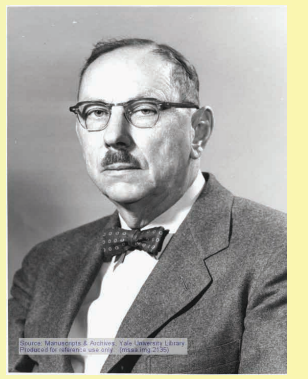


Paul B. Sears  
High school  
yearbook  
1908

# Paul B. Sears and the development of palynology, a field central to understanding climate and vegetation change

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Paul Bigelow  
Sears  
1891-1990



A bright spot in my early years at Columbus was the visit to your home at Bucyrus, and the interesting field trips to bogs and prairies of that region. I recall the arguments we had with your father about the origin of the prairies. After stacking the cards we thought we came off victorious.  
E.N. Transeau to Sears, August 18, 1946, recalling circa 1918.

## Early Influences

Sears was born in Bucyrus, Ohio, in 1891, at the height of deforestation of the state. His father, an attorney/farm manager, and his mother, a former college English teacher and high school principal, focused on education, family, their land, and history.

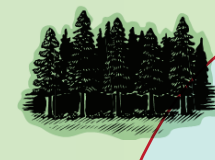
"I grew up in an atmosphere where plants were important, and more than a casual knowledge was available. Working in a law office I learned a respect for language and clear thinking, even though the latter still comes hard. I also learned something of the conflicts of human interest and the limitations of human nature—both important in applied ecology."  
Sears to B.C. Patten, January 26, 1954

## Flood of 1913

While at Ohio Wesleyan, Sears experienced the catastrophic flood in Delaware, Ohio. That flood impressed his mind with the relationship between land use and disaster, and he often wrote of it as an example.



"There have been about three days of the usual spring rains, but the air is clear and the students in the quiet little Ohio town start for their first-hour classes as usual. But there are no classes. ...For three blocks on either side...of the harmless trickle...the flood is raging...a grand show it is...then paralyzing."  
Deserts on the March, 1935, p. 133



Sears was born at a time of maximum forest clearance

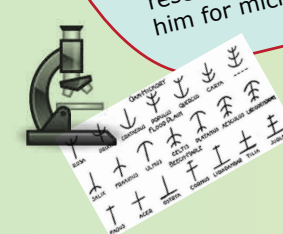
Family stories of virgin forest and unplowed prairies reveal history

Bucyrus Mastodon (discovered 1838) shows climate change over time.



Flood of 1913 previews interaction of land use and disasters.

1914-1926 Early cytological research into variation prepares him for microscopic work.



## OVERVIEW

### Background/Question/Methods

Paul B. Sears (1891-1990) began his career in 1915, the same year that a group of botanists and zoologists met at The Ohio State University to form the Ecological Society of America. Although Sears' initial work was in cell biology and physiology, he was intrigued by his colleagues' debates on the origins of the extensive Ohio prairie areas. We were able to reconstruct an almost day-by-day account of his activities by examining the archival resources [1] and by interviewing former colleagues. A chain of coincidental events and opportunities led ultimately to Sears' facilitating the development of palynology in North America, a field based in descriptive science that provides a viable tool for asking hypothesis-based questions. As ESA's centennial approaches, we use Sears' role in Quaternary palynology to illustrate research of early ecologists; in particular we focus on the decades of primarily descriptive research that typify an emphasis more valued by ecology than some other life sciences. In palynology, as in Sears' other major contributions to ecology, chance and the recognition of opportunity played a major role.

### Results/Conclusions

Sears began research into the origins of Ohio prairies by developing a methodology to map prairies present at Euro-American settlement and attempting to correlate their distribution with hydrogeologic features. However, he had no way to test H.A. Gleason's competing hypothesis that the prairies were remnants of an earlier, warmer period. In 1925, Sears read a German review of the new science of palynology and immediately realized it could provide such a test. At the University of Oklahoma (1927) he focused on palynological research; his data and exquisite drawings of pollen grains became the keystone Fossil Pollen of the Erie Basin (1930). By the early 1930s he was attempting to transform pollen data to climate data and examining sediment accumulation rates in basins. The Dust Bowl drove him to write *Deserts on the March* (1935), bringing him prominence in conservation. At Oberlin College (1938), he continued palynological research. His *Pollen & Spore Circular* kept American and European palynologists in communication through World War II, although his conservation activities increasingly took precedence. Recent examples from global climate change and restoration ecology show the importance of Sears' contributions for addressing issues facing the world today.

