Variation in *Talitrus saltator* strategies as response to environmental change

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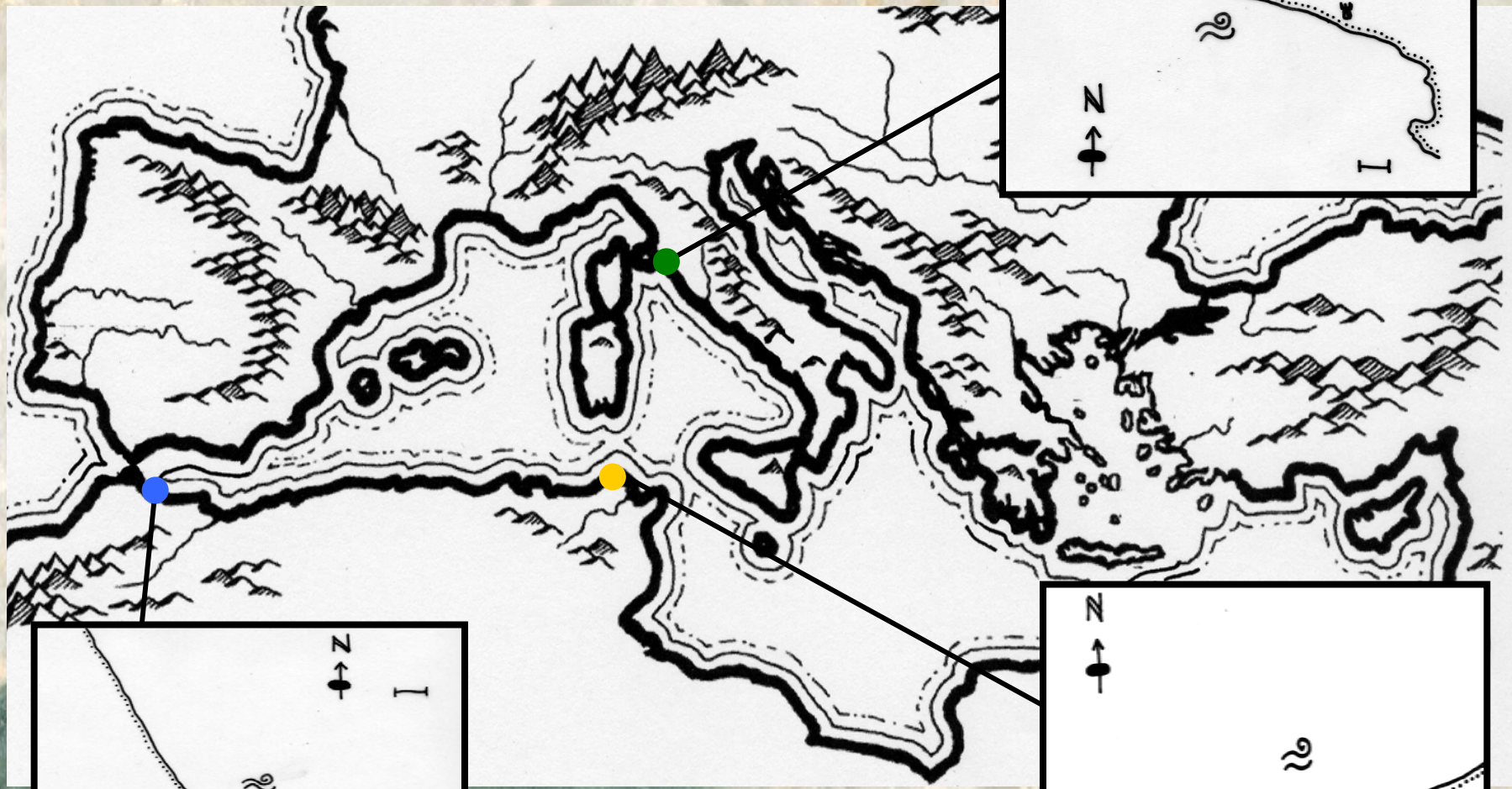
During the day, the “safe place” for *Talitrus saltator* is represented by the wet sand zone, where it can burrow, avoiding both to get dry and to be swashed away by the sea.

Therefore, orientation capability is needed to recover the safe place, in case of displacement

Cues for orientation: visual, slope, magnetic field

The same cue could be used for multiple mechanisms, e.g. the sun vision could be used for a sun compass or for a simple phototaxis

Study-site approach



Study-site approach

Material and methods

On field:

A circular arena, placed directly on the beach was used to test the orientation of animals collected *in loco*. Traps at the arena's rim, subtending 5° each, were used to calculate the direction chosen by the animals. The landscape vision was avoided, when needed, by placing a white cardboard 10 cm height all around arena's side.

