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Herman James Almquist
(1903–)

Herman James Almquist (1903–): Biographical Sketch

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"In a country rich in gold, an observant traveller may find nuggets on the surface. . . ."

Herman Almquist was an observant traveller in the golden age of nutrition. His discovery, identification and synthesis of the antihemorrhagic vitamin were achievements of epic proportions and have been inadequately recognized. This work was followed by his basic studies that established the amino acid requirements of the chick.

Herm (as he is known to his friends) is a true westerner. He was born 3 March 1903 in Helena, Montana, and attended Helena High School. From there he went to Montana State University, Bozeman. He started in electrical engineering, but after a year he switched to chemistry, and he received a B.S. in industrial chemistry in 1925. He was offered a fellowship at an eastern university, but he decided to turn it down, for financial reasons, because he had some debts to repay. After a few years of working and teaching, he went to Berkeley, where he was admitted as a graduate student in the College of Chemistry in 1929. Three years later, he was awarded the Ph.D. degree in organic chemistry for a study of the reaction of benzaldehyde with oxygen (1, 2), and he also published on association of solute molecules in nonaqueous phases.

The year 1932 was in the depths of the depression and, as he says, "jobs were as scarce as the proverbial hen's teeth." In search of hen's teeth, he went to the legendary Professor Joel Hildebrand,[1] who found him a job as Instructor in the Division of Poultry Husbandry, with its chicken houses clinging precariously to the side of Strawberry Canyon,[1] on the east side of the Berkeley campus. He was hired for "the application of chemistry to nutritional problems," which became investigating changes in "egg quality" such as "measurement of deterioration in the stored hen's egg" (3). Soon this prosaic task was interrupted by a scientific thunderbolt.

The division head was Dr. Walther Holst. He and a graduate student, E. R. Halbrook, reported in *Science* (4) that a hemorrhagic disease in chicks was produced on a restricted diet, containing California sardine meal as a source of protein, and was prevented by fresh cabbage. Holst, the professor of poultry husbandry, was the son of Axel Holst, the Norwegian scientist who, in 1906, discovered that scurvy, one symptom of which is hemorrhages caused by capillary fragility, could be produced in guinea pigs on a diet containing no antiscorbutic foods such as cabbage. This discovery, by producing an assay procedure, led eventually to the isolation and identification of vitamin C. It was understandable that Holst's son should have called the chick disease "scurvy-like" when it was produced by a restricted diet, was accompanied by hemorrhages and was prevented by cabbage. Holst and Halbrook suggested, erroneously, that they believed "contrary to previous reports, growing chicks may suffer from scurvy due to an absence of vitamin C in the diet." It was known before then that chickens could make vitamin C, starting during their development as embryos, so it was unlikely that vitamin C deficiency caused the symptoms. The experiments by Holst and Halbrook published in *Science* (4) were carried out just before the death of Walther Holst, after which Halbrook left Berkeley.[2] This brought an end to the investigations of the hemorrhagic disease in the Division of Poultry Husbandry. An unsuccessful attempt to repeat the findings was reported in *Science* by Cribbett and Correll (5). The attempt failed because a different diet was used, containing meat scrap (meat meal, a slaughterhouse by-product), but the significance of this difference was not realized, and the publication placed the report by Holst and Halbrook under a cloud, the consequences of which are described below.

[1]Professor Hildebrand (1881–1983) was still working in his laboratory in Hildebrand Hall, University of California, Berkeley, when he was 100 years old. I have described the Strawberry Canyon laboratory in Samuel Lepkovsky, Biographical Sketch, *J. Nutr.* 116: 329–340.

[2]Everett Halbrook became head, Poultry Department, Montana State College, in 1945.

