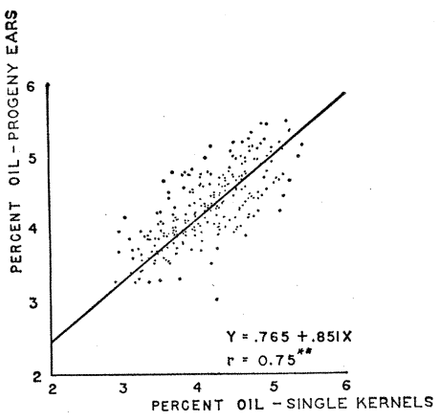

Fig. 2. Oil content of single kernels of the corn single cross, Hy × Oh 45, plotted against oil content of grain from corresponding progeny ears.

cross are standard inbreds that differ somewhat in oil content, 3.6 and 4.6 percent oil, respectively. The range of oil content for kernels of the HO-18 line was 7.9 to 12.5 percent oil, with a frequency distribution curve similar to that of the single cross. All of the analyzed kernels were planted, and bulked kernels from each selfed progeny ear were analyzed for oil content by using the 40-ml coil and an instrument sweep time of 2 minutes.

The 289 single kernels from the selfed ear of the single cross Hy × Oh 45 produced 256 progeny ears which similarly ranged from 3.00 to 5.4 percent oil. The correlation between oil content of the single kernels and that of their progeny was highly significant [$r = +0.75$ (Fig. 2)], indicating that the single-kernel differences were heritable. The eight kernels with the highest content produced progeny averaging 4.99 percent oil, compared with the average of all progeny of 4.28 percent. This represents a mean improvement in oil content of about 16 percent through single-kernel selection.

From the 189 kernels of HO-18, 137 progeny ears were obtained. The correlation of the oil content of the single kernels with that of their progeny was not significant ($r = +0.14$). The extreme susceptibility of the progeny plants to stalk rot undoubtedly had an adverse effect on grain quality and thus obscured any real genetic differences.

Normally, selections for oil content are based on analysis of bulk samples from individual ears in segregated populations. Since single-kernel variations in oil content are to some degree heritable, it is possible with NMR spectroscopy to enhance selection efficiency by selecting kernels with highest oil content within the selected families (ears). This is essentially a form of embryo selection which will result in increased oil content in the grain of the succeeding generation.

Further studies are under way to determine the effectiveness of single-kernel selection for oil content in stocks with various degrees of genetic heterozygosity. Information is needed on the number of generations beyond which single-kernel selection will no longer be effective as the genetic variation decreases and oil content increases with selection. Such information will help to formulate efficient plans for utilizing the single-kernel selection technique for improving the oil content of corn.

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23 November 1962

Virus-Containing Leukocytes in Polioencephalitis

Abstract. *Crystalline aggregates of strain MM virus occur in polymorphonuclear leukocytes in association with osmiophilic granular structures which are occasionally membrane-bound. This suggests either a phagocytosis and segregation of virus by leukocytes, analogous to the disposition of bacteria by leukocytes, or a utilization of the leukocyte by the virus as a host cell for virus replication.*

After subcutaneous injection in white mice of a brain homogenate infected with the MM strain of Columbia SK virus (*1*), a severe polioencephalitis occurred within 48 hours. The presence of intraneuronal crystalline aggregates of virus-like particles has been previously reported (*2*), and this and other alterations in nerve cells have been described in detail (*3*). It is believed that such crystalline structures are made up of virus particles, since they closely resemble poliovirus crystals seen in tissue culture (*4*) and the size of the individual particles is approximately that determined for the poliovirus and other enterovirus groups (*5*); furthermore, there was a marked elevation in titer of virus in brain at the time of the encephalitis. Finally, homogenates prepared from the brains of these animals proved fatal in repeated passages in mice, with production of a typical polioencephalitis. Brain homogenates prepared from control animals injected with uninfected homogenate were not pathogenic, and light and electron microscopy of the brains of control animals revealed no crystalline structures. The purpose of this report is to illustrate and describe similar virus crystals seen within more than 40 polymorphonuclear leukocytes in areas of polioencephalitis in three infected animals from the same experimental series, and to comment briefly on the relation of the virus to this host cell.

