

# POPULACIJSKA GENETIKA IMOTSKE GAOVICE

*(Delminichthys adspersus)*

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# Gaovice- opće ime za mnogobrojne vrste

- Na području Hrvatske i Bosne i Hercegovine – Dinarski krš.
- Postoji (najmanje) 10 endemskih vrsta.
- Zajedničko im je da su relativno neistražene- biologija i ekologija.
- Žive u stalnim i povremenim izvorima.
- Periodična kolonizacija špilja (do 6 mjeseci godišnje!)
- Evolucijsko stare vrste (srednji miocen -13 milijuna godina).
- Geografsko jedne od najizoliranijih vrsta ciprinida u Europi i zapadnoj Aziji.

# PRIJE

(LJETO)



# POSLIJE

(JESEN)



# Freyhof i suradnici, 2006. NOVA TAKSONOMIJA

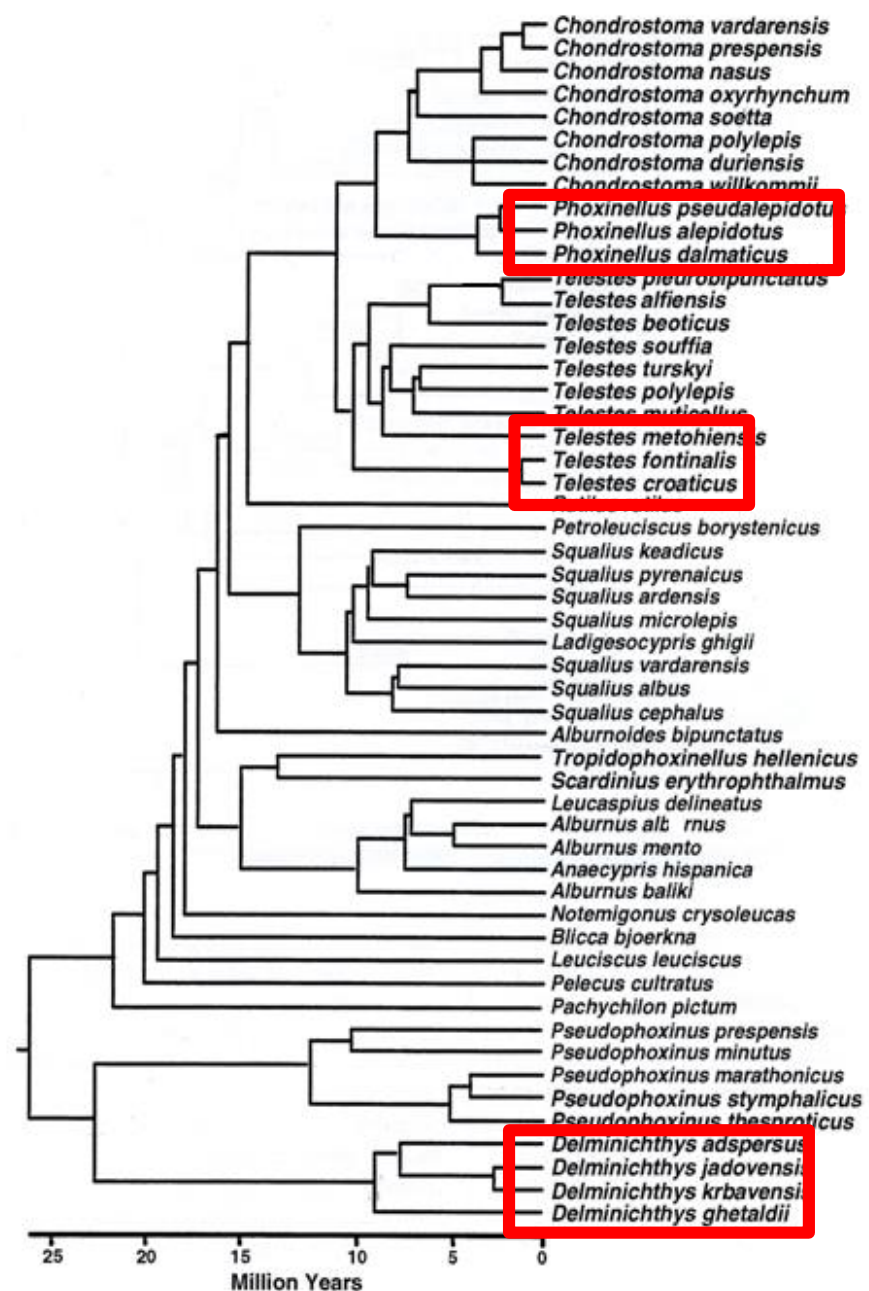
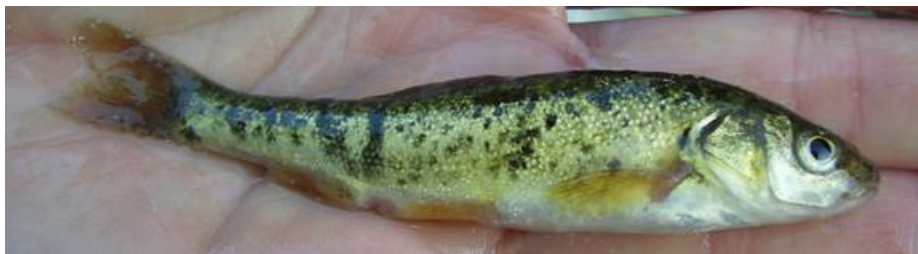


