

## SOME NOTES ON THE HISTORY OF CURL

*Met een samenvatting: Enige opmerkingen over de geschiedenis van „Curl”*

BY

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It would appear that the earliest English reference to the disease in potatoes, later to be known as the Curl, is to be found in a book published in 1751, in which ROBERT MAXWELL (11) states that „In Galloway we find that potatoes for seed... require changing, not only from one ground, but also from one country to another, so when we have an opportunity of purchasing any from England or Ireland, we chuse them, and find that the produce is greater than from our own potatoes”.

The plaint that the crop of this or that variety fell off after a few years, has a very familiar ring about it, and before very long it was regarded as the result of some degenerative process. To-day we know it to be produced by disease. If it be true that the disease was known in Great Britain at the beginning of the second half of the XVIIIth century, such evidence as we have, leads us to believe that it was far from being general and that it had only recently been observed.

In Lancashire it was first recorded, according to RHIND, (17) in 1764, up till which time growers had seen no reason to make any change of seed. Nor indeed does it seem likely that they were aware of the external characters of a curled plant. Hence one is not surprised to learn that a farmer in the Liverpool area in 1766 (9) who „was very attentive to anything that had the appearance of profit, judged they must be some new sort, and very early, from their arriving at an immature ripeness sooner than the rest. Upon which grounds he had a number of this kind selected out of the crop, and kept for seed the succeeding year which he planted but found his error by a very great deficiency of produce. From this time they began to be dreaded and the evil seems to have kept increasing yearly”. Twenty years earlier a similar error had been made, as we shall see, on the Continent.

The disease spread rapidly, gathering impetus and extending its range with each succeeding season until it reached its apogee between 1780 and 1790. In Yorkshire MARSHALL, (10) the most experienced agriculturist of his day, writes „Curl has of late years been fatal to the potato crop in this and other districts”, a view which was shared by RALEY (16) who in 1782 wrote „the curl is so bad that it will soon extinguish the potato”. In Lancashire his prophecy looked like coming true, indeed the position was so threatening that several authorities feared that the growing of potatoes as a field crop would have to be discontinued. The Agricultural Society of Manchester took alarm and in 1778 offered a silver cup worth eight guineas „to the person who should discover, by actual experiment, the most probable cause of the curled disease in Potatoes”. It prefaced its invitation with the statement that the disease had been only known a few years and had made alarming progress.

Nineteen letters or essays were submitted but none was considered worthy of the prize, whose inadequacy, incidentally, is exposed by one of the contestants who pertinently remarks „who ever hits upon a remedy deserves six times the premium offered by your honourable Society”.

It might have been expected that in the course of these essays at least one

author would have afforded us a clinical description of the disease. But that was not to be, and we are left to build our picture of the Curl disease from such scraps of information as are to be found scattered through the essays. They are detailed below:

- Foliage:* (1) Letter XIII speaks of the diseased plants as „brocally leaved or curled potatoes”.
- Haulm:* (2) Letter XI states that occasionally only one stem of a plant is curled.
- Tubers:* (3) Letter XIII says they are „small and hard ill shaped, ugly, and of a disagreeable brown colour”.
- The old seed set:* (4) Letter XVII states that the set remains hard and undecayed.
- Use as seed:* (5) Letter IV advises that the tubers of a diseased plant invariably give rise in the following season to diseased plants.
- „ „ „ : (6) Letter VII states that large sized tubers more frequently give rise to curled plants than do small sized seed.

Of the six relevant passages, No 1 tells strongly in favour of the disease being due to an infection by the 'Y' virus. No 2 is, in my opinion, rather more frequently found in the case of 'Y' infection than that of Leaf Roll but cannot be held to be pathognomonic. No 3 is characteristic, at least in certain varieties of mixed infection by 'Y' and the more severe forms of the 'X' and Streak viruses. No 4 may occur as a sequence to any of the viruses mentioned. No 5 is of course common to all viruses concerned, as indeed is No 6. The evidence, such as it is, points definitely in the direction of a mosaic infection in which the 'Y' virus is playing the major role. The presence of Leaf Roll, however, cannot be altogether excluded. A like conclusion may be drawn from the remarks of HOLLINS (5) who described three types of Curl, one obviously a form of 'Curly Dwarf', another which results in the death of the plant before emerging above soil, and a third in which the leaves are long, slightly curled and the crop but moderate; features which might suggest an attack of Leaf Roll, especially in its first season.

Although the references to Curl in the literature increase as we approach the early decades of the XIXth century, in none, which I have met so far, can one discover with any degree of certainty what was the type of the symptoms of which complaint was made.

ANDREW KNIGHT (7) in 1810 writes „that the leaves of several kinds of potatoes, which were dry and farinaceous, that I cultivated, produced curled leaves, whilst those of other kinds which were soft and aqueous, were perfectly well formed”. This might be interpreted as a reference to potatoes with an early seasonal attack of Leaf Roll in which the leaves become tough and dry before they actually roll longitudinally. However, in a later reference to Curl (8) he talks of the „rough and crumpled state of the leaf” as the condition observed in the curled plants described in the earlier article. One is therefore driven to the conclusion that it is a „crinkled” leaf which he regards as characteristic of ‘Curl’.

A similar impression is conveyed by SPROULE (21) in 1844 when he observes that the leaves of an affected plant are diminutive and curled, which suggests an affection of a crinkle type of infection rather than that of Leaf Roll. It was not till a hundred years later, that is, till the second decade of the XXth century, that we

find in the literature any adequate and concise account of the symptoms included under the term 'Curl' as it occurs in England.

Curl was observed in widely separated areas of Great Britain. A review of the localities where it is most complained of is evidence rather of the intensity of potato culture than that these particular districts favoured infection. Indeed the southern counties where potatoes were proverbially subject to Curl, are rarely referred to and the midlands only occasionally; on the other hand, complaints of the prevalence of Curl are common during the critical years of 1780 to 1830 in the great potato growing areas, whether in the north of England, Scotland, or Ireland. Wales escapes attention not, we may be sure, because there was no Curl to be found there, but because potato culture was confined to the small peasant type of economy and hence created no problem of industrial or social importance.

The loss of crop soon led agriculturists in England to seek for varieties which were resistant to Curl.

New varieties began to invade the market and were often heralded as immune; scores more were bred and produced locally and never strayed far from the place of their birth. Whatever their origin it was not long before the great majority of them succumbed to the Curl. Many conflicting statements as to the relative behaviour of different varieties are to be found in the literature. Not a little confusion, however, is occasioned by the synonymy of varieties which, even at this early date, had begun to hamper the efforts of intelligent breeders. To-day, when we no longer can refer to the living plants, it is frequently impossible to know to which variety a given name used a century and more ago, belongs.

In 1782 ARTHUR YOUNG and others were much concerned about the situation and frequently refer to the varieties which succumbed to Curl and those which in their experience had withstood its onslaughts. If occasionally a variety was declared to be immune in one district, as often as not it would fall a victim in another, or was amongst the casualties recorded in the following year. In the same year YOUNG stated that all his white kidney potatoes had curled but none of his red kidneys. In one of the Manchester Letters of 1778 a similar experience is noted. In 1784 the Ilford Market Gardeners who were responsible for raising the greater part of the potatoes destined for the London market found themselves obliged to abandon the variety 'red-nosed kidney' which had hitherto been their sheet anchor. This same variety failed all over the country and, like many another, went out of cultivation.

The disease appeared in all the main potato growing areas of England though a few districts were reported to be free from the trouble. Usually the localities thought to be free of Curl were merely those in which potato growing had made little or no headway; yet there was a certain residue in which a reputation for freedom from Curl over the years became well established. Chief amongst these were the moss lands of Lancashire, the Hebrides and parts of Scotland, and the limestone hills of Denbighshire in Wales. As early as 1800 the custom of procuring a renewal of seed from the 'moor lands' and Scotland had become established amongst the farmers of Lancashire and Yorkshire and gradually spread throughout the north. In the south and midlands this did not become general for another hundred years. <sup>1)</sup> It will be observed that the areas which won the reputation

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<sup>1)</sup> The Scottish Potato Seed Industry had another and distinct origin. See Salaman, R.N. 1949. *The History and Social Influence of the Potato* (19).

for good 'seed' are, in fact, those which enjoy the climatic conditions we now know are inimical to the movement of the green-fly: high moisture-laden winds, and heavy rains.

