MUTUAL PLANT DISEASE PROBLEMS
ALASKA & NORTHERN EUROPE

Observations and Notes of a 1958 field review

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FOREWORD

Through the assistance of the Rockefeller Foundation, the Alaska Agricultural Experiment Station was enabled to continue its studies of the relations of Alaska's agricultural problems to those of Northern Europe by sending Dr. Charles E. Logsdon to Europe to investigate mutual phytopathological problems.

Prior investigations consisted of a review of horticultural and general farming problems by Mr. Arvo Kallio who spent the growing season of 1956 in Northern Europe, and a three-month's review of the Alaska Station's research program by Professor Øivind Nissen of the Agricultural College at Vollebekk, Norway.

During his stay in Europe, Dr. Logsdon also presented a paper at the VII International Congress for Microbiology in Stockholm, Sweden, on one phase of Alaska's phytopathological research—Allan H. Mick, Director.

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Alaska's climate—especially in agricultural areas—is subarctic. Most of the State lies between 55° and 70° north latitude and most agricultural areas are far enough from the sea to have the climate tempered only slightly. The Tanana Valley is almost completely away from the modulating influences of the ocean while the Matanuska Valley has a modified marine climate.

Into this subarctic environment has been placed a system of agriculture, crop varieties, and their culture developed in much more southerly latitudes. That problems have arisen as a result is not surprising. More surprising is how well many crops do. Because these crops—wheat, oats, barley, potatoes, and many vegetables—can be produced abundantly, agriculture in the subarctic has a base on which to build.

There are problems, however, facing production of these crops in this environment. Not the least of these is diseases. Many plant diseases now present in Alaska have been transferred here with the crops themselves, but there are those that may be indigenous or that thrive under subarctic conditions.

Europe has a very old and well-established agriculture compared to Alaska, and much of its northern areas fall within the same latitudes as Alaska. Granted that the climate of that area is modified by the warmth of the Gulf Stream, there are still environmental factors such as light and possibly soil and perhaps microorganisms that may be compared to environmental conditions encountered in the agricultural areas of Alaska.

Rather than trying to superimpose on agriculture in Alaska only the knowledge gained from work done in the latitudes of the other states, it seemed reasonable to investigate as well the possible use of the knowledge of plant diseases gained by workers in northern Europe. The review reported here was begun in late July of 1958 with the following objectives in mind:

** To observe phytopathological problems of Europe in an environment similar to Alaska.

** To observe work on phytopathological problems of mutual interest to Alaska and Europe.

** To see where and if work of a cooperative nature might be desirable and feasible.

** To observe research on some of the more basic aspects of phytopathology where newly developed principles might have application to research in Alaska.

** To observe organization of research efforts in Europe with a view to increasing the efficiency of plant pathological research in Alaska.

** To establish personal contacts with European workers in plant pathology in order to promote exchange of ideas on a more informal basis than would otherwise be necessary.
To observe the problems of seed testing and certification and note their methods of handling these problems.

In order to accomplish the above objectives, an itinerary was arranged through to Sweden, Norway, Denmark, Germany, the Netherlands, and Switzerland. No effort was made to see all of the plant pathological research under way in all of the countries, since that would have been patently impossible in the time allotted, and was probably not necessary for the purpose of this trip. In addition to visiting institutions in these countries, I also attended the VII International Congress for Microbiology at Stockholm where I met several pathologists from the United States and other countries and attended sessions of interest.

The following is an account of plant pathological problems encountered and work being done.

POTATO DISEASES

Blackleg - Most work on blackleg is apparently being done in Denmark. Professor Hellmers (1)* of the Agricultural University in Copenhagen has shown that blackleg can be caused by either Erwinia carotovora or E. atroseptica, if the bacteria are introduced into the vascular system or find their way there. He would solve the controversy over these two species by putting them both in the same species, E. carotovora, and reducing them to varietal status. Professor Hellmers considers blackleg more a physiological disease than a bacterial disease because storage and other environmental factors seem to be more important in its development than the species of bacteria involved.

In addition to the above two species of bacteria, he has also been able to produce blackleg symptoms with Pseudomonas marginalis, one cause of lettuce slime (an Alaskan problem) and Bacillus polymyxa, a spore-forming bacterium which is not normally thought of as a plant pathogen. In support of Professor Hellmer's contention that this is primarily a physiological disease, workers at an experiment station north of Vandel, Denmark, where they are studying potato storage problems, have some very good data showing that wet storage of seed potatoes leads to increased blackleg in the field the following year. The most striking thing about this blackleg in the field is that it gets worse as the season progresses. This is exactly the situation in Alaska, and one that has been difficult to explain.

Many Alaskan storages are notoriously poor in ventilation and in circulation of the air within the storage, and this poor storage could very well account for a major portion of the blackleg found in Alaskan potato fields. Since other factors may be involved in predisposition to this disease, the American system of cutting seed may previously have obscured this storage factor. European potato seed is not cut before planting. Whole seed was used in the experiments from which the above-mentioned data were taken.

Late Blight - Late blight is a problem throughout north central Europe. In 1958 this disease was epidemic. Alaska is fortunate in that late blight has not been reported in the major potato growing areas, but information regarding

*Numbers in parenthesis refer to the list of research workers on page 26.
this disease in northern Europe is of more than academic interest to Alaskans. There is little chance that late blight has not been introduced into Alaska, but for one reason or another it has not become established. One reason may be that the nights during the growing season are probably too cool for maximum sporulation.

Another clue might be found in the work of Denward(45) and Umaerus(50) at Svalöf, Sweden, in which field resistant potato varieties have been found to become completely susceptible under short daylength (8 to 10 hours). Resistance and susceptibility were found to be correlated with peroxidase activity which in turn increased with increasing day length. The susceptible variety Bintje also fluctuated in peroxidase activity, but never became resistant. The resistant variety President became susceptible when a decrease in peroxidase activity occurred, but the level of activity at which it occurred was higher than that of Bintje under long days. On this basis, Denward and Umaerus postulate a threshold level of peroxidase which differs for each variety. It is possible, therefore, that Alaska's long days during the growing season may be beneficial as far as protection from late blight is concerned.

These two workers are also breeding for resistance to late blight using field resistance as is Dr. Frandsen(10), the potato breeder at the Max Planck Institute in Cologne, Germany. Presumably most of the potato breeders in both Europe and America are now attempting to incorporate field resistance into their material rather than hypersensitive resistance. In looking at the field plots at Svalöf in which new varieties with commercial possibilities are tested for at least five years before release, it was quite obvious that there are a number of new varieties with a high degree of field resistance to late blight.

The nature of field resistance seems to be a somewhat intangible item as yet. The variety Bintje was almost 100% down with the disease all through Jutland while the variety Bedelia, which is a much later maturing variety grown for starch purposes was almost completely free of the disease even where it was growing side by side with Bintje. Professor Jacobsen(2), potato breeder at Vandel, Denmark was quite emphatic that this was not field resistance, but rather maturity. He did not attempt a definition of field resistance. Dr. Frandsen(10) also said that he was not presently working on the nature of field resistance, but was merely using this form of resistance in his breeding program.

Van der Zaag(32) who has worked on the epidemiology of late blight and who is now doing extension work at Wageningen, Holland has some evidence that part of the effect of maturity on susceptibility of potato varieties is merely a matter of growth rate. Where plants are growing rapidly, the new leaves formed have not been subjected to infection giving the false impression that the plants are resistant. He pointed out that the inoculum comes sporadically and not continually. This must undoubtedly be kept in mind in assessing this maturity-susceptibility factor. There are also microclimatic effects that must be kept in mind.