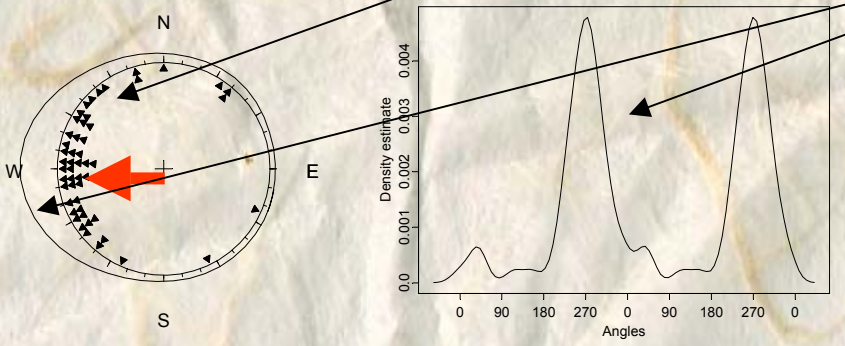
Air temperature, air humidity, sun visibility and sky cover were recorded at every release of animals.

In the lab:

Individual characteristics of the sample were measured: size (as cephalon length), age (as number of 2.antennae tagma) and sex

Material and methods:

statistical analysis

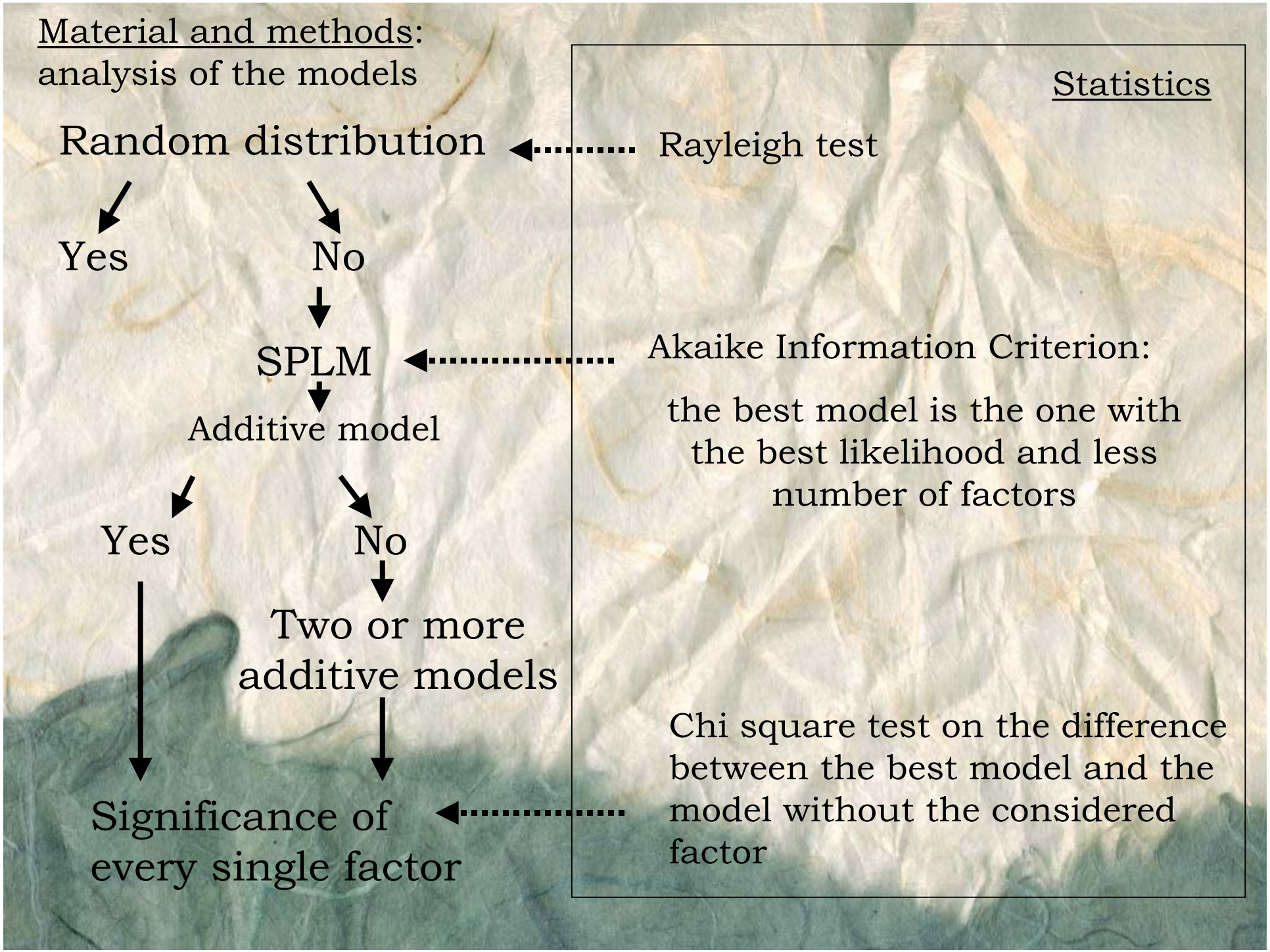


Dots: individual choices

Curves: density graphs (smoothed with kernel)

0< **r** < 1: *precision* around the mean value

TED (Theoretical Escape Direction) ,perpendicular to the shoreline, included in IC (Batschelet, 1972): *directional choice*


Material and methods:
analysis of the models
Random distribution
Yes
No
SPLM
Additive model
Yes
