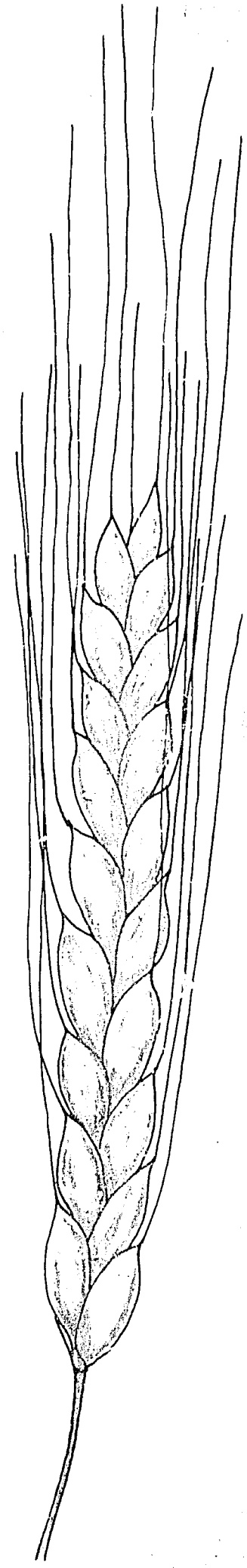
A World Survey of Wheat Genetic Resources



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INTERNATIONAL BOARD FOR
PLANT GENETIC RESOURCES

AGP:IBPGR/80/59
February, 1981

A WORLD SURVEY OF WHEAT GENETIC RESOURCES

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The International Board for Plant Genetic Resources (IBPGR) is an autonomous, international, scientific organization under the aegis of the Consultative Group on International Agricultural Research (CGIAR). The IBPGR, which was established by the CGIAR in 1974, is composed of 14 members, its Secretariat is provided by the Food and Agriculture Organization of the United Nations. The basic function of the IBPGR, as defined by the Consultative Group, is to promote an international network of genetic conservation, documentation, evaluation and use of plant germplasm and thereby contribute to raising the standard of living and welfare of people throughout the world. The Consultative Group mobilizes financial support from its members to meet the budgetary requirements of the Board.

Work summarized in this report was suggested by the IBPGR Advisory Committee on Wheat Genetic Resources. The data presented have been discussed by the Committee at its third meeting and the report endorsed.

Preface

The International Board for Plant Genetic Resources (IBPGR) has a mandate to develop a world network of genetic resources activities on the major crop species for use in present and future plant breeding programmes. This document presents the findings of a survey of the major world wheat collections which has been made in order to identify gaps existing in these collections and to give recommendations for future collection priorities.

In wheat, variation is being reduced in the primitive cultivars and in their wild and weedy relatives as such material is in many cases rapidly becoming extinct due to advanced plant breeding, agricultural improvements and, in places, environmental degradation. Erosion of wheat germplasm is most severe in the Vavilovian Centres of Diversity where, as a result of the extreme antiquity of cultivation, variation has accumulated as the crops became adapted to a wide range of habitats and farming practices.

Wheat genetic resources have been accorded a high priority for action by the IBPGR because wheat is a staple food for 35 percent of the world population, it accounts for more than 20 percent of food calories consumed and it contains many essential nutrients (Feldman, 1976). Wheat is cultivated in all continents over a total area exceeding 230 million hectares and in 1978 the total crop yield was 441 million metric tonnes (FAO data, 1978).

To safeguard this contribution to man's food supply it is of particular importance that the crop does not become genetically vulnerable. Present and future wheat breeders must be assured of a supply of diverse breeding material which will not only enable higher yielding varieties to be produced but may also allow the area of wheat cultivation to be extended through the breeding of types with special characteristics such as earlier maturing, tolerance to salt or resistance to drought. It is therefore essential that the collections of wheat germplasm should be maintained properly and that they include as much variation as possible. In order to collect adequate and representative diversity, clear regional and species priorities need to be established.

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I. INTRODUCTION

During the 1970s international efforts were made to define priorities - both taxonomic and geographic - for the collection, conservation, evaluation and documentation of the genepools of Triticum and Aegilops, so that urgent field work could be initiated and material could be made widely available for use by breeders.

The major efforts were under the auspices of the IBPGR which from its creation in 1974 recognized the need for an inventory of the present collections of major crops, and the identification of gaps in these collections. A Symposium to formulate a world programme for the genetic resources of wheat was sponsored by the IBPGR and was held in Leningrad, USSR in July 1975. The Symposium included curators of major wheat collections, wheat breeders and scientists, and led to the identification of major geographical regions in which collections should be made.

To continue the work of the Leningrad Symposium, the IBPGR established an Advisory Committee on Wheat Genetic Resources which has since held two meetings in Rome in 1976 and 1978 and its third meeting at the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT), Mexico, in January 1981. CIMMYT acts as a co-sponsor of the Committee with the IBPGR.

The Wheat Committee reaffirmed the priority ratings of geographical regions for wheat collecting which were drawn up at the Leningrad Symposium as well as making several modifications at its first two meetings. The IBPGR subsequently funded a number of collecting missions (vide FAO/IBPGR Newsletter: 37, 1979 and Newsletter: 45 1981).

Nevertheless it was apparent to the Wheat Committee that the priorities discussed in the previous decade by FAO, the Leningrad Symposium and by the Committee itself were somewhat subjective. This was because there was no summary of the data relating to the many samples held in the large numbers of wheat collections. It was thus necessary to survey these collections to find out where material had, or had not, been collected and further to define better the collecting priorities. It would also help to estimate the amount of duplication of accessions. This report presents those summary data and aims to identify gaps in the taxonomic range of wheats and wild relatives and gaps in geographic areas.

There have been several factors limiting the scope of this report, viz:

1) There are many collections which vary in size from extremely large (e.g. those in the USA and USSR) to small national collections, breeders collections and others. (In 1970 it was estimated that there were more than 250,000 accessions of wheat in collections: vide Plant Introduction Newsletter: 24, 1970.) It has been difficult to obtain detailed information from all of these collections.

2) The curators of some of the collections are in the process of computerizing data, consequently full information was not readily available. This was the case with two important collections i.e. the collection at the N.I. Vavilov Institute of Plant Industry, USSR and the collection at the Aegean Regional Agricultural Research Institute (ARARI), Izmir, Turkey. However, the authors have discussed these collections with the relevant curators and have made fairly reliable estimates. It is expected

that computerized data will be available in the near future but we have not delayed issuing this report in view of the urgency of the work still to be carried out.

3) Several taxonomic systems are currently in use and there is a great deal of synonymy in the documentation of collections. This necessitated a simplified approach which is fully discussed in the report.

4) Absolute numbers of samples may be somewhat meaningless unless information is available on which samples represent variable populations, narrow populations or breeding lines. In many cases such information is not available.

5) The collections include a great number of samples which have been exchanged and hence represent duplicates. Thus the summary data are over-estimates. It has been possible to broadly identify duplications but it has not been possible to identify the amount of duplication of individual accessions. All too often the original collection site of an accession is unknown. Reference to tables 2 and 3 should be made to compare the "Total" with the "Total excluding samples of unknown origin and duplicated samples". For *Aegilops* accessions there has been relatively little duplication but in *Triticum* the amount of duplication can be as high as 14 times e.g. the *sphaerococcum* group. Reference to table 4 gives the summary data for the origin of accessions of *durum* and *aestivum* wheat. It is thought that these totals should be at least halved to present realistic figures.

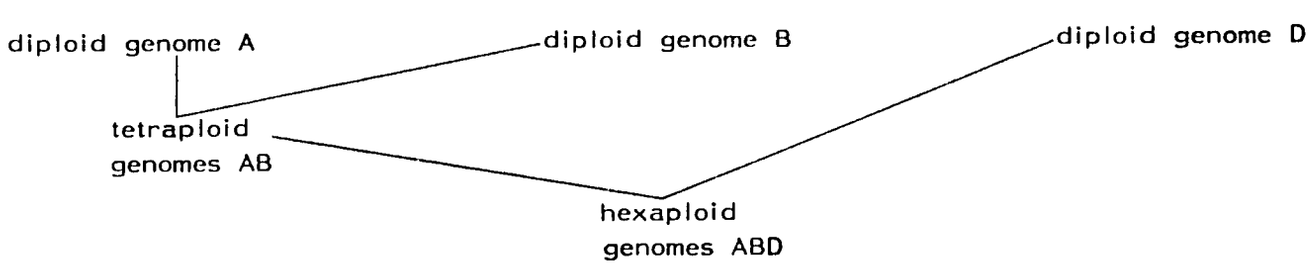
Good data management is essential to be able to identify duplicates; it cannot be emphasized too strongly that the original collection number of an accession should always accompany accessions and their subsamples wherever they are sent. This will enable duplicates to be identified.

THE TAXONOMY OF WHEAT AND ITS RELATIVES

1. Classification

Since the first taxonomic classification of the genus *Triticum* by Linnaeus a number of diverse classifications have been produced using information derived from distribution, morphology, physiology, ecology, genetics, cytology and archaeology. The earlier classifications were primarily based on morphology and later, as more became known, on genomic relationships and patterns of variability. Genome analysis has shown that the origin of cultivated wheats has involved the three genomes A, B and D as shown below:

Origin of cultivated wheat groups by allopolyploidy



The higher categories of Tribe: Triticeae Dumort. and Subtribe: Triticinae Holmberg are agreed upon. Disagreements between authorities occur at the generic and specific levels and below.

Percival (1921) reviewed and revised the earliest wheat classifications and Zhukovsky (1928), Eig (1929), and Kihara (1954) classified the genus Aegilops. With the discovery that at least one and probably two of the genomes of the polyploid wheats had come from the genus Aegilops, the classifications were again revised to indicate the species relationships. The most important of these classifications are given below.

(a) Jakubziner (1959) outlined a classification with three diploid, twelve allotetraploid and seven allohexaploid species.

(b) Bowden (1959) considered that since there were intergeneric hybrids in the species complex, the taxonomy was at fault because "the inclusion of parental diploid wheat species along with the allotetraploid and allohexaploid wheat of hybrid origins in the genus Triticum while the other parental diploid species are included in the genus Aegilops is nomenclaturally incorrect". He thus lumped all species into the one genus Triticum. Furthermore, he reduced the ranks of many species to "groups" because of their genomic relationships and consequent breeding behaviour.

(c) Morris and Sears (1967) considered Bowden's classification to be satisfactory, modifying it slightly.

(d) MacKey (1966) argued that the boundaries of the genus Triticum L. be maintained as they were first amended by Dumortier because the amalgamation of the genera Aegilops and Triticum does not reflect an evolutionary divergence into wild and cultivated forms. Based on genetic relationships he revised the taxonomy and proposed that there be five species. MacKey (1968) further argued that Aegilops and Triticum should be treated as separate genera again because of their different evolutionary trends, provided that T. monococcum was placed in a separate genus; Crithodium, in order to comply with nomenclatural rules. He foresaw that the crop would evolve to a point where all brittle and spelting wheats would disappear from agriculture and would only be maintained in botanical gardens.

In summary, Bowden lumped the species together because of their similarities whilst MacKey emphasized their differences (Parker, 1978). From the point of view of genetic conservation the genomic relationships and the evolutionary relationships between the species are important. Two schemes of possible evolutionary relationships are shown below in figures 1 and 2.

Figure 1

Traditionally accepted relationships (based on cytogenetic evidence)

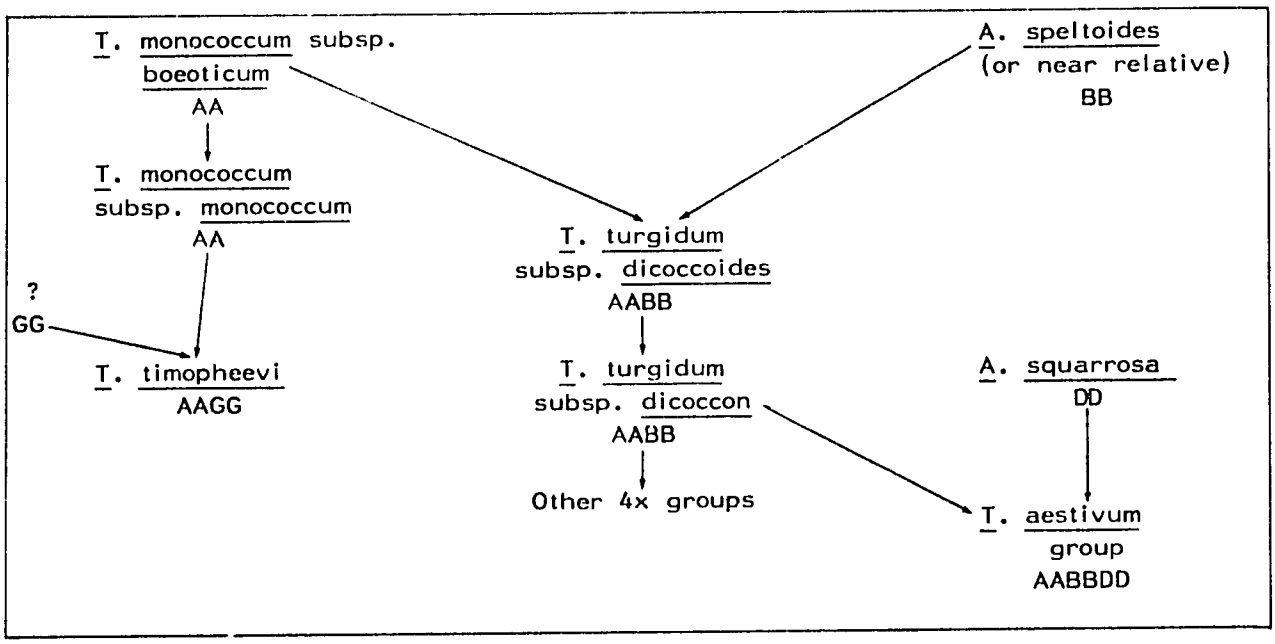
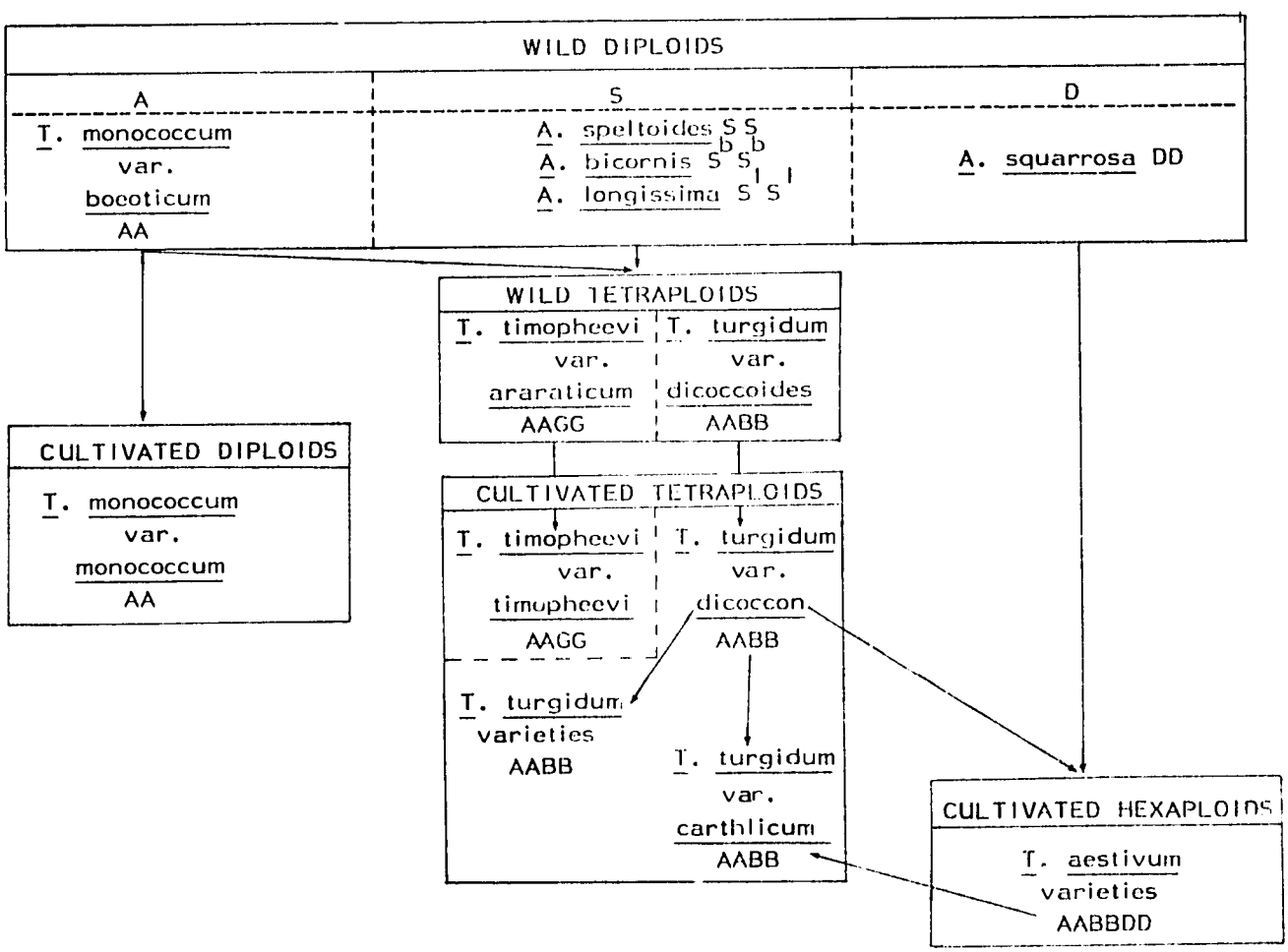


Figure 2

Recent ideas on wheat evolutionary relationships (after Feldman 1976)



The different taxonomic treatments and evolutionary schemes have produced a diverse nomenclature which is confusing when dealing with data from different centres. It was found necessary to use one classification in this survey for the sake of clarity. Since many scientists still prefer to distinguish between the genera Aegilops and Triticum they have been retained and the classification used here has been adopted from that of MacKey and used by Zeven and Zhukovsky (1975) since it is one which is concise and practical as well as one which follows a genepool treatment. The classification used is shown in Table 1, and a list of the most common synonyms is presented in Appendix III to enable unfamiliar names to be cross-referenced.