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Ironically, and unknown to Cribbett and Correll, the explanation of their failure to repeat the findings by Holst and Halbrook had already been published. McFarlane and co-workers at Guelph, Ontario, Canada, produced hemorrhagic disease in chicks inadvertently during an attempt to use chicks for the assay of vitamin A in cod liver oil (6). Their diets contained meat scrap that had been extracted with petroleum ether to remove any possible content of vitamin A, and other sources of vitamin A or its precursors, such as alfalfa meal, were, of course, omitted from the basal diet. The experimental chicks were identified by wrapping numbered metal bands around their legs at hatching, and at 2 wk the band was removed from the leg and inserted through the web of the wing, upon which the chicks bled to death. The investigators did not pursue their finding, because they left for other positions. No one suspected that in the petroleum ether that was the discarded extract of the meat meal there was an antihemorrhagic vitamin.

K. G. Scott, a student who had assisted Holst and Halbrook, moved to the Department of Physiology, University of California, subsequent to the death of G. Holst. He brought the idea of the disease with him, and in collaboration with S. Cook, Professor of Physiology, he again produced the hemorrhagic disease in chicks. They made the portentous observation that the disease occurred in chicks fed diets containing California sardine meal, but did not appear when meat scrap was used instead as a source of protein. They incorrectly attributed the hemorrhages to a toxic factor in sardine meal. Their findings and conclusions were used for promotional purposes by producers of meat scrap. The F. E. Booth Co., manufacturers of sardine meal, promptly appealed through their manager, Fred Mullins, to the Regents of the University of California against what they perceived to be a misuse of scientific results, which they felt to be invalid because commercial feeds containing sardine meal did not produce hemorrhages in chickens.

At this point, the dean of agriculture, Dr. Claude Hutchison, asked Herman Almquist to look into these matters so that, thanks to Fred Mullins, Herm was able to put aside his pedestrian experiments on egg quality in favor of an exciting scientific study. With the advantage of hindsight, we can look at the problems confronting Almquist.

1. Holst and Halbrook had made a scientific boner by calling the hemorrhagic disease "scurvy-like" and attributing it to vitamin C deficiency without either testing vitamin C (rather than "fresh cabbage") or accepting the fact that vitamin C was synthesized by chicks in vivo.

2. Cook and Scott had made a second scientific boner by attributing the hemorrhagic disease to a toxic factor in California sardine meal, allegedly an amine.

Both these mistakes by others worked to Almquist's disadvantage in slowing his first publication. His approach to the problem was based on the following leads.

1. The findings by McFarlane and co-workers showed that either the protective factor was removed from meat scrap and fish meal by petroleum ether or the solvent had made these supplements toxic. I remember that Herm questioned me in 1934 about the Guelph results, knowing that I had worked for McFarlane at Guelph as an undergraduate, although on a different problem.

2. The processing histories of sardine meal and meat scrap were different. Sardines were caught at night, off San Francisco, in the cold Pacific Ocean and processed next morning to forestall spoilage, because part of the catch was canned for human consumption. No such precautions were taken with the slaughterhouse leftovers and by-products that were cooked up for meat scrap. Putrefaction began to be suspected as engendering an antihemorrhagic property.

3. The protective effect of fresh cabbage was intriguing, especially so since none of the hemorrhage-producing diets contained any green leafy material such as alfalfa meal.

Almquist moistened some hexane-extracted sardine meal and let it stand at room temperature to putrefy spontaneously. Bob Stokstad, who was then a graduate student, had the job of drying it. It "stunk up the place," but it did not produce hemorrhages. Almquist then reextracted the smelly product with hexane. The extracted product produced hemorrhages, but these were prevented when the hexane extract was added to the diet. He had discovered vitamin K_2.

A hexane extract of alfalfa meal also protected against hemorrhages, even at levels corresponding to only 0.125% of alfalfa meal in the diet. In this case, putrefaction played no part in the protective effect. Almquist had discovered vitamin K_1. Unlike labile vitamin C, vitamin K was not destroyed by heating alfalfa in the production of dehydrated alfalfa meal. The high potency of alfalfa meal disposed of the practical question of vitamin K in poultry diets, because alfalfa meal is routinely used in them at far higher levels than are necessary to supply the vitamin K requirement.

