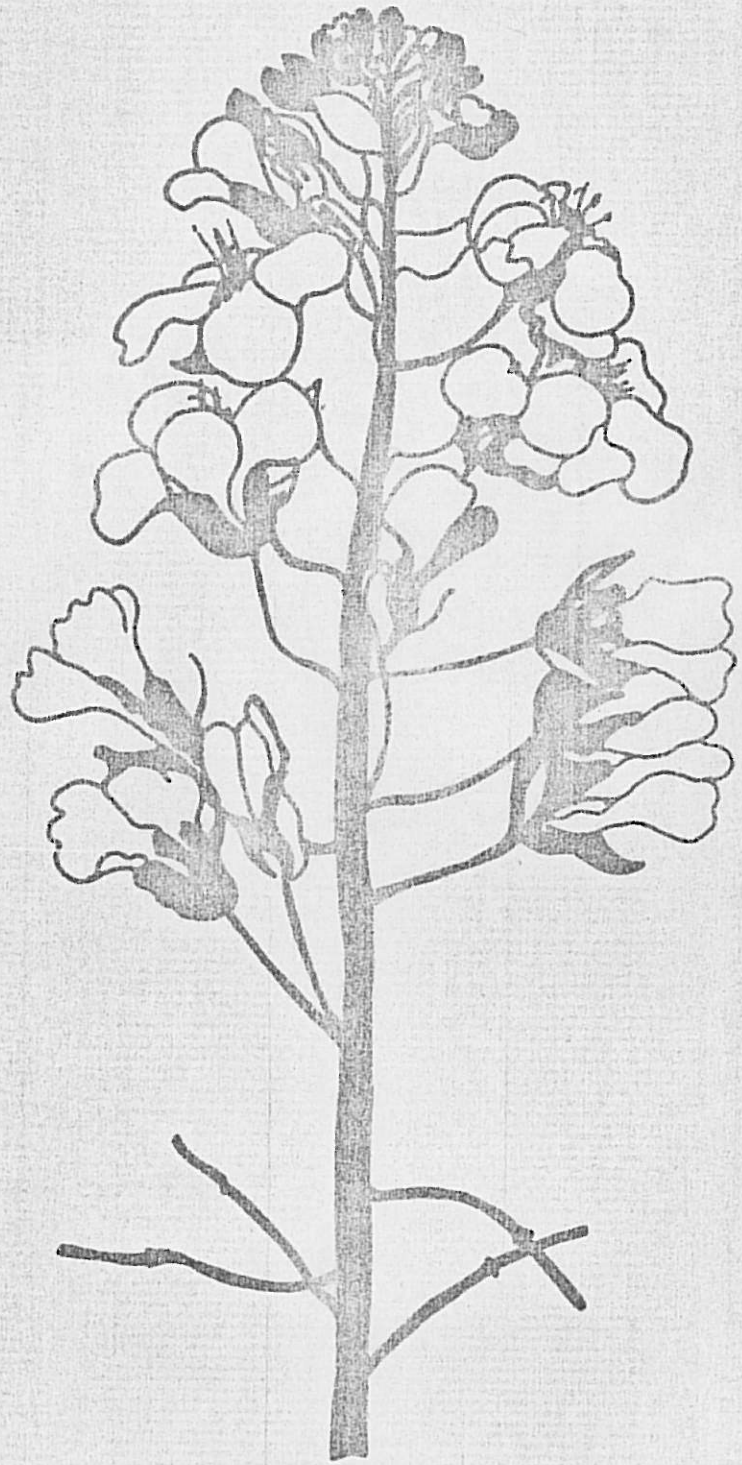
# EUCARPIA

# CRUCIFERAE



## NEWSLETTER No. 2

December 1977

## Editorial

This is the second edition of the Cruciferae Newsletter, the production of which was first debated at a meeting of the Vegetable Crops Section of Eucarpia in 1974. The Newsletter is now at a critical stage in its life. Will the initial enthusiasm for the venture be maintained so that a steady flow of up-to-date information is passed out to a wide range of readers? Does this range represent adequately the interests of brassica workers in terms of geographical location, crop species and research topics?

If the Cruciferae Newsletter is to survive as a viable entity it must create sufficient interest to attract contributions readily and it must continue to receive financial backing. As a reader of it you are asked to draw the attention of colleagues to it and to encourage them to offer contributions for Newsletter No. 3. Our intention is to provide a forum for the exchange of views and a means of notifying the results of recent research before they are ready for formal publication. Readers are reminded that material published in the Newsletter should not be quoted elsewhere without the authors permission.

The first Newsletter was financed largely by the Board of Eucarpia. For this and the next two annual issues we have been offered a supporting grant by the Chairman of the National Seed Development Organisation, Cambridge, U.K., Mr. M.G. Falcon. We would like to express our thanks to him and to the Board of N.S.D.O. for this contribution.

Chris North, editor and founder member of Cruciferae Newsletter No. 1 retired recently and is living at Newmill of Knapp, Inchture, Perthshire, U.K., where he hopes that colleagues and other brassica workers will maintain contact with him. We wish him a happy and active retirement with a continuing interest in painting.

Tony Wills, also of the Scottish Horticultural Research Institute has filled Chris North's place as editor. The assistance of Ian McNaughton of the Scottish Plant Breeding Station in preparing this issue is gratefully acknowledged.

The Newsletter will be published annually towards the end of each year. Contributions should be sent so as to reach Mr. Whitehouse at the address below by 20th October 1978.

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Announcements

1. Questionnaire

Please use the questionnaire to provide the editors with information and ideas which may help to enhance the value of future Newsletters. If you indicate that you are willing to contribute to No. 3 we will send you a reminder during September 1978.

2. New Cultivars

In future the editors would like to have brief information about new crucifer cultivars, their origin and likely place in agriculture.

3. Exchange and Mart

We hope to include in No. 3 a section devoted to the exchange of seed, germplasm or information. If you have or need special genetic material for gene banks, hybridisation or other experimental purpose please include a note to this effect together with your address. The editors cannot undertake to store or forward such items.

Similarly if you need information as part of a survey or study please include a request for it in Newsletter No. 3 to reach the Scottish Plant Breeding Station any time from now to 20th October 1978.

4. 3rd International Congress of Plant Pathology, Munich. 16-23 August 1978

The International Clubroot Working Group (I.C.W.G.) will organize an evening discussion group during the congress under the title "Clubroot Workshop". The possible date will be 18 August 1978. A tentative programme will be available in the next few months. For further information please write to Dr Peter Mattusch (address below).

4th Meeting of the International Clubroot Working Group during the 3rd International Congress of Plant Pathology.
Following the above mentioned evening meeting the International Clubroot Working Group will hold the 4th meeting. At the present time it is uncertain whether it will be a one or two day meeting. This depends on the number of interested participants and the room facilities available. The possible dates will be 19/20 August 1978. For further information please contact:

Dr Peter Mattusch,
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# BRASSICA CLOSEST RELATIVES

César Gómez-Campo

The tribe Brassiceae to which the genus Brassica belongs, is only one of the nineteen tribes that are usually recognized in the Crucifer family. After the contents of a few recent publications, some changes need to be introduced in the list of genera of this tribe. These are briefly reviewed below.

Three tentative new genera have been described in the last few years. The genus Quezelia Scholz from Tibesti mountains (SCHOLZ, 1966) appears to be a very distinct drought adapted taxon whose affinities are still uncertain. Though its facies resembles that of other desertic plants as Foleyola, Zilla, etc., the fruit is more primitive in structure. The genus Fabrisinapis Townsend was described from Sokotra island in the Gulf of Aden (TOWNSEND, 1971). However, its affinities with Hemicrambe soon became so apparent that both taxa have been united under the last generic denomination (GOMEZ-CAMPO, 1977). Two related species growing seven thousand kilometers apart, with no relatives in between, provide an interesting case of geographic disjunction. The genus Pseudofortuynia Hedge was described (HEDGE, 1968) from central Iran. It is somewhat similar to Moricandia but the presence of a combination of three primitive characters make it to appear very distinct.

Other generic names should be definitely erased out of the list. Such is the case of Spryginia M. Pop and Orychophragmus Bunge which are now regarded (BOTSCHANTZEV, 1966) as closer to the tribe Hesperideae. Also Calepina Adans. is very doubtfully a member of the tribe Brassiceae, though the proper place for this genus remain to be determined. Finally, two other related genera, Rhynchosinapis Hayek and Hutera Porta have been combined under the last generic name, with basis on a gradative clinal variation observed between member species of both (GOMEZ-CAMPO, 1977).

With all the above modifications included, the list of genera of the tribe Brassiceae becomes as follows:

Ammosperma (1)
Boleum (1)
Brassica (37)
Cakile (7)
Carrichtera (1)
Ceratocnemum (1)
Chalcanthus (1)
Conringia (6)
Cordylocarpus (1)
Crambe (31)
Crambella (1)
Didesmus (2)
Diplotaxis (20)
Douepia (18)
Enarthrocarpus (5)
Eremophyton (1)
Eruca (4)
Erucaria (8)
Erucastrum (11)
Euzomodendron (1)
Fezia (1)
Foleyola (1)
Fortuynia (2)
Guiraoa (1)
Hemicrambe (2)
Hirschfeldia (2)
Hutera (12)
Kremeriella (1)
Moricandia (8)
Morisia (1)
Muricaria (1)
Otocarpus (1)
Oudneya (2)
Physorrhinchus (2)
Pseuderucaria (3)
Pseudofortuynia (1)
Psychine (1)
Quezelia (1)
Raffenaldia (2)
Raphanus (3)
Rapistrum (2)
Reboudia (2)
Rytidocarpus (1)
Savignya (2)
Schouwia (2)
Sinapidendron (4)
Sinapis (7)
Succowia (1)
Trachystoma (3)
Vella (3)
Zilla (2)

The tentative number of species for each genus has been indicated with parentheses. There are fifty-one genera and two hundred and thirty-five species. It is to be noted that twenty-one genera are monotypic.

Most of the genetic variability of the tribe Brassiceae is concentrated in the West Mediterranean region, especially in Morocco, Spain and Algeria.

A number of recent papers on cytogenetics (HARBERD, 1972), seed coats (BENGOECHEA and GOMEZ-CAMPO, 1975), juvenile characters (GOMEZ-CAMPO, 1974) and flower characters (CLEMENTE, 1977) has helped to provide new points of view on the phylogenetic relations between the members of the tribe. Present and future studies in this field may lead to additional taxonomic changes. Some doubts have been raised, for instance, in relation to the status of Conringia. The case of Brassica itself may well be an object of revision in the near future, since as it is conceived today, the genus appears to be rather heterogeneous and seems to have a poliphyletic origin. In general, figures for the number of species are much dependent upon the criteria used, but the tendency seems to be towards giving sub-specific rank to some of the species at present included in large genera as Crambe or Brassica.

In the light of present knowledge, the genera which can be considered the most directly related to Brassica might be: Erucastrum, Diplotaxis, Hirschfeldia, Eruca, Hutera, Sinapidendron, Sinapis and Raphanus.

Literature:

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CLEMENTE, M. (1977) Doctoral Thesis. Esc. T. S. Ing. Agrónomos. Universidad Politécnica. Madrid. 378 pp.

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# BREEDING IN FRANCE OF A RADISH F1 HYBRID OBTAINED BY USE OF CYTOPLASMIC MALE STERILITY.