Table 1

A Triticum by ploidy and genomes

			STATUS
DIPLOIDS			
Genome - AA			
T. urartu Tum.			wild
T. monococcum L.	subsp. boeoticum (Boiss.) MK.		wild
	subsp. monococcum L.		cultivated
TETRAPLOIDS			
Genome - AABB			
T. turgidum (L.) Thell.	subsp. dicoccoides (Körn.) Thell.		wild
	subsp. dicoccon (Schrank) Thell.		cultivated
	subsp. paleocolchicum (Men.) MK.		cultivated
	subsp. carthlicum (Nevski) MK.		cultivated
	subsp. turgidum L.		cultivated
		conv. turgidum L.	cultivated
		conv. durum (Desf.) MK.	cultivated
		conv. turanicum (Jakubz.) MK.	cultivated
		conv. polonicum (L.) MK.	cultivated
		conv. aethiopicum Jakubz.	cultivated
Genome - AAGG or AAB'B'			
T. timopheevi Zhuk.	subsp. araraticum (Jakubz.) MK.		wild
	subsp. timopheevi Zhuk.		cultivated
HEXAPLOIDS			
Genome - AAAABB			
T. zhukovskyi Men. et Er.			cultivated
Genome - AABBDD			
T. aestivum (L.) Thell.	subsp. compactum (Host) MK.		cultivated
	subsp. macha (Dek. et Men.) MK.		cultivated
	subsp. spelta (L.) Thell.		cultivated
	subsp. sphaerococcum (Perc.) MK.		cultivated
	subsp. vavilovii (Tum.) Sears		cultivated
	subsp. vulgare (Vill.) MK.		cultivated

Table 1 Cont.

B Aegilops by ploidy and genomic relationship (After Kihara 1954)

2n = 2x = 14		2n = 4x = 28	2n = 6x = 42
C group:	A. caudata L. C	A. triuncialis L. $C^u\ C$	
	A. umbellata Zhuk. C^u	A. cylindrica Host $C\ D$	
M group:	A. squarrosa L. D		A. juvenalis (Thell.) Eig $DC^u M^j$
	A. comosa Sibth. et Sm. M	A. lorentii Hochst. $C^u\ M^b$	
	A. mutica Boiss. M^t	A. columnaris Zhuk. $C^u M^o$	
	A. uniaristata Vis. M^u	A. ovata L. $C^u\ M^o$	
		A. triaristata Willd. $C^u\ M^t$ and $C^u\ M^t\ M^{t2}$	
S group:	A. speltoides Tausch S	A. ventricosa Tausch DM^v	A. vavilovi (Zhuk.) Chenn. $CM^{cr}\ S^p$
	A. bicornis (Forsk.) Jaub. et Sp. S^b	A. crassa Boiss. DM^{cr} and $D\ D^2\ M^{cr}$	
	A. longissima Schweinf. et Muschl. S^l	A. kotschyi Boiss. $C^u\ S^v$	

2. The use of the term 'variety'

The formal description of infraspecific taxa goes back over a hundred years. To date several hundred varieties have been listed but systems using them are artificial and impractical and do not account for many morphological and physiological characters. In some cases biologically different wheats may be split into quite different groups (Peterson, 1965). Bowden (1959) rightly maintained that many of the domesticated varieties should be considered as cultivars. This report has not considered this level of variation. This variation will be much more meaningful when an internationally agreed descriptor system is used and information entered into data management systems.

III. THE DATA

1. Methodology and totals

For the past three years the IBPGR has been gathering information from centres holding major wheat collections, especially on the number of accessions held, the details of the species and from where the accessions originated. Information has been received in a diversity of forms and reference has been made to catalogues and other publications. The major collection centres are listed in Appendix II.[1/] Data, when received, were standardized to the classification given in Table 1.

For each taxon the numbers of accessions available in all the holdings has been totalled according to the countries of origin. Accessions originating from outside the known areas of indigenous distribution were regarded as either exchanged material or advanced cultivars. Unfortunately many curators have not recorded in their data the original collection site for many of their accessions. However it has been possible to identify duplication of material although this is not fully accurate and allowances must be made for this.

Tables 2, 3, 4 and 5 show the data which emerged from this survey. In figures 3-43 (Appendix IV) the distribution areas of taxa are shown along with the numbers of accessions known to have been collected from each country.

2. Analysis of the data and identification of species and areas for future collecting

In order to identify gaps in collections several factors need to be considered. Firstly it is impractical to attempt to capture all diversity and a compromise has to be reached to be able to state with reasonable confidence that sufficient material is conserved. Secondly, it would be wrong to say that once a certain number of accessions has been reached, collecting should cease (unless a taxon had become extinct) because species will continue to evolve. Hence it is difficult to estimate the

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1/ Curators of those which are not listed are invited to communicate with the IBPGR Secretariat, Plant Production and Protection Division, FAO, Viadelle Terme di Caracalla, 00100, Rome, Italy.

number of accessions which will provide representative variability and the current emphasis should clearly be placed on collecting material which is (a) obviously under-represented in collections and (b) endangered.

To define this we need to answer the following questions: How important is a taxon? Where is its greatest diversity? How much has been collected and from where? If a serious gap is found then action needs to be taken if the taxon is still available for collection. Thus, areas where little collection activity has taken place or where erosion is great need to be identified as first priority collection regions. This survey provides information for each species and will enable priorities to be more clearly defined than hitherto.

As plant breeders usually require material that is easily utilized, collection in the past has concentrated on collecting durum and bread wheats somewhat to the neglect of the other groups. The other groups contain taxa which are parental to the polyploid cultivars and need greater attention because they form a valuable genetic resource.

Gaps have been identified from Tables 2, 3 and 4 which show the total number of accessions collected from the countries which form the known areas of distribution of each species. The gaps represent three situations: 1) where a species is clearly inadequately represented, 2) where nothing has been collected from the country in the area of diversity, and 3) where an area is inadequately represented.

Table 5 summarizes the number of accessions held for each taxon.

The authors proposed a series of priorities by taxa and areas in Tables 6-8. Comparisons with the 1978 priorities of the Wheat Committee (Appendix I) show certain overall similarities i.e. in countries listed but the new data enabled a further revised action programme to be formulated in 1981 (Appendix Ia).

IV. A STRATEGY

The information about samples held in collections show that the collecting of wheat is far from complete. All too often in the past sampling has been inadequate because (a) insufficient material has been taken in the field i.e. not representing the crop population structure, (b) expeditions have followed main roads and neglected inaccessible areas, and (c) not enough is known about genetic erosion in the wild species.

Factors limiting collection will continue to be the speed with which wild and primitive types can be collected before they become extinct. With such a range of species the statement of Allard (1970) that the geographical distribution of genetic variation is not uniform applies. The variation should thus be sampled on the broadest scale so as to cover all environmental extremes. There is no single answer for a sampling strategy for the wheat genepool because each species and area has its own problems associated with ecological factors which affect the overall pattern of variation.

Hence the action plan, based on the analysis of this report (Appendix Ia) requires broad definition. Collecting should be intensively carried out with visits during

more than one season of the year to collect species which ripen at different times. At the same time, it is important to record species and areas where extinction threatens. It is also essential to collect adequate and representative material from remote regions which may only be visited once.

The approach must be pragmatic, must include as many taxa as possible and the aim must be to conserve sufficient stock with which to supply breeders now and in the long-term.

Finally, two practical points: firstly, in this survey curators were unable, in many cases, to supply original collection numbers and this made the identification of duplicates difficult. The absolutely essential role of the data management system has already been touched upon. This system must retain all original collection numbers. Secondly, collections must be duplicated. Two major wheat collections have already been lost: a large part of Gögkol's in Turkey when he retired (Kuckuck 1970); and that of Percival's in Reading (UK) - half was destroyed in store and the rest was given away in small amounts over the years (Watkin Williams Pers. Comm.). However, good examples of duplications are: (a) the University of California, Riverside which is duplicated in the University of Punjab, India, and in the genebank of Canada Agriculture, Ottawa; and (b) the IBPGR designated collections, the curators of which are arranging to fully duplicate the material in the other centres.

Table 2

Totals of Aegilops

ORIGIN \ TAXON	C Group						M Group								S Group					
	A. caudata	A. umbellulata	A. triuncialis	A. cylindrica	A. squarrosa	A. comosa	A. mutica	A. uniaristata	A. lorentii	A. columnaris	A. ovata	A. triaristata	A. juvenalis	A. vavilovi	A. speltoides	A. bicornis	A. longissima	A. ventricosa	A. crassa	A. kotschyi
Unknown and Duplicate	12	7	27	16	35	8	7	5	6	3	26	13	8	4	36	7	12	18	12	15
Afghanistan	+		56	+	74														21	
Algeria			+						+		+	+						+		
Bulgaria			3	1																
Canaries											+									
Corsica											2									
Cyprus	+		+						+		3									1
Egypt											+					16	+			15
France			1	2					+		6	+						+		
Greece and Aegean	14	+	8			25		5	4		8	46								+
Hungary				+																
Iran	1	8	42	63	119		5		5	24	4	4	13		2				28	2
Iraq	13	70	156	3	+				29	2	+	58	14		218				22	28
Israel	+		+	+					2		3			+	44	5	50		1	20
Italy			+	+					+		22	8						5		+
Jordan											7						3			69
Lebanon	+		+			+			+	+	2				+		+		+	7
Libya											+					+		+		+
Morocco			+								+	+						2		+
Pakistan					9															
Portugal			+								2									
Romania									+											
Spain			60								81	+						4		
Syria	2	4	9		2				9	2	40	2		12	1		4		3	14
Tunisia											+							+		
Turkey	104	202	427	181	97	14	99	3	203	63		145			369				2	5
USSR		7	78	82	206				8	10		4	3						1	6
Yugoslavia			+					+	+		2									
Total	146	298	867	348	536	47	111	13	266	104	208	280	38	16	670	28	69	29	90	182
Total excluding unknown and duplicate	134	291	840	332	501	39	104	8	260	101	182	267	30	12	634	21	57	11	78	167

- Countries of natural distribution, no samples known to be held.

Table 3

Totals of primitive and wild Triticum

ORIGIN \ TAXON	T. monococcum			T. turgidum								T. timopheevi		T. zhukovskyi	T. aestivum				
	urartu type	ssp. boeoticum	ssp. monococcum	ssp. dicoccoides	ssp. dicoccon	ssp. paleocolchicum	ssp. carthlicum	ssp. turgidum conv. turgidum	conv. turanicum	conv. polonicum	conv. aethiopicum	ssp. araraticum	ssp. timopheevi		ssp. compactum	ssp. macha	ssp. spelta	ssp. sphaerococcum	ssp. vavilovii
Unknown and duplicate	24	180	209	170	1348	3	308	901	53	362		16	42		659	78	438	143	7
Afghanistan								7		11					19			1	
Austria															22		60		
Balkans			77																
Central Europe			213					282									158		
Czechoslovakia					15														
Ethiopia					84			118			169								
Germany																	1336		
India					34					+								6	
Iran	6	51		3	15		2	8	6	8		15			9		76	+	
Iraq	1	450		38			+	+	1			504							
Israel		+		115															
Jordan		+		1															
Lebanon	106	15		50															
N. Africa			12																
Pakistan										1					3			4	
Sahara																	2	+	
Southern Europe										16									
Spain			31		14												483		
Switzerland															5		292		
Syria	1	2	2	14															
Turkey	121	499	108	225	62		5	3		3		71	1						
USSR	21	77	30		18	11	26					66	60	16	+	25			15
Yemen AR					30														
Yugoslavia			3		1														
TOTAL	280	1274	685	616	1621	14	341	1319	60	401	169	672	103	16	717	103	2845	154	22
Total excluding unknown and duplicate	256	1094	476	446	273	11	33	418	7	39	169	656	61	16	58	25	2407	11	15

\+ Countries of distribution, no samples known to be held.

Table 4

Accession totals for the two most commonly cultivated wheats

(a) *T. turgidum* subsp. *turgidum* convar. *durum*

Afghanistan	185
Albania	16
Algeria	126
Anatolia	124
Austria	5
Balkans	153
Canary Islands	1
China	2,027
Crete	62
Cyprus	240
Czechoslovakia	49
Egypt	269
Ethiopia	2,372
France	130
Germany	156
Greece	308
Hungary	108
India	754
Iran	563
Iraq	258
Israel	110
Italy	589
Japan	10
Jordan	194
Korea	1
Lebanon	26
Libya	3
Malta	3
Morocco	158
Pakistan	15
Poland	52
Portugal	1,818
Romania	29
Saudi Arabia	20
Spain	405
Syria	131
Tibet	6
Tunisia	592
Turkey	4,647
USSR	1,296
Yugoslavia	97
TOTAL	18,108*
Also: S. America & Mexico	857
Australia	245
Canada & USA	403
Unknown and duplicate	7,027
Grand total	26,640

* This figure should be halved to give a more realistic total i.e. 9,054

Table 4 Cont.

(b) *T. aestivum* subsp. *vulgare*

Afghanistan	2,687
Albania	25
Algeria	170
Austria	1,306
Bangladesh	13
Belgium	208
Bhutan	204
Bulgaria	553
Burma	3
Canary Islands	53
China	11,421
Cyprus	27
Czechoslovakia	509
Denmark	183
Egypt	290
Ethiopia	646
Finland	287
France	1,719
Germany	3,385
Greece	245
Hungary	858
India	2,748
Iran	2,488
Iraq	189
Israel	167
Italy	1,472
Japan	2,167
Jordan	5
Korea	247
Lebanon	15
Libya	3
Mongolia	34
Morocco	96
Nepal	1,067
Netherlands	361
Norway	55
Pakistan	566
Poland	387
Portugal	594
Romania	377
Saudi Arabia	22
Spain	436
Sudan	13
Sweden	662
Syria	34
Tibet	471
Tunisia	94
Turkey	4,961
UK	772
USSR	3,096
Yemen	69
Yugoslavia	682
TOTAL	49,140*
Also: S. America & Mexico	2,943
Africa south of the Sahara	951
Australia	3,495
Canada & USA	6,486
Unknown and duplicate	51,846
Grand total	114,861

* This figure should be halved to give a more realistic total i.e. 24,570

Table 5

Total number of accessions for each taxon
(Excluding those of unknown origin and duplicates)

AEGILOPS	
C Group	
A. caudata	134
A. umbellulata	291
A. triuncialis	840
A. cylindrica	332
M group	
A. squarrosa	501
A. comosa	39
A. mutica	104
A. uniaristata	8
A. lorentii	260
A. columnaris	101
A. ovata	182
A. triaristata	267
A. juvenalis	30
A. vavilovi	12
S group	
A. speltoides	634
A. bicornis	21
A. longissima	57
A. ventricosa	11
A. crassa	78
A. kotschyi	167
TRITICUM	
T. urartu	256
T. monococcum subsp. *boeoticum*	1,111
T. monococcum subsp. *monococcum*	476
T. monococcum unspecified	126
T. turgidum subsp. *dicoccoides*	446
T. turgidum subsp *dicoccon*	273
T. turgidum subsp. *paleocolchicum*	11
T. turgidum subsp. *carthlicum*	33
T. turgidum subsp. *turgidum* convar. *turgidum*	418
T. turgidum subsp. *turgidum* convar. *durum*	9,054
T. turgidum subsp. *turgidum* convar. *turanicum*	7

Table 5 Cont.

T. turgidum	subsp.	turgidum	convar.	polonicum	39
T. turgidum	subsp.	turgidum	convar.	aethiopicum	169
T. timopheevi	subsp.	araraticum			656
T. timopheevi	subsp.	timopheevi			61
T. zhukovskyi					16
T. aestivum	subsp.	compactum			58
T. aestivum	subsp.	macha			25
T. aestivum	subsp.	spelta			2,407
T. aestivum	subsp.	sphaerococcum			11
T. aestivum	subsp.	vavilovii			15
T. aestivum	subsp.	vulgare			24,570

Totals for Major World Collections

C Group of Aegilops	1,597
M Group of Aegilops	1,504
S Group of Aegilops	968
Aegilops Total ...	4,068
T. monococcum	1,969
T. turgidum group	10,450
T. timopheevi	717
T. zhukovskyi	16
T. aestivum group	27,086
Triticum Total ...	40,238

(N.B. The 1970 survey showed the world total accessions amount to about 250,000 and the total in this survey including unknown and duplicates = 157,259).

Table 6

Taxa of high priority

(Based on taxa which are arbitrarily under-represented i.e. those of which there are less than 100 accessions with the origin identified)*

Ploidy	Aegilops	Number of Accessions	Triticum	Number of Accessions
Diploids	A. comosa	39		
	A. uniaristata	8		
	A. bicornis	21		
	A. longissima	57		
Tetraploids	A. ventricosa	11	T. turgidum	
	A. crassa	78	subsp. paleocolchicum	11
			subsp. carthlicum	33
			subsp. turgidum convar. turanicum	7
			convar. polonicum	39
			(N.B. These groups may have been included in convar. durum by some institutions)	
Hexaploids	A. juvenalis	30	T. zhukovskyi	16
	A. vavilovi	12	T. aestivum	
			subsp. compactum	58
			subsp. macha	25
			subsp. sphaerococcum	11
			subsp. vavilovii	15

* For many taxa it will be difficult to obtain many more samples because of their rarity.

Table 7

Priorities for Aegilops

(Countries forming parts of areas of natural distribution from where no material is known to be held in collections)

Country	Species	Country	Species
Afghanistan:	A. caudata		A. lorentii
	A. cylindrica		A. kotschyi
Algeria:	A. triuncialis	Lebanon:	A. caudata
	A. lorentii		A. triuncialis
	A. ovata		A. comosa
	A. triaristata		A. lorentii
	A. ventricosa		A. columnaris
Canary Islands:(Spain)	A. ovata		A. speltoides
Cyprus:	A. caudata		A. longissima
	A. triuncialis		A. crassa
	A. lorentii	Libya:	A. ovata
Egypt:	A. ovata		A. bicornis
	A. longissima		A. ventricosa
France:	A. lorentii		A. kotschyi
	A. triaristata	Morocco:	A. triuncialis
	A. ventricosa		A. ovata
Greece & Aegean:	A. umbellulata		A. triaristata
	A. kotschyi		A. kotschyi
Hungary:	A. cylindrica	Portugal:	A. triuncialis
Iraq:	A. squarrosa	Romania:	A. lorentii
	A. ovata	Spain:	A. triaristata
Israel:	A. caudata	Tunisia:	A. ovata
	A. triuncialis		A. ventricosa
	A. cylindrica	Yugoslavia:	A. triuncialis
	A. vavilovii		A. uniaristata
Italy:	A. triuncialis		A. lorentii
	A. cylindrica		

Table 8

Priority areas for the two most commonly cultivated wheats
(based on gaps in collections where they are/were most diverse)

T. turgidum subsp. *turgidum* convar. *durum*	*T. aestivum* subsp. *vulgare*
Less than 100 accessions	Less than 100 accessions
Albania	Albania
Lebanon	Libya
Libya	Morocco
Pakistan	Saudi Arabia
	Sudan
	Syria
	Tunisia
	Yemen
100 - 500 accessions	100 - 500 accessions
Algeria	Algeria
Egypt	Egypt
Greece	Greece
Iraq	Korea
Jordan	Tibet
Morocco	
Syria	

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Acknowledgements

The authors are indebted to all those curators of institutes who provided information about their collections. We also wish to thank Dr. J.R. Witcombe, IBPGR/FAO Technical Adviser (Genetic Resources) at ICARDA, and members of the IBPGR Wheat Committee for much useful criticism during the drafting of the report. Mrs. Joyce Shuter-Buccini typed several drafts and we are grateful to her for her careful work.