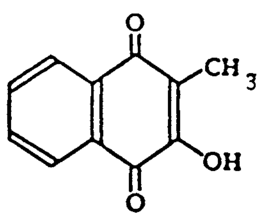
The next task, a more difficult one because it involved politics as well as science, was to discredit the "toxic fishmeal theory" of Scott and Cook. Adjudication was required by the university and there was an internal debate with hearings, in one of which I participated. During this time, Almquist was not allowed to submit his results for publication.

Finally, the manuscript was released and sent to *Science*, the editors of which, mindful of the report by Cribbett and Correll, rejected it. So Almquist and his graduate student and collaborator, Bob Stokstad, sent their rejected manuscript to *Nature*. Unknown to them, a little earlier, Henrik Dam of Copenhagen had also sent a manuscript to *Nature*, describing his own findings of the hemorrhagic disease in chicks and its prevention by a new vitamin: vitamin K (Koagulationfaktor). Dam's publication (7) appeared 10 wk ahead of the article by Almquist and Stokstad (8). This time lapse

had an important effect some years later on the award of the Nobel Prize.

The race was then on to identify the chemical nature of vitamin K. Almquist was one of the two starters (Dam and Almquist), who were joined by other competitors, and Almquist finished first. The other competitors used Almquist's assay method and diet.

Large supplies of raw material for fractionation were available in the form of hexane extract of alfalfa meal. Almquist also studied the bacterial source of the vitamin, and in collaboration with C. F. Pentler (of the Hooper Foundation, University of California Medical School, San Francisco) found that pure cultures of a number of bacteria, among them *Mycobacterium tuberculosis*, contained vitamin K activity (9). Almquist, aided by A. A. Klose and E. Mecchi, obtained highly potent concentrates by molecular distillation. Some properties of the concentrates led Almquist to wonder about lipids that had been obtained from the waxy sheath of the tubercle bacillus by R. J. Anderson. One of these compounds was phthiocol, 2-methyl-3-hydroxy-1,4-naphthoquinone (structure below). A test showed that synthetic phthiocol protected chicks against the hemorrhagic disease.



Phthiocol

This time there was no manuscript sent to *Science*. Instead, a telegram was sent on 21 May 1939, as a Letter to the Editor of the *Journal of the American Chemical Society*, and was published in the June issue (10).

The activity of phthiocol solved the vitamin K problem. Subsequent chemical synthesis of active compounds, including vitamins K_1 and K_2, were essentially "molecule manipulations."

The natural forms of vitamin K were relatives of phthiocol with different side chains replacing the 3-hydroxy group. Indeed, simple removal of this group produced a compound that was far more active than phthiocol. The high activity of this compound, 2-methyl-1,4-naphthoquinone (menadione) was reported simultaneously by Almquist and Klose (11) and by Ansbacher and Fernholz (12) in July 1939. Almquist then synthesized vitamin K_1 by attaching a phytyl side chain, derived from chlorophyll, to the 3-position of menadione. Almquist and Klose described this synthesis in an article received for publication 21 July and published in September 1939 (13). The same synthesis was carried out by other investigators and teams, including Karrer and co-workers (14) and Doisy's group (15). Doisy and co-workers identified the side chain of vitamin K_2 as farnesyl digeranyl at position 3 (16). They used putrefied fishmeal, the source that had been discovered by Almquist, as a supply of the vitamin.

The work by Dam and by Doisy attracted the attention of the Nobel Prize committee, and they received the Nobel Prize in Physiology and Medicine in 1943. Almquist's reward was the applause and respect of his colleagues. The University of California gave him a routine promotion, from six years as assistant professor, to associate professor in 1939, with a munificent salary increase of $300 per year. At least the university did not put him back to work on egg quality.