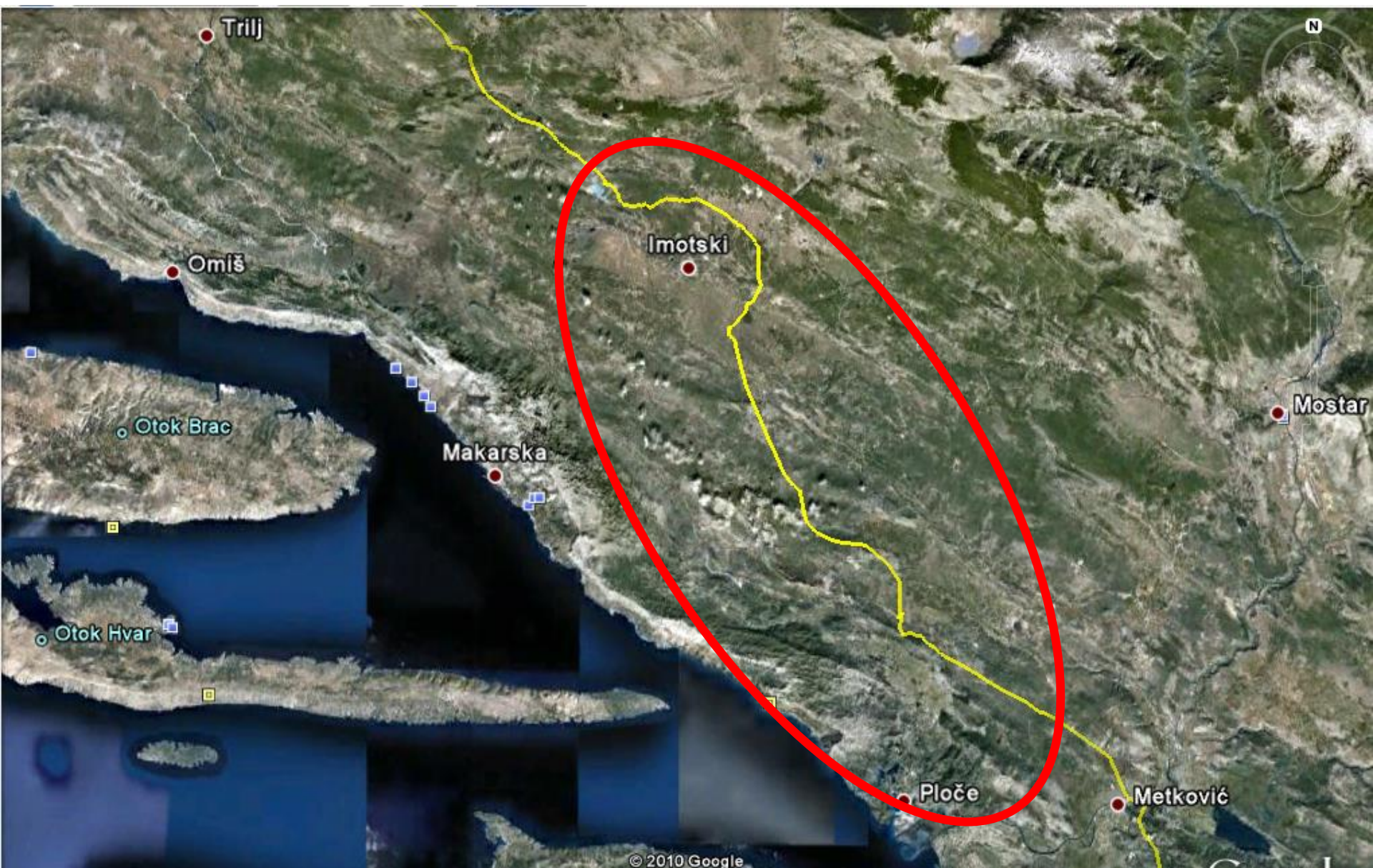
Fig. 2. Clock-constrained ML tree (chronogram) showing the cladogenesis of cyprinid taxa examined. The tree was constructed under the GTR+G+I model ( $I = 0.844$ , proportion of invariable sites = 0.512). The node ages were estimated according to Sanderson (1997) nonparametric rate smoothing (NPRS) method using TreeEdit and PAUP\*. The scale bar below the tree shows the time scale in millions of years resulting from a calibration of the molecular clock based on the opening of the Strait of Korinthos (see text). The corresponding split between *Telestes pleurobipunctatus* from the Arachthos River and *T. alfiensis* from the Alfios River is indicated (arrow).

