OF LIGHTNING

On Insect Life

Foresters have been long disturbed by the rather fast occupancy of lightning struck conifers in the South by bark beetles and the possibility of beetle epidemics arising from such infestations. In the Thomasville, Georgia—Tallahassee, Florida hunting plantation forests, forests of uneven age classes that with one exception have had a long period of annual control burning, observations over long periods (H. L. Stoddard, 1924 to 1965; the Komareks, E. V., Betty and Roy, 1934 to present; and Leon Neel, 1950 to present) have led us to believe that such fears are not well founded. We have yet to find a sizeable infestation except where an old longleaf and slash pine forest was allowed to grow up into a jungle of hardwood trees of several species. Fire had been excluded there for well over 75 years. In this one area, out of about 300,000 acres of forest-hunting plantation lands, there have been only two infestations that required drastic cutting. Both of these occurred in droughts and we have speculated that the transpiration of the broad-leaved hardwoods

so weakened the pine trees to make them susceptible to insect attack and that the forest management was at fault not the lightning or the insects.

In this region lightning struck trees are very common and certainly would constitute about 1 percent mortality or more per year as found in forestry studies elsewhere in the South and in the West in pine, and in one case hemlock, forests. Lightning has struck trees in dense stands and yet only those individuals that have been struck died from so-called insect attack. In 1968 I reported on a group or cluster lightning strike that occurred on August 9, 1966 at 5:15 PM. I was fortunate in being able to find this early the next morning. I found only five that showed lightning streaks but 27 others that showed needle scorching in that the needles in sections of the top, not necessarily all of the crown, were dark brown. As I visited this group within 16 hours after the lightning attack I feel certain I was there before insects could have damaged the trees to that extent. In fact, I was unable to see any obvious insect workings. This cluster of 32 trees continues to be studied. In 7 years of observation not one single tree has been effected by any insect attack outside of the 32 originally numbered trees although the area is surrounded by pine trees of like composition and age. Within a few days of the lightning attack, however, all the numbered trees showed insect activity.

Birdlife

The insect activity in the foregoing group strike attracted a very diverse bird fauna in a very few days. Among these were six species of woodpeckers Red-bellied (*Centurus carolinus*); Red-cockaded (*Dendrocopos borealis*); Hairy (*D. villosus*); Downy (*D. pubescens*); Pileated (*Dryocopus pileatus*); and somewhat later a Flicker (*Colaptes auratus*). Observations at irregular intervals have shown a great many other birds frequenting the area including Florida White Breasted Nuthatch (*Sitta c. carolinensis*), Brownheaded Nuthatch (*S. pusilla*), Bluebird (*Sialia sialis*).

Even though 6 years have passed, the area is still being used by many species of birds. Seven trees have fallen but all the others still remain upright and all have had an apparent succession of many

kinds of insects and other invertebrates which in turn continue to furnish a high protein food for many species of birds. Unfortunately time has not permitted a thorough study of both the invertebrate and the vertebrate fauna. Studies of the relationship of the food habits of the birds and other vertebrates to lightning struck trees over a long period of time would be of great interest and of value in the proper understanding of forest ecology.

Another interesting aspect of the relation of lightning and bird life in the forest was brought to my attention by my colleague and wife Betty. She made the following interesting ecological observations in the Ponderosa pine forests near Show Low, northern Arizona on July 24–26, 1970 and I have extracted the following from her notes:

> "Five miles east of Show Low. While Ed was photographing lightning struck ponderosas, I heard purple martins really chattering and thought they sounded like when the new hatched young and adults go around visiting others about to emerge from holes in nesting boxes or gourds. Sure enough, I located the nest with young. Much to my amazement in was in an old wound of a lightning strike in old, yet living ponderosa. When Ed came up he was as excited as I in finding our first martins in natural or pre-man conditions. We located five other trees within one half mile. Next day, before 8 a.m. we went out again and located two more of the nests where 25 odd martins had congregated. In one old tree there were five holes on one side (only one occupied) and one hole on the other side, plus a pair of tree swallows with young in a crooked stub. There was much chattering and excitement while some would fly off and visit other trees . . . Apparently these holes were made by the acorn woodpecker and a pair were quite disturbed while visiting was going on near their nesting hole with partly emerged young . . . Near the Maxwell House Lodge I watched a pair of Lewis woodpeckers in an old dead lightning struck tree."