APPENDIX I

The 1978 Priorities of the Wheat Committee

PRIORITY 1

Turkey:	southeast and east.
Caucasus:	especially Armenia and Georgia. (The Committee thought that the collections of the Vavilov Institute are relatively comprehensive, but until full information is available, this region must remain a high priority.)
Syria:	particularly the north of the country.
Iraq:	particularly the Zagros mountains.
Iran:	mountainous regions, eastern oases and a plateau to the west.
Afghanistan:	the north and mountains of Hindukush across the centre of the country.
Albania:	
Greece:	northern Pelopponese.
Egypt:	Upper Egypt
Yemen A.R:	mountainous area bordering on Saudi Arabia.
Saudi Arabia:	region along the Red Sea, adjacent to Yemen A.R.
People's Republic of China:	especially the mountains in the west and Tibetan regions.

PRIORITY 2

Spain:	
Portugal:	
Yugoslavia:	especially for *T. monococcum*
Morocco:	
Libya:	coastal highlands, and wadis, South of Tripoli.
Sudan:	Jebel Marra region.
Ethiopia:	
Pakistan:	South Baluchistan, borders of Afghanistan and the edge of Kashmir.
Nepal:	hill regions.
Bhutan:	
India:	hills of Uttar Pradesh, Himachal Pradesh, Madhya Pradesh and Kashmir; and some parts of peninsular India.
People's Republic of China:	regions other than those mentioned above.
Mongolia:	
Brazil:	improved descendants of European varieties selected for acid soils.

APPENDIX I
(Continued)

PRIORITY 3

Tunisia:	
Algeria:	
Italy:	
France:	
Mexico:	northern plateau and in the south in Oaxaca.
Paraguay and Uruguay:	
Bolivia:	
Peru and Ecuador:	old durum from Spanish colonial introductions (in the highlands).
Chile:	

PRIORITY 4

Burma:	
Korea:	northern region.
Mozambique:	
Angola:	
Chad:	

The following regions and countries require the material which is scattered in collections to be gathered together: Northwest Europe, Eastern Europe and temperate USSR, USA, Canada, Kenya, South Africa and Rhodesia, Australia and New Zealand, and Japan.

Appendix Ia

The 1981 Priorities of the Wheat Committee

Triticum species

PRIORITY 1

Europe

Albania	
Portugal	northeast
Spain	northern areas and border with northeast Portugal
Yugoslavia	For *T. monococcum* especially

Southwest, Central Asia and North Africa

Afghanistan	
Algeria	Tindouf area only
Egypt	For *durum*
Iran	Azerbaijan, Elburz Mountains, Mashad 1/
Iraq	Sulaimaniya region only
Jordan	
Lebanon	
Libya	coastal highlands, and wadis, south of Tripoli
Oman	mountainous regions including Dhufar
People's Democratic Republic of Yemen	mountainous regions bordering on Yemen Arab Republic and Hadramout
Saudi Arabia	Hijaz region along the Red Sea, adjacent to North Yemen and Abha Asir regions

South Asia

Bhutan

PRIORITY 2

Africa

Ethiopia	a continuing programme of the national genebank
Morocco	genetic resources not seriously threatened
Mozambique	collections have been made by INIA and material should be duplicated

---

1/ If collections from 1978 expedition are not duplicated elsewhere then S.W. Iran and Baluchistan should be included.

APPENDIX Ia
(Continued)

Asia

Burma	
People's Republic of China	especially in the west and Tibetan regions[1/]
South Korea	northern region
USSR	especially the Caucasus[2/] (Armenia and Georgia)

South America

Bolivia	
Uruguay	

PRIORITY 3

Asia

Mongolia	
Nepal	western hill regions
North Korea	

Americas

Brazil	duplication of collected material is needed
Mexico	north plateau and Oaxaca

OTHER PRIORITIES

Areas thought to have been well covered and near to completion

Europe

Greece
Italy

Africa

Sudan	Jebel Marra to be completed in 1981

1/ A large collection is held at the Chinese Academy of Agricultural Sciences, Beijing in China but further information is required. It therefore, remains a priority 2 area.

2/ Although the collections of the N.I. Vavilov Institute are relatively comprehensive, full information was unavailable to the Committee.

Appendix 1a
(Continued)

Southwest, Central Asia and North Africa

India	NBPGR is filling in remaining gaps
Pakistan	expedition planned for Baluchistan during 1981-82
Syria	
Turkey	
Tunisia	
Yemen A.R.	

The following regions and countries require the material which is scattered in collections to be gathered together and documented: Northwest Europe and Scandinavia, Eastern Europe, temperate USSR, USA, Canada, Kenya, South Africa and Rhodesia, Australia and New Zealand, and Japan.

APPENDIX II

List of centres holding major collections from which data were analyzed in this report

Australia:	Australian Wheat Collection New South Wales Department of Agriculture Private Mail Bag 944 Tamworth NSW 2340
Canada:	Agriculture Canada P.O. Box 440 Regina, Saskatchewan S4P 3A2
	Canadian Genebank Canada Agriculture Ottawa, Ontario K1A OC6
Czechoslovakia:	Research Institute of Plant Production 16106 Prague 6 - Ruzyne 507
France:	Station Centrale de Génétiques et d'Amélioration des Plantes Centre Nationale de Recherches Agronomiques Route de St. Cyr 78000 Versailles
Germany, D.R.:	Akademie der Wissenschaften der DDR Zentralinstitut für Genetik und Kulturpflanzenforschung Correnstrasse 3 4325 Gatersleben
Germany, F.R.:	Institut für Pflanzenbau und Saatgutforschung Bundesforschungsanstalt für Landwirtschaft Braunschweig-Völkenrode (FAL) Bundesallee 50 3300 Braunschweig
Hungary:	Orszagos Agrobotanikai Intézet National Institute for Agricultural Variety Testing (NIAVT) 2766 Tapioszele
India:	National Bureau of Plant Genetic Resources IARI Campus Pusa Complex New Delhi 110012

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APPENDIX II
(Continued)

Israel:	Israeli Agricultural Research Organization (IARO) The Volcani Centre P.O. Box 6 Bet Dagan 50200
Italy:	Istituto del Germoplasma del CNR Via G. Amendola 165/A 70126 Bari
Japan:	Plant Germplasm Institute Kyoto University Mukoshi Kyoto 617
	Central Agricultural Research Station Konosu Saitama
	National Institute of Agricultural Sciences (NIAS) Division of Genetics Kannondai 3-1-1, Yatabe-machi Tsukuba-gun, Ibaraki-ken
Netherlands:	Foundation for Agricultural Plant Breeding (SVP) Laboratory de Haaff P.O. Box 117 6700 A.C. Wageningen
Turkey:	Aegean Regional Agricultural Research Institute (ARARI) P.K. 9 Menemen Izmir
UK:	Plant Breeding Institute Maris Lane Trumpington Cambridge CB2 LO
USA:	University of California, Riverside Riverside, CA 92521
	Small Grains Collection Building, 046 BARC-West U.S. Department of Agriculture Beltsville, MD 20705

APPENDIX II
(Continued)

USSR:	N. I. Vavilov Institute of Plant Industry Herzen Street 44 190000 Leningrad

Appendix III

List of synonyms

Taxon		Classified in this survey as:
T. abyssinicum (Vav.) Flaksb.	=	T. turgidum (L.) Thell. subsp. turgidum convar. aethiopicum Jakubz.
T. aegilopoides (Link) Bal.	=	T. monococcum L. subsp. boeoticum (Boiss.) MK.
T. aegilops P. Beauv. ex. R. & S.	=	A. squarrosa L.
T. aestivum L. em. Thell.	=	T. aestivum (L.) Thell.
T. aethiopicum Jakubz.	=	T. turgidum (L.) Thell. subsp. turgidum convar. aethiopicum Jakubz.
T. araraticum Jakubz.	=	T. timopheevi Zhuk. subsp. araraticum (Jakubz.) MK.
T. armeniacum (Jakubz.) Mukush	=	T. timopheevi Zhuk. subsp. timopheevi Zhuk.
T. bicorne Forsk.	=	A. bicornis (Forsk.) Jaub. & Spach.
T. boeoticum Boiss.	=	T. monococcum L. subsp. boeoticum (Boiss.) MK.
T. carthlicum Nevski	=	T. turgidum (L.) Thell. subsp. carthlicum (Nevski) MK.
T. caudatum (L.) Godr. & Gren.	=	A. caudata L.
T. columnare (Zhuk.) Morris & Sears	=	A. columnaris Zhuk.
T. comosum (Sibth. & Sm.) Richt.	=	A. comosa Sibth. & Sm.
T. compactum Host	=	T. aestivum (L.) Thell. subsp. compactum (Host) MK.
T. crassum (Boiss.) Aitch. & Hemsl.	=	A. crassa. Boiss.
T. cylindricum Ces., Pass. & Gib.	=	A. cylindrica Host
T. dichasians (Zhuk.) Bowden	=	A. caudata L.
T. dicoccoides (Körn. ex Aschers. & Graebn.) Schweinf.	=	T. turgidum (L.) Thell. subsp. dicoccoides (Körn.) Thell.
T. dicoccon Schrank	=	T. turgidum (L.) Thell. subsp. dicoccon (Schrank) Thell.
T. dicoccum Shübl.	=	T. turgidum (L.) Thell. subsp. dicoccon (Schrank) Thell.
T. durum Desf.	=	T. turgidum (L.) Thell. subsp. turgidum convar. durum (Desf.) MK.
T. georgicum Dek.	=	T. turgidum (L.) Thell. subsp. paleocolchicum (Men.) MK.
T. ispahanicum Heslot	=	T. turgidum (L.) Thell. subsp. turgidum convar. polonicum (L.) MK.
T. juvenale Thell.	=	A. juvenalis (Thell.) Eig
T. kotschyi (Boiss.) Bowden	=	A. variabilis Eig
T. longissimum (Schweinf. & Muschl.) Bowden	=	A. longissima Schweinf. & Muschl.
T. lorentii (Hochst.) Zeven	=	A. lorentii Hochst.

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Appendix III
(Continued)

Taxon		Classified in this survey as:
T. macha Dek. & Men.	=	T. aestivum (L.) Thell. subsp. macha (Dek. & Men.) MK.
T. macrochaetum (Shuttl. & Huet. ex Duval) - Jouve) Richter	=	A. lorentii Hochst.
T. monococcum L.	=	T. monococcum L.
T. orientale Perc.	=	T. turgidum (L.) Thell. subsp. turgidum convar. turanicum (Jakubz.) MK.
T. ovatum (L.) Raspail	=	A. ovata L.
T. paleocolchicum Men.	=	T. turgidum (L.) Thell. subsp. paleocolchicum (Men.) MK.
T. peregrinum Hack. & Fraser	=	A. variabilis Eig
T. persicum Vav.	=	T. turgidum (L.) Thell. subsp. carthlicum (Nevski) MK.
T. polonicum L.	=	T. turgidum (L.) Thell. subsp. turgidum convar. polonicum (L.) MK.
T. pyramidale Perc.	=	T. turgidum (L.) Thell. subsp. turgidum convar. durum (Desf.) MK.
T. rodeti Trabut.	=	T. turgidum (L.) Thell. subsp. turgidum convar. durum x A. ventricosa Tausch
T. sativum Aschers.	=	T. monococcum L. subsp. boeoticum (Boiss.) MK.
T. spelta L.	=	T. aestivum (L.) Thell. subsp. spelta (L.) Thell.
T. speltoides (Tausch) Gren. ex Richt.	=	A. speltoides Tausch
T. sphaerococcum Perc.	=	T. aestivum (L.) Thell. subsp. sphaerococcum (Perc.) MK.
T. spontaneum Flaksb.	=	T. monococcum L. subsp. boeoticum (Boiss.) MK.
T. syriacum Bowden	=	A. vavilovii (Zhuk.) Chenn.
T. tauschii (Coss.) Schmal.	=	A. squarrosa L.
T. thaoudar Reut. in Bourg. ex Hausskn.	=	T. monococcum L. subsp. boeoticum (Boiss.) MK.
T. timopheevi Zhuk.	=	T. timopheevi Zhuk.
T. triaristatum Godr. & Gren.	=	A. triaristata Willd.
T. tripsacoides (Jaub. & Spach) Bowden	=	A. mutica Boiss.
T. triunciale (L.) Raspail	=	A. triuncialis L.
T. turanicum Jakubz.	=	T. turgidum (L.) Thell. subsp. turgidum convar. turanicum (Jakubz.) MK.
T. turcomanicum (Rosh.) Bowden	=	A. juvenalis (Thell.) Eig
T. turgidum (L.) Thell.	=	T. turgidum (L.) Thell.
T. umbellulatum (Zhuk.) Bowden	=	A. umbellulata Zhuk.
T. uniaristatum Richt.	=	A. uniaristata Vis.
T. urartu Tuman.	=	T. urartu Tuman.
T. vavilovii (Tuman.) Jakubz.	=	T. aestivum (L.) Thell. subsp. vavilovii (Tuman.) Sears
T. ventricosum Ces., Pass. & Gib.	=	A. ventricosa Tausch

Appendix III
(Continued)

Taxon		Classified in this survey as:
T. vulgare Host.	=	T. aestivum (L.) Thell. subsp. vulgare (Vill.) MK.
T. zhukovskyi Men. & Er.	=	T. zhukovskyi Men. & Er.

Synonyms of Aegilops

a) By priority of publication, or revision

Invalid		Valid
A. aucheri Boiss.	=	A. speltoides Tausch
A. biuncialis Vis.	=	A. lorentii Hochst.
A. bushirica Rosh.	=	A. triuncialis L.
A. crassa Boiss. subsp. vavilovii Zhuk.) subsp. palaestina Eig)	=	A. vavilovii (Zhuk.) Chenn.
A. heldreichii Holzm.	=	A. comosa Sibth. & Sm.
A. tauschii Coss.	=	A. squarrosa L.
A. turcomanica Rosh.	=	A. juvenalis (Thell.) Eig
A. variabilis Eig	=	A. kotschyi Boiss.

b) As a result of lumping or splitting of species according to some authors.

A. ligustica (Savign.) Coss.	placed in	A. speltoides Tausch
A. peregrina (Hack.) Maire & Weill.	placed in	A. kotschyi Boiss.
A. sharonensis Eig	placed in	A. longissima Schweinf. & Muschl.
A. searsii Feld. & Kis.	separated from	A. longissima Schweinf. & Muschl.
A. triaristata Willd.	divided into	A. triaristata Willd.
		A. recta (Zhuk.) Chenn.

Table for comparing recent classifications of the genus Triticum. Synonyms run across the page

	JAKUBZINER 1959	BOWDEN 1959	MORRIS & SEARS 1967 1/	MAC KEY 1968	DOROFEEV et al 1979
DIPLOIDS	T. urartu Tum. T. boeoticum Boiss T. monococcum L.	T. monococcum L.	T. monococcum L.	T. urartu Tum. T. monococcum (L.) MK. subsp. boeoticum (Boiss.) MK. subsp. monococcum	T. urartu Tum. T. boeoticum Boiss. T. monococcum L. T. sinskajae A. Filat. & Kurk.
TETRAPLOIDS	T. dicoccoides (Körn.) Schweinf. T. dicoccum Schübl. T. paleocolchicum Men. T. carthlicum Nevski T. turgidum L. T. polonicum L. T. durum Desf. T. aethiopicum Jakubz. T. turanicum Jakubz. T. araraticum Jakubz. T. timopheevi Zhuk.	T. turgidum (L.) Bowden var. dicoccoides group dicoccon group paleocolchicum group carthlicum group turgidum group polonicum group durum group aethiopicum group turanicum var. tumanianii (Jakubz.) Bowden var. timopheevii (Zhuk.) Bowden f. timopheevii	T. turgidum L. var. dicoccoides group dicoccon group carthlicum group turgidum group polonicum group durum T. timopheevi (Zhuk.) Zhuk. var. timopheevi	T. turgidum (L.) Thell. subsp. dicoccoides (Körn.) Thell. subsp. dicoccum (Schrank) Thell. subsp. paleocolchicum (Men.) MK. subsp. carthlicum (Nevski) MK. subsp. turgidum convar. turgidum convar. polonicum (L.) MK. convar. durum (Desf.) MK. convar. turanicum (Jakubz.) MK. T. timopheevi (Zhuk.) MK. subsp. araraticum (Jakubz.) MK. subsp. timopheevi	T. dicoccoides (Körn.) Schweinf. T. dicoccum (Schrank) Schübl. T. karamyschevii Nevski T. carthlicum Nevski T. turgidum L. T. jakubzineri Udacz. & Schachm. T. polonicum L. T. ispahanicum Heslot T. durum Desf. T. aethiopicum Jakubz. T. turanicum Jakubz. T. militinae Zhuk. & Migusch. T. araraticum Jakubz. T. timopheevi (Zhuk.) Zhuk.
HEXAPLOIDS	T. zhukovskyi Men. & Er. T. spelta L. T. macha Dek. & Men. T. sphaerococcum Perc. T. compactum Host T. aestivum L. T. vavilovi Jakubz.	f. zhukovskyi 2/ T. X aestivum (L.) Bowden group spelta group macha group sphaerococcum group compactum group aestivum group vavilovii	var. zhukovskyi (Men. & Er.) Morris & Sears T. aestivum (L.) Thell. group spelta group sphaerococcum group compactum group aestivum group vavilovii	T. zhukovskyi Men. & Er. T. aestivum (L.) Thell. subsp. spelta (L.) Thell. subsp. macha (Dek. & Men.) MK. subsp. sphaerococcum (Perc.) MK. subsp. compactum (Host) MK. subsp. vulgare (Vill.) MK. subsp. vavilovi (Tum.) Sears	T. zhukovskyi Men. & Er. T. spelta L. T. macha Dek. & Men. T. sphaerococcum Perc. T. compactum Host T. aestivum L. T. vavilovi (Tum.) Jakubz. T. petropavlovskyi Udacz. & Migusch. T. kiharae Dorof. & Migusch. (= T. timopheevi X Aegilops squarrosa)

1/ Abandoned the traditional division into diploid, tetraploid and hexaploid groups.

2/ Considered that the autoallohexaploid should be included with var. timopheevi as it is so closely related.

Table for comparing classifications of the genus Aegilops. Synonyms run across the page

Genome	ZHUKOVSKY 1923	EIG 1929	KIHARA 1954	MAC KEY 1966	BOWDEN 1959 1/	MORRIS & SEARS 1967 1/
	SUFCULOSA	PLEIONATHERA	POLYEIDES	POLYEIDES		
C^1C	A. triunciialis L.	A. triunciialis L.	A. triunciialis L.	A. triunciialis L.	T. triunciale (L.) Raspail	T. triunciale (L.) Raspail
C^1S^v	subsp. brachyathera Boiss.	A. variabilis Eig	A. variabilis Eig	A. variabilis Eig		
C^1H	subsp. kotschyi Boiss.	A. kotschyi Boiss.	A. kotschyi Boiss.		T. kotschyi (Boiss.) Bowden	T. kotschyi (Boiss.) Bowden
	A. columnaris Zhuk.	A. columnaris Zhuk.	A. columnaris Zhuk.	A. columnaris Zhuk.		T. columnare (Zhuk.) Morris & Sears
	POLYEIDES					
C^1M^b	A. biuncialis Vis.	A. biuncialis Vis.	A. biuncialis Vis.	A. biuncialis (Vill.) Vis.	T. macrochaetum (Shutil. & Hurt.) Richter	T. macrochaetum (Shutil. & Hurt.) Richter
C^1M^M	A. triaristata Willd.	A. triaristata Willd.	A. triaristata Willd. 4x	A. triaristata Willd.	T. triaristatum (Willd.) Godr. & Gren.	T. triaristatum (Willd.) Godr. & Gren.
			A. triaristata Willd. 6x	A. reyla (Zhuk.) Chenn.		
C^1	A. umbellulata Zhuk.	A. umbellulata Zhuk.	A. umbellulata Zhuk.	A. umbellulata Zhuk.	T. umbellulatum (Zhuk.) Bowden	T. umbellulatum (Zhuk.) Bowden
C^1M^v	A. ovata L.	A. ovata L.	A. ovata L.	A. ovata L.	T. ovatum (L.) Raspail	T. ovatum (L.) Raspail
	CYLINDROPYRUM	MONOLEPTATHERA	CYLINDROPYRUM	CYLINDROPYRUM		
CC	A. cylindrica Host	A. cylindrica Host	A. cylindrica Host	A. cylindrica Host	T. cylindricum Ces., Pass. & Gib.	T. cylindricum Ces., Pass. & Gib.
	COMOPYRUM	MACRATHERA				
C	A. caudata L.	A. caudata L.	A. caudata L.	A. caudata L.	T. dichasians (Zhuk.) Bowden	T. dichasians (Zhuk.) Bowden
			COMOPYRUM	COMOPYRUM		
M	A. comosa Sibth. & Sm.	A. comosa Sibth. & Sm.	A. comosa Sibth. & Sm.	A. comosa Sibth. & Sm.	T. comosum (Sibth. & Sm.) Richter	T. comosum (Sibth & Sm.) Richter
	A. heldreichii Holzm.	subsp. heldreichii (Holzm.) Eig				
M^U	A. uniaristata Vis.	A. uniaristata Vis.	A. uniaristata Vis.	A. uniaristata Vis.	T. uniaristatum (Vis.) Richter	T. uniaristatum (Vis.) Richter
	AMBLYOPRUM	ANATHERA	AMBLYOPYRUM	AMBLYOPYRUM		
M^L	A. mutica Boiss.	A. mutica Boiss.	A. mutica Boiss.	A. mutica Boiss.	T. tripsacoides (Jaub. & Spach) Bowden	T. tripsacoides (Jaub. & Spach) Bowden
	SITOPSIS	PLATYSTACHYS	SITOPSIS	SITOPSIS		
S^D	A. bicornis (Forsk.) Jaub. & Spach	A. bicornis (Forsk.) Jaub. & Spach	A. bicornis (Forsk.) Jaub. & Spach	A. bicornis (Forsk.) Jaub. & Spach	T. bicorne Forsk.	T. bicorne Forsk.
S^l	A. longissima Schweinf. & Muschl.	A. sharonensis Eig	A. longissima Schweinf. & Muschl.	A. longissima Schweinf. & Muschl.	T. longissimum (Schweinf. & Muschl.) Bowden	T. longissimum (Schweinf. & Muschl.) Bowden
		A. longissima Schweinf. & Muschl.				
		A. libustica Ces.				
S	A. speltoides Tausch	A. speltoides Tausch	A. speltoides Tausch	A. speltoides Tausch	T. speltoides (Tausch) Gren. ex Richter	T. speltoides (Tausch) Gren. ex Richter
	A. aucheri Boiss.					
	VERTEBRATA	PACHYSTACHYS	VERTEBRATA	VERTEBRATA		
O	A. squarrosa L.	A. squarrosa L.	A. squarrosa L.	A. squarrosa L.	T. aegilops P. Beauv. ex R. & S.	T. tauschii (Coss.) Schmal.
	POLYEIDES					
D^2M^{cr}	A. crassa Boiss.	A. crassa Boiss.	A. crassa Boiss.	A. crassa Boiss.	T. crassum (Boiss.) Aitch. & Hemsl.	T. crassum (Boiss.) Aitch. & Hemsl.
D^2M^S				A. vavilovii (Zhuk.) Chenn.	T. syriacum Bowden	T. syriacum Bowden
D^2		A. juvenalis (Thell.) Eig	A. juvenalis (Thell.) Eig	A. juvenalis (Thell.) Eig	T. juvenale Thell.	T. juvenale Thell.
$D^2M^{cr}C$	A. turcomanica Rosh.				T. turcomanicum (Rosh.) Bowden	
	GASTROPYRUM					
DM	A. ventricosa Tausch	A. ventricosa Tausch	A. ventricosa Tausch	A. ventricosa Tausch	T. ventricosum Ces., Pass. & Gib.	T. ventricosum Ces., Pass. & Gib.

1/ Both Bowden and Morris & Sears include Aegilops in the genus Triticum.

APPENDIX IV

Maps showing where collected samples originated (Figures 3-43)

The sources of information for distribution areas [1/] were:

Dorofeev, V.F. (1976)

Wild wheat species and their representation in the VIR world collection
In, Wheat Genetic Resources, Proceedings of International Symposium,
The N.I. Vavilov Institute of Plant Industry, p.21

Harlan, J.R. and Zohary, D. (1966)

Distribution of wild wheats and barleys
Science, New York, 153: 1074-1080

Johnson, B.L. and Dhaliwal, H.S. (1976)

Reproductive isolation of *Triticum boeoticum* and *Triticum urartu* and the origin of the tetraploid wheats
American Journal of Botany, 63: 1088-1094

and the following are cited in full in Section V:

Eig, A. (1929)

Peterson, R.F. (1965) pp. 89-93

Zeven, A.C. and Zhukovsky, P.M. (1975)

Zhukovsky, P.M. (1928)

and

Dr. J.R. Witcombe (personal communication)

1/ Areas of distribution drawn on the maps do not imply continuous presence. The numbers shown in each country correspond to those in Tables 2 and 3 and represent the number of accessions which originated from the particular country.

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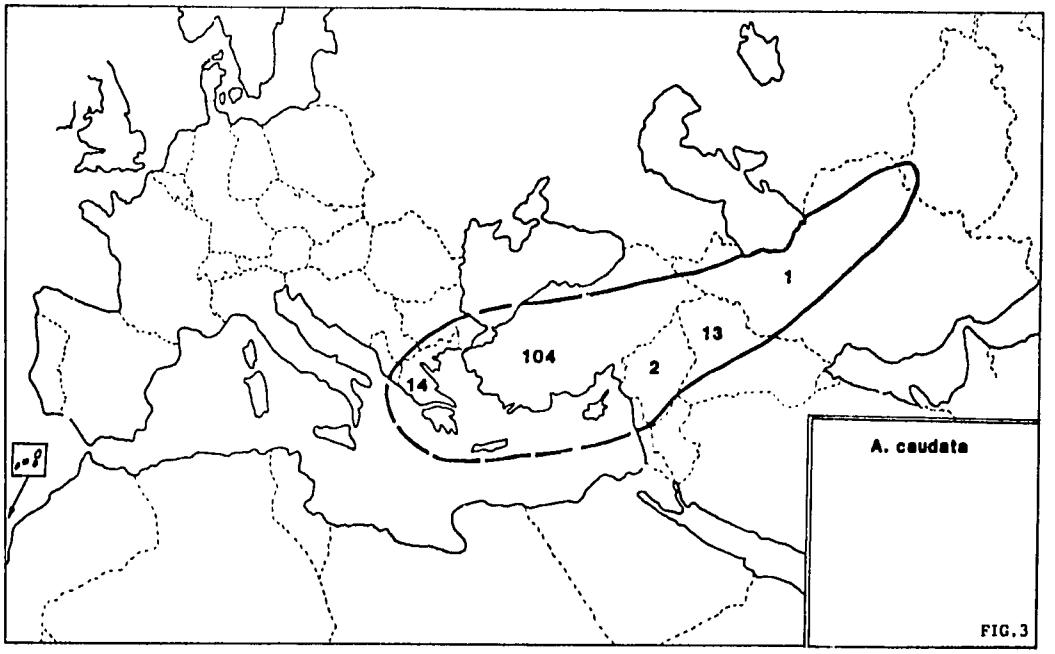
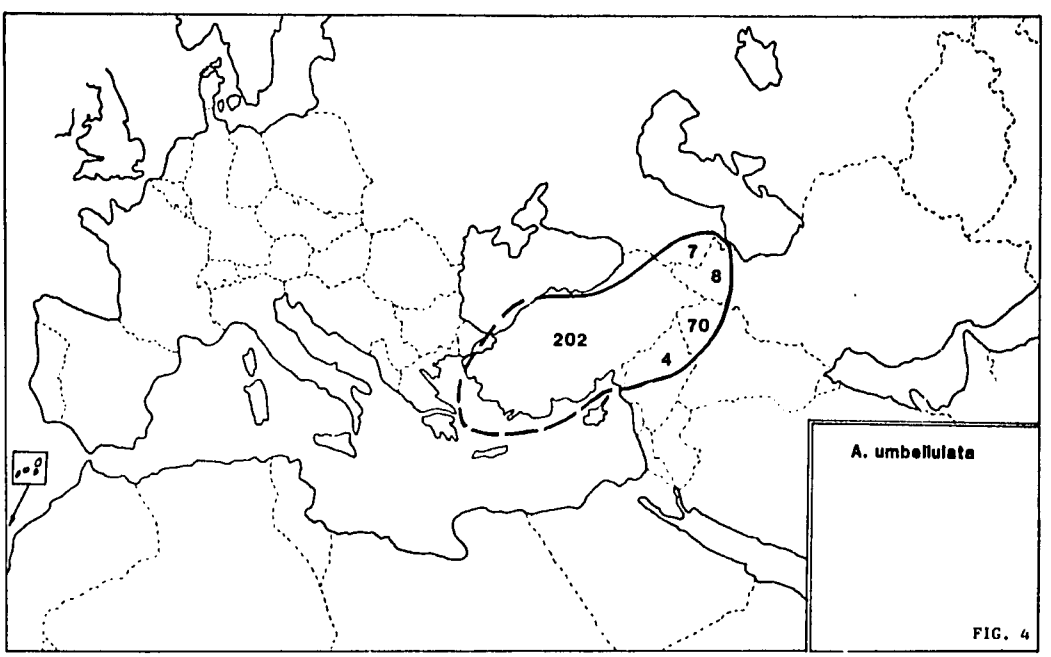


FIG.3



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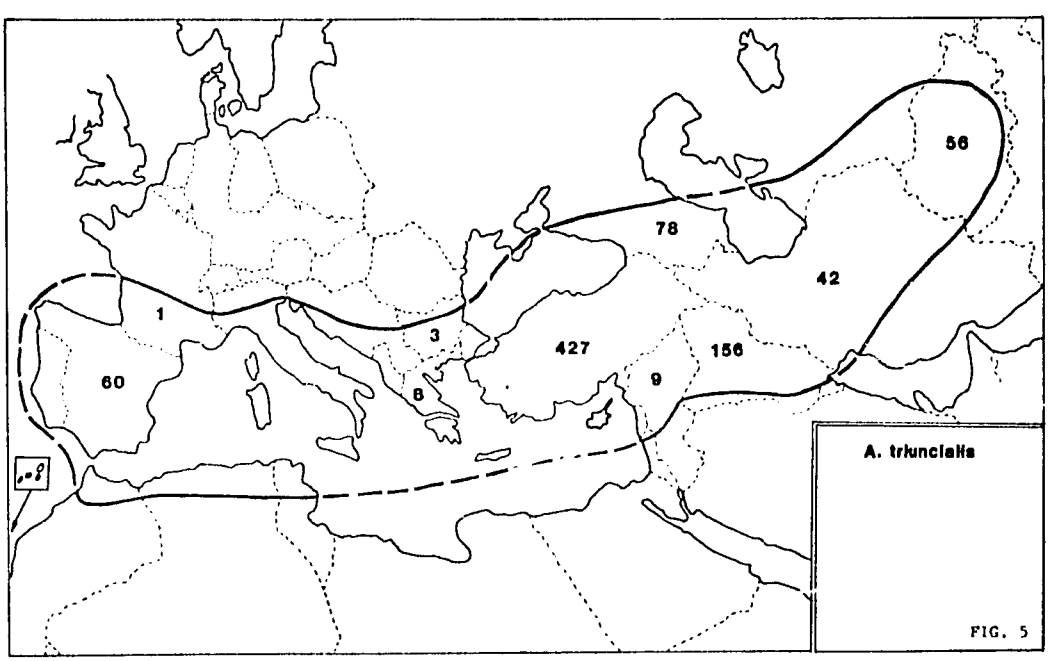

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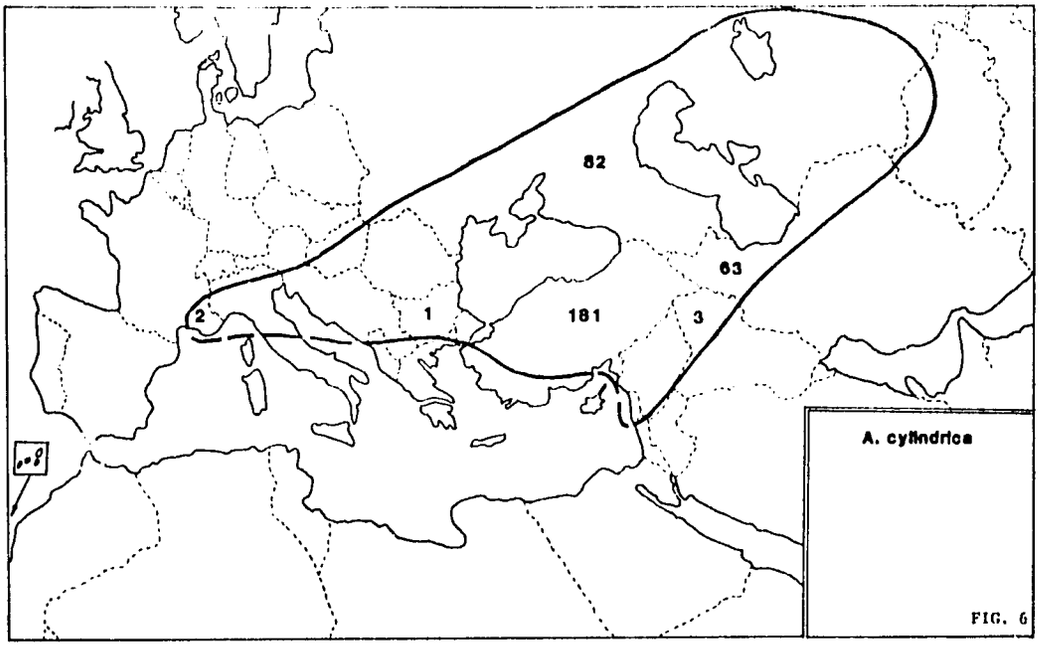

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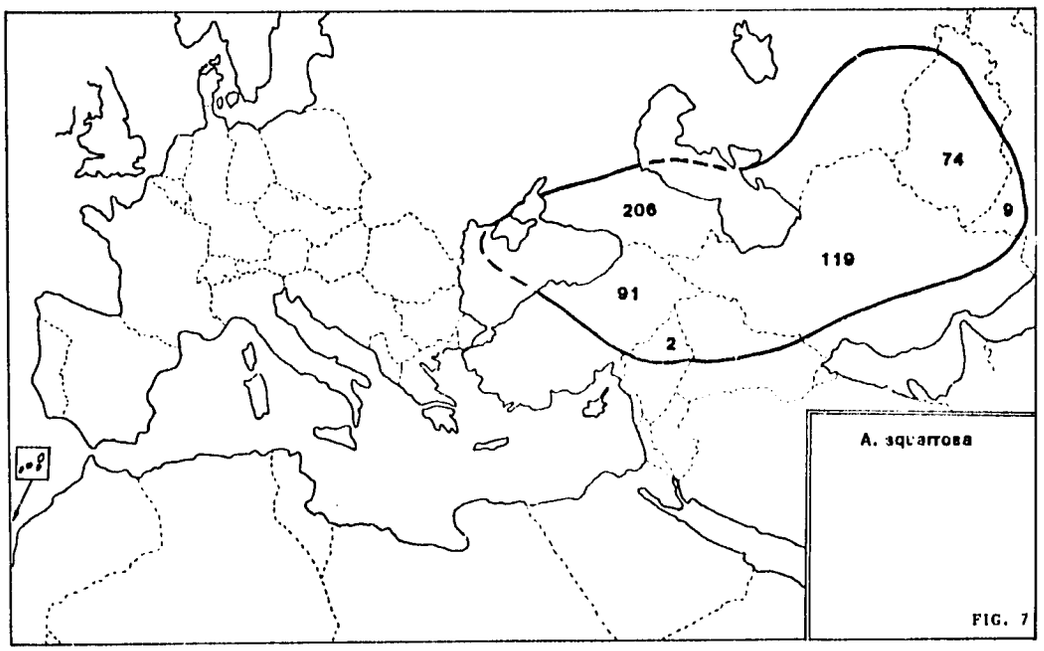

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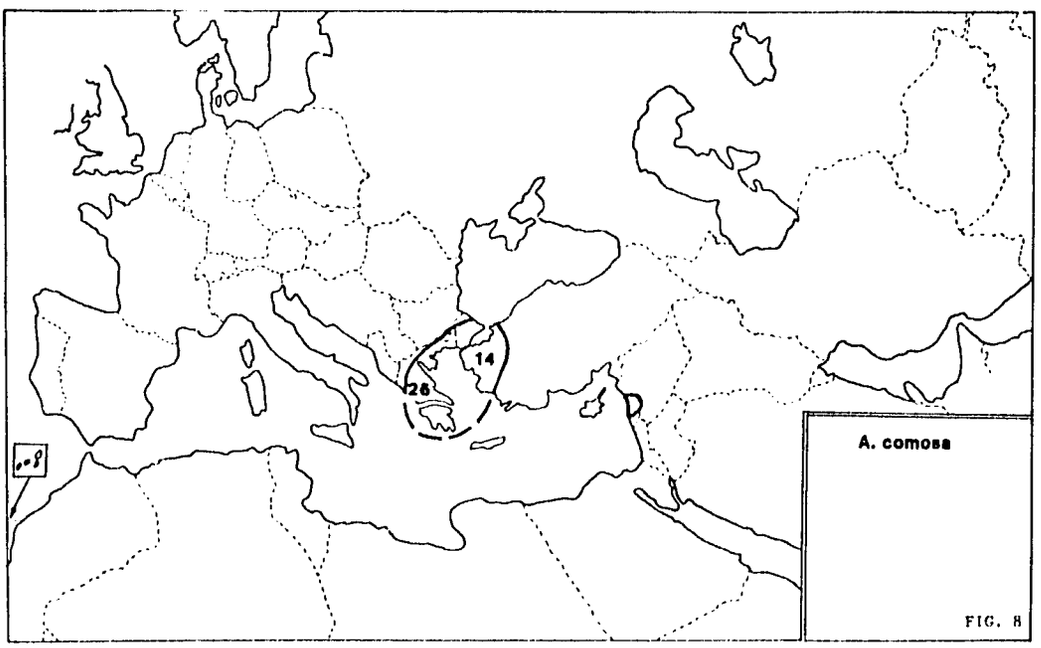

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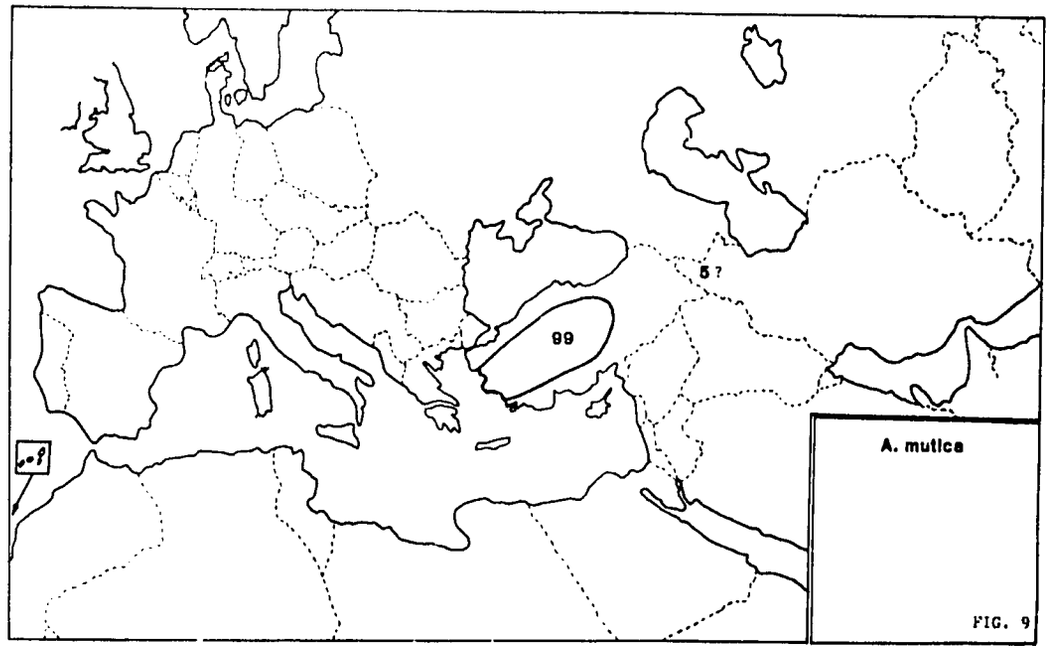

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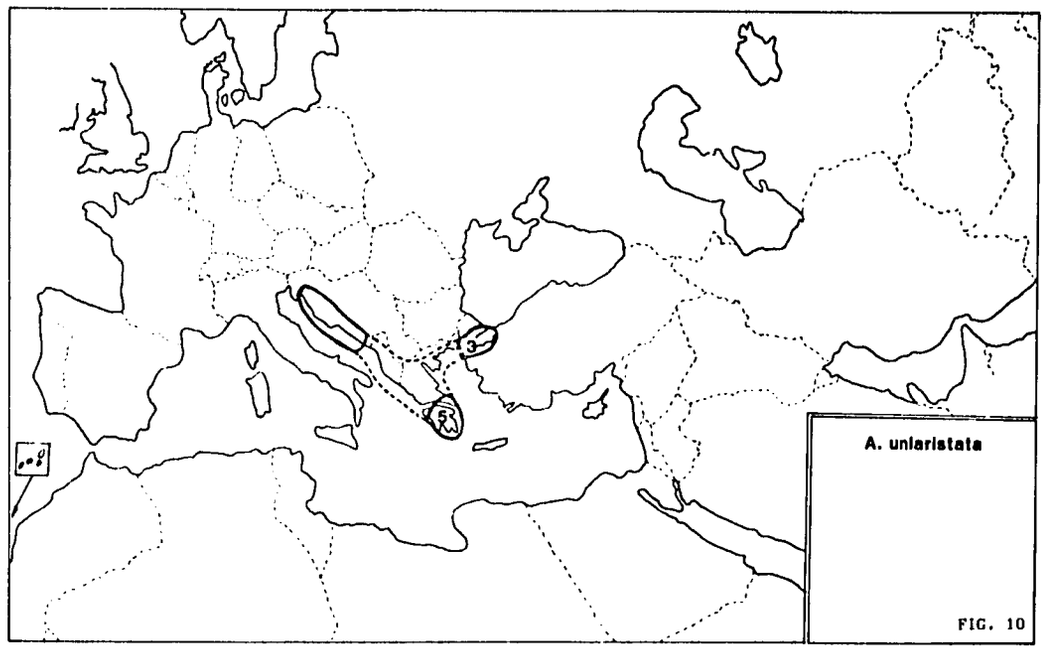

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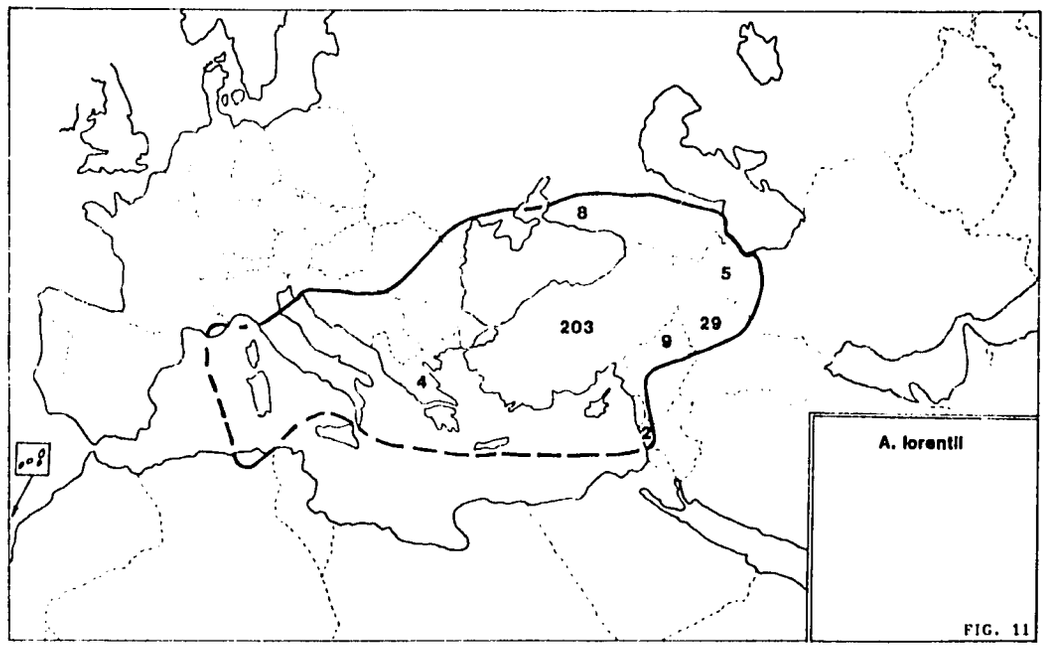

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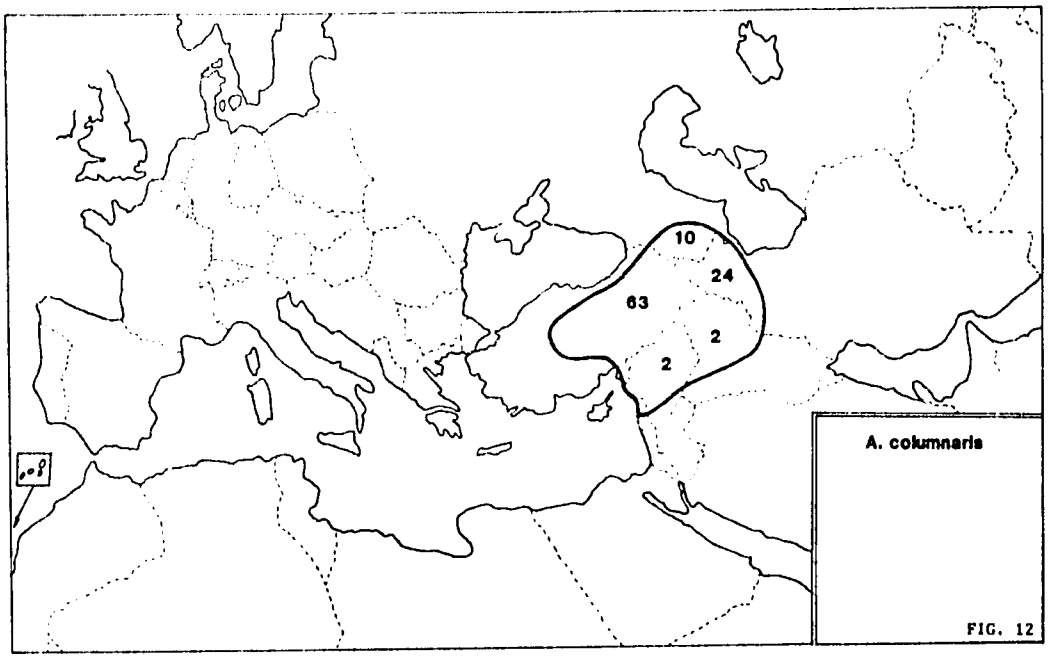


FIG. 12

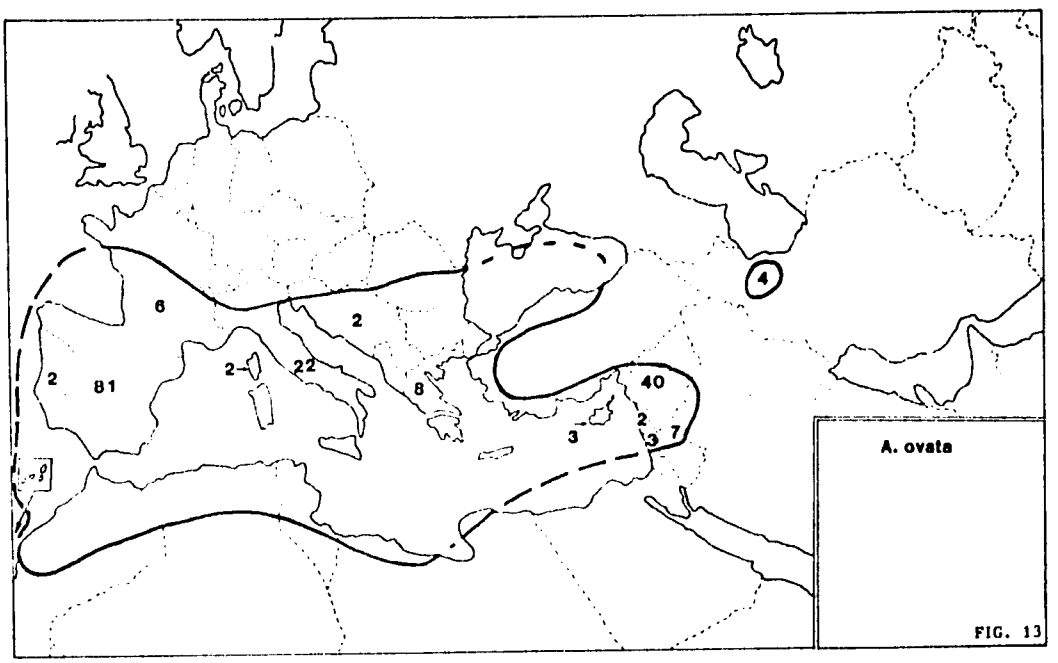


FIG. 13

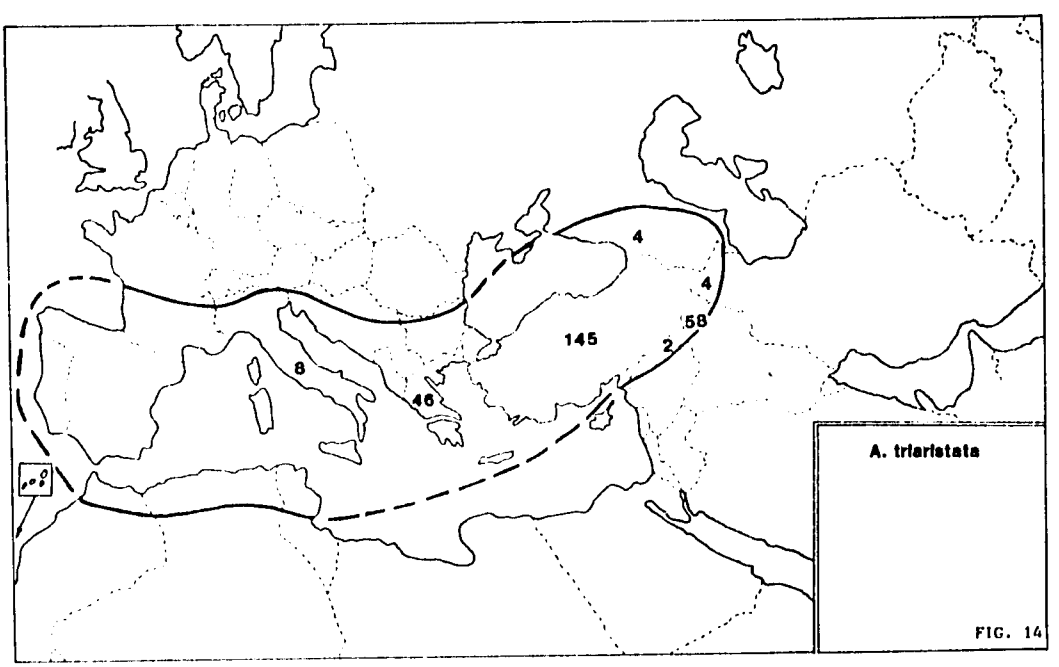


FIG. 14

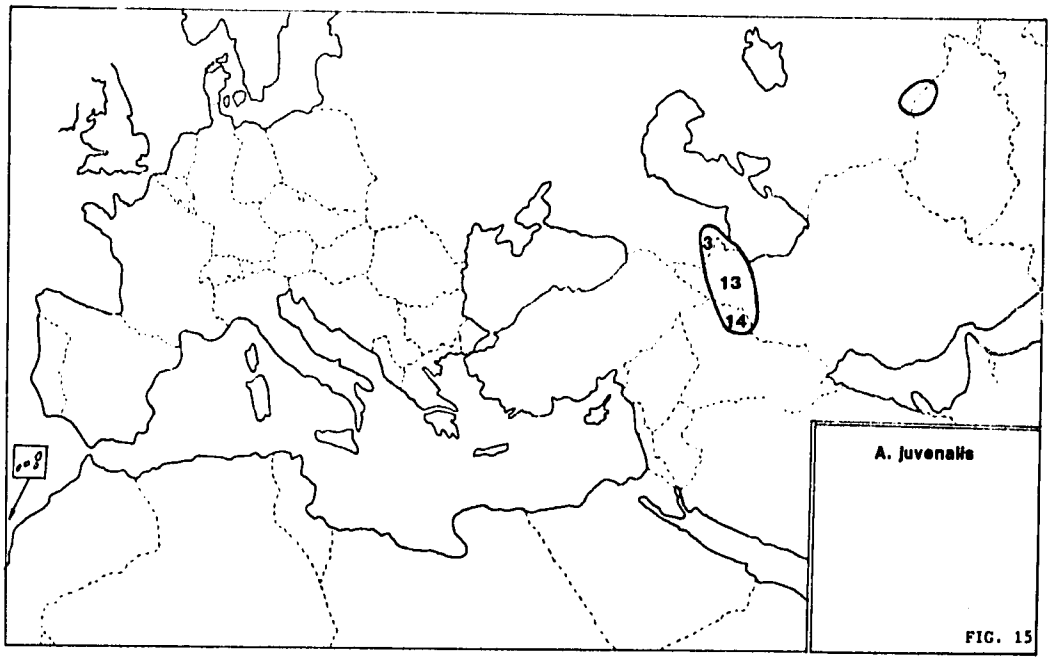
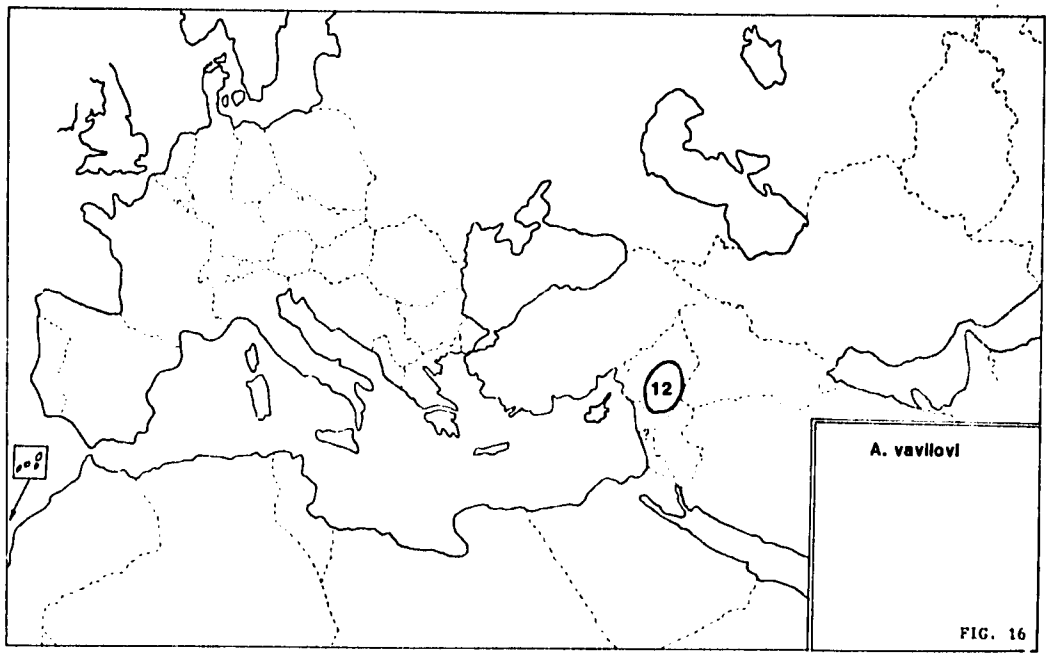