Imotsku gaovicu su Freyhof i suradnici  
(2006.) zajedno s još tri vrste gaovica  
(*Ph. ghetaldii*, *Ph. krbavensis* in *Ph.*  
*jadovensis*) razvrstili u novi rod-  
***Delminichthys*.**

*Phoxinellus adpersus* → *Delminichthys adpersus*



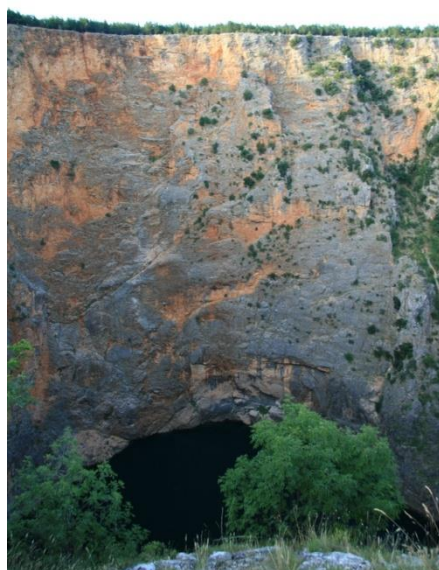
- Sve vrste gaovica imaju fragmentirano stanište, što je najizraženije kod imotske gaovice.



- Ona naseljava izvore i podzemne vode od Imotskog polja na sjeveru do Bačinskih jezera kod Ploča na jugu.
- Zbog geografske fragmentiranosti vrste, došlo je do pojave više populacija.



