TESTS INDICATE PLANT SEEDS MAY LIVE FOR CENTURIES

By JOHN W. THIERET
CURATOR OF ECONOMIC BOTANY

RECORDS of exceptionally long life in living things, including redwood trees and confirmed alcoholics, have always attracted much attention. The longevity of seeds is a subject about which have appeared many reports, some authentic, some contradictory, and some completely false. One of the most common and persistent false reports concerns the germination and growth of mummy wheat from Egypt. No authenticated record of the germination of wheat taken from Egyptian tombs is available. Indeed, a number of observations indicate the complete loss of germinability of such wheat and equally old barley.

Attempts have been made to germinate ancient grains but none has ever been successful. For example, about fifty years ago at the Royal Botanic Gardens in Kew, an experiment was run with some grain from a model granary found in a tomb of the 19th dynasty. Samples were tested under various conditions, but after several months all the grain had disintegrated. Another experiment with mummy wheat from a sarcophagus of the Grecian epoch in Old Memphis proved completely unsuccessful in spite of precautions taken and the various conditions for germination provided. Examination of the internal structure of such mummy grains has shown the embryo to be dark brown and greatly shriveled, with little of its structure visible.

Several explanations have been offered for the frequent and popular belief in the germination of grains from Egyptian tombs. Recently harvested wheat has been packed into ancient coffins and sent to England. When such grains were tested for germination, of course they gave positive results. Some Egyptian businessmen have substituted fresh wheat for genuinely ancient grains and have sold such wheat to tourists who, upon return to their homes, plant and grow in their gardens "genuine mummy wheat from Egypt." Actually, cereals seem to be ill-adapted to a long period of seed dormancy, so ill-adapted, in fact, that the germination of 25-year-old wheat has been called exceptional, although in one case wheat stored for 32 years under dry conditions showed 69 per cent germination.

LONGEVITY RECORDS

Let us now examine some authentic records of longevity in seeds. In 1856, seeds of more than 600 different species were sent from Kew to Australia's then newly founded University of Melbourne. The seeds were intended for the university garden, but, upon their arrival, the garden was not ready. So they were set aside and replaced later with fresh material. The original 1856 shipment found its way into a dry, airy, dark, and vermin-free cupboard where it remained until its rediscovery in 1906.

SACRED LOTUS

The record for long life in seeds is held by those of this species, Nelumbo nucifera, reproduced here from Blanco's folio "Flora de Filipinas" (1878-80).

To this set of seeds were added others from various sources including dated herbarium specimens and seed collections. In all, there was ample material for about 3,000 germination tests. Of the 1,400 species and varieties of old seeds tested, the experimenter, Dr. A. J. Ewart, found that 46 were still viable after fifty years of storage. These were mostly leguminous seeds, but others were from the mallow, linden, spurge, mint, and iris families. The oldest seeds that germinated were those of two Australian legumes (*Goodia lotifolia* and *Hovea linearis*), both of which had been stored for 105 years.

The longevity record of 105 years obtained in Ewart's experiment was surpassed by the germination in 1934 of two seeds of a legume, one of the cassias (*Cassia multijuga*), which had been collected 158 years before. The experiment utilized, among others, some old seeds found in a storage room of a Paris museum.

At Kew about 20 years ago germination tests were run on seeds that had been collected in 1842 and 1851 and had been kept in loosely corked bottles. The age record for this experiment was held by the seeds of kidney vetch (*Anthyllis vulneraria*) and a clover (*Trifolium striatum*), both legumes, which germinated when 90 years old. Seeds of three species of the 1851 collection were sown in 1951. Those of red clover (*Trifolium pratense*) and bird's-foot trefoil (*Lotus uliginosus*), other legumes, showed a small per-cent germination at the age of 100 years.

During the fire in the British Museum in September, 1940, seeds of silk-tree (*Albizzia julibrissin*), still another legume, collected in China in 1793, became moistened. About one month later it was discovered that three of these seeds had germinated after a dormant period of 147 years.

SACRED LOTUS TOPS LIST

There seems to be little doubt that the record for the retention of viability by seeds is held by those of the sacred lotus (*Nelumbo nucifera*). Late in the 17th century (exact date apparently unknown) Sir Hans Sloane collected specimens of this species, and his collection was eventually acquired by the British Museum. Between 1843 and 1855 Robert Brown, the first Keeper of Botany at the British Museum, successfully germinated twelve seeds (actually fruits) from the Sloane material. At this time, the seeds were known to be at least 150 years old.

In 1926 another experiment with some Sloane seeds was quite unsuccessful, most of the seeds examined showing traces of mold. Early during World War II a further attempt was made to germinate a seed from this collection, then about 250 years old. This time the single seed used germinated within a short time and grew rapidly.

Approximately 250 years, then, is the longest record of longevity in a case about which the details are fairly well known. Perhaps far surpassing this record, however, are the ages of various sacred lotus seeds that have been shown to be still viable after apparently long periods of burial. Near the village of Liu-chia-tung in Manchuria is a naturally drained lake bed. One and one-half to two feet below the present surface of the soil is a layer of peat that is one foot to one and one-half feet deep. Numerous lotus seeds are found in the upper portion of the peat layer. It is the age of

these still viable seeds that has been the object of a great amount of speculation and study.

Since the sacred lotus grows in water, the seeds found in the peat layer must have been shed before the lake dried up. After the formation of the layer of peat on the bottom of the lake and the accumulation of many lotus seeds in this layer, the lake was somehow drained and about two feet of windblown dust from the Gobi Desert was then deposited over the peat. The Pulantien River has cut a valley about 40 feet deep through the lake bed into the underlying bed rock, thus exposing the peat layer high on the valley sides. In 1923 Dr. Ichiro Ohga, a Japanese botanist, published a paper wherein he estimated the age of the seeds to be perhaps as great as 400 years. Dr. Ohga presented a number of these seeds to the British Museum (some plants raised from these seeds flowered at Kew in 1933).

GROWN AT THIS MUSEUM

In our own Chicago Natural History Museum botanical laboratories a lotus seed, apparently from the same source, germinated in 1938 and grew rapidly. The plant was then transferred to Garfield Park Conservatory where it flowered about a year later. Unfortunately, it has since died. In 1951 more lotus seeds from the Manchurian lake bed germinated in Washington.

The original estimate of the age of these seeds has increased in a spectacular manner, for Dr. Seido Endo, geologist at Tohuko University in Japan, believes their age to be 50,000 years, the presumed age of the peat deposit in which they are found. However, radio-carbon dating of a few seeds by Dr. Willard F. Libby of the University of Chicago puts their age at from 830 to 1,250 years—doubtless a more reliable figure. Nevertheless, it is apparent that the question of their age is as yet unsettled, but there seems to be little doubt that the seeds are very old. The seeds from the peat differ in size, shape, and color from the seeds of the modern lotus. These differences may well be due to evolutionary change over a great lapse of time.

In January of this year, Dr. Libby reported the radio-carbon dating of wood from a canoe found twenty feet below the ground near Tokyo. The age of the wood, estimated at about 3,100 years, may perhaps be the age of three viable lotus seeds found associated with the canoe. Maybe someday the title of the world's oldest living things will be held by the seeds of the sacred lotus.

The long life of certain seeds would seem to be an illustration of anabiosis—the apparent suspension of life processes—in higher plants. It is difficult to imagine how, in cases of extreme anabiosis, the metabolic processes characteristic of life can proceed at all. One is reminded of the fact that certain micro-organisms can withstand temperatures as low as 269° below zero Centigrade, a temperature at which these processes certainly halt. Similarly, it is hard to visualize that a balance between the continuous life processes of building-up and tearing-down has been maintained for perhaps 1,000 or more years in the case of the sacred lotus seeds. Such stability of biological materials would seem to result only from a complete cessation of life activities. These are resumed rapidly when conditions become favorable.

From an economic standpoint, the percentage of germination of stored seeds is a figure of more significance than the oldest recorded age for still viable seeds. The major interest, so far as many economic plants are concerned, is in the maximum period of time that seeds may be stored and yet retain a high percentage of germination. It should be pointed out that optimal storage conditions are not yet known for any type of seed. Experimentation has indicated, however, that for many seeds these include (1) low temperature, (2) absence of oxygen, and (3) various degrees of dryness. It is quite probable that these are effective because any one of them results in checking respiration and other chemical reactions, thus preventing changes in the seeds.

A good example of the effectiveness of these conditions in prolonging viability is seen in work done with sugar-cane seeds. When stored in open air, these seeds degenerate rapidly, and consequently shipping them from one area to another cannot be done with confidence. Experimentation has shown that their life can be lengthened materially by taking the seeds from air-dry heads, placing them in cans with a suitable drying agent, displacing the air with carbon dioxide, sealing, and storing at the freezing point.

Similarly the seeds of the rubber plant retain their viability only a short time in open air. This rapid loss of life has been a stumbling block to the extension of rubber plantations. In this case, viability may be prolonged markedly by storage of the seeds in 40 to 45 per cent carbon dioxide. The life span of the seeds of a number of vegetables, including lettuce, cauliflower, onion, tomato, and carrot, may be increased by controlled conditions of storage, particularly low temperature and reduction in moisture content.

The problem of the loss of viability of seeds has yet to be solved, although several hypotheses have been advanced to account for it. One of these suggests that such loss is due to gradual degeneration of the nuclei of the cells of the embryo. Another main-

(Continued on page 8, column 3)

MICHIGAN SCHOOL CHILDREN ON MUSEUM TOUR

A group of nearly 1,400 children from the schools of Allegan County, Michigan, came to Chicago on May 7 by chartered train especially to visit the Museum. All the visitors were escorted on tours of the exhibits. Because of the size of the groups, seventeen members of the Museum staff had to be assigned to guide service.

Vanguard of a group of nearly 1,400 young visitors from schools of Allegan County, Michigan.

ARMED GUARD PROTECTS MUSEUM COLLECTOR

Zoological collecting while accompanied by a military escort of two to four armed guards is the unusual experience reported by Dr. Fritz Haas, Curator of Lower Invertebrates, who returned to the Museum last month after a three-month expedition to Israel. When recent friction with the Arabs developed, the Israeli government insisted that Dr. Haas not only be armed at all times but that he also accept the protection of the escort during his trips into the field.

Dr. Haas collected mollusks and other invertebrates, both land-inhabiting and aquatic, throughout a variety of terrain ranging from the forests of northern Israel to the desert areas in the south and at altitudes from a region of 3,000-foot hills down to the level of the Dead Sea, which is about 1,200 feet below standard sea-level. His collecting was conducted in close cooperation with the Hebrew University in Jerusalem, which expedited his work by providing facilities for travel, preparation, and study. In addition to invertebrates, in which Israel's fauna is unusually rich, Dr. Haas collected some reptiles and other animals for the Museum.

SCIENTIST AND BEDOUIN GUARD

Because of unsettled conditions in the Near East, the Israeli government insisted that Dr. Fritz Haas, while collecting for the Museum, be personally armed and be accompanied by armed military escort. This desert scene is in Wadi El Abyad in Negev.

Among objectives of the expedition were observation of the adaptation of invertebrate animals to life under desert conditions and study of the fresh-water life of isolated rivers in the Near East. Dr. Haas delivered two lectures before the biology group of the Hebrew University—one on "Origin and Composition of Pearls" and the other on "Importance of Mollusks for the Reconstruction of Life Conditions in the Past."

From Israel, Dr. Haas traveled through Italy, France, Switzerland, and Germany, collecting en route and consulting with colleagues in various museums. In Frankfort-on-Main, Dr. Haas was welcomed by the Senckenberg Natural History Society, and a medal of Jacob Cretzschmar, founder of the society, was presented to him in recognition of his scientific achievements. He is the first scientist to receive this medal.

NEW MEMBERS

The following persons became Museum members from April 16 to May 14:

Associate Members

Julian H. Levi, Frank Billings Nichols

Annual Members

George Albiez, Dr. Clifford L. Alsin, William D. Bavelaar, David B. Baxt, James P. Baxter, Ray C. Bennigsen, Woodward Burgert, Eugene L. Cohn, Dr. Pauline M. Cooke, William H. Cooke, G. D. Crain, Jr., Mrs. A. W. Cushman, Dr. William L. DeLarye, Peter T. Demos, Robert A. Dwyer, Dr. James B. Flanagan, Nelson Forrest, Charles G. Frank, John M. Frank, Victor E. Gidwitz, Gerson I. Gluck, William Haddow, J. E. Harrington, Rodney D. Harrison, Gerald E. Hendricks, Carl Hirschfeld, Alfred Hochschulz, Arthur M. Holland, William E. Judd, Miss Minnie B. Kaiser, Michael F. Laterza, Paul L. Latham, Dr. Clarence A. Lathrop, Mrs. Nathan Leavitt, M. R. Mackaye, Joseph H. Makler, Frank O. Marks, Sydney R. Marovitz, Samuel A. Marx, Robert B. Mayer, Richard W. McLaren, Dr. Freda Morgan, Robert L. Muckley, John J. O'Toole, S. William Pattis, Harold L. Perlman, Raymond L. Perlman, Robert A. Podesta, James N. Rawleigh, George C. Reeves, W. W. Rice, Kenneth C. Ring, Donald M. Roche, Frank Ryser, Robert L. Sampson, Michael Sappanos, Calvin P. Sawyier, T. H. Schaffer, Mrs. William Sevic, Henry Shapiro, E. John Sierocinski, Dr. Nicholas M. Simmon, George H. Simmons, E. V. Stanley, Miss Sidney A. Steck, A. L. Steele, Marshall E. Strauss, Walter N. Stuckslager, John Temple, William E. Uhlmann, Miss Elizabeth VanHagen, J. L. Vette, T. A. E. Vyse, D. P. Wells, George H. Willis, John S. Woolman, George W. Yeoman

---

Technical Publications

The following technical publications were issued recently by Chicago Natural History Museum:

Fieldiana: Zoology, Vol. 34, No. 18. *A Colombian Race of Tinamus osgoodi.* By Emmet R. Blake. 4 pages. $.15

Fieldiana: Zoology, Vol. 34, No. 19. *A New Fruit Pigeon from Nepal.* By Austin L. Rand and Robert L. Fleming. 4 pages. $.15

Fieldiana: Zoology, Vol. 34, No. 20. *Mollusks from Ilha Grande, Rio de Janeiro, Brazil.* By Fritz Haas. 8 pages. $.25

Fieldiana: Botany, Vol. 26, No. 2. *Orchids of Guatemala.* By Oakes Ames and Donovan Stewart Correll. 328 pages. $4.

Fieldiana: Zoology, Vol. 34, No. 21. *A New Barbet from French Indo-China.* By Austin L. Rand. 2 pages. $.10

Fieldiana: Zoology, Vol. 35, No. 2. *Placentation of a Primitive Insectivore, Echinsorex Gymnura.* By Waldemar Meister and D. Dwight Davis. 16 pages. $.75

Fieldiana: Geology, Vol. 11, No. 7. *Early Devonian Fishes from Utah, Part II, Heterostraci.* By Robert H. Denison. 64 pages. $1.25

Fieldiana: Zoology, Vol. 34, No. 22. *Marine and Fresh-water Mollusks of the Solomon Islands.* By Alan Solem. 16 pages. $.25

Fieldiana: Botany, Vol. 28, No. 3. *Contributions to the Flora of Venezuela.* By Julian A. Steyermark and Collaborators. 229 pages. $4.25

Fieldiana: Zoology, Vol. 34, No. 24. *Amphibians and Reptiles of Yemen.* By Karl P. Schmidt. 9 pages. $.15

VERNAY ANGOLA SAFARI TO BENEFIT MUSEUM

Through the courtesy of Arthur S. Vernay, of New York, for many years a friend and supporter of Chicago Natural History Museum, the institution will share in the collections of the Vernay–Transvaal Museum Expedition to Angola (Portuguese West Africa). This expedition left Pretoria, where the Transvaal Museum is located, in May and is now well under way. Other institutions participating are the British Museum (Natural History) and the Peabody Museum of Harvard University.

The expedition sponsored by Mr. Vernay, while primarily concentrating on the collection of insects, has a wide range of other objectives including reptiles, birds, small mammals, plants, anthropological data on the native tribes, and investigations of past climates in the Huila, Benguela, Malange, and Bie provinces. Personnel of the expedition includes J. Balfour-Browne, entomologist of the British Museum, and the following members of the Transvaal Museum staff: Dr. G. Van Son and C. Koch, entomologists; J. T. Robinson, anthropologist, and his assistant, K. C. Brain, and A. G. White, taxidermist. The expedition will have a full complement of native helpers and will travel in a fleet of motor vehicles.

Mr. Vernay has presented funds and collections of specimens to Chicago Natural History Museum in the past. In 1930 he financed and led the Vernay-Lang Kalahari Expedition. The Trustees of the Museum have honored him by electing him an Honorary Member, a Patron, and a Contributor.

GIFTS TO THE MUSEUM

Following is a list of some of the principal gifts received recently:

Department of Anthropology:

From: Estate of Henry C. Schwab, Chicago—10 pieces of Chinese porcelain; Robert Trier, Chicago—plate made from mother-of-pearl, Hong Kong

Department of Botany:

From: Albert Greenberg, Tampa, Fla.—Thumbergia; E. J. Palmer, Webb City, Mo.—473 plants; Simon Segal, Chesterton, Ind.—2 Lycopodia; Dr. John W. Thieret, Chicago—90 phanerogams, Illinois, Indiana, Michigan; Grady L. Webster, Ann Arbor, Mich.—15 Phyllanthus, Cuba; Archie Wilson, Flossmoor, Ill.—Castanea, Korea; Dr. T. A. Stephenson, Aberystwyth, Wales—23 algae, Bermuda; Dr. J. J. Symoens, Brussels, Belgium—6 algae, Belgian Congo; Dr. P. C. Silva, Urbana, Ill.—5 marine algae, California; Dr. J. E. Tilden, Hesperides, Lake Wales, Fla.—153 algae, South Pacific, Australia, New Zealand; Dr. G. T. Velasquez, Quezon City, Philippines—28 algae; Dr. Cesar Vargas C., Cuzco, Peru—7 algae; Dr. R. D. Wood, Kingston, R.I.—12 algae; Annie Zimmerman, Chicago—28 algae, California

Department of Geology:

From: B. F. Hazel, Fort Peck, Mont.—Cretaceous fossil crabs and ammonites

Department of Zoology:

From: Marshall Laird, Suva, Fiji—24 frogs, 38 lizards, 2 snakes, Solomon Islands, New Hebrides; Ian M. Moore, El Cajon, Calif.—2 paratypes of a beetle, Mexico; William E. Old, Jr., Norfolk, Va.—2 lots of seashells; David W. Bergstrom, Oxford, Ohio—147 insects and allies, Mexico; Chicago Zoological Society, Brookfield, Ill.—3 birdskins; Albert J. Franzen, Chicago—birdskin; Harry Hoogstraal, Cairo Egypt—130 skins, 123 skulls, 7 skeletons, 4 specimens in alcohol, 16 frogs, 32 lizards, 8 snakes, 18 lots of fishes; Lois Jones, South Bend, Ind.—734 insects and allies, Burma; Mathon Kyritsis, Waukegan, Ill.—12 fishes (6 species); Dr. Harold Trapido, Panama—24 bats in alcohol; U. S. Fish and Wildlife Service, Pascagoula, Miss.—75 lots of fishes (118 specimens), Gulf of Mexico

Raymond Foundation:

From: Dr. R. M. Strong, Chicago—5 black-and-white slides

Library:

From: William J. Gerhard, Chicago; René d'Harnoncourt, Director, Museum of Modern Art, New York; United Food Co., Boston