Bob Stokstad obviously had an exciting scientific life as a student. He may have been the only graduate student in history to collaborate in the discovery of a new vitamin for which the Nobel Prize was awarded to a competitor. He was also one of the few graduate students to participate in the discovery of a new vitamin and then, postdoctorally, to find another one. He went elsewhere to hunt for other vitamins and reported in 1938 that chicks needed "factor U," which he subsequently identified as folic acid. But that is another story.

To summarize, the history of vitamin K can be sharply divided into three periods. The first period includes the discovery of the hemorrhagic disease in chicks by various investigators and the efforts that were made to understand the cause of the disease. Some of these efforts were fruitless. One group called the disease "scurvy-like," another group offered no explanation and a third group confused the issue by alleging that the hemorrhagic disease was caused by a toxicity. Finally, Dam, 7 years after his original description of the hemorrhagic tendency, found that it was a nutritional deficiency disease and stated in 1935 that it was caused by lack of a new vitamin, vitamin K. Simultaneously, Almquist and Stokstad, whose manuscript was delayed for several months by the University of California bureaucracy and then rejected by *Science*, stated that the hemorrhagic disease was of dietary origin and that the protective factor was fat-soluble, and they described a diet that made it easily possible for other investigators to duplicate their findings, and the race to isolate and identify vitamin K started.

The role of fishmeal and meat scrap in the first period is indeed fascinating. California sardine meal contained no vitamin K, so the chickens used by Holst and Halbrook and by Cook and Scott developed hemorrhages. Other fishmeals, such as those used by McFarlane and co-workers, contained vitamin K and were protective until they were extracted with petroleum ether. Almquist noted that "meat scraps were made mostly from the offal from meat packing, which would include the viscera and incidental manure, condemned living animals and dead animals picked up from the hinterland. . . . The starting material often could be pretty ripe. . . . It occurred to me that possibly the opportunity for bacterial action . . . might have something to do with the problem." This was certainly the case.

In contrast, Dam's diets were based on casein as a protein source, which evidently was free from vitamin K.

The first period was also marked by the discovery that spoiled sweet clover hay caused a hemorrhagic disease in cattle. It was this discovery, made by Schofield at Guelph, that led eventually to the isolation and synthesis of dicumarol ("warfarin"), a vitamin K antagonist, followed by its use as a rat poison, and, remarkably enough, to the use of the same compound to *produce* vitamin K deficiency in human beings as a means of preventing intravascular blood clotting that could lead to coronary obstruction. The anticlotting effect of dicumarol was shown to result from blocking the action of vitamin K.

The second period, 1935 to 1939, was dominated by attempts of biochemists to isolate and identify the new vitamin from the source materials, alfalfa meal and putrefied fish meal, described by Almquist and Stokstad. The leading laboratories during this period were those of Almquist, Doisy and Karrer, the last-named of whom had been sought as a collaborator by Dam. This phase of the investigation ended abruptly in May 1939, when Almquist reported that phthiocol had vitamin K activity. The biological activity of phthiocol was considerably diminished by the presence of a hydroxyl group on the 3-position (Fig. 1), but once this was removed, the active nucleus, 2-methyl-1,4-naphthoquinone (menadione), as the core of vitamin K remained. Alone among the vitamins, this simple "core group" was more active than the more elaborate forms of the vitamin (K_1 and K_2) found in nature.

The second period also included some outstanding biological discoveries, including low prothrombin in vitamin K deficiency, the discovery that vitamin K deficiency could occur in human beings as a result of biliary obstruction, thus showing the role of bile in enabling the uptake of vitamin K from the intestine, vitamin K deficiency caused by lack of intestinal bacteria, the finding that the vitamin deficiency could be produced in rats by translocating the bile duct to the urinary tract, or even by placing rats at birth on wire screens and feeding their mothers a vitamin K-free diet, and synthesis of vitamin K by various species of bacteria.