No
Two or more additive models
Significance of every single factor
Statistics
Rayleigh test
Akaike Information Criterion:
the best model is the one with the best likelihood and less number of factors
Chi square test on the difference between the best model and the model without the considered factor

Berkoukech

One site, on left bank of Oued Berkoukech

Experiments in April and June

With and without landscape

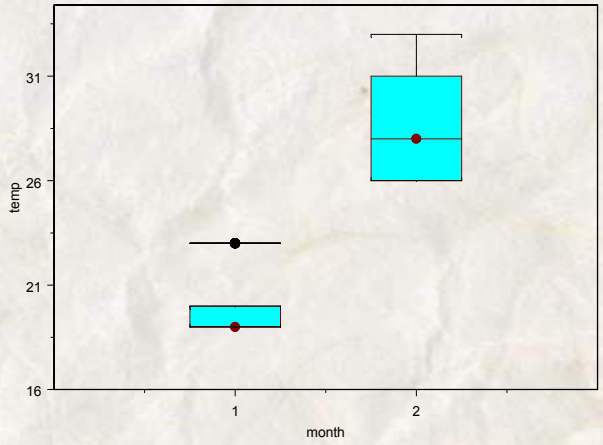
TED 320°

Model: **interaction** with the factor “month”

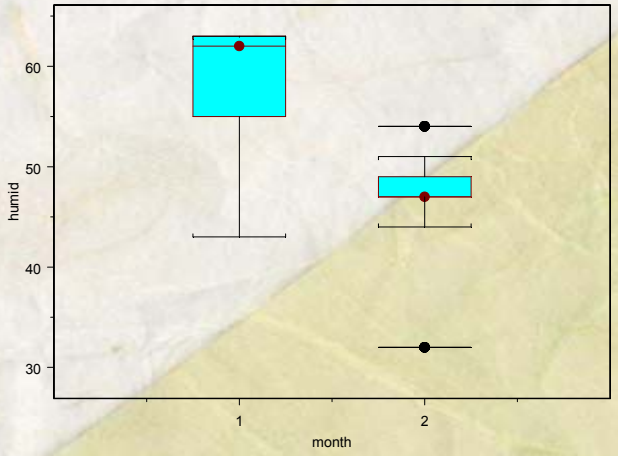
What kind of information does “month” include?

<u>Abiotic:</u>

air temperature (°C);



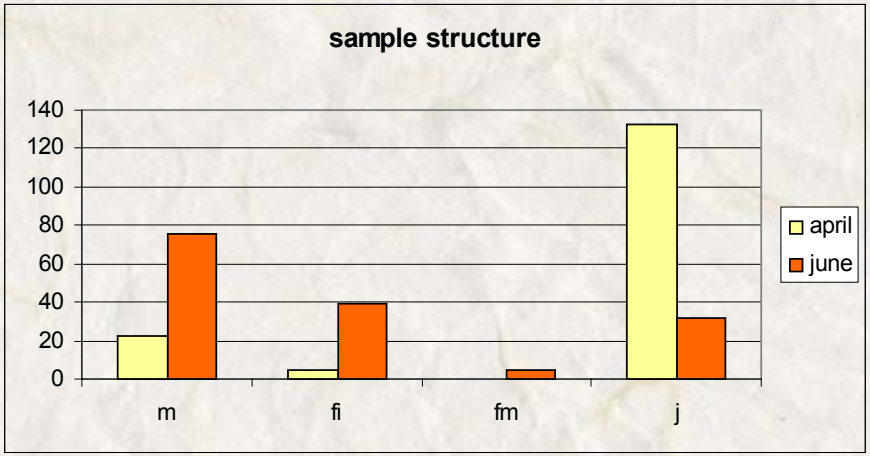
air relative humidity (%)