Our observations in the southern pine region certainly have shown that lightning is of considerable importance to the welfare of some of our forest birdlife. In both pine and hardwood trees such affected trees furnish a variety of insect food for a variety of birds for a very long time, even a decade or more. Many times in hardwoods, such

as oak trees, the tree will not die but live for many years. Meanwhile, the resulting damage along the channel of the lightning streak continues to furnish food for birds for several years.

Plant Succession

Cluster or group lightning strikes have been reported from many parts of the world and it is beginning to appear that they are more common than previously thought. They simply have not been observed or reported. As an example, on a recent visit to the Gartow Forest in Germany which consists primarily of European pine (*Pinus sylvestris*) and beech (*Fagus sylvatica*), Oberforestmeister Jancek showed us a group strike in the pine forest that was very similar to those found in southern pine forests and reported that they are very common, about one to five each year. He also reported that lightning strikes of one, two or three trees are very common and we saw several of these as well. In 1968 I posed the question, "Does lightning play a regenerative role over the long time span in determining a type of forest and where it occurs?" As evidence continues to accumulate on lightning effects in various kinds of forests in many different parts of the world the answer appears to be yes.

Unfortunately, I have been unable to find any references as to the effect of the lightning discharge on the components of grasslands except as an ignition agent. Certainly the effect of not only lightning fires but of lightning itself should be part of forest and grassland investigations such as the IBP programs.

Mutagenic Effects

Considerable interest has been maintained in the effect of electrical discharges on the evolution of living organisms since Miller's (1935) classical studies. However, I can find no references to lightning discharges on the possibility of developing mutagenic effects. It would appear, as I have reported previously, that such events could occur and with modern laboratory facilities the effect of electrical discharges on living organisms should be a most interesting investigation.

CONCLUSION

This Introduction to Lightning Ecology, with its attendant bibliography, is exactly what it pertains to be—an introduction to a

pioneer field, lightning ecology. It is my hope that this paper and the following session may stimulate and create an interest in the study of this interesting subject much as our Fire Ecology Proceedings have with the study of fire ecology. In ecology, one step always leads to another and so it has with fire ecology. With the realization that fire was, and is, a natural ecological factor interest has been stimulated into investigations on the natural ignition factors of such fires. Although there are other means of ignition, such as vulcanism, spontaneous combustion, etc., the abundance of lightning has demonstrated that this is and was a major natural factor. This then led into the interest and study of lightning which has led us into lightning ecology. This I wish to point out is only one aspect of "electrical ecology" the relationship of living things to electricity one of the great forces in our environment. Certainly the investigation into lightning and electrical ecology can be considered pioneering studies and fruitful fields for research for a great many years, in particular to those more youthful students and investigators that do not wish to spend their time constantly redoing, over and over again, studies that have been carried on for many years. Too much scientific effort today appears to have been caught in a closed cycle, and is recycled and recycled, as if there were no more frontiers for science, human thought and endeavor.

REFERENCES

Komarek, E. V. 1964. The Natural History of Lightning. Proc. Third Ann. Tall Timbers Fire Ecol. Conf. p. 139–183. Tall Timbers Res. Sta. Tallahassee, Fla.

———. 1965. Fire ecology—Grasslands and man. Proc. Fourth Ann. Tall Timbers Fire Ecol. Conf. p. 169–220. Tall Timbers Res. Sta. Tallahassee, Fla.

———. 1968, Lightning and Lightning Fires as ecological forces. Proc. Eighth Ann. Tall Timbers Fire Ecol. Conf. p. 169–199. Tall Timbers Res. Sta. Tallahassee, Fla.

———. 1972. Ancient Fires, Proc. Twelfth Ann. Tall Timbers Fire Ecol. Conf. p. 219–241. Tall Timbers Res. Sta., Tallahassee, Fla.

Taylor, Alan R. 1969. Lightning effects on the forest complex. Proc. Ninth Tall Timbers Fire Ecol. Conf. p. 127–149. Tall Timbers Res. Sta. Tallahassee, Fla.

———. 1971. Lightning: agent of change in forest ecosystems. J. For. 68(8):477–480.