The third stage was anticlimactic. Starting in June 1939, swarms of organic chemists entered the field and produced variations on the core molecule by adding side chains to the 3-position. Many of these variants are listed by Rosenberg (17). These molecules, including those of vitamins K_1 and K_2, had a lower activity than 2-methyl-1,4-naphthoquinone, but this did not deter the synthetic chemists from churning out new compounds. Almquist was the first, in a "photo finish," to synthesize the main source in foods, vitamin K_1, 2-methyl-3-phytyl-1,4-naphthoquinone. Even at this point, there was a disturbing incident; this manuscript was delayed for a month by the *Journal of the Amerian Chemical Society* so that two other similar reports appeared simultaneously (15, 18).

An excerpt from Herman Almquist's own account of the discovery, identification and synthesis of vitamin K is quoted for its substantial historical importance as follows:

> The Nobel Prize for vitamin K was split between Dam, at Copenhagen, and Doisy of St. Louis University. Doisy and his group of several biochemists and biologists entered the field after the vitamin had been discovered and much information released on functions, properties and determination. This group, which had done much work on the steroid hormones, did a good job on the isolation and structure of vitamin K_1, the form present in green plant tissues. However . . . by the time their big announcement of synthesis appeared in 1939, we had already broken the main problem of the structure of the vitamin, and had identified the active nucleus, which was several times more potent than vitamin K_1. We had also reported synthesis of K_1. I would not have objected if the entire prize had been given to Dam, as his paper did appear in print shortly before ours, announcing the discovery of the vitamin. I have no idea when Dam secured his proof of the existence of vitamin K in his laboratory, in advance of his publication. I do know that *our paper was unduly held up on the campus*, and should have made it into print 8–10 months earlier. In this case, it would have considerably preceded Dam's report.
>
> About 6 years elapsed from the time of first mentioning of a bleeding condition in chicks on experimental diets, by Dam and others, and his announced proof of the existence of a new vitamin. If these observations had been fully appreciated, it seems strange that it took so long to arrive at the cause of the condition.
>
> It is a general opinion of my peers in this field that, since the prize was to be split, I should have been included. In a generous letter to me, Dam, whom I knew personally, strongly indicated the same opinion (1944). This letter, which I withheld for many years, was finally made public by Jukes, who had been a close observer when these events were in progress [*Trends in Biochemical Sciences*, T. H. Jukes, May 1980].
>
> I had come to understand that it would appear unseemly and unpolitic for the University of California to indicate, in any way, any disagreement with the decision of the Nobel Committee. The University already had several Nobel Laureates. I kept quiet for a long time, feeling that the matter was over and done with. Friends finally prevailed upon me to tell our side of the story. An account of the early developments was published in the *Journal of Clinical Nutrition* (1975). Later, by invitation, I presented the story again at a symposium on the vitamins at Dallas (1979). Copies of the latter were sent out to meet over 200 requests from all over the world. I have been

selected to write a number of chapters and reviews on the vitamin.

In 1939, I received the Borden Award for *"discovery of vitamin K*, and preparation of purified concentrates, development of methods for determining vitamin K in foods, determination of the chemical nature of the physiologically active portion of nature vitamin K molecule. . . ."

In 1952 I was called back to Montana State University and given an honorary Doctor of Science degree for my vitamin K work.

In 1967, I received a California Legislative Citation which mentioned among other things, "co-discoverer of vitamin K, an important blood clotting factor, which he identified and synthesized."

I claim for myself and co-workers:

*Discovery of vitamins K_1 and K_2;
*Occurrence and functions;
*Methods of determination;
*Isolation and structure;
*Identification of first pure form;
*Synthesis of vitamin K_1;
*Provision of first pure form to be demonstrated active for humans.

I shall always remember the day when our chick assays showed that synthetic phthiocol, 2-methyl-3-hydroxy-1,4-naphthoquinone was active as a form of vitamin K.

