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HAWAIIAN ACADEMY OF SCIENCE

The Hawaiian Academy of Science was organized July 23, 1925, for "the promotion of research and the diffusion of knowledge."

The sessions of the Eighth Annual Meeting were held in Dean Hall, University of Hawaii, May 3 to 5, 1933, ending with a banquet at the Pacific Club, May 6.

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PROGRAM OF THE EIGHTH ANNUAL MEETING

WEDNESDAY, MAY 3, 7:30 P. M.

Preliminary announcements.
Election of members.
Appointment of committees.
Presentation of papers:
Mr. J. F. Voorhees: Some factors controlling rainfall and rainfall distribution in the Hawaiian islands.
Mr. E. G. Burrows: Climate and health in Hawaii.
Dr. Romanzo Adams: The population of Hawaii in 1779.
Dr. J. W. Coulter and Miss Bernice B. H. Kim: The Koreans in Hawaii. (Presented by Miss Kim.)
Mr. L. A. Henke: Cane molasses as a feed for livestock.
Miss Carey D. Miller: Studies of the nutritive value of opihi (*Helcioniscus exaratus* and *H. argentatus*). II—Hemoglobin regeneration in anemic rats fed on opihi.
Dr. C. J. Hamre: Histology of the spleens of anemic rats fed on opihi.
Dr. H. L. Lyon: Measuring sunlight.

THURSDAY, MAY 4, 7:30 P. M.

Presentation of papers:
Dr. J. L. Collins: The genotype of the Cayenne pineapple.
Mr. K. R. Kerns: Histological studies on gametogenesis and fertilization in the pineapple.
Dr. M. B. Linford: Correlation studies on pineapple fruits and crowns.
Dr. O. C. Magistad: Nitrogen fertilization of pineapples.
Dr. Constance E. Hartt: The rôle of potassium in the nutrition of plants, with special reference to sugar cane.
Dr. F. B. H. Brown and Dr. Elizabeth D. W. Brown: A discussion of representative Pacific genera with evidence bearing on their origin and migration. (Presented by Mrs. Brown.)
Dr. T. G. Yuncker: A revision of the Hawaiian species of Peperomia.
Mr. T. C. Zschokke: Poisonous plants now in Hawaii.

FRIDAY, MAY 5, 7:30 P. M.

Presentation of papers:
Dr. F. X. Williams: Architecture among wasps.
Mr. D. T. Fullaway: A new Thripoctenus parasite from the Philippines.

Dr. E. M. Bilger, Mr. W. H. Hammond, and Mr. R. M. Loveland: The iodine content of Hawaiian food products. (Presented by Dr. Bilger and Mr. Loveland.

Dr. Leonora N. Bilger, Mr. W. Y. Young, and Mr. Mark Westgate: Some chemical investigations of the avocado. (Presented by Mr. Westgate, introduced by Dr. Bilger.)

Dr. Leonora N. Bilger and Mr. H. Y. Young: A study of the chemical reactions occurring at the various stages in poi fermentation. (Presented by Mr. Young, introduced by Dr. Bilger.)

Dr. C. P. Sideris and Miss Beatrice H. Krauss: Physicochemical variations in pineapple fruits and their importance in the quality of the fresh and canned product. (Presented by Miss Krauss.)

Mr. R. S. Bean: Protease activity of the vegetative tissues of the pineapple plant.

Mr. G. C. Munro: Preserving the rare plants of Hawaii. (Read by the Secretary.)

Mr. R. J. Baker: Biological records by means of motion pictures.

SATURDAY, MAY 6, 6:45 P.M.

Pacific Club banquet.
Constitutional order of business.
Installation of new officers.
Presidential address: Water.
Adjournment.

ABSTRACTS OF PAPERS

WATER
(Presidential Address)

By

CHARLES S. JUDD

"The cry of the wounded on the battlefield, of the traveler lost on the desert, and of shipwrecked mariners adrift in a boat; that which is usually taken for granted and is never missed until the well goes dry; the greatest solvent known; a good servant but a most powerful and destructive master; the lack of which is the most effective agency in limiting human settlements; a powerful factor in changing the configuration of the earth's surface; and what for centuries was considered and still is spoken of as an element, and what, when pure, is colorless, tasteless and odorless."

Water exists in the greatest quantity of any single substance and is absolutely essential for existence. Covering as it does five-sevenths of the earth's surface it would, were this surface smooth, without mountains or valleys, cover it uniformly to a depth of about two miles. The amount of water used by some plants is shown by calculation that an acre of normal beech forest will transpire in a year the equivalent of about 10.6 inches of rainfall. Man's absolute dependence on water is indicated by the fact that this substance makes up about two-thirds the composition of the human body.

The problem of how the topmost cells of trees obtain the water in which they are continually bathed is still unsolved, but experimentation has indicated that water in thin columns has tensile strength and power of coherence sufficiently strong to withstand the pull from above.

The terrific power and force of water in motion is exemplified by the work of the waves of the sea, and by laboratory tests where the hardest steel alloys have been cut through by tiny jets of water. To water in motion in the form of ocean currents we are indebted not only for marked influences on the climate of many lands, but also for the wide dissemination of plants over the face of the globe. To the oceans and inland waters we are indebted also for a large share of our food supplies, and for easy and comparatively cheap methods of transportation. To water in motion, in the form of floods and freshets, we owe the almost inconceivable damage caused by the erosion of agricultural lands, although it must be admitted that this damage is initiated in great part by man's misuse of lands.

The practical problem of controlling and preventing this excessive erosion lies almost wholly in retaining and passing into the soil the maximum amount of precipitation, instead of allowing it to run off the surface. Soil conservation, chiefly the building or retaining of a vegetative cover, is almost

synonymous with moisture conservation, and vegetation is our most dependable ally in the control of precipitation waters.

In opposition to the view that a forest cover is essential for water conservation, two prominent mainland engineers, Hoyt and Troxell, have argued against the protective value of the forest, basing their opposition on water measurements from certain watersheds which are extreme in character of soil and climate. In their arguments they omitted many facts that are vital to any logical and sane discussion of the subject of forests and stream flow, of watershed protection, and of the general utilitarian value of forested versus denuded lands. Despite the fact that their revolutionary ideas, if brought to their logical conclusion that to obtain a higher yield of water it is necessary simply to remove all the vegetation from the watersheds, would mean the eventual removal of all the soil as well, some misguided local individuals have been sufficiently influenced by these assertions to disparage the work of forest protection carried on in this Territory.

The value of the forest cover for water conservation has been recognized in Hawaii for many years, and during the last quarter of a century great progress has been made in preserving the unspoiled native forest areas and in reclaiming other areas on which the native forest has been destroyed. About 25 per cent of the total land area of the Territory has been set aside as forest reserves, and open areas in this important estate are now being replanted at the rate of about 30,000 trees per month. Despite the progress being made, we are still behind on our program of properly protecting our soil and water resources through forest extension.

Water supply, floods, erosion and worn-out soils are problems of the entire nation, and once the few fundamental facts about erosion are understood, the remedies become apparent. The situation is simply that there is only one fundamental way to control navigability and regularity of streams and to maintain normal climatic conditions and abundant crops, and that is by retaining in the ground itself as much as possible of the precipitation falling on the ground, and by retarding as much as possible its run-off from the surface of the soil.

SOME FACTORS CONTROLLING RAINFALL AND RAINFALL DISTRIBUTION IN HAWAII

By

JOHN F. VOORHEES

Nearly all rainfall is produced by mechanical cooling of the atmosphere. This cooling is due to the expansion of rising bodies of air. Air rises as a result of two forces, convection and the upward deflection of winds by mountains.

Convectional rains are comparatively few in the Hawaiian islands, but are more or less general in character and produce about one-fourth of the annual precipitation. The infrequency of convectional rains is probably due to the presence of an inversion in the vicinity of the 10,000-foot level when trade winds are blowing.

Distribution of the orographic rain is controlled by the direction and force of the wind, by the slope, height, dissection, and trend of mountains, and by their location with respect to other mountains.

A study of absolute humidity indicates that sea-level air ascending a mountain will nearly always reach its saturation point before attaining an altitude of 2300 feet. We would therefore expect to find rainfall increasing from sea level to 2300 feet and decreasing above that altitude. This is approximately true on the broad comparatively smooth windward slopes of Mauna Kea, Mauna Loa, and Haleakala. On Oahu the steep windward slopes of the Koolau mountains seem to drive the air upward so rapidly that the rain is carried over the top of the range, which is 2500 to 3000 feet high, and the maximum rainfall is found a short distance to the leeward.

On western Maui and Kauai are mountains 5000 to 6000 feet high with deep V-shaped valleys facing the trade winds and acting like funnels through which the rain is carried to the crest of the mountain and dropped there. These two crests are the wettest points in the Territory.

The mountains on Molokai seem to produce less rain than the Koolau mountains of Oahu although they are considerably the higher. The reason appears to be that the Molokai range is almost parallel to the trade winds, instead of at nearly right angles to them.

The Waianae Mountains on Oahu are higher than the Koolau Range and parallel to it, but receive less rain because they are to the leeward and the air has lost the major portion of its moisture in passing over the windward range. (Illustrated with maps.)

CLIMATE AND HEALTH IN HAWAII

By

EDWIN G. BURROWS

This study was made under the direction of Prof. Ellsworth Huntington, of Yale University, as a test case of the proposition that white men do not thrive in tropical climates. The study has two objectives; to gain a general idea of the healthfulness of Hawaii's climate, and to analyze in detail the effect on health of various climatic factors in Hawaii.

Army statistics of admissions to hospitals are a more accurate index to health than any civilian figures. Admissions at United States army posts show that Hawaii is distinctly more healthful than the other tropical stations, the Panama Canal Zone and the Philippines, and for the last few years has been more healthful than any mainland corps area. This shows that Hawaii is decidedly healthful for a residence of two or three years.

To study effects of residence lasting through several generations, the status of members of the Hawaii Mission Children's Society was compared with that of other Caucasians in Hawaii. The descendants of missionaries hold an average of one and one-half directorates per man in corporations listed on the Honolulu Stock Exchange, as compared with one directorate to forty men among other Caucasian residents. The percentage of descendants listed in "Who's Who in America" is 0.09 as against 0.03 for other Caucasian residents. Although irrelevant factors affect these comparisons, they show that a superior group of Caucasians can maintain its superiority in Hawaii through at least three generations.

Detailed analysis of climatic factors brought out the following conclusions: 1, the warmer months in Hawaii are the more healthful; 2, a clear optimum of effective temperature was not found, Hawaii's climate staying either within the "summer comfort zone" or slightly below it; 3, sunlight appears to have no marked effect on health under ordinary living conditions; 4, Kona weather is as healthful as trade-wind weather, if the samples studied are adequate.

The healthfulness of Hawaii shows that the proposition "White men do not thrive in tropical climates" is not entirely true. A comparative study of effective temperatures and admissions to hospitals at a large number of army stations, in and out of the Tropics, promises progress toward a more accurate statement of what truth may be in the proposition. This might be expected to take the form of an optimum range of effective temperatures. (Illustrated with charts.)

THE POPULATION OF HAWAII IN 1779

By

ROMANZO ADAMS

It is now possible to compare the estimate of the population of Hawaii made by Captain King with the estimate made by Mr.—later Admiral—Bligh, who was master on Captain Cook's ship. So far as the islands of Kauai and Niihau are concerned, the estimates of King and Bligh may be

compared with that of Captain Cook. The data for such a comparison are found in the following table.

	Capt. Cook 1778	Capt. King 1779	Mr. Bligh as of 1779
Hawaii	.....	150,000	100,000
Maui	.....	65,400	40,000
Molokai	.....	36,000	20,000
Lanai	.....	20,400	1,000
Oahu	.....	60,200	40,000
Kauai	30,000	54,000	40,000
Niihau	500	10,000	1,000
Lehua	.....	4,000	200
Total		400,000	242,200

The main purpose of this paper is to point out the desirability of some competent re-estimate not only of the population at this time, but of other early doubtful statistical data. It is suggested that the Hawaiian Academy of Science appoint a committee to assemble the relevant factual information, to deliberate thereon and report findings at some future meeting. (Illustrated with charts.)

THE KOREANS IN HAWAII

By

John Wesley Coulter and Bernice B. H. Kim

The Koreans in Hawaii, although small numerically, 6,461 in 1930, only 1.8 per cent of the total population of the islands, are a people about whom one hears peculiar reports concerning their political and national movements and the relatively high proportion of youthful and adult delinquents. Their economic and cultural status in the islands is largely the result of their natural environment and social background. Korean civilization approximates that of the Chinese, yet the two peoples are as different as the French and the English. The four main aspects of the cultural background of the Koreans are: a great respect for learning; filial piety and ancestor worship; the *yangban* (gentleman class) philosophy; the subservient position of women and their seclusion. Between 1903 and 1905 more than 7000 Korean immigrants, mainly common laborers and ex-soldiers from port cities, came to Hawaii to work on sugar cane plantations. Over 6000 were young bachelors between the ages of 20 and 30, the remainder being married people, some with families. The general reaction to plantation work and life was one of disappointment, and resulted in the return of about 2000 to Korea and the moving on of 1000 more to the mainland United States. With the loss of Korea's independence in 1910, the remaining Koreans divided into two fac-

tions, and the cleavage has remained. Two factors caused the Koreans to migrate from the country to the city: the bringing in of picture brides from 1910 to 1923 and subsequent settling about Honolulu, and the Japanese strike on Oahu in 1919, during which a large number came as strike-breakers from the other islands. Many settled in the Liliha district of Honolulu because of its proximity to the pineapple cannery and the water front, where they found employment. Within a generation the change from Korean to American ideas and practices has taken place, a change too rapid and unselective, resulting in an appreciable personal and social disintegration. In educational advancement the Korean students in Hawaii compare favorably with the two older and more numerous Oriental groups, both in achievement and in proportional representation. A special problem that will arise in the near future for the Korean community will be the guidance of the children of the picture brides, who compose the large majority of the young Koreans.

CANE MOLASSES AS A FEED FOR LIVE STOCK

By

LOUIS A. HENKE

Hawaii with its million tons of sugar produces about 225,000 tons of cane molasses annually, some of which is exported and some used locally as a fertilizer or feed.

Cane molasses is a feed low in protein but rich in carbohydrates, largely in the form of easily digestible sugars. The potash content is high. In general it is appetizing to most animals and it has long been fed to plantation horses and mules in Hawaii and elsewhere with satisfactory results. The investigations with this feed, recently carried on at the Hawaii Experiment Station and reported here, have to do largely with the value of cane molasses for fattening swine and for dairy cows.

As a result of five experiments, ranging in length from 70 to 126 days and involving a total of 63 pigs, it seems well established that cane molasses in amounts up to 20 per cent of the concentrate mixture fed is worth approximately as much or more, pound for pound, as barley as a feed for fattening swine.

Dairy cows were fed a ration containing 25 per cent cane molasses in the concentrate mixture. In two, short-time, fifteen-week, double-reversal feeding experiments, one with 8 and the other with 10 cows, the production of milk and fat was practically the same on the molasses and non-molasses rations. The cost of milk production was lower on the molasses ration.

In a long-time test designed to show the accumulative effects, if any, of heavy molasses feeding to dairy cows, a 25 per cent cane molasses ration

was fed for seven years, including with the necessary controls, a total of 232 cow years to date. Production on the molasses ration has been quite satisfactory, but a lowered reproduction efficiency has necessitated continuing this work for further data. (Illustrated with charts.)

STUDIES OF THE NUTRITIVE VALUE OF OPIHI (HELCIONISCUS EXARATUS AND H. ARGENTATUS)
II.—HEMOGLOBIN REGENERATION IN ANEMIC RATS FED OPIHI

By

CAREY D. MILLER

Young albino rats raised in the laboratory were used as subjects. From birth until the supplementary feeding began they had milk as their only food. At weekly intervals blood samples were taken and the hemoglobin determined. When the rats showed a very severe anemia, 3.0 to 5.0 gms. of hemoglobin per 100 cc. of blood, the supplementary feeding was begun.

The first set of experiments, in which 4 to 8 gms. of *opihi* were fed daily as a supplement to the milk diet of 16 anemic rats, showed that the *opihi* had a low hemoglobin regenerating value. Four control rats fed daily 4 gms. of calves' liver showed a rapid rise in the hemoglobin. Three rats fed a supplement of 0.5 gm. iron per day were expected to serve as positive controls. After 4 weeks they still showed little hemoglobin regeneration and were in poor condition, but when 0.01 mg. copper was added daily, the rats began to look better in 2 days, and in 3 or 4 weeks the hemoglobin was almost normal.

After the first set of anemia experiments was complete, Miss Ruth Robbins made additional analyses of the *opihi,* including calcium, phosphorus, copper, and iron. These analyses showed the *opihi* to be very high in iron, 0.0134 per cent of fresh material, but very low in copper, 0.00023 per cent of fresh material.

A second set of experiments was then carried out in which 15 anemic rats were fed daily 2 to 4 grams of *opihi* as the only supplement to the milk diet, and 12 anemic rats were fed *opihi* plus 0.01 mg. of copper as the daily supplement. In several cases the subjects of these contrasting diets were carefully matched litter mates. The results showed that the hemoglobin content of the blood will rise more rapidly and to a higher figure when copper and *opihi* are fed as supplements than when *opihi* alone is fed. Our results confirm the contention that copper is necessary for hemoglobin building and that the hemoglobin regenerating value of foods, at least for the anemic rat, depends largely on their iron and copper content.

In the course of these experiments it was noted that severely anemic rats usually showed enlarged hearts, a fact that has previously been reported.

We have also noted a condition which seems not to have been previously reported, namely enlarged spleens. The control animals on milk that succumb rather quickly to severe anemia, have spleens of normal size, but animals fed supplements such as *opihi,* that permit a moderate recovery of hemoglobin may show much enlarged spleens.

A word of caution about applying the results of these experiments to human nutrition. Enlarged spleens do not necessarily follow the eating of *opihi.* The changes taking place in the spleens occur only in rather severely anemic animals and can be produced at will by feeding other foods as supplements to the milk diet. The *opihi* is undoubtedly a valuable food, being a concentrated source of vitamin A and an excellent source of calcium, phosphorus, and iron. The need of the human body for iron is very much greater than is the need for copper, and we are more likely to get enough copper than enough iron. (Illustrated with slides and charts.)