## 1915-1926 Thinking about Prairies and Forests

Sears' father told of crossing the extensive, unbroken prairies to the west during visits to Iowa; elderly relatives told of isolated prairie patches in Ohio surrounded by original forest. Prairie patches were the first to succumb to agriculture, but remnants could be found in unplowed areas. Sears' grandfather remembered his father, who arrived slightly later, cutting and burning valuable hardwoods to clear land to feed his family. The origins of the scattered prairies were puzzling and intensively discussed with Transeau while at Ohio State. Were they edaphic or remnants of past, more extensive prairies? Sears' attempt to map the original prairie patches using historical documents led him by chance to survey early land records and development of a system to map all vegetation at the time of the Euroamerican settlement. This creative approach to mapping forest types, using "witness trees" from survey records, stimulated his ability to make ecological correlations.

## Midwest Pollen Sequence

The *Bucyrus Bog* (1930) and *Mud Lake* (1931) Ohio pollen record defined the basic outline of the Midwestern late-glacial and post-glacial vegetation sequence—a detailed look at the questions/conclusions at the end of his *Natural Vegetation of Ohio* series (1925-1926). In the latter he found the pattern of presettlement vegetation was consistent with re-vegetation after glacial retreat; he was able to confirm this with palynology.

## Transfer Functions/Response Surfaces

Sears urgently wanted to convert pollen data to climate estimates, in part because of the question of the origin of the Ohio prairies. In the *Mud Lake* (1931) paper, he developed a matrix based on the ecological responses of modern species, and then created a climate change graph.

## 1925 Iowa Lakeside Laboratory

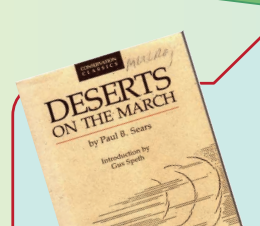
"... I learned of the Swedish technique of pollen analysis and saw in it a key to the historical factor in vegetation. But before I could get on with it, I had to take a long time to learn something about pollen."  
Sears to B.C. Patten, January 26, 1954



"More than that, [Oklahoma] was a seething laboratory of social and other ecological forces to which I could not, in honor, shut my eyes. When drought and dust and economic disaster hit, the administration sent around to find out what scientists could do about it. And since the basic story was clear enough to any student of landscape, I offered to tell it, as my contribution."  
Sears to B.C. Patten, January 26, 1954

## Shifting to Conservation

The disasters of the 1930s led to publication of Sears' first two books and launched his career in a new direction, combining his interest in vegetation pattern, climate, and culture.



"We do not and cannot manipulate nature from the outside. We must work our will by knowing laws and conforming to them, never forgetting that we are a part of that upon which we work, as a horse and his rider are interrelated."

## This is Our World (1937)

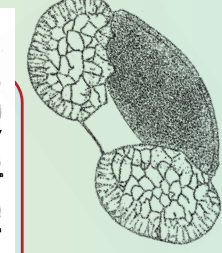
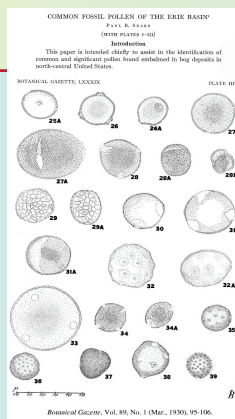
"In planning a journey, one needs to know where he is heading, how he will get there, and what, once arrived, he will do. This homely reminder will serve us conveniently in what follows. We need only assume that the human adventure on this planet is worth continuing for as long as possible and in a way that deserves to continue."  
Sears, 1969, *Ohio Journal of Science*



"a scientist who writes as well as he thinks"  
- Clifton Fadiman, 1937 review in *The New Yorker*

## Landscape & Fossil Pollen—Building a Tool

From the first moment he became aware of stratigraphic pollen studies, Sears saw a tool to answer his landscape history questions, and worked steadily to refine techniques and create a means of identifying pollen. Although he and his students reported progress in state and national meetings, the watershed publications appeared in 1930, followed quickly by others already in progress. *Common Fossil Pollen of the Erie Basin* (1930b) provided methodology, a key, and magnificent drawings done laboriously under 770x oil immersion, thus making this new tool available to all researchers. A succession of papers by Sears and his students that had been in the works quickly followed.



## Hypsithermal and Comparisons with European Sequences:

Sears published several papers working with the European records and Transeau's and Gleason's ideas on postglacial warming. His primary conclusion: **climate is always shifting** (1935b). This is in strong contrast with the Clementsian concepts of climax and equilibria.

"From this exceedingly technical and rapidly growing field it will suffice to note that no a priori reason exists to doubt the probability of significant climatic fluctuations during postglacial time." Sears (1942b)

## Synthesis at Continental Scales

Sears (1942a) examined the revegetation patterns of five species after the ice retreat by synthesizing information collected by various investigators from one hundred eleven North American sites, expanding on earlier work (Sears, 1935a) and showing the individualistic responses of the species. This paper was the direct basis of M.B. Davis (1981) work (M.B. Davis pers. comm. with L.C.K. Shane) and of subsequent pollen mapping by other researchers.

## Sedimentation Rates

Before <sup>14</sup>C, Sears wrestled with the question of absolute vs. relative chronologies. Without a way to date layers of a core, regional and global comparisons were tenuous and contentious. Sears and Janson (1933) was based on dissection of peat layers and measuring the depth of the first occurrence of needles under isolated trees of known age. They determined that a log function could be applied but their data were inadequate to form an absolute chronology.

Asking Questions: Between 1930 and 1942, Sears wrote several key papers testing palynology ideas and methodology.

1940

Columbia

Oberlin

Yale

Yale

Yale

Yale

Yale

Yale

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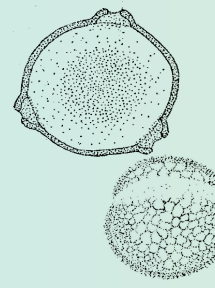
Yale

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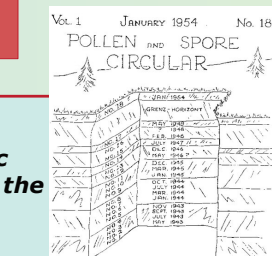
Yale



... a satisfying community is largely the expression of sane ecological conditions.  
1954

... a knowledge of nature is a source of vast enrichment to the educated mind.  
Sears, 1956, *Ohio Wesleyan Magazine*

## POLLEN & SPORE CIRCULAR 1943 - 1954



## WW II International Communication

"Because of the suspension of many scientific meetings and increasing handicaps to travel, the undersigned feels greatly the need of a freer interchange of information ..."  
This mimeographed newsletter kept the N.A. and European scientific community together during the trying times of WWII. Informality was central. Harry (later Sir Henry) Godwin: "I have been getting the pollen analysis circulars quite regularly and they give me a lot of pleasure, and are useful in indicating what is going on and in giving candid and informal opinions such as folk would never publish [emphasis added] ..."  
When our pollen analysis community has got integrated and the world will let us do it I should dearly like to raise the wind enough to come over to the States to take part in a meeting about all the matters we have in common."  
*Pollen Analysis Circular*, Issue 1, *Pollen & Spore Circular*, Issue 10, p. 30

## The Importance of Teaching

Invaluable as his contributions to knowledge are, Sears does not rank them as his primary accomplishments. His self-evaluation (1967) may be a surprise: "Teaching is my profession and has been for more than half a century. Now that retirement has freed me from the grimmer aspects of academic life, I have nothing to lose by referring to my research as an avocation. Largely it has been concerned with the total landscape; not only earth-forms and the climates that impinge upon them, but the living communities that clothe and give them character."  
Sears, 1967, *American Scientist*