Berkoukech

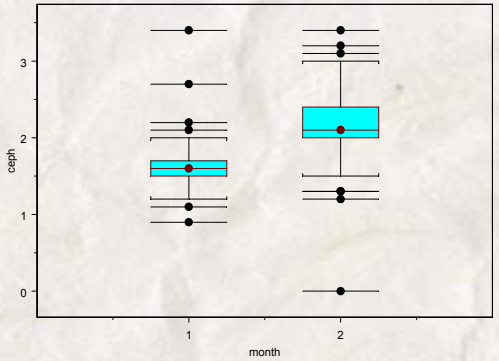
Biotic:

sample structure



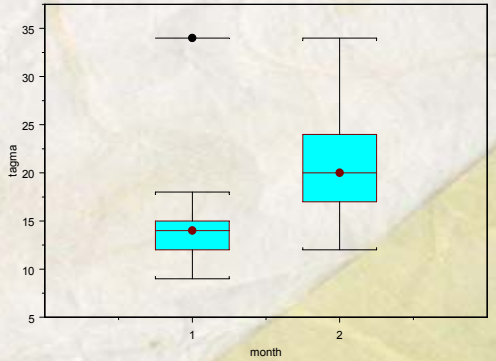
(few *Talorchestia brito* were found and excluded in the following analysis)

cephalic length (mm);



Sandhoppers found <u>on the dune</u>

tagma of second antennae (n)

