PN-AAL-652

GENETIC RESOURCES OF CRUCIFEROUS CROPS

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AGP:IBPGR/80/100
June 1981

INTERNATIONAL BOARD FOR PLANT GENETIC RESOURCES

IBPGR Secretariat Consultation on the Genetic Resources of Cruciferous Crops

Rome, 17-19 November 1980

REPORT

IBPGR SECRETARIAT
Rome, 1981

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INTRODUCTION

1. When the International Board for Plant Genetic Resources (IBPGR) finalized its priorities for action on crops it was agreed that further study was required for vegetables. As a result, in 1976, the IBPGR commissioned the Royal Tropical Institute of the Netherlands (RTI) to produce a consultant's report on vegetable germplasm with special reference to those grown in the tropics. This report was available by the end of 1977. The RTI/IBPGR report included a summary of available information on genetic erosion and the priority requirements for collection and conservation of germplasm. The IBPGR concluded that more information was required and therefore an expert consultation was held 24-25 January 1979 at the National Vegetable Research Station (NVRS), Wellesbourne, UK. As a result of this consultation the IBPGR, at its meeting in February 1979, decided to invite the Asian Vegetable Research and Development Center (AVRDC), Taiwan, China to coordinate and prepare a plan of action for priority *Brassica* spp. in cooperation with NVRS and the Vegetable and Ornamental Crops Research Station (VOCRS), Tsu, Japan.

2. During the European Association for Research on Plant Breeding (EUCARPIA) Cruciferae 1979 Conference, 1-3 October, European cruciferous crop breeders established the Crucifer Genetic Conservation Group (CGCG). The CGCG's major objective is the prevention of further genetic erosion of cruciferous crops, particularly in Europe. Considering the participants deep concern about the very serious and increasing genetic erosion of these crops, the Conference adopted a motion, formulated by the CGCG, which addressed an urgent appeal to the IBPGR to establish a global working group to tackle the problem of the integral genetic conservation of cruciferous crops. The CGCG offered to actively participate in any relevant resulting action.

3. After discussions between AVRDC and IBPGR, and considering the appeal of the Crucifer Genetic Conservation Group, it was decided to prepare a report during an expert consultation held in Japan on 30 March 1980, concurrent with the Chinese Cabbage Symposium, Tsukuba. This report should include: identification and information of the existing collections of *Brassica* spp. (mainly *B. oleracea*, *B. pekinensis*, *B. juncea* and *B. carinata*); duplications and gaps in these collections; identification of priorities for collecting to fill the geographical/species gaps; needs for long-term conservation; a plan for coordinated action on preliminary evaluation of material; and suggestions for a list of descriptors for collection and evaluation data.

4. The report of this meeting (AGP:IBPGR/80/29) was discussed by the IBPGR during its meeting in May 1980. Following this discussion the IBPGR Secretariat was requested to obtain additional information on a wider range of cruciferous crops. Accordingly a number of experts were requested to submit status reports on the genetic resources of cruciferous crops for specific regions. The response to this request was overwhelming (see Appendix I). Subsequently a Secretariat Consultation was organized in Rome, 17-19 November 1980 in order to condense the abundant information into a comprehensive "plan of action report" to advise the IBPGR on action to be taken. This meeting was chaired by Ir. D.H. van Sloten, IBPGR Genetic Resources Officer.

5. Of the participants invited, the following were able to attend: Dr. I.J. Anand (IARI, India), Dr. P. Crisp (NVRS, UK) 1/, Prof. C. Gómez-Campo (UPM, Spain), Dr. S. Nishi (VOCRS, Japan), Dr. R.T. Opena (AVRDC, Taiwan), Ir. H. Toxopeus 1/, (SVP, The Netherlands) and Prof. P.H. Williams (University of Madison - Wisconsin, USA). Dr. Chu Ming Kai

1/ on behalf of the EUCARPIA Crucifer Genetic Conservation Group

(VRI, China) and Dr. P.P. Khanna, (NBPGR, India) were unable to attend. The IBPGR Secretariat was represented by Dr. J.T. Williams, Dr. N. Murthi Anishetty, Dr. J.T. Esquinas-Alcazar, Mr. C.W. Howes and Ir. D.H. van Sloten. The full addresses of the participants are shown in Appendix II.

6. Dr. J.T. Williams, IBPGR Executive Secretary, welcomed the participants on behalf of the IBPGR and expressed the hope that the meeting would reach definite conclusions on action required and that specific recommendations would be made to the Board, particularly on collection requirements, sites for conservation and on the descriptor list. The agenda, as adopted by the meeting, is shown in Appendix III.

RECOMMENDATIONS

7. The major recommendations of the Secretariat Consultation, which were endorsed by the IBPGR during its meeting in Rome, 17-20 February 1980, are described below.

7.1 The IBPGR should designate base collection centres for specific cruciferous crops as listed in Table 2 (see page 23). In connection with base collection centres, recommendations are given for the extension of storage facilities, the global collections of wild relatives, the sample size for base storage and the procedures for multiplication and regeneration. These recommendations are outlined in para 40.

7.2 The IBPGR should use the list of crop priorities provided in Table 3 (see pages 25, 26) in planning collecting missions. These priorities should also be brought to the attention of other concerned parties, e.g. the National Bureau of Plant Genetic Resources (New Delhi, India), the Chinese Academy of Agricultural Science (Beijing, China), the IBPGR Southeast Asia Regional Committee and the European Community (EC) Standing Committee on Agricultural Research, the latter especially for funding of collecting activities in countries of the EC.

7.3 The IBPGR should take immediate action on first priority cruciferous crops as outlined in para 42 and Table 4 (see page 27).

7.4 It is recommended that the list of descriptors for PASSPORT DATA (Appendix V) and the COLLECTION DATA SHEET (Appendix VI), be used during collection and conservation of crucifer germplasm. Separate descriptor lists for characterization and evaluation are needed for each crop within the crucifers. Specialists will be contracted by the IBPGR to produce these descriptor lists.

7.5 Considering the economic importance and complexity of these crops, the number of items for which no immediate solution could be provided during the Secretariat Consultation (e.g. descriptor lists, key for cruciferous crop species), and the need to review global activities on collection and conservation, it is recommended that the Working Group on Cruciferous Crops Genetic Resources be reconvened at a future date.

Figure 1. Pak-choi (*Brassica campestris* subsp. *chinensis*) awaiting shipment to market near Nanking, China

REPORT

INTRODUCTION

8. Within the Cruciferae a diversity of crop form, utilization and distribution unparalleled by any other genus exist among the *Brassica* species. Brassicas have an important role in world agriculture: as vegetables, oilseed, forage and fodder, green manure and condiment. *Brassica* oil ranks fifth in world production, being widely used for edible fat, as industrial lubricants and as a base for polymer synthesis. Oilseed cake is an important source of protein for animals and is currently being considered as a potential supplementary protein source for human beings. Crucifer vegetables span a range of morphotypes represented by highly nutritious and succulent modifications of roots, stems, buds and floral parts. They are the major vegetables in the diet of the Chinese, Japanese, Koreans and Europeans. In China for example the daily per capita consumption of vegetables is 0.5 kilogramme, 50 percent of which are cruciferous crops. In northern China 85 percent of the vegetables consumed from November to April are crucifers. Fodder and forage crops producing fresh winter fodder are of considerable and growing importance in Europe and potentially important to other areas of the world. Both in China and Europe cruciferous field crops are highly regarded for their green manure properties in cropping or farming systems.

9. *Brassica oleracea*, *B. campestris* and *B. juncea* occur as a range of morphotypes representing parallel evolution of numerous vegetable and oilseed forms. Each of these species is represented by heading forms, open leafy rosettes, swollen stems, enlarged roots, prominent floral parts and oilseed producing forms. Secondary and tertiary evolution has resulted in adaptations of species to different regions of the world. The *B. oleracea* group or cole crops are found primarily around the Mediterranean and in northern Europe, representing vegetable, forage and fodder types. Forms of *B. campestris* occur throughout Europe, China and Japan, where they are primarily used as vegetables and oilseeds (see Figure 1). *B. juncea* is primarily an oilseed crop. It is grown widely throughout southern China for oilseed as well as in the Indian subcontinent. *B. napus* is of considerable importance as an oilseed and fodder crop. Though adapted to northern Europe, *B. napus* is now also grown widely as an oilseed in China, Canada and South America. Although of limited geographical distribution, *B. carinata* is an important vegetable and source of edible oil in Ethiopia. In the past *B. nigra* has been an important source of condiment and oil whereas today it is considered a noxious weed of almost ubiquitous distribution.

10. In addition to the brassicas, *Raphanus sativus*, covering a great range of morphotypes, is a major vegetable in the Orient (Japan, China, Korea and India) as well as in Africa. Large quantities of radishes are consumed, either fresh, cooked or pickled. The oriental radish is high yielding and also serves as animal feed. In Europe and North America radish is a minor vegetable, while it is also grown in northern Europe and parts of South America as green manure, oilseed and fodder.

11. Although the genetic plasticity of *Brassica* and *Raphanus* species and their antiquity as cultivated crops has led to the vast diversity in form and utilization, modernization of agriculture on a world scale now severely threatens the existing diversity. The desire of vegetable growers throughout the world for F_1-hybrids is resulting in the replacement of most landraces and open-pollinated cultivars of *B. oleracea* and *B. campestris*. This replacement is virtually complete in Japan, Korea, North and South America and northern Europe. Very significant losses have occurred

during the past 20 years in China, perhaps the last great resource of genetic diversity in oriental brassica vegetables; F_1-hybrids are now coming into wide use. The rapid progress presently being made in the development of F_1-hybrids in crucifer oilseed crops will increase genetic erosion within this group of crops.