Dr. Fuchs(11) and his group at the University of Göttingen are also working with the late blight organism, but are not interested particularly in the disease as such. They are using this disease as a tool for investigating the host-parasite relationship in the disease complex.

Dr. Gatner(12), of Professor Fuch's laboratory, is a mycologist working on the culture of Phytophthora infestans. He has found that the late blight
fungus responds to rather high concentrations of iron in the medium. Not only was mycelial growth enhanced, but sporulation was better and a high percentage of the sporangia produced on this medium would germinate with zoospores. When produced on an iron deficient medium, none of the sporangia would germinate with zoospores even at the optimum temperature for zoospore production. Silica gel is used as a base for his media to avoid the variability of agar and to eliminate the nutritional elements found in agar. When hyphal tips from a culture were transferred to an unbuffered medium, the final pH of the individual subcultures ranged from 4 to 8. Buffering was found to give quite uniform colonies.

Dr. Grossman(13), also of this laboratory, is studying this problem by investigating the chlorogenic acid, caffeic acid, and similar material in late blight resistant and susceptible varieties. He is not much impressed with the peroxidase work as an indication of the nature of the host-parasite relationship, because there is no way to tell what it means.

The third way in which the Göttingen laboratory is using the late blight organism is through respiration studies. Menke(17) is doing this work using respiration inhibitors and Warburg apparatus. He is using blight-free and blight-infected resistant and susceptible tuber tissue. He did not agree wholeheartedly that the rapid and great increase in respiration in the infected resistant tissue might be due to the fact the tissue was actually susceptible since they are using only the hypersensitive type resistance in their studies at Göttingen.

Experiments in Denmark(4) showed conclusively that spraying for late blight control was very effective if more than two sprayings were made during the season. Actidione(3) was not found effective as a spray at Frederickhoje, Denmark. It is surprising that the farmers do not spray their susceptible varieties more than twice a season. In a year such as 1958, two sprays are almost a waste of material and time.

Wart - Potato wart seems to be a rather peculiar disease in its distribution. Professor Nielssen-Leisner(18) of the Central Seed Testing Station in Stockholm said that wart occurred only in isolated areas in Sweden and that these areas were quarantined. Even though their main varieties were not resistant, wart was not a problem. Jacobsen(2) said that wart in Denmark was a problem only in isolated gardens. Dr. Keller(52) of the experiment station in Zurich said that wart was only a problem in isolated areas in Switzerland. The same is true in the United States where wart is confined to gardens in the mining area of Pennsylvania and West Virginia. Perhaps the Germans pin-pointed the problem best when they said in Germany they refer to wart as more of a social problem rather than a plant disease because it only becomes serious where, because of restricted land and low living standards, the people are forced to plant potatoes year after year on the same ground.

Professor Hassebrauk's laboratory at Braunschweig is at present involved in testing potato varieties for their resistance to this disease. On the basis of tuber inoculations they have been able to distinguish 7 different races of Synchytrium endobioticum. This includes not only the old races, but also new ones that have apparently arisen in the past few years.

Dr. Frandsen(10) at Cologne is also looking for resistance to this disease to incorporate into his breeding program. He disagrees with the
testing method used at Braunschweig since he says that in order to get a valid test of susceptibility or resistance, the work must be done in the field. His field and lab tests are not completely correlated. He has tested several American varieties to the so-called "Orpe" biotype which is the most common new strain in that area. He finds that Russet Rural is resistant; Katahdin is somewhat resistant but far from immune; and the following varieties are susceptible: Early Gem, Marygold, Delus, B70-4, B73-3, B69-16, Norkota, Mesaba, Calrose, 1276-185, Green Mountain, and Chippewa. In addition, he found that Jubel was susceptible, and this variety is one of the major sources of scab resistance used in American varieties.

Alaska's climate appears to be favorable for the development of wart; the major varieties grown here are susceptible; scarcity of cleared land requires growers to replant potatoes on the same ground for more than one year; new and more virulent strains of wart are appearing; and the increase in polar air traffic from Europe to Alaska offers a possible method for the transport of Synchytrium to Alaska.

Common Scab - Scab is considered a problem in northern Europe, but it is not the problem it is in the United States, nor is it the problem in Europe now that it may become in the future. Scab is primarily a marketing problem because the scab lesions make the tubers unattractive, and in Europe, very few potatoes are washed and very few of them are packaged for sale in small lots. The majority of the potatoes sold for consumption are sold in bulk or in large containers, and the family purchasing them buys their winter supply for storage at home. Washing of potatoes is on the increase, however, as is the packaging in smaller lots. This will undoubtedly emphasize the scab problem as it has done in the United States.

Jacobsen(2) in Denmark is concentrating on breeding for scab resistance. At present, he has no other source of scab resistance than the usual Arnica, Jubel, Hindenburg types commonly used in the United States. He has been screening wild Solanums but so far has found no new source.

Nissen(3) at Frederickshoje, Denmark has been testing planting depth as a possible means of reducing scab, but he has found that the tubers are set at the same depth whether he plants at 3, 6, or 12 cm. This has been the experience of other workers also. Scab has been controlled in Denmark by PCNB, but it is too expensive to be economical.

Labryere(30) who has been testing soil fungicides and seed treatment at Wageningen, The Netherlands also found PCNB to be effective. His results are quite comparable to those obtained in Alaska and elsewhere. PCNB at 90 kilos per hectare was effective in reducing scab, but also reduced yields somewhat. He did, however, get a carryover effect to the second year. There are fields in the Netherlands with a pH of 3.8 on which potatoes can get very scabby. He still says that pH 5.3 and lower gives effective control of scab with rotation.

Rhizoctonia - This disease is not the problem in Alaska that it is in northern Europe, although it may become more important in Alaska as time goes on. There are two detrimental phases to this disease: the killing of the stems and the formation of unsightly sclerotia on the tubers. The perfect stage of this disease which is most common in Alaska does not seem to cause much damage. Formation of sclerotia on the tubers is quite uncommon.
in Alaska except in a few areas, and this surface-borne inoculum may be mostly responsible for the stem killing action of the fungus in the spring. Northern Europe has a much longer growing season and consequently a much longer time for the formation of sclerotia. Very often, especially in their seed crops, the vines are pulled early to avoid aphid transmission of virus diseases, and the tubers are left in the ground for as much as four weeks before harvesting them. The workers in Denmark(3) have found that deep planting of seed emphasizes the stem killing phase of the disease.

Labryere(30) and others in the Netherlands have found that seed treatment is effective in controlling Rhizoctonia even when there are no visible sclerotia on the tubers. Apparently bits of mycelium are just as effective inoculum as the sclerotia. The Netherlands workers have found also that soil treatment with PCNB is very effective in control of this disease. They report that one grower got excellent control of both scab and Rhizoctonia on sandy soil with 30 kilos per hectare of PCNB. The major effect of the PCNB on the Rhizoctonia was in the prevention of sclerotial formation after the vines were removed and before harvest.

There have been some attempts to control this disease by breeding. Frandsen(10) at Cologne has definite resistance to the disease, but he considers breeding for resistance to be a very difficult task until we know more about the organism because testing requires such large scale plots that it is uneconomical.