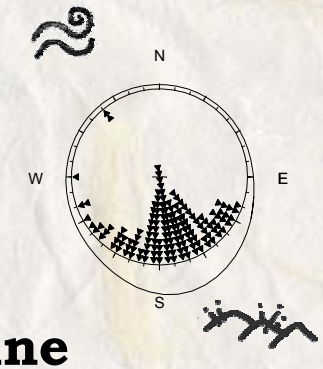


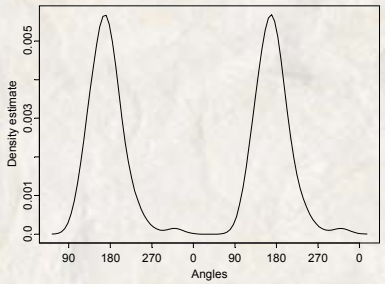
Sandhoppers found <u>on the shore</u>

Berkoukech

April

orientation ~ time of the day** + age* + sun azimuth**

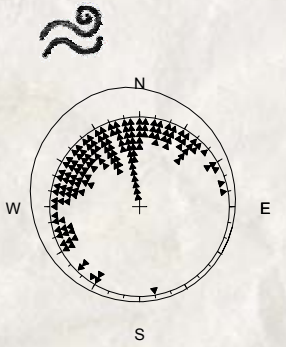


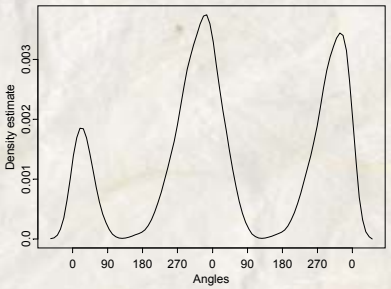


Mean 170.1
r 0.8437**
N 148
IC 95% ± 5° shorter dune direction included

June

orientation ~ landscape vision** + age + temperature* + sky cover*



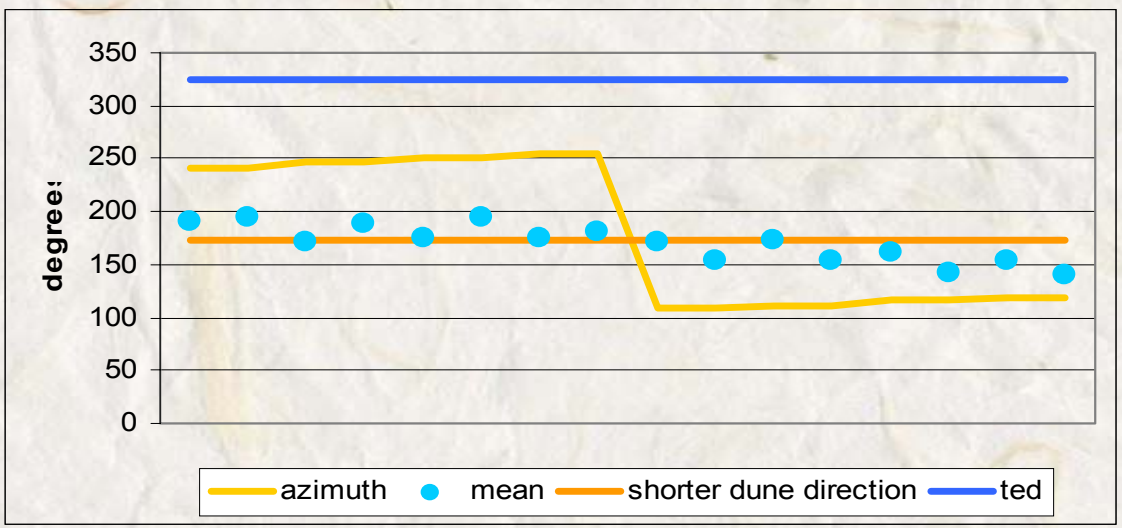


Mean 329.1
r 0.6709**
N 152
IC 95% ± 9° TED included

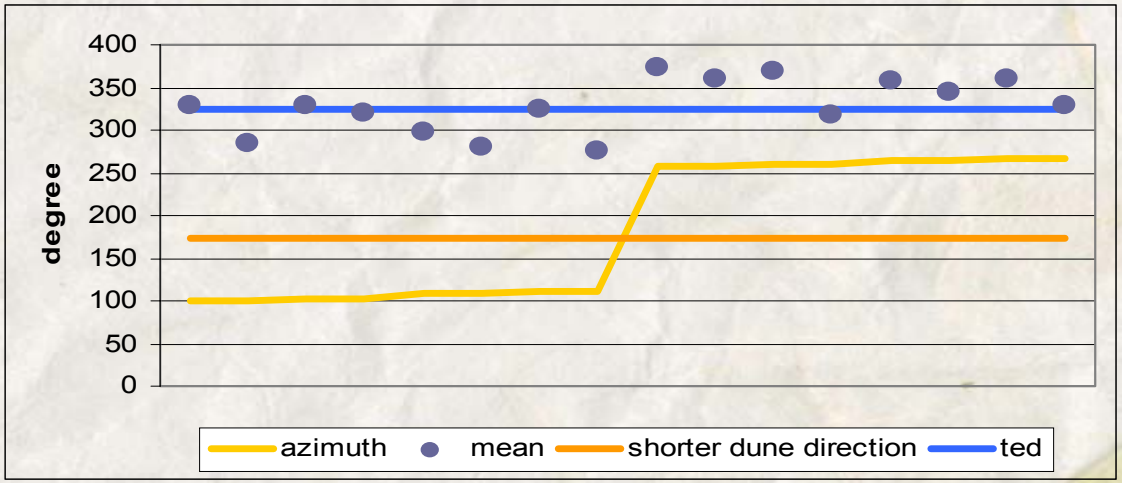
Berkoukech

Means of the single groups released

April



June



TED

shorter dune direction, perpendicular to dune inclination

Oued Laou

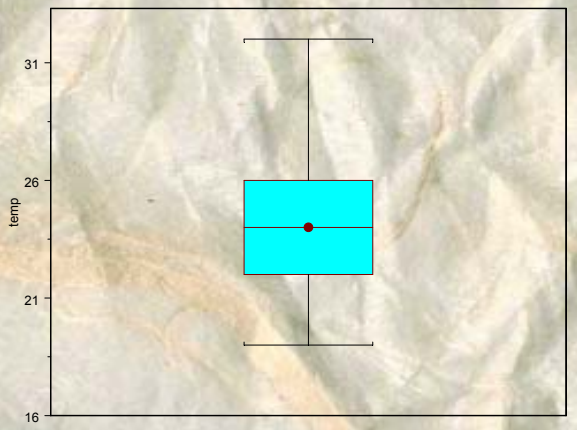
Two sites: left and right bank of the Oued Laou
(2 km far each other)
TED 60°
experiments with and without landscape

Model: **interaction** with factor “oued bank”

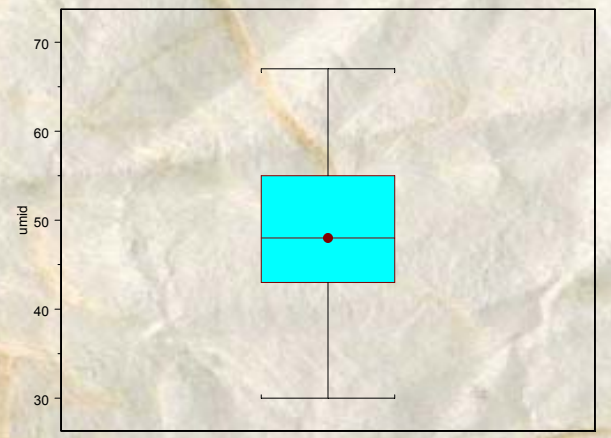
What kind of information includes “oued bank”?