The occurrence of influenza virus within leukocytes was demonstrated by means of the fluorescent antibody technique by Hanson *et al.* (*6*). Two electron-microscopic studies also showed individual particles which were interpreted, in still other in vitro studies in which Coxsackie virus (*7*) and influenza virus (*8*) were used, as virus within vacuoles in leucocytes. Mannweiler and Palacios (*9*) showed possible virus crystals in endothelial cells of poliovirus-infected rhesus monkeys and mentioned, but did not illustrate, aggregations of virus-like particles in leukocytes within the vessel lumen. As emphasized by Kallman *et al.* (*10*), the occurrence of a crystalline array of virus particles greatly increases the likelihood of their proper identification.

Figure 1 (top) shows a portion of a polymorphonuclear leukocyte from the brain of a white mouse infected 2 days earlier. Within the cytoplasm are virus particles which measure approximately 190 A, with a center-to-center spacing of about 210 A. Figure 1 (bottom) is a different section of the same cell at higher magnification. The ordered aggregate is still apparent; this indicates that it is three-dimensional. The crystals are closely associated with finely granular material of moderate osmiophilia. Also apparent are particles of the same appearance within structures bound by a single membrane which re-

semble the normal intracytoplasmic granules of the neutrophil. In other micrographs, crystalline formations were occasionally evident in such membrane-bound structures, though for the most part the crystals occurred in osmiophilic areas without clear boundaries. Occasionally vesicle and membrane formation was apparent within the osmiophilic regions in close association with the virus particles. Small granules of the proper size and shape for virus were often noted scattered in the cytoplasm; however, the similarity in morphology between small animal viruses and normally occurring ribonucleoprotein particles made positive identification of these granules impossible.

Of interest is the recent electron-microscopic and histochemical study of Cohn and Hirsch (*11*) which presents evidence of some similarity between the normal granules of the neutrophil and the hydrolytic-enzyme-containing bags or "lysosomes" of other cells. In studies on phagocytosis of bacteria in experimental meningitis we have suggested that "lysosomal material" is deposited in and around the phagocytic vacuole and its contained bacteria and may be concerned with their segregation and destruction (*12*). Elegant experiments by Dales (*13*) have demonstrated phagocytosis of adenovirus by HeLa cells, with accumulation of the virus in "packets" which resemble the membrane-bound bodies in which the virus sometimes occurred in our studies. It may be that polymorphonuclear leukocytes phagocytose and dispose of virus in much the same way that they handle bacteria. If so, these cells may be of much greater importance in the defense of the body against viral infections than has hitherto been suspected.

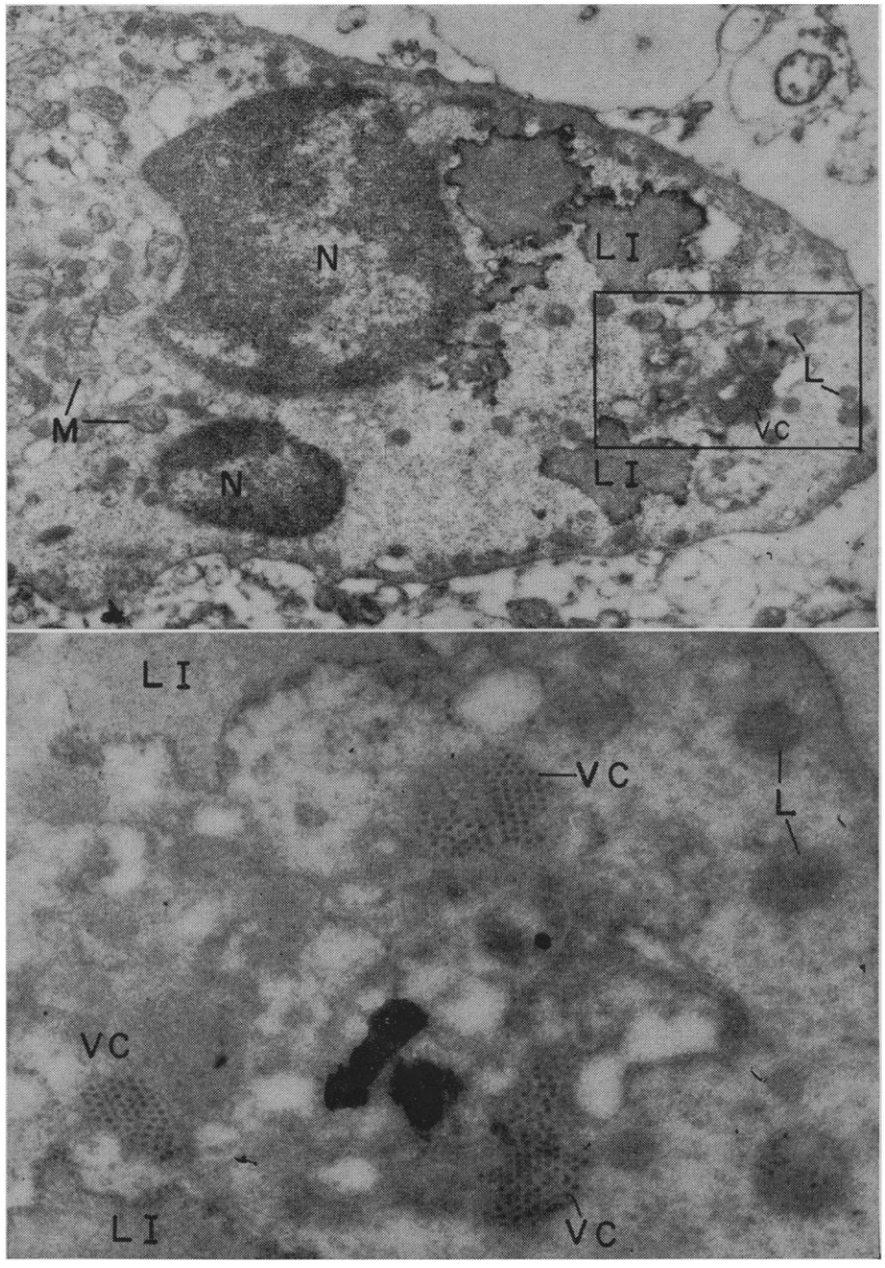

Fig. 1. (Top) Polymorphonuclear leukocyte in an area of polioencephalitis. *VC*, virus crystal associated with poorly circumscribed osmiophilic material; *L*, lysosome-like structures some of which contain particles of the proper size and shape for virus; *LI*, lipid inclusions in cytoplasm; *N*, portions of multilobed nucleus (about × 19,500). (Bottom) A different serial section of the same cell, at higher magnification. The very dense irregular material at lower center is an artifact (about × 61,400).

It is also conceivable that the existence of virus within leukocytes may indicate an invasion of this cell by the microorganism, the white blood cell being utilized as a site for virus production. Rifkind *et al.* (*14*) have postulated that osmiophilic granular areas such as those shown in Fig. 1 may represent the locus of ECHO virus replication in rhesus kidney epithelial cells. Primary leukocytic invasion by the virus, with cellular destruction, might then explain the leukopenia which is seen in a number of virus infections. Conceivably, the infected leukocyte might also play a significant role in transport of the virus within the blood stream to its target organs (*15*), although it is doubtful that this is the sole method of dissemination, since such a hypothesis would seem not to explain fully the phenomenon of leukocyte emigration out of the circulation into the involved tissues (*16*).

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Predictors of Human Food Consumption

Abstract. *Efficient psychological and nutritional measures by which food acceptance can be predicted were sought. Three-fourths of the variation in percentage of enlisted military personnel who take the foods at the serving table is predictable from knowledge of food preferences, the subjective satiety or "fillingness" of the food, and the amount of two major nutrients, fat and protein, the food contains.*

Surveys of the food preferences, as measured by a like-dislike rating scale, of the American soldier and various studies of his food acceptance behavior have shown that preference can account for 30 to 50 percent of the variability in consumption (*1*, chapter 6). Other literature, including a recent review (*2*), would lead one to expect that many variables might be needed to increase the precision with which consumption can be predicted. Our problem was to discover variables other than preference that are related to the food acceptance behavior of groups. For convenience, the variables can be grouped into three broad categories covering sensory, physiological, and attitudinal or environmental factors (*3*).

Preference is possibly a resultant of all three factors. One physiological factor, related to the amount of food ingested and to the rate of digestion, is reflected in subjective feelings of satiety. Another physiological factor is the nutritive content of the food itself, particularly the major nutrients, protein, fat, carbohydrate. Attitudinal or environmental variables would include familiarity with the food, particularly whether or not a person had ever tried it, and such factors as quality of preparation or desired frequency of serving.

All psychological or attitudinal data consisted of responses of enlisted military personnel to food names on rating scales in a questionnaire. Four dimensions were measured in each questionnaire: preference, desired frequency of serving, satiety or "fillingness," and quality of preparation. The latter three scales were similar to the various rating scales described previously (*1*). Each scale had seven to ten categories with each category anchored by a descriptive phrase. In actual use a given scale appeared nine times on a page—once for each food name. A questionnaire consisted of eight pages of rating scales plus four pages of instructions. The instructions for a given dimension of rating always included two examples. The sequence was: instructions, two pages or 18 food names to be rated, instructions on the second dimension, two pages of ratings, and so forth. There were 72 foods, 18 to be rated on each dimension for any given respondent, and there were four forms of the questionnaire so that all foods were rated on each dimension by one-fourth of the respondents.

The respondents were 400 airmen at Truax Air Force Base, Wisconsin. Most of them were technicians or technician trainees. Their activities varied and were not modified for this study. The same master menu is used for both the Army and Air Force, and on each day essentially the same meals are served in all mess halls throughout the country. The four forms of the questionnaire were interleaved so that they were assigned randomly to the respondents within any session. The number of respondents (N) for each mean rating was about 100; the variation was caused by the "not tried" responses, which naturally are higher for some foods than for others. One other predictor was included. It was the average food preference ratings obtained in a series of national surveys in the Army (*1*). These were based on an average N of 2000 and hence have greater reliability than the preference ratings from the airmen.

The food composition data were obtained from analyses of foods taken from Army mess hall serving lines (*4*), so they give the best available estimates of the composition of the foods eaten in the Army and Air Force. The data on percentage of protein, fat, carbohydrate, and water were used as such, and the first three were also converted to percentage of calories provided by each of these nutrients. This calculation, in effect, removes the water from foods—that is, it gives the composition on a dry-weight basis. A seventh measure was the calories per unit weight of food as served, termed the caloric density.

The criterion was the percentage of men taking a food from Army mess hall serving lines. In a recent study (*5*) on consumption and reasons for nonconsumption, information was obtained on about 160 different foods from the fresh garrison ration served in Army mess halls. One of the findings was that the percentage of a food eaten by those taking it was not a differentiating index of acceptance. This result arose in part because men usually ate what they took; hence, this measure showed little variability. However, the number of men taking a food from the serving line was a very discriminating measure. Since men usually ate what they took, the percentage taking a food from the serving line was considered the most meaningful measure of consumption or acceptance.

The number of messes in which a food was surveyed varied from 5 to 60, depending on the number of times a food was served during the month-long survey at four posts. The actual number of men sampled on each food ranged from a minimum of 122 to more than 2000, but for most of the foods there were 200 to 400 respondents. The study was conducted at four posts that were widely separated within the continental United States: yet, the average intraclass correlation over 66 foods that were served in more than one mess at each of the four posts was .95—a 90 percent reliability. The percentage of men taking a food ranged from 100 percent (for some meats) to less than 40 percent (for some vegetables), giving a wide range of variability.

For the attitudinal data, successive integers were assigned to the successive scale categories (see *1*, chapter 4); the integers associated with the ratings were then averaged to obtain a mean rating for each food on each psychological dimension. In addition, the percentage of soldiers circling the "not tried" category on the preference scale was calculated for each food. The data that were