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In 1968, OGURA described a new male-sterility in Japanese radish, Raphanus sativus L., controlled by a cytoplasmic and genic system.

This material was supplied to us in 1969.

A series of crosses made with several lines issued from European varieties of little radishes proved that this male sterility is due to the interaction of the sterile cytoplasm and a single recessive nuclear gene further complicated by interference of modificatory genes.

Some sterility maintainers were discovered in the European material ; a good male-sterile line was obtained by backcrosses and the stability of the character was checked over nine generations.

Several F1 hybrids were made from 1972 on using this male-sterile line. All manifested great vigour expressed in a net gain in precocity ; they were homogeneous, solid and tasty.

A F1 hybrid was registered in the Official Catalogue of species and varieties in 1977.

Trials are in process to study F1 seed production problems as seed yield is poor in spite of the good fertility of the female line. Accordingly, the price of seed will be high.

A diversification of sterility maintainer lines will allow male sterile F1 hybrids to be obtained in a few years and thus permit three-way crosses. The latter have sufficient homogeneity and a yield equal to F1 hybrids. Used as parents, F1 hybrids have a seed production at last five times higher than that of lines.

## References

Bonnet A., 1975. Introduction et utilisation d'une stérilité mâle cytoplasmique dans des variétés précoces européennes de Radis. Raphanus sativus L. Ann. Amélior. Plantes, 25 (4), 381-397.

Ogura H., 1968. Studies of the new male-sterility in Japanese radish, with special reference to the utilization of this sterility towards the practical raising of hybrid seeds. Mem. Fac. Agric. Kagoshima Univ., 6, 2, 39-78.

# TRANSFER OF ECONOMIC CHARACTERS BY MEANS OF INTERSPECIFIC AND INTERGENERIC CROSSES IN THE TRIBE BRASSICEAE OF CRUCIFERAE

H.Namai

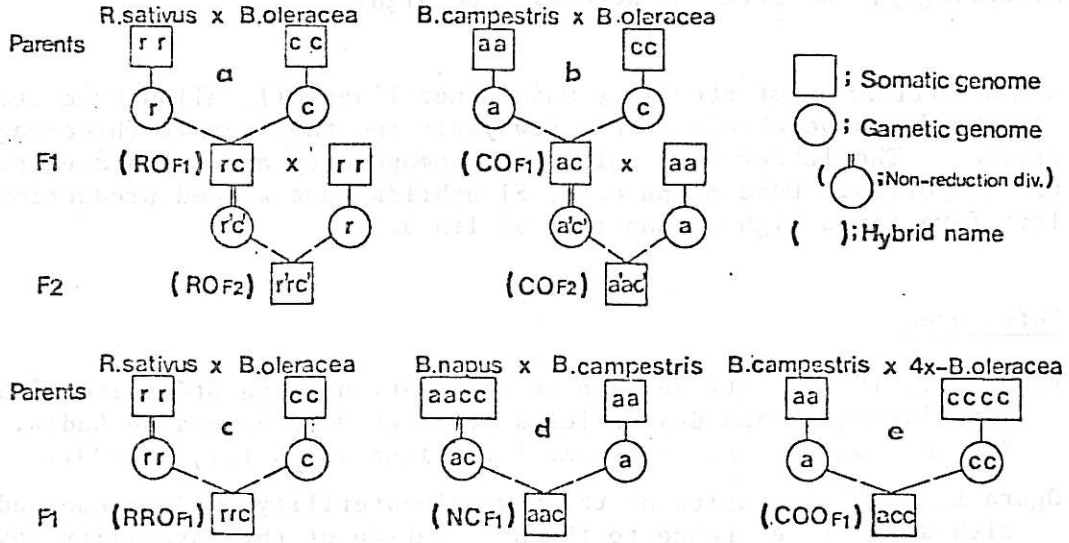
The author has been engaged in cytogenetic and breeding studies of the interspecific and intergeneric hybridizations in Cruciferous crops,with the special reference to the transfer of economic characters from B.oleracea(2n=18,cc) to Raphanus sativus(2n=18,rr),from B.oleracea and B.napus(2n=38,aacc) to B.campestris(2n=20,aa),and from B.campestris to B.napus. For that purpose many sorts of hybrids were obtained. They were sixty amphihaploid F1 plants namely ROF1 (2n=18,rc) and one sesquidiploid F1 plant RROF1(2n=27,rrc) obtained from the crosses between R.sativus and B.oleracea,three amphihaploids F1 plants COF1(2n=19,ac) obtained from B.campestris and B.oleracea, fifteen sesquidiploid F1 plants COOF1(2n=28,acc) obtained from B. campestris and 4X-B.oleracea,and forty four sesquidiploid F1 plants NC or CNF1(2n=29,aac) obtained from B.napus and B.campestris. These interspecific and intergeneric hybrids were classified into two groups being based on the way of formation of the sesquidiploid plants as follows;

(1) Type-1 -- in which the sesquidiploid plants were obtained in the F1 generation as in c,d and e of Figure.

(2) Type-2 -- in which the sesquidiploid plants were obtained in the F2 generation as in a and b of Figure.

It appeared that the parent-like reversional plants such as radish-like,Chinese cabbage-like,turnip-like,etc.were segregated in the next generation of the sesquidiploid plants including hyper- and hypo-ones. The term"parent-like reversional plant" means the offspring which has the same number of somatic chromosomes and a very similar plant shape as one of the parental species has,and their genome constitution is presumed to be much the same as that of the parental species.

In the 2nd generation from the sesquidiploid RROF1 plant,all of 113 plants obtained by selfing,back-crossing with parental radish cultivar or open-pollination were completely radish-like reversional plants that had no clear characteristic distinction from the original radish cultivar. In the 2nd generation from NC or CNF1 plants and COOF1 plants,some campestris-like reversional plants were also obtained by back-crossing with B.campestris or open-pollination. But no good mono-genomic reversional plants were obtained in the




Schematic diagram of formation of various kinds of sesquidiploid plants.

2nd generation from the sesquidiploid F1 plants,with the exception of COOF1 plants.

On the other hand,no reversional plants were obtained in the 2nd generation from the amphihaploid ROF1 and COF1 plants. Instead of that,sesquidiploid plants including hyper- and hypo-ones were frequently obtained by back-crossing with R.sativus or B.campestris and open-pollination. Then,in the 3rd generation many radish-like and Chinese cabbage-like reversional plants appeared by successive back-crossing with radish or Chinese cabbage,or open-pollination. In that cases,some shifts occurred in various characters from the original radish and Chinese cabbage type toward B.oleracea type, and some promising reversional plants were obtained. They were stronger in resistance to virus and soft-lot diseases,and shown very vigorous growth. Moreover,in the 4th generation promising reversional plants were frequently obtained passing through the sesquidiploid F2 plants and radish-like or Chinese cabbage-like heteroploid F3 plants having some oleracea chromosomes.

Incidentally,the promising campestris-like reversional plants might be obtained in the progenies from the campestris-like heteroploid F2 and/or F3 plants of the sesquidiploid NCF1 plants,especially in the case of the sesquidiploid derived from the crossing between artificially synthesized napus crop and B.campestris. And some promising rape-like reversional plants were obtained in the progenies from NCF1 plants,by successive back-crossing with B.napus. These reversional plants had both economic characters of disease resistance in B.napus and of cold resistance in B.campestris.

At the M1 of PMCs in the amphihaploids,a number of bivalent chromosomes were observed. Therefore,it seems to be quite all right to consider that partial substitution (translocation) of chromosomes between r- or a-genome and c-genome must be taken place at the meiotic divisions in the amphihaploids. As a result of this,transfer of economic characters must have occurred from c-genome plants to r- or a-ones. And it was proved that the most of viable gametes in the amphihaploids were the diploid gametes including hyper- and hypo-ones which rised from restitution nuclei. Because of this, sesquidiploid F2 plants appeared frequently in the 2nd generation of the amphihaploids by back-crossing with partial mono-genomic species. On the other hand,with the exception of COOF1 plants, trivalent chromosomes were not observed frequently in the sesquidiploid F1 plants. Therefore,only in the COOF1 plants partial substitution of chromosomes between a-genome and c-one must be taken place at the meiotic divisions. And the author supposed that the appearance of the promising rape-like reversional plants in the progenies from the sesquidiploid NCF1 plants was based on the partial substitution of the chromosomes between a-genome in B.napus and that in B.campestris. In this case,there might be strong correlation between frequency of trivalent chromosomes at M1 of PMCs in the sesquidiploid NCF1 plants and frequency of the healthy and vigorous plants in the 2nd generation.

As mentioned above,the most effective method for transfer of economic characters owing to partial substitution of homologous chromosomes between two mono-genomic species is probably to make several strains by back-crossing with one of the parental species to the parent-like heteroploids in the progenies from the sesquidiploids including hyper- and hypo-ones,derived from the amphihaploid F1 plants,and by successive inbreeding(mass-pollination) of the strains,or by successive inbreeding of the original reversional plants from twice back-crossing with one parental species to the amphihaploid F1 plants.

# AUTUMN AND WINTER CAULIFLOWER BREEDING IN FRANCE

Y. HERVE - Station d'Amelioration des Plantes I.N.R.A. Ecole Nationale Superieure Agronomique, 65 Rue de St-Brieuc - 35042 RENNES Cedex (France).

Cauliflower breeding has been undertaken at the Institut National de la Recherche Agronomique (I.N.R.A.) since 1965 for winter and winter hardy cauliflower and since 1970 for autumn cauliflower.

## General breeding organization

The breeding laboratories are partly granted by all growers of Brittany, which is the main cauliflower growing area in France (25,000 hectares of winter cauliflower - 4,000 hectares of autumn cauliflower).

The two breeding programmes are conducted by the Rennes Plant Breeding Station in two experimental sites: one is the autumn cauliflower growing area around St-Malo (Northern coast of Ille et Vilaine department) and the other is at St-Pol.de.Leon which is the center of the most important growing country for winter cauliflower.

For the moment the growing work is managed by 6 permanent workers with about 6 hectares trials every year.

## Chief objectives

The main purpose is to create $F_1$ hybrids, leading to a better production homogeneity, especially for shortening the harvest costs. Yield increase and the stability of the varieties are two other important aims.

Up to now the cultivated varieties in France are: - for winter cauliflower: farm's populations selected by growers through mass selection. They remain heterogeneous but well adapted to the country conditions.

- for autumn cauliflower: commercial populations obtained by family selection outside the growing area. Their quality is often shifting and mean yield is only 60 to 70%. Some new Dutch and Australian varieties are better, but only for some growing periods.

## Breeding methods

Pure lines are obtained by bud-pollination of self-incompatible plants. However the best self-compatible lines are not rejected because, according to the high seed yield of cauliflower, only one self-incompatible line can be used as a parent to make $F_1$ hybrids.

Genic male sterilities have been found at a low rate and are being introduced in the best self-compatible lines. To produce hybrids, male fertile plants appearing in the female parent can be destroyed at the beginning of flowering. Male-sterile lines can also be propagated by cuttings.

Gene-cytoplasmic male sterility from radish and broccoli have been introduced in cauliflower but they raise major problems for practical use (chlorosis-bad female fertility).

## Progress and prospects

1500 S 5 and S 6 inbred lines of winter cauliflower and about the same for autumn cauliflower have been created. Several hundreds hybrids are now produced every year.

In the trials the average reduction of the harvest period is 4 to 6 weeks for populations to 1 or 2 weeks with hybrids using S 3 to S 4 parental lines. Some $F_1$ hybrids reached single cropping and mechanical harvesting might be foreseen in the next 10 years.

# MARKER GENES IN BRASSICA NAPUS

FRITJOF W. HEYN

A small collection of marker gene lines in Brassica napus has been built up and part of the genetics of the characteristics has been elucidated. As far as the original material was provided by somebody else, it is mentioned in brackets.

1. LEAF MARKERS:

   $Gl_D$ = glossy, dominant to waxy (K.F. THOMPSON, Cambridge)
   no wax on leaves, small amounts of wax on stems.
   $F_2$: 3 $Gl_D$ : 1 waxy

   $gl_R$ = glossy, recessive to waxy (K.F. THOMPSON, Cambridge)
   $F_2$ : 15 waxy : 1 $gl_R$

2. MALE STERILITY:

   $ms_1$ $ms_1$ $ms_2$ $ms_2$ = male sterility (TAKAGI, Mishiyama). This is a stable form of genic male sterility. The genes $ms_1$ and/or $ms_2$ can be found in many varieties. It is a digenic inheritance, not a monogenic one as claimed by TAKAGI (1970, Z. Pflanzenzüchtung 64, 242-247).
   $F_2$: 15 : 1 and 3 : 1 (male fertile : male sterile)

3. FLOWER COLOURS:

   white (introgressed from a Raphanobrassica by STEFANSSON, Winnipeg) is dominant to all other flower colours in B. napus.
   $F_2$: 9 white : 7 yellow
   yellow is dominant to all the following flower colours:

   yellowcream
   cream
   ochre
   orange
   } all $F_1$-combinations result in yellow flowers

   $F_2$ of yellow x ochre: 15 yellow : 1 ochre (in most cases)
   yellow x orange: 15 yellow : 1 orange and 3 yellow : 1 orange

   Details will be given in a forthcoming publication.

# BREEDING OF CLUBROOT RESISTANT RUTABAGAS (SWEDES) IN CANADA

K. G. Proudfoot

Rutabagas or swede turnips (B. napus L. spp. rapifera) are one of the most popular vegetable crops grown in Eastern Canada. Up to the 1940's a considerable acreage was also grown for livestock feed but this practice has disappeared. Varietal evaluation and development has been undertaken by Agriculture Canada since the early 1900's. The early programs stressed root yield, both total and dry matter, as well as uniformity of size, shape and color. More recently, since rutabagas are now only used as a vegetable crop, uniformity of size, good color development and smoothness are of prime importance. Additionally, resistance to clubroot Plasmodiophora brassicae Woron has been and still is of great importance.

Different races of the clubroot organism occur but the most widespread has been Ayers race 2. Resistance to this race has been obtained with the cultivar York, a selection of unknown origin from the program at Charlottetown, P.E.I. York is similar in appearance to the widely grown but susceptible Laurentian. Resistance to other races of the pathogen have been obtained by crossing York and Wilhelmsburger (YW). Crosses of YW with the Dutch turnip (B. campestris) Gelria R and subsequent backcrossing to the rutabaga parent has produced progenies (RST) showing an even wider spectrum of resistance. The New Zealand turnip York has also been used in the present program, along with the Norwegian rutabaga Gry.

As well as incorporating the desired clubroot resistance from the turnip parent, it appears that self-incompatability factors are also present in the RST material. I am investigating the amount of cross pollination occurring in the field using intercrossing blocks of RST roots and varieties selected for other desirable characters. Included are the varieties Doon Spartan, a well known variety of good keeping quality; Parkside, claimed to have resistance to Phoma rot; and selections from the Quebec program for virus resistance.

# OILSEED RAPE CULTIVARS SUSCEPTIBLE TO CLUBROOT

K. G. Proudfoot

As part of the program to produce rutabagas, B. napus L. spp. rapifera (Metz) Sinsk, resistant to infection by the clubroot fungus Plasmodiophora brassicae Woron, several oil seed rape cultivars and breeding lines have been screened for their reaction to this organism. All the cultivars so far tested have been found susceptible to the races present in the test plots - races 1 and 4 Ayers or E.C.D. 16/22/30 and 16/22/31.

Included in those tested were the recently introduced low erucic acid cultivars - Zephyr, Oro and Midas (B. napus); and Span and Torch (B. campestris).

Also susceptible were the "double zero" (low erucic acid, low glucosinolate) cultivars Tower and Regent (B. napus) and Candle (B. campestris). In their paper in 1974, Butcher et al[1] suggested that Brassica plants with a low or zero level of indole glucosinolates would not produce the characteristic clubbing following infection by P. brassicae. It is not known whether these cultivars are free of indole glucosinolates, but they were severely attacked in our tests with very large clubs being produced.

I thank Professor Stefansson, University of Manitoba, Winnipeg, and Dr. Klassen, Agriculture Canada, Research Station, Saskatoon, for supplying the cultivars used in these tests.

[1] The role of indole glucosinolates in the clubroot disease of the cruciferae. D. N. Butcher, Sayadat El-Tigani and D. S. Ingram, Physiological Plant Pathology, 1974, 4:127-141.

# GENETICS OF CYTOPLASM IN CRUCIFERAE
## I: CYTOPLASMS OF SPECIES HAVING "AA" GENOME AND ARTIFICIAL B. napus

Shiga T., Y. Ohkawa and K. Takayanagi

The cytoplasmic male sterile line of B. napus L. (abbreviated to MS) found by Shiga (1973) was derived from an intraspecific cross of B. napus. According to the type of cytoplasm (S or N) and the number of restorer genes (I, II, III and IV), we could classify Japanese cultivars of B. napus into nine classes, i.e. S-0, S-1, S-IIa, S-IIb, S-III, S-IV, N-0, N-I and N-II(1976). Consequently, we knew that most Japanese cultivars in B. napus had S cytoplasms but the remainder had N cytoplasms.

B. napus is amphidiploid (2n=38, genome formula AACC) derived from the crosses between species with ten (2n=20;AA) and nine (2n=18; CC) chromosomes (1934, Morinaga). We are interested in whether the S and N cytoplasm of B. napus derived from the ten or nine chromosome species. First, we have investigated the differences between S cytoplasm and the cytoplasms of "AA" genome species and artificial B. napus (2n=38; AACC). The degree of male sterility was shown by the relative position of anther to stigma, i.e. low position indicates male sterile and high position male fertile.

In 1977 we have examined 14 cultivars with "AA" genome cultivated in Asia, seven cultivars of artificial B. napus and the reciprocal crosses between MS and "AA" and between MS and artificial B.napus. The cultivars having "AA" genome included six cultivars in B.campestris, five in B.pekinensis and two in B.rapa.

All hybrids except one between an MS and an "AA" genome cultivar were male sterile like the MS line, but hybrids from the reciprocal crosses were male fertile. This means that these 13 cultivars had cytoplasms which behaved like N cytoplasm of B.napus and had no restorer genes. The exception was a hybrid with Murasakidaimarukabu (B.rapa), whose cytoplasm we couldn't estimate because both reciprocal crosses with MS were fertile.

Six of the artificial B.napus cultivars used were derived from crosses of "AA" x "CC" genome, and one cultivar, Kyabusai, derived from "CC" x "AA". From the relative position of anther to stigma of the reciprocal hybrids between MS line and artificial B.napus, we estimated that five cultivars ("AA" x "CC") had the cytoplasms like N. But the reciprocal hybrids between MS and the other cultivar were fertile, so we couldn't estimate its cytoplasmic type. On the other hand, Kyabusai ("CC" x "AA") had the cytoplasm like S of B. napus and had few restorer genes.

From above results, we concluded that the 13 cultivars of "AA" genome had N cytoplasms. If Murasakidaimarukabu cultivar has also N cytoplasm, then the S cytoplasm of B.napus did not originate in plants of "AA" genome cultivated in Asia. The cultivars with "AA" genome used in our experiment were limited to Asian cultivars. We now hope to confirm these results using "AA" genome cultivars from Europe and India.

# BREEDING ASPECTS OF RAPHANUS AND BRASSICA

T. D. Johnston
Welsh Plant Breeding Station, Aberystwyth

The development of a non-hairy strain of fodder radish: The fodder radish is a crop species of relatively minor importance, although it is capable of developing rapidly into a high yielding forage crop for grazing about two months after sowing in mid- to late summer. It is attractive to sheep, but quickly runs to flower and becomes less attractive and lower in digestibility. Also at all stages of growth the leaves (laminae and petioles) and stems carry many short, quite rigid and sharp hairs which tend to cause lip and mouth irritation in the grazing animal.

A few years ago a non-hairy north African form of Raphanus sativus was acquired by the Welsh Plant Breeding Station. This material was found to have a very brief vegetative phase, coming into flower rapidly after production of few leaves. However the plants were completely glabrous and were fully interfertile when hybridized with fodder radish (cv. Neris). Numerous hybridizations were made, and in the $F_2$ progenies only a few non-hairy segregants were found, indicating the presence of 2 or 3 dominant genes for hairiness. These plants were backcrossed to Neris and rigorous selection of non-hairy $F_2$ plants again carried out. The selected $F_2$ plants have been intercrossed in 1977 to produce sufficient seed for grazing tests in 1978, and have also been backcrossed again to Neris as this appears likely to be necessary to ensure maximum achievement of vigour and yield potential in the glabrous strain.

Variation in susceptibility of some Brassica varieties to glyphosate: Roundup (a. i. glyphosate) is an efficient total plant killer and useful as a pre-sowing or pre-emergence herbicide. Preliminary investigations have been carried out at WPBS into the possible existence of variations in susceptibility of some varieties of the main Brassica species to low dose rate applications of it. Applications were made of solutions containing 0.3 ml, 0.1 ml and 0.03 ml Roundup per litre by hand sprayer onto plants at about the 2 - 3 leaf stage growing in J. I. 3 compost in seedling flats.

Observations were recorded up to about 4 weeks after application to the young plants. Five days after spraying, yellowing of centre leaves was apparent, even in the low dose rate material in the swedes and to a lesser extent in the turnips. After a further 9 days it was apparent at all dose rates that the swedes were most affected and kales the least with the rapes and turnips intermediate in reaction. Furthermore, at the very low dose rate all swede and rape plants exhibited extensive purpling. Stubble turnips had a small amount of similar coloration, and none was apparent in the kales, except for a variety of dwarf thousand headed kale which also showed extensive leaf purpling. The coloration appeared generally similar to that brought about by phosphate deficiency.

A month after application of the herbicide final observations were made. Almost all plants subjected to the high dose rate had died. All rapes and kales survived the medium rate, also most of the turnips, but fewer of the swedes remained and they appeared to be very chlorotic and severely checked. At the

low rate all swedes and rapes were surviving but purplish, most turnip plants were healthy with only a few showing some discoloration and the kales appeared normal except for the dwarf thousand headed variety mentioned previously. Plants of this variety were still relatively much smaller and had medium purple coloration.

Thus, from these preliminary investigations it appears that variations exist in levels of susceptibility. They are being further studied although no direct practical importance of the differences is at present apparent.

Some investigations have also been carried out into variations in response to Semeron (a.i. desmetryne) herbicide among varieties of the main Brassica species. First results from tests of individual leaves of $I_1$ progenies of some marrow-stem kale plants selected for their apparent immunity or partial susceptibility to higher than normal dosage application indicated similarity to parental reaction.

## BRASSICA BREEDING PROGRAMME IN W. WASHINGTON

R. L. Gabrielson

In the United States most of the broccoli (calabrese) and cauliflower is produced in the coastal valleys of California. The climate of western Washington is also ideal for these two crops. Presently two diseases, downy mildew (Peronospora parasitica) and club root (Plasmodiophora brassicae) limit the potential of these two crops here. A program to breed horticulturally suitable hybrid varieties with resistance to these diseases is in progress.

We are currently working with two sources of resistance to downy mildew. Both are apparently controlled by a dominant gene. One is from the Harris Seed Co., Inc. The other is from the South Carolina Experiment Station. We plan to incorporate one gene from each source in the 2 inbred parents so the resulting hybrid will have 2 genes for resistance.

We are also working with two sources of resistance to clubroot. One is from the breeding program of Dr. Jim Baggett of Oregon State University. The other was discovered in a heavily infected commercial broccoli field in Western Washington.

Our horticultural type is derived from the Northwest Waltham variety. We have had problems with sibbing in our potential varieties. Ms. Georgia Voss is currently screening our breeding lines and other available broccoli varities to determine the availability of self-incompatibility (SI) genes suitable for hybrid production in broccoli. She is working with tester lines supplied by Dr. David Ockenden of NVRS in England.

We have been cooperating in a tissue culture program of Dr. W. C. Anderson of the Northwestern Washington Research and Extension Unit of Washington State University. He has developed a method of tissue culturing large numbers of clonal plants that can 1) aid breeders in vegetatively maintaining breeeding stock and inbreds and 2) sufficient plants to produce commercial quantities of seed and coincidentally rapidly stabilizing breeding populations (Anderson and Carstens 1977). We further plan to examine anther culture as an alternative measure of rapidly stabilizing desirable characteristics in inbreds that are controlled by complex mechanisms of inheritance, eg. club root resistance.

Dr. Louis Getzin, Entomologist at Western Washington Research and Extension Center is screening Brassica oleracea for resistance to worms, aphids and maggots.

An associated program is underway to develop chemical and cultural controls for these problems where possible (Anderson et al. 1976) and Gabrielson 1964).

Cauliflower lines from the program of Dr. Paul Williams of the University of Wisconsin are being selected for resistance to clubroot and horticultural suitability. We aparently have homozygous resistance in some lines and an attempt to develop a commercially acceptable open pollinated line is underway.

We are most interested in cooperating with other public and private breeders exchanging germplasm, ideas, etc.

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# UNEXPECTED DIFFICULTIES MET WITH THE RADISH CYTOPLASM IN BRASSICA OLERACEA

H. BANNEROT, L. BOULIDARD* et Y. CHUPEAU**

We reported, in 1974, (Eucarpia Cruciferae Meeting), the successfull introduction of the cabbage nucleus into the cytoplasm of the male sterile japanese radish (OGURA, 1968), by the means of repeated backcrosses.

The level of 18 chromosomes was reached only after the fourth backcross and only after culturing in vitro the immature embryos from this last backcross.

We have observed now, that under our conditions, all the B. oleracea genotypes exhibit, when they are introduced in this radish cytoplasm, a more or less severe yellowing of the young leaves, when the plantlets are grown at temperatures below 12°C. This defect was not observed before, probably because the plants were grown in heated greenhouses.

It looks as if the nucleus of B. oleracea (and also of B. napus or campestris) does not function properly when in the radish cytoplasm. Different levels of yellowing were observed with different recurrent male parents. The most severe effect was seen with cauliflower, whereas brussels sprouts and savoy were greenest, but even in this case the deficiency remained too severe to allow the use of the radish male sterile cytoplasm for breeding purposes in the genus Brassica.

We suspect that the interaction of the radish chloroplasts with the cabbage nucleus may be responsible for this deficiency. We intend to replace the original set of chloroplasts, from radis origin, by a set of cabbage chloroplasts via protoplast fusion. However, before this can be achieved, we will have to master the regeneration process with protoplasts from B. oleracea or B. napus/

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# POSSIBILITIES OF STABILIZING INTERMEDIATE CHROMOSOME NUMBERS BETWEEN B. NAPUS AND B. CAMPESTRIS

S. Gowers

The material studied was derived from B. campestris (turnip) x B. napus (swede) hybrids which were open-pollinated in the presence of swede (every third row) to promote backcrossing. Apart from 38 chromosome plants obtained work has also been carried out on two highly fertile aneuploids. One plant had 37 chromosomes and was obtained from chromosome screening; the other was selected on pollen fertility and, on bag-selfing, set 96g seed.

Screening of progeny from this plant showed:

| Chromosome No. | 34 | 35 | 36 | 37 | 38 | Total |
|---|---|---|---|---|---|---|
| No. plants | 6 | 15 | 17 | 4 | 5 | 47 |

It is deduced that the parent plant possessed 36 chromosomes, although the distribution does not fit the expected 1 : 4 : 6 : 4 : 1 ratio, mainly due to the lack of 37 chromosome plants. 34, 35 and 38 chromosome plants are at higher frequencies than expected. Assuming complete bivalent formation at meiosis, the 34 chromosome plants would be expected to be stable.

Similarly, 36 chromosome plants obtained from the 37 chromosome plant would be expected to be stable if pairing were precise. The distribution of progeny from the 37 chromosome plant was:-

| Chromosome No. | 35 | 36 | 37 | 38 | 39 | Total |
|---|---|---|---|---|---|---|
| No. plants | 1 | 11 | 16 | 9 | 1 | 38 |

The frequency of 36, 37 and 38 chromosome plants would fit the expected 1 : 2 : 1 ratio, but the 35 and 39 chromosome plants were not expected and indicate some irregularity in meiotic behaviour of the parent.

The 38 chromosome plants were highly fertile, with seed set ranging from 5.0 to 17.8 seeds/pollination, except for one plant which only set 1.6 seeds/pollination. Of the 36 chromosome plants one died and six others were either male sterile or infertile; the remaining four were fertile with 3.6, 6.4, 7.3 and 7.6 seeds/pollination. Chromosome screening has shown these plants to have produced some 35 and 37 chromosome progeny, and even the odd 34, 38 and 39 chromosome plant.

This lack of stability may, however, be due to other causes than aneuploidy, as the 38 chromosome plants produced some irregularities in meiosis and some aneuploid progeny. Stable, fertile nulliploids have not yet been produced, although they may possibly be obtained by selection from the present material or from plants with more stable meiosis.

# SUSCEPTIBILITY OF CAULIFLOWER TYPES TO CABBAGE ROOT FLY

P. Crisp, P.R. Ellis, J.A. Hardman and A.R. Gray

As part of the NVRS project to investigate the resistance of cruciferous crops to cabbage root fly (Delia brassicae), a trial was conducted in 1977 in which 173 varieties and breeding lines of cauliflower were subjected to natural attack by the fly. The trial consisted of randomised plots of five plants of each genotype, with four replicate blocks. Damage was scored nine weeks after transplanting on a scale of 0 (no damage) to 3 (severe damage).

Analysis of the plot means showed highly significant differences between genotypes. We postulate that these differences may be explicable in terms of two factors:

1. The World distribution of the fly: The fly is restricted to the temperate zone of the holarctic region (35°-60°N) and is therefore absent from southern Asia and Australia. Additionally, it may be restricted to one generation per year in regions with hot, continental summers. Thus in those years before insecticides protected the seeding crop, there was probably a selection pressure which may have resulted in some resistance in those cauliflower types grown in areas subject to attack by the fly.
2. The evolution of cauliflower types: Cauliflowers appear to have originated in the Mediterranean region; they then developed (probably in the 15th to 17th Centuries) in northern Europe to give self-compatible annuals, and in maritime north-west Europe to give self-incompatible biennials. The introduction of European crop plants to India and Australia (during the 18th and 19th Centuries) resulted in genetic recombinants so that Asian cauliflowers are predominantly self-incompatible annuals, and Australian cauliflowers include self-compatible biennial types.

Analysis of variance of the trial data on the basis of this evolutionary concept shows that distinctions could, indeed, be made between and within such "taxonomic" groups of cauliflowers (Tables 1 and 2).

Table 1 Analysis of variance of cabbage root fly damage scores on 173 genotypes of cauliflower.

| Source of variation | | DF | MS |
|---|---|---|---|
| Replicate blocks | | 3 | 6.2569*** |
| Between "taxonomic" groups | | 4 | 1.0704*** |
| Between ancestral types | | 1 | 0.1003 ns |
| Between European biennial types | | 3 | 0.1081 ns |
| Between European annual types | | 3 | 0.4431* |
| Between Asian annual types | | 3 | 0.1691 ns |
| Ancestral types: | between Flora Blanca genotypes | 10 | 0.4944*** |
| | between Autumn Giant genotypes | 7 | 0.5639*** |
| European biennials: | between Roscoff genotypes | 40 | 0.1001 ns |
| | between Angers genotypes | 11 | 0.2783* |
| | between English Winter genotypes | 6 | 0.0495 ns |
| | between Walcheren genotypes | 5 | 0.3710* |
| European annuals: | between Le Cerf genotypes | 7 | 0.3150* |
| | between Alpha genotypes | 1 | 0.2812 ns |
| | between Erfurt genotypes | 1 | 0.2450 ns |
| | between Mechelse genotypes | 2 | 0.3233 ns |
| Between Australian genotypes | | 41 | 0.2776*** |
| Asian annuals: | between Snowball genotypes | 10 | 0.1937 ns |
| | between Japanese genotypes | 12 | 0.1385 ns |
| | between Indian genotypes | 1 | 0.0013 ns |
| | between Russian genotypes | 4 | 0.2430 ns |
| Residual | | 516 | 0.1458 |

ns $P > 0.05$, * $P = 0.01$-$0.05$, *** $P < 0.001$

Table 2 Mean cabbage root fly damage score and variability of score in different taxonomic groups of cauliflowers.

| Taxonomic group | Number of genotypes | Damage score | |
|---|---|---|---|
| | | mean | variance |
| Ancestral | 19 | 0.786 | 0.4995 |
| European biennial | 66 | 0.614 | 0.1468 |
| European annual | 15 | 0.652 | 0.3362 |
| Australian | 42 | 0.712 | 0.2776 |
| Asian annual | 31 | 0.814 | 0.1693 |

The means are significantly different (see Table 1)
The variances are also significantly different ($X^2$ with 4 degrees of freedom in the Bartlett's Test = 15.69, P = 0.01-0.001

We suggest that these results may be interpreted as outlined in Table 3.

Table 3 Interpretation of susceptibility to cabbage root fly of types of cauliflowers.

| Taxonomic type | Susceptibility | Interpretation |
|---|---|---|
| Ancestral | High, variable | Edge of fly's range, therefore there may be heterogeneity of selection pressure. |
| European biennial | Low, uniform | Consistent selection by the fly. |
| European annual | Low, variable | Some types (e.g. Erfurt) may have evolved at edge of fly's range where it is not a serious pest during much of the year. |
| Australian | Fairly low, variable | No selection by the fly, but much Australian material is of recent introduction. |
| Asian annual | High, uniform | No selection by the fly for many generations. |

There may, therefore, be no source of complete resistance to the fly in cauliflowers, but some resistance may be maintained by selection. Different kinds of resistance may occur in those groups of cauliflowers which have evolved under selection pressure from the fly, but in isolation from each other: - that is, by selecting from European biennial x European annual populations it may be possible to produce recombinants with greater resistance than either parent.

(We are grateful for the assistance of Sandra Ellis, Kathleen Phelps and Liz Seymour with this work).

# A COMPARISON OF HAND AND MACHINE HARVESTING OF SWEDE TRIALS

F.J.W. England

Swedes may be harvested either by hand or by machine. At the Scottish Plant Breeding Station a single row swede harvester which automatically cuts off the tap root below the bulb and cuts off the top at a pre-determined height above the bulb has been fitted with an automatic weighing device. The basic machine is the "Ambassador" root harvester made by Boswell of Blairgowrie, UK, and has been fitted with a wire mesh collector basket and "Statimeter" balance by our own workshop.

Machine harvesting is less labour intensive and pleasanter than harvesting by hand but is much more dependent upon soil conditions. Under wet conditions it may be necessary to harvest by hand. In addition, swede trials are carried out at different sites both by this institute and by other organisations and a suitable machine is not available at all sites and indeed is not worth purchasing except where trials of swedes or similar crops are conducted on a fairly large scale. Because of these two considerations it is obviously desirable to have some measure of the extent to which the relative performance of varieties or breeders lines may be affected by the method of harvesting.

In 1976, there was available at the SPBS a 5 x 5 Latin square trial in which each plot consisted of four ten metre rows, 711 mm (28 inches) apart and the opportunity was taken to harvest half of each plot by hand and the other half by machine. Within each column of the Latin square, the same half of each plot was harvested by the same method but the choice of which half was made at random.

The cultivars used were Pentland Harvester, Bangholm Magres, PH8 (a selection from P. Harvester), Bangholm Ruta Øtofte and Doon Major.

The analysis of variance which appears in Table 1 is that given by Cochran and Cox (1957) (their Table 7.13) and was carried out on fresh weight yields after conversion to tonnes per hectare.

Table 1. Analysis of variance of swede trial date ($t\ ha^{-1}$)

| Source of Variation | d.f. | Mean square | |
|---|---|---|---|
| Main plots | | | |
| Rows | 4 | 43.53 | NS |
| Columns | 4 | 41.63 | NS |
| Varieties | 4 | 627.57 | $P<.001$ |
| Error (a) | 12 | 58.11 | |
| Sub plots | | | |
| Harvest method | 1 | 96.86 | NS |
| Error (b) | 4 | 17.18 | |
| Var x H. method | 4 | 23.64 | NS |
| Error (c) | 16 | 20.18 | |

The particular point of interest is that there was no significant interaction between variety and method of harvest. The effects due to varieties, method of harvest and the interaction between them are shown in Table 2.

Table 2. Effects due to varieties, methods of harvest and (in the body of the table) their interaction. t $ha^{-1}$.
Grand mean = 42.55

| | | Variety | | | | |
|---|---|---|---|---|---|---|
| | | PH | BM | PH8 | BR | DM |
| Harvest method | | -5.81 | +4.20 | -5.78 | +6.28 | +0.59 |
| Hand | +0.98 | +0.23 | ±0.00 | -1.83 | +0.59 | +0.98 |
| Machine | -0.98 | -0.23 | ±0.00 | +1.83 | -0.59 | -0.98 |

The interaction effects are generally small compared with the varietal effects and it is obvious that selections or recommendations based on the results of this trial would be the same irrespective of whether the trial was harvested by hand or by machine.

One further point is of interest and that is the precision of the two harvesting methods as measured by the coefficient of variation. If the trial is analysed as two ordinary Latin squares then the coefficient of variation for hand harvesting is 4.82% and that for machine is 4.56% and there is no reason to suppose that one method is more precise than the other.

The evidence from this data is that swede trials may equally well be harvested by hand or machine and that the results obtained by one method may be extended to those that would be obtained by the use of the other; that, if necessary, one part of a trial could be harvested by hand and another by machine so long as the change corresponds to a replication boundary and that the harvesting methods give equally precise results. This being said it is obvious that the results of one trial do not enable us to generalise; significant and important interaction might arise on other occasions but the evidence, as far as it goes, is encouraging.

Reference: Cochran, W.G. and Cox, G.M. (1957). Experimental designs, Second edition. New York. Wiley.

# A PRELIMINARY GENE LIST IN BRASSICA OLERACEA

A. B. Wills

Easily recognised genes giving simple Mendelian ratios can be valuable to the breeder as purity markers within inbred lines and as aids in determining sib proportions in hybrid cultivars. At another level the labour required to assess segregating populations for such characteristics as self-incompatibility, disease resistance or male-sterility, might be considerably reduced by the use of linkages to suitable morphological markers. It is important therefore that breeders and pathologists should be aware of the range of known genes, and also be prepared to investigate novel phenotypes, especially when these are associated with genes that it is desired to exploit in breeding procedures.

A selected list of genes in B. oleracea is appended. Genes known or suspected to be difficult to work with and disease resistance genes have not been included and the descriptions are brief. Almost all of the genes listed and all of the linkage groups have been described since the comprehensive review of the cytogenetics of B. oleracea by Yarnell (1956). The original isolator or the authors of published data are noted in parentheses following gene description but full references are omitted for brevity.

The conventional symbolism is generally similar to that used for tomato and in the publications of Sampson. Genes are denoted by a two letter symbol derived from their descriptive name except where a single letter has precedence; alleles within a series are distinguished by a following superscript usually chosen to indicate the source of the allele; non-allelic genes having the same phenotype are distinguished by numbers, in addition dominant glossy foliage genes are distinguished from recessives by different symbols.

Additions to the list would be welcome and seeds of mutant material would be greatly appreciated.

## GROUP A. SEEDLING CHARACTERS

1. A Anthocyanin development. Dominant. Allelic series (Linkage Group II)

   $A^{rc}$, red cabbage, intense.

   $A^{pb}$, purple broccoli, moderately intense.

   $A^{mk}$, marrow-stem kale, moderately intense.

   aa, hypocotyl faintly pigmented, traces on first leaf.

2. C Anthocyanin suppressor. Recessive. Pigmentation suppressed in all parts.

   c-1, curly kale and variegated ornamental kale (Sampson) (LG V)

   c-2, "The Cluseed" Brussels sprout (Sampson) (LG VI)

   c-3, marrow-stem kale (Sampson)

3. Hr Hairy-leaf. Dominant. Hairs typically on margins of young leaves, sometimes more widely distributed. Penetrance and expressivity variable.

   Hr-1, marrow-stem kale, margins only (Thompson) (LG IV)

Hr-2, marrow-stem kale, additional short hairs on underside of mid-rib (Thompson) (LG IV)

Hr-3, margins only (Wills) (LG VII)

4. Gl Glossy foliage. Recessive. Wax on leaf surfaces and stems more of less inhibited.

Gl-1, sprouting broccoli (Anstey) (LG I)

Gl-3, "The Cluseed" Brussels sprout (Priestley) (LG VI) ($gl_1$, of Priestley)

Gl-4, cauliflower (Sampson)
At least four further genes known (Priestley; Wills)

5. Go Glossy foliage. Dominant.

Go-1, "Green Glaze" collard (Priestley)

Go-2, broccoli; (Gl-5 of Sampson)

6. Fc Fused cotyledon. Recessive. Outer edges of cotyledons fused to form funnel.

fc-1, "Cambridge Special" Brussels sprout (Wills)

7. Al Albino

At least three different loci (Wills)

al-1, (Wills) (LG VII)

8. Pg Pale-green foliage. Recessive. Yellow-green true leaves, reduced vigour.

pg-1, green sprouting broccoli (Sampson) (LG III)

pg-2, green sprouting broccoli (Sampson) (LG IV)

pg-3, Brussels sprout (Johnson)

9. Fn Fern leaf. Partial Dominant. Leaves lobed or dissected. Marrow-stem kale. (Thompson) (LG VI)

10. Le Leaf excrescence. Recessive. Pimply or vein-like outgrowth on upper leaf surface. (Sampson)

11. Rd Retarded development. Recessive. Laminae narrow, margins incurved, slow growth rate (Wills)

12. Pz Pilzkeimlinge. (Mushroom seedling). Recessive. Cotyledons small, fleshy; swollen hypocotyl and plumule (Heyn)

13. Dw Dwarf. Recessive. Many isolates.

$dw^{fb}$, "Flora Blanca" cauliflower. Short internodes, rounded leaves (Crisp)

## GROUP B. FLOWERING PLANT CHARACTERS

14. Wh White petal. Dominant. (Anstey) (LG I)

15. Cr Cream petal. Recessive. (Anstey) (LG III)

16. Cp Crinkly petal. Recessive. Double fold across petals, flower bud pear-shaped (Priestley) (LG II)

17. An Anther spot. Dominant. Ubiquitous. Purple spot on anther tip (Thompson and Taylor) (LG II)

18. Ps Persistent sepals. Sepals remain green and adhere after petal fall (Sampson) (LG II)

19. Ms Male-sterile. Several isolates.

ms-1, broccoli (Sampson) (LG V)

ms-2, brussels sprout (Sampson).

ms-4, purple cauliflower (Borchers)

ms-6, broccoli (Dickson)

20. S Self-incompatibility. Multiallelic (LG II)

21. Or Orange-curd. Dominant. Extra-early Snowball cauliflower (Crisp and Walkey)

## GROUP C. BIOCHEMICAL CHARACTERS

22. Acp Acid phosphatase. Isoenzyme system; many loci.

acp-1, five co-dominant alleles in seeds, no hybrid molecules (Te Nijenhuis)

acp-2, two co-dominant alleles in seeds, no hybrid molecules (Woods and Thurman)

acp-3, approximately six co-dominant alleles in seedlings and older plants, hybrid molecules in heterozygotes (Wills and Wiseman)

Reference

Yarnell, S.H. (1956). Cytogenetics of the vegetable crops II. Crucifers Bot. Rev. 22, 81-166.

# SIB NUMBERS IN INDIVIDUAL BRUSSELS SPROUT SILIQUAE

T. Hodgkin

In spite of the information that has been collected on the various factors that may contribute to the occurrence of sibs in $F_1$ Brassica cultivars, our ability to quantify the effects of these factors in seed crops and describe the precise way in which they make their contribution is very limited. A first stage would be to describe the distribution of sib seeds in a hybrid seed crop and, with this in mind, I have obtained data on the numbers of sib and hybrid seed in siliquas containing different numbers of seed.

Two brussels sprout inbred lines, one of which was homozygous for a recessive glossy foliage marker gene were intercrossed in the field and up to 50 siliqua collected from each of six of the glossy leafed inbreds. Seed was harvested from each siliqua individually and sown separately. For each siliqua records were taken of total seed number, the number of seeds germinating and the number of those germinating that were sib (glossy leafed) or hybrid (normal leafed). The results are given in Table 1 with the data from siliqua with 11-19 seeds pooled to give two classes, the procedure used for the analysis.

Table 1. Seed germination and sib production from six inbred plants

| seeds per siliqua | number of siliquae | number of seeds | % siliquae with germinating seeds | % seeds germinating | % siliquae[1] with sibs | % sib[2] seeds |
|---|---|---|---|---|---|---|
| 1 | 39 | 39 | 64 | 64 | 32 | 32 |
| 2 | 34 | 68 | 56 | 44 | 21 | 17 |
| 3 | 28 | 84 | 79 | 51 | 50 | 39 |
| 4 | 34 | 136 | 79 | 48 | 15 | 8 |
| 5 | 31 | 155 | 84 | 52 | 38 | 34 |
| 6 | 28 | 168 | 86 | 48 | 45 | 21 |
| 7 | 17 | 119 | 94 | 55 | 31 | 20 |
| 8 | 26 | 208 | 92 | 53 | 33 | 9 |
| 9 | 16 | 144 | 94 | 56 | 47 | 21 |
| 10 | 7 | 70 | 86 | 53 | 17 | 3 |
| 11-14 | 15 | 180 | 100 | 50 | 27 | 4 |
| 15-19 | 8 | 128 | 100 | 60 | 12 | 2 |
| Overall Percentage | | | 80.2 | 52.4 | 26.1 | 16.5 |

[1] as a percentage of siliquae with germinating seeds

[2] as a percentage of the germinating seeds

Germination levels were rather low (52.4%) which may possibly result from seed dormancy since seed harvesting and sowing followed on very closely from when the seeds had been judged mature. The percentage of non-germinators was independant of the numbers of seed in the siliquae (siliqua class) with $X^2 = 11.39$, $P = 0.4\text{-}0.5$ for 11 d.f. In addition, as would be expected from a binomial distribution, the percentage of siliquae in which at least one seed failed to germinate increased with seed number per siliqua, so that in siliquae with more than 11 seeds there were always some seeds that failed to germinate.

A comparison of sib numbers with total germinating seed numbers showed that the overall percentage of sibs was 16.5 but although some sibs were found in nearly all siliqua classes, the distribution of such seeds was not independant of the siliqua class ($X^2$ = 45.4, P 0.001 for 11 d.f.). Much of this lack of fit could be accounted for by apparently random class to class fluctuations as shown in the variation between siliquae with 1, 2, 3 or 4 seeds in them. However there also appeared to be a tendency for siliqua with fewer seeds (1-5) to contain a higher percentage of sibs than expected and those with more seeds (11-19) to contain a lower one. The proportion of siliquae with sibs in them was independant of the number of seeds per siliqua ($X^2$ = 13.8, P = 0.2-0.3 for 11 d.f.) so that sibs were just as likely to occur in siliqua giving more than 10 seeds per siliqua as in those giving only one or two. Where sibs did occur there appeared to be a tendency for them to occur in the same siliqua especially in siliquae with 2, 3 or 5 seeds, although the small numbers of siliquae involved meant that it was not possible to test this statistically.

It seems therefore that sibs did not occur with a binomial distribution, they tended to occur at higher frequencies in siliquae with fewer seeds and, possibly, in particular siliquae more than in others. However, all siliquae were equally likely to give some sibs and they nearly always occurred together with hybrid seeds.

Without more information it is impossible to determine the causes of the observed distribution of sibs but one of the factors contributing might well be non-random pollination by bees possibly giving high levels of self pollen on many stigmas (Faulkner, 1974). The inhibition of cross pollen tube growth by self pollen observed by Ockendon and Currah (1977) may also play a part. Finally, the observation by Hodgkin (1976) that self seed set levels often depend more on the proportion of flowers in which partial self-compatibility occurs than on the level of self-compatibility in those flowers may be important in that it implies there is a proportion of flowers which will set no sibs. Clearly, to ascertain the influence of these and other factors more extensive experiments must be conducted.

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# USE OF THE WORD 'BRASSICA' AND ITS DERIVATIVES

R.N.H. Whitehouse

There seems to be some confusion in our use of the word Brassica and its various derivatives. I put forward the following suggestions as the basis of a common policy.

(i) Brassica (capital initial and italics), refers to a botanical genus and occurs in latin names and sentences such as "That plant is a Brassica" i.e. belongs to that genus and not, say, to Raphanus.

(ii) Brassicae (capital initial and italics), the plural of Brassica, is unlikely to occur frequently but might be used thus: "Amongst the oil producing species the Brassicae are the commonest." It can also refer to the botanical tribe.

(iii) brassica (lower case initial and no italics)
brassicas (lower case initial, no italics and final s)
are used to describe the agricultural crops belonging to the genus Brassica. These are english words to be used in the same way as 'beans' or 'cereals', for example: "We grow brassicas on this field every six years" or "A late-sown brassica crop provides autumn grazing".

(iv) Brassica (capital initial and no italics)
Brassicas (capital initial, no italics and final s)
There seems to be no case for using these, except at the beginning of sentences, as proper names or in captions, since as english words they do not require a capital initial and if latin would be in italics.

(v) Brassicas (capital initial, italics and final s)
brassicas (lower case initial, italics and final s)
Brassicae (capital initial, no italics and final ae)
brassicae (lower case initial, no italics and final ae)
These should all be avoided as they are unacceptable hybrids of english and latin forms.

(vi) brassica (lower case initial and italics)
brassicae (lower case initial, italics and final ae)
cannot refer to the latin name of a genus as they would then have capital initial letters and are thus excluded. Note, however, that the form, brassicae is also used as a specific name, as in Pieris brassicae and then brassicae might be used when Pieris is understood. Example "The virus extracted from P. napi was multiplied in other Pieris stocks e.g. rapa and brassicae".

The only acceptable forms are marked with a tick in the table below. Thus a gardener may correctly write "I shall be planting my brassicas tomorrow" and a scientist should not reply "I expect you mean your Brassicae."

| Initial and italics | Terminal | | |
|---|---|---|---|
| | a | s | ae |
| B | ✓ | x | (✓) |
| b | x | x | (✓) |
| B | (✓) | (✓) | x |
| b | ✓ | ✓ | x |

# USE OF BRASSICA AND CONCERNED BRASSICA OBJECTIVES IN INDIA

S. K. Batra.

Among cruciferous crops, Brassica forms the dominant cultivated group in India. Among the Brassica species, the oleiferous group mainly belonging to Brassica campestris and Brassica juncea have been cultivated on a large scale while Brassica nigra and Eruca sativa are grown to a limited extent, the eruca being restricted to chronic drought prone areas. The vegetable forms of Brassica campestris group have also been introductions from the temperate regions.

Oleiferous brassicae appear to have been cultivated in India from 3600 BC or early as evident from the carbonized grains available from the exacavations of Harappa Khokharkot revealed. The area under cultivation of rape and mustard in India during the past three years is about 3.37 million hectares and a total production was 1.95 million tonnes with an average yield of 577 kg per hectare. The chief growing states are Uttar Pradesh, Punjab, Rajasthan, Haryana, Bihar, West Bengal, Assam, Madhya Pradesh, Orissa and Jammu and Kashmir. The cultivation of rape and mustard is done under both irrigated and rainfed conditions.

There exists a great diversity in oil yielding brassicae in India. A large number of species are still grown in semi-primitive conditions. The names refer to botanical species, chromosome numbers and mode of reproduction are given in the table.

| Vernacular names | Botanical species | Common English name | Chromosome No. 2n | Mode of reproduction |
|---|---|---|---|---|
| A) Rape | | | | |
| 1) Toria | Brassica Campestris Linn. var. Toria Duthie & Fullar | Turnip rape | 20 | Cross-pollinated |
| 2) Kali sarson | B.campestris Linn. var dichotoma watt | Brown sarson Lotni type (self-incompatibility) | 20 | do. |
| | do. | Brown sarson Tora type (self-compatible) | 20 | Self-pollinated |
| 3) Sarson | B.campestris Linn. var. sarson prain | Yellow sarson | 20 | do. |
| 4) Banarasi rai | B.nigra Koch | Black mustard | 16 | Cross-pollinated |
| 5) Tara mira | Eruca sativa Lam | Rocket | 22 | do. |
| B) Mustard Rai | Brassica juncea coss | Indian mustard | 36 | Self-pollinated |

The Plant Introduction report (1970) have revealed maximum variation for developmental and reproductive characters in toria among Assam cultivars. Therefore, it appears that North-East India might be an important centre of diversity for toria. Sarson (B.campestris) Linn. var sarson Prain) has more affinity with toria (self-compatible) type brown sarson and originated due to inversion and chromosomal rearrangements that has changed the seed colour (Rajan, 1958).

The maximum diversity is met in Eastern India for yellow sarson. Brassica juncea coss. is considered to be introduced into India from China through a north-eastern route. Banarasi Rai (B.nigra Koch) is cultivated only to a limited extent and probably introduced into India from Europe. Taramira (Eruca sativa lam), a native of south Europe and north Africa is a recent introduction in India.

As regards quality of rape and mustard, the earliest forms are found in West Bengal and Assam and latest maturing types are cultivated in Punjab. The boldest and two valved types of yellow sarson are grown in western districts of Uttar Pradesh and Punjab, whereas multivalved and smaller seed types are grown in Eastern India. The above variation could be explained that evolution and colonisation of late and early with different height categories might be due to domestication under varied ecological conditions.

Both B.juncea as well as B.campestris are grown essentially for oil in Northern, Central, Western and Eastern India in the subtropical zone and more so for pungent oil in the eastern part of India. Only a small fraction goes as seasoning in food and powdered form to be used in pickles and the green leaves are used as vegetable or fodder. It may, therefore, be concluded that oil and pungency are the major requirements in India from the oleiferous Brassica. The oil cakes are used as cattle feed, organic manure and occasionally in poultry feed.

## Uses of Rape and Mustard

The green leaves are used as fodder and green vegetable. The seed and oil are used as condiment in the preparation of pickles and for flavouring curries and vegetables. The seed oil is used mostly as an edible oil for cooking and frying in the Northern India. It is also used for the preparation of salad and medicinal preparations. It is used as a hair oil for oil bath and for application over body sometimes. The use of rape and mustard oil is extensive for production of hydrogenated oil. It's use for industries is limited such as in the manufacture of greases and soft soaps and for tanning of hide.

The oil cake is mostly used as cattle feed in India. Cattle fed on Taramira cake are reported to be free from tick attacks. Oil cake is extensively used as manure. The Indian rape and mustard oil has a high percentage of erucic acid (45 to 58%) and allyl-sio-thiocyanate that reduces its nutritional value.

## Breeding Objectives of Rape and Mustard

The rape and mustard are cultivated from September to March as winter crop in India. The major limiting factor for poor yield is due to - cultivation under marginal areas, poor plant type, non-synchronous growth, and severe attack of insect pests.

Toria is of short duration grown from September to first week of December as an autumn crop before wheat or sugarcane in Punjab and foothills of Himalayas in Uttar Pradesh. Brown sarson (self-incompatible) is mostly cultivated as rainfed and adapted to diverse condition of cultivation. Brown sarson (self-compatible) and yellow sarson are cultivated under both rainfed irrigated condition. Brassica juncea is grown as a mixed crop with wheat or gram and also as pure crop in rainfed areas.

The main research programmes in Brassica improvement have been on higher yield only with very little effort on oil content and quality. The existing cultivars have 35-38% oil in Brassica juncea, 35-42% in Brassica campestris and around 25-28% in Eruca. Both Brassica campestris and B. juncea have 45-58% erucic acid and only limited effort is now in progress to bring down the level of erucic acid. Since the consumers in eastern part of India prefer highly pungent oil, the content of allyl-siothiocyanate cannot be reduced if consumer's preference is to be met. From the composition of the present-day varieties of oilseeds, brassica is quite acceptable to the hydrogenated oil industry.

The research programmes on improvement of yield are for earliness and synchronous maturity and adaptability to paddy soils and irrigated conditions, so that the crop can be sown in the beginning of September and harvested before the end of December, in the case of B.campestris (Toria) in the intensive agricultural areas of Uttar Pradesh, Punjab and the neighbouring states. This is necessary to permit a late sown crop of wheat to be taken from December in the case of B.campestris (sarson) and emphasis is on varieties suitable for specific maturity zones such as 100-110 days in Eastern India, 120-135 days in Uttar Pradesh and adjacent states, and 125-140 days in north-west India. In the late maturing types resistance to pests is a major criterion as in Punjab. A plant type suitable for inter-cropping with cereals is preferred for this group. Drought resistance is the objective in both brown sarson and yellow sarson and B.juncea. Resistance to aphids is emphasized in the research programmes, although no success so far in identifying resistant lines has been achieved in the existing commercial varieties. In the case of B.juncea, frost resistance, medium maturity (130-150 days), and pungent seed are aimed. Although selection for oil content per seed has not been practiced due to emphasis on seed yield, selection for bold seed size has provided stability for oil content.

Recently effort is underway to breed types in mustard paste, resistance to aphids, higher oil content and low erucic acid content. The success of such varieties will depend upon a remunerative price for the special types without which the farmer will not have an incentive to grow the same. Thus, most of the advanced research programmes are for seed yield per unit area, early maturity, drought resistance, and stability for specific cropping patterns with limited emphasis on oil content and quality.

# 'CAROLINA' COLLARD, 'CHARLESTOWNE' AND 'ROOTS' TURNIPS

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The South Carolina Agricultural Experiment Station and the United States Department of Agriculture announce the joint release of 'Carolina' downy mildew resistant collard, and 'Charlestowne' and 'Roots' aphid resistant turnips.

Genetic makeup and description of 'Carolina' collard. 'Vates' collard was hybridized with downy mildew resistant P.I. 261774 cabbage and mass selection material was backcrossed to 'Vates.' Recurrent selection was practiced for the duration of the breeding process.

'Carolina' is a compact growing collard and is quite similar to 'Vates' in color, plant type, wind and cold resistance. It has bolting resistance similar to 'Georgia LS.' The major advantage of 'Carolina' over 'Vates' is resistance to one or more races of downy mildew. 'Carolina' is comparable to 'Vates' in plant vigor and yield. Plant type is more uniform than present varieties. It has been observed also to have less damage from flea beetles and caterpillars than existing varieties.

Genetic makeup and description of 'Charlestowne' turnip. Brassica campestris L., Rapifera group. 'Raab Salad,' which is cold tolerant, was hybridized with bolt resistant 'Purple Top White Globe,' and the $F_1$ was hybridized with 'Shogoin,' which is resistant to the turnip aphid, Hyadaphis erysiimi (Kattenbach). Recurrent selection was practiced for the duration of the breeding process.

'Charlestowne' is an aphid resistant, bolt resistant, cold tolerant foliage turnip with small, white storage roots and elliptical glabrous leaves. Bolt resistance and cold tolerance are major features that 'Charlestowne' offers over 'Shogoin.' It has also broader, darker leaves and thus differs from 'Shogoin' in appearance.

Genetic makeup and description of 'Roots' turnip. Brassica campestris L., Rapifera group. 'Raab Salad,' which is cold tolerant, was hybridized with bolt resistant 'Purple Top White Globe,' and the $F_1$ was hybridized with 'Shogoin,' which is resistant to the turnip aphid, Hyadaphis erysiimi (Kattenbach). Recurrent selection was practiced for the duration of the breeding process.

'Roots' turnip has large roots with dark purple tops and white globes. Its leaves are aphid resistant, pinneately cleft, dark green and glabrous. Plants have a single growing point, and foliage tends to remain erect and off the soil. 'Roots' is the first aphid resistant root turnip.

## International Clubroot Working Group

Ir. Hille Toxopeus

International cooperation in Clubroot research made significant progress in the last two years and culminated in the so called "Woronin + 100" International Conference on Plasmodiophora brassicae.
This occasion commemorated the publication of Woronin's classical paper on Plasmodiophora brassicae 100 years ago.
The Conference was held in the Bay Conference centre of the University of Wisconsin Madison, from 5-7 September 1977. Organisors were Prof. Paul H. Williams of the Plant Pathology Department of Wisconsin University and Dr. Stephan Buczacki of the National Vegetable Research Station, Wellesbourne, UK, under the aegis of the Group.
Clubrooters from Canada, the USA, Great Britain, the Netherlands, Germany (BRD), Poland, Sweden, Malaysia, Taiwan and Japan were present as well as other pathologists and breeders also from the private sector, some 40 scientist all together.
We were very happy to have professors Walker and Karling as guest of honour.
The larger part of the first day was devoted to a review of the present position of research on Plasmodiophora brassicae and Clubroot disease outlined by various speakers. The remainder of that day and the second day were taken up by papers presented and in depth discussions. On the third day we visited the Department of Plant Pathology and its facilities including a field trip to the University's Experimental Farm. Prof. Paul H. Williams, students and the staff of the Plant Pathology Department went all out to make our stay worthwhile and pleasant, the organisation was excellent.
The folowing two days were spent with closed sessions of the Clubroot Working Group, many loose ends were tied up and the activities were reviewed. Dr. Peter Mattusch of the Institut für Pflanzenschutz im Gemüsebau, Hürth-Fischenich, BRD was elected as the new Chairman.
The Group decided to become affiliated to the International Society of Plant Pathology, we were grateful for an explanation of the purpose of this society by its president Prof. Kelman of the University of Wisconsin Plant Pathology Department.
The details of the meetings will be reported in proceedings of the Conference and the next issue of the Clubroot Newsletter.
Our next meeting will be the evening of 18 August 1978 as part of the 3rd International Congress on Plant Pathology, Munich.

# ANTHER CULTURE STUDIES IN *BRASSICA* SPP

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One of the goals of our research is to develop the methodology for reproducible, high frequency production of Brassica spp haploids for utilization in crop improvement programs. Anther culture has been selected as a potential method for haploid production.

Preliminary studies carried out with *B. campestris* revealed that embryogenesis could be induced in anthers cultured in darkness at 25°C (Keller *et al.* 1975). High levels of sucrose (10%) in the medium were essential for production of embryos and embryogenesis was also stimulated by the presence of glutamine and auxins. Embryos were produced in approximately 1% of the cultured anthers and only 1 or 2 embryos generally developed from each anther. Plants were regenerated from the embryos and grown to maturity. Cytological analysis revealed that they were diploid or polyploid. However, a study of the inheritance of morphological traits by the progeny of anther-derived plants demonstrated that they were homozygous and, therefore, of pollen origin.

Preliminary studies with *B. napus* resulted in induction of embryogenesis at frequencies similar to that in *B. campestris* (Keller and Armstrong, 1977). The majority of embryos were abnormal and did not develop directly into plantlets on embryo culture media. Plants could, however, be regenerated by induction of shoot organogenesis in hypocotyl explants cultured on media containing benzyladenine. Only diploids and polyploids were detected amongst the regenerated plants.

*Brassica napus* has been used in a recent study on the effect of culture temperature on embryogenesis in which anthers were cultured at 30, 35 or 40°C for varying periods prior to transfer to 25°C (Keller and Armstrong, 1978). High culture temperature treatments dramatically stimulated embryogenesis. The optimum treatment of 30°C for 14 days (prior to transfer to 25°C) increased the frequency of anthers producing embryos (> 10%) as well as the number of embryos produced per anther (> 5). Several hundred plants have been regenerated from the embryos and haploids were identified amongst the anther-derived plants at frequencies of 20–30%.

Keller, W. A. and K. C. Armstrong. 1977. Embryogenesis and plant regeneration in *Brassica napus* anther cultures. Can. J. Bot. 55:1383-1388.

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Keller, W. A., T. Rajhathy, and J. Lacapra. 1975. *In vitro* production of plants from pollen in *Brassica campestris*. Can. J. Genet. Cytol. 17:655-666.

# EFFECTS OF STORAGE UNDER UNFAVOURABLE ENVIRONMENTAL CONDITIONS ON VIABILITY OF TURNIP SEED

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Whereas it is widely known that the quality of seed may be considerably influenced by the moisture and temperature in the storage environment, the damage caused by clearly unfavourable conditions is only known in detail for a very few species.

The work on newly harvested turnip seed (Brassica rapa var. rapa), "Navet rouge" cultivar, which we began in July 1975, will be completed by the end of this year.

The seeds were stored under various conditions of moisture and temperature at 35, 55, 76% R.H. obtained, respectively, with saturated solutions of magnesium chloride, calcium nitrate and sodium chloride in desiccator with an excess of the salts; at 40°C, 30°C and environmental temperature.

We established the time necessary for the temperature and moisture of the seeds to tally with those of the atmosphere (experimental atmospheric conditions), the amount of moisture they absorbed and their germination capacity after being kept in the various conditions for successive periods.

At 30°C the turnip seed took 49 days to tally with the environment for 35% R.H., passing from 5.99% of moisture to 4.55%, 41 days to 5.22% at 55% R.H. and 31 days to 8.64% at 76% R.H. After 13 months the first two samples had a germination capacity of 99 and 96% respectively, while the one kept at 76% R.H. did not germinate at all.

# LINKAGE STUDIES IN *BRASSICA CAMPESTRIS* BETWEEN PHENOTYPIC MARKER GENES AND GENES FOR RESISTANCE IN CLUBROOT

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Experiments are being performed to determine if linkage relationships exist between genes for resistance to clubroot of crucifers, caused by *Plasmodiophora brassicae*, and phenotypic marker genes in *Brassica campestris*. The race of the pathogen prevalent in the United States, race 6, was characterized using the European Clubroot Differential set as race 16/2/30. Cytoplasmic male sterile stocks are being developed which contain phenotypic markers controlled by single genes. Single genes for resistance are being identified from plant introduction lines and from four of the *B. campestris* lines of the European Clubroot Differential set. Crosses will be made between plants containing marker genes and those with genes for resistance. Analysis will be carried out in the $F_2$ generation to determine if any linkage relationships are present. Identification of linkage between phenotypically expressed marker genes and genes for resistance would facilitate transfer of resistance genes in future intraspecific and interspecific breeding studies.

# WORONIN +100 CONFERENCE ON CLUBROOT DISEASE OF CRUCIFERS

Paul H. Williams

On September 5-7, 1977, the Woronin +100 Conference was held at the University of Wisconsin, Madison. The Conference was held to commemorate the centennial of the publication of M. S. Woronin's classical paper on Plasmodiophora brassicae Wor. and the clubroot disease. Thirty-five scientists representing 12 countries attended the Conference which consisted of a half-day symposium on various aspects of P. brassicae, the clubroot disease, and its control. Following the symposium were a day and a half of research presentations and discussions.

The Conference was particularly fortunate to have Professors John Karling and J. C. Walker in attendance. Professor Karling provided a scholarly lecture on Woronin, the Man, while Walker contributed insights and perspectives to research on clubroot over his past 65 years as an active plant pathologist. Research presentations and discussions followed the major themes established by the symposium speakers, the titles of whose presentations are listed below.

1) J. Karling - Woronin, The Man
2) J. R. Aist - Plasmodiophora brassicae - The Organism and Life Cycle
3) P. H. Williams - Clubroot Disease - Pathogenesis and Host-Parasite Relations
4) P. Mattusch - Plasmodiophora brassicae - Epidemiology, Variation and Specialization
5) H. Toxopeus - Clubroot Control - Breeding and Genetics of Resistance
6) S. Buczacki - Clubroot Control - Chemical and Cultural Control

Of particular interest in the research sessions were presentations by 1) I. McNaughton (S.P.B.S.) on intergeneric transfer of resistance to clubroot resistance into Raphanobrassicas; 2) M. S. Chiang (Agriculture Canada) on the transfer of clubroot resistance from B. napus to B. oleracea. Considerable discussion centered around the ranges of pathogenic variability of P. brassicae in papers presented by H. Yoshikawa, K. Proudfoot, G. R. Dixon, P. Mattusch, H. Toxopeus and J. O. Strandberg. The elegant elctron microscopy of R. Garber and J. R. Aist (Cornell University) served to demonstrate the effectiveness of this approach in resolving some of the more elusive aspects of parasite cytology. A general consensus of the Conference was that if significant progress were to be made in controlling clubroot, a greater degree of coordinated research among "clubrooters" throughout the world will be necessary. Plans are being made to publish the proceedings of the Conference under the auspices of the J. C. Walker Endowment Funds at the University of Wisconsin. Those interested in obtaining a copy of the proceedings should contact P. H. Williams.

After the Woronin +100 Conference, the International Clubroot Working Group (ICWG) met for two days in sessions dealing primarily with the problems of pathogen variability and means of coordinating international research on the clubroot disease. Plans are to hold sessions of the ICWG at the 3rd International Congress of Plant Pathology, Munich, August 16-23, 1978.

# BRASSICA CROPS IN MALAYSIA

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Brassica crops are an integral part of the Malaysian diet as they are in all Southeast Asian countries. Locally grown Brassica oleracea, B. juncea and B. campestris (pekinensis and chinensis groups) provide the predominance of leafy vegetables available in the market and significant amounts are currently being imported.

Within B. oleracea, two of the favored crops, white cabbage and cauliflower, have until recently been confined to the cooler, highland areas for production, while the other favored crop, B. oleracea var. alboglabra (Kailan) has been traditionally grown in the warmer areas nearer the market place.

Chinese cabbage (B. campestris, pekinensis group) is still limited to highland production, but pak choi and the other B. campestris crops of the Chinensis group are grown with Kailan and members of Brassica juncea in the warmer areas.

All seeds for the production of the biennial types of Brassica must be imported and under the continuous cool or warm, wet conditions, intensive production practices are necessary, including the heavy use of pesticides.

Work is currently underway in Malaysia and at Madison to develop (simple) techniques for full cycle biennial crop production under these tropical conditions. This could provide both the potentiality for self-sufficiency in crop and seed production if needed, as well as the means to initiate a breeding program for these crops which have not benefited from the local selection available to annual types.

Crosses have been made in Malaysia and Madison between B. oleracea var. capitata and B. oleracea var. alboglabra. The first three generations of these crosses have been selected for annual heading and flowering ability. These $F_3$ progeny will be introduced into a backcross program with standard tropical types, along with one white cabbage variety from Indonesia and one from Brasil with early bolting habits. All progeny will be screened against locally occurring races of Plasmodiophora brassicae and the other prevalent diseases of Brassica in Malaysia. Field trials are to be conducted in Malaysia and Wisconsin.

# GENETIC STUDIES IN *BRASSICA CAMPESTRIS* L.

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The inheritance of 14 phenotypic variants in *Brassica campestris* L. was investigated. The following 10 characters are under monogenic recessive control: cream corolla (*cr*), light yellow corolla (*ly*), dark yellow corolla (*dy*), cupped petal (*cup*), apetalous (*pl*), puckered leaf (*pkl*), anthocyaninless hydathode (*ahd*), anthocyaninless bud tip (*ab*), anthocyaninless anther tip (*aa*), and anthocyaninless style tip (*as*). Rolled petal margin (*Ropm*) is under monogenic dominant control and polypetalous (*Pp*) is under dominant control, but strongly influenced by environmental conditions. Striped petal (*sp*) is exclusively maternally inherited and red petal margin (*rpm*) is preferentially maternally inherited.

Preliminary studies were conducted on gene interaction and linkage relationships among several of the marker genes. The flower color genes cream (*cr*), light yellow (*ly*), dark yellow (*dy*), and orange (o) were found to be nonallelic and independently inherited. The following interactions were observed: *cr* epistatic to *ly*, *dy* and *o*; *ly* epistatic to *dy*; and *dy* epistatic to *o*. No evidence for linkage between yellow green plant ($yg_2$) and any of the three flower genes *cr*, *ly* and *dy* was obtained. Close linkage (5.5-7.1%) of anthocyaninless anther tip (*aa*) and anthocyaninless style tip (*as*) was detected.

# GENETIC STUDIES IN *BRASSICA NIGRA* (L.) KOCH

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Five recessive marker genes, cream-colored pollen (*cpo*), yellow-green plant ($yg_1$), yellow-green cotyledons ($ygc_1$), lutescent plant (*lu*), and glabrous ($g_1$), and one dominant marker gene, *Ac2*, for resistance to *Albugo candida* race 2, were identified in *Brassica nigra* (L.) Koch. The genetic behaivor of 10 additional phenotypes was also studied; those phenotypes were: glabrous (three types), virescent leaves, folded petals, floral retention, yellow-green cotyledons (a different source from $ygc_1$), anthocyaninless hypocotyl, anthocyaninless leaves, yellow-green plant (a different source from $yg_1$), and xanthovirescent plant. The folded petal trait appears to be under the genetic control of two loci; the glabrous phenotypes are conditioned by genes whose expressions appear to vary with genetic backgrounds and modifying genes; the xanthovirescent trait seems to be under dominant genetic control; the remaining five phenotypes appear to be under monogenic recessive control.

Mutagenesis experiments with ethyl methanesulfonate resulted in the generation of many mutants in the species *B. nigra*, primarily chlorophyll mutants. The calculated chlorophyll-mutation frequency was 23.4% of $M_1$ plants giving rise to chlorophyll mutants in the $M_2$ generation, or 1.2 chlorophyll mutants per 100 $M_2$ individuals screened. Using sodium azide as the mutagen (at concentrations from $2.5 \times 10^{-4}$ M to $4.0 \times 10^{-3}$ M), 5% of the $M_1$ plants gave rise to chlorophyll mutants in the $M_2$ generation (1.3 chlorophyll mutants per 100 $M_2$ individuals screened).

An isolate of *Albugo candida* obtained from *B. nigra* plants growing in the University of Wisconsin experimental field plots was tested on a number of wild and cultivated crucifer species. The reactions of these hosts to this isolate of *A. candida* suggested that this isolate was different from the seven previously characterized races of *A. candida*; the isolate was tentatively designated race 8.

# THE PROBLEM OF GENOMIC AND CYTOPLASMIC NOMENCLATURE IN CRUCIFER GENETICS

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Colleagues, this note is designed to solicit your responses to a problem which has confronted me as our program has increasingly begun to take into account the possible effects of cytoplasmic factors and gene-cytoplasm interactions in crosses among and between various Brassica and Raphanus species. The problem is that of how best to deal with the designation of specific cytoplasms. The presumption is that the internationally recognized forms of designating nuclear genes is adequate for most nuclear genotypes and would continue to be used by those describing new traits. Let me indicate how we are now designating various cytoplasms in the hopes that, perhaps through this Crucifer Newsletter or through direct correspondence among interested persons we might, in the future, find an effective agreed-upon system that could be adopted widely among crucifer geneticists and breeders.

1) We use the traditionally accepted genomic letters in lower case for designation of the species-chromosomal relationships; e.g., aa = B. campestris, aacc = B. napus, rr = Raphanus sativus, etc.
2) We use the single capitalized letter to designate the cytoplasm in which the nuclear genome is functioning in; e.g., A = B. campestris cytoplasm, AB = B. juncea cytoplasm, etc., R = Raphanus sativus cytoplasm, etc. The use of a capital letter represents a nonspecified cytoplasm of a particular species origin; however, when a particular phenotype is associated with that cytoplasm, then a number is also added to the cytoplasmic designation and the phenotype associated with the number recorded. Thus, we have designated the cytoplasmic male sterility developed by Pearson (1972) from B. nigra as B1 and, when transferred to B. oleracea as B1cc, and Ogura's cytosteriles from Raphanus sativus (Heyn, Brassica Newsletter #1) as R1. R1 has now been combined with B. napus R1aacc, B. campestris R1aa and B. oleracea R1cc. Other cytoplasmic factors with which we are working are a chimeral varigation in B. campestris designated A1aa and a chimeral varigation derived from R1 cytoplasm and designated R2.
3) In the case of nuclear genes which interact with specific cytoplasms, these should be treated as regular nuclear genes; e.g., restorer factors for cytoplasmic male sterility, could be designated as rf1, rf2 or Rf1, etc., depending on their expression and inheritance.
4) Nuclear genes are written in script or underlined to differentiate them from possible confusion with genome designations which are not underlined. We have found the above system workable and useful particularly when we are resynthesizing amphidiploid species, e.g., we have constructed Brassica juncea with the following constitutions, R1aabb, Aaabb, Baabb.
5) To distinguish those brassicas in our program which are primarily being used for genetic purposes and, hence, selected for rapid flowering habit from those directed toward some utility as a breeding stock, an additional one or two lower case letters are assigned to the genome to identify the particular subspecies or host-variety being emphasized. Added to breeding stock of B. oleracea or B. campestris would be one of the following descriptors.

| | | | | | | |
|---|---|---|---|---|---|---|
| B. | oleracea | cc | capitata | c | = | ccc |
| " | " | " | italica | i | = | cci |
| " | " | " | botrytis | b | = | ccb |
| B. | campestris | aa | pekinensis | p | = | aap |
| " | " | " | chinensis | c | = | aac |
| " | " | " | rapa | r | = | aar |

Thus, Chinese cabbage in Ogura's cytosterile would be designated Rlaap or cytosterile broccoli as descbried by Dixon (1975) would be Blcci.

I would welcome your comments on the above presentation.

Paul H. Williams

## REQUEST FOR SEED (Raphanus sativus).

Following discussions of the International Club-root Working Group, at The Voronin +100 Conference at Madison, U.S.A., in September 1977, it was decided to investigate the feasibility of adding a Raphanus sativus (radish) set to the Plasmodiophora differential host set (ECD series).

The current ECD series comprises only Brassica species.

Seed of any forms of Raphanus sativus (oil-seed, fodder or culinary cultivars) would be very gratefully received. Samples should be sent to Dr C.J. Williamson, Scottish Plant Breeding Station, Pentlandfield, Roslin, Midlothian, EH25 9RF, Scotland, U.K.

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