<u>Abiotic:</u>

air temperature (°C);



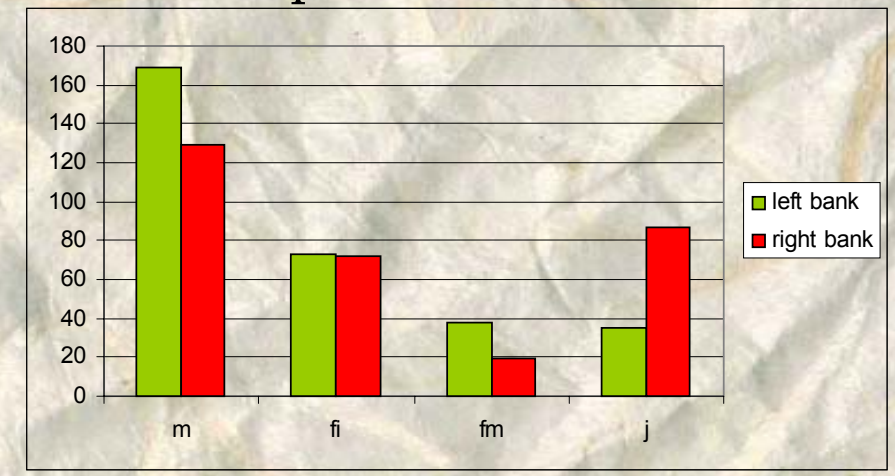
air humidity (%)



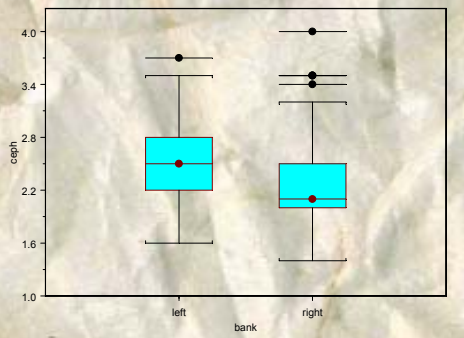
Oued Laou

Biotic:

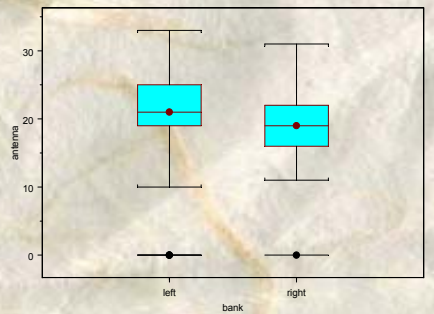
sample structure



cephalic length (mm)



tagma of second antennae (n)



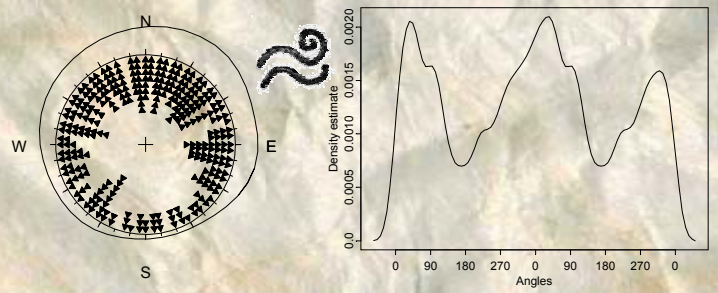
Difference in human use between banks

Oued Laou (left bank) **Ka'asrass** (right bank)

Oued Laou

left bank

Orientation ~ ampm* + age** + sex* + temperature* + humidity* + sky cover* + sun visibility**