12. Because of the genetic erosion as outlined above and the important role of crucifers in the nutrition of such a large sector of the world population and the increasing importance of brassica oil as a cash commodity in Asia and Europe, high priority must be given to collection and preservation of the still existing diversity within this group of crops.

ORIGIN AND DIVERSITY, EXISTING COLLECTIONS AND NEED FOR FURTHER COLLECTING

13. Because of the great diversity of cruciferous crops, each major crop is briefly described in paragraphs 15-38. The subject is treated in the following three categories:

(i) Assessment of the value as breeding material of the genetic base of the crop. The broader the genetic variation present, the higher its value. The variability and degree of differentiation in a crop is largely a function of its economic importance in time. A crop that has been intensively cultivated on a large scale for more than a few hundred years will have acquired a considerable degree of differentiation into forms and have a broad, and therefore very valuable, genetic base. Consequently knowledge of the history of crops is an important aid to this assessment;

(ii) Assessment of the extent to which the genetic variation of a crop is conserved; and

(iii) Assessment of gaps and the priority for further collecting.

14. A map indicating the origin and diversity of major *Brassica* spp. is supplied in Figure 2 A summary of existing collections is given in Appendix IV, while more detailed information on curator, nature of samples, source of collection, storage facilities, documentation, evaluation, etc. will be published at a later date in the IBPGR Directory of Vegetable Germplasm Collections. The information on further collecting required is summarized in the chapter on priorities for action. Table 1 is provided for easy reference to the different crops.

15. *Brassica oleracea* (Wild relatives; n = 9 cytodeme)

15.1 The taxa related to *B. oleracea* have traditionally been described to the following specific epithets:

B. bourgaei (syn. *Sinapidendron bourgaei*) Canary Islands

B. oleracea wild in England, Brittany (and northern Spain?); coastal

B. robertiana northeastern Spain, Mediterranean, France, (Italy?); coastal

B. insularis Corsica, Sardinia, Tunisia; mostly coastal

B. macrocarpa Egadi Islands near Sicily

B. villosa-incana (complex) Sicily, mainland Italy, northwestern Yugoslavia; coastal

B. cretica (complex) Greece and Aegean Islands, Crete

B. hilariana Cyprus

Table 1. Reference to genera, species, subspecies and varieties, common name, main use and related paragraphs

Taxonomic name	Common name	Main use	Paragraph
Brassica campestris			
B. campestris subsp. *chinensis*	Pak choi	Vegetable	30
B. campestris subsp. *japonica*		Vegetable	32
B. campestris subsp. *narinosa*		Vegetable	31
B. campestris subsp. *oleifera*	Turnip rape	Oilseed	26
B. campestris subsp. *pekinensis*	Chinese cabbage	Vegetable	29
B. campestris subsp. *rapa*	Turnip	Vegetable/Fodder	33
Brassica carinata	Ethiopian mustard	Vegetable/Oilseed	34
Brassica juncea	Indian mustard Chinese mustard	Oilseed Vegetable	27 28
Brassica napus			
B. napus var. *biennis*	Rapekale	Fodder	23
B. napus var. *napobrassica*	Swede turnip	Fodder/Food	24
B. napus var. *oleifera*	Oilseed rape	Oilseed	25
Brassica nigra	Black mustard	Condiment	35
Brassica oleracea	Wild relatives		15
B. oleracea var. *acephala*	Kale	Vegetable/Fodder	16
B. oleracea var. *alboglabra*	Chinese kale	Vegetable	22
B. oleracea var. *botrytis*	Cauliflower	Vegetable	20
B. oleracea var. *capitata*	Cabbage	Vegetable/Fodder	17
B. oleracea var. *gemmifera*	Brussels sprout	Vegetable	18
B. oleracea var. *gongylodes*	Kohl rabi	Vegetable/Fodder	19
B. oleracea var. *italica*	Broccoli	Vegetable	21
Raphanus sativus	Radish	Vegetable/Fodder Oilseed/Green manure	37
Raphanus spp.	Wild relatives		38
Sinapis alba	White mustard	Oilseed/Green manure	36

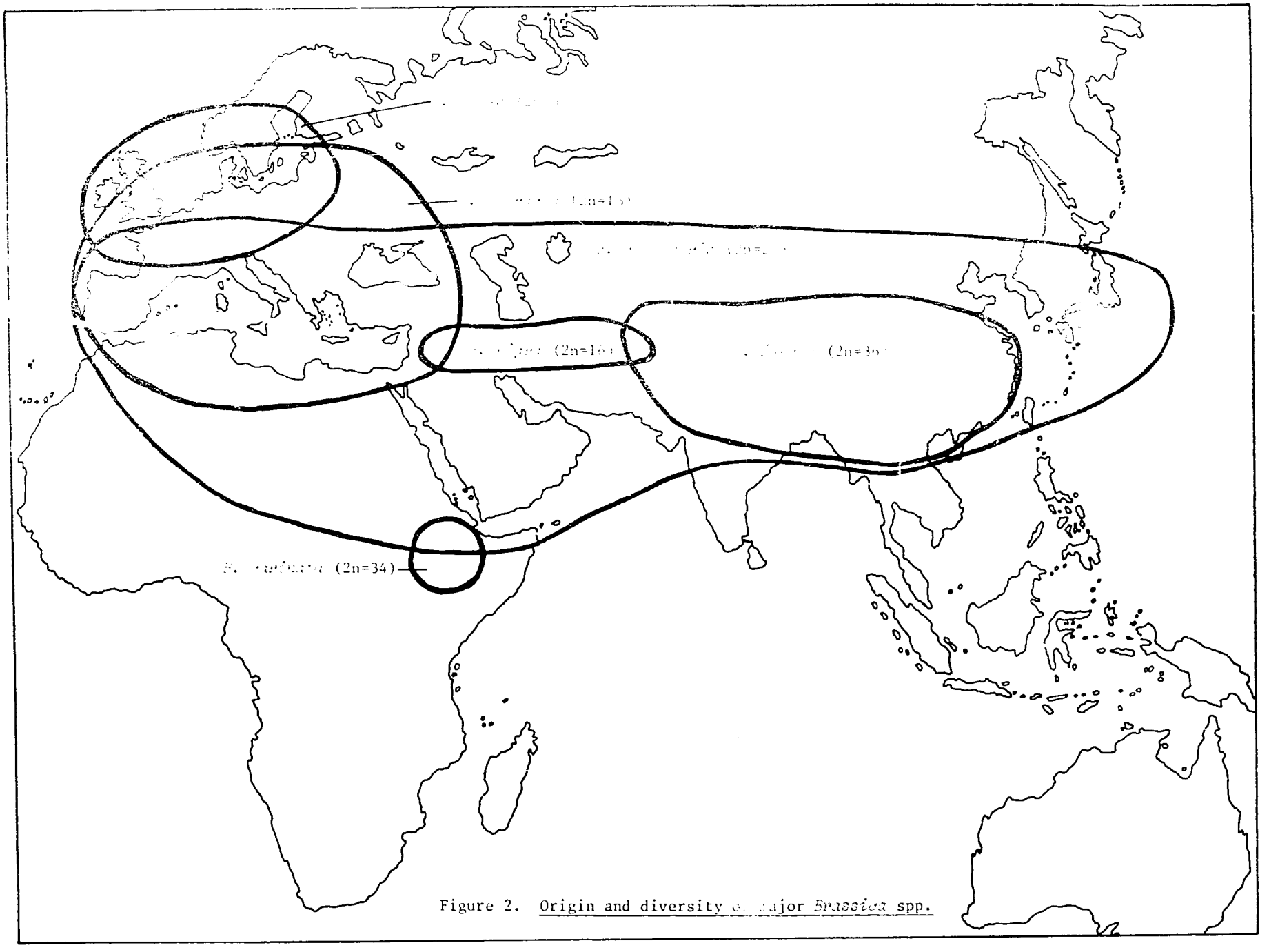

Figure 2. Origin and diversity of major *Brassica* spp.

Some populations in Syria and Lebanon seem to correspond to the *B. cretica* complex. The commonly established use of specific epithets for these taxa can be misleading. All the above taxa have n = 9 chromosomes and are cross-fertile with cultivated *Brassica oleracea*. They have been treated as subspecies or varieties of *B. oleracea* by a number of authors. Domestication was probably not only made from wild *B. oleracea* but also from *B. cretica*. In any case, it is obvious that it took place from a limited number of wild populations. The whole group constitutes a super complex with many isolated and genetically differentiated populations and is of great importance as a source of useful genes.

15.2 *Brassica* breeders usually keep some samples of these wild taxa in their collections. At specific level they can be also obtained from UPM (Gómez-Campo) collection. Several samples are also kept by Snogerup (Lund), Wills (Dundee), etc. It is evident that wild taxa have been collected previously, but this has never been done systematically, i.e. covering their whole area of distribution and taking into account the genetic diversity that different populations can contain.

15.3 At least three of the above taxa should be considered endangered. *B. bourgaei* had even been considered extinct for more than 50 years until two individuals were recently re-found. *B. macrocarpa* with indehiscent fruits is restricted to a certain altitude and orientation on a small island near Sicily. *B. hillarionis* seems to be very rare in Cyprus. *B. oleracea*, *B. robertiana*, *B. insularis*, *B. villosa-canescens* and *B. cretica* may not be endangered as species, but many of their populations are. Thus, from the point of view of the genetic resources they may contain, these should be both collected and preserved. At least 100-120 samples can and should be collected by covering the entire geographic and taxonomic range. This should be done by taking the necessary precautions to avoid irreversible damage to the natural populations. Recommendations on the minimum sample size should in this special case be neglected. A prudent sampling of each existing population followed by multiplication should be carried out. Data recorded at the time of collection should take into account conservation aspects such as total size of plant population, possible threats, ecological aspects, etc. Other descriptors used for cultivars could be only partially followed. Collecting should be undertaken by the simultaneous use of the following three procedures:

(i) while collecting cultivars in adjacent areas;

(ii) by planning some expeditions to areas with the highest concentration of diversity; and

(iii) by using the basic structure provided by the members of the Organization for the Phyto-Taxonomic Investigation of the Mediterranean Area (OPTIMA).