The text of the remarkable letter from Dam to Almquist is:

4 December 1944
Dear Dr. Almquist:

It was very kind of you to congratulate me on the Award of the Nobel Prize.There must have been reason for some bitterness for you in the fact that you so nearly missed being the first to report the existence of vitamin K, and also in the fact that you were not considered when it was decided to split the prize. The final stages of the hunt for the pure vitamin was to some extent a question as to who could obtain the best support. When I joined with Karrer in this part of the work it was because I had not the sufficient facilities in my laboratory for solving the problem within a reasonable time. You may have felt the same way about your situation.[3] Furthermore, I fully realize that there is always a good deal of chance in the reward a scientist receives for his work; therefore the fact that this time I was among those who had good luck has in no way brought me to suffer from any feeling of superiority.

With kind regards to you and Mrs. Almquist.

Sincerely yours,
Henrik Dam

The impact of Almquist's vitamin K research on poultry husbandry as a field was far-reaching. Departments of Poultry Husbandry were traditionally utilitarian.[4] The University of California department published information on the construction of burglar alarms for henhouses, and members of the department made frequent journeys into rural backwaters to speak before perspiring audiences of farmers. This had its rewards: the public of those days was appreciative, rather than distrustful, of science.

The bucolic image of poultry husbandry abruptly changed when the Mayo Clinic group showed a therapeutic effect of Almquist's vitamin K preparations, when given with bile or bile salts, on the bleeding tendency in human patients with biliary obstruction (19). Soon it was found that hemorrhagic disease of newly born infants was caused by vitamin K deficiency resulting from paucity of intestinal bacteria. The babies were "too clean"; their food supply contained little or no vitamin K, and, unlike the coprophagous and nonhemorrhagic laboratory rats, they had no access to their feces. Scientific medicine learned something from the chickens.

The role of bile in vitamin K absorption led Almquist to investigate its effects on erosions of the gizzard lining, which occur commonly in chicks. He found that bile prevented gizzard erosions when added to the diet of chicks, and he concluded that the bile acts as a hardening or conditioning agent on the detachable lining of the gizzard.

After his synthesis of vitamin K_1, Herman Almquist continued his studies on the dietary requirements of chicks, including amino acid requirements. He did not return to opening eggs and measuring the height of the egg yolks and the viscosity of the white. However, he had contributed to a novel observation of importance to egg quality. A common weed in California is cheeseweed, *Malva parviflora*, belonging to the mallow family and introduced from Europe. When hens roamed freely, as was the case in those idyllic days, they often ate wild plants, including cheeseweed, as a result of which they laid eggs with pink whites (20, 21). It was cheeseweed that produced this discoloration of the egg whites. Later, sterculic acid was identified as the substance producing the pink color, which became intensified during storage of the eggs. This finding was probably of more economic importance to the poultry industry than was the discovery of vitamin K. California poultry growers were

[3]Evidently Almquist did *not* feel "the same way" about his situation. He was an organic chemist and, unlike Dam, did not recruit help from a chemical laboratory. He designed and built a small molecular still for concentration of vitamin K.

[4]I was given the assignment (without a budget!) in 1934 of investigating the calcium and phosphorus requirement of turkeys at a time when most of the vitamins and several of the minerals needed by turkeys had not even been *discovered*! Since I had not been provided with funds, I did not spend much time on this assignment, but instead I started to hunt for new vitamins, and eventually I obtained approval for a "project," approved by USDA, to produce a purified diet that would supply the complete requirements of chickens for growth and reproduction. Herman Almquist also participated in this effort, which reached its goal in 1948.

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so enthusiastic that one of them phoned Dean Hutchison to voice his appreciation. Unfortunately, the official news of the finding had not yet filtered up to the front office through the regular channels, and the dean was temporarily disconcerted. This caused more commotion in the Poultry Department than was evinced when the Nobel Prize committee excluded Almquist (22).[5]

An unexpected discovery in 1940 was that glycine, hitherto considered as a dispensable amino acid in nutrition, was needed in the diet for rapid growth of chicks. Glucuronic acid was also found to increase growth of chicks on a purified diet.