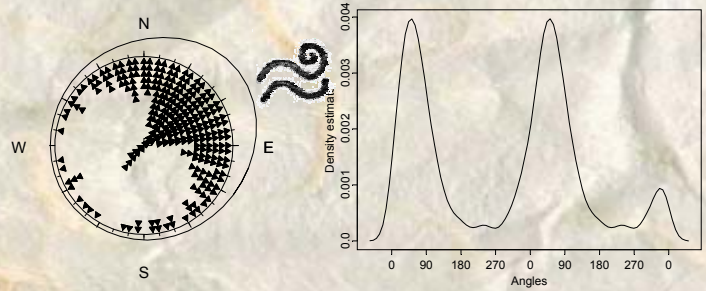


Mean 14.21
r 0.2313*
N 314
IC 95% ± 27° TED not included

right bank

Orientation ~ day** + solar time** + age* + sun visibility**

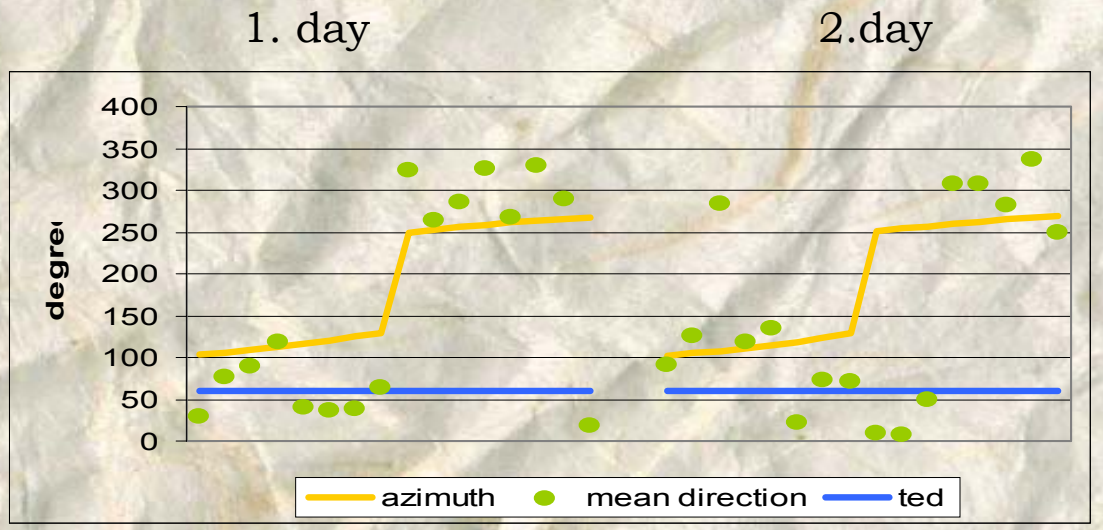
Mean 51.75
r 0.6275**
N 306
IC 95% ± 9° TED included