An examination of the literature relating to Curl in England from the middle of the XVIIIth to the end of the XIXth century creates a clear impression, viz that the symptoms observed were those of the Mosaic and Crinkle types of virus infection, and that Leaf Roll infection, if it occurred at all, was extremely rare. In contrast with this is the fact that in the last three decades of the present century, whilst the mosaic-crinkled type of disease is common enough in those parts of the country where the potato is only a collateral or a garden crop in the agricultural system of the district, in the great potato growing areas where the utmost care is taken to plant 'healthy seed' and the finest crops are raised, it is relatively rare. It is not uncommon, however, for a widespread attack of 'Curl' to develop in the most favoured potato areas in Scotland and Ireland within a season. In such cases the trouble has almost invariably been due to Leaf Roll.

So much has this view impressed itself on those conversant with the potato crop that the belief has gained ground that the Curl complained of during the last forty or fifty years has in the main been due to the spread of Leaf Roll. Such may indeed be true, but it would seem certain that prior to that, the 'Curl' was a severe mosaic or crinkle, presumably due to infection by the 'Y'-virus.

A comparison of the data concerning Curl of the potato on the Continent with that which I have outlined above in respect to Great Britain, brings out several facts of interest. On the Continent, Curl was recognised some thirty years earlier than in England and does not appear so rapidly to have attained the importance that it won in Great Britain. On the other hand, it must be gratefully acknowledged that the disease is described in much greater detail and with far greater accuracy, thus allowing a distinction to be made between a 'Curl' of the mosaic-crinkle class of virus symptom and one of the Leaf Roll type.

The earliest Continental description of Curl I have discovered, occurs in a Doctorate thesis by CONRAD TOBIAS HOPPE which he presented to Prof. ERNEST BRÜCKMANN in Wolfenbüttel in 1747. The pamphlet, which was brought to my notice by Mr S. SAVAGE, Assistant Secretary of the Linnean Society, is to be found in a bound volume of collected Essays in Linneaus' own Library, now in the possession of the Linnean Society of London. HOPPE's (6) thesis consists of 32 quarto pages and was printed in 1747. The Title Page runs as follows:

T. C. H(OPPE)

Kurzer Bericht von denen Knollichten und essbaren Erd-Aepfeln,  
oder denen  
Solanis Tuberosis Esculentis,  
welche in der Haushaltung sehr dienlich und einem Land-Gute vielen  
Nutzen schaffen können,  
nebst  
einem kleinen Anhang  
von  
Hier zu Lande wachsenden geringen Gewächsen  
welche doch gleichwohl in der Haushaltung brauchbar sind  
in einem Send-Schreiben  
an Herrn Francisc. Ernest Brückmann, Phil. & Medicinæ

Doctoren, Acad. Caesar Nat. Cur. & Soc. Reg. Pruss. Scient.  
 Membrum Collegii medici Brunsvic Assessor und Med. Pract.  
 in Wolfenbüttel

Wolfenbüttel, verlegt von J. C. Meissner, 1747

On page 13 HOPPE speaks of the Potato, *Solanum Tuberosum esculentum*, describing four varieties differing from each other only in respect to the colour of tuber and flower. He then proceeds to describe what he can only call a fifth species which is so peculiar as to merit the additional title '*crispis*'. The characters of this aberrant species are described as follows: Dieses weicht von vorhergehenden sorten im kraute ganz ab, es ist solches sehr milde und kraus, und gleich den *Italiänischen braunen Blumen-kohl* <sup>1)</sup>).

Um hiesige gegend heissen sie die Land-Leute *Paruquen-Aepfels* <sup>1)</sup> weil das kraut einer Paruke gleicht, die Aepfel sind gut vom geschmack.

HOPPE goes on to say that in the district of Gerra (60 km S.E. of Leipzig) the Potato had only been introduced 6-8 years previously, i.e., c. 1740.

This fifth species of HOPPE's was obviously a severely 'curled' potato, whose occurrence in his district at the time of his writing must have been not uncommon or it would surely not have already acquired so apt a sobriquet as *Paruquen aepfel*.

The question as to whether the Curl was of the Leaf Roll or the Crinkle type can be settled with something very near certainty. Much depends on what was the type of leaf of the Brown Italian Cauliflower. There are two possibilities: one, that like the Cornish cauliflowers and broccolis of to-day, the leaves are long and smooth with a slightly waved edge, the other, that the leaf is rounder, shorter, and its surface rugose. On this issue I have had the benefit of the advice of the greatest living English authority, Mr WALTER F. GILES; his opinion is that the brown Italian broccoli of the mid-XVIIIth century had most probably a rugose leaf. He informs me that the brown Italian broccoli he knew in Italy some fifty years ago had a leaf as intensely crinkled as that depicted in fig. 90 of his communication to the Royal Horticultural Society (4). A similar type of rugose leaved broccoli is presumably intended in RONALDS (18) description of a Late Dwarf close-headed broccoli as well as the variety Giant Sulphur described by him and grown in Cornwall up till 1830. Old men in the Penzance area of Cornwall still speak of the pre-Roscof strains of broccoli as Italian and describe the leaves as being 'very curly'.

If then HOPPE's analogy between the abnormal 'species' of potato he calls '*crispis*' and the broccoli implies as I believe a variety which had rugose leaves, we can confidently assume that the condition of the leaf of his '*crispis*' variety of potato was similar to that we know to-day as Crinkle or Severe Mosaic. We may go further and say that the probability is that the appearances he described resulted from a chronic infection by the 'Y' virus or from a combination of the viruses 'A' and 'X'. To the consideration of this latter possibility I will return later.

HOPPE's further comparison of the '*crispis*' species of potato to a 'Peruke' raises an intriguing issue. Men's wigs were subject to the dictates of fashion to almost as great an extent as was the head-dress of their women-folk. Moreover,

<sup>1)</sup> The italics are mine, R. N. S.

the fashions were not uniform throughout Western Europe and England. We can dismiss at once the great heavy curled wig of the late XVIIth and early XVIIIth centuries: it had gone completely out of fashion before the middle of the century. A peruke, strictly speaking, was a service wig used for travelling and compaigning, hence it was far less exaggerated and more conventional in type than the full-bottomed wigs of Queen Anne's reign (1702–14). I have consulted the available literature and examined all the XVIIIth century portraits in the Royal Society and the National Portrait Gallery in London, and have found that the great majority of the wigs of the mid-XVIIIth century were, as regards the areas covering the crown, back, and upper half of the sides of the head, wavy and often 'nodular' but never rolled; on the other hand, the lower half of the sides was made up of one or two horizontally rolled curls – generally the rolls were rather loose and soft in appearance, quite unlike the formal hard pipe-like roll which is still retained in the wigs of English barristers to-day. This interpretation of the character of the peruke is further borne out by Grimms Dictionary. Under 'peruke' SCHILLER (1759–1805) is quoted as follows: „Setzt die perrücken auf von millionen Locken", and, again, „Sein Herbarzt, ein studierter Herr mit knotigter peruke", both of which suggest a peruke with an irregular crumpled surface, rather than one tortured into formal rolls.

To sum up, both of HOPPE's similies point to a condition of leaf which fits closely with the picture familiar to us in Mosaic-Crinkle infection of the potato, whilst differing *in toto* from that characteristic of Leaf Roll.

It is interesting to note that HOPPE uses the word „Aepfel" as meaning the berry and says those of his 'crispis' variety taste well. It is rather as a second thought that he adds „die erwähnte fünf species (including 'crispis') dienen also vor Menschen und Vieh, so wohl das kraut als die knollen".

PARMENTIER who wrote so much about the potato, has little to say about the Curl, though he did devote a short space to it in an essay written in 1781 (13) when he identifies Curl with what he calls Frisée or Pirvé. It would appear that the condition he is describing is that which we know as Mosaic or Crinkle.

MÜNTER in his excellent account of the Diseases of the Potato (12) states that MÜLLER in 1780 described the „Krauselkrankheit" which he says is known in England as Curl, and which has already been observed in Darmstadt and Schwabia. In the same book MÜNTER refers to the work of ALBRECHT THAER who in 1790 observed a similar trouble in Hannover and identified it with the English Curl. The haulm, he says, is dwarfed before flowering, wilts and dries and the crop is miserable. He observes that seedlings often become seriously affected, a fact which coincides with my own experience.

The pastor STOCKMAR (22) describes the 'curl' as it occurred near Halle. The haulm, he says, was crinkled and seemed to be fully „eingeschnitten" – again a picture of Crinkle. STOCKMAR was convinced that the trouble was an infectious disease due to growing in the proximity of the English variety 'Howard', the famous cattle potato, whose pollen he thought infected the neighbouring plants. This fanciful suggestion apart, the statement has a certain interest of its own. For suspicion to rest on the 'Howard', the latter must have itself appeared infected, which is somewhat surprising seeing that in England at this time the 'Howard' was held up as the crowning example of a variety which maintained an immunity to the trouble.

In 1819 PUTSCHE published his important work on the Potato (15). He also

described the disease of 'krauselkrankheit' and identifies it with the English 'Curl' and the French 'Frisolée'. The leaves, he says, are crinkled and harsh and close to the stem. The colour is not brownish or dark green as the leaves of healthy stocks, but at once a scattered mixture of these different colours, so that in brown green leaves bright and yellow green spots occur.

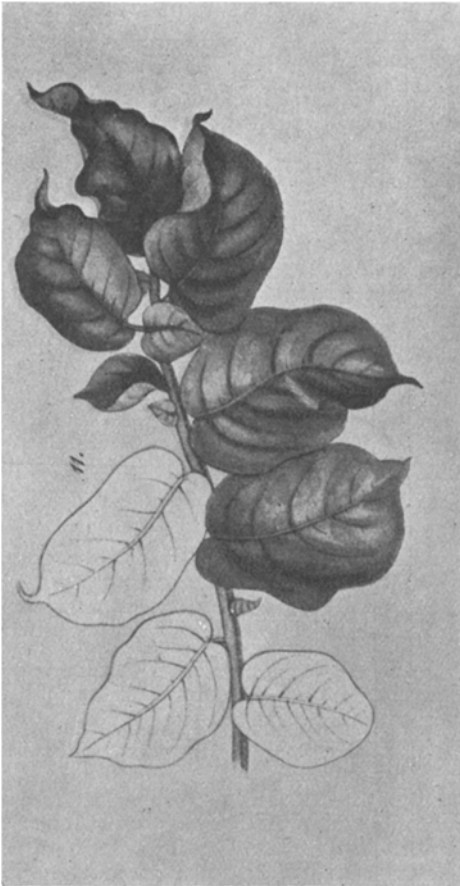
When Graf FRIEDERICH BERCHTOLD (2) says the leaves of the diseased plants are „rauh runglich, mager, kraus, und verschrümpft, sitzen mehr am stengel", he leaves one in no doubt that the disease described is Crinkle.

HERMANN SCHACHT (20) contributed an illustration as well as an admirable description of the Curl, both of which are here reproduced. It is of interest that he should with so much perspicacity have concluded that Curl was identical with the disease that had ravaged Germany between the years 1776 and 1784, and Scotland between 1770 and 1810, and nevertheless have fallen into the grievous error of

believing that Curl was but another form of the Blight of 1845, and that the early devastations of the potato referred to were attacks of the same disease. Here is SCHACHT's description in the original:

„Die krauselkrankheit zeigt sich am Blatte zuerst in Form rosenroth oder Violet-braun gefärbter Flecke, welche an der Spitze und an den Randern des Einzelblattes und zwar vorzugsweise am endblatte auftreten (See fig. 1). An der oberseite erschien sie zuerst, der Rand des Blattes krauselt sich; seine wellenförmigen Falten richten sich empor. Die gekrauselten, violett-braun gefärbten Partien fühlen sich gleich-zeitig starrer, fester an als das sie umgebende gesunde, aber weiche Blattgewebe."

We have now traced the history of Curl in England and the countries of Western Europe over one hundred years, viz., from 1750–1850 and have so far gathered no clear evidence of the occurrence of true Leaf Roll. On the other hand, there is abundant evidence of the wide distribution of a disease known under the names of Curl, Kräuselkrankheit and Frisolée. Nor is there any doubt but that the clinical symptoms displayed by this disease were identical with that which in our day we



A leaf of a Curled Potato Plant from Hermann Schacht's Bericht. Taf VI, fig. 11. Berlin. 1856

call severe Mosaic or Crinkle, the causative virus or viruses of which we now know.

The problem of how and when other virus infection occurred which became included under the general term 'Curl', is worthy of some consideration.

As a serious and widespread disease of the potato, I think we may safely infer that Leaf Roll had not appeared either in England or on the Continent before the end of the first decade of the XXth century. How little it was known may be deduced from the fact that it was only after it had swept over Germany in epidemic form in 1904, that OTTO APPEL (1) recognised and described it as a separate disease. In his classical paper APPEL identified Leaf Roll with Kräuselkrankheit and notwithstanding his photograph of the typical Leaf Roll infected plants, he states that SCHACHT's description applies equally to his, this is an error as is his ascription of the cause of Leaf Roll to a fusarium fungus invading the vessels.

With the work of ORTON in America, QUANJER and OORTWIJN BOTJES at Wageningen, MURPHY in Dublin, KENNETH SMITH, BAWDEN and myself in Cambridge, Curl was at last brought within the field of exact science and analysed into its constituent pathogenic factors. In 1937 STANLEY in America isolated the actual virus particle of Tobacco Mosaic, a work which was followed by BAWDEN and PIRIE of Cambridge with regard to the 'X' and other viruses of the potato. This phase, too, is drawing now to its close, and the study of Curl, as of kindred diseases in other plants, is gradually passing out of the hands of the biologist, to become the monopoly of the statistician, the physicist and their allies.

We cannot leave the subject of Curl without considering a problem which is as full of interest as it is obscure, viz., the origin, advent and spread of a virus in a particular crop. From what has been said so far, it would appear that towards the second half of the XVIIIth century, one or more viruses made their appearance in the potato crops at some point on the Continent, from whence they spread, not necessarily continuously, from Swabia in Central Germany, to Darmstadt on the Rhine. From the Rhineland one may suppose that the viruses were carried by winged aphids via Eastern France and the Normandy coast to England, reaching the main potato growing areas about 1770. We can say with some confidence that the chief and may be the only virus involved was the aphid-carried 'Y' virus, and perhaps with equal confidence that the virus of Leaf Roll, also aphid-carried, was not present in England until near the end of the XIXth century.

In view of our present day knowledge of the viruses capable of producing the syndrome our ancestors called Curl, the question arises as to whether the viruses 'X' and 'A' were not also involved. Virus 'A', though also aphid-carried, is by itself from a clinical standpoint, almost negligible. The Scotch Champion variety in its decline after a highly successful career of nearly fifty years in Ireland, according to CLINCH and others (3) contained the virus 'A' but not 'X'; how long it had been present we cannot say. We know, however, that if 'A' is joined by 'X', in most of our varieties a Crinkle ensues. Hence the presence or absence of 'X' becomes a matter of importance. Recently VAN DER PLANK (14) has shown very good reasons for the belief that the virus 'X' is a latecomer to England and that it did not seriously affect our potato stocks till after the first decade of the present century. If he is right, then the virus 'A' would have played no part in the production of Curl.

If virus 'X' is a recent importation, there seems to be no reason why Leaf Roll



should not be so also; this can only be substantiated by a study of the descriptions which have come down to us, hence the importance of a correct interpretation of the clinical symptoms of Curl as observed by our ancestors of the XVIIIth century.

There is a further aspect of the problem of Curl which deserves consideration, namely the manner in which a virus is conveyed, for this must necessarily influence its spread both in space and time. As virus 'X' is acquired by contact between the leaves, and roots, of contiguous plants, it follows that it is necessary to introduce an infected plant into an 'X'-free district before any 'natural' spread of disease can take place. For the same reasons its spread will be neither rapid nor epidemic in character.

The viruses 'A' and 'Y' as that of Leaf Roll, are conveyed by aphides hence the spread, of 'Y', can become serious locally under conditions favourable to the multiplication and dispersion of the vector. In regard to Leaf Roll, wide spread epidemics are not infrequent at the latter end of the season. This difference in behaviour is related to the fact that the 'Y' virus remains active in an infected aphid but a very short time, whereas the Leaf Roll virus persists and renders the insect infectious over an indefinite period.

If we are correct in believing that virus 'X' did not appear in force in England until the beginning of the XXth century, then we may rule out virus 'A' as a cause of Curl. This leaves us with 'Y' and Leaf Roll. Of them we can say that Leaf Roll did not come in with the potato from South America for it is unknown amongst the indigenous cultivated varieties. Virus 'Y' in the form we know it, is also absent from the native South American varieties, though a related type is to be found amongst them. It is therefore not surprising that we hear nothing about Curl for a full century and a half after the potato reached Europe. What the source and where the focus from which the first great epidemic of Curl was derived, we do not know. Nor are we in better case as regards the later epidemics of Leaf Roll which were responsible for most of the Curl observed in Great Britain during the early decades of the XXth century.

At this point we may bring the tale of Curl in the potato to its logical conclusion, namely the steps which are being taken to establish a supply of Curl-free, i.e., virus-free, potato-seed stocks.

In 1934 I presented a scheme to the Potato Marketing Board of Great Britain by which the virus-free stocks of some dozen standard varieties which I had isolated during the previous eight years whilst Director of the Potato Virus Research Station at Cambridge, might be multiplied and distributed on a commercial scale, whilst still maintaining a laboratory check on their health.

Before the war, the authorities were not interested, during the war they were not in a position to undertake the work, but after the war the project was adopted by the National Institute of Agricultural Botany who, employing both the material and the methods advocated in the original scheme, have, during the last few years, been distributing virus-free stocks to the Potato Seed producers of Scotland and Northern Ireland, with most encouraging results.

I trust I may be forgiven if, without assuming too much on the vantage which age and experience are sometimes thought to confer, I close this essay on a note of caution. I feel strongly that we must not allow ourselves to be so beguiled by the brilliant discoveries of the mathematicians, chemists and physicists in the realm of virus study as to neglect the training of young workers who will carry

on the great tradition of phytopathologists so brilliantly represented by QUANJER, who to-day „we are delighted to honour”. The catastrophes which have overtaken the cocoa plant in West Africa and the clove-trees of Zanzibar, are timely warnings that the shortage of trained pathologists and field workers, a consequence not only of the war but of the misplaced parsimony which preceded it, must be made good without delay if we are to conserve the food stocks of the world.

#### SAMENVATTING

De eerste Engelse vermelding van de aardappelziekte, die later „Curl” genoemd wordt, wordt gevonden in een in 1751 verschenen boek van MAXWELL. Oorspronkelijk werd onder „Curl” een grofmozaiek of kinkel verstaan, een ziekte vermoedelijk veroorzaakt door het Y-virus. Op het vasteland van Europa werd „Curl” (Kräuselkrankheit) een dertig jaar eerder herkend dan in Engeland. De eerste beschrijving vindt men bij HOPPE (1747). Gedurende de laatste veertig of vijftig jaar is – zoals aannemelijk wordt gemaakt – de als „Curl” beschreven ziekte hoofdzakelijk veroorzaakt door het bladrolvirus, dat zich in de eerste decade van de twintigste eeuw begon te verspreiden.

#### LITERATUUR

1. APPEL, OTTO, Neuere Untersuchungen über Kartoffel- und Tomaten Erkrankungen. Jahrber. Vereinig. angewandten Bot. 3 Jahrg. 1904/5, pp. 122–136, 1906.
2. BERCHTOLD, Graf FRIED. VON, Die Kartoffeln. Prague, 1842.
3. CLINCH, P., J. B. LOUGHNANE and P. A. MURPHY, A study of the infiltration of viruses into seed potato stocks. Sci. Proc. R. Dublin Soc. N.S. 22: 17, 1938.
4. GILES, WALTER F., Cauliflower and Broccoli. J. Roy. Hort. Soc. 66: 265–277, 1941.
5. HOLLINS, W., Curl of Potato. J. Soc. of Arts, p. 19, 1790.
6. HOPPE, T. C. H., Kurzer Bericht v. d. Knollichten u. essbaren Erd-aepfeln. J. C. Meisner, Wolfenbüttel, 1747.
7. KNIGHT, ANDREW, On Potatoes. J. Hort. Soc. 1; 187–196, 1810.
8. KNIGHT, ANDREW, On the Prevention of the Disease called Curl in the Potatoe. J. Hort. Soc. 2: 64–67, 1813.
9. Manchester Letters, Letters re Curl I–XIX. Manchester, 1778.
10. MARSHALL, W., The Rural Economy of Yorkshire, Vol. II, p. 53, London, 1788.
11. MAXWELL, ROBERT, The Practical Husbandman, 1757.
12. MÜNTER, JULIUS, Die Krankheiten der Kartoffeln. Verlag Hirschwald. Berlin, 1846.
13. PARMENTIER, ANTOINE, Sur les Pommes de Terre. Paris, 1789.
14. PLANK, J. E. VAN DER, Some suggestions on the History of Potato Virus X. J. Linnean Soc. Bot. 53: 251–262, 1949.
15. PUTSCHE, CARL, Versuch einer Monographie der Kartoffeln etc. Weimar, 1819.
16. RALEY, A Treatise on the Management of Potatoes. London, 1782.
17. RHIND, WILL., A History of the Vegetable Kingdom. Blackie & Son, Glasgow, 1840.

18. RONALDS, HUGH, Description of the Different Varieties of Broccoli. Trans. Hort. Soc. 13: 161-169 (1920) London, 1818.
19. SALAMAN, R. N., The History and Social Influence of the Potato. Camb. Univ. Press., 1949.
20. SCHACHT, HERMANN, Bericht an das königl. Landesökonomie collegium u. d. Kartoffelpflanze, Berlin, 1856.
21. SPROULE, JOHN, Elements of Practical Agriculture, 3rd ed., 1844.
22. STOCKMAR, Landwirtschaftlicher Zeitung, 4: 501, 1806.

## SYSTEMS OF VIRUS CLASSIFICATION AND NOMENCLATURE

*Met een samenvatting:*

*Systemen van classificatie en nomenclatuur van viren*

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The first discovery that a virus disease was transmissible from one host species to another species or genus indicated the need of a form of nomenclature to avoid confusion in the identification of disease. The further need for virus disease classification and nomenclature was established by the recognition of more than one kind of virus disease on a single host species. Thus the early work of QUANJER on potato virus disease differentiation was a pioneer effort in this direction (35, 36). In QUANJER's, and in most of the later descriptions of virus diseases, symptom expression was the chief basis for differentiation (39). With the discovery of distinct virus diseases in larger numbers and with the accumulation of more information about their causal agents, it became evident that symptom expression alone was both insufficient and unreliable as a criterion for the differentiation of many virus diseases. Such variables as the variety and growth stage of the host at the time of infection, the environmental conditions and other circumstances were found to influence symptoms to a remarkable degree. The discovery of the presence of viruses in symptomless hosts added to these difficulties.

Other means of differentiation and identification were consequently sought such as those based on the properties of the virus. These studies developed into the logical conception that the virus entity itself, as the causal agency of disease, was the primary subject in need of description and differentiation. The disease symptoms, though highly useful in the identification of certain viruses, seemed destined to find their greatest usefulness in distinguishing strains of the same virus. Some progress was made before 1930 in the differentiation of many viruses on the basis of modes of transmission, properties, host-range, symptomatology and other criteria. The origin of the common names applied to the different viruses, and especially the increase of synonymyous names for a single virus soon became highly confusing to research workers and students of pathology alike. A single technical designation for the virus entity itself seemed to be the logical way of avoiding further confusion.