Genetic evaluation with uncertain parentage in aquaculture

In aquaculture

- physiological reasons
- logistic reasons

Mass spawning

- no control on the contributions of parents
- impossible to trace paternity of newborn
Knowledge of relationships helps to:

- estimate breeding values
- control the loss of diversity and the rise of inbreeding

Use of molecular markers to reconstruct genealogies
We seek

✓ every candidate assigned to a father and a mother

We find

✓ some fishes assigned to several possible parents

⇒ usually discarded

\[
\text{low cost breeding program}
\]

\[
\text{reduced number of markers}
\]

\[
\text{population structure}
\] → \[
\text{large proportion of the population}
\]
... possible solutions ...

- Enlarge the markers’ panel
- Higher budget
- Using more candidates

implies

- Deal with uncertain paternities/relationships
- Change methodology (software)

Opportunity for higher selection pressure

Higher accuracy of estimates of BV

Larger response
OBJECTIVE

➢ Study through simulation the advantages of:

✓ Genotyping with an increasing number of markers

✓ Using individuals with uncertain paternity
Population structure
- First round of sea bream breeding program from ABSA (Culmaredex)
- 1500 selection candidates
  - offspring from 50 males and 50 females

Mating strategy
- random (breeders in a single tank)
- controlled monogamous mating (FS families)

Trait (infinitesimal)
- Measured in candidates themselves
- $h^2 = 0.5$ or 0.1
Genotyping

- 4 or 8 microsatellites
  - real frequencies of sea bream population

- 25, 50 or 100 SNP
  - equal frequencies

Paternal assignment with tailored FORTRAN program

*probability of every ‘trio’ ⇒ probability of every possible parent*

- only assigned to a single mother and a single father
- a single parent of one sex and several of the other sex
- several mothers and several fathers
EBVs calculated through BLUP

- REMLf90 (I. Misztal)

Relationship matrix (accounting for uncertainties)

- U_P_C (J. Fernández)

Truncation selection of 50 highest EBVs
Benchmark selection strategies
- BLUP with real genealogical relationships
- truncation based on phenotypes

Control parameters
- percentage of parentage assignment
- correlation between selection criteria and TVB
- mean TVB of selected individuals
- mean coancestry of selected
- number of coincident selected
RESULTS

- Precision of paternity assignment

**Random**

<table>
<thead>
<tr>
<th></th>
<th>4 mic</th>
<th>8 mic</th>
<th>25 SNP</th>
<th>50 SNP</th>
<th>100 SNP</th>
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<tbody>
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<td>30.51</td>
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**FS families**

<table>
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<th>50 SNP</th>
<th>100 SNP</th>
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<td>98.72</td>
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</table>

- no genotyping errors
- unrelated breeders (families)
Efficiency of selection

- mean TBV of selected

<table>
<thead>
<tr>
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<tbody>
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<td>108.62</td>
<td>109.73</td>
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<tr>
<td>8 mic</td>
<td>110.72</td>
<td>110.72</td>
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</tr>
</tbody>
</table>

- improvement due to more evaluated
- almost no change in the rest of scenarios
- BLUP_G better or equal than anyone
- Using phenotype worse (except extreme cases)
Similar results with the other heritability

⇒ but responses lower (obviously)

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Percentage of selected individuals coinciding

<table>
<thead>
<tr>
<th></th>
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<td>99.30</td>
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<td></td>
</tr>
<tr>
<td>100 SNP</td>
<td>100.00</td>
<td>100.00</td>
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</tbody>
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- very similar with acceptable assignment probabilities
- slightly lower figures for low heritability
Including individuals with multiple paternities is not advantageous.

Paternity assignment improves greatly if mating is controlled.

Uncertain relationships may difficult to implement OC to control the lose of diversity and the rise of inbreeding.
FURTHER REMARKS

- Some other factors to be accounted for
  - genotyping errors may exist
  - more uncertainty expected if breeders are relatives and/or inbred

- Probably larger benefits when dealing with later generations
  - mixed offspring from selected and unselected breeders
  - more uncertainty expected in selected families (higher inbreeding)

- Repeat study with the second round of selection
UNCERTAINTY = PROBLEMS
Thank you!

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A. Millán
P. Martínez