GROSS AND HISTOLOGICAL CHANGES OF THE SPLEEN OF ANEMIC RATS FED SUPPLEMENTARY DIETS

By

CHRISTOPHER J. HAMRE

Gross and histological studies were made of the spleens of anemic rats and of rats in various stages of recovery induced by various supplementary diets. Strictly anemic rats possessed spleens of about normal size, that is, of a normal proportion to their total body weight. The supplementary diets were found to induce enlargement of the spleen in an inverse proportion to their capacity to induce recovery from anemia, those producing the lowest grade of recovery producing the greatest enlargement of the spleen. The supplemented diets found to produce the greatest enlargement of the spleen and the lowest grade of recovery from anemia were milk and flour, and milk and *opihi.* Milk, *opihi,* and copper produced complete recovery and normal-sized spleens, as did also milk, iron and copper. Milk and iron produced a very low grade of recovery from anemia and was without effect on the size of the spleen.

Histologically the spleens of strictly anemic animals were found to be characterized by the loss or reduction of the periarterial white pulp and the malpighian corpuscles and a relatively proportionate increase of the red pulp. Iron added to the anemia diet induced no histological changes in the spleen while other supplementary foods induced regenerative changes. These changes were characterized by the early appearance of groups of basophilic cells and lymphocytes in the red pulp area and their later disappearance as the periarterial white pulp and malpighian corpuscles were regenerated.

No explanation of the enlargement of the spleen was offered other than that it might have been associated with the general resumption of growth which the supplementary foods induced. The possible connection of the groups of basophilic cells to lymphocyte production was also suggested. (Illustrated with slides and charts.)

MEASURING SUNLIGHT

By

HAROLD L. LYON

The speaker exhibited and described an instrument in which a Franklin pulse glass was supported at its center across the upper end of a rotating axis, said axis being inclined to the vertical. An adjustable stop inserted at the highest point in the circle in which the pulse glass might swing permitted the pulse glass to swing back and forth or teeter on the axis through an angle of from 150° to 175°. The instrument was enclosed in a housing which was so designed that when a bulb of the pulse glass was at the lowest point of its possible swing it would be exposed to sunlight, while the other bulb, which would at the same time be at the highest possible point in its swing, would be shaded. Heat from sunlight would drive the liquid out of the exposed bulb into the shaded bulb until this bulb became heavier than the exposed bulb, when the pulse glass would swing on its axis and the heavier bulb would pass to the lowest point in its swing, where it would in turn be exposed to the sunlight. The liquid would then be driven out of this second bulb back into the first bulb until it caused rotation in the other direction. A wing was so arranged on the axis that at each swing of the pulse glass it would simultaneously contact two points and, in so doing, close an electric circuit which operated a recording device yielding a printed record. Records made by one of these instruments were exhibited, which clearly showed not only the length of time that the sun was obscured by clouds, but also the relative density of those clouds. (Illustrated with charts and instruments.)

THE GENOTYPE OF THE CAYENNE PINEAPPLE

By

J. L. COLLINS

Vegetative reproduction such as we have in the pineapple offers almost no opportunity for heterozygous recessive genes which are present in the genotype to become apparent in development, and they may be carried along hidden and unsuspected for many generations.

We learn about the kind of genes present in the genotype of an individual or variety by examination of the progeny from sexual reproduction and from the rare mutations occurring in asexually produced populations. These two methods have shown that the genotype of the Cayenne pineapple contains many hidden recessive genes.

From a study of the progeny produced when Cayenne is selfed it is evident that the variety has many more heterozygous recessive genes than the 16 that have been rather critically studied, and concerning which something is known. The question naturally arises as to why this variety is so extremely heterozygous. Two explanations can be offered for this fact: 1, we believe the Cayenne originated as a seedling, a hybrid between two other types, and part of its heterozygosity dates from the hybrid origin; 2, some of the recessive genes now present in the genotype were not there originally, but have appeared since the variety was a clon.

Vegetative reproduction is a method which permits the accumulation of recessive mutations, while sexual reproduction, and in particular self-fertilization, prevents the accumulation of recessive genes in the genotype.

The phenomenon of mutation is not new, but the knowledge of the rôle it plays in increasing the heterozygosity of clons is relatively new. Müller made use of this principle in an ingenious manner in studying the rate of mutation in the fruit fly *Drosophila melanogaster,* a sexually reproduced organism, and Banta and Wood found that long continued parthenogenesis in *Cladocera* resulted in the accumulation of recessive genes, which became evident in the subsequent sexually produced progeny.

It is, therefore, my opinion that the genotype of the Cayenne pineapple today contains many more recessive genes than it had when the variety was new, and, furthermore, that this heterozygosity will continue to increase. As a result we may reasonably expect an increasing number of mutant characters to appear in Cayenne populations with the passage of time. (Illustrated with slides and charts.)

HISTOLOGICAL STUDIES ON GAMETOGENESIS AND FERTILIZATION IN THE PINEAPPLE

By

KENNETH R. KERNS

The archesporial cell arises under two layers of nucellus. It is recognized by its larger size and different staining capacity. As the archesporial cell enlarges, the ovule bends, becoming the anatropous type. When the ovule becomes bent about 90 degrees the inner integuments first appear. The archesporial cell continues to elongate and enlarge, and the outer integuments are

differentiated. The inner and outer integuments continue to encircle the ovule, forming the micropyle where they meet. This is the small opening through which the pollen tube will enter at the time of fertilization.

When the inner integument has nearly encircled the ovule the archesporial cell first divides reductionally. Each of the two resulting nuclei divide again equationally to form four nuclei. Apparently walls are formed between these nuclei. The basal of the four nuclei separates from the other three and is destined to form the entire embryo sac. The degeneration of the three nuclei at the micropylar end is apparently a general rule, although at least one instance was observed when those at the chalazal end degenerated, leaving the one at the micropylar end.

The remaining nucleus divides three times equationally to form eight free-swimming nuclei. These move into place, two forming the synergids and one the egg nucleus at the micropylar end of the ovule. Three form the antipodals, which lie at the chalazal end of the ovule and quickly degenerate. The other two form the endosperm nuclei, each of which keeps its own identity, lying together in the mid portion of the embryo sac.

The fertilization is very regular, the pollen tube entering the micropyle and the double fertilization taking place. The two male nuclei are about the size of the egg nucleus and smaller than the endosperm nuclei.

The styles of Cayenne flowers have a distinct tendency to arrest the development of Cayenne pollen tubes. (Illustrated with slides and charts.)

CORRELATION STUDIES ON PINEAPPLE FRUITS AND CROWNS

By

MAURICE B. LINFORD

This discussion deals with some relationships of pineapple fruit development and quality.

Quality has been judged visually on a numerical basis by comparison with 5 standard photographs defining 5 quality classes. Class 1 includes very poor fruit with wholly opaque flesh, while Class 5 includes superior, translucent-fleshed fruits. Classes 2, 3, and 4 are intermediate.

About three-quarters of the period from planting to harvest is given to growth of stem, leaves, and roots. Then, during a brief transition, the number of florets to compose the aggregate fruit is fixed by floral differentiation. Unlike most horticultural fruit plants, which blossom profusely and then absciss excess blossoms or immature fruits, the pineapple must carry to maturity the full number of florets or eyes differentiated.

Number of florets differentiated was found correlated with stem diameter,

less closely with stem weight, but not at all with stem length in two sample lots. Number of eyes differentiated is not directly proportional to plant size and probably is not proportional to ability of the plant to mature fruit of good quality.

Eye weight is a measure of degree of development. Eye number, for calculation of eye weight, has been estimated by counting eyes in one spiral and multiplying by 8 the number of similar spirals.

Specimen data presented showed no correlation of translucence (quality) with eye number, some correlation with fruit weight, and better correlation with eye weight.

Data from one fertilizer test showed increasing rates of application to be followed by better quality, heavier fruit, more eyes, heavier eyes, and relatively shorter crowns. Advance of the season here resulted in reverse changes.

Adverse factors during fruit growth and ripening may limit quality, but it is suggested that sometimes quality is limited by the differentiation of more fruitlets than the plant is prepared to mature. (Illustrated with slides and charts.)

NITROGEN FERTILIZATION OF PINEAPPLES

By

O. C. Magistad

The results of 28 field experiments with pineapples, in each of which the amount of nitrogen added was varied, was shown in the form of graphs. With but a few exceptions on virgin soils, addition of nitrogen caused an increase in average fruit weight and tonnage per acre. It was shown that yields were greater on virgin soils at the same level of added nitrogen than on non-virgin soils.

On the basis of a composite yield curve derived as a mean of the result of field experiments, the most economical rate of nitrogen fertilization at varying prices of fertilizer and fruit was graphed. (Illustrated with charts.)

THE RÔLE OF POTASSIUM IN THE NUTRITION OF PLANTS WITH SPECIAL REFERENCE TO SUGAR CANE

By

Constance E. Hartt

Data are presented indicating that in sugar cane potassium deficiency causes derangement in synthesis and translocation of proteins and carbohydrates.

Sugar cane plants, variety H-109, grown in quartz sand and supplied with 1, 87.9 p.p.m. K; 2, 39.0 p.p.m. K; 3, 3.9 p.p.m. K; 4, no K, but Na; 5, no K, no Na, were harvested in November, 1931, and April, 1932, when they were 9 weeks and 7½ months old, respectively.

Determinations were made of the percentages of amino, protein and total nitrogen, and sucrose, reducing and total sugars found in the blades and stems of plants 1 to 3 of the November harvest and of all the plants in the April harvest.

Because in November the blades of plants 3 contained 0.231% amino and 1.461% protein nitrogen, whereas the blades of plants 1 contained 0.07% amino and 1.585% protein nitrogen, it is suggested that the synthesis of proteins from amino acids was curtailed in the potassium-deficient plants. Stems at that age showed similar but smaller variations. When 7½ months old, the blades of all the potassium-deficient plants contained larger percentages of amino, protein, and total nitrogen, while stems showed the reverse condition. It is, therefore, suggested that by the time of the second harvest, translocation of nitrogenous compounds from blades to stems was decreased. Microscopic observation showed a necrosis of the phloem, which might decrease translocation.

Sugar analyses showed that in general the blades and stems of the controls contained more sucrose and less hexose and a more active invertase than the potassium-deficient plants. This indicates that the synthesis of sucrose from hexoses is curtailed by potassium deficiency due to the weak activity of invertase. The stems of plants 4 and 5, harvested in April, were low in hexoses, and since the blades of those plants were high in hexoses it is suggested that their translocation from blades to stems was affected by severe starvation. (Illustrated with charts.)

A DISCUSSION OF REPRESENTATIVE PACIFIC GENERA WITH EVIDENCE BEARING ON THEIR ORIGIN AND MIGRATION

By

FOREST B. H. BROWN AND ELIZABETH D. W. BROWN

In the paper as presented the data dealing with the Pteridophytes were contributed by Dr. E. D. W. Brown, those with the Spermatophytes by Dr. F. B. H. Brown.

Investigations now in progress show with fair conclusiveness that more than 80 per cent of the flora of southeastern Polynesia is of American origin. Many close affinities are Malaysian, but here the ultimate affinities, significant as to origin, are largely American. Neither Asia nor Malaysia

seem to have contributed more than a very minor proportion of the antecedents of the flora of southeastern Polynesia.

It is not improbable that the antecedents were carried by ocean currents in two main waves of dispersal from isthmian America, one in Cretaceous time or earlier, and the other in the Lower Eocene, as suggested in previous publications dealing with the Hawaiian flora. That whole islands of living vegetation may have been transported at this time is suggested by the presence of peculiar fauna associated with nearly every species. *Ficus prolixa,* for example, and the closely related *Ficus marquesensis,* are both present in the Marquesas, together with the peculiar wasps necessary for the fertilization of the fruits.

Plant evidences strongly indicate that the Tuamotus were at one time emerged, with high altitudes above the timber line, and supported a rich independent flora, largely of American origin. This flora, which possibly existed in Cretaceous time, is here designated as the Pre-Tuamotuan flora in distinction from the meager flora of the present Tuamotus. Affinities suggest that before and during submergence the Tuamotuan flora was dispersed to the Marquesas, Society Islands, Austral Islands, Rapa, and even westward to Malaysia. Some emigrants seem to have reached Hawaii.

Close affinities between Hawaii and islands centering around the Tuamotuan region suggest that the long ridge upon which Palmyra and other atolls now rest was probably emerged with high protuberances during Cretaceous time, affording a path of intermigration between the Hawaiian and the Pre-Tuamotuan floras. Very likely it also supported a Pre-Palmyra flora of American origin, from which some elements were dispersed to Hawaii and others to the Pre-Tuamotuan flora, from which, in turn, radiations reached the Marquesas, Society Islands, Rapa, Austral Islands, and other parts of Polynesia or westward to Malaysia. The distribution of *Campylotheca,* for example, suggests a Pre-Palmyra origin for this genus. (Illustrated with maps.)

A REVISION OF THE HAWAIIAN SPECIES OF PEPEROMIA

By

TRUMAN G. YUNCKER

(DePauw University, Greencastle, Indiana)

The Piperaceae are represented in Hawaii naturally by the genus *Peperomia* and by two introduced species of *Piper.* In 1913 Casimir deCandolle presented a treatment of the Hawaiian Peperomias recognizing 73 species, of which 47 were described as new. Many species of *Peperomia* exhibit considerable variation and it is often difficult if not impossible to identify

specimens with the use of existing keys. As a result of a study made during the past nine months of a large amount of herbarium material including most of the types and, more especially, of the plants in the field, a revision of the genus is presented which includes 38 species, 8 of which are described as new to science. All but 4 species are believed to be endemic. It has been impossible to verify or accept some of the features which previous authors have used for specific distinction, which accounts for this great reduction in the number of species. *Peperomia reflexa,* a widely distributed species, is our only member of the subgenus Micropiper. Several species which develop fruit with an oblique apex and a subterminal stigma belong in the typically American subgenus Sphaerocarpidium. There are present in Hawaii, in addition, a number of species with fruit having rounded or pointed apexes and more or less apically placed, divided, and penicillate stigmas. These do not agree with any of the subgeneric divisions which have been previously established, and a new subgenus is described to include them. All members of this new subgenus, for which the name Hawaiiana is proposed, are believed to be endemic. The fruit of *Peperomia* is very viscid and it appears most logical to assume that distribution has been by birds. From available evidence it appears that the Polynesian species of *Peperomia,* including those in Hawaii, are more closely related to American than to Malaysian species.

POISONOUS PLANTS NOW IN HAWAII

By

THEO. C. ZSCHOKKE

The list of plants presented, comprising upwards of 80 species, was compiled with the assistance of botanists, foresters, physicians, and veterinarians, and is as complete as available information can make it. These species are roughly classified as poisonous if swallowed, poisonous if introduced into the blood stream through wounds or otherwise, possessing juice which is extremely painful although not fatal if taken into the mouth, possessing juice which causes temporary blindness or blisters on the skin, possessing stinging hairs or similar irritants other than sap, unsafe to use if not properly prepared, poisonous to live stock, fish poisons, and plants reputed to be unsafe, but concerning which no definite information is at hand.

Little was found in the literature concerning the poisonous properties of many of these plants, at least in a form that is intelligible to a layman, and much of this little seems to be contradictory or indefinite. Considerable research is necessary to determine at what stage in the growth of the plant the deleterious properties are most effective, or whether the reputedly poison-

ous effects assigned to certain plants have a basis in fact. In many species, likewise, it is not definitely known in just what part or parts of the plant the poisonous properties reside. As a corollary to this, the symptoms of the various types of poisoning should be classified and information concerning the antidotes made known to the public at large.

The list of poisonous plants, to which reference is made here, has been issued by the Agricultural Extension Service of the University of Hawaii as No. 49, dated May 3, 1933, and copies are available to persons interested.

ARCHITECTURE AMONG WASPS

By

FRANCIS X. WILLIAMS

The architecture in the nests of wasps varies from mere holes in the ground through the mud-cell type to a culmination in the elaborate paperlike nests of the social species.

In the genus *Larra* are wasps that build no nests. Their prey consists of mole crickets, which the wasps drive to the surface of the soil, temporarily more or less immobilize by several stings and, before the crickets recover, glue an egg upon them. The crickets soon go underground, to be finally killed by the wasp grub. The large Philippine *Ammobia* wasp digs a burrow, stores it with Orthoptera and plugs up the entrance with soil. The tropical American *Podium* wasps go one step further, for they plug up with mud their short burrows, stored with cockroaches, or else make entire clay cells, as do the *Sceliphron* spider wasps. There is considerable architecture in some of the nests of the slender *Trypoxylon* wasps, and in the Psammocharidae of the group *Pseudagenia* and its relatives; here the cells are of mud, sometimes a number of cells together; one wasp uses a spider's retreat for her cells, another waterproofs them, while others use dried leaf-bits for building materials. The East Indian *Zethus cyanopterus* makes an elegant roofed-over nest of green leaf-bits and feeds her larvae daily with disabled caterpillars. *Stenogaster* wasps construct very elegant nests of old wood pulp and the like, and also feed their young daily. In the completely social wasps, such as *Polistes,* the cells are of papery materials and in many genera are protected by a cover. One species, *Leipomeles lamellaria,* builds under a leaf, the petiole of which is covered with gummy material as a protection against ants, etc. *Parachartergus apicalis,* also tropical American, makes a large, rather finely ribbed paper nest. (Illustrated with slides.)

A NEW THRIPOCTENUS PARASITE FROM THE PHILIPPINES

By

DAVID T. FULLAWAY

The account here given is based entirely on a report made by Dr. I. D. Dobroscky.

The genus *Thripoctenus* is fairly new, it having been erected by Crawford in 1911 to provide for a Tetrastichus-like chalcid fly which had been reared from the bean thrips in California. Other species were found later in various parts of the world, the one here noted being the eighth. All are larval parasites of thrips, with similar habits.

This species, *Thripoctenus vinctus,* was found by Dr. Dobroscky at Los Banos, P. I., while searching for natural enemies of *Thrips tabaci,* which had been proved by Linford to be the vector of pineapple yellow spot virus. *Thrips tabaci* not being available in the Philippines, other possible hosts of *Thripoctenus* were investigated. *Taeniothrips longistylus* was found to be very common in the flowers of the lima bean and the cowpea, and when these were brought into the laboratory invariably a few *Thripoctenus* were brought with them. It was not known whether this species would parasitize *T. tabaci,* but as it was late in the season when the parasite was obtained, on the off-chance that it would be able to accommodate itself to other hosts, efforts were made to secure the parasite in sufficient numbers to test its adaptability in Japan, where *T. tabaci* is abundant on onion plants. In securing the parasites we learned much about their life history and habits. The adult was found to be positively phototropic, which made its collection easy at window lights. Females, which reproduced parthenogenetically, were generally collected. They chose to oviposit mostly in young thrips larvae not past the third instar. The time elapsing between oviposition and the first outward sign of parasitism in the prepupa was 7 to 9 days. When the prepupal skin of the thrips is shed, the pupa of the parasite is exposed. This transition occupied 1 to 2 days. The pupal period was 10 to 12 days. Adults lived about 4 days. Propagation in test tubes was secured by placing one female *Thripoctenus* with 50 larval *Thrips,* the highest degree of parasitism obtained by this method being about 40 per cent. Increase was very uncertain, however, since both parasite and host proved to be very delicate. Adults were more often reared from larvae collected in the field. The percentage of parasitism in field-collected material, however, was very low at times, probably due to fluctuations in the host populations. Transportation from the Philippines to Japan was effected while the parasite was in the pupal stage. Many lots were successfully transported, but the species failed to maintain itself on *Thrips tabaci* larvae, giving additional evidence of the correctness of the assumption

that there is a high degree of specificity in *Thripoctenus*. The work here reported was done under the auspices of the Experiment Station, Association of Hawaiian Pineapple Canners, and the Territorial Board of Agriculture and Forestry. (Illustrated with specimens.)

THE IODINE CONTENT OF HAWAIIAN FOOD PRODUCTS

By

EARL M. BILGER, WESLEY HAMMOND, AND ROBERT LOVELAND

Iodine is an essential constituent of the diet, and small quantities are necessary for the elaboration by the thyroid gland of thyroxine, a regulatory substance or hormone important, among other things, in determining the rate of metabolism. In this investigation, which included the determination of the iodine content of air and water, two different colorimetric methods were employed. Turner's method, used by Mr. Hammond, depends upon ashing the dried sample, liberating iodine by means of bromine water, and estimating the amount through its blue color with starch in a Klett colorimeter. In the McClendon method, used by Mr. Loveland, the usual silica tube was replaced by a muffle furnace, where large samples (300 to 1000 grams) were necessary. This furnished a satisfactory method of ashing for most vegetables, but was unsuitable for cereal grains, nuts, or oily materials. In the latter cases an especially constructed oxygen burner was used. The iodine salts obtained by either process were treated with phosphoric and sulphurous acids and the resulting iodides converted to free iodine by means of sodium nitrite. The iodine, dissolved in carbon tetrachloride, was determined with a Klett colorimeter. Results of the analyses are expressed in parts per billion (p.p.b.) of air or water, or of the food material dried to constant weight at 100° C. Air contained 2.1×10^{-8} p.p.b. Ten samples of Honolulu tap water averaged 1.7 p.p.b., and ten samples of Aiea well water averaged 1.6 p.p.b. Places in the United States where water contains more than 2 p.p.b. are few. Water from typical goitrous regions contains less than 0.5 p.p.b. Other water analyses gave for Hahaione trench water 15 p.p.b.; Kaelepulu fishpond, 4.0; Manoa brook water, 3.5; ocean water, 25.7. Twenty-four food products were analyzed, the p.p.b. of the dried weight being: avocado oil, 8092; burdock, 156; beets, 167; string beans, 1427; mustard cabbage, 726; head cabbage, 192; cucumbers, 335; carrots, 548; celery, 635; daikon, 7706; fish powder, 936,198; ginger, 326; lotus, 1719; lettuce, 600; opihi, 4480; bell peppers, 330; Chinese peas, 436; pineapple, 1070; poi, 316; Irish potatoes, 164; sweet potatoes, 75; spinach, 2023; squash, 610; tomatoes, 200; yams, 175. A comparison between these figures and figures obtained by other investigators in the determination of iodine in vegetables grown in various sections

of the United States shows that the iodine content of Hawaiian foods is sufficient to meet the needs of normal animal metabolism and that the foods compare favorably in this respect with the food products of certain mainland localities. The results are consistent with the absence of simple goiter in the islands. (Illustrated with charts and demonstration.)

SOME CHEMICAL INVESTIGATIONS OF THE AVOCADO

By

LEONORA N. BILGER, W. Y. YOUNG, AND MARK WESTGATE

This investigation of the sterol content and vitamin value of avocado oil was undertaken as part of a series of chemical studies on avocado pears. Some time ago W. Y. Young made an investigation of the tannin content. For commercial as well as scientific purposes it was of interest to establish certain facts concerning the nutritive value of avocados. Attention was directed to the oil, since Santos, Weatherby, and others worked with dried oil-free pulp, avocado mash, or whole fruit.

Vitamin research has revealed the fact that ergosterol when irradiated becomes Vitamin D. With a view to establishing a connection between the sterols of avocado oil and the nutritive value of the pears, the sterols of avocado oil were isolated by the following process: the whole oil was saponified with potassium hydroxide, the diluted soap extracted with ether, the ether solution of sterols evaporated, and the residue recrystallized from absolute alcohol. A yield of 0.2 per cent of sterols, glistening white flakes melting at 143-144° C., was obtained. A combustion analysis and molecular weight determination showed the molecular formula to be $C_{26}H_{44}O$.

A series of experiments on white rats was carried on, using irradiated and unirradiated whole avocado oil, sterol-free oil, and pure sterols. Avocado oil was shown to be a poor source of Vitamin D, and no Vitamin A was present. In a comparative study of avocado oil with Wesson's cooking oil, the former was shown to have no unusually high nutritive value.

AN INVESTIGATION OF THE CHEMICAL CHANGES OCCURRING IN THE VARIOUS STAGES OF POI FERMENTATION

By

LEONORA NEUFFER BILGER AND H. Y. YOUNG

A bacterial study of poi at various stages of its fermentation, made by Dr. O. N. Allen and Mrs. Ethel Allen, resulted in the establishment of the presence of lactobacilli, streptococci, yeasts, and mycoderms.

The purpose of this chemical study was to determine the products of the fermentations induced by the above organisms.

Three preliminary investigations were made. Poi was subjected to a complete quantitative analysis, in which water, starch, pentosans, reducing sugars, sucrose, proteins, fat, crude fiber, ash, phosphorus, and calcium were determined. The changes in starch and reducing sugar content during fermentation were determined. A decrease in reducing sugars at the beginning of the fermentation and a decrease in starch in the later stages were shown. The volatile and non-volatile acids were estimated at various stages of fermentation. More non-volatile acids were shown to be present at early stages and equal quantities of volatile and non-volatile acids at the later periods.

In the chemical study of fermentation products, the tests were made at the same stages as those used by Dr. and Mrs. Allen in their bacteriological investigation. These ranged from two hours to ten days. Lactic acid was found to be present at all stages although smaller amounts in zero-hour poi and in early stages than in later. In the presence of calcium carbonate, butyric acid was formed in later stages. The butyric ferment was present in poi, but is active only when the fermenting medium is neutral or slightly acid. Acetic acid was found to be present from two hours to ten days in gradually increasing quantities. Its formation results from the action of mycoderms on alcohol. Positive tests for small amounts of formic acid were given at all periods from two hours to ten days. *Lactobacillus pastorianus,* found in poi, is known to produce formic acid through its action on sugars and dextrin. Alcohol was absent at the beginning of the fermentation, but small amounts were detected from two hours to ten days. Carbon dioxide was found throughout the fermentation.

The products of fermentation, lactic, acetic and formic acids, alcohol and carbon dioxide, proven to be present at various stages, were consistent with the bacteria found at corresponding periods.

PHYSICOCHEMICAL VARIATIONS IN PINEAPPLE FRUITS AND THEIR IMPORTANCE IN THE QUALITY OF FRESH AND CANNED PRODUCT

By

C. P. Sideris and Beatrice H. Krauss

The tissues of ripe pineapple fruits may be opaque, semi-opaque, semi-translucent, or translucent. This condition is due to the presence of air in the intercellular spaces of the tissues, an opaque fruit containing great amounts, whereas a translucent fruit may have very little or none.

Tissues are white or opaque because of the great light-reflecting power of the air bubbles, which are here analogous to foam. In the translucent

tissues the yellow pigments reflect the yellow rays, absorbing those of other colors. The air content of opaque tissues influences their specific gravity as well, opaque tissues being lower in this respect than the translucent. It has been found that fruits with translucent tissues will sink in water to an extent of 98 to 100 per cent, while those with opaque tissues will float to an extent of 80 per cent.

The total acid content of pineapple fruits varies to a great extent with the physical properties of the tissues, opaqueness being associated with high acidity and translucency with low. The accumulation of great quantities of organic acids in pineapple tissues is the result of abnormal metabolic conditions, this having been proven experimentally, but it has not yet been definitely proven whether the development of a high acidity is the cause of opacity or vice versa.

The palatability of pineapple fruits varies with the balance of sugar to acid, those containing great quantities of acid being as objectionable as those containing very little. Fresh fruits with a ratio of sugar percentage to citric acid percentage of about 28, and canned ones with a ratio near 33 are more palatable than those with values much above or below these figures. We have introduced the term "index of sweetness" to express the ratio of sugar percentage to citric acid percentage.

We have canned a number of fruits with different index-of-sweetness values. The cans were opened after two months and their contents submitted to experts for opinion. The results indicated that fruits with an index sweetness of 33 ± 5 received a higher grade than did those either side of this value. (Illustrated with slides and charts.)

PROTEASE ACTIVITY IN THE VEGETATIVE TISSUES OF THE PINEAPPLE PLANT

By

Ross S. Bean

The expressed and filtered saps of leaves and stems of pineapple crowns were more effective than equal amounts of fresh fruit juice in digesting either freshly coagulated egg albumin or commercial blood-fibrin. Sap and juice of natural acidity were more efficient than that neutralized with sodium hydroxide.

When partially purified by successive precipitations with alcohol, the enzyme from a definite volume of fruit juice digested more egg albumin than a similar preparation from the sap of the leaves of actively growing plants.

The immature leaves and the senescent leaves constituting respectively

the upper and lower thirds of the total number on actively growing plants were much less active than the mature middle third of the leaves. This was true whether the amount of albumin digested by the purified enzyme was referred either to equal volumes of expressed sap or to equal weights of green tissue. For the senescent leaves the amount of albumin digested increased regularly with the concentration of enzyme in the preparation. Such differences were less marked in the mature leaves for the time period used, though the amounts digested by all concentrations were greater. This suggests that the slight differences noted were due to early retardation of the reaction by accumulated products.

In the higher enzyme concentrations, the particles of albumin retained their original sharp outlines throughout the digestion process, but in the lower concentrations the substratum assumed the form of a viscous slime that was very difficult to filter. This change of state progressed regularly through the varying concentrations of enzyme.

Purified enzyme from leaves and bracts of a mature plant bearing a half-grown fruit was comparable in activity to that from the fruit juice.

Variations in hydrogen ion had little influence in the activity of the purified enzyme between pH 3.0 and pH 6.0. At pH 7.0 and pH 8.0, however, the activity was much higher than in the acid medium. (Illustrated with charts.)

PRESERVING THE RARE PLANTS OF HAWAII

By

GEORGE C. MUNRO

This is an appeal to those interested in things Hawaiian, and especially in the endemic flora of Hawaii, to promote some work looking toward saving and rendering accessible the straggling remnants of the very ancient flora of these islands, and making a growing collection of these rare and interesting plants.

The dry land, open country, and forest border plants will be taken care of by a plantation started a year ago by the Board of Agriculture and Forestry in coöperation with the University of Hawaii at Waahila, on the ridge between Manoa and Palolo valleys, Oahu.

The plants of the rain forests and open marshes of the higher elevations are equally worthy of attention, though more difficult to make accessible. In the rain forest we have the *Gunnera,* many varieties of banana, loulu palm, and woody-stemmed violet, the rare *Hesperomannia,* numerous species of Lobelioideae, *Cyrtandra, Stenogyne* and many other interesting forms. On the open moss-covered bogs and on their borders there are violets, lobelias,

Plantago, Wilkesia, Lagenophora and others, including the silver sword of western Maui. Most of these plants can be grown on the ridges leading up to and on the top of the higher peaks of Oahu or even on some of the lower and more accessible peaks.

The open marshes are at elevations of 3700 to 6000 feet, but the present bog flora probably extended much lower down before being crowded out and driven to a last stand in the high open bogs by taller and thicker foliaged trees and shrubs. The extremely wet condition is not absolutely necessary for their existence, but light is certainly essential, and by preventing taller plants from interfering with them they do very well on Lanai, whither plants from the high bogs of western Maui have been transplanted, in situations much lower in elevation and with but a fraction of the annual rainfall of their former location.

BIOLOGICAL RECORDS BY MEANS OF MOTION PICTURES

By

RAY J. BAKER

The "talk" consisted of the showing of two reels of motion pictures, with a few brief words of explanation. The first reel showed the germination and early seedling growth of cowpeas and barley grains, speeded up to 400 times their actual rate. The second reel, taken with a microscope replacing the lens in the camera, showed rotifers, minute worms, and several kinds of protozoa in action. The magnification, on the film, was about 500 diameters, and that on the screen about 10,000.

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