FIG. 15



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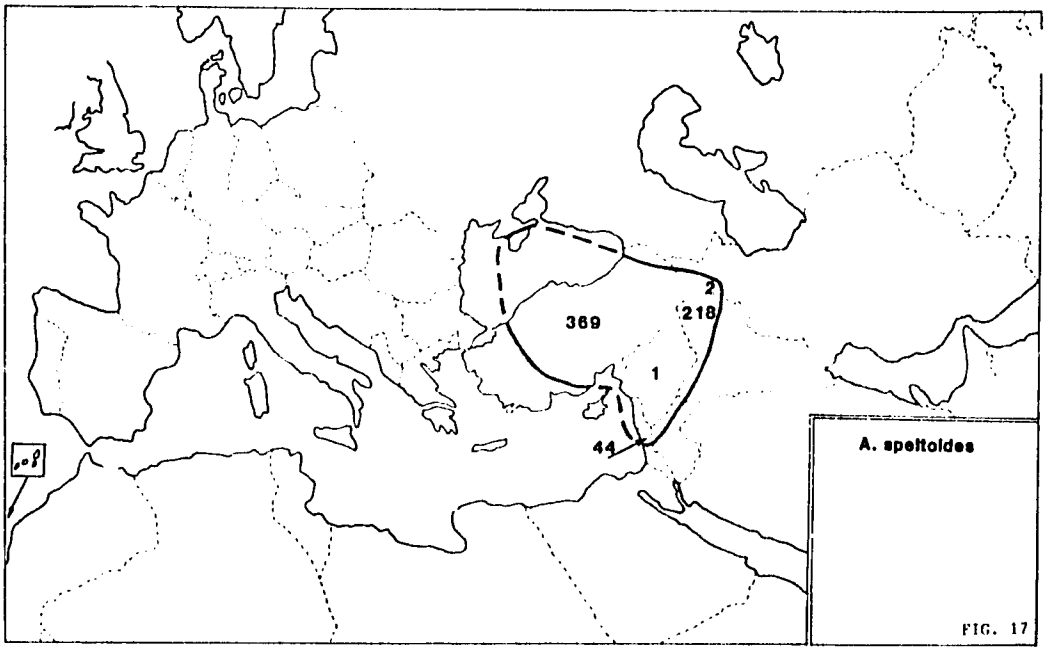

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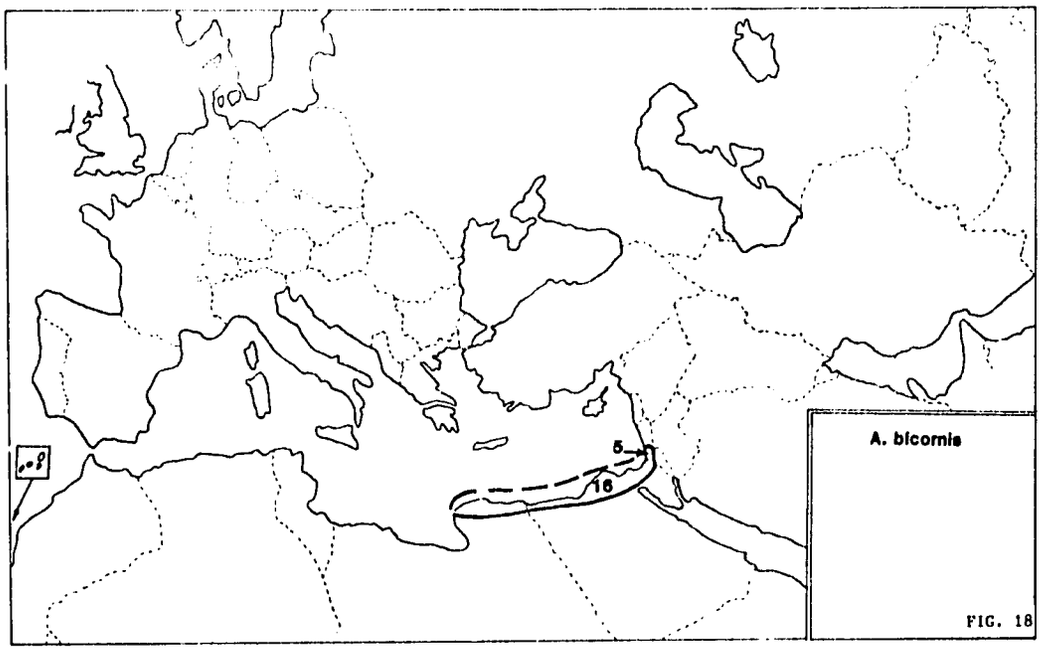

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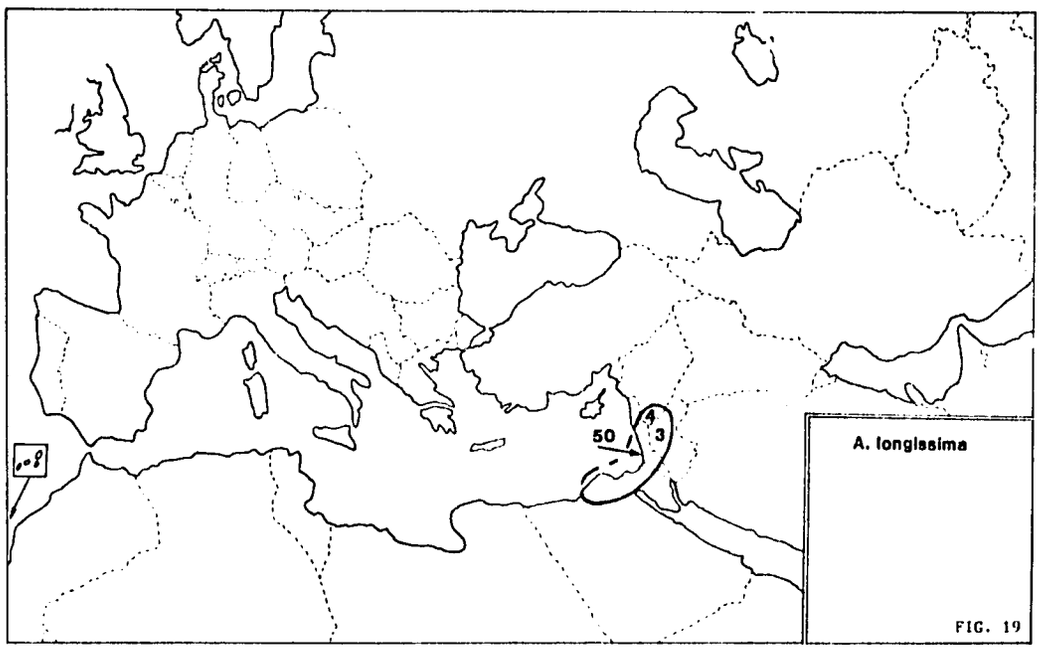

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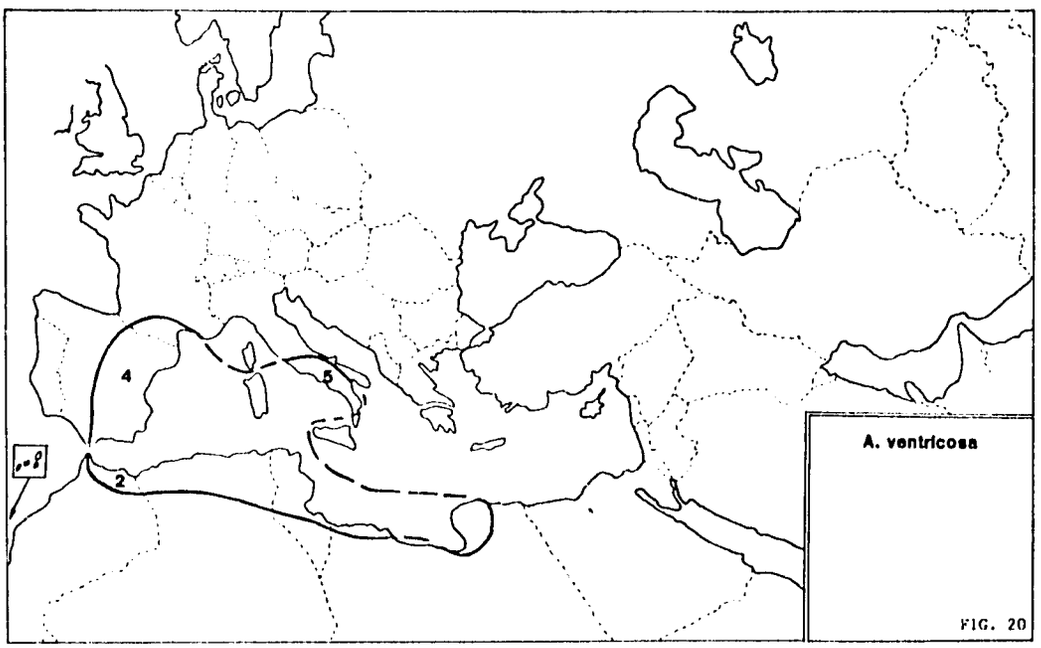
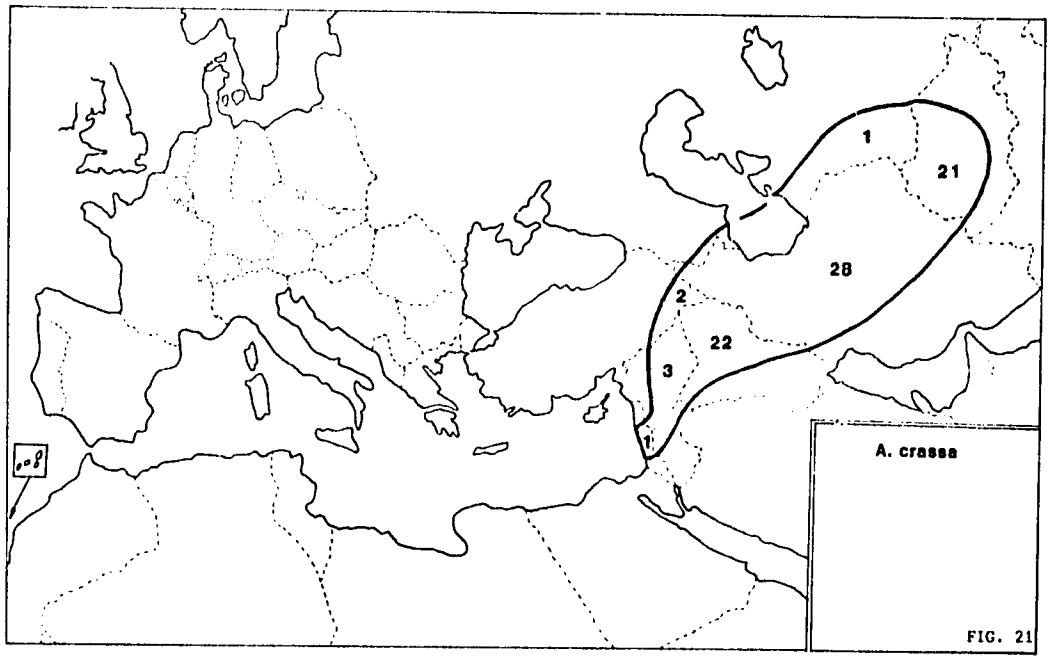


FIG. 20



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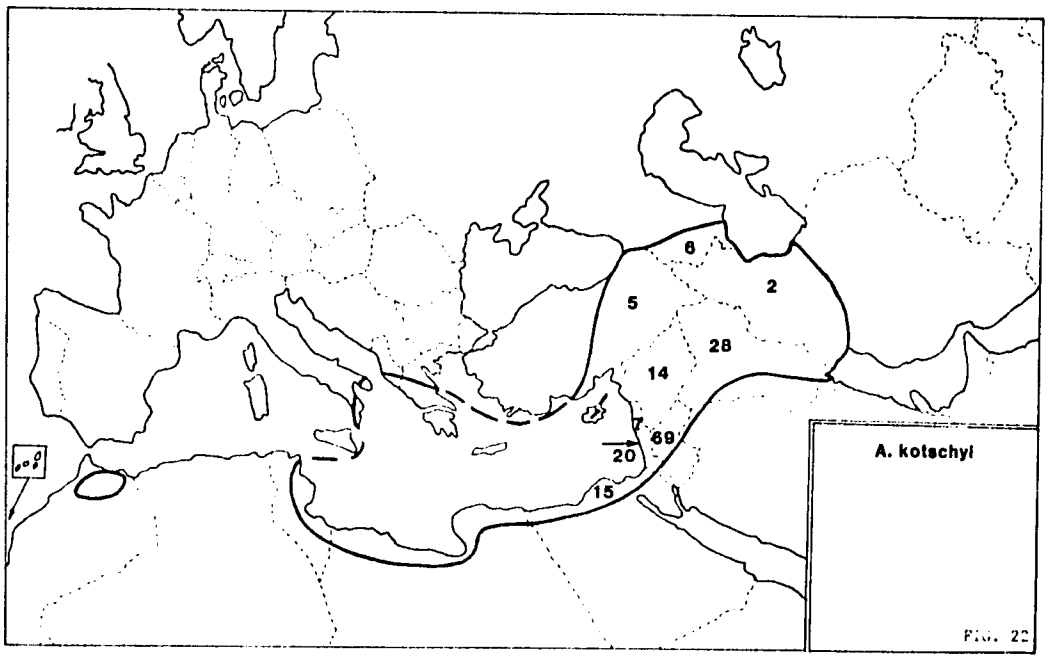

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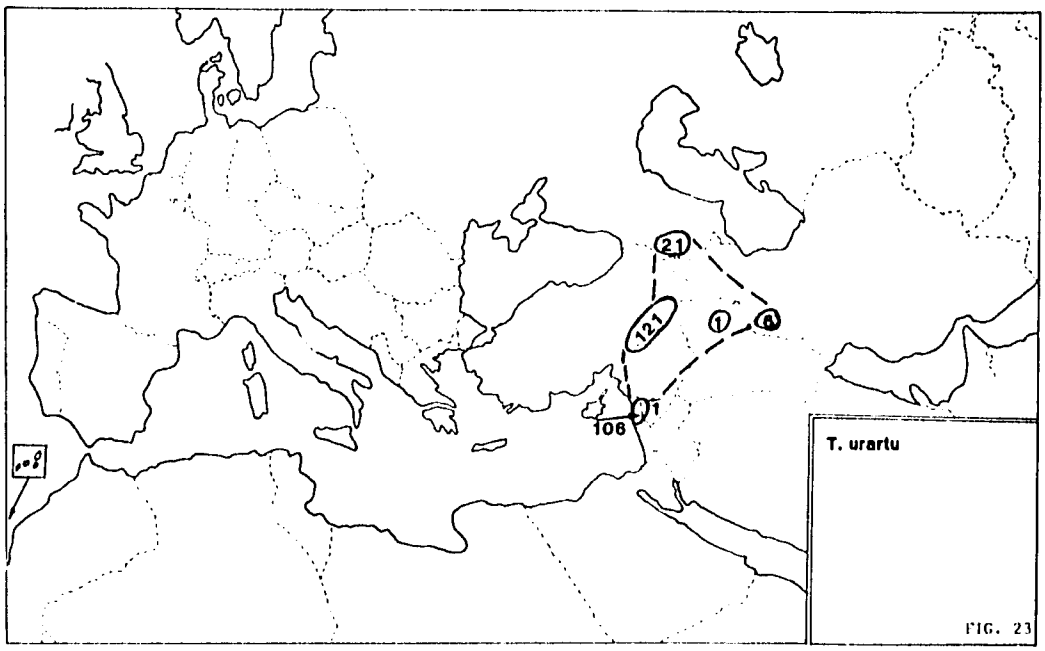

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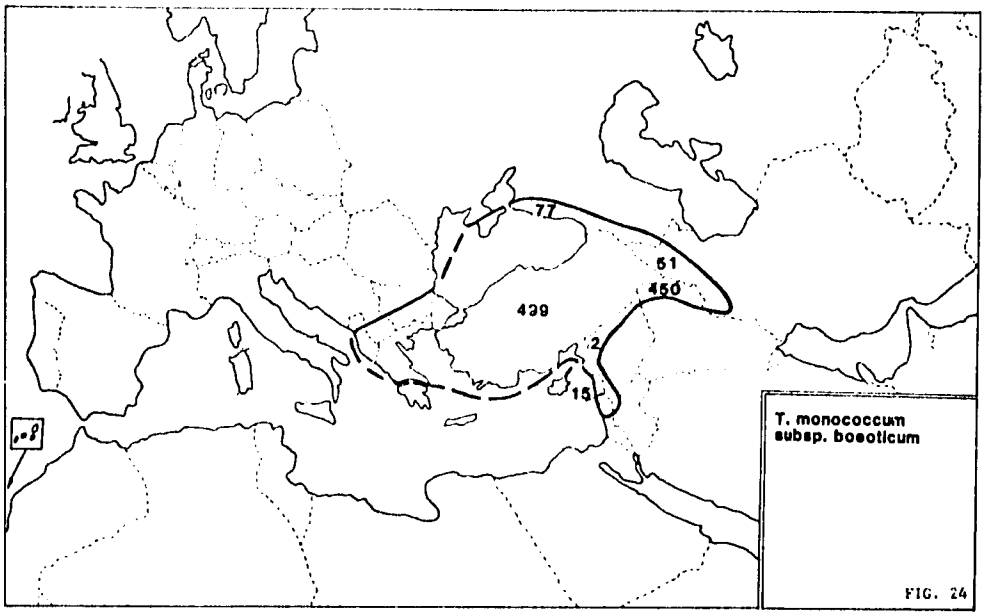