16. <u>*Brassica oleracea* var. *acephala* (Kale)</u>

16.1 The antiquity as crops of kales (and of cabbages) makes them the main source in *B. oleracea* of genes conferring resistance to environmental stress. It is surely no coincidence that resistance to drought, cold and disease is found repeatedly in kales, but seldom in more recently evolved *B. oleracea* crops. Centres of diversity for annual and biennial (winter hardy) types of kales throughout Europe must be of great antiquity. Since the Seventeenth Century kales have been used increasingly for cattle food in northern Europe, and many regional types still exist. Distinctive types include

the branched 1000-head kale, the tall, woody Jersey or tree kale, the marrow-stem kale, and others differing in leaf shape (smooth or curled), colour (green, brown, purple or variegated), hardiness, and disease resistance.

16.2 There are collections of northern Europe biennial types in the UK and the Federal Republic of Germany.

16.3 Although there is relatively little danger of breeding or other agricultural developments causing major erosion of northern European types, supplementary collecting is necessary, notably in northern France. There are no records of collections from central Europe and the Mediterranean; they are urgently required. Types (which must be of recent introduction) are reported in China, but are probably not represented in collections.

17. *Brassica oleracea* var. *capitata* (Cabbage)

17.1 Cabbages are of old, southern European origin, with numerous secondary gene centres throughout Europe. Types differ in size, shape, colour, hardiness, period of maturity and disease resistance. Tertiary gene centres include parts of Asia, where 'tropical' types have been developed.

17.2 Sizeable collections exist in France, Germany, Sweden, Taiwan and the USA, and lesser ones in England, the Netherlands and Scotland.

17.3 Despite the relatively large scale of cabbage collections, its additional importance as a gene source for the rest of *B. oleracea* should not be underestimated. A systematic collection of existing types in Europe, including the Mediterranean, is necessary; a particular deficiency is the fodder cabbages. In addition, cabbage genetic resources in many parts of the world are threatened by the increasing use of F_1-hybrid cultivars. Cabbages are also becoming a major crop in the sub-tropics. Although of recent origin, the 'tropical' types - in particular those of India and China - appear to be under-collected.

18. *Brassica oleracea* var. *gemmifera* (Brussels sprout)

18.1 Brussels sprouts originated in the Eighteenth Century in Belgium and then became established as a major crop in several northwestern European countries. Early-maturing Asian types have also been developed.

18.2 Good collections exist in most northwestern European countries and in the USA (see Figure 3).

18.3 Despite the massive genetic erosion in this crop caused by the advent of F_1-hybrids, most types have been relatively well collected. Because of this, and because the relatively recent origin of the crop indicates that it has acquired few unique genes, further systematic collection is unnecessary.

19. *Brassica oleracea* var. *gongylodes* (Kohl rabi)

19.1 Kohl rabi first appeared in the Middle Ages in central or southern Europe. The crop is now widely grown in southern, central and northern Europe for both human and animal consumption. Types differ in colour, size, shape and

flowering behaviour. The crop has become established in parts of Asia over the course of the last two centuries and is important in northern China.

19.2 Minor collections exist in Europe, Taiwan and the USA.

19.3 This is a crop which could easily contribute to other *B. oleracea* crops, or become established more widely in its own right. More collections, especially from southern Europe, are necessary.

Figure 3. A Brussels sprout (*Brassica oleracea* var. *gemmifera*) introduction into the USA (PI number 343675)

20. *Brassica oleracea* var. *botrytis* (Cauliflower)

20.1 The ancestral gene centre of cauliflower is southern Italy, although an earlier origin in the Levant has been postulated. It became established throughout the Mediterranean region during the Middle Ages. From the Sixteenth to Eighteenth Centuries, secondary northwestern European centres were established for annual types in the continental area and biennials in maritime zones. From the Eighteenth to Twentieth Centuries tertiary centres

developed in India and Australia, and the 'tropical' types which first evolved in India have spread throughout South Asia. Cauliflower is now an important crop in most countries of the world.

20.2 Substantial collections exist in the Netherlands, Sweden and the UK. These are almost entirely of the northwestern European types. In addition, there are large collections in the USA and Taiwan.

20.3 The Italian gene centre has not yet been assessed or collected and this range is rapidly eroding as the export cauliflower industry develops there. Collecting is a major priority. There are apparently also no accessions from North Africa and very few from other countries bordering the Mediterranean. The import of Australian varieties has virtually replaced traditional autumn-maturing stocks in several parts of northern Europe. These deserve conservation. British and Dutch biennial types are still represented by a wide range of commercial and growers-own cultivars. These can easily be collected before current advances in breeding threaten erosion. The 'tropical' types are probably represented only in the Taiwan collection. Despite their relatively recent origin there is a wide diversity of type, and systematic collecting - particularly in India - is required. Many farmers' stocks still exist in Australia. They are of relatively recent origin, and are primarily recombinants of existing (or extinct) types. They have, however, formed the base of cultivars which have been successful in many other parts of the world and, therefore, deserve conservation.

21. *Brassica oleracea* var. *italica* (Broccoli)

21.1 Broccoli share their main gene centre - Italy - with cauliflowers and may also have originated in the eastern Mediterranean. Biennal forms have been selected in northwestern Europe since the Sixteenth Century. One of the annual forms (the green-sprouting broccoli, or 'Calabrese') has become a major crop in southeast Asia and North America since the Nineteenth Century. Many other types have not been exploited.

21.2 Biennal types from northwestern Europe are stored as a fairly good collection in the UK. The 'Calabrese' type is amply represented in European, Asian and American collections.

21.3 Collection from the Italian gene centre is of high priority as it is threatened by the growth of the Italian cauliflower industry. In particular, the narrow genetic base of 'Calabrese' requires expansion. Biennial types exist in several European countries, usually as growers-own stocks. Although under no immediate threat, the crop has the potential to become of major importance, and this gene base deserves further conservation.

22. *Brassica oleracea* var. *alboglabra* (Chinese kale)

22.1 Chinese kale is the only ancient oleraceous crop of southeast Asia and the Orient. Despite its wide distribution there appears to be relatively little diversity of type, probably because of the absence of gene flow from other cole crops.

22.2 There is a small collection in Taiwan, and minor secondary collections in Europe.

22.3 Supplementation is necessary, particularly of Chinese material. Adequate representation of the genetic diversity could probably be easily achieved.

23. *Brassica napus* var. *biennis* (Rapekale)

23.1 The rapekale or fodder rape is a crop which first appeared in England in the Seventeenth Century; it became the fresh winter fodder crop of the UK and Ireland. Landrace material still exist, mainly with seed merchants.

23.2 There are no substantial collections.

23.3 The genetic basis appears to be in serious danger of extinction.

24. *Brassica napus* var. *napobrassica* (Swede turnip)

24.1 The Swede turnip or rutabaga is of recent Eighteenth Century origin in Europe as the winter napus oilseed rape. Like the turnip it was a major crop until the introduction of the potato, after which it became a vegetable of generally minor importance. However it was a widely grown fodder crop until recently and has also been used in Germany to gap up fodder beet fields. Presently its importance as a fodder crop is limited to certain areas. Swedes are difficult to distinguish from turnips, and they cross quite readily. Seed stocks must have had a mixed parentage in many places for generations, resulting in very substantial introgression of turnip genes into the Swede, which would explain the nearly complete series of parallel variation with the turnip. The genetic-base of the Swede turnip is unexpectedly broad.

24.2 There are several major collections of Swedes in Europe.

24.3 Most of the genetic variation appears to be conserved, some additional collecting is important.

25. *Brassica napus* var. *oleifera* (Oilseed rape)

25.1 Of the oilseed rapes, or Swede oilseed rapes or Swede rapes or colza (cole seed), two forms are recognized:

> Winter rape, a biennial form, sown in the autumn and harvested in the middle of the summer; it is sown a little earlier and harvested a little later than winter turnip rape.

Winter rape first appeared as a crop around the year 1600 in Flanders and very rapidly replaced the existing winter turnip rape throughout north-western Europe. The Dutch name is koolzaad, from which the French name colza is derived; the German name is Ölraps. The oil was mainly used for illumination but with the introduction of petroleum products, electricity and the tropical vegetable oils, winter rape production underwent a severe decline in the first part of this Century. This, combined with the fact that the crop has had a short domestication period, probably explains why the existing genetic base is small.

> Summer rape, the annual form, sown in spring and harvested in the latter part of the summer.

Little is known of the histroy of summer rape; it is not mentioned as a crop plant, or otherwise, in historical documents at least until ca. 1700.

Since then it has developed as a summer oilseed crop - like summer turnip rape - grown in places where winters are too severe even for winter turnip, such as the Canadian prairies and northern Sweden. Summer rape is also a highly valued green manure crop grown between small grain crops in Germany. There has been little or no differentiation into forms (until recently with the creation of the erucic acid zero cultivars); it seems that only relatively few landraces exist, but these show a great internal variation.

25.2 Good collections of oilseed rapes exist in Europe, especially in Poland and the Federal Republic of Germany, and also in Japan and Korea.

25.3 Most of the genetic variation appears to be conserved, some additional collecting of summer rape is important.

26. *Brassica campestris* subsp. *oleifera* (Turnip rape)

26.1 Of the turnip oilseed rapes or turnip rapes, two ecologically different forms are recognized:

Winter turnip rape, a biennial form, sown in the autumn and harvested in the early part of summer; and

Summer turnip rape, differentiated in European and Asian forms. The European turnip rape (or spring turnip rape), is an annual form, sown in spring and harvested in mid summer of the same year, while Asian forms are normally sown in autumn and harvested by the end of spring of the following year.

Winter turnip rape: beginning in the late Fourteenth Century seed from turnips was used for pressing oil. This was a widespread practice in Europe and gradually specialized oilforms developed. However, in the temperate parts of northwestern Europe the (*B. napus*) winter rape appeared around 1600 and replaced winter turnip rape. Only on the fringes to the east and north, is winter turnip rape still used, apparently because of its greater capacity to survive the winter. Its genetic variation seems limited.

Summer turnip rape (European): very little is known about summer turnip rape except that it was used as an emergency oilseed crop in case of failure of the winter crop. It is grown in areas with a very short summer period like Poland, northern Sweden and on a large scale in the Canadian prairies. Unlike the parallel Indian forms, its genetic base seems narrow; a few landraces exist, however, showing great internal variation.

Summer turnip rape (Asian): Asian summer turnip rape forms are extensively grown in China, India, Pakistan and Bangladesh. The Indian types include three morphologically different ecotypes, toria, brown and yellow sarson. Toria is dwarf, highly incompatible, erect with comparatively fewer fruiting branches and earlier in flowering and maturity than the other two ecotypes. In brown sarson, two morphologically distinct forms are identified and are grown extensively throughout the Indian subcontinent. The three forms, in general, do not show much variation for percent of oil, protein and glucosinolate content of the meal. The different types of Asian turnip rapes are believed to have originated from a wild *B. campestris*, which had its distribution from western Europe to eastern China. This wild progenitor is believed to have given rise to a range of subspecies as a result of three different types of selection in the three main regions of its habitat. In the west, selection for rapiferous types gave rise to the turnip forms, while in the Far East selection for

leafy vegetables yielded the great diversity of Chinese cabbages. In the Indian subcontinent, human selection for oil content has led to three morphologically distinct oleiferous races. The possible centre of origin is eastern Afghanistan and adjoining areas of Pakistan and northwest India.

26.2 The main collections of the two types of European turnip rape are in the Federal Republic of Germany and the Netherlands with somewhat smaller ones in Sweden and Poland. It seems likely that the variation is effectively conserved. The conserved genetic variation of Asian turnip rape forms is rather limited. In India, some efforts have previously been made to collect landraces and these are presently being maintained as breeders' collections at the research stations. There are no reports on collection and conservation available from other Asian countries.

26.3 There are probably no gaps for European turnip rapes and there seems to be no need for additional collecting missions, also considering the action of the European Rapeseed Breeders Group. Chinese material needs to be collected south of the Yangtze river. Regarding Asian turnip rape and mustard forms (see para 27), the limited material collected represents narrow genetic variation and extensive collecting and conservation is required. In the Indian subcontinent, the areas along the foot-hills and lower mountain ranges of the northwestern and northeastern Himalayas need to be explored. In view of the fact that i) different brassicas have originated all along these two main lines, ii) a great diversity of vegetables and oleiferous brassicas are grown in these regions, and iii) a number of related cruciferous species are found growing in the wild state in these areas, the following three collecting expeditions are suggested to be made on a priority basis:

(i) area covering the states of Himachal Pradesh (region around Palampur), Chamba area and Tarai area of Uttar Pradesh, parts of Punjab and along Himachal Pradesh and Jammu, and the regions of Kashmir adjoining Pakistan as indicated by the cultivation of rape and mustard in these areas;

(ii) area covering the lower mountain ranges of the Himalayas of western Uttar Pradesh (including the districts of Nainital and Garwahl) and the low Shivalik Range of the Outer Himalayas of southwest Nepal;

(iii) area covering the northeastern part of India (Tripura, Assam and Sikkim), Nepal (including the valley of Kathmandu), Bhutan and Bangladesh.

27. *Brassica juncea* (Indian mustard)

27.1 The Indian or brown mustard is grown extensively for its oil in Asia with India, Pakistan, China, Bangladesh and Nepal being the principle growing countries. Due to eco-geographical variation in the area of its cultivation and differences in the requirement of the produce, three morphologically diverse types are grown in the Indian subcontinent. These include oleiferous (oilseed types), semi-oleiferous (the dual purpose type, i.e. for its semi-succulent early leaves as vegetable and seeds for oil) and rapiferous or leafy type (for its leaves as vegetable and fodder). The oleiferous types are grown practically throughout the Indian subcontinent, while the leafy and vegetable types are grown in the northeastern part of India, Nepal, China and southeast Asia. Due to the sympatric range of distribution of two species, *B. nigra* and *B. campestris*,

that are widely distributed throughout the Mediterranean region, the Ethiopian and the northern Indian plateaux extending toward the Far East, the allopolyploid *B. juncea* may have originated almost anywhere between eastern Europe and China. Two major centres of diversity of Indian mustard (viz., the northeastern and northwestern) contributing to the two different races of characteristically different phenotypes are recognized. These two races appear to have originated due to natural crossing between *B. nigra* (2n = 16, BB genome) as a common genome and different subspecies of *B. campestris* (2n = 20, AA genome).

27.2 Over the years, breeders and explorers have collected landraces, and some of their related wild and cultivated species, from different states of India. More than 1 500 accessions are currently being maintained at major research institutes.

27.3 In China material needs to be collected south of the Yangtze river and along the Sikiang river (for wild material). Collecting in the Indian subcontinent should be executed following the guidelines as provided in para 26.3.

28. *Brassica juncea* (Chinese mustard)

28.1 The leaf mustards (*B. juncea*) have an ancient history of cultivation in China. Several types are recognized; vars. *rugosa*, *bulbifolia* ('tsa-tsai'), *napiformis*, *foliosa*, *crispifolia* and *integrifolia*. China is generally regarded as the original region of varietal differentiation, with the highest level of diversity centering in the Sichuan district where the famous 'tsa-tsai' pickle is produced. According to the trend of variations, the geographical distribution of *B. juncea* is as follows:

a) Hakarashina group with pinnate leaves - distributed in India central Asia and Europe;

b) Nekarishina group with enlarged roots - distributed in Mongolia, Manchuria and northern China;

c) Hsueh li lung and Nagan sz kaai group with leathery leaves and many branches - distributed in central and northern China; and

d) Takana group with entire, succulent leaves - distributed in southern and central China, southeastern Asia towards the Himalayas.

28.2 Major collections exist in Japan and Taiwan.

28.3 Further collecting is required in China, Korea and southeast Asia.

Figure 4. Early autumn types of Chinese cabbage (*Brassica campestris* subsp. *pekinensis*) being loaded for market on vegetable commune near Beijing, China

29. *Brassica campestris* subsp. *pekinensis* (Chinese cabbage)

29.1 In *B. campestris*, several important subspecies are recognized: subsp. *pekinensis*, *chinensis*, *japonica* and *narinosa*. With the exception of subsp. *japonica*, all subspecies have been cultivated in China since before the time of Christ. They have a wide range of variation (both between and within subspecies) and established themselves more or less in isolation from each other. They are considered to have differentiated and developed from a common progenitor - oilseed rapes - after the latter moved to China through western Asia or Mongolia as an agricultural crop. Chinese cabbage originated in Shantung Province of China and a large variation can still be observed (see Figure 4). Heading types of Chinese cabbage were introduced in Japan about 70 years ago. Through the introduction of F_1-hybrids, especially in Japan and Korea, much of the open-pollinated material was lost.

29.2 Major institutional collections exist in Japan, Korea and Taiwan.

29.3 China, the centre of origin, is considered to be a major gap until collecting of landraces and other open-pollinated cultivars is completed and their conservation assured. This collecting activity is considered to be extremely urgent, since the cultivation of F_1-hybrids is rapidly expanding and it may not be before long that the landraces could be irretrievably lost.

30. *Brassica campestris* subsp. *chinensis* (Pak choi)

30.1 Pak choi originated in China (see also para 29.1) and is a very important vegetable, especially in southern China (see Figure 5). Although there have been no reports of any existing collections, a wide range of diversity should be available in view of the long history of its cultivation. In Japan F_1-hybrids are now widely grown, but a number of landraces have been collected and stored. Pak choi is also an important crop in southeast Asian countries.

Figure 5. Pak choi (*Brassica campestris* subsp. *chinensis*) being harvested for market on vegetable commune near Nanking, China

30.2 Major collections are in Japan and Taiwan.

30.3 As in the case of Chinese cabbage, China should be considered a gap until collection and preservation of the genetic resources in the farmers' fields are accomplished. Since F_1-hybrids probably will not be too practical on short-growing *chinensis*, it is preferable to give it a lower collecting priority than *pekinensis*. Some old cultivars grown and perpetuated through the ages by traditional farming practices in the southeast Asian highlands (Thailand, Malaysia, Indonesia and Philippines) ought to be collected, possibly through the assistance of the respective national programmes.

31. *Brassica campestris* subsp. *narinosa*

31.1 *B. campestris* subsp. *narinosa* originated in China (see also para 29.1) and was introduced in Japan about 40 years ago, where it is now considered to be a minor vegetable crop.

31.2 A small collection of two cultivars, which is considered to be sufficient, is maintained in Japan.

31.3 China is considered to be a geographical gap until its genetic resources for this subspecies have been explored, collected and preserved.

32. *Brassica campestris* subsp. *japonica*

32.1 The subspecies *japonica* differentiated in Japan after the introduction of other subspecies and has a cultivation history of 200 to 300 years. This vegetable crop is important only in Japan.

32.2 A good collection exists in Japan.

32.3 No further collecting is required.

33. *Brassica campestris* subsp. *rapa* (Turnip)

33.1 The turnip was probably known to most ancient civilizations in temperate and subtropical Eurasia. The turnip is grown to date in varying amounts in many of these countries; usually as a vegetable but sometimes as fodder. It is an important crop and is grown widely in Japan, northern China and Mongolia, parts of the Indian subcontinent, Europe and the Mediterranean. Although there is some uncertainty whether the plant was already known to ancient Egypt, it was definitely known to ancient Greek civilization as a vegetable. Within the old Roman empire the turnip was decidedly popular both as food and fodder. The crop subsequently played a significant role in the agrarian revolution of northern Europe after the Middle Ages and became widely used throughout entire Europe. From the seventeen-hundreds it gradually began to lose its prominence as a food crop to the potato and it continues to linger on to this day as a minor vegetable. However it still is an important stubble fodder and forage crop in mixed farming systems in many parts of Europe.

33.2 There are major collections in Japan and Europe.

33.3 In Japan the available genetic variation is conserved; in Europe an important part is collected, but there is a need for additional collecting.

Largely unidentified and virtually uncollected are the traditional turnip-growing areas in China, the Indian subcontinent, the Middle East and the Mediterranean.

34. *Brassica carinata* (Ethiopian mustard)

34.1 Ethiopian mustard, previously also called Abyssinian mustard, is the main indigenous *Brassica* oilseed and vegetable crop of Ethiopia. It is an ancient, widely grown crop in Ethiopia. Three types may be distinguished based on use: types mainly used as oilseed crop, those mainly for vegetable use and types for both purposes. There does not appear to be very much differentiation into crop types. A great deal of genetic variation exists within many of the accessions.

34.2 There are major collections in Ethiopia and Europe.

34.3 Much of the genetic variation would appear to be conserved. The European collection at Wageningen (about 150 accessions) is in urgent need of multiplication.

35. *Brassica nigra* (Black mustard)

35.1 Black mustard became widespread in the Old World during the Middle Ages, probably having originated in Asia Minor. Landraces occurred throughout Europe. It had little apparent use except as a condiment. It became virtually extinct as a crop during the nineteen-fifties, being replaced by *B. juncea*. A current minor use is as green manure, but its short life cycle and the shattering habit of *B. nigra* siliquas - leading to its establishment as a weed - will probably prevent the crop from ever becoming of major importance again in Europe.

35.2 Collections are minor, and are largely restricted to wild or Asian accessions.

35.3 Many landraces have been lost, although their genes may persist in wild populations. These should be collected, for possible use in, say, new forms of *B. carinata*; but since it is not a crop itself, except in some parts of India, *B. nigra* must have a low priority relative to the other brassicas.

36. *Sinapis alba* (White mustard)

36.1 The medicinal qualities of the seed of white mustard were highly regarded in ancient times, however it never appears to have been grown intensively on a large scale. It is used in northern Scandinavia as a summer oilseed crop and as a green manure crop in Germany. There appears to be no differentiation into forms. The varieties on the market are landrace-like material probably with a considerable internal variation.

36.2 The main collections are in the Federal Republic of Germany and the USSR and are substantial.

36.3 It seems likely that most of the existing genetic variation is in these collections. However, much valuable wild material can still be collected in the southwestern Mediterranean area.

37. *Raphanus sativus* (Radish)

37.1 The eastern Mediterranean was probably the site of origin of the large-rooted cultivated form (var. *radicola*) which spread east and west from

there to become a major crop - especially as a 'poor man's' vegetable - throughout most of Southeast Asia and the Orient (see Figure 6.) and a minor, less important crop in most European countries. The small European form of var. *radicola* probably originated during the Sixteenth Century. Substantial gene centres now exist for the large forms in Asia and for the small forms in Europe. Fodder and forage types also developed recently in northern Europe from the large *radicola*. Two non-bulbing types have more obscure origins. Var. *mougri*, grown for its edible leaves and pods, has gene centres across southern Asia. Var. *oleifera* - the 'oilseed radish' - probably dates from the Egypt of the Pharaohs. This variety, or forms used for a similar purpose, are ancient crops in Asia. It was a traditional green manure crop in Taiwan and it has recently been adopted as a green manure in northern Europe.

Figure 6. Chinese radish (*Raphanus sativus*) being graded for market on vegetable production commune near Nanking, China. This cultivar is bright red in colour

37.2 Substantial collections of European and Asian material exist in Europe. There is a large collection in the USA which probably contains a few representatives of all the geographic types. There are several large collections in India, Japan, Korea and Taiwan, predominantly of Asian types.

37.3 The small-rooted European *radicola* appears to be fairly well collected, although some supplementation may be necessary. The large-rooted European *radicola*, which includes fodder forms, needs further collecting, particularly from the Mediterranean region. Several Asian centres, notably the Middle East, India, Korea and China, are known to contain many distinct types of *radicola*, but collections are small or non-existent. These must have the highest priority among the radishes.

The recent development of green manure radishes in Europe emphasizes the importance of the collection of this type (i.e. the 'oilseed radish') from Asia. It appears to be represented by very few accessions. As an introduction it is believed to occur as a minor oil crop in Chile and should be collected from there as well as Asian countries where it still occurs.

38. *Raphanus* spp. (Wild relatives)

38.1 *Raphanus sativus* does not occur in the wild in the Mediterranean area, except as an occasional escape. Several subspecies of *Raphanus raphanistrum* are recognized: subspecies *raphanistrum* is weedy with a wide distribution; subspecies *maritimus* occurs on the west Mediterranean and Atlantic ocean coasts; subsp. *landra* is found on the central Mediterranean coast; subsp. *microcarpus* is weedy and rare in Spain and Portugal; and subspecies *restratus* occurs on the east Mediterranean (Aegean) coasts.

38.2 Collections of wild relatives are very minor.

38.3 Perhaps, with the exception of subspecies *microcarpus*, the subspecies of *R. raphanistrum* are neither rare nor endangered. The relative overlapping of their distribution areas with those of wild (n = 9) brassicas suggest that no special expeditions should be organized, but collecting of *Raphanus* should be considered when collecting wild brassicas.

BASE COLLECTION CENTRES

39. The IBPGR endorsed the recommendation of the meeting to designate base collection centres for cruciferous crops as specified in Table 2.

40. In connection with the storage of cruciferous crops, the following recommendations were endorsed by the IBPGR:

(i) Storage facilities

The need for storage facilities in China and India was recognized. The IBPGR will investigate the possibilities of providing financial assistance and expertise to China and to expedite the construction of storage facilities in India;

(ii) Wild relatives

The global base collection of Prof. C. Gómez-Campo needs to be duplicated. The IBPGR is investigating whether Dr. S. Tsunoda of Tohoku University,

Table 2. IBPGR designated centres for base collections of cruciferous crops

Base collection centres	Cruciferous crops
Plant Gene Resources of Canada (PGRC) Ottawa, Canada	Global collection oilseeds and green manure crucifers: *B. campestris*, *B. juncea*, *B. napus*, *Sinapis alba*
National Vegetable Research Station (NVRS) Wellesbourne UK	Global collection *B. oleracea* Global collection vegetable and fodder types of: *B. campestris**, *B. juncea*, *B. napus* Global collection *Raphanus* spp.
Institute for Horticultural Plant Breeding (IVT) Wageningen Netherlands	Global collection *B. oleracea*
Institut für Pflanzenbau und Pflanzenzüchtung der FAL Braunschweig Federal Republic of Germany	Global collection vegetable and fodder types of: *B. napus* Global collection oilseeds and green manure crucifers: *B. campestris*, *B. juncea*, *B. napus*, *Sinapis alba* Global collection *B. carinata*
Universidad Politecnica Madrid (UPM) Madrid Spain	Global collection wild relatives
Plant Genetic Resources Center (PGRC) Addis Ababa Ethiopia	Global collection *B. carinata*
National Bureau of Plant Genetic Resources (NBPGR) New Delhi India	Asian collection oilseed crucifers: *B. campestris*, *B. juncea* Global collection *Raphanus* spp.
Chinese Academy of Agricultural Sciences (CAAS) Beijing China	Global collection *B. oleracea* Global collection vegetable types of: *B. campestris*, *B. juncea* Global collection *Raphanus* spp.
Seed Storage Laboratory National Institute of Agricultural Sciences (NIAS) Tsukuba Japan	East Asian collection of all cruciferous crops

* includes the turnip

Sendai, Japan, would be willing to accept the duplicate global collection of wild relatives;

(iii) Sample size for base storage

It is recommended that base collections should store a minimum of 12,000 seeds per accession. In general terms samples of 12,000 seeds correspond to 50 grams of seed for *Brassica* spp. and 100 grams of seed for *Raphanus* spp. It is recommended to use subsamples of 200-400 seeds.

(iv) Multiplication/Regeneration

In order to maintain most of the variability within an accession it is recommended to use a minimum of 100 plants for all cruciferous crops whenever the material is multiplied or regenerated (see Figure 7). The storage sample should represent equal amounts from each plant.

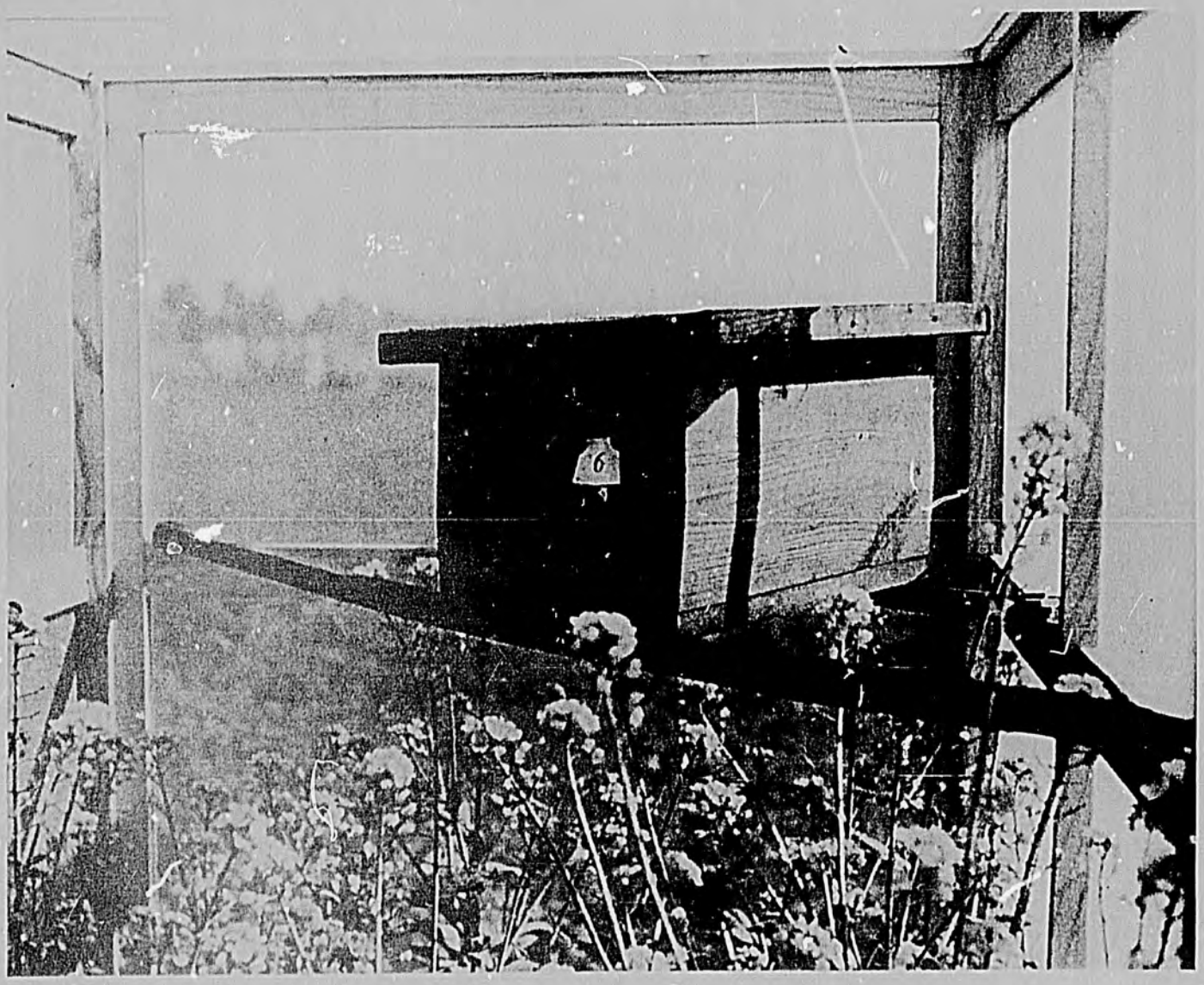

Figure 7. Isolation cage at Gatersleben, GDR used for multiplication of crucifer accessions

PRIORITIES FOR ACTION

41. Based on geographical/species gaps in existing collections and genetic erosion, as discussed in paragraphs 15-38, the meeting developed a detailed priority list for future collecting activities (see Table 3).

Table 3. Priorities for collecting cruciferous crops

Priority	Crops	Region
1	*Brassica campestris* subsp. *chinensis*	China*
	Brassica campestris subsp. *pekinensis*	China*
	Brassica campestris subsp. *rapa*	China*, Indian subcontinent, Middle East, Mediterranean
	Brassica campestris subsp. *oleifera*	China*, Indian subcontinent
	Brassica juncea oilseeds	China*, Indian subcontinent
	Brassica juncea vegetables	China*, Indian subcontinent
	Brassica oleracea (wild relatives)	Mediterranean
	Brassica oleracea var. *acephala*	Mediterranean
	Brassica oleracea var. *botrytis*	Mediterranean, especially Italy
	Brassica oleracea var. *capitata*	Mediterranean
	Brassica oleracea var. *italica*	Mediterranean, especially Italy
	Raphanus sativus	China*, Indian subcontinent, Middle East, Mediterranean
2	*Raphanus* (wild and 'oilseed' radishes)	Chile
	Brassica campestris (wild)	Chile
	Brassica oleracea ('tropical' types)	India
	Brassica oleracea ('tropical' types)	Brazil
	Brassica napus var. *biennis*	U.K.
	Brassica oleracea var. *gongylodes*	Central and southern Europe
	Brassica campestris subsp. *rapa*	Europe
3	*Brassica oleracea* var. *alboglabra*	China
	Brassica oleracea ('tropical' types)	Southeast Asia and China
	All American *B. oleracea/B. juncea/ B. campestris* and *Raphanus* leafy vegetables. (Although not referred to in the detailed reports, some of these may represent types which have disappeared from the Old World)	North and South America
	Brassica oleracea var. *acephala*	Northern Europe

* As area indication includes Taiwan and the Koreas

Table 3. (Cont'd)

Priority	Crop	Region
3	*Brassica oleracea* var. *capitata*	Europe (non-Mediterranean)
	Brassica oleracea var. *botrytis*	Europe (non-Mediterranean)
	Brassica oleracea var. *italica*	Europe (non-Mediterranean), Australia
	Brassica napus var. *napobrassica*	Europe
	Brassica napus var. *oleifera* (summer rape)	Europe
	Brassica campestris subsp. *oleifera*	Europe
	Brassica campestris (vegetable types)	Southeast Asia
	Brassica campestris subsp. *narinosa*	China
	Brassica juncea (vegetable types)	Southeast Asia
	Brassica carinata	Ethiopia
	Raphanus sativus var. *radicola*	Europe (non-Mediterranean)
	Raphanus spp. (wild relatives)	Mediterranean
4	(i.e. no action required)	
	Brassica campestris subsp. *japonica*	
	Brassica oleracea var. *gemmifera*	
	Brassica napus var. *oleifera* (winter rape)	
	Brassica nigra	
	Sinapis alba	

42. An action plan for first priority crops, also taking into account the need for an effective network of base collection centres (see paragraphs 39 and 40), is supplied in Table 4.

- The meeting was informed that collecting activities in China are well organized and that no assistance in this area is required. The major obstacles to an effective genetic resources programme are the lack of (i) cold storage facilities and (ii) technical knowledge on the construction and development of seed storage and maintenance programmes. Therefore the IBPGR will investigate possible assistance in these fields.

- The National Bureau of Plant Genetic Resources (NBPGR), New Delhi, India, is coordinating the collecting of germplasm on a nation-wide basis. Some financial assistance from the IBPGR might be required for collecting priority cruciferous crops. Details of areas to be explored are provided in para 26.3. The lack of long-term storage facilities represents the main limitation to an effective genetic resources programme. The IBPGR will use its influence to expedite the construction of storage facilities.

- Emphasis should be given to collecting missions in the Mediterranean. The meeting recommends that the IBPGR provide financial assistance and that the European Community be requested to support collecting activities in Italy and

France. Details of areas in which collecting should be undertaken are given in Figure 8.

Table 4. Action plan for first priority crucifers

Region	Crop	Para ref.	Type of support
China (as a country)	*Raphanus sativus*	37	Seed storage technology
	Brassica campestris subsp. *chinensis*	30	
	Brassica campestris subsp. *pekinensis*	29	
	Brassica campestris subsp. *rapa*	33	
	Brassica campestris subsp. *oleifera*	26	
	Brassica juncea oilseeds	27	
	Brassica juncea vegetables	28	
Indian subcontinent	*Brassica juncea* oilseeds	27	Seed storage technology and collecting missions
	Brassica campestris subsp. *oleifera*	26	
	Brassica juncea vegetables	28	
	Brassica campestris subsp. *rapa*	33	
	Raphanus sativus	37	
Mediterranean	*Brassica oleracea* (wild relatives)	15	Collecting missions
	Brassica oleracea var. *acephala*	16	
	Brassica oleracea var. *botrytis*	20	
	Brassica oleracea var. *capitata*	17	
	Brassica oleracea var. *italica*	21	
	Raphanus sativus	37	
	Brassica campestris subsp. *rapa*	33	

DESCRIPTOR LIST

43. The meeting agreed upon a list of descriptors for passport data (Appendix V). It is recommended that this list, and the collection data sheet (Appendix VI), be used during collecting and conservation of crucifer germplasm. Separate descriptor lists for characterization and evaluation are needed for each crop within the crucifers. Specialists will be commissioned by the IBPGR to produce these descriptor lists.

KEY FOR CRUCIFEROUS CROP SPECIES

44. A first attempt to develop a standard key for cruciferous crop species for genetic resources use (as provided in the European report no. 2. Appendix I), was discussed and found inadequate. The specific points of disagreement were identified and briefly discussed. Efforts to produce improvements will continue.

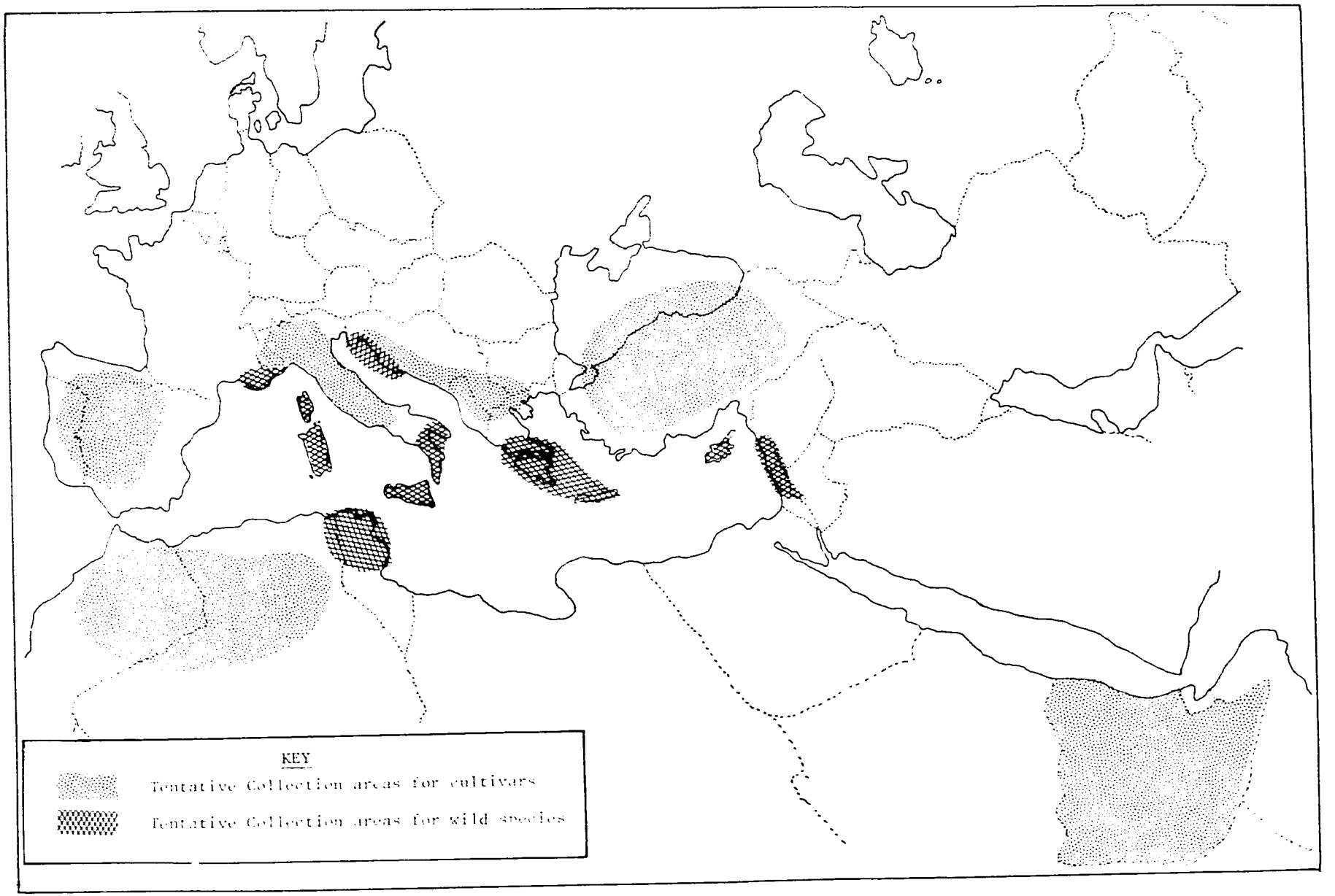

Figure 8. Areas in which collection should be undertaken in the Mediterranean region

APPENDIX I

REPORTS CONSULTED DURING THE MEETING

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3. GRUBBEN, G.J.H., 1977. Tropical Vegetables and their Genetic Resources. AGP:IBPGR/77/23
4. IBPGR, 1979. IBPGR Expert Consultation on the Genetic Resources of Vegetables for the Tropics. AGPE:IBPGR/79/3
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10. OPEÑA, R.T., 1980. A Survey of Genetic Resources of Cruciferous Crops in Southeast Asia. AGP:IBPGR/80/65
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15. WILLIAMS, P.H., 1980. Genetic Resources of Cruciferous Crops in Taiwan. AGP:IBPGR/80/77
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APPENDIX II

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Members invited, but unable to attend

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APPENDIX III

A G E N D A

1. Introduction
2. Verbal explanation regional/national status reports
3. Review of major existing collections and identification of species/geographic gaps
4. Identification of priorities for collecting
5. Institutes to be designated by the IBPGR as base collection centres
6. Finalization of descriptor list
7. Identification of resources and expenditure

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APPENDIX IV

SUMMARY OF EXISTING COLLECTIONS

Taxonomic name	South & Central America	North America	Europe (excluding USSR)	USSR	Africa	India/ (Pakistan)	China/ (Korea)	Japan	South-east Asia
Brassica campestris		267	112	191				90 1/	13
subsp. *chinensis*		2	145					10	96
subsp. *japonica*								9	
subsp. *narinosa*								2	
subsp. *oleifera*		43	224			1000 (124)	(8)	89	
subsp. *pekinensis*		39	232				(277)	81	570
subsp. *rapa*		137	647					162	17
subsp. unspecified									
Brassica carinata		51	176		322	(22)			
Brassica juncea									
- *oleifera*						1553 (216)			
- vegetable forms						7		46	126
- unspecified		215	153	857					
Brassica napus			29	400		(16)		5	17
var. *biennis*			48						
var. *napobrassica*		19	192	822				2	
var. *oleifera*		73	633				(320)	1008	
Brassica nigra		62	120	24		15			
Brassica oleracea		15	43					58	
var. *acephala*		29	407						
var. *alboglabra*		1	30						26
var. *botrytis*		377	1069					20	71
var. *capitata*		1374	1319						254
var. *gemmifera*		76	761					2	
var. *gongylodes*		48	79						15
var. *italica*		76	248						32
var. unspecified				3045			(40)		
Brassiceae									
- Genera			45						
- Species/Subspecies			215						
Eruca sativa				35		150 (2)			
Raphanus sativus		641	931	1599			(285)	342	177
Raphanus spp.		3							
Sinapis alba			153	182					

1/ Mainly subsp. *chinensis*

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APPENDIX V

DESCRIPTORS FOR CRUCIFEROUS CROPS

PASSPORT DATA

1. ACCESSION DATA

1.1 ACCESSION NUMBER

This number serves as a unique identifier for accessions and is assigned by the curator when an accession is entered into his collection. Once assigned this number should never be reassigned to another accession in the collection. Even when an accession is lost, its assigned number is still not available for re-use. Letters occur before the number to identify the genebank

1.2 SCIENTIFIC NAME

1 *Brassica campestris* subsp. *campestris*
2 *Brassica campestris* subsp. *chinensis*
3 *Brassica campestris* subsp. *japonica*
4 *Brassica campestris* subsp. *narinosa*
5 *Brassica campestris* subsp. *oleifera**
6 *Brassica campestris* subsp. *pekinensis*
7 *Brassica campestris* subsp. *rapa*
8 *Brassica carinata*
9 *Brassica juncea* var. *bulbifolia*
10 *Brassica juncea* var. *crispifolia*
11 *Brassica juncea* var. *foliosa*
12 *Brassica juncea* var. *integrifolia*
13 *Brassica juncea* var. *napiformis*
14 *Brassica juncea* var. *oleifera*
15 *Brassica juncea* var. *rugosa*
16 *Brassica napus* var. *biennis*
17 *Brassica napus* var. *napobrassica*
18 *Brassica napus* var. *oleifera*
19 *Brassica nigra*
20 *Brassica oleracea* var. *acephala*
21 *Brassica oleracea* var. *alboglabra*
22 *Brassica oleracea* var. *botrytis*
23 *Brassica oleracea* var. *capitata*
24 *Brassica oleracea* var. *gemmifera*
25 *Brassica oleracea* var. *gongylodes*
26 *Brassica oleracea* var. *italica*
27 *Brassica oleracea* var. *oleracea*
28 *Raphanus sativus* var. *mougri*
29 *Raphanus sativus* var. *radicola*
30 *Raphanus sativus* var. *oleifera*
31 *Raphanus* spp.
32 *Sinapis alba*
33 Others (specify)

---

* mixed group to include all oleiferous campestris, i.e. *rapa oleifera* (winter), *oleifera* (summer) and *chinensis oleifera*.

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APPENDIX V
(Continued)

1.3 COMMON ENGLISH NAME

1 Wild *campestris*
2 Pak choi
3 Turnip rape
4 Chinese cabbage
5 Turnip
6 Ethiopian mustard
7 Chinese mustard
8 Toria
9 Sarson
10 Marrow stem *junsea*
11 Rapekale (fodder rape)
12 Swede turnip (rutabaga)
13 Oilseed rape
14 Black mustard
15 Wild *oleracea*
16 Marrow-stem kale
17 Perennial kale
18 1000-head kale
19 Chinese kale
20 Cauliflower
21 Portugese cabbage (conve tronchuda)
22 Savoy cabbage
23 Storage cabbage (white cabbage)
24 Other cole cabbages
25 Brussels sprout
26 Kohlrabi
27 Broccoli
28 Radish
29 Rat-tail radish
30 Oilseed radish
31 Fodder radish
32 White mustard
33 Others (specify)

1.4 YEAR OF LAST MULTIPLICATION OR REGENERATION

1.5 DONOR NAME

1.6 DONOR NUMBER

1.7 ANY OTHER NAMES OR NUMBERS ASSOCIATED WITH THE ACCESSION

e.g. USDA Plant Introduction number etc. (Not collection number, 2.2).

2. COLLECTION DATA

2.1 COLLECTING INSTITUTE

Institute or person collecting the original sample

2.2 ORIGINAL NUMBER ASSIGNED BY COLLECTOR OF THE SAMPLE

APPENDIX V
(Continued)

2.3 DATE OF COLLECTION OF ORIGINAL SAMPLE

Expressed as day/month/year, e.g. 12 August 1981 as 120881

2.4 COUNTRY OF COLLECTION

Use the three letter abbreviations supported by the Statistical Office of the United Nations. Copies of these abbreviations are available from the IBPGR Secretariat.

2.5 TRADITIONAL NAME OF FARMING AREA

2.6 LOCATION OF COLLECTION SITE

Name and address of supplier, and/or number of kilometres and direction from nearest town or village; or map grid reference

2.7 LATITUDE OF COLLECTION SITE

Degrees and minutes followed by N or S, e.g. 4055 N

2.8 LONGITUDE OF COLLECTION SITE

Degrees and minutes followed by E or W, e.g. 1410 E

2.9 ALTITUDE OF COLLECTION SITE

Elevation above sea level, in metres

2.10 COLLECTION SOURCE

1 Wild
2 Farmer/grower
3 Plant breeder
4 Market
5 Seed firm
6 Genebank

2.11 STATUS OF SAMPLE

1 Wild
2 Landrace
3 Cultivar
4 Breeding material
5 Genetic material

2.12 TYPE OF SAMPLE

1 Population
2 Pure line

2.13 NUMBER OF PLANTS SAMPLED

APPENDIX V
(Continued)

2.14 CULTIVAR NAME

Romanized local name of the cultivar used by the people of the area where the sample was collected

2.15 LOCAL NAME OF CROP

Romanized local name of the crop used by the people of the area where the sample was collected

2.16 DISTANCE IN METRES FROM CROSS POLLINATING CROPS

2.17 NORMAL SOWING SEASON

1 Spring
2 Summer
3 Autumn
4 Winter
5 All year round

2.18 NORMAL HARVESTING SEASON

1 Spring
2 Summer
3 Autumn
4 Winter
5 Autumn/winter
6 Winter/spring
7 All year round

2.19 ORGAN USED AS PRIMARY PRODUCT

1 Siliqua
2 Seed
3 Seedling
4 Inflorescence
5 Apical bud (e.g. cabbage)
6 Axillary bud/branch
7 Leaf
8 Stem
9 Hypocotyl and/or root

2.20 ORGAN USED AS A SECONDARY PRODUCT

1 Siliqua
2 Seed
3 Seedling
4 Inflorescence
5 Apical bud (e.g. cabbage)
6 Axillary bud/branch
7 Leaf
8 Stem
9 Hypocotyl and/or root

2.21 PRIMARY CROP USAGE I

1 Vegetable
2 Oil
3 Forage/fodder
4 Green manure
5 Ornamental

2.22 SECONDARY CROP USAGE I

1 Vegetable
2 Oil
3 Forage/fodder
4 Green manure
5 Ornamental

2.23 PRIMARY CROP USAGE II

1 Fresh (immediate use)
2 Stored unprocessed
3 Ensiled
4 Sauerkraut
5 Kimchee
6 Other stored processed
7 Condiment
8 Lubricant/fuel oil
9 Vegetable oil
10 Chemical synthesis
11 Meal cake/protein

2.24 SECONDARY CROP USAGE II

1 Fresh (immediate use)
2 Stored unprocessed
3 Ensiled
4 Sauerkraut
5 Kimchee
6 Other stored processed
7 Condiment
8 Lubricant/fuel oil
9 Vegetable oil
10 Chemical synthesis
11 Meal cake/protein

2.25 STRESS DESCRIPTORS

Wild species and primitive cultivars are mainly used as sources of resistance to pests, diseases, and other environmental stresses. If such resistances occur, they are most likely to have developed in areas which are subject to abnormal environmental stresses, or where particular pests or diseases are prevalent. The breeder's chance of finding resistance is, therefore, greatly increased if he knows which of these factors occur where each seed stock evolved; he is interested in factors which have repeatedly damaged or stressed plants over many seasons in that general area.

The following descriptors should all be coded as follows:

0 Absent
+ Present

2.25.1 High temperature
2.25.2 Low temperature
2.25.3 Frost
2.25.4 High winds
2.25.5 High relative humidity
2.25.6 High rainfall
2.25.7 Drought

2.25.8 Soil waterlogging
2.25.9 Soil salinity
2.25.10 Acid soil (pH<4.0)
2.25.11 Alkaline soil (pH>8.0)
2.25.12 Nitrogen deficiency
2.25.13 Phosphorus deficiency
2.25.14 Potassium deficiency
2.25.15 Sulphur deficiency
2.25.16 Calcium deficiency
2.25.17 Magnesium deficiency
2.25.18 Molybdenum deficiency
2.25.19 Boron deficiency
2.25.20 Iron deficiency

APPENDIX V
(Continued)

2.25.21	Thrips
2.25.22	Capsids
2.25.23	White fly
2.25.24	Aphids
2.25.25	Springtails
2.25.26	Sawflies
2.25.27	Flea beetles
2.25.28	Stem and gall weevils
2.25.29	Other weevils
2.25.30	Lepidopteran larvae
2.25.31	Leaf miners
2.25.32	Midges
2.25.33	Cabbage root fly
2.25.34	Other diptera
2.25.35	Viruses
2.25.36	Bacterial rots
2.25.37	Clubroot
2.25.38	Powdery mildew
2.25.39	Downy mildew
2.25.40	Dark leaf spot
2.25.41	Canker
2.25.42	White spot
2.25.43	White mould
2.25.44	Light leaf spot
2.25.45	White blister rust
2.25.46	Wirestem
2.25.47	Ring spot
2.25.48	Grey leaf spot
2.25.49	Molluscs
2.25.50	Birds
2.25.51	Mammals
2.25.52	Nematodes

APPENDIX VI

COLLECTION DATA SHEET

Expedition/Organization (name, year etc): .....

Country: .....

Team/Collector(s): ..... *Collector's number:* .....

Date of collection (day/month/year): ..... *Photo number(s):* .....

Scientific name (genus, species, subspecies, varietal, in full): .....
.....

Common English name: .....

Local crop name: ..... *Cultivar name:* .....

Locality (name and address of supplier, and/or number of kilometres and direction from nearest town or village; or map grid reference):
.....
.....

Traditional name of farming area: .....

Latitude: .....° .....' *Longitude:* .....° .....' *Altitude:* ..... *m.*

Source: 1 Wild 2 Farmer/grower 3 Plant breeder 4 Market 5 Seed firm 6 Genebank

Status: 1 Wild 2 Landrace 3 Cultivar 4 Breeding material 5 Genetic material

Material: Seeds Herbarium

Sample type: 1 Population 2 Pure line *Number of plants sampled:* .....

Distance from cross-pollinating crops: ..... *m.*

Normal sowing season: 1 Spring 2 Summer 3 Autumn 4 Winter 5 All year round

Normal harvesting season: 1 Spring 2 Summer 3 Autumn 4 Winter 5 Autumn/winter 6 Winter/spring 7 All year round

Organ used as primary product: 1 Siliqua 2 Seed 3 Seedling 4 Inflorescence 5 Apical bud 6 Axillary bud/branch 7 Leaf 8 Stem 9 Hypocotyl and/or root

Organ used as secondary product: 1 Siliqua 2 Seed 3 Seedling 4 Inflorescence 5 Apical bud 6 Axillary bud/branch 7 Leaf 8 Stem 9 Hypocotyl and/or root

Primary crop usage I: 1 Vegetable 2 Oil 3 Forage/fodder 4 Green manure 5 Ornamental

Secondary crop usage I: 1 Vegetable 2 Oil 3 Forage/fodder 4 Green manure 5 Ornamental

Primary crop usage II: 1 Fresh 2 Stored unprocessed 3 Ensiled 4 Sauerkraut 5 Kimchee 6 Other stored processed 7 Condiment 8 Lubricant/fuel oil 9 Vegetable oil 10 Chemical synthesis 11 Meal cake/protein

Secondary crop usage II: 1 Fresh 2 Stored unprocessed 3 Ensiled 4 Sauerkraut 5 Kimchee 6 Other stored processed 7 Condiment 8 Lubricant/fuel oil 9 Vegetable oil 10 Chemical synthesis 11 Meal cake/protein

Collector	*Collector*	*Collector*	*Collector*	*Collector*
No:	*No:*	*No:*	*No:*	*No:*

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APPENDIX VI
(Continued)

Wild species and primitive cultivars are mainly used as sources of resistance to pests, diseases, and other environmental stresses. If such resistances occur, they are most likely to have developed in areas which are subject to abnormal environmental stresses, or where particular pests or diseases are prevalent. It therefore greatly increases the breeder's chance of finding resistance if he knows which of these factors occur where each seed stock evolved; he is interested in factors which have repeatedly damaged or stressed plants over many seasons in that general area.

Record and mark which of the following stress factors have repeatedly damaged or stressed plants over many seasons in the general area of collection:

High temperature	High relative humidity
Low temperature	High rainfall
Frost	Drought
High winds	
Soil waterlogging	Sulphur deficiency
Soil salinity	Calcium deficiency
Acid soil (pH <4.0)	Magnesium deficiency
Alkaline soil (pH >8.0)	Molybdenum deficiency
Nitrogen deficiency	Boron deficiency
Phosphorus deficiency	Iron deficiency
Potassium deficiency	
Thrips	Stem and gall weevils
Capsids	Other weevils
White fly	Lepidopteran larvae
Aphids	Leaf miners
Springtails	Midges
Sawflies	Cabbage root fly
Flea beetles	Other diptera
Viruses	White spot
Bacterial rots	White mould
Clubroot	Light leaf spot
Powdery mildew	White blister rust
Downy mildew	Wirestem
Dark leaf spot	Ring spot
Canker	Grey leaf spot
Molluscs	Mammals
Birds	Nematodes