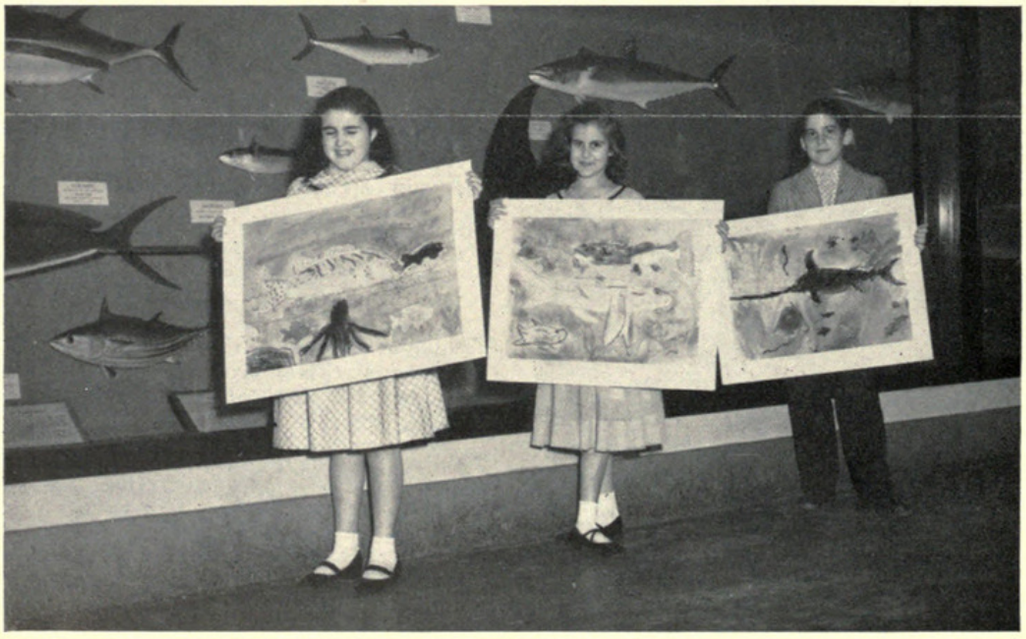
Daily Guide Lectures

Free guide-lecture tours are offered daily except Sundays under the title "Highlights of the Exhibits." These tours are designed to give a general idea of the entire Museum and its scope of activities. They begin at 2 P.M. on Monday through Friday and at 2:30 P.M. on Saturday.

Special tours on subjects within the range of the Museum exhibits are available Mondays through Fridays for parties of ten or more persons. Requests for such service must be made at least one week in advance.

Although there are no tours on Sundays, the Museum is open from 9 A.M. to 6 P.M.

JUNIOR ARTISTS FIND SOURCE MATERIAL AT MUSEUM



Three of the youngest art students from the classes held in Chicago Natural History Museum by the School of the Art Institute of Chicago are (left to right) Lya Avny, Patricia Anderson, and Bernard Lipshires, all eight years of age. They are seen in the Hall of Fishes with crayon drawings that were among the examples of school children's work selected for a special exhibit last month.

LONGEVITY OF SEEDS—

(*Continued from page 6*)

tains that loss of viability may result from the depletion by respiration of the stored food supply of the seed; still others place the blame upon the degeneration of enzymes, on the gradual coagulation of proteins of the embryo, or on the accumulation of toxic products of metabolism. Many investigators emphasize the importance of impervious seed coats in maintaining viability.

Long-term tests represent an obvious way for determining not only the length of time seeds may remain alive under various conditions but also the environment most favorable for retaining viability during storage. It should be emphasized that the data from such experiments—and indeed all seed longevity data—do not necessarily reveal the maximum life span of the seeds concerned but only the life span under the experimental conditions—figures possibly much lower than the maximum time that viability may be retained under ideal conditions.

The best-known of several buried-seed experiments is the one started in 1879 by Dr. W. J. Beal, then professor of botany at Michigan State College, who buried twenty bottles, each containing a mixture of sand and seeds of twenty species. The original plan was to dig up a bottle every five years for germination tests so that the entire experiment would extend over 100 years. However, in 1920 the decision was made to test the remaining twelve samples at 10-year periods in order that the experiment might be extended over an additional 60 years. The most recent germination test was made in 1950 after the eleventh bottle had been dug up. The seeds of only three of the original twenty species were found to be still viable after 70 years of burial: evening-primrose (*Oenothera biennis*), moth mullein (*Verbascum blattaria*), and yellow dock (*Rumex crispus*).

Based on the thesis that the viability of seeds may be prolonged by storage in dry condition and in the absence of oxygen, a long-term test of seed viability has recently been initiated at the California Institute of Technology. Seeds of about 100 species of California plants were sealed in vacuo in glass tubes after the seeds were quite thoroughly dried. The first set of tubes was opened after one year (in 1948). It was found that the average germination percentage for all the species had dropped somewhat, although certain species showed an increase in germination as compared to tests made at the beginning of the experiment. Present plans call for testing of the next set of seeds in 1957, and subsequent sets at regular intervals until 2307. By that time, with increased knowledge and new techniques, we may be able to keep seeds alive vastly longer than we even imagine at present.

PRINTED BY CHICAGO NATURAL HISTORY MUSEUM PRESS