VRLJIKA



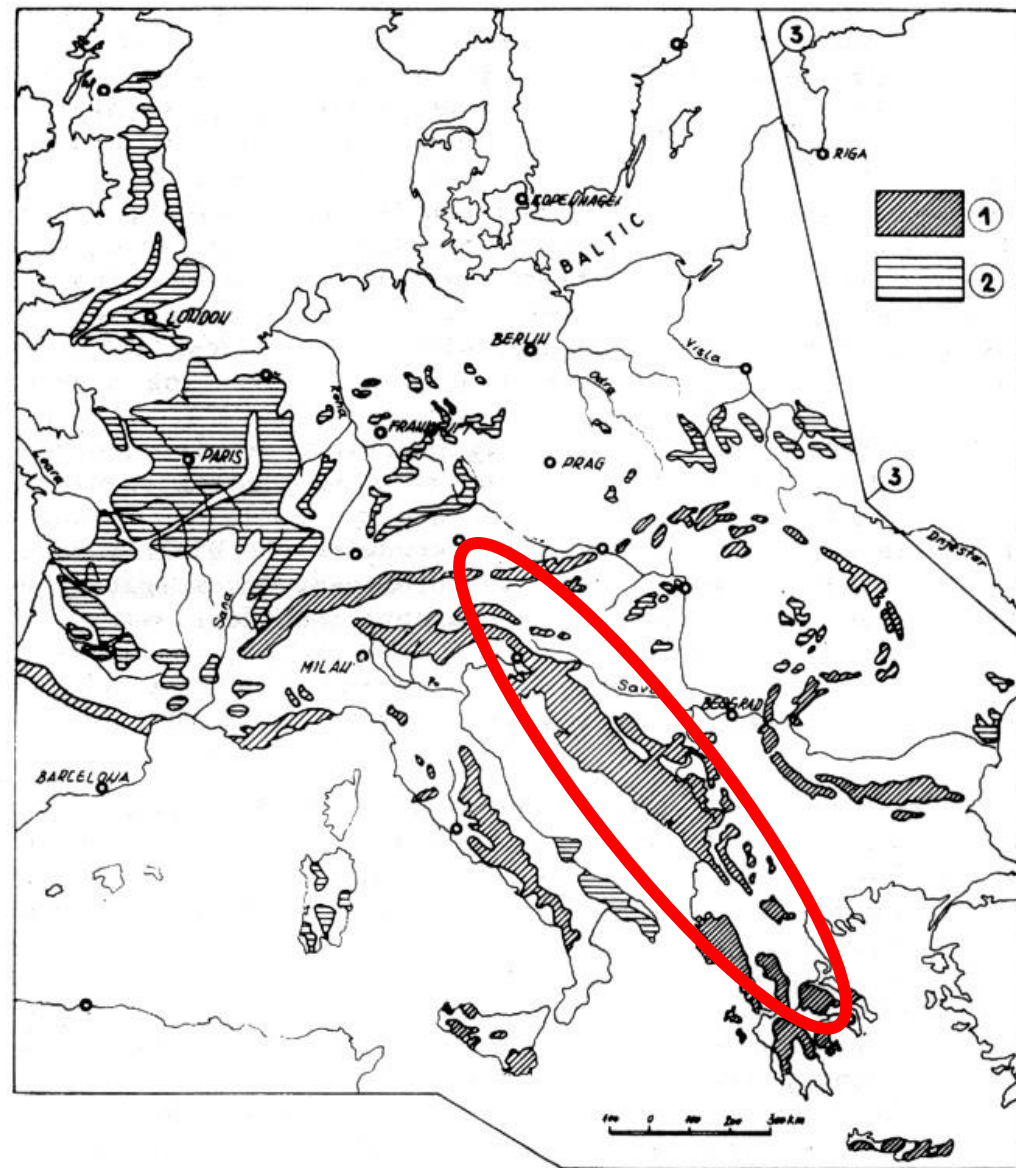
CRVENO JEZERO



PROLOŠKO BLATO

# Dinarski Krš

- Hidrološki sistemi u kršu su složeni.
- Podzemne veze nisu uvijek poznate.
- Poplave, suše.
- Jako osjetljiv sistem.



Distribution of karst areas in the western and central Europe: (1) Karst of geosynclinal regions; (2) Karst of platforms and young tectonic depressions; and (3) The boundary of karst terranes.

Geologija (i hidrogeologija) krša – Krš Dinarida, Mladen Juračić,  
Geološki odsjek PMF-a, Sveučilište u Zagrebu 2006/07

# Krš + ekologija gaovica= HIPOTEZA

- Vrsta imotska gaovica (*Delminichthys adspersus*) predstavlja jednu panmiktičnu populaciju.
- Jedinke migriraju između različitih lokacija po površinskim i podzemnim vezama.

# Iz literature...



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***Asellus aquaticus***

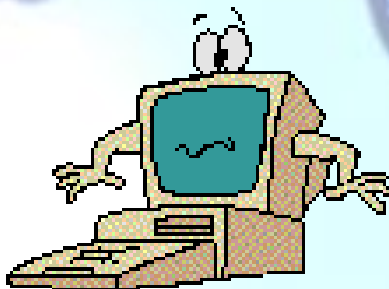


***Salmo obtusirostris***

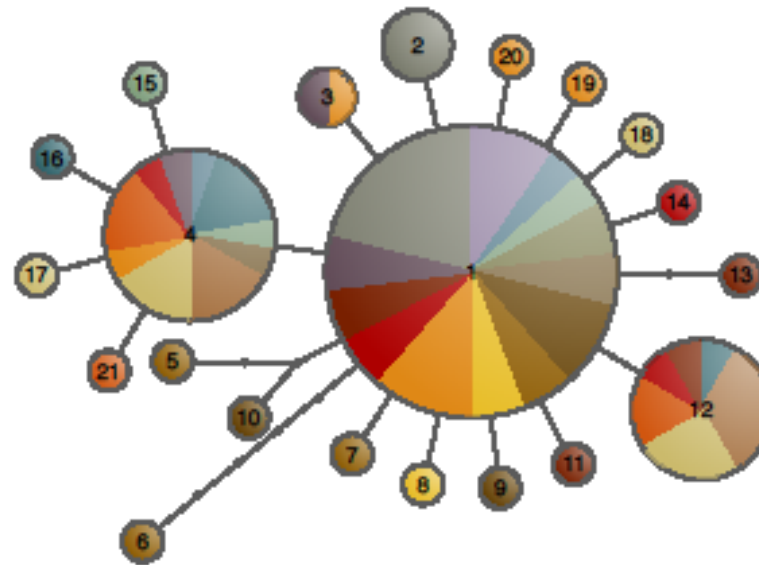
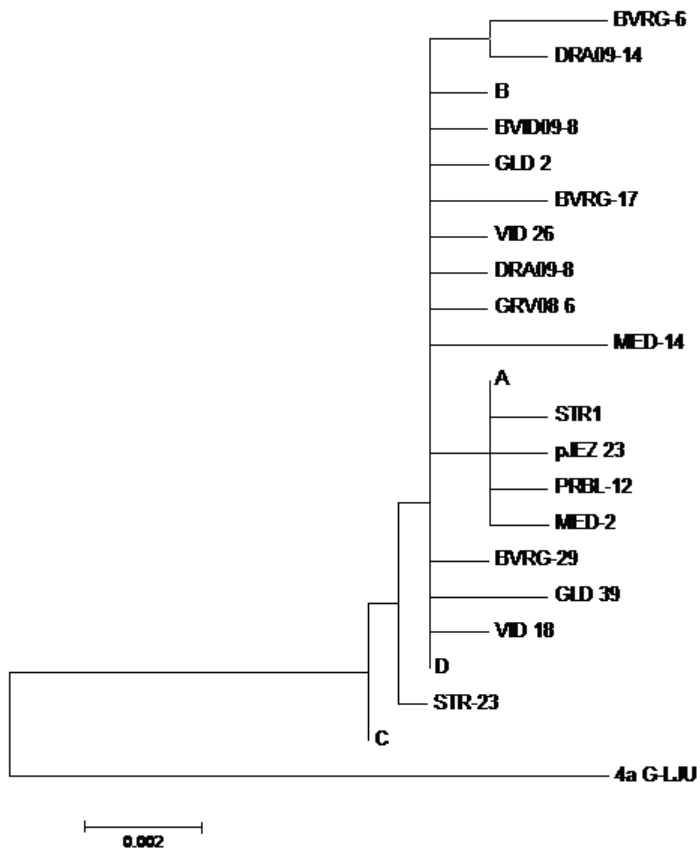
**Metode:** Uzorci iz različitih, površinski povezanih i nepovezanih lokacija



**Metode:** DNK (mitohondrijska, mikrosateliti) – “riblja forenzika” i računalna analiza

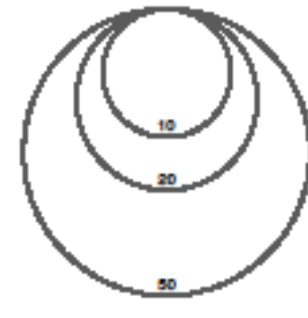


# Rezultati- MITOHONDRIJSKA DNK



Legend for pie charts:

- NEZ
- BVID
- GLD
- GRV
- pJEZ
- VID
- CRV
- STR
- GRB
- BVRG
- DRA
- GRAN
- JAM
- MED
- PRBL
- REB
- UDV



|   |                                                                                                                                                                                                                                                                                                                                                                                                            |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A | PRBL-6, PRBL-16, PRBL-20, pJEZ-12, pJEZ-15, pJEZ-21, GRB-11, GRB-12, GRB-20, GRV08-7, GRV-13, STR-2, STR-3, STR-6, REB-14, BVID-2, GRAN-1, MED-11                                                                                                                                                                                                                                                          |
| B | GRB-1, GRB-10, GRB-16, GRV08-4, PRBL-14, GLD-36, STR-15, STR-17, STR-20, pJEZ-9, pJEZ09-10, GRV08-4, PRBL-14, GLD-36                                                                                                                                                                                                                                                                                       |
| C | 1d NEZ, 1h NEZ, 1f NEZ                                                                                                                                                                                                                                                                                                                                                                                     |
| D | CRV-1, CRV-2, CRV-3, CRV-4, CRV-5, 1a, 1b, 1c, 1e, 1g, 1i, 1j, 1k, NEZ09-18, NEZ09-24, DRA09-2, DRA09-6, DRA09-9, DRA09-11, DRA09-10, DRA09-11, GLD-5, GLD-10, GLD-15, VID-3, VID-8, VID-19, GRV-4, GRV08-13, GRV08-14, UDV-6, UDV-10, UDV15, UDV-16, JAM-14, JAM-21, JAM-22, JAM-46, BVRG-11, BVRG-12, BVRG-19, MED-1, MED-13, REB-7, REB-19, BVID-1, BVID09-7, BVID09-1, GRAN-9, GRAN-22, GRAN-24, POL-1 |

# Rezultati-MIKROSATELITI

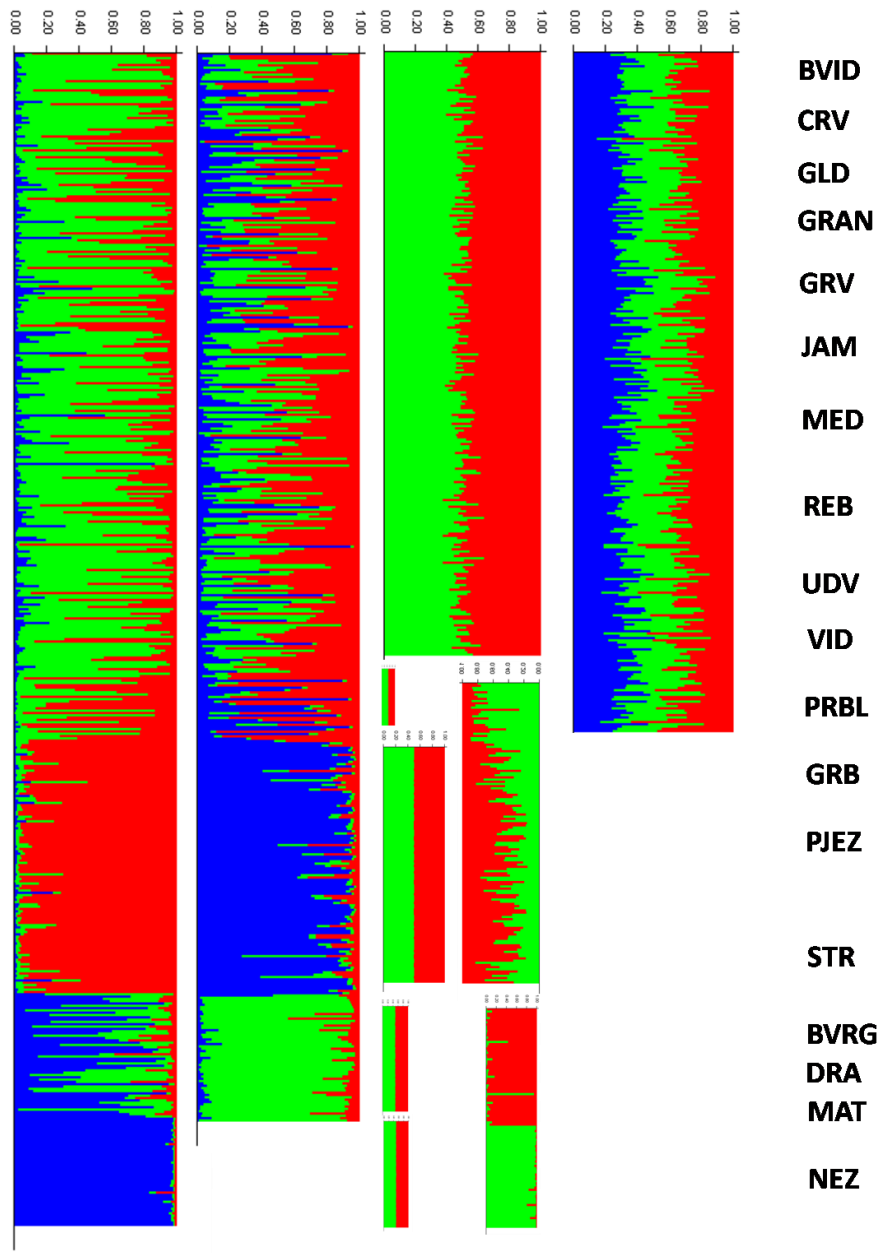
PAIRWISE FST-s

|      | BVID   | BVRG   | CRV    | DRA    | GLD    | GRAN   | GRB    | GRV     | JAM     | MAT     | MED     | NEZ    | PJEZ   | PRBL   | REB     | STR     |
|------|--------|--------|--------|--------|--------|--------|--------|---------|---------|---------|---------|--------|--------|--------|---------|---------|
| BVID | 0.0000 | 0.0490 | 0.0343 | 0.0361 | 0.0091 | 0.0018 | 0.0533 | -0.0038 | 0.0079  | 0.0529  | 0.0021  | 0.1139 | 0.0630 | 0.0352 | 0.0054  | 0.0543  |
| BVRG | ***    | 0.0000 | 0.0472 | 0.0018 | 0.0381 | 0.0397 | 0.0697 | 0.0336  | 0.0354  | -0.0074 | 0.0324  | 0.0723 | 0.0895 | 0.0706 | 0.0377  | 0.0775  |
| CRV  | NS     | **     | 0.0000 | 0.0230 | 0.0111 | 0.0217 | 0.0459 | 0.0168  | 0.0200  | 0.0621  | 0.0115  | 0.1465 | 0.0707 | 0.0310 | 0.0036  | 0.0416  |
| DRA  | ***    | NS     | NS     | 0.0000 | 0.0292 | 0.0211 | 0.0699 | 0.0254  | 0.0252  | 0.0038  | 0.0204  | 0.0762 | 0.0893 | 0.0589 | 0.0191  | 0.0743  |
| GLD  | NS     | ***    | NS     | ***    | 0.0000 | 0.0058 | 0.0277 | 0.0010  | 0.0087  | 0.0397  | -0.0027 | 0.1207 | 0.0404 | 0.0264 | 0.0016  | 0.0311  |
| GRAN | NS     | ***    | NS     | ***    | NS     | 0.0000 | 0.0523 | -0.0048 | 0.0028  | 0.0404  | -0.0076 | 0.1213 | 0.0621 | 0.0327 | 0.0042  | 0.0509  |
| GRB  | ***    | ***    | **     | ***    | ***    | ***    | 0.0000 | 0.0498  | 0.0439  | 0.0982  | 0.0404  | 0.1704 | 0.0041 | 0.0246 | 0.0419  | -0.0001 |
| GRV  | NS     | ***    | NS     | **     | NS     | NS     | ***    | 0.0000  | -0.0023 | 0.0410  | -0.0043 | 0.1079 | 0.0618 | 0.0357 | 0.0022  | 0.0494  |
| JAM  | NS     | ***    | NS     | ***    | **     | NS     | ***    | NS      | 0.0000  | 0.0443  | 0.0010  | 0.1127 | 0.0527 | 0.0268 | 0.0012  | 0.0378  |
| MAT  | NA     | NA     | NA     | NA     | NA     | NA     | NA     | NA      | NA      | 0.0000  | 0.0400  | 0.0563 | 0.1230 | 0.0985 | 0.0474  | 0.1074  |
| MED  | NS     | ***    | NS     | **     | NS     | NS     | **     | NS      | NS      | NA      | 0.0000  | 0.1222 | 0.0497 | 0.0251 | -0.0085 | 0.0357  |
| NEZ  | ***    | ***    | **     | ***    | ***    | ***    | ***    | ***     | ***     | NA      | ***     | 0.0000 | 0.1876 | 0.1757 | 0.1180  | 0.1842  |
| PJEZ | ***    | ***    | ***    | ***    | ***    | ***    | NS     | ***     | ***     | NA      | ***     | ***    | 0.0000 | 0.0272 | 0.0495  | -0.0051 |
| PRBL | **     | ***    | NS     | ***    | ***    | *      | **     | *       | *       | NA      | NS      | ***    | ***    | 0.0000 | 0.0251  | 0.0162  |
| REB  | NS     | ***    | NS     | **     | NS     | NS     | ***    | NS      | NS      | NA      | NS      | ***    | ***    | *      | 0.0000  | 0.0370  |
| STR  | **     | ***    | NS     | ***    | **     | ***    | NS     | **      | NS      | NA      | NS      | ***    | NS     | NS     | NS      | 0.0000  |
| UDV  | NS     | ***    | NS     | ***    | ***    | NS     | ***    | NS      | NS      | NA      | NS      | ***    | ***    | ***    | NS      | **      |
| VID  | NS     | ***    | NS     | ***    | NS     | NS     | ***    | NS      | NS      | NA      | NS      | ***    | ***    | ***    | NS      | *       |

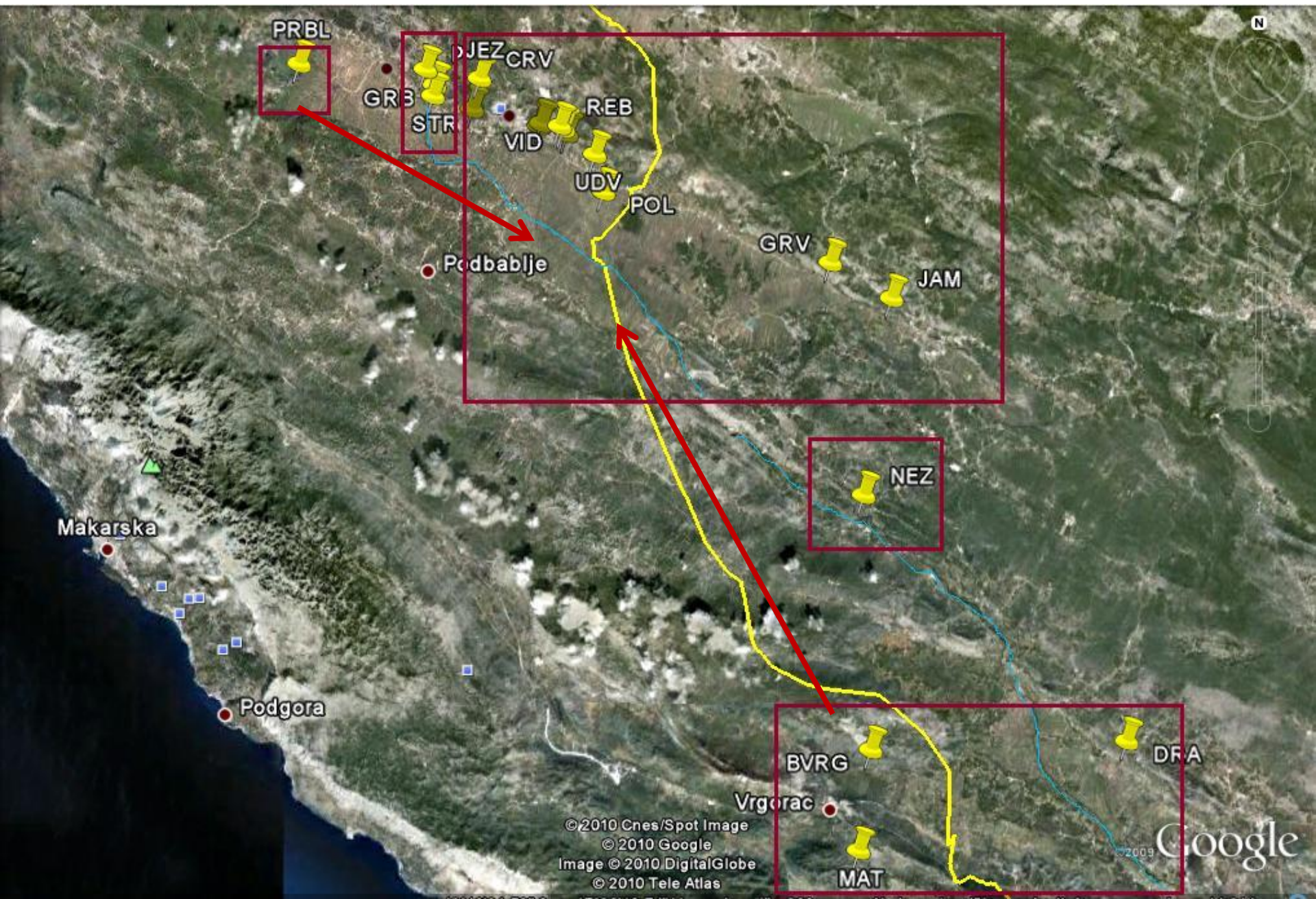
NA- nedovoljno podataka; NS-nesignifikantno; \*, \*\*,\*\*\*-različiti stupnjevi signifikantnosti (p-vrijednost 5, 1 i 0,1 %)

# Rezultati-MIKROSATELITI

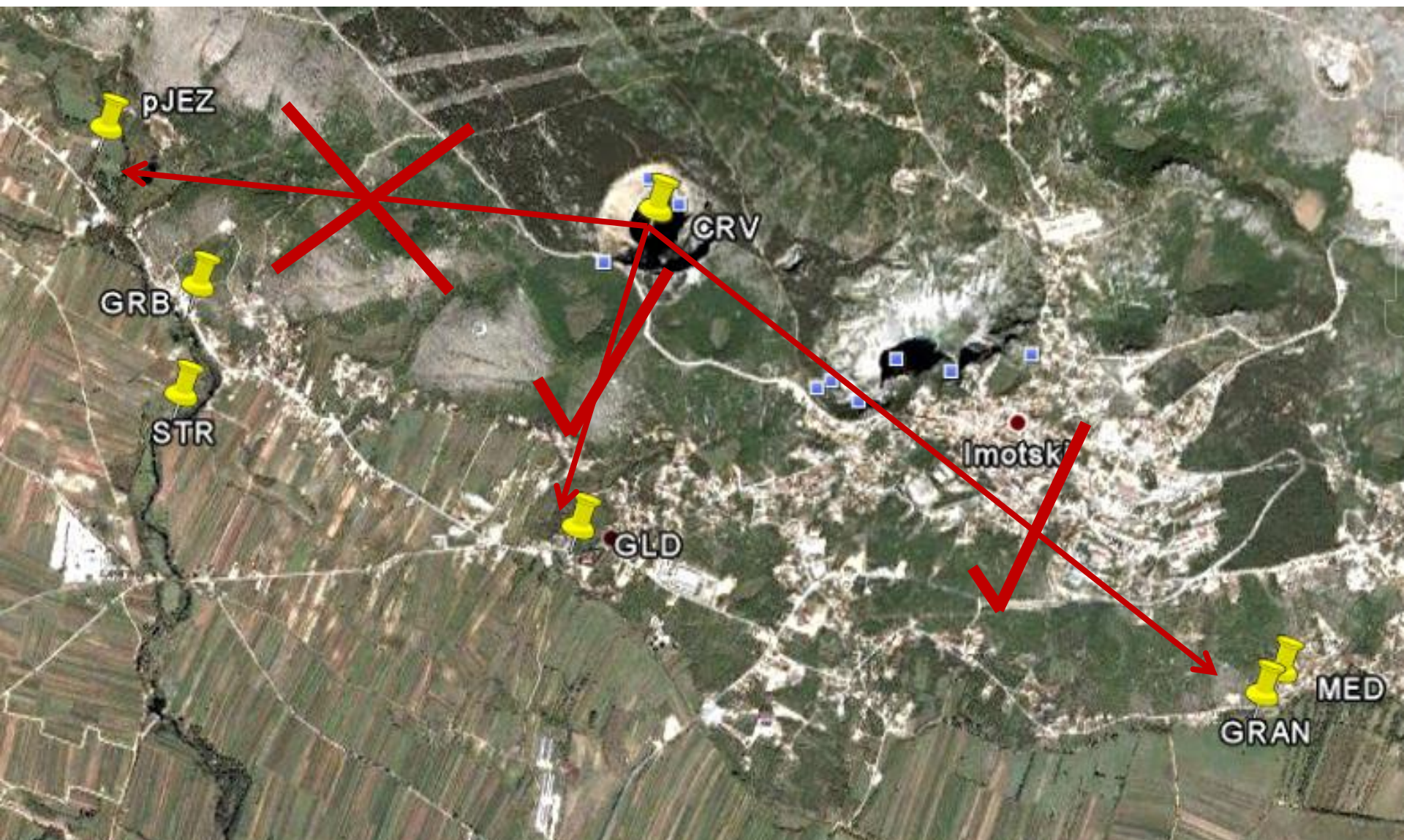
Razpoređivanje u pod-populacije



# Rezultati



# Rezultati



# Zaključci

- Na osnovi mitohondrijske DNK-jedna populacija, Nezdravica malo diferencirana.
- Na osnovi mikrosatelita, najmanje tri populacije.
- Populacija iz Nezdravice izolirana.
- Da bi objasnili demografsku strukturu, moramo pretpostaviti migraciju ispod zemlje!