By 1944, Herman Almquist had been a faculty member of the University of California for 12 years, had discovered, identified and synthesized vitamin K, had published 13 papers on amino acid requirements of poultry and had reached the rank of associate professor, with a salary of about $4000 annually. At this point, he notes, he had parents to support and his wife was pregnant, so "for economic reasons" he left the University of California to become director of research for the F. E. Booth Company in Emeryville, California, manufacturers of sardine meal and vitamin concentrates, especially vitamins A and D. In 1948, he moved to the Grange Company of Modesto as director of research, vice president, a post that he held until his retirement in 1967. During 1948 to 1967, he published on a variety of nutritional subjects, especially on proteins and amino acids in animal nutrition. Other topics included the nutritional effects of antibiotics on turkeys, effects of antitrypsin on chick growth and on accentuation of dietary amino acid deficiency, conversion of carotene to vitamin A and utilization of vegetable protein supplements. As Bob Stokstad says, "he has been a prodigious worker and prolific writer."

Herm's quantitation of the amino acid requirements of chickens was of great economic importance to the poultry industry, because quantitation enabled balancing of poultry feeds with various sources of protein to produce the right proportions of essential amino acids for maximum growth. Today these requirements are computerized and fed into the blending machinery during manufacture of commercial feeds. It is often said that chickens are better off than human beings in receiving balanced and complete diets. Also, chickens do not read the health food literature and thus avoid overdosing themselves with vitamins.

Herman Almquist's most recent publication is on a rather unusual subject: the increasing numbers of postage stamps of primates in regard to the preservation of the wild species in their natural habitats (23). He and his son Alan have surveyed 500 different issues of stamps representing over 100 identifiable genera and species of primates, issued by 91 different countries in South America, Central America, Africa and Asia. The percentage of such stamps has increased more than fourfold in the past 4 years.

Herman Almquist served on the Board of Directors of Annual Reviews, Inc., Palo Alto, from 1942 to 1973 and was on the editorial board of Annual Review of Biochemistry from 1942 to 1950. In addition to the awards mentioned earlier, he is a Fellow of the American Institute of Nutrition, of the Poultry Science Association, and of the American Association for the Advancement of Science. He has over 200 scientific publications. A comprehensive review of the early history of vitamin K was published by him in 1941 (24).

Herm is a calm and unflappable type, deliberate and effective. He is a chronic punster, perpetrating such monstrosities as "Vitamin Be-Hind" as a proposed analog of vitamin B-4, and he is never at a loss for a dry anecdote.

Herm was married to Viola Pimentel in 1935, and his family life obviously has been very happy. The Almquists are a closely knit family with two sons, Alan and Eric, who were born in 1944 and 1947, and one granddaughter, Lori. Alan, who has helped me with this biographical sketch, is Director of the Museum of Anthropology at California State University, Hayward. He recalls his father's incessant construction projects at the family home at Soda Bay on Clear Lake in California, and he says that his father found it easier to "draw up the plans after construction was completed." He also says that his father strongly urged him toward graduate work at the University of California, Berkeley. This advice was followed, and Alan was awarded his Ph.D. in anthropology.

Alan says that his father's lifetime stamp collecting hobby "took on academic proportions after his retirement from the nutrition laboratory." Herm's research on specialized printing eccentricities of Mexican stamps has led to numerous publications in the philatelic journals. He now journeys to the cyclotron at the University of California, Davis, for the use of proton-induced X-ray emission in analysis of pigments used in old postage stamps, but he is still involved in nutrition, and his advice and consultation are frequently sought on nutritional questions in California.

On my way up Strawberry Canyon, to the east of the University of California football stadium, I frequently pass by the modest and decrepit stucco building that once housed the laboratory of the Department of Poultry Husbandry. This laboratory has a unique place in history as being the only laboratory in which a vitamin was discovered, identified and synthesized. This will never happen again, because there aren't any more vitamins.

[5]In this publication, the authors state: "Dam was evidently of the opinion that Almquist should have shared the Nobel Prize for the discovery of vitamin K."

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