## Ecosystem Services

"What I have seen from the air and on the ground in fifty states and a number of foreign countries has long since convinced me that from twenty to twenty-five percent of a healthy landscape should be a kind of living cover that is so far as possible like its original, indigenous vegetation. This would be, in my judgement, the minimum required to ensure the purity of air, regulate the flow and storage of water, maintain the structure and quality of the soil, and in general stabilize the land surface. These are the benefits that derive normally from the presence of living communities in nature undisturbed by man—communities that made the earth habitable for him in the first place."  
Wild Wealth, 1971

Linking Past and Future  
Sears linked landscape change, climate change, and human impacts on continental and global scales as part of his research and education mission from the very beginning. The foundation represented by this linkage echoes daily in research and public concerns. SEE: <http://www.nrcdc.noaa>



## Conservation: Delivering the Message

After two decades of scientific publications Sears began to speak and to write for the public. It became a lifelong practice. From *Country Life* and *Saturday Review of Literature* in 1940-41 to the *New York Times* (1959) and *The Nation* (1960), no publication seems to have escaped his notice. He ventured across disciplines, writing for *American Antiquity* (1947) as readily as the *Ohio State Medical Journal* (1948). He wrote for teachers, garden club members, and graduating classes. In 1952 alone, he published in, e.g. *Mademoiselle*, the *Journal of Geology*, and *American Scholar*. In the 1960s, the rest of society began to catch up with his vision, giving him hope, for a time, that his point had somehow gotten across.

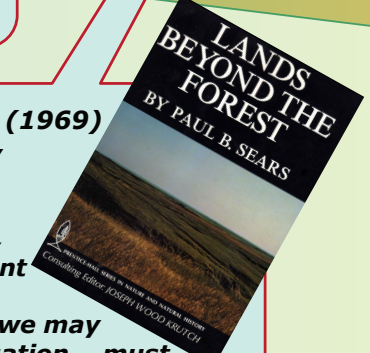
A Note on Sources  
This research is based on a number of archival resources, interviews, and published work. Because of the difference in citation conventions between history of science and science, and to avoid cluttering the poster with documentation of virtually every sentence, we have arrived at the following compromise:  
Published sources appear in abbreviated form on the poster, and in full on the accompanying handout.  
We have limited use of archival material to one repository: Paul Bigelow Sears Papers, Manuscript Group Number 663, Manuscripts and Archives, Sterling Memorial Library, Yale University. Quotations from letters identified by correspondent and date may be found using Diane Kaplan's 1989 Finding Aid. Further information on archival sources may be found on the handout or from Juliana Mulroy ([mulroy@denison.edu](mailto:mulroy@denison.edu)).

## The Living Landscape (1966)

Because the counsel of the naturalist often runs "counter to immediate and visible benefit ... it has no ready buyers. The only way it can become effective is through the gradual spread of a kind of scientific literacy not especially popular in an age of atomic and electronic miracles." [7], p. 16

## Lands Beyond the Forest (1969)

"...unless I am completely wrong, the trend of man's activity is to lower, rather than maintain or enhance, the capacity of environment to sustain him in the long run. ... Whatever success we may have in improving the situation ... must come from a far more general understanding of man as a part of the world of nature than we now have. The products of this kind of knowledge cannot be sold over the counter like new chemical compounds or mechanisms..." [9], p. 194



## The Population Problem

From the beginning, Sears' books and many of his conservation papers touched on implications of the population increase for the sustainability of culture and civilization, but his friends sounded the alarm more directly: Fairfield Osborn (*Our Plundered Planet*, 1948) and William Vogt (*Road to Survival*, 1948). "In the background of all great issues today is the fact that world population is pressing hard upon the material resources which must support it. Only the willfully blind or idiotically optimistic ignore this fact. . . ."  
Sears, 1952, *American Scholar*

Science is the discovery and formulation of the laws of nature. In our enthusiasm we may forget that a law not only tells you what you can do, but what you cannot do.  
Sears, 1959, *Key Reporter*

No other species has ever been known to continue such a rapid rate of increase without finally coming to terms with the limitations of its environment.  
Sears, 1969, *Ohio Journal of Science*