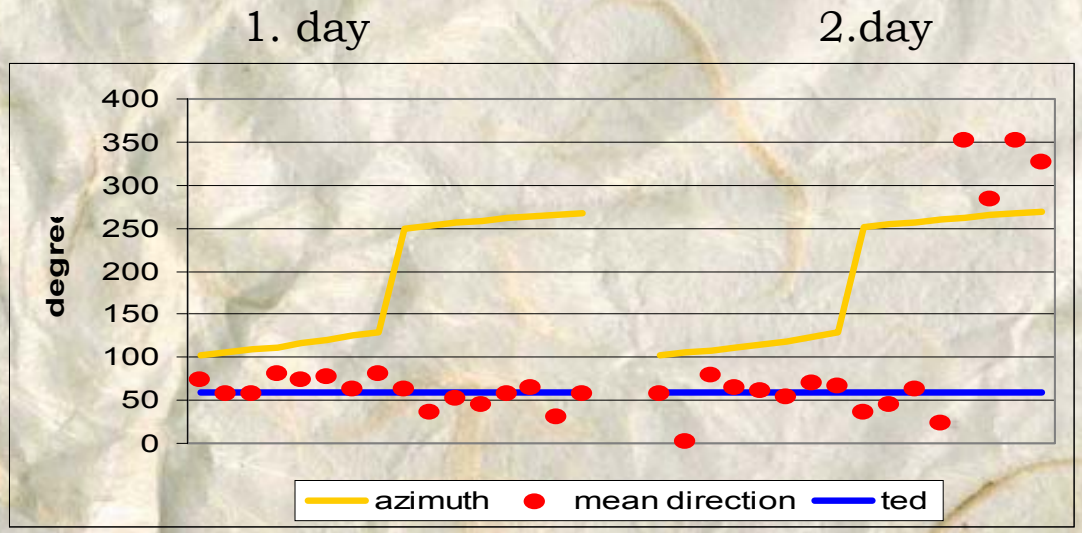
Oued Laou

Means of the single groups released

Left bank



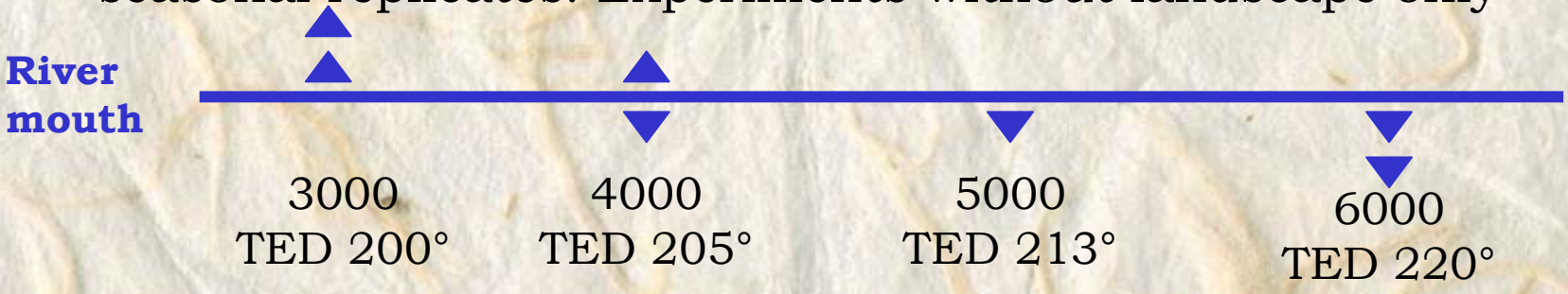
Right bank



Maremma Regional Park

Four sites, subjected to different shoreline dynamics

seasonal replicates. Experiments without landscape only



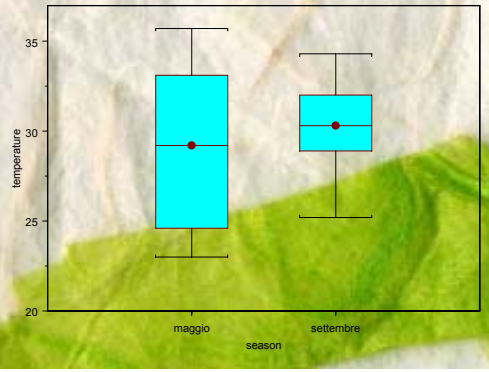
Model: **no interactions** between factors

Best model

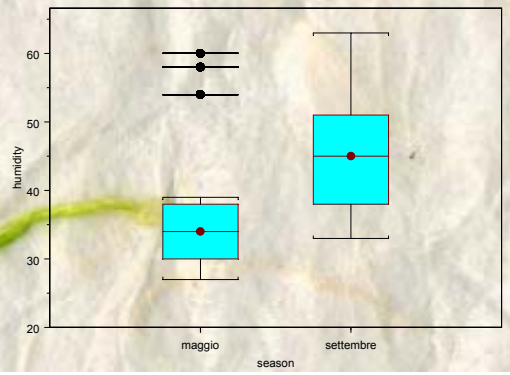
Orientation ~ season** + sun** + ampm** + trampling** + distance from river mouth** + air humidity + sex

seasonal variations:

air temperature (°C)



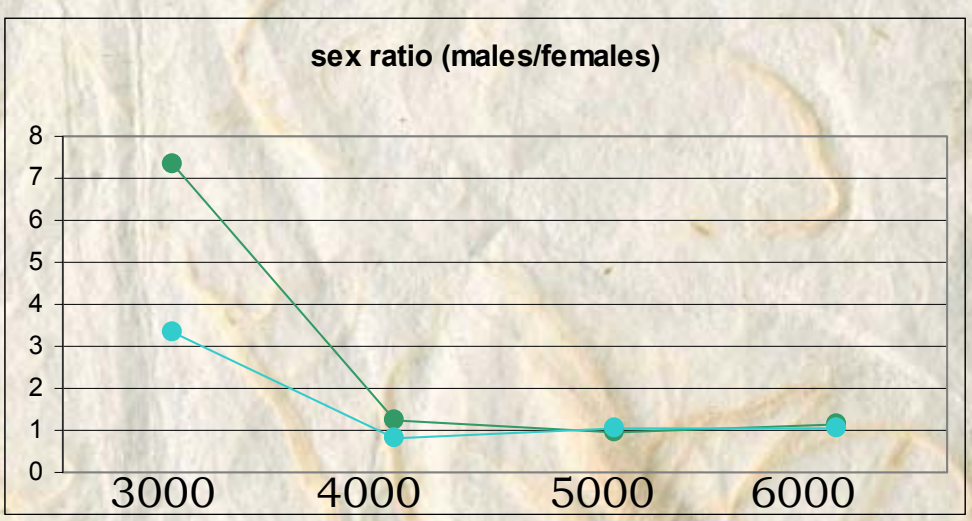
air relative humidity (%)



Maremma Regional Park

Seasonal differences of the sample

juveniