

BROOMRAPE
(*Orobanche cumana* WALLR.)
PARASITE SITUATION IN
SUNFLOWER CROP IN THE
REPUBLIC OF MOLDOVA

Maria DUCA
academician, professor



MORPHO-PHYSIOLOGIC AND GENETIC ASPECTS OF HOST-PARASITE INTERACTION (Helianthus annuus L. - Orobanche cumana Wallr.)

Chisinau, REPUBLIC OF MOLDOVA, 2011

CURRENT SITUATION OF SUNFLOWER BROOMRAPE IN THE REPUBLIC OF MOLDOVA

Cordoba, SPANIA, 2014

BROOMRAPE (Orobanche cumana WALLR.) PARASITE SITUATION IN SUNFLOWER CROP IN THE REPUBLIC OF MOLDOVA

Bucarest, ROMANIA, 2018

1845

- First documentation about sunflower in RM

1867

- First evidence of oil production from sunflower seeds

3th

- Place after wheat and corn

65%

- Total agricultural land

17th

- Place regarding world sunflower oil export

19th

- Place regarding world seeds production

76 PRODUCERS, 19 EXPORTERS, ONE BIG AND MORE THAN 590 SMALLER PROCESSORS OF SUNFLOWER



1863

1st

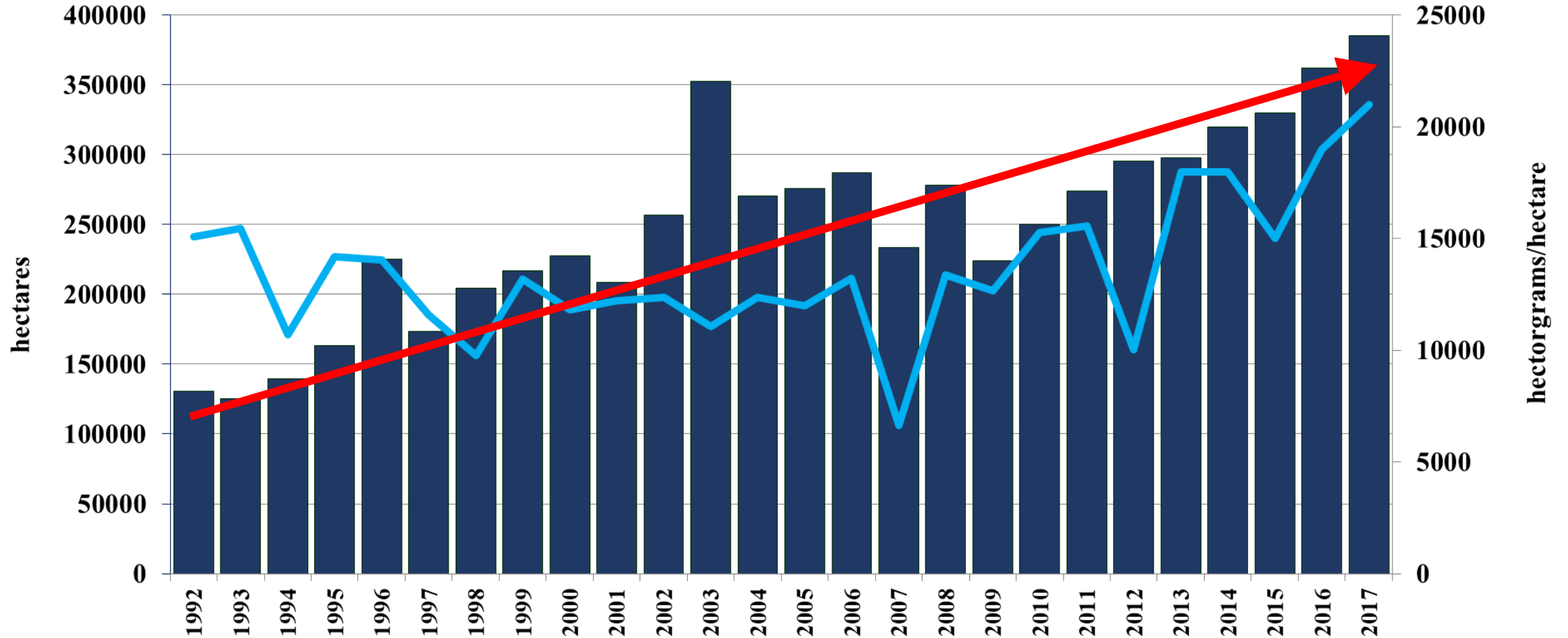
**identification
of broomrape**

National Archives

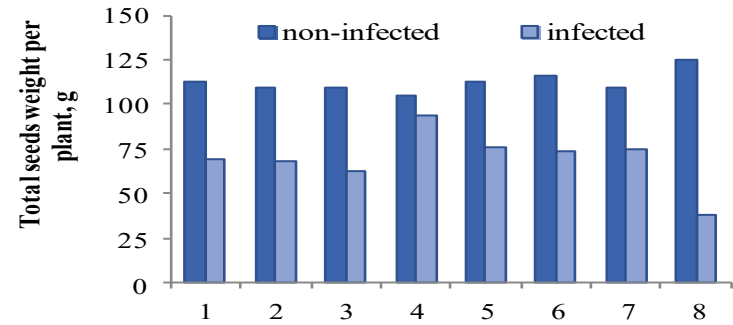
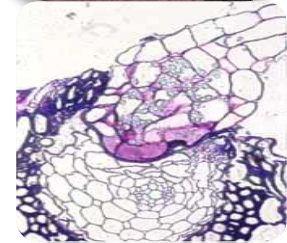
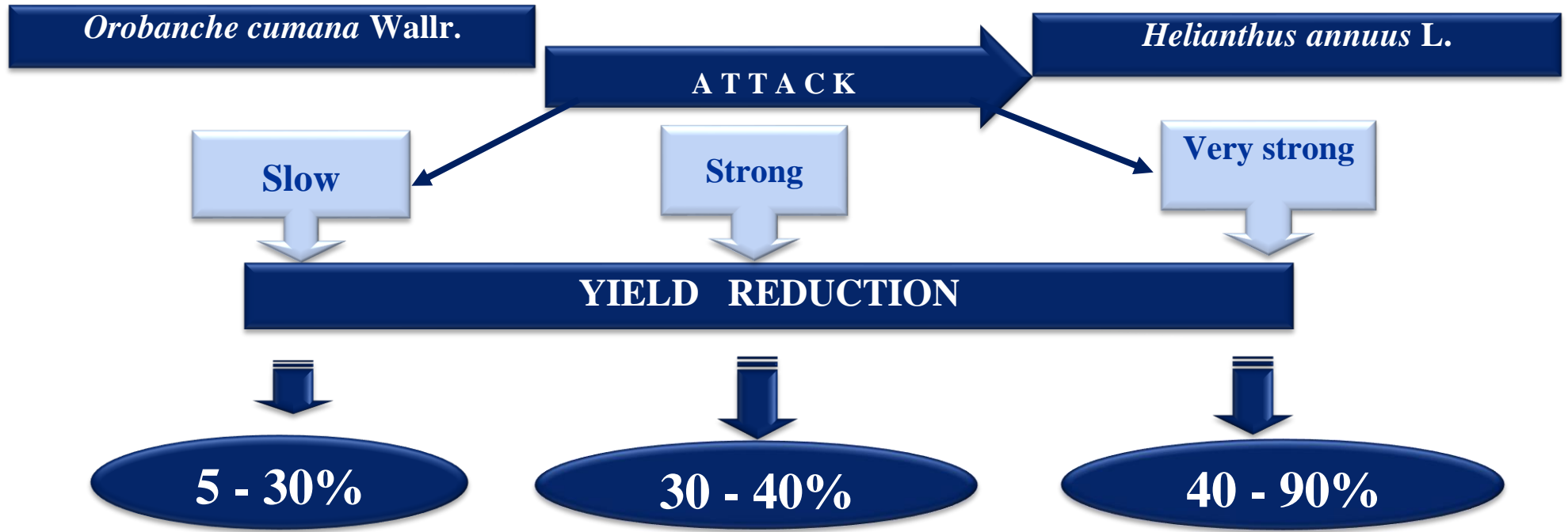


CULTIVATION AREA AND PRODUCTION OF SUNFLOWER IN THE REPUBLIC OF MOLDOVA (1992-2017)

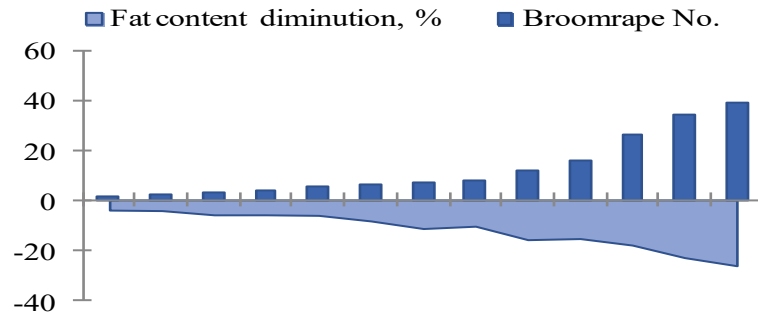
■ Area harvested (Ha) — Yield (Hg/Ha)



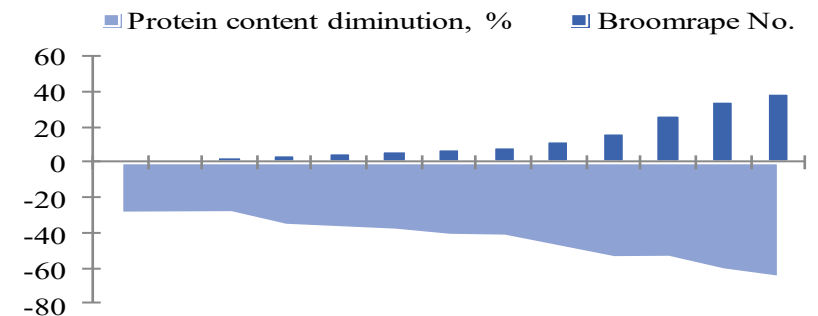
ECONOMIC IMPACT OF *Orobanche cumana*



O. cumana attack influence on total seeds weight per head



Correlation between kernel fat content diminution (%) and broomrape number per sunflower plant



O. cumana attack influence on total seeds weight per head

ANALYSIS OF BROOMRAPE FROM DIFFERENT REGIONS

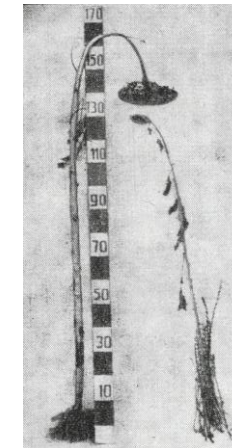
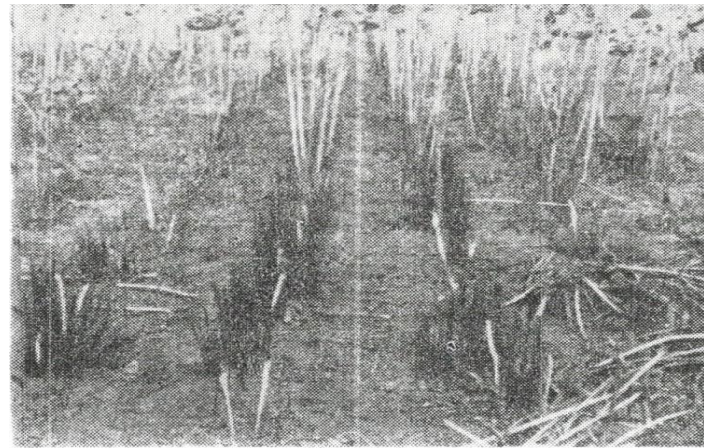
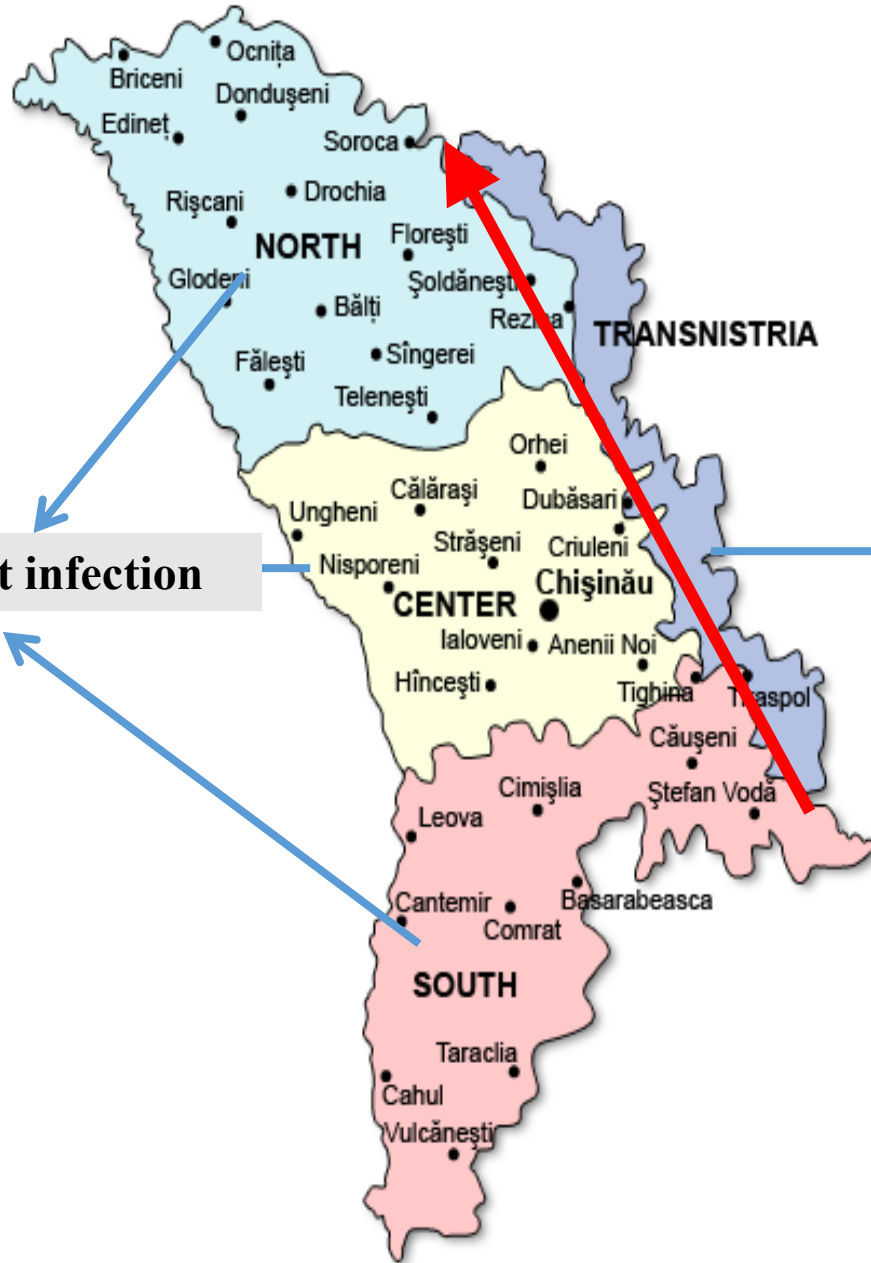
1937

AFANASEV and ARHANGHELSCI,
Agricultural Chamber of Balti

Race A and B

Frequent infection

Sporadic infection



ANALYSIS OF BROOMRAPE FROM DIFFERENT REGIONS

1961-1968

SHAROVA P. G., Selektzia podsolnecinika v sveazi s izuceniem rasovogo sostava zarazih v usloviah Moldavii, avroreferat, Chisinau, 1968.

Race A and B

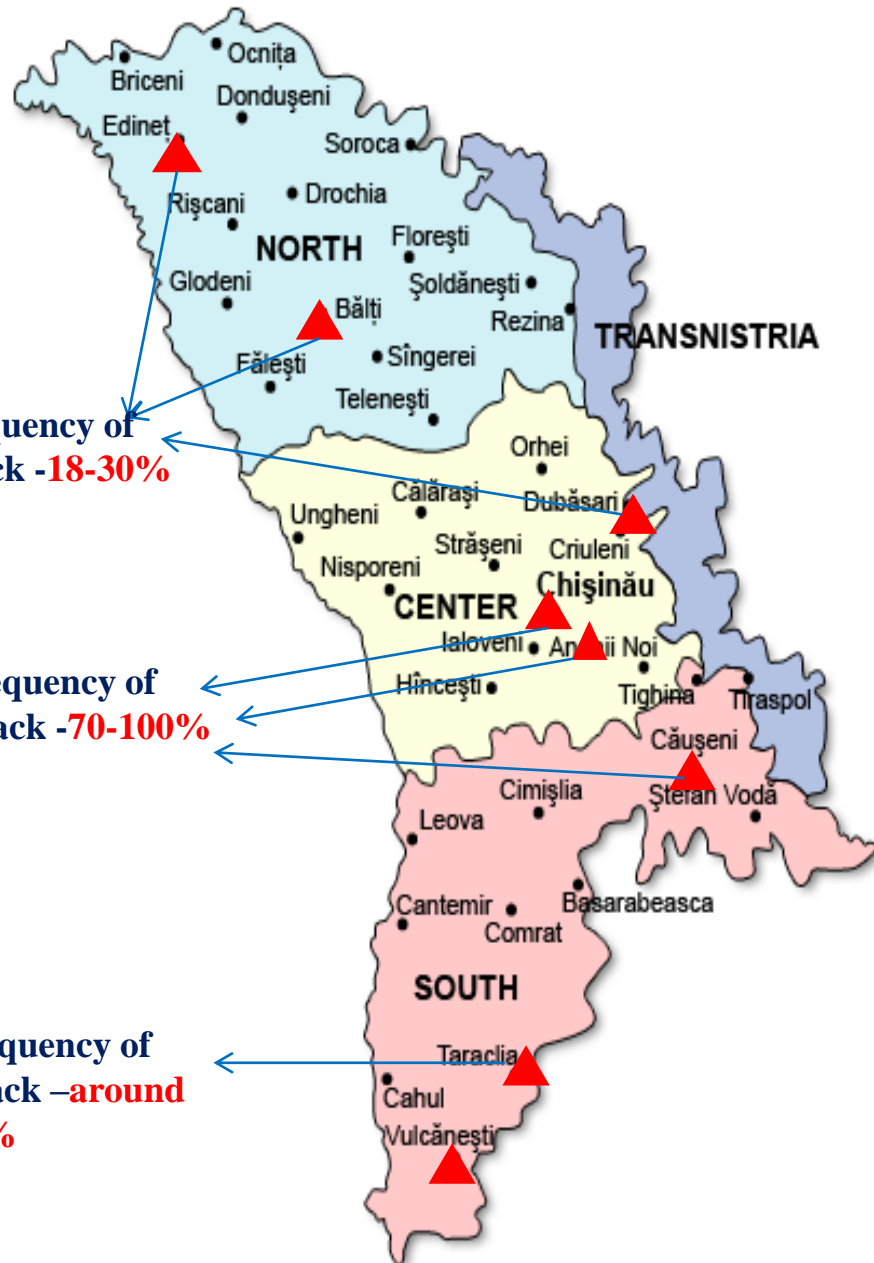
Investigated regions

Edinet, Balti, Dubasari, Chisinau, Anenii-Noi, Causeni, Taraclia, Vulcanesti.

44 different pathotypes, highly virulent, affecting all sunflower industrial varieties resistant to broomrape in other region of USSR

Sunflower variety	Broomrape pathotypes					
	Number			%		
	1962-1966	1968-1970	1962-1971	1962-1966	1968-1970	1962-1971
A-41	16	19	19	91,4	86,3	90,5
VNIIMK 1646	9	13	9	52,9	59,1	42,8
Peredovik	9	10	7	47,0	45,4	33,3
Jdanovskiy 8281	9	13	10	52,9	59,1	47,6
Cherneavka 66	8	11	8	52,9	50,1	38,1
Voronejskiy 154	-	14	12	-	63,6	57,1

Moldovan population of broomrape or race C

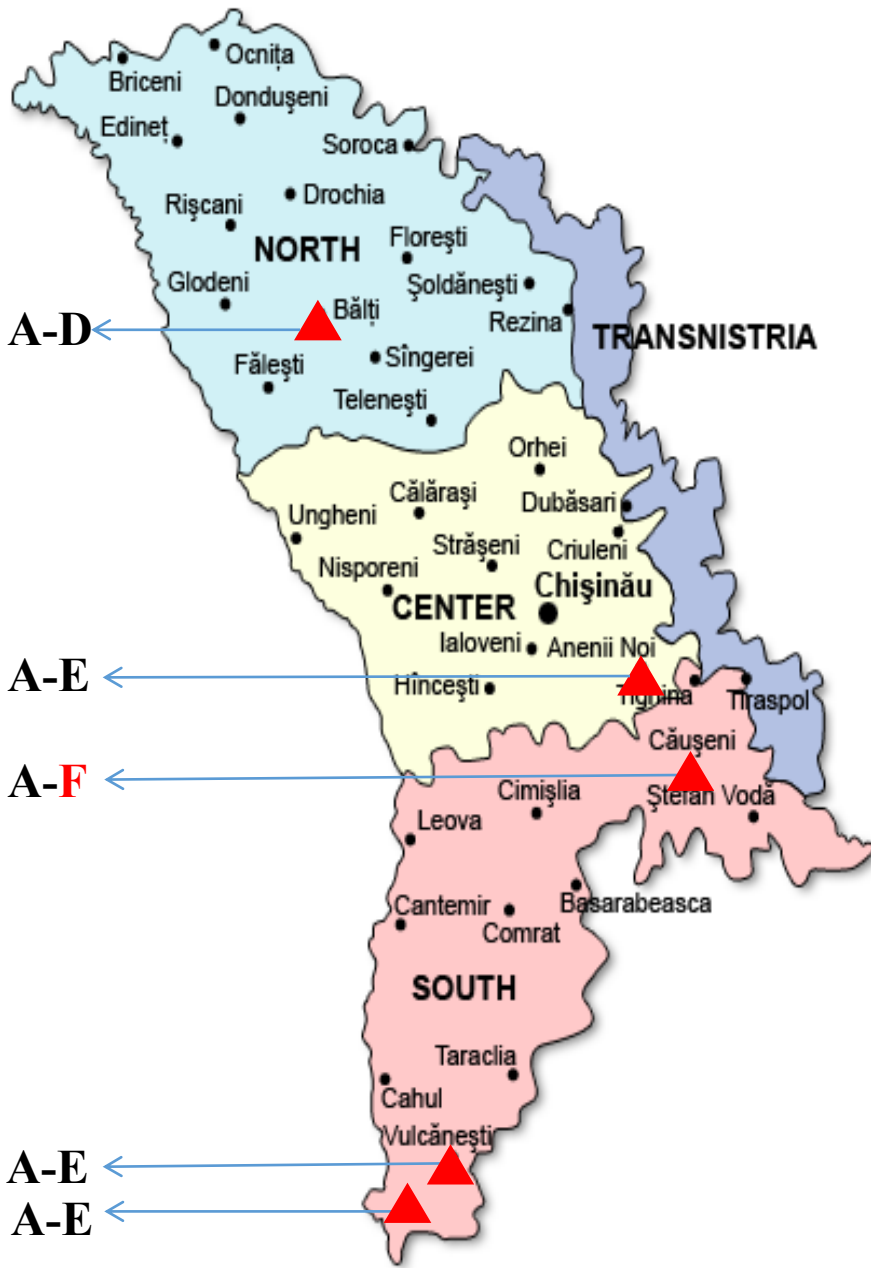


Frequency of attack -18-30%

Frequency of attack -70-100%

Frequency of attack -around 30%

ANALYSIS OF BROOMRAPE FROM DIFFERENT REGIONS



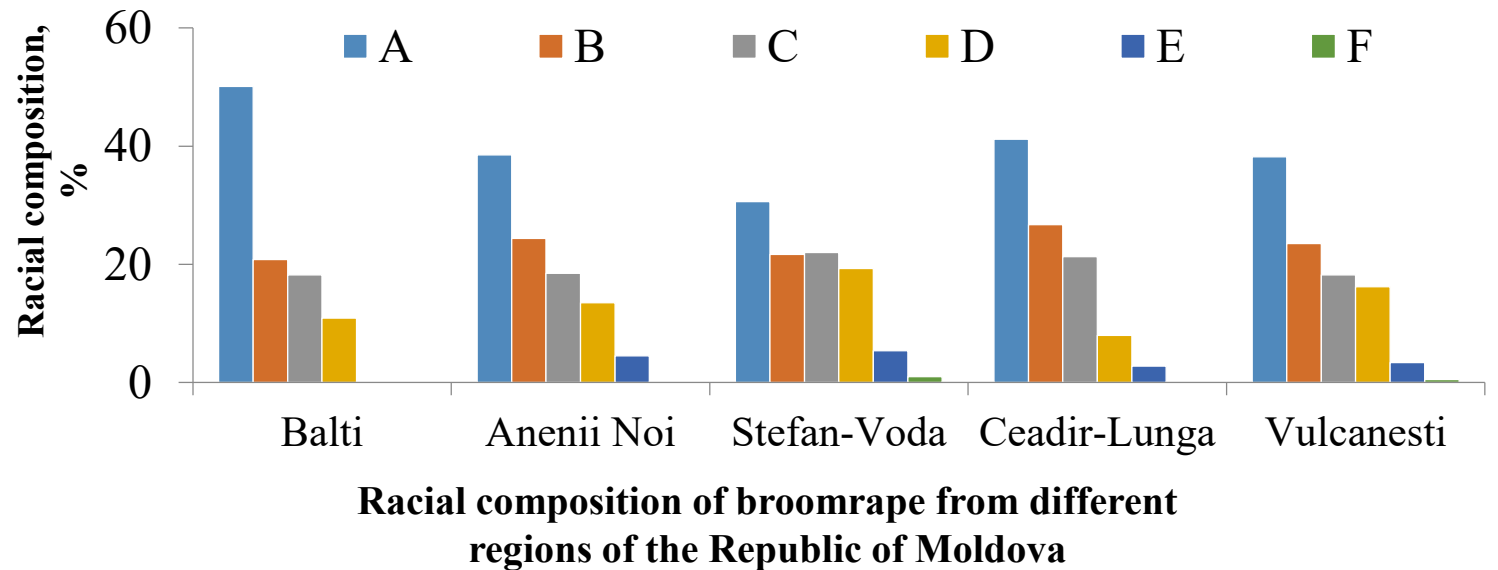
2002-2006

PETCOVICI I., BUCIUCIANU M. and LUNGU E. 2009. Izucenie rasovogo sostava zarazihi v Respublike Moldova i rezultati selectii podsolnecinika na ustoicivosti k nei. p. 225-230. In: Proc. Int. Conf. Integrated protection of field crops. Balti. (in Russian).

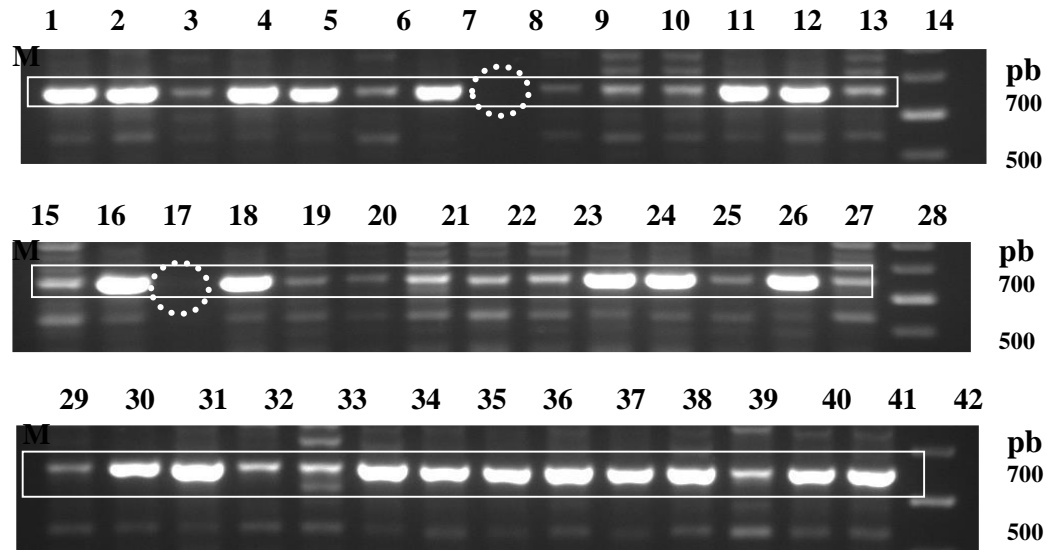
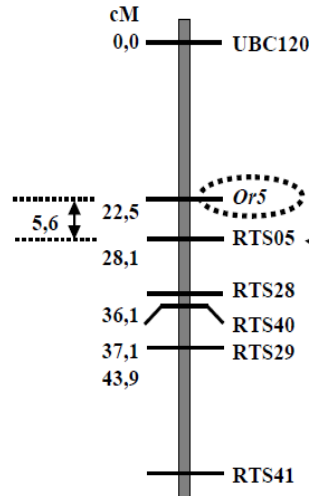
Race A, B, C, D, E, F

Investigated regions

Balti, Anenii-Noi, Stefan-Voda, Vulcanesti, Ceadir-Lunga.



ANALYSIS OF BROOMRAPE FROM DIFFERENT REGIONS

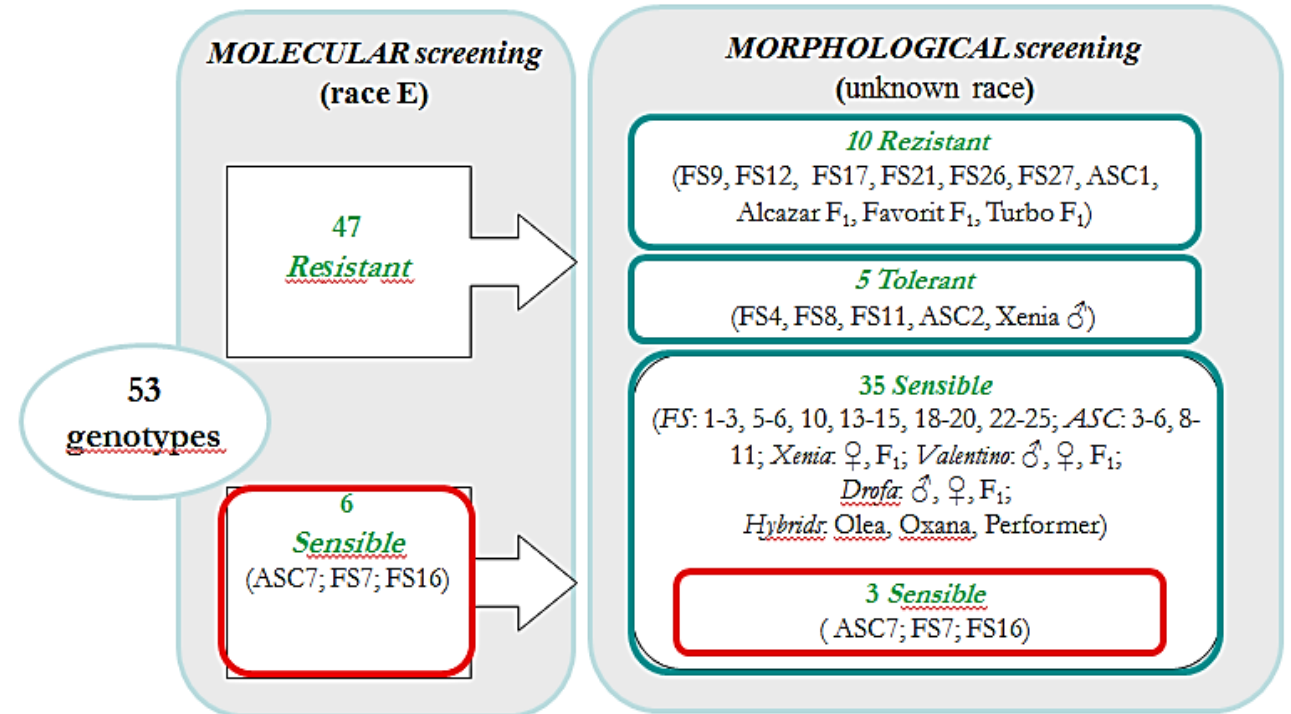


Electrophoresis of the amplification product (650 bp) with the SCAR - RTS05 specific primer

2010

ROTARENCO V. - Morpho-physiologic and genetic aspects of host-parasite interaction (Helianthus annuus L. - Orobanche cumana Wallr.)”, PhD thesis in Biology, Chişinău, 2010.

Race F



ANALYSIS OF BROOMRAPE FROM DIFFERENT REGIONS



2012

GISCĂ I., CUCEREAVÎ A., PORT A., DUCA M. Expression of defence-related genes in sunflower infected with broomrape, Biotechnology & Biotechnological Equipment, 2016

Race E, F, G

Investigated regions

Soroca, Anenii-Noi, Tulcea (Romania)

Genotype	Attack frequency (F, %)	Attack intensity (I)	Attacking rate (AR, %)	Resistance degree*
Population from Soroca				
MS-2161A	3,88	3,86	0,15	R
MS-2098A	96,97	4,47	4,33	SS
MS-2091A	100,00	15,53	15,53	SS
MS-2077A	94,44	10,53	9,94	SS
MS-2067A	94,29	5,48	5,17	SS
MS-2039A	10,29	7,17	0,74	T
MS-1589A	100,00	12,19	12,19	SS
Population from Anenii Noi				
MS-2161A	0,00	0,00	0,00	R
MS-2098A	78,79	3,22	2,54	SS
MS-2091A	94,44	9,12	8,61	SS
MS-2077A	88,89	3,66	3,25	SS
MS-2067A	52,78	2,37	1,25	SS
MS-2039A	7,06	3,00	0,21	T
MS-1589A	94,44	7,26	6,86	SS
Population from Tulcea				
MS-2161A	4,24	32,71	1,39	R
MS-2098A	88,24	4,50	3,97	SS
MS-2091A	100,00	12,85	12,85	SS
MS-2077A	91,67	11,64	10,67	SS
MS-2067A	91,43	6,16	5,63	SS
MS-2039A	15,29	21,19	3,24	T
MS-1589A	97,22	11,51	11,19	SS



The most aggressive population from Soroca and Tulcea

ANALYSIS OF BROOMRAPE FROM DIFFERENT REGIONS



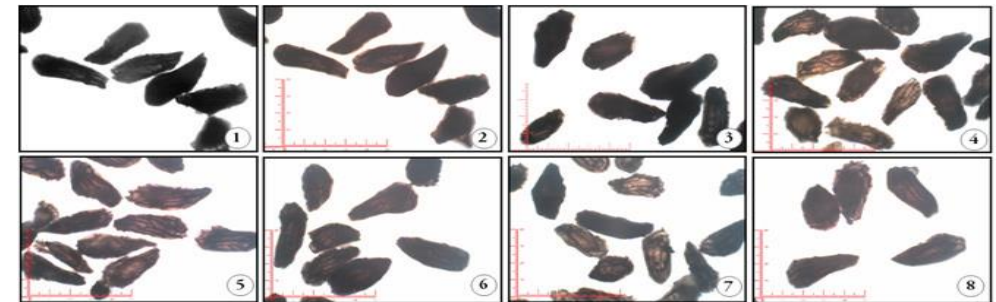
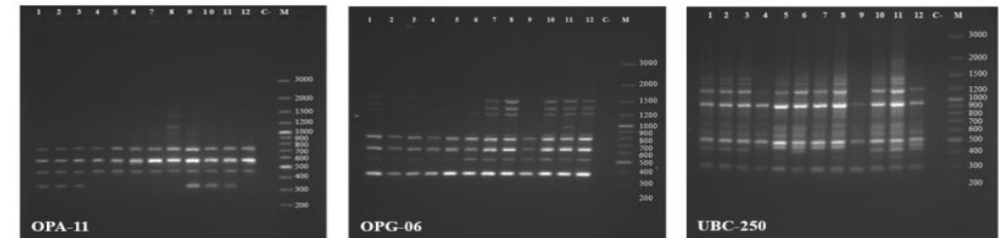
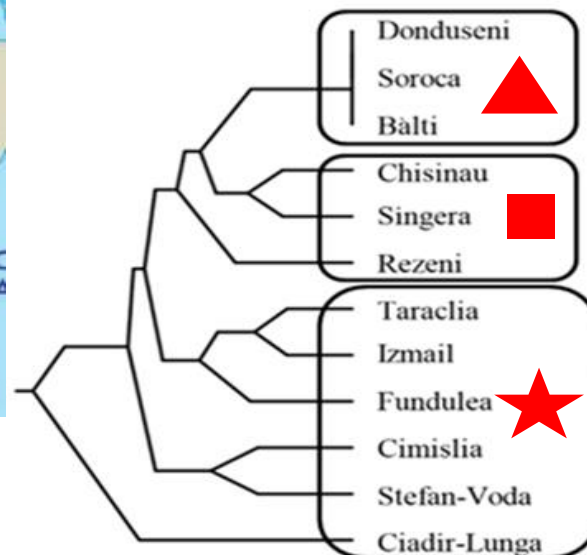
2013

GISCA I., ACCIU A., GLIJIN A., DUCA M., Highly virulent races of sunflower broomrape in the Republic of Moldova, Current Opinion in Biotechnology Vol. 24, Supplement 1, July 2013

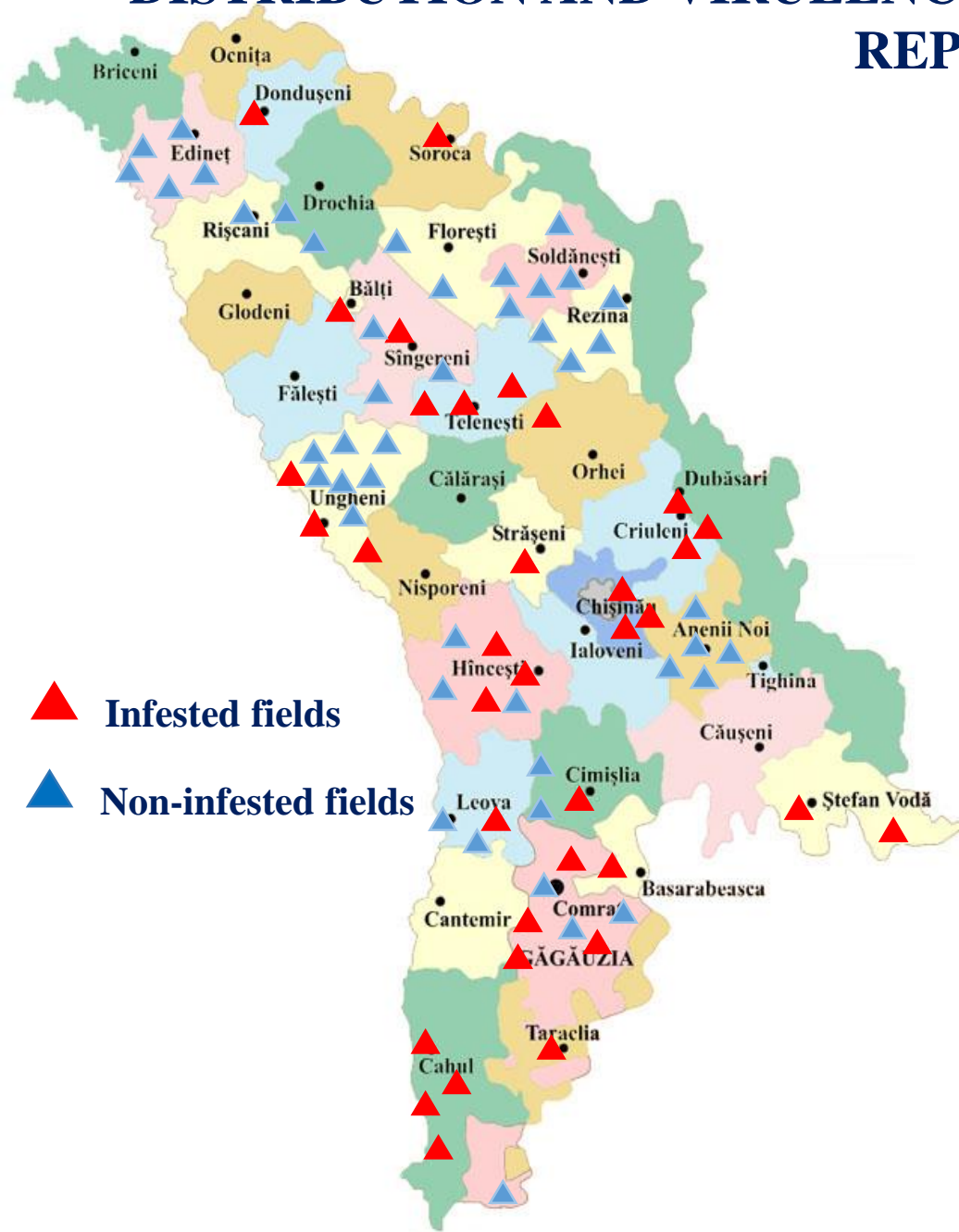
Race E-G

Investigated regions

Donduseni, Soroca, Balti, Chisinau, Singera, Bacioi, Rezeni, Taraclia, Stefan-Voda, Cimisia, Ceadir-Lunga, Izmail, Fundulea



DISTRIBUTION AND VIRULENCE OF BROOMRAPE ON THE TERRITORY OF THE REPUBLIC OF MOLDOVA



▲ Infested fields

▲ Non-infested fields

2014

Centre of Functional Genetics, UnASM

Investigated regions

27 districts, 95 localities, 156 sunflower fields

Field evaluation

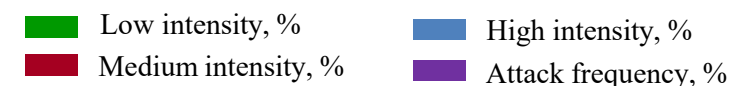
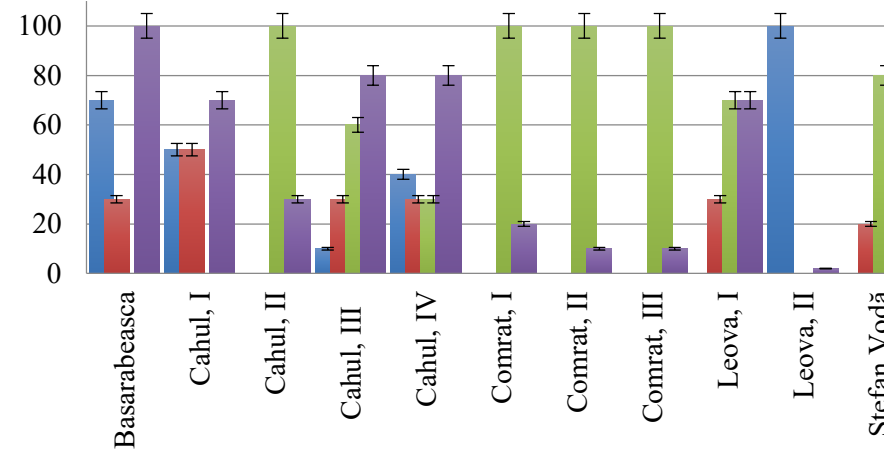
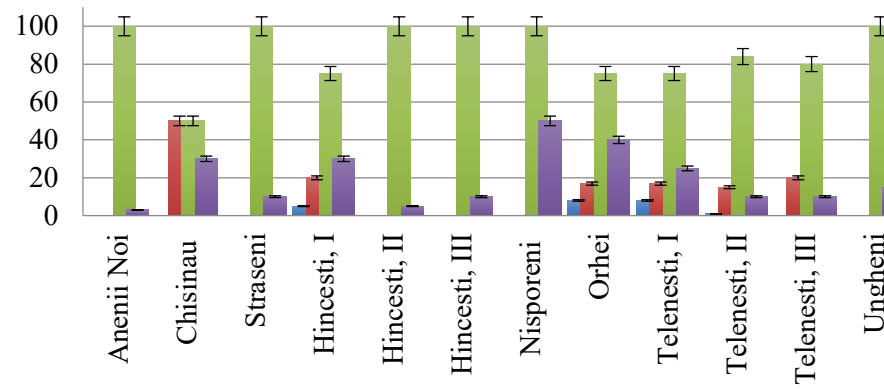
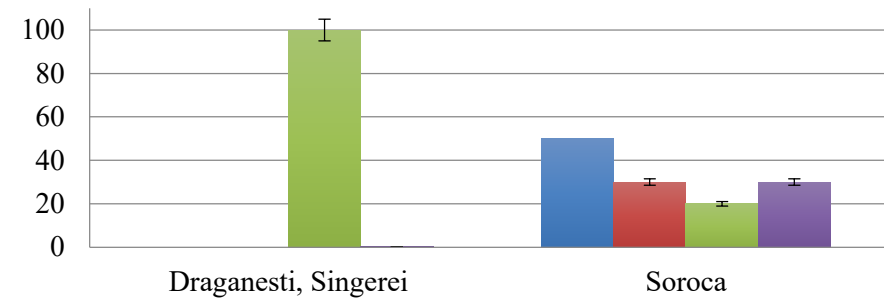
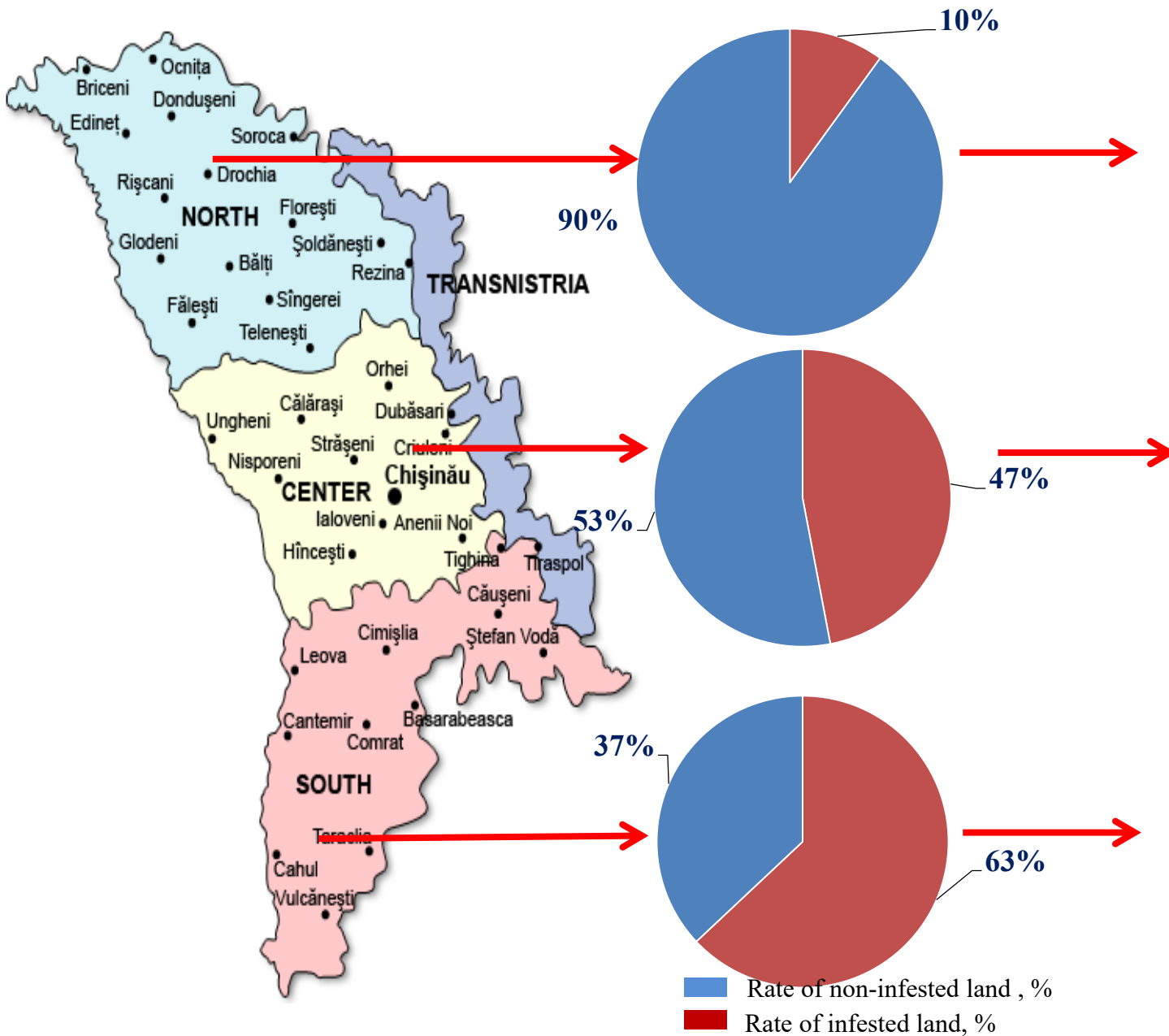
Sociological survey

Soil samples

Geographical coordinates

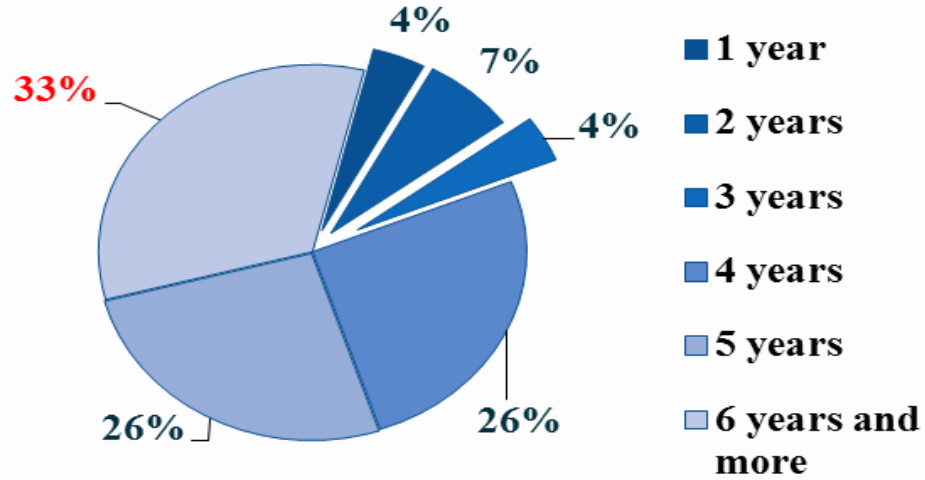


DISTRIBUTION AND VIRULENCE OF BROOMRAPE IN THE REPUBLIC OF MOLDOVA

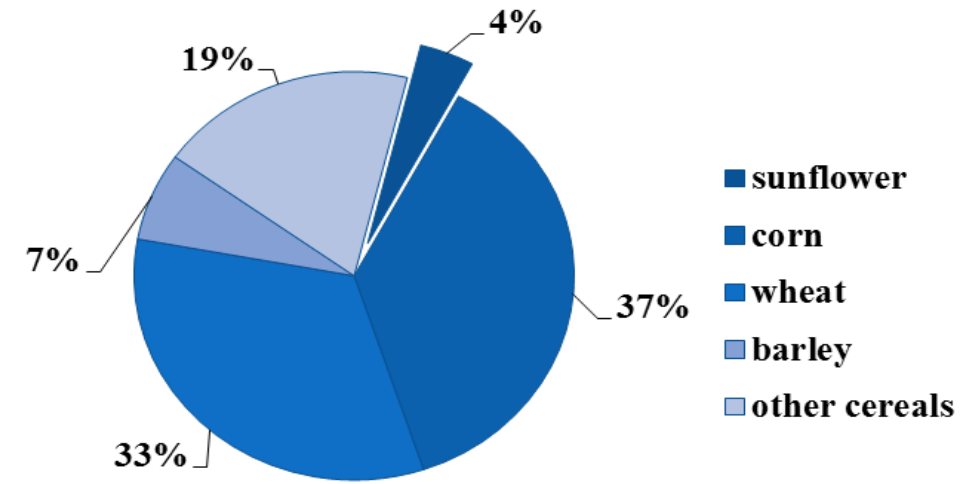


DOCUMENTATION OF SUNFLOWER FIELDS STATE AND BROODRAPE DISTRIBUTION

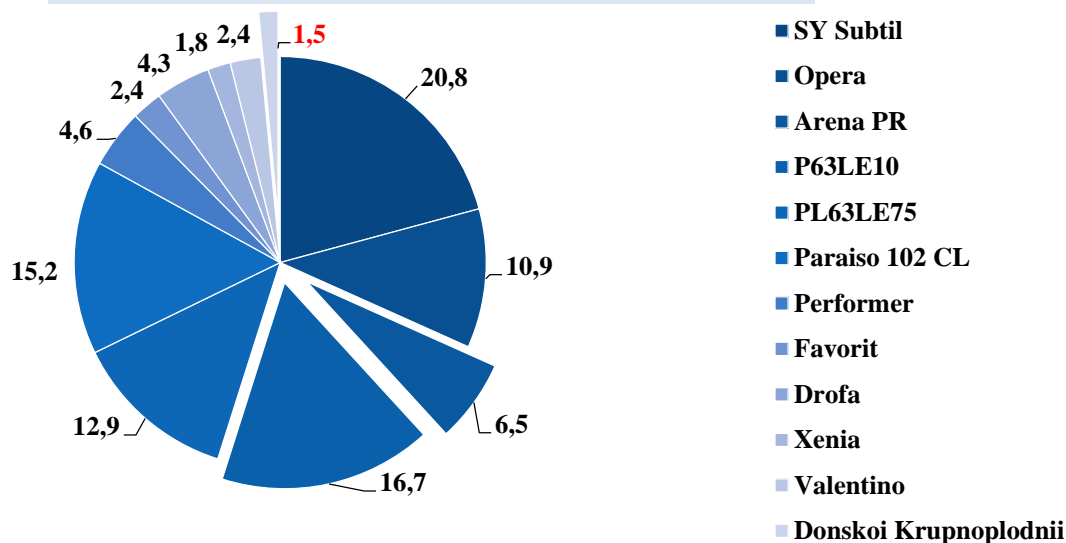
CROP ROTATION



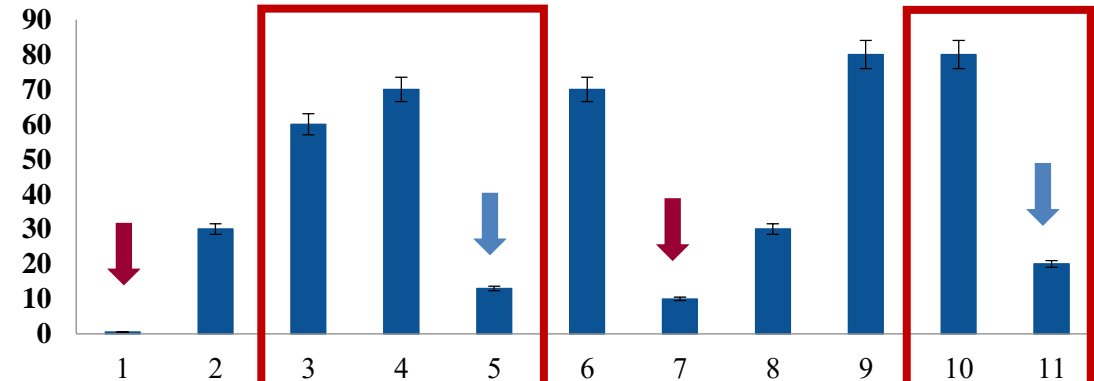
PREDECESSORS



HYBRIDS CULTIVATED IN RM



FREQUENCY OF ATTACK, %



1 – Arena PR (Singerei); 2 – Drofa (SNH 311) (Chisinau); 3 – Paraiso 102 CL (Basarabasca); 4 – Paraiso 102 CL (Leova, I); 5 – Paraiso 102 CL (Leova, II); 6 – SY Subtil (Comrat); 7 – SY Subtil (Cahul, I); 8 – Opera PR (Cahul, II); 9 – Performer (Cahul, III); 10 – P63LE75 (Cahul, IV); 11 – P63LE10 (Comrat)

SUNFLOWER DIFFERENTIALS SET RESISTANT TO THE BROOMRAPE RACES E – G

<i>DENOMINATION</i>	<i>SOURCE</i>	<i>CHARACTERISTICS</i>	<i>RESISTANCE GENE</i>
LMD1	Limagrain Moldova, RM	susceptible	without resistance genes
LMD2	Limagrain Moldova, RM	resistant to race E	Or 5
LC1093A	NARDI Fundulea, RO	resistant to race F	Or 6
LMD3	Limagrain Moldova, RM	resistant to race G	Or 7
LG5661	NARDI Fundulea, RO	resistant to race G	Or 7

65 samples of broomrape collected and included in greenhouse experiences



$$\text{Frequency} = \frac{\text{The plant number infested by Orobanche}}{\text{Total sunflower plant in the pot}} \times 100$$

% of sunflower plant with broomrape

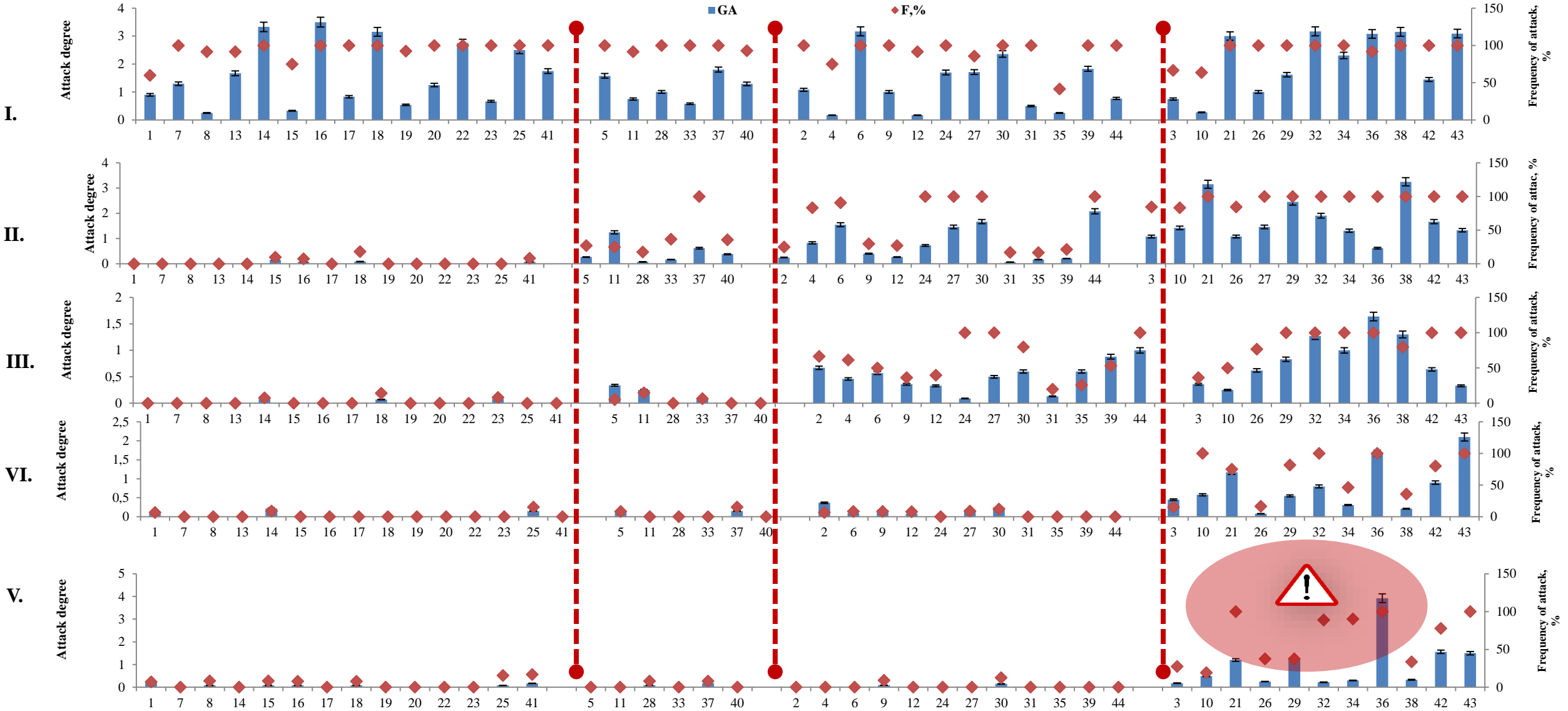
$$\text{Intensity} = \frac{\text{Total broomrape plants}}{\text{Total sunflower plants infested by broomrape}}$$

No. of *Orobanche* on one infested plant

$$\text{Degree of attack} = \frac{F \times I}{100}$$

No. of *Orobanche* on one plant in the pot

ASSESSMENT OF THE BROOMRAPE VIRULENCE AT THE LATE POST-VASCULAR STAGE OF DEVELOPMENT



Set of sunflower differential genotypes: I – LMD1, with R, sensibil; II – LMD2, R rasa E; III – LC1093A, R rasa F; IV – LMD3, R rasa G; V – LG5661, R rasa G (H).

Populații de lupoaie: 1 - Dondușeni; 2 - Soroca; 3 - Bălți; 5 - Prepelița; 6 - Verejeni; 7 - Căzănești; 8 - Brînzii Noi; 9 - Costuleni; 10 - Ciocîlteni; 11 - Rassvet; 12 - Frăsînești; 13 - Izbiște; 14 - Holercani; 16 - Sîngera; 17 - Chișinău; 18 - Băcioi; 19 - Floreni; 20 - Bușeni; 21 - Sărata Mereșeni; 22 - Fundul Galbenei; 23 - Cazangic; 24 - Gura Galbenei; 25 - Cimișlia; 26 - Ermoclia; 27 - Talmază; 28 - Ștefan-Vodă; 29 - Congaz; 30 - Chirsova; 31 - Beșalma; 32 - Svelli; 33 - Carabetovca; 34 - Corten; 35 - Ciadîr-Lunga; 36 - Taraclia; 37 - Grigorievca; 38 - Alexanderfeld; 39 - Manta; 40 - Slobozia-Mare; 41 - Crihana Veche.

RACIAL AND GEOGRAPHICAL DISTRIBUTION OF *O. cumana* POPULATIONS

≤ E

F

G

H

N O R T H

Dondușeni

Prepeleța

Soroca

Bălți

C E N T E R

Băcioi, Sîngera
Căzănești, Izbiște
Holercani, Chișinău
Floreni, Buțeni
Brînzenii Noi
Fundul Galbenei

Rassvet

Frăsînești
Verejeni
Costuleni

S. Mereșeni
Ciocîlteni

S O U T H

Cimișlia
Cazangic
Crihana Veche

Ștefan-Vodă
Grigorievca
Carabetov.
Slobozia-Mare

Gura Galbenei
Beșalma, Chirsova
Ciadîr Lunga
Talmaza, Manta

Ermoclia
Corteni, Congaz
Svetlii. Taraclia
Alexanderfield

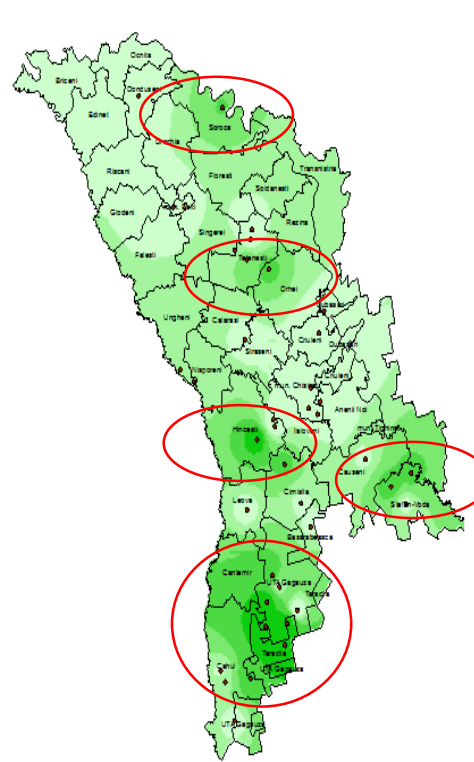
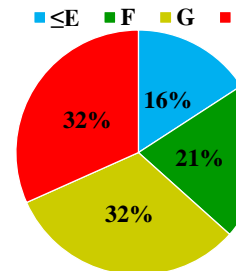
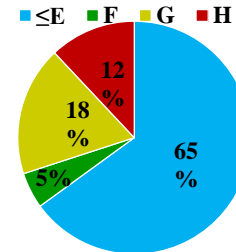
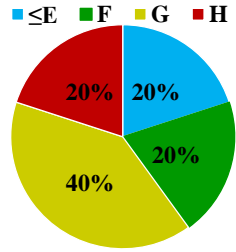
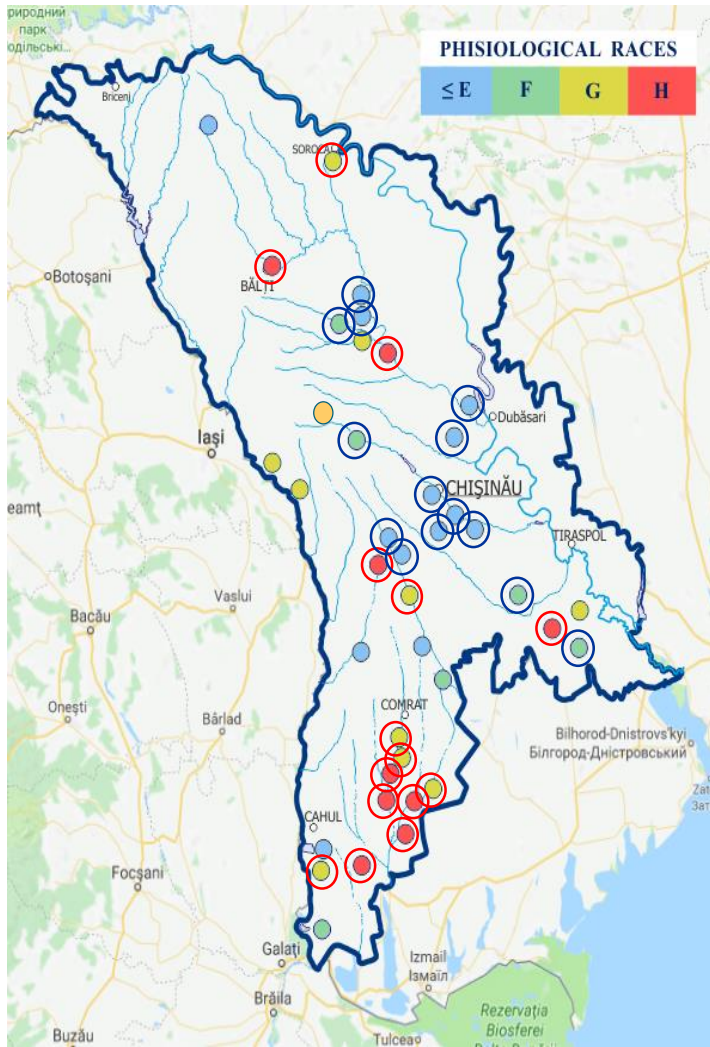
14

6

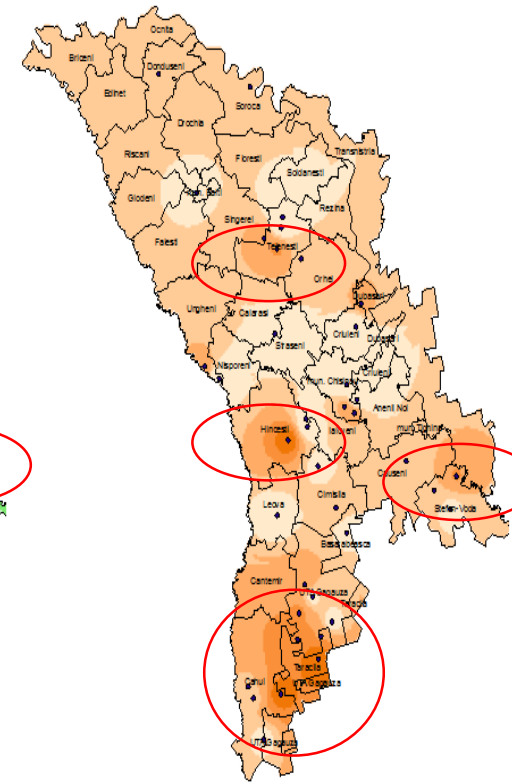
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9

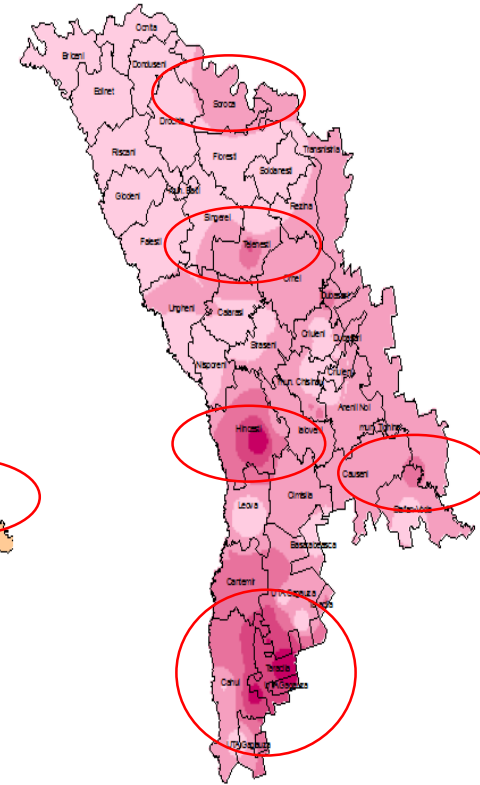
RACIAL AND GEOGRAPHICAL DISTRIBUTION OF *O. cumana* POPULATIONS



A



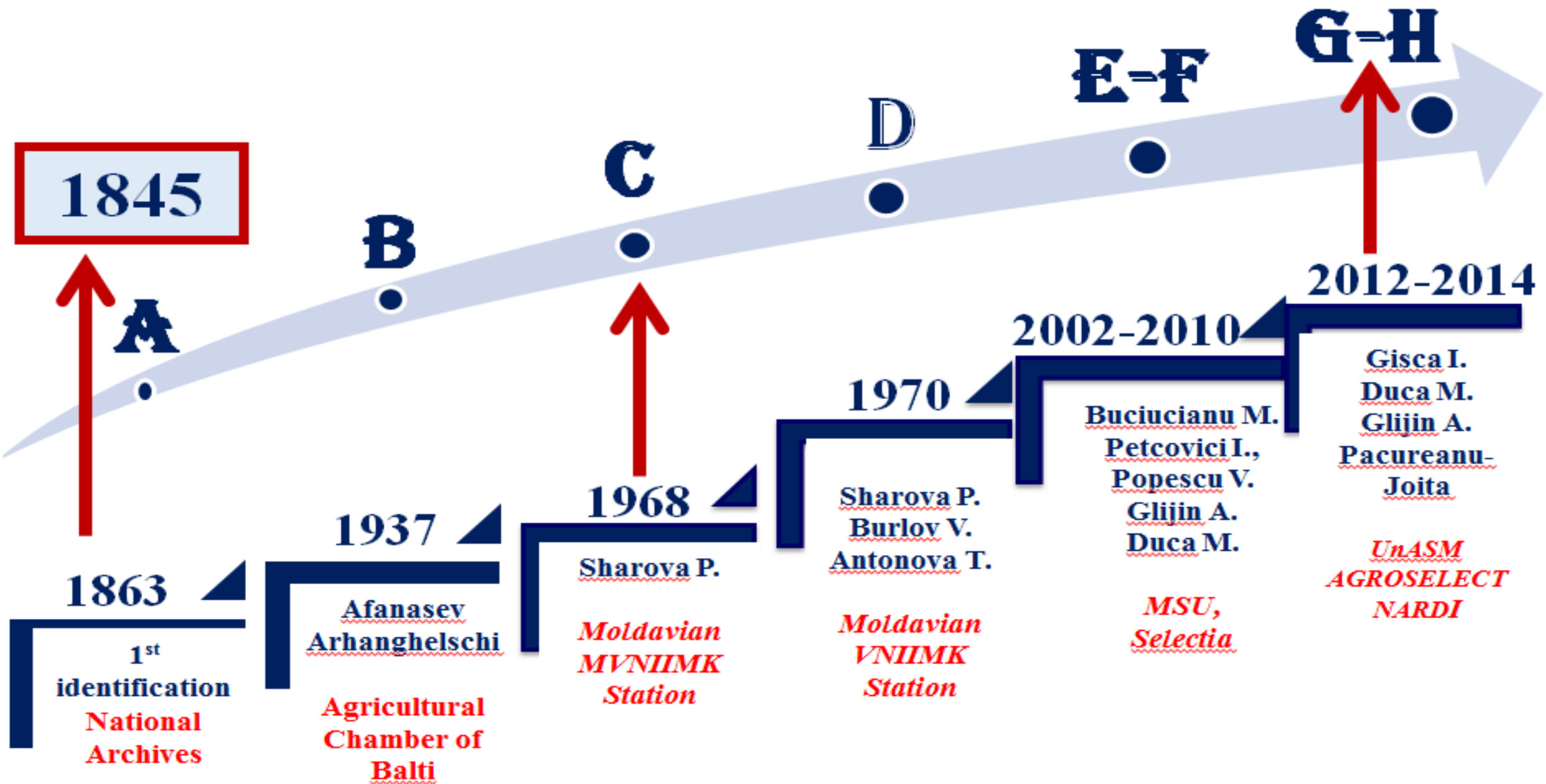
B



C

Spatial maps of *frequency* (A), *intensity* (B) and *attack degree* (C) of *O. cumana* on the territory of Republic of Moldova

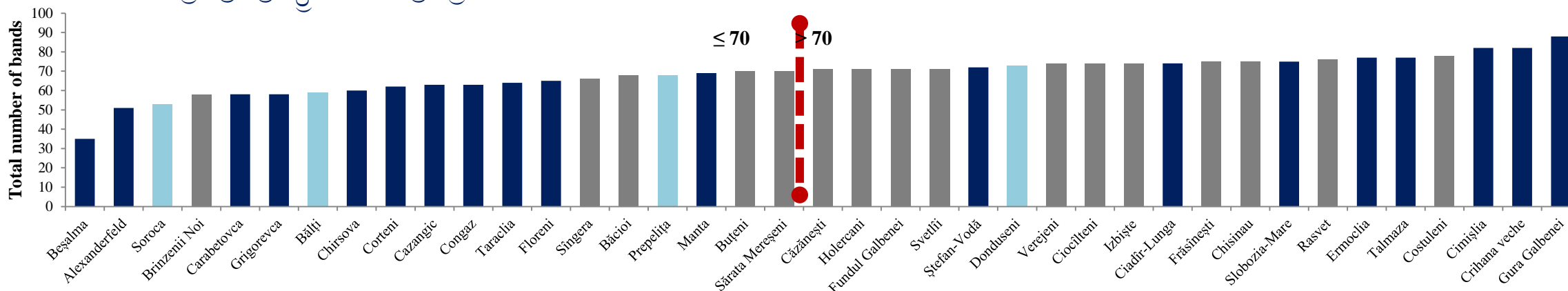
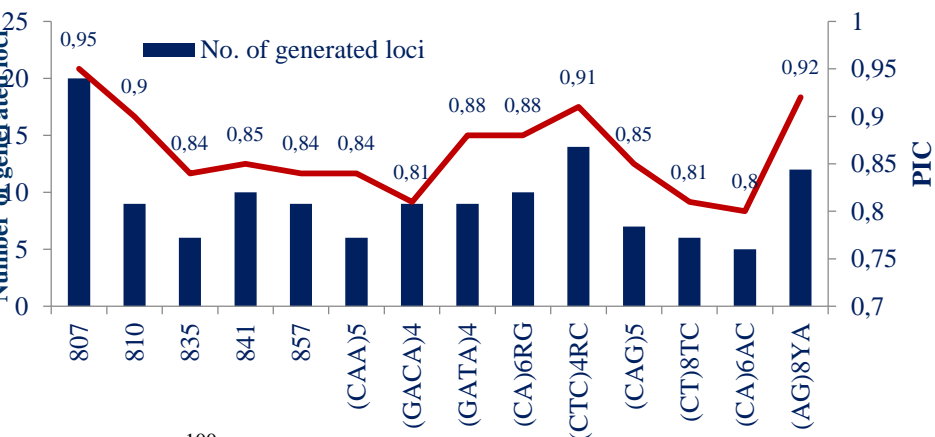
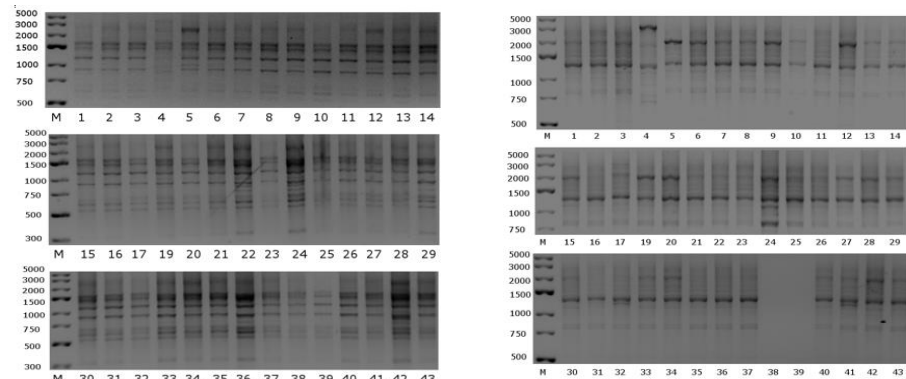
RACES IDENTIFICATION



SPREADING OF *O. CUMANA* PATHOGENIC RACES

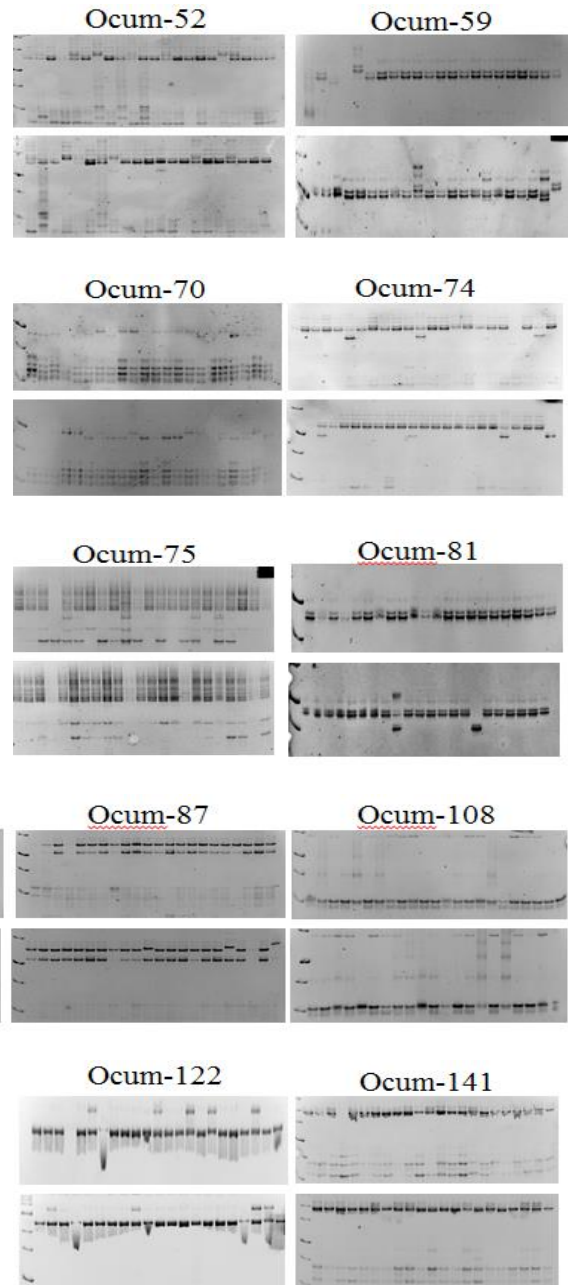


MOLECULAR CHARACTERIZATION OF BROOMRAPE USING ISSR MARKERS



E	F	G	H	Nr
(GATA) ₄ ⁸³⁵ , 841 ⁹²⁶ , 841 ¹¹⁷⁰ , (CA) ₆ AC ¹⁰⁶² , 841 ¹⁴³² , (CA) ₆ RG ⁷⁵⁰ , (CA) ₆ RG ¹⁵⁸⁴				7
(CT) ₈ TC ⁴⁵⁶⁶ , (CTC) ₄ RC ²⁸¹⁵ , (GACA) ₄ ¹³⁰¹ , (GACA) ₄ ¹⁴⁸⁰ , (GACA) ₄ ¹⁷⁷² , 857 ³⁷⁵ , 857 ⁶⁷²				7
(CTC) ₄ RC ⁴⁰³				1
(GACA) ₄ ²¹⁵⁵ , (CAA) ₅ ¹⁴⁵⁰				2
841 ³⁴⁵ , 841 ⁸¹⁴ , (GATA) ₄ ²⁵⁶⁷		841 ³⁴⁵ , 841 ⁸¹⁴ , (GATA) ₄ ²⁵⁶⁷		3
857 ²⁰⁰⁰ , (CTC) ₄ RC ¹¹⁹¹ , (AG) ₈ YA ³⁹²		857 ²⁰⁰⁰ , (CTC) ₄ RC ¹¹⁹¹ , (AG) ₈ YA ³⁹²		3
(CA) ₆ RG ⁸⁸⁵ , (CTC) ₄ RC ¹⁰⁶⁵		(CA) ₆ RG ⁸⁸⁵ , (CTC) ₄ RC ¹⁰⁶⁵		2
(CA) ₆ RG ¹⁴¹⁷ , (CA) ₆ AC ¹⁶²				2
(CAG) ₅ ¹⁵⁸³				1

MOLECULAR CHARACTERIZATION OF BROOMRAPE USING SSR MARKERS

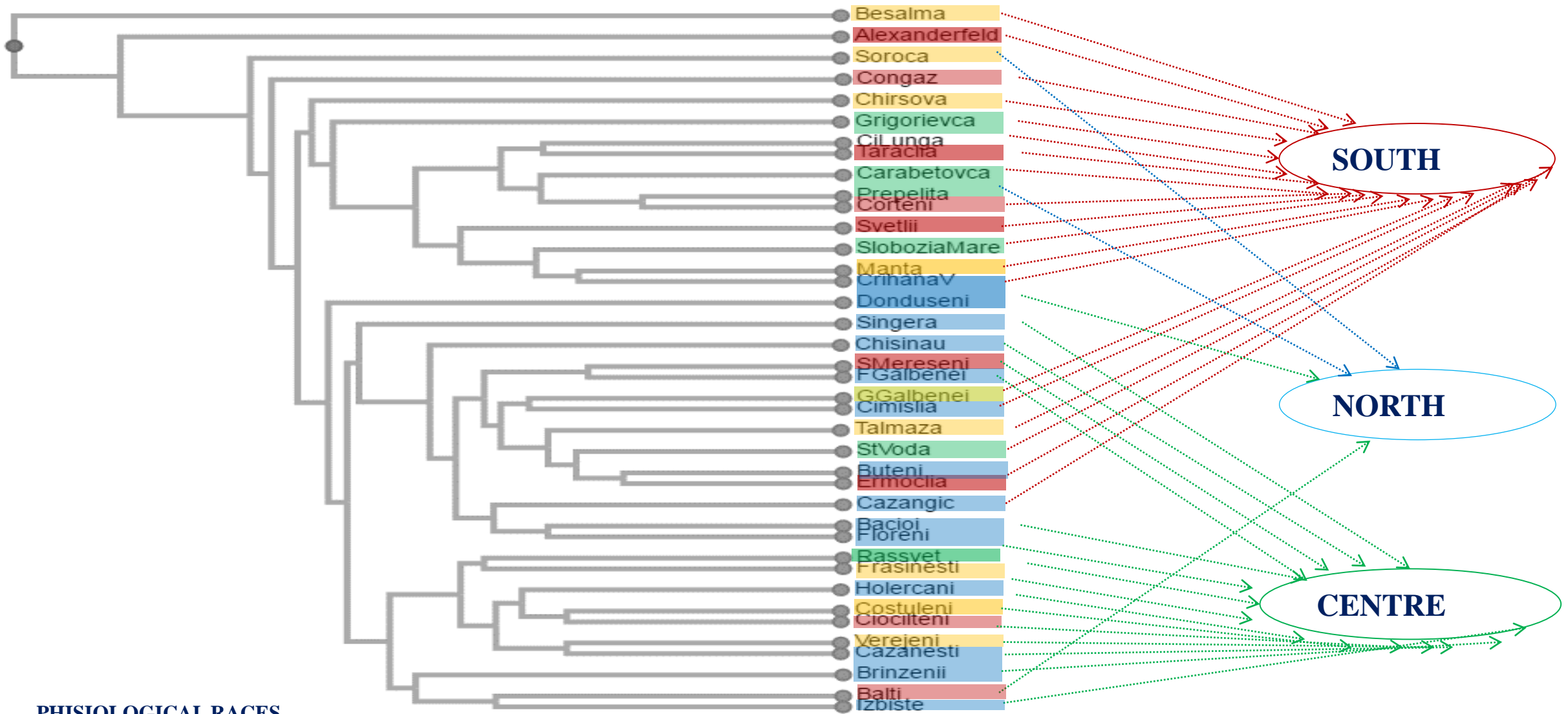


LOCUS	MOTIF	ALLELES	DETECTED ALLELES				PIC*			
			COMMON	UNCOMMON	N	C	S	M		
Ocum-52	(AG) ₁₀	4	122/129	106/132	0.44	0.62	0.63	0.60		
Ocum-59	(TC) ₁₁	4	87/89/93	97	0.00	0.69	0.70	0.68		
Ocum-70	(TG) ₁₁	5	104/109	100/110/115	0.69	0.00	0.55	0.55		
Ocum-74	(GA) ₁₂	5	113/119	97/115/122	0.75	0.65	0.57	0.63		
Ocum-81	(CA) ₁₃	8	87/91	75/89/94/106/109	0.49	0.69	0.63	0.65		
Ocum-87	(TTC) ₁₃	3	105/124	131	0.59	0.00	0.52	0.52		
Ocum-108	(GTAT) ₆	4	81/140	107/129	0.50	0.46	0.66	0.60		
Ocum-122	(AGTGTG) ₆	3	230	241/341	0.00	0.36	0.19	0.27		
Ocum-141	(CTT) ₆	2	182/192	-	0.50	0.40	0.35	0.41		
Ocum-174	(AAG) ₇	4	187/202/213	190	0.50	0.64	0.55	0.61		
Ocum-197	(GA) ₇	5	105/111/116/121	96	0.72	0.76	0.76	0.77		
Ocum-206	(TG) ₈	3	120/127	116	0.00	0.50	0.55	0.53		
MEAN (T=50)		4.17	-	-	0.43	0.48	0.56	0.57		

Notes: *N – PIC for Northern region, C– PIC for Central region, S – PIC for Southern region populations

E	F	G	H	Nr
O ¹⁴¹ 182, O ¹⁷⁴ 187, O ¹²² 230, O ⁸⁷ 105, O ⁷⁴ 113				5
O ⁷⁰ 104, O ⁸¹ 91, O ²⁰⁶ 120				3
O ⁷⁰ 109				1
O ⁸⁷ 124	O ⁸⁷ 124			1
O ⁷⁴ 119, O ²⁰⁶ 127		O ⁷⁴ 119, O ²⁰⁶ 127		2

CLUSTERING ANALYSIS BASED ON THE ISSR MOLECULAR PATTERN OF *O. CUMANA* POPULATIONS

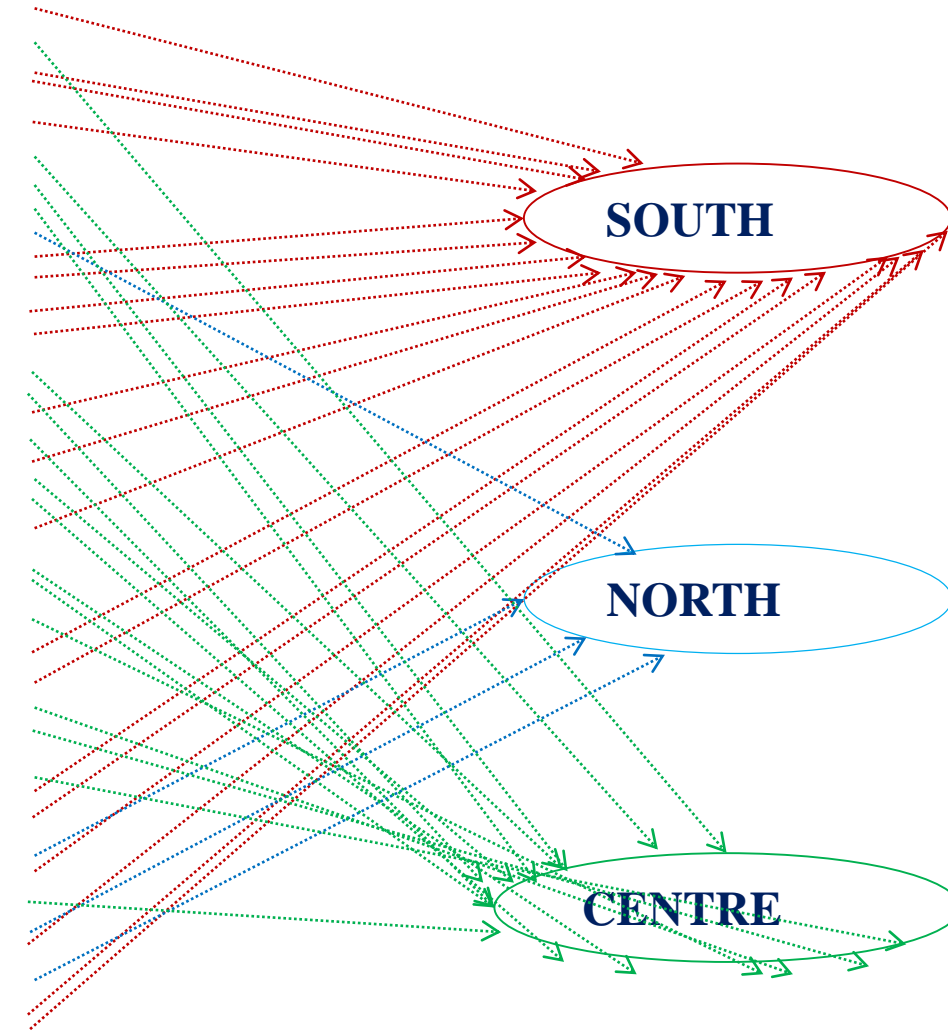
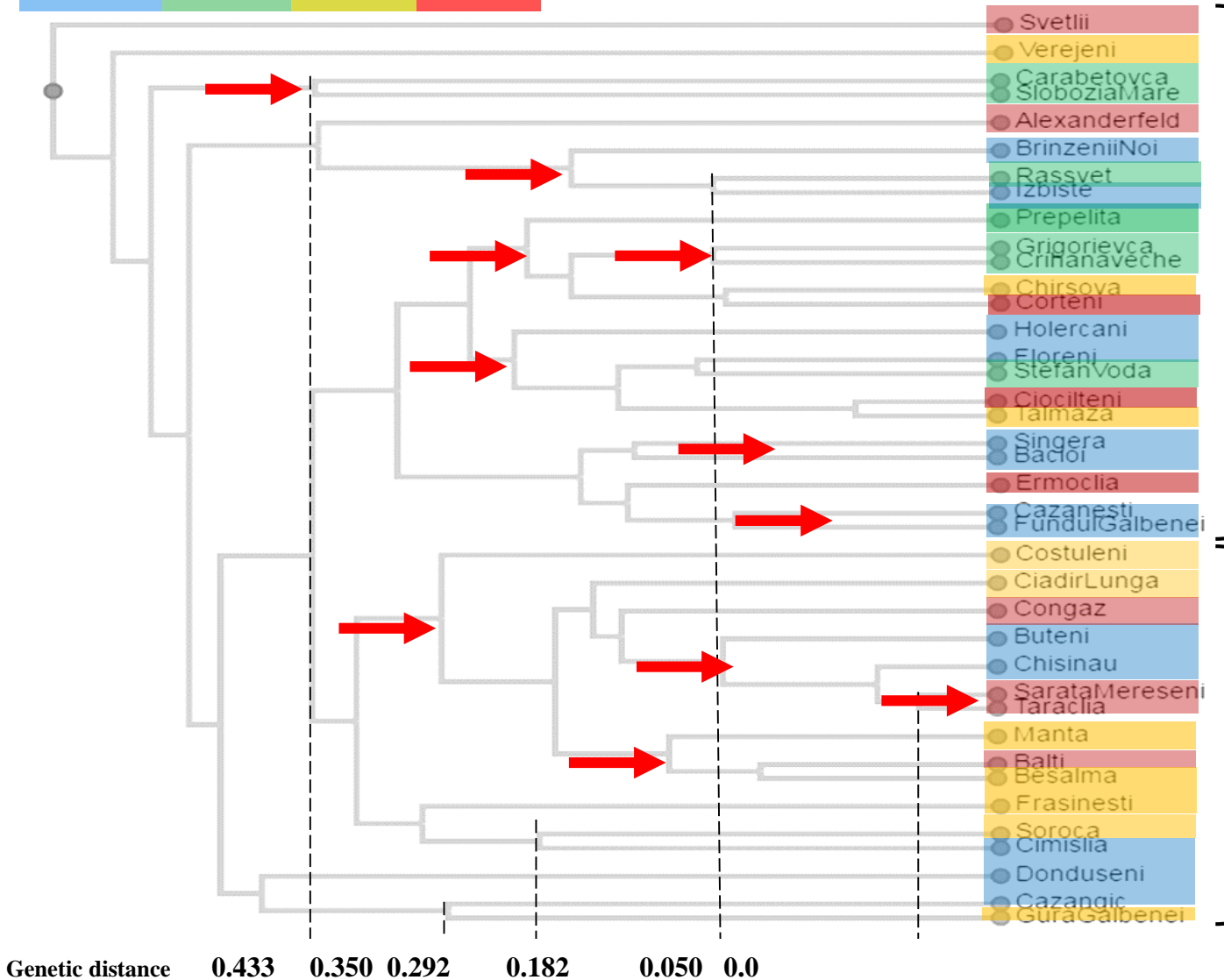


PHYSIOLOGICAL RACES

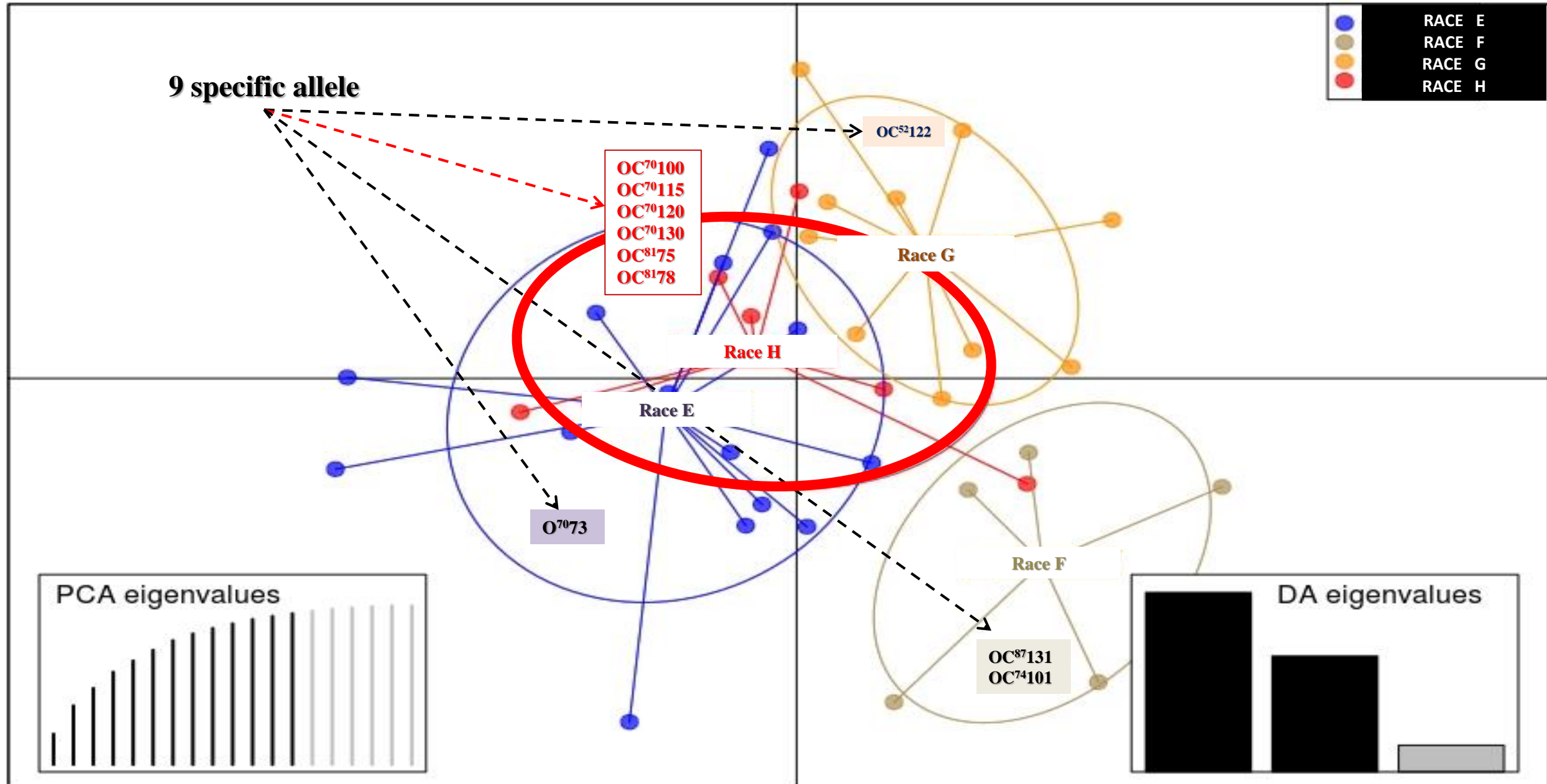


CLUSTER ANALYSIS OF *O. CUMANA* POPULATIONS USING SSR MARKERS

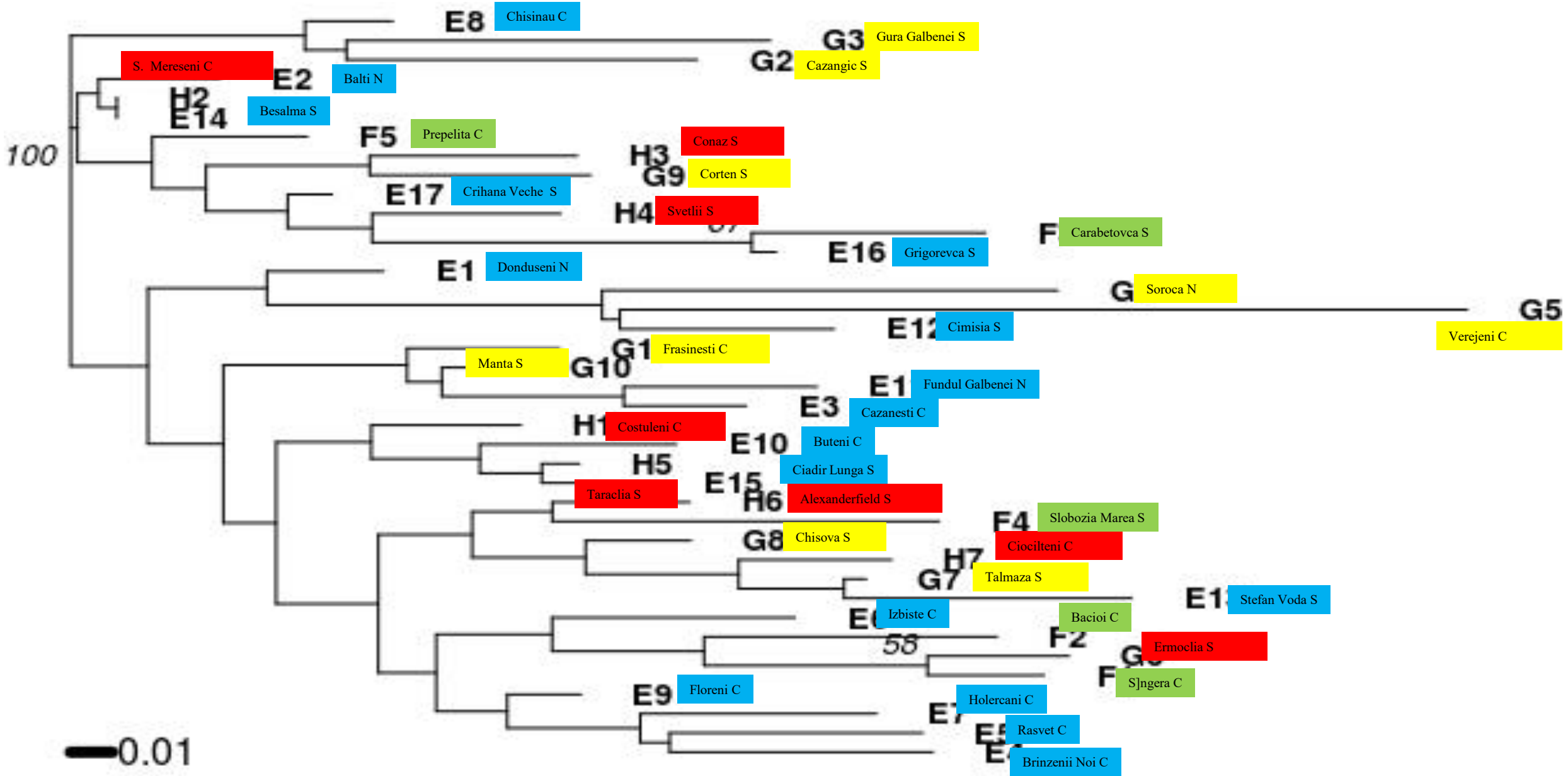
PHYSIOLOGICAL RACES



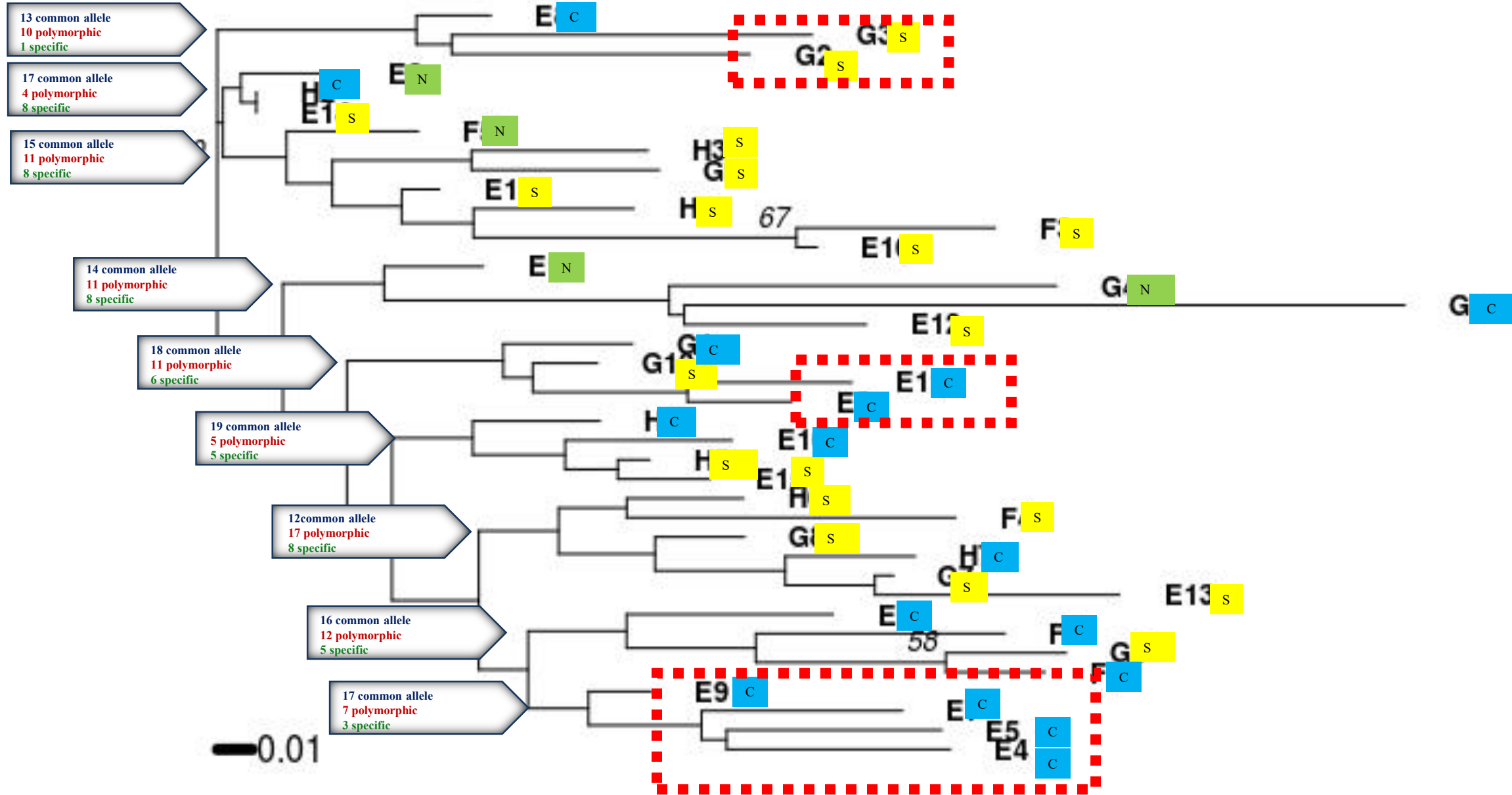
STRATIFICATION OF BROOMRAPE POPULATIONS USING SSR MARKERS



PHYLOGENETIC TREE



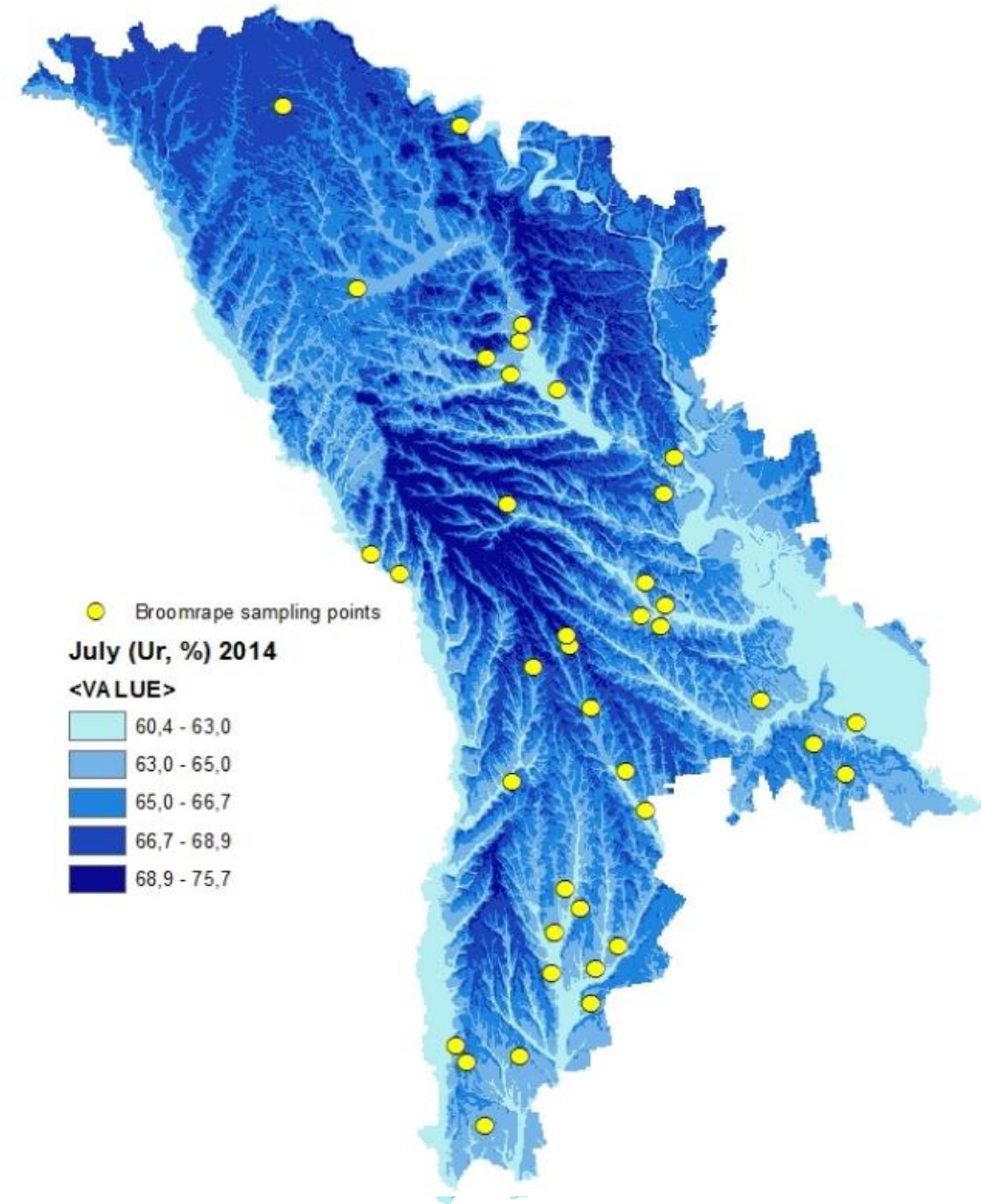
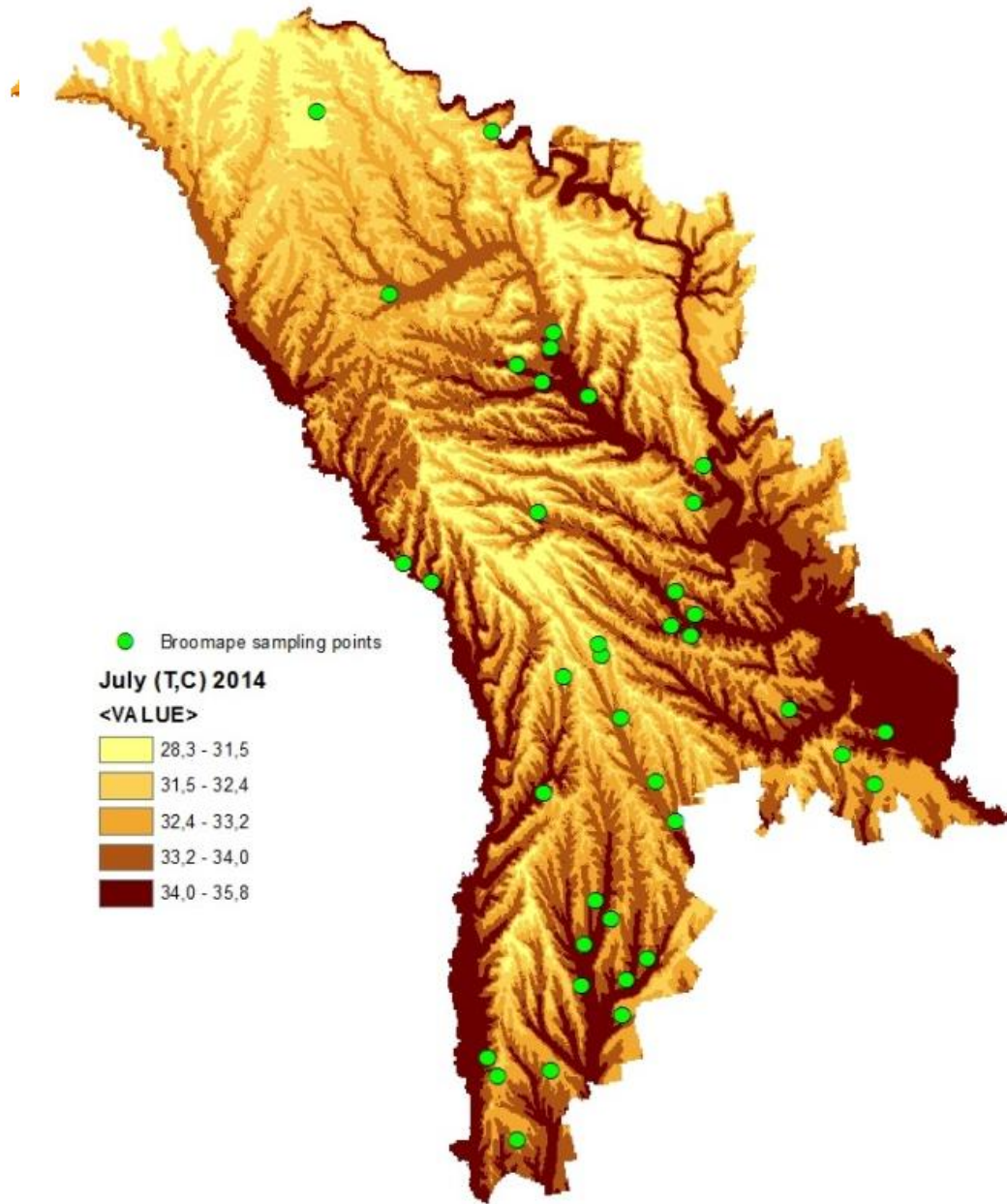
PHYLOGEOGRAPHIC TREE



VARIATION OF THE INFECTION DEGREE WITH *O. CUMANA* ACCORDING TO PHYSICO-CHEMICAL PARTICULARITIES OF SOIL

Localities	Intensity of attack, %			Frequency of attack, %	SOIL PARAMETERS							
					pH	%		mg/100 g				me/ 100 g
	>10	5-10	1-4			Humus	Total N	NH ₄	NO ₃	P ₂ O ₅	K ₂ O	Ca
Telenesti, Verejeni	-	20	80	10	7.50	2.25	0.24	0.6	18.1	5.9	60.6	22.00
Telenesti, Cazanesti	1	15	84	10	8.00	1.85	0.31	0.7	3.7	9.3	64.0	22.90
Telenesti, Brinzeni	30	20	50	25	7.80	2.95	0.28	0.9	7.4	2.7	51.6	21.60
Orhei, Ciocilteni	8	17	75	40	7.80	3.65	0.26	0.9	1.8	1.5	29.0	22.60
Mun. Chisinau	-	50	50	30	7.30	3.70	0.20	0.6	1.6	1.2	28.2	21.10
Hincesti, Buteni	5	20	75	30	8.00	3.05	0.19	0.6	4.9	1.5	30.2	27.60
Sarata-Mereseni	-	-	100	10	7.40	2.65	0.26	1.1	1.0	3.8	26.6	16.80
Fundul-Galbenei	-	-	100	5	7.40	2.65	0.16	0.6	5.8	1.4	25.8	20.25
Leova, Cazangic	-	30	70	70	7.45	3.30	0.15	0.6	1.4	1.3	21.4	13.25
Ermoclia	-	20	80	10	8.20	3.45	0.22	1.1	29.3	3.7	24.6	27.90
Comrat, Chirsova	-	-	100	10	8.30	2.30	0.18	0.6	4.3	1.6	24.6	19.10
Comrat, Besalma	-	-	100	20	8.20	2.50	0.18	0.9	24.4	4.0	29.4	18.00
Comrat, Svetlii	-	-	100	10	8.25	2.30	0.18	0.7	3.9	1.8	23.4	18.50
Carabetovca	60	30	10	60	8.30	2.80	0.18	0.7	11.4	1.4	19.0	16.90
Alexanderfeld	50	50	-	70	7.75	3.45	0.16	0.9	2.0	4.2	32.0	23.10
Cahul, Manta	10	30	60	80	7.75	3.25	0.24	0.9	2.3	3.9	19.0	23.10
Slobozia-Mare	40	30	30	80	7.90	3.25	0.24	1.0	2.1	8.0	25.0	19.25
Crihana-Veche	-	-	100	30	7.80	2.10	0.21	0.8	7.4	4.8	59.4	17.75

CLIMATIC CONDITIONS ON DISTRIBUTION OF *O. cumana* IN RM



CONCLUSIONS

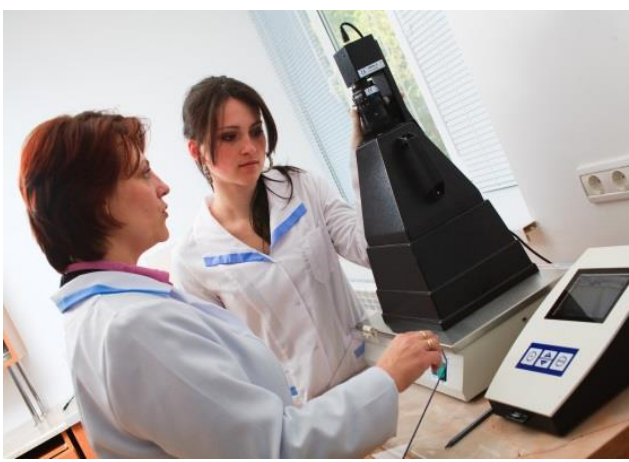
Broomrape is spread across all regions of the RM from the first years of sunflower cultivation

All *Orobanche* races were detected on the territory of the Republic of Moldova

The main factors involved in the appearance and dispersion of broomrape physiological races are:

- *the pathogen-host co-evolution determined by continuous search for the new resistance genes*
- *favorable environmental conditions in the RM*
- *occurrence of bidirectional sunflower seeds and varieties flow*

The obtained data reflect a very unfavorable situation on a country level, which requires greatest and urgent efforts and strategies for long-term control measures to this parasite



*Thank you
for your attention!*