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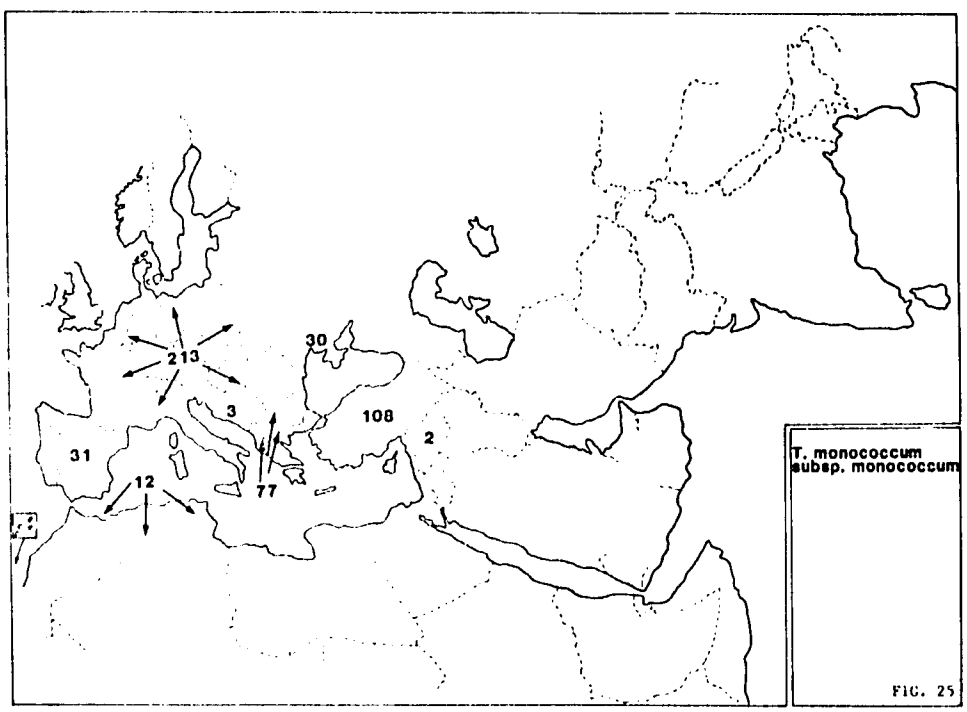

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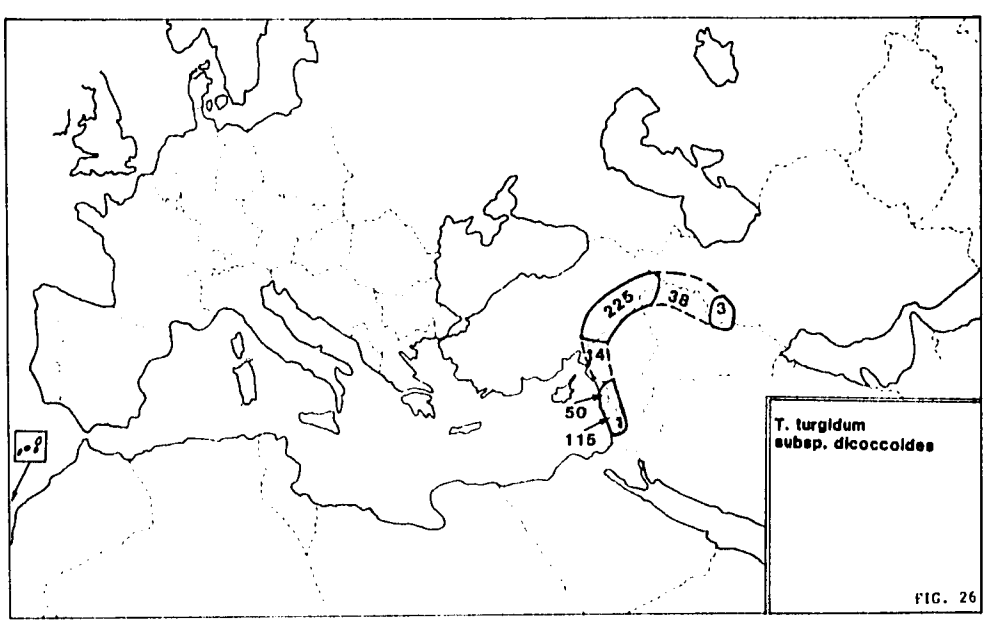
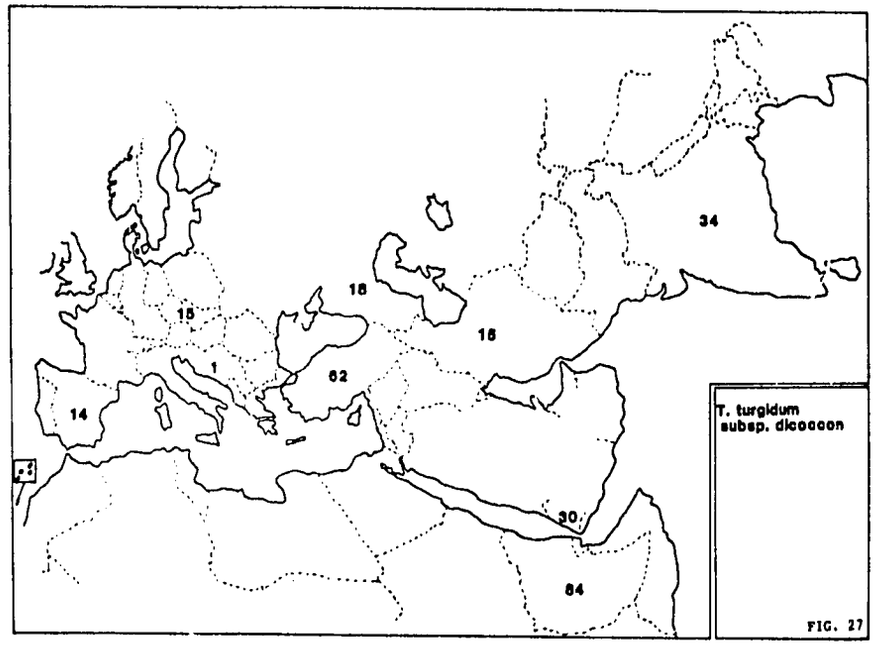


FIG. 26



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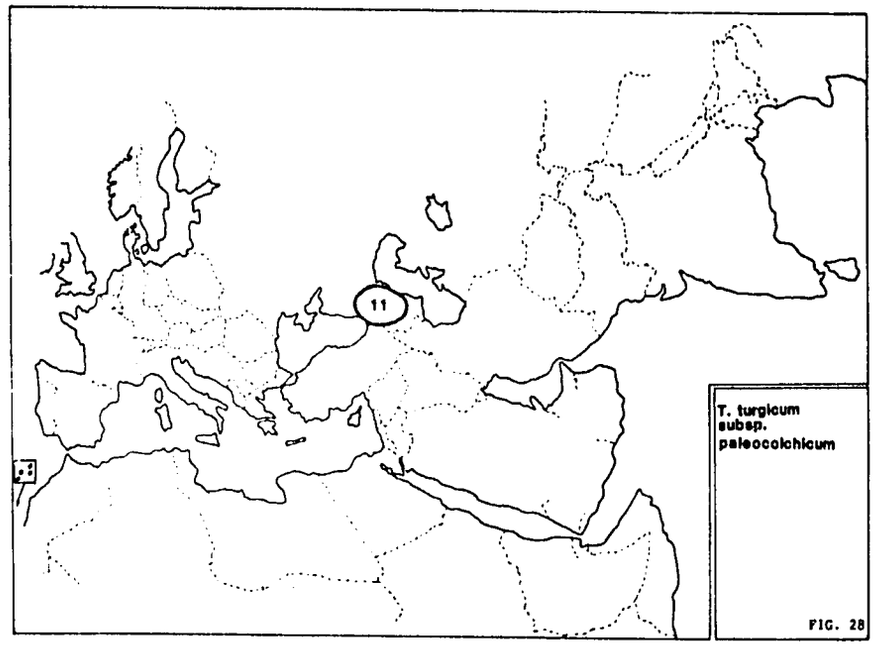

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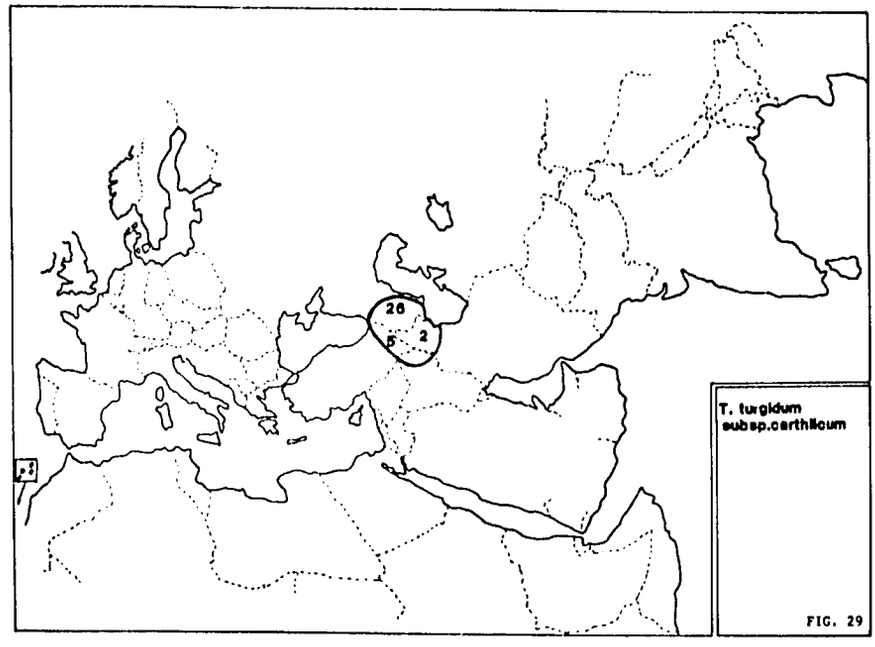

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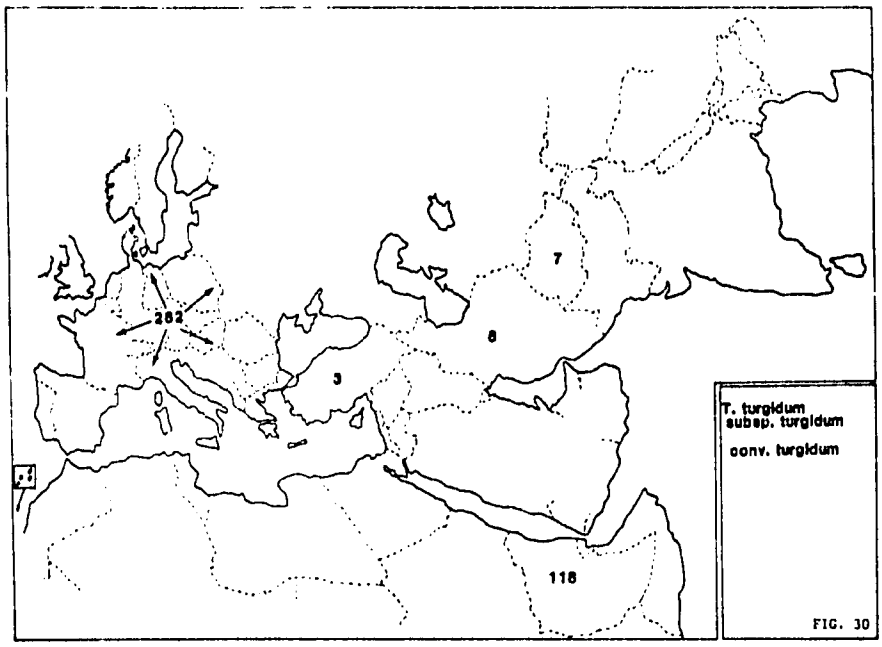

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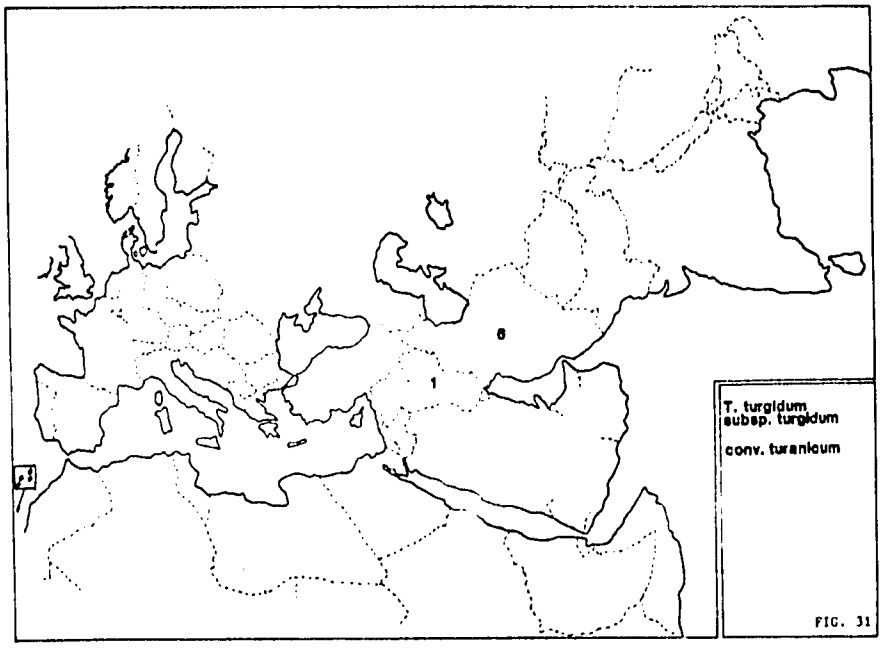

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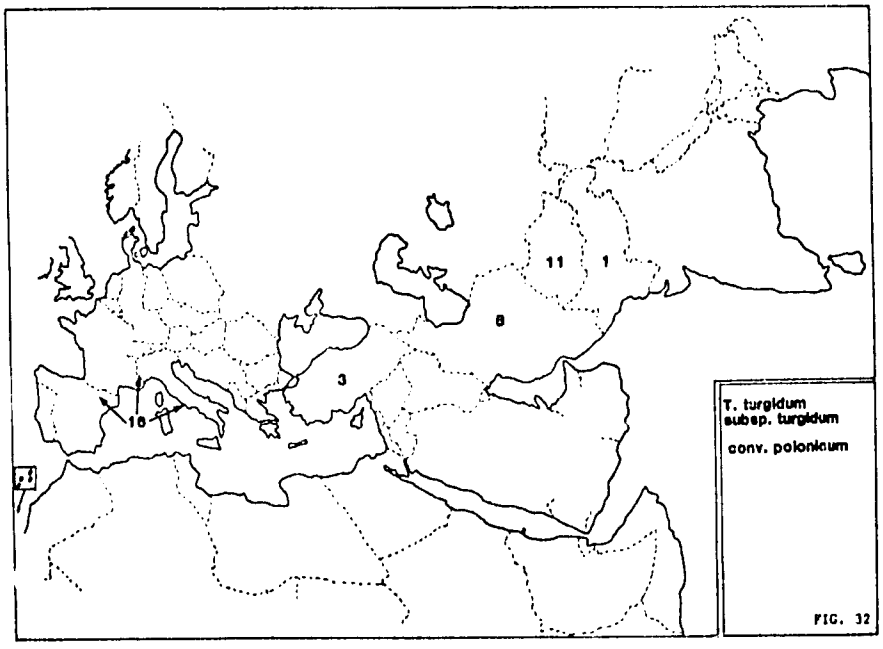

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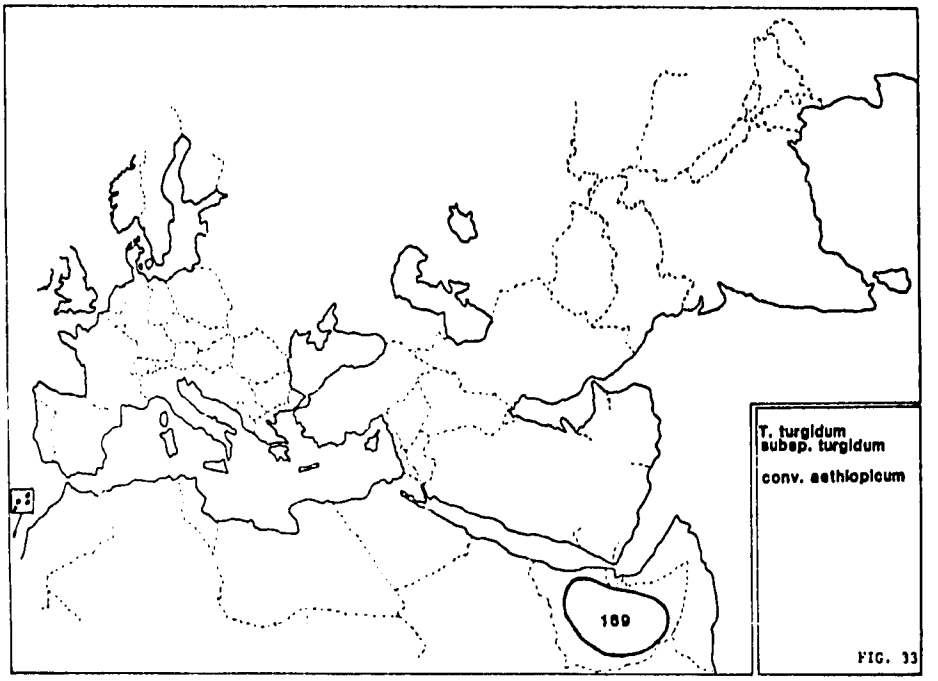

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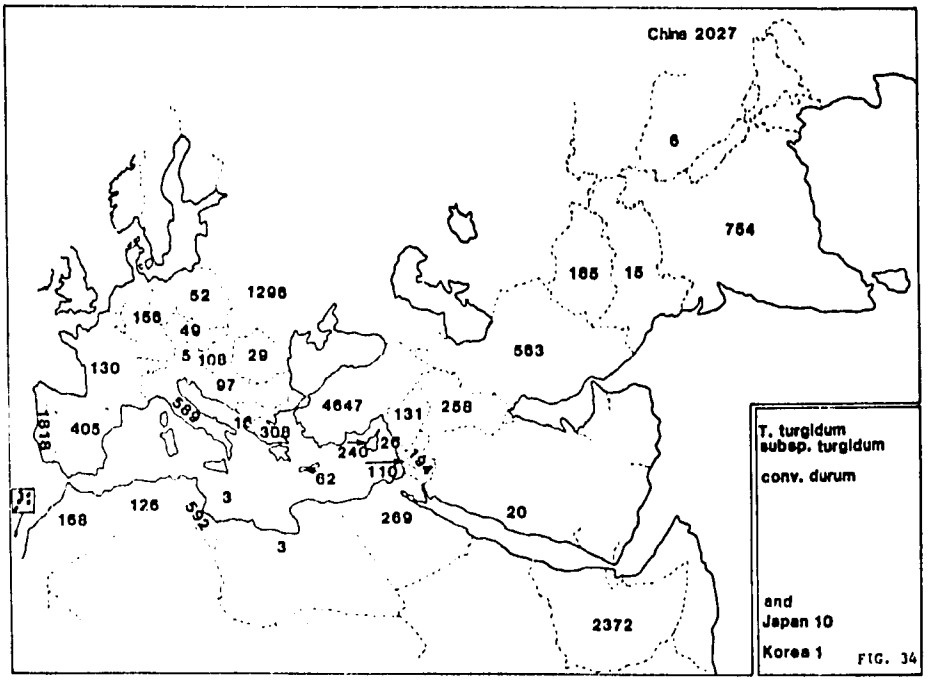