Phoma - Drs. Braun(9) and Kranz(16) at the University of Bonn, Germany have for many years been working on various diseases of potatoes, and Dr. Braun has just recently published an excellent compilation of potato tuber diseases. One of these diseases on which Dr. Kranz(16) is working is caused by Phoma foveata. This is not the Phoma disease that has plagued Alaskan growers from time to time. This work is interesting and pertinent, however, since they have been working on the effect of light on the morphology of the fungus and the effect of predisposing factors on disease development. Up to the present time they have not found any special influence of either blue or red light on this fungus. The fungus does respond to photoperiod by sporulation. They have found temperatures above 20°C to predispose tuber tissue to infection. This predisposition can be reversed by storage of the tubers at low temperatures for about ten days.

Powdery Scab - This disease has never been reported in Alaska although according to Dr. Kole(29) of Wageningen, the Netherlands, conditions in Alaska should be favorable for its development. It is possible that the tubers in Alaska are too immature to show the disease. He has found that when tubers are harvested early the symptoms of powdery scab are atypical and few if any spore balls are produced in the lesions. Dr. Kole has slides and photographs showing that the tuber attempts to wall off the infection by putting down cork layers, but these photos also show that it is possible for the fungus to find its way through or around these cork layers if conditions are favorable. Although he has never found the fungus to penetrate very deeply into the tuber, he does agree that it might be possible under special environmental conditions. There is no evidence at present that it will do so. He has offered to make sections of fixed Alaskan specimens to identify the disease if it is present in Alaska. Presumably, if the fungus does not have the chance to produce spores, it does not remain much of a threat to Alaska. When there is light infection at the time of harvest, there is some slight development of the fungus after the tubers go into storage.
Ring Rot - Ring rot of potatoes is practically a thing of the past in Europe according to Professor Nielssen-Leisner (48) of the Central Seed Testing Station in Stockholm, Sweden. Ring rot was introduced into Sweden about 5 years ago in seeds imported from the United States. This is the apparently only known ring rot in north central Europe at the present time. Professor Stapp (20), the man who did the first really comprehensive work on bacterial ring rot of potato is at present retired but still actively doing research at Braunschweig, Germany. When it was suggested that the optimum temperature for the growth of Corynebacterium sepedonicum might be lower than he originally found it to be, he declared it was not possible. He has recently published a new book on bacterial plant pathogens which states that the optimum temperature for this organism is 23°C, and he refuses to recognize that there might be strains of this bacterium with a different optimum temperature. Although ring rot was first described in Germany, they succeeded in eliminating this disease by planting whole tubers and roguing out the diseased plants. The people in Sweden who are again confronted with this problem are convinced that they will be able to eliminate the disease there also by planting whole seed and roguing. There is some question on the basis of Alaskan experience whether or not this will be a simple thing to accomplish, since in years of normally low temperature the ring rot disease often fails to appear in the field.

Silver Scurf - Silver Scurf is quite common in most of the potato-growing regions of the United States, Alaska, and Europe, but it has never been considered as a very serious problem. At the Potato Storage Institute in Wageningen (33), the Netherlands, they have discovered that silver scurf can become a very serious problem. In order to cool potatoes in storage, when they first come from the field, they have developed a technique of moving tremendous volumes of air through the piles of stored potatoes. In doing so, they discovered that those potato tubers infected with silver scurf lose sufficient moisture through the infected skin to cause shriveling of the tubers. This is a new problem and one on which no work has been done as yet.

Potato Viruses - Work on potato viruses in Alaska has received little emphasis in the past because there is little apparent spread in the field and because those viruses which are most detrimental to potatoes and which can be easily detected can be rogued in the field. The certification program has been very effective in bringing these virus diseases under control. There are many viruses, however, to which little attention is paid in the Alaska certified seed program.

Contrary to the situation in Alaska, the certified potato seed business in Northern Europe is extremely important. For instance, the Netherlands alone controls 60 percent of the world's export market in certified seed potatoes. Competition for export markets has been very keen; and because of this, attempts have been made in most of the northern European countries to eliminate all of the viruses from their potato seed. This has not been simple for several reasons. In the first place, insects are common, and quite high populations of aphids can develop during a growing season. Secondly, many of the viruses they are attempting to control are latent in several varieties as the virus x is in most American potato varieties. Where viruses x and y may or may not be latent in our American varieties, most European varieties develop distinct symptoms. Some of their varieties even show strong symptoms of virus s, although for the most part virus s as well as viruses m, k, etc (23), may be latent. A new strain of virus y has
arisen in Europe, according to Dr. Bode(7), which is latent in potatoes but which causes very severe symptoms on tobacco. This new strain of y has also been found to attack previously resistant potato varieties.

Not only are the symptoms of this virus on tobacco very severe, but tobacco infected with this virus cures a dark brown rather than a light golden color which is desirable in cigarette tobaccos. In some areas of Germany they have lost as high as 40 percent of the cigarette tobacco crop from this one virus alone.

Viruses x, s, and y appear to be the most important of the potato viruses in Norway. Dr. Bjornstad(36) of Vollebekk did not mention virus m or leafroll which are problems elsewhere in Europe. He has found that in the early harvested material, infection with x or s is a help in that the potatoes are considerably more mature and the yields are even higher. When the potatoes are harvested later, however, the virus-free material consistently outyields infected ones.

Dr. Bjornstad(36) has discovered another virus of potatoes that could become important in Alaska. This virus causes a yellow mottling similar to that of acuba mosaic. The symptoms only become apparent in the cool part of the season around Vollebekk but are common throughout the season in western Norway where the weather remains cool throughout the growing season as it does in Alaska. It is quite characteristic of this virus that only a portion of the plant may be affected. That is, one stem may be affected where another does not have symptoms. It is apparently more than just a lack of symptoms since the virus itself may be present only in a part of the plant. This peculiar distribution within the plant is also manifest in the tubers and, as a result, the disease is tuber-transmitted only about 10 to 15 percent of the time. The virus does not cause necrosis in the tubers but it does cause necrosis in the sprouts. This virus disease is similar to the one described by Rozendaal(31) at Wageningen, Holland who says that his virus disease is actually the tobacco rattle disease. Because of the acuba-like symptoms produced, they call it pseudo acuba.

The disease in Wageningen is soil borne, easily sap transmitted, but not transmissible by grafting. It characteristically produced symptoms on one side of the plant or on one half of the leaf. He has, however, also found tuber necrosis. According to correspondence that Professor Rozendaal had received from Larson at Wisconsin, tobacco rattle is probably the same virus which has been causing a disorder in the States called heat necrosis.

Dr. Rozendaal(31) has also discovered another soil borne virus disease that produces quite severe necrosis and wilting. The leaves of the affected plant drop but remain attached to the plant. Other than its soil borne nature, they have little information about this new virus.

The new virus y strain that is quite common in Germany and in Switzerland is not a problem in the Netherlands. Apparently through their system of certification they were able to detect this virus strain before it was able to spread very far into the Netherlands. It was discovered in the eastern part of the country, but they feel sure they have it under control at the present time.

Probably, the most important virus disease in Germany, Switzerland, and Holland is leafroll. Although this disease can be controlled to a certain
extent by roguing, the main difficulty is in current season spread and because of this the major efforts are concentrated on predicting aphid population peaks and on microscopic examination of the tubers.

Dr. Moericke(18), an entomologist at the University of Bonn developed the use of a yellow bowl filled with water for sampling aphid populations. Apparently, only certain species of aphids are attracted to the yellow and, fortunately, Myzus persicae is one of them. These yellow bowls are placed at intervals throughout the country and the number of Myzus persicae are counted. In this way, they can detect the first migration of this aphid from the peach trees to the potato fields and thus predict the eventual population peak. This technique is used in Germany, Holland, and Switzerland.

On the basis of this predicted population peak, the certification agencies of these countries determine the date on which the vines of certified seed must be destroyed. After harvest, all of the tubers of the higher grades of certified seed are examined microscopically using the "Eagle-Langer" test. This test depends on the staining of callous tissue that the leafroll virus causes to be developed on the sieve tubes. The major drawback to the Eagle-Langer test is that things other than the leafroll virus may cause calloused sieve tubes, so any tubers showing a positive test are indexed in the greenhouse. The people at the University of Bonn are working on this test to develop more accurate methods.

Perhaps the most important method of detecting many of the other virus diseases is by serology. Although most of the countries use serology to at least a limited extent, the process is most highly developed in the Netherlands where they use a combination antiserum to test for the presence of x, s, m, a, and y. If they get a positive reaction with this combination antiserum the tuber is tested for each of these viruses individually to determine the distribution of those present in the country.

In the Netherlands, tubers of all varieties grown commercially are inoculated with all the known strains of all the viruses that are apt to appear in the Netherlands to determine how each of these varieties may react and how it may appear in the field. By this means they also determine the varieties they will allow to be grown in the same vicinity. For instance, Duke of York contains 100 percent a strain of virus x that causes top necrosis in Bintje. Duke of York is only allowed in their seed program at all because of the seed demand from Germany. They cannot, however, allow Duke of York to be produced in the vicinity of Bintje. This need for separating varieties is very apparent in Denmark(2) where the German variety Bedella which is 100 percent infected with virus x is grown in the vicinity of certified seed fields. As a result, only their foundation seed is maintained completely free from this virus, while their certified seed runs from 1 to 2 percent infected.

One virus disease which is not common enough in Europe to be included in the certification program is witches-broom. According to Bos(28) in Wageningen, Holland witches-broom-producing viruses are not uncommon on many plants since these viruses do not have a great deal of host specificity. Apparently all witches-broom viruses cause phyllody in the flowers and he suggested that unless this is the case in the wild lupines in Alaska, the Alaskan lupines are probably infected with lupine yellows. Dr. Swanze(22), who is studying legume viruses at Braunschweig, Germany has a potato witches-broom virus which causes extreme dwarfing of the leaves when it is grafted onto tomato. In addition, he has an alfalfa plant which he suspects of
having the same type of virus but he has yet to propagate the plant in order to have enough material with which to work. He, as well as Bos(28), suggested that the source of the potato witches-broom in Alaska might be white or alsike clover.

In the planting of disease material at Svaløf, Sweden that had been obtained from Dr. Reddick many years ago, several plants were found this summer that appeared identical to the plants in Alaska that are believed to have the witches-broom virus. This disease previously has not been reported in Scandinavia.

Dr. Ross(19) and Mrs. Berike(6) of the Max Planck Institute at Cologne are doing considerable work on breeding for virus resistance in potatoes using wild Solanum species. Dr. Ross has located in Solanum stoloniferum genes for resistance to virus y and these same genes confer resistance to virus a. He considers this as additional evidence of the relation of these two viruses. In order to insure his inoculation of seedlings with virus y, he grafts them onto y-infected tomato plants and then tries to recover the virus from the scion. From this graft which feeds a continual supply of the virus to the scion he gets three reactions to virus y. In the first case, the seedlings may prove susceptible; in which case they produce symptoms and the virus can be recovered from them. In the second case, he gets immunity in which no symptoms are developed and the virus cannot be recovered. In the third case, he gets hypersensitivity in which dieback from the tip occurs, but he is unable to recover the virus. These three types are due to three alleles in which the immunity is dominant over top necrosis, and top necrosis is dominant over susceptibility. In spite of the fact that these genes condition resistance to virus a also, the top necrosis reaction is lacking. He has found an intermediate type of resistance to virus a, but it apparently is conditioned by minor genes. Ross believes that the immunity and top necrosis are merely degrees of the same thing. He hopes to start work on this problem from the respiration angle as soon as he can obtain an oxygen carbon-dioxide analyzer with automatic transcriber. He considers the automatic transcriber necessary to detect minute and very early changes in respiration.

Mrs. Berike(6) has been searching for resistance to potato leafroll, but has been unable to find any resistance in Solanum tuberosum. She has, however, found a small increase in resistance in crosses of Solanum tuberosum with 3 wild species. When these hybrids are selfed the resistance increases, and when resistant times resistant is crossed, resistance again increases. She postulates that polygenes are involved but so far she has been unable to increase resistance to a practical degree. The resistance exhibited by these lines can only be demonstrated in the field since they are 100 percent susceptible in the greenhouse. It is possible that they may be a quantitative effect of the virus breaking down the resistance since they are also 100 percent susceptible when grafted to an infected plant. She has also found the correlation between field resistance and lack of tuber propagation of the virus.

Golden Nematode - The Golden Nematode seems to be present in most of the north central countries of Europe but for some reason it is not considered particularly important. It apparently is much like the wart problem in that it is primarily confined to isolated areas or to home gardens(2,14,52). The potato breeders at Svaløf(15,50) had an unfortunate experience with this organism this summer. They purchased soil in which to plant their potato seedlings and only after their seedlings emerged did they realize the soil was completely infested with the Golden nematode. Just what they will do to rid their seedlings of this organism is uncertain at present.
Most of the people of north central Europe prefer yellow-fleshed potatoes and fairly small tubers. In fact, most of the potatoes consumed would be about the right size for planting as whole tubers. This is probably the reason that no cut seed is used for planting in Europe. Van der Zaag (32) in the Netherlands advocates fairly shallow planting, and hilling just before flowering so all the tubers will be set in the hill. This would facilitate digging. His spacing recommendations are based on the number of plants per hectare and not on the distance between plants. Curiously enough, the growers on sandy soil plant the rows close together for moisture conservation. The reason is that with narrow rows the plants grow together about 2 weeks sooner than with wide rows and thus shade the ground. Perhaps this affords some cooling of the soil during about two weeks of hot weather. Conversely, in Alaska where hot weather is not a problem, the rows are planted farther apart for moisture conservation. Another advantage of the shallow planting is that the plants have a better chance to emerge in the cool soil in the spring before the Rhizoctonia has a chance to cut the stems off.

Many of the potato fields in Europe are tended by hand, especially in those areas in Germany where the land has been divided up through generations until now the area farmed by individuals is very small. Where fields are large enough, planting and caring for the potatoes is done by machinery. The Machinery Institute of Wageningen (31) in the Netherlands has a very good automatic planter on display that uses a series of cups on a chain. It is also fixed with a device which automatically feeds a seed tuber into the cup in case it fails to pick one up from the hopper. This is a fairly lightweight machine and needs only a tractor driver for a 2- or 3-row planter. This might be a very good machine for Alaska.

It would seem that most often the potato vines are removed before harvest although this may not be the case wherever potatoes are dug by hand. In the case of certified seed the removal of the vines is required and is based on the population peak of aphids (52, 31). The vines may be removed various ways but the Dutch are rather partial to the vine puller. It is not known how commonly this is used by the farmers.

The Machinery Institute has improved on the American type vine pullers by substituting rather soft pneumatic rolls for the solid rubber rolls on the pulling device. These rolls rotate rapidly and thus give the plants a jerk which removes the vine from the tubers. The puller also has a rotating knife device which destroys the vines. The people at this Institute say that the vine puller will work in any kind of soil. They did not say, however, if the vine puller was effective at any stage of maturity.

There are various types of diggers used in north central Europe most of which would be completely unsatisfactory with Alaska's immature tubers. The worst of these machines has a series of metal fingerlike bars that twirl rapidly and knock the potatoes out of the ground. Even with mature potatoes it often causes 60 to 70 percent damage (3). The best digger at the Machinery Institute was a chain type digger with an attached harvester. The chain was constructed with rubber-fiber belts of the cross bars rather than links. This eliminates damage from the links but it might make servicing of the machine more difficult. The digger also had a split point and adjustable shakers.
Many of the potatoes in northern Europe are still stored in "clamps" which are really nothing more than holes in the ground with straw and dirt on top of the potatoes. These clamps may be satisfactory from the standpoint of maintaining storage temperatures but they are completely unsatisfactory from the standpoint of aeration or ventilation. In the Netherlands their big problem is one of cooling the potatoes since the outside temperature fluctuates right around proper storage temperature. Most of the storages other than the clamps are cooled by opening them when the temperature is down and closing them when the temperatures outside are higher than good storage temperature.

At the Potato Storage Institute(33) they have been working with the cooling problem and have developed a system of forcing the air directly through the potatoes at the rate of about 100 volumes of air per 1 volume of potatoes per hour. They can apparently do this because of the maturity of the potatoes at harvest. It probably could not be done in Alaska where the potatoes are stored in a very immature condition. Air can be forced directly through potatoes very easily since there is very little static pressure developed. Only about 1 inch static pressure is developed even where as much as 30 percent dirt is put in storage with the potatoes. There is a bit more static pressure when the potatoes are stored in sacks and the sacks cannot be full or the air will move around instead of through them.

Heating from respiration is a problem only where there is much bruising and rotting. The results of the Potato Storage Institute show that normal respiration during after-ripening without ventilation will raise the temperature only about 1/3 to 1/2 degree centigrade per day. This is not a significant factor where the potatoes are ventilated during the after-ripening period.

CEREAL DISEASES

Root Rots - Root rots, especially of wheat and barley are common in Sweden(47), Norway(37), Germany(2h), Switzerland(56), and probably in the other north central European countries. The most important of these are Ophiobolus graminis and Cercosporella herpotrichoides. According to Mr. Robert Hansen(37) of the Norwegian Plant Protection Service and Dr. Zogg(56) of the experiment station in Zurich, Switzerland these diseases are most important on fields planted to wheat or barley for more than one year in a row. The diseases in Norway are becoming more important because with a government monopoly in cereals the farmers are assured of the sale of their wheat and barley; and with the reduction in the importance of livestock in the farming economy, there is less and less rotation practiced with clover and oats which are not attacked by these diseases. Also, Agropyron repens is susceptible to Ophiobolus and is quite a weed problem in many of the fields. Mr. Hansen(37) has evidence that planting of oats for one year will decrease the incidence of the disease by about 50 percent. Dr. Zogg(56) of Switzerland believes from his work that rotations involving wheat or barley only one year in three or four is necessary to keep Ophiobolus under control and control of Cercosporella requires four or five years rotation. Since rotation seems to be the most promising method of keeping these diseases under control, Mr. Hansen proposes the use of a cruciferous crop such as turnip rape in the rotations so that quack grass can be controlled with TCA.

Attempts to breed for resistance to Ophiobolus graminis have not been successful in Norway. Kenya 131 which is resistant to "take-all" in some
places is not resistant in Norway. Dr. Strand(41) suggested a reason for this was due to the nature of the resistance. In those areas where Kenya 131 is resistant, the resistance is due to the regeneration of roots during that part of the season which is unfavorable for the development of disease. In Norway there is no part of the season in a normal year that is unfavorable for its development. Dr. Strand(41) has found some slight resistance to Cercospora but it seems to be conditioned by minor genes, and the resistance developed to date is not great.

Dr. Zogg(56) has evidence that the pathogenicity of Ophiobolus may be influenced by the previous substrate on which the fungus has been growing. When Ophiobolus was grown on different concentrations of biotin, pathogenicity increased with increasing concentrations. This was determined by washing the mycelium free of the substrate before using it as inoculum. There was no carryover of the biotin unless it was within the mycelium.

Pathogenicity, he has found, also depends on predisposition of the host. Where he grew four fungi that are normally pathogenic on wheat in sterile soil in all possible combinations there was sometimes a stimulation of the disease reaction and in some cases there was a suppression. Where all four of these organisms were grown together with the wheat there was a reduction in the amount of the disease. He suggested the hypothesis that where many fungi are normally growing in the soil, disease development must depend upon predisposition of the host.

Powdery Mildew - Powdery mildew is a major problem of wheat and barley in most of northern Europe. Finnish wheats growing at Norkoping, Sweden at the Holmberg Seed Company were heavily infected with powdery mildew, while the standard Swedish varieties being grown by Mr. Holmberg(47) were practically free of this disease. Dr. Wlenhues(21) listed powdery mildew as the major problem in barley around Cologne, Germany. Perhaps the most extensive breeding work for resistance to this disease has been done by Strand(41) at Vollebekk. He has worked out the race complex of powdery mildew present in Norway and surveys each year for the races present. In addition, he has developed several varieties resistant to this disease. He has found six genes for resistance and is holding some of them in reserve in case of the appearance of new races in Norway. He has attempted to combine some of these genes but found that it was a very time-consuming job because each succeeding generation had to be test crossed to see if it still retained both genes.

Stripe Rust - Stripe rust is becoming more important in central Europe although it was not mentioned as a problem in Scandinavia. Stripe rust has suddenly become important also in the central United States as well as other areas. Outbreaks have occurred even in Egypt where the temperature is considerably higher than the optimum for the disease. In Alaska where no rusts have been reported on cereals, Dr. Dickson found stripe rust epidemic on Agropyron species in the Yukon Valley at Eagle. Since this rust appears not to need an alternate host, the disease poses a potential threat because of the possibility of new races arising which would be capable of attacking Alaska's cereals.

Professor Hassebrauk(14), who is in charge of the stripe rust race identification laboratory at Braunschweig, Germany just returned in July from a trip to Egypt where he was studying the stripe rust situation. It might be well for the workers in the central United States to consider what
Professor Hassebrauk might be able to do for them in regards to their stripe rust problem. One very interesting feature of this problem in Europe is that it is one disease that is being attacked on an international basis. The Netherlands is in part supporting this identification laboratory at Braunschweig. They also have planted cereal plots throughout the countries of Europe and have a man whose job is to supervise them and make collections of stripe rust which are sent to Braunschweig for identification.

Dr. Wienhues(24) and his wife at Cologne are crossing wheat and Agropyron sp. for resistance to stripe rust. They have not only obtained stripe rust resistance in these crosses but have found that the crosses yield just as well as the best standard varieties. Difficulties have arisen, however, because of the difference in the chromosome numbers between the wheat and the Agropyron, and the odd chromosome in the hybrid disappears about 95 percent by the second generation. They are now trying to break off a piece of this chromosome by x-ray and tack it onto one of the normal chromosomes so it will remain constant.

One very significant fact about the identification of stripe rust races at Braunschweig is that they are made on the basis of single urediospore isolations in those cases where it appears that more than one race may be present in a single pustule.

Stem Rust - Dr. Fuchs' group(11) at Göttingen is using Puccinia graminis to study host-parasite relationships. Dr. Gattner(12) has found that ferric iron is essential in the culture of Puccinia graminis as it is in the culture of Phytophthora-infestans. With the use of iron and other materials he has managed to get germination of the rust spores, an appressorium, infection peg, substomatal vesicle and branched hyphae up to 3,000 microns long. His paper on this subject is now in press. He said he believed the secret of culturing rusts would be found in their inorganic nutrition.

Another gentlemen(25) working at the same institution is studying the problem of phosphorus deposition in the vicinity of rust pustules. This deposition has been determined by some Canadian workers using radiophosphorus and the supposition is that the phosphorus is accumulated in the vicinity of the rust pustules due to the need in the parasitic process of high energy phosphate bonds. The question is whether this is from RNA; and if so, is it from host RNA or parasite RNA. He has developed a technique for isolating quantities of RNA from wheat leaves and hopes to answer this question by separation of the two types from infected leaves by serology.

Miscellaneous Cereal Diseases and Cereal Breeding Problems - Leaf rust in wheat and barley seem to be quite common throughout Scandinavia and Germany but not a great deal of emphasis is being given to this disease. Snowmold, probably Fusarium nivale and dwarf bunt were mentioned as problems by Dr. Wienhues at Cologne. Both of these diseases are only problems at high altitude in Germany and one chemical for soil treatment has been found effective against both. He knew only the trade name for this material.

Much of the cereal breeding in Sweden is done by private breeders and very little of their emphasis is on plant disease resistance. Mr. Holmberg(47) of the Holmberg Seed Company does have a plant pathologist come in to look at his material and assist in discarding badly diseased selections. It is possible that he has some rather serious soil-borne disease problems which he may or may not recognize. In testing wheats this spring he found that a
series of Finnish selections exceeded the standard check in emergence under the unfavorable conditions at that time even though the standard had a high germination in the laboratory. He was under the impression that the lack of germination was due to the compaction of the soil by the high rainfall. It is quite possible that soil organisms were playing some part in this lack of emergence.

Dr. Hagberg, cytogeneticist and head of the chromosome department of the Swedish Seed Association in Svalof has been doing work on quantitative inheritance of head density in barley. He has identified 108 alleles at 25 loci affecting head density. Linkage groups have been established by breeding tests and translocations have been used to establish locations on the chromosomes. All in all, he has by very careful observations, established quantitative inheritance on the same basis as ordinary Mendelian genetics. He has, however, observed in nature mutations causing even slighter changes than those obtained by the use of mutagenic agents indicating that studies of this type are limited by ability to measure differences.

Stoy, a physiologist at this same station is working on the assimilative abilities of various wheat varieties. He grows the plants under controlled light, temperature and humidity conditions, detaches leaves and places them in a device for measuring CO₂ evolution. The leaves are subjected to light and a flow of air is passed over them. The gases are collected and run through an automatic CO₂ analyzer. He has found by this method that in the early stages of growth the relative ability of the varieties to photosynthesize is approximately the same. But some varieties are more prone to use these photosynthates to produce more leaf area. In later stages of growth some of the early varieties have the capacity to photosynthesize more effectively per leaf area. Breeding work is now starting to combine these factors of early rapid increase of photosynthetic area with the ability to photosynthesize more efficiently.

There is considerable interest at some locations in obtaining the cereal materials that may have been developed by the Russians. Most people are rather vague on what the Russians are doing in the way of plant breeding. Professor Wexelsen just returned from Russia in June where he had the opportunity of talking to Lysenko and others. Apparently, Lysenko is still boss of Russian genetics but his ideas do not have the favor with Russian geneticists that they once had. Also, Vasilof's work has returned to favor to the extent that at least his name and work are mentioned freely.

There should actually be little difficulty in getting Russian cereal genes since many of them can probably be obtained by purchasing commercial grains. Some of the Russian seed lots growing at Uppsala, Sweden were very thoroughly mixed varieties. It should be possible to separate out many different genetic characters from a seed lot such as this.

FORAGE DISEASES

Mr. Sven Bingefors of the Swedish Seed Association at Uppsala stated that the major problems of red clover in that area were winterhardiness, stem nematode, Sclerotinia trifoliorum and pollinating insects. They have not investigated the nature of winterhardiness but believe winter killing to be caused by little or no snow cover because of wind, mid-winter thaws and glazing. This is the same situation that occurs in the Matanuska
Valley in Alaska. He did not think that snowmolds or other low temperature pathogens were involved in winter injury, but apparently they have not done much work along this line. He indicated that only in northern Sweden were snowmolds of importance. He was leaving, however, within a few days to visit Canada and expected to visit Jack Lebeau at Lethbridge. He may return to Sweden with some new concepts of snowmolds and their action after he talks with Lebeau.

He also did not seem to be concerned with any interrelations of stem nematodes and other microorganisms. Swedish workers have developed a new variety of red clover named Ulva which is resistant to both stem nematode and crown rot. It is a tetraploid out of the variety Ultuna by colchicine. The main drawbacks to production of the new variety are the low seed yield caused by pollen sterility of the tetraploid and lack of pollinating insects. They have teams of people sweeping the country this summer for bees to determine more suitable areas for seed production.

Sclerotinia trifoliorum and stem nematode are also problems on red clover in the southern portion of Sweden around Svalöf. Several of their tetraploid red clovers are resistant to Sclerotinia trifoliorum and they have the added advantage of rapid recovery after cutting. Dr. Hagberg said they were trying to develop allotetraploid clovers in order to introduce a higher degree fertility in the material.

Mr. Hertsch of the Max Planck Institute at Cologne also indicated that stem nematode and Sclerotinia were problems in that area, but he believed that there was plenty of resistance to both available. He was probably referring to the Swedish tetraploid clovers.

Mr. Røed of the Norwegian Plant Protection Institute at Oslo had a somewhat different idea concerning the importance of snowmolds in the overwintering of crops. He stated that he had sufficient evidence to indicate that disease is a major factor in the overwintering of crops in Norway. The principal organisms causing this destruction are Sclerotinia trifoliorum, Sclerotinia borealis, and Typhula. Typhula does not seem to be nearly as serious as the other two. Fusarium nivale is not a problem in Norway. He has never found the low temperature basidiomycete that has been reported from Canada and from Alaska. When informed that this low temperature basidiomycete caused damage by the production of hydrogen cyanide he mentioned one basidiomycete reported from Denmark--Pholliota aerea that also produces hydrogen cyanide. Apparently, hydrogen cyanide production is not uncommon in the basidiomycetes and may not be a very good clue to the identity of the Canadian and Alaskan pathogens.

NEMATODES (General)

Roger Anderson who until recently has been a graduate student at the University of Minnesota now has a newly created job in Norway surveying for nematodes. Apparently the extent of nematode infestation and damage has not received a great deal of emphasis there until quite recently. Although Anderson has only been working on this problem a short time, he has found quite a number of plant parasitic species of nematode in the vicinity of Vollebekk. Most of these are the common parasitic species found in the United States and elsewhere. There is nothing particularly unusual about this since nematode species have been found abundantly almost
everywhere that a concerted effort has been made to find them.

MISCELLANEOUS VIRUS DISEASES

One of the plant breeders at Vollebekk has developed some tomatoes which are resistant to tobacco mosaic, and Bjornstad(36) has shown that there are two types of resistance concerned here. In the first case, there is a hypersensitivity causing the failure of the graft union. In the second case, there is a tolerance to the virus with a lack of symptoms. To prove this latter, the resistant scion was grafted between a susceptible stock and a susceptible scion and when the stock was inoculated, the virus was translocated into the upper portion where it produced symptoms. No symptoms were produced on the resistant portion.

Dr. Bauer(5) at Cologne has made a survey of the strawberry viruses in Germany and has found only the non-persistent types. The most important of these are virus 1 (mild), virus 1 (severe), and stunt. He also has some evidence that June yellows is genetic and not virus in nature.

COLD RESISTANCE

One of the problems concerning the plant breeders at Cologne is cold resistance. Dr. Ross(19) has obtained some cold resistance from Solanum acaule which he has been able to incorporate into Solanum tuberosum. However, their major need for cold resistance in Germany is resistance to spring frosts and this type of resistance would not necessarily be of value to us in Alaska. He believes the cold resistance of Solanum acaule is a matter of rapid regeneration. Dr. Bauer(5) of the same station is also working on frost tolerance in Ribes species. One species he has from Kamchatka is not winter-hardy in Germany because it breaks dormancy during rises in temperature in January. He has also found some winterhardiness in strawberries and they seem to be those with deeper growing roots which resist frost heaving.

SMALL FRUIT DISEASES

Dr. Bauer(5) at Cologne is working on breeding for disease resistance in small fruits. The major problems of strawberries are viruses for which he is presently searching for resistance, and the major problems of Ribes are mildew, Cronartium ribicola, and pseudopeziza leaf spot. Both the Cronartium ribicola and the Pseudopeziza are sufficiently severe in his breeding plots to have completely defoliated the susceptible selections. He does have at the present time a few selections that are resistant to both of these diseases. Perhaps the most striking of his work was his study of the nature of resistance to powdery mildew in Ribes. There is apparently a difference in susceptibility due to age which extends even to different tissues in the same leaf. This resistance due to age is involved in what he calls ontogenetic resistance. The young tissue is hypersensitive so the fungus may continue to form haustoria which are killed or ineffective until the spore is exhausted. Then there is a period of development of the tissue when it may become susceptible and normal pathogenicity is established. If there is resistance during this middle age, it is due to a thickening of the protoplasm surrounding the haustorium. Resistance in old tissue is
either due to the lack of hormones or because the haustorium develops within the large vacuole.

Dr. Bauer(5) contends that parasitism in this disease only becomes established when the host dissimilation exceeds assimilation. He has also found another type of resistance in another Ribes species. In this type there seems to be no reaction on the part of the host for about 10 days after infection when suddenly the parasite dies. Investigation revealed that when infection took place the nucleus started to enlarge and in about 10 days the nucleus actually engulfed the haustorium. Dr. Bauer’s conclusion was this: “We may find that the nature of resistance is different in each disease and only after we know what this is can we do effective breeding for disease resistance.”

TOXINS AND ANTIBIOTICS

Dr. Gmummann's(51) lab at the Institute for Special Botany in Zurich, Switzerland is working primarily on antibiotics and toxins in a study of the nature of parasitism. They are working in the lab very closely with industry with their antibiotics and are running pilot plant studies on production. For this purpose they have large controlled temperature rooms for incubation of their cultures. Mr. Niesch(54) is working on toxins produced by Stereum purpureum. The toxins have not been isolated as yet, but he does have some rather good evidence that toxins or similar substances are involved in the disease of fruit trees. Inoculation of the stems of Prunus species results after a time in the splitting of the leaves as though the mesophyll had been destroyed and eventual death of the foliage. The fungus actually only moves a very short distance from the site of inoculation and is not found in the leaves. Apparently some substance is being produced by the fungus and translocated to the leaves where the pathogenic action occurs. He did not mention if any other portions of the plant were affected by this substance.

Mr. Schupp(55) of this Institute is working on Mycorrhizal associations with orchids. It appears that the fungi associated with this phenomenon do more to stimulate the orchids than merely converting the substrate to a more usable form as has been previously supposed. Orchids will produce a substance called orchideen which has antibacterial properties. At least five species of fungi will stimulate the orchids to produce it but a question is which one will cause the greatest stimulation and why.

Dr. Kern(53) who is in charge of the toxin work for the Institute explained that their program has three phases. First of all, they isolate the toxins regardless of the microorganisms that produce them. Secondly, they test the spectrum of activity in the toxins against higher plants, microorganisms and animals. And last of all, they investigate the mode of action of the toxins. Some of the toxins are completely non-specific in their actions and affect animals as well as plants. One substance with which they have done considerable work is lycomarasmin, a substance produced in tomatoes by Fusarium lycopersici. Studies have shown that this compound forms complexes with iron in the stems of the plant causing iron starvation of those tissues. The complex is then translocated to the leaves where, because the complex is unstable, the iron is given up causing iron toxicity. They are also studying the metabolism of Fusaric acid and other toxic substances produced by this same organism. They have been able to synthesize Fusaric acid with C14 as a tag at one location on the molecule.
By chromatography they have been able to determine that the C\textsuperscript{14} is transferred to several compounds during metabolism. C\textsuperscript{14} also appears in the CO\textsubscript{2} tube given off during respiration. Some of the compounds have been isolated and the structural formula determined. Attempts are now being made to label other portions of the Fusaric acid molecule.

They have developed a very ingenious device for measuring the effect of these toxins on water uptake and transpiration by plants. This device uses a balance on which the plant or cut stem is placed in the solution. The device automatically adds water or whatever solution is being tested, and the weight changes are recorded on a revolving drum by exposure of photographic paper to a pinpoint of light. With the single curve derived, they can determine the green weight of the plant, uptake of water, and transpiration. The amplification of weight changes is mechanical, and would probably be more accurate if they could be amplified electronically. They plan to make such modifications as soon as they have funds available.

SEED CONTROL AND SEED CERTIFICATION

Professor Nielssen-Leisner(48) is in charge of the Central Seed Testing Station in Stockholm where all kinds of seeds are tested for use throughout Sweden. He has compiled and catalogued a collection of several thousand species of plant seeds. It is probably one of the most complete collections of its kind in the world. In explaining the work of this organization, he brought out several points about seed testing which might be of considerable importance in Alaska. The cereal seeds are germinated in a container of coarsely ground brick and the seeds are covered with about an inch of this material. Seeds damaged by frost fail to emerge. Seeds damaged by fungi can be detected by gently uncovering them at the end of the germination period. Seeds which fail to germinate well under the usual test are treated with fungicides and another test is run. If they germinate satisfactorily the second time, the recommendation for seed treatment is sent to the farmer. All cereal seed samples taken are tested for moisture content by oven drying. Tetrazolium is used only as an index of quality or for a quick general test. Ultraviolet is used to distinguish between potato varieties. Field plots of every certified seed lot are planted in the year of certification and also the following year.

This system of field plot control of certified seed is also followed in Norway according to Mr. Peter Krosby(38), head of the Norwegian Seed Testing Station. The Seed Testing Station in Norway does not do the certification work but they do the field testing of certified seed by running these control plots. There are specialists in each district who make field inspections, but these control plantings are made at Vollebekk early enough that the specialists can be notified as to what to watch for in each seed lot.

Certification in Norway is handled by the State Seed Board. The State Seed Board reviews the list of eligible varieties, appoints inspectors for certified seed, designates the tag that will be used, and in general supervises the seed certification. If a breeder wants to release a new variety, he submits data on that variety to the Research Council which is composed of the directors of the various agricultural agencies and institutes and representatives from approved seed companies. If the Research Council approves the variety it submits its recommendations to the State Seed Board which then goes to the State Seed Testing Station which increases the seed on foundation seed farms.

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Under the seed law of 1953 the only seed which can be sold in Norway without test by the Seed Testing Station is that sold by a farmer to his neighbors. The farmer cannot advertise his seed for sale without paying a license as a seed dealer. This is too involved to be economical for the farmer. Also, there is a government monopoly in small grains so the government buys all that is produced. The government controls the amount that can be exported or imported.

Drying the seed is Norway's biggest seed problem as it is in Alaska. This problem in both regions has come about through the increased use of the combine. Krosby suggested that the solution for maintaining germination and to a lot of the problems involving carryover germination would be drying to 6 to 10 percent moisture and sealing the seed airtight such as the Asgro Seed Company is now doing with small lots of vegetable seeds.

**GENERAL CONCLUSIONS AND RECOMMENDATIONS**

It would seem that there are several disease problems which northern Europe and Alaska either have in common or which they could have in common if well-established diseases of Europe were to be brought to Alaska. Two of these disorders, Golden Nematoide and Potato Wart, would be especially disastrous to Alaska if they were introduced because of the attitude of the people in the potato industry in the other states. This would eliminate any possibility of developing a specialty seed market for Alaska grown seed potatoes. Alaska would immediately be quarantined from shipping any potatoes whatsoever to the other states. This would, of course, be in addition to the damage these two diseases would cause directly to the potatoes in Alaska.

What is the danger of these two diseases and possibly others being transferred to Alaska and becoming established? No one can answer this question directly because of lack of information on this point. One can say, however, that with the advent of polar flights by SAS, Air France, and KLM, the chances appear to be greatly enhanced. Investigations are definitely in order to determine whether disease organisms are or can be transferred from northern Europe to Alaska via these polar flights. If it is determined that this dangerous condition exists, quarantine measures are a must in order to protect Alaska from their introduction and to protect the other States from possible secondary spread from Alaska.

Introduction of a disease into a new area is only the first step. There is also a question as to whether it can become established there. The climate of Alaska is favorable for the establishment of some of those diseases which are not present here now. The crops these diseases attack are not only present, but the varieties grown are probably susceptible. The only other factor would be the opportunity these disease organisms would have to come in contact with these crop plants when they are deposited in Alaska. On this score, there is again little information.

This whole problem would bear investigation.

There is another question that has been answered only in part. What future cooperation is desirable and feasible between Alaskan workers and those in Northern Europe? At least one agronomist from the Alaska station should look at the cereal and forage breeding work being done in Scandinavia.
This might eventually lead to comparative variety trials in Alaska and Scandinavia. Secondly, the European literature should be made more readily available to Alaskan workers, and some money might be well spent on translations into English, if the material is not published in English. The third thing to do is to maintain contact with those individuals who were so helpful to both Mr. Kallio and myself during our respective trips to Europe. These contacts can be enlarged through correspondence and should be so enlarged.

Fourth, because of the greater formality in the European system, it might be well to obtain support for travel of European scientists to Alaska where this formality can more easily be broken down, rather than concentrating on sending Alaskan scientists to the European countries.

Fifth, I think we should look forward to an exchange of scientific personnel on a work rather than an observation basis. By this I mean Alaskan personnel and European personnel should be exchanged for periods of about one year to work on specific problems of a mutual nature.

There is a tremendous expanse of land in the world between 50° and 70° north latitude in which crops can be produced abundantly if we learn how to utilize this environment to the maximum. This may not be important at the present time because the economic and political systems of various countries and the objectives of the various countries prohibit the use of this land for food production to feed the world’s starving people. The problem of this time and generation is to assess the value of this land and its productive capacity in hopes that future generations may use this area to survive. Agricultural research in this area should not be confined to the short-term objectives of the solution of immediate problems, but should be based primarily on the long-term objectives of readying this large land mass for future generations.
LIST OF EUROPEAN WORKERS TO WHOM REFERENCE HAS BEEN MADE

DENMARK


3. Mr. Nissen - Fredrickshoje. Scab, Rhizoctonia, and late blight control. Pages 8, 9, 10, and 15.


GERMANY

5. Dr. Bauer - Max Planck Institute, Köln-Vogelsang. Disease and cold resistance in small fruits, nature of resistance to Erysiphe on Ribes. Pages 21 and 22.


10. Dr. Frandsen - Max Planck Institute, Köln-Vogelsang. Resistance to late blight and wart. Pages 7, 8, and 10.

11. Professor Fuchs - Head of Department of Plant Pathology, University of Göttingen. Host-parasite relationship. Pages 7 and 18.

12. Dr. Gatner - Department of Plant Pathology, University of Göttingen. Mycologist. Culture of Phytophthora and Puccinia. Pages 7 and 18.


*Blanks are unknown names.


17. Dr. Menke - Department of Plant Pathology, University of Göttingen. Respiration inhibitors and late blight. Page 8.


23. Dr. Wetter - Biologische Bundesanstalt, Braunschweig-Gliesmarode. Potato viruses especially s, m, k, paracrinkle, etc. Page 11.


25. - Plant Pathology Department, University of Göttingen. Accumulation of phosphorus in rusted tissue. Page 18.

26. - Plant Pathology Department, University of Göttingen. Metabolism of nitrobenzines by soil organisms.

27. - Plant Pathology Department, University of Göttingen. Predation of aphids by serfids and population dynamics.

THE NETHERLANDS (Wageningen)


31. Dr. Rozendaal - Laboratory of virology. Potato viruses. Pages 12 and 15.

32. Dr. Van der Zaag - Research and Advisory Institute for field crops. Potato culture and late blight epidemiology. Pages 7 and 15.
33. Institute of research on storage and processing of agricultural produce. Potato storage. Pages 11 and 16.

34. Department of Agricultural Machinery and Farm Buildings. Machinery. Page 15.


38. Mr. Peter Krosby - Norwegian Seed Testing Station, Vollebekk. Seed testing and seed control. Page 23.

39. Professor Lindeberg - Department of Microbiology, Agricultural College of Norway, Vollebekk. Litter decomposition, physiology of parasitism.


42. Professor Wexelsen - Geneticist, Director of Agricultural College of Norway, Vollebekk. Page 19.

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43. Professor Åberg, Royal Agricultural College, Uppsala. Cereal breeding.

44. Mr. Sven Bingefors, Swedish Seed Association, Uppsala. Forage and cereal breeding. Page 19.

45. Dr. Dénward - Swedish Seed Association, Svalöf. Potato breeding; late blight races. Pages 7 and 14.


47. Mr. Sven Holmberg - Holmberg Seed Company, Norkopping. Cereal and soybean breeding. Pages 16, 17, and 18.


52. Dr. Keller - Landwirtschaftliche Versuchsanstalt, Zurich-Oerlikon. Seed certification, leafroll. Pages 8, 14, and 15.