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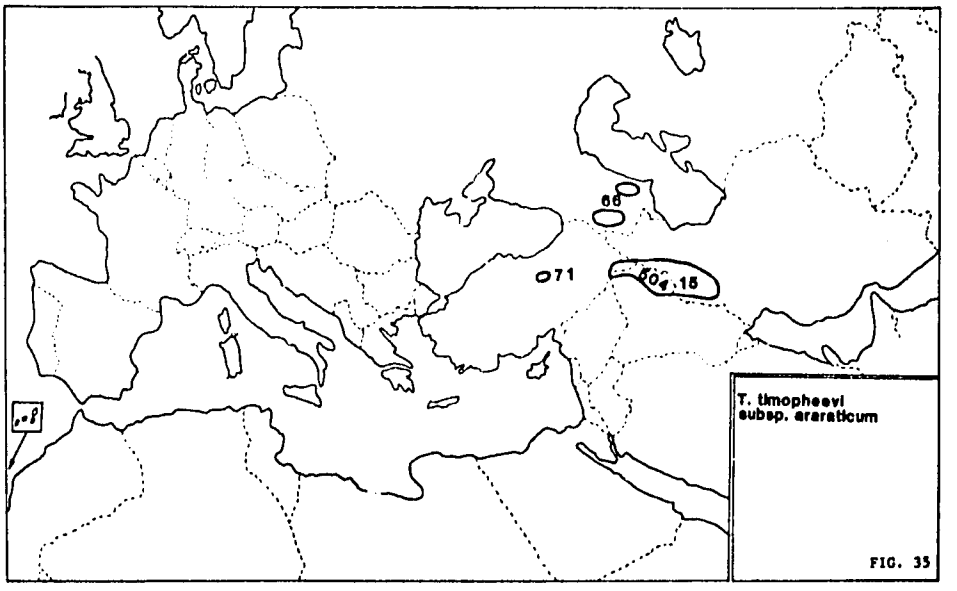

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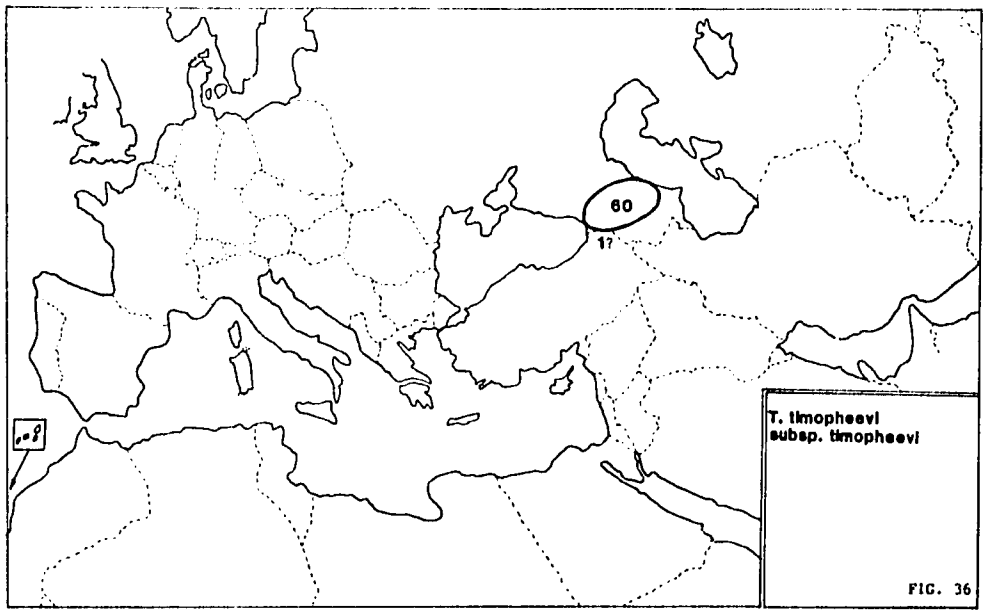

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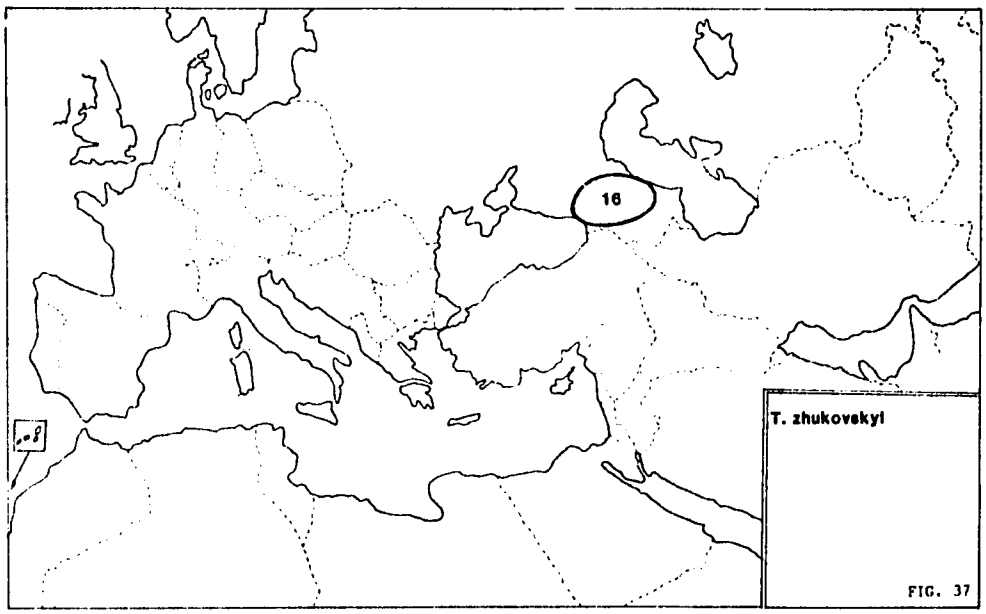

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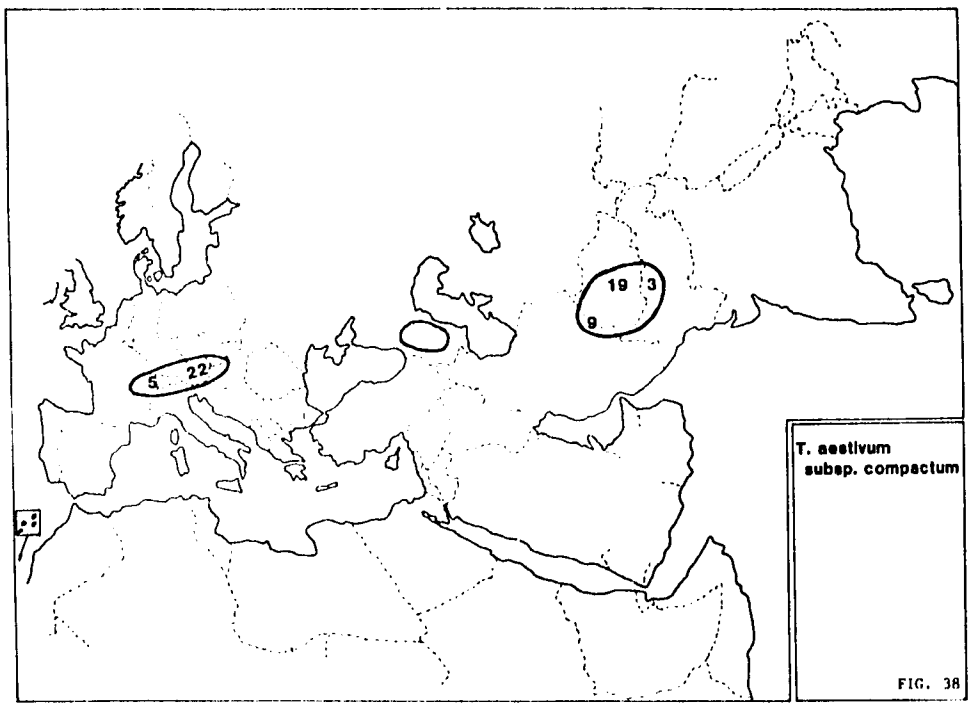


FIG. 38

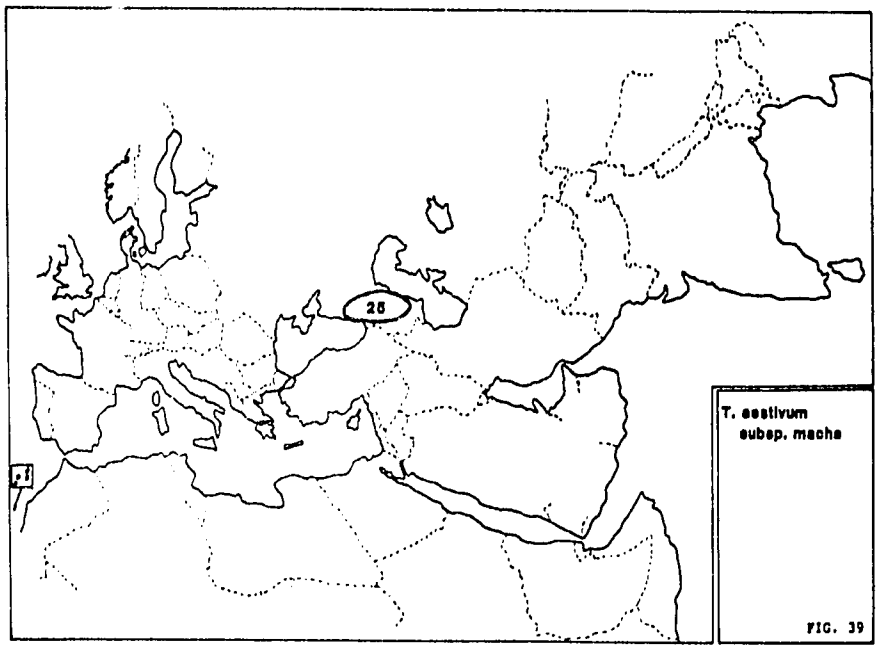


FIG. 39

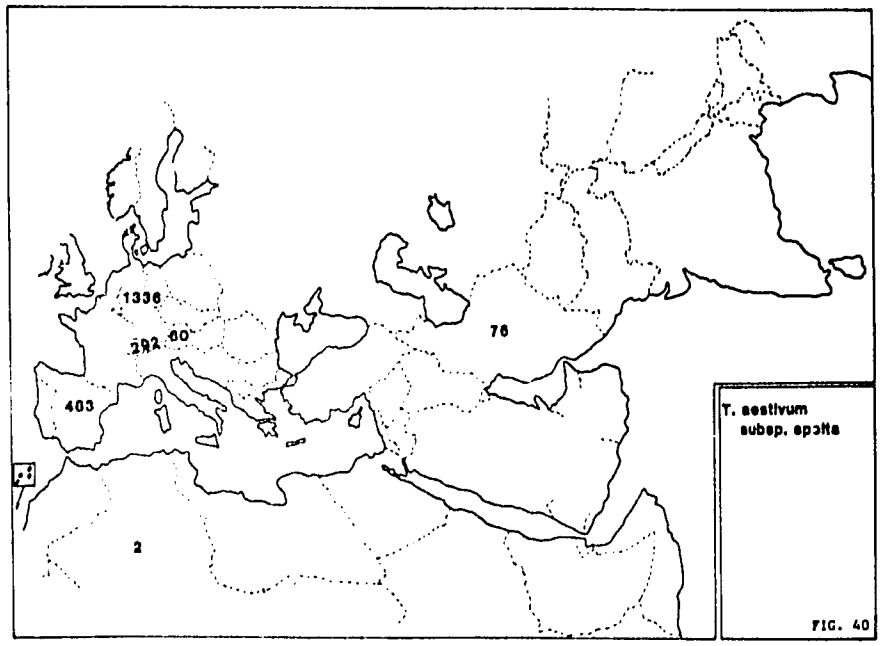


FIG. 40

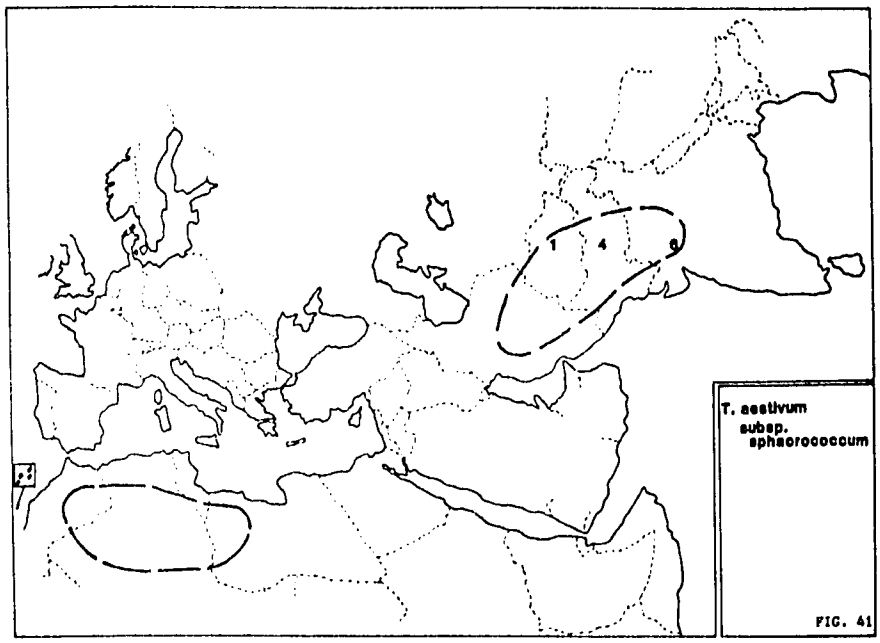


FIG. 41

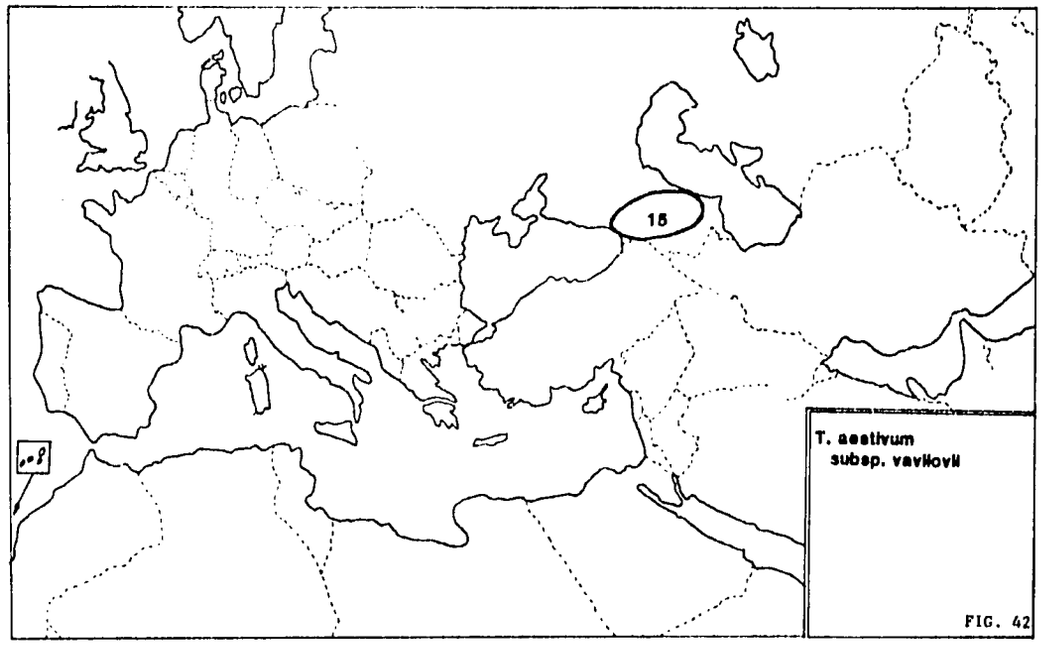
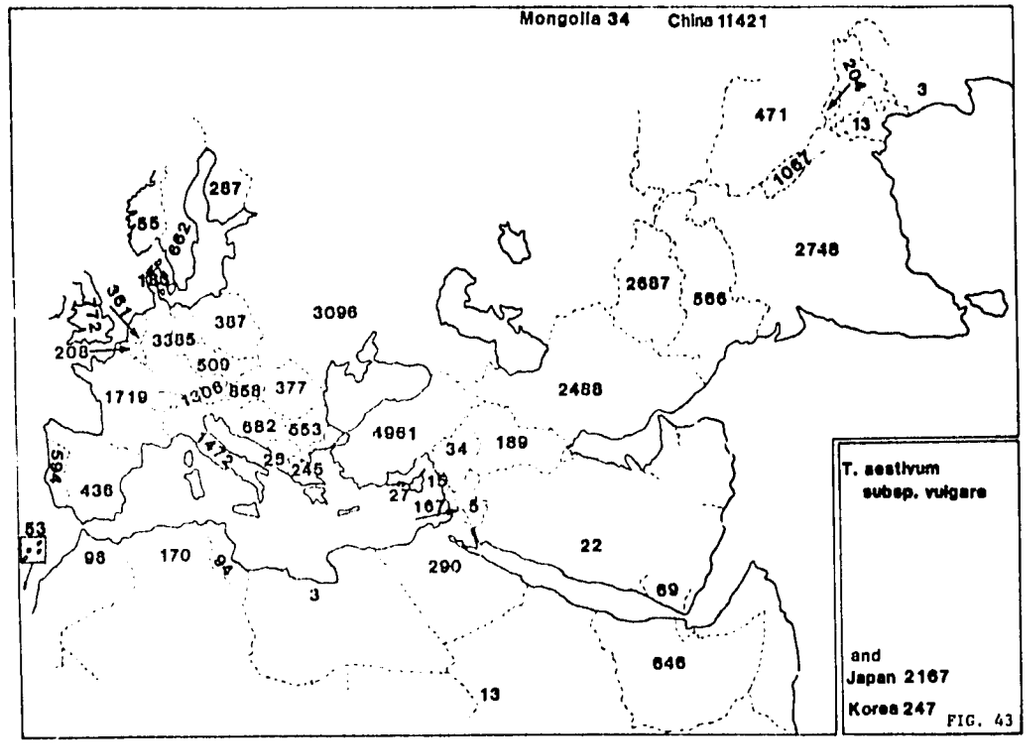

15
T. aestivum
subsp. vavilovii

FIG. 42


Mongolia 34
China 11421
204
3
471
13
1067
2748
2687
566
287
55
662
361
772
208
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387
3096
500
1719
1306
858
377
682
553
4961
34
189
2488
594
436
1472
29
245
27
15
167
5
53
98
170
94
3
290
22
69
646
13
T. aestivum
subsp. vulgare
and
Japan 2167
Korea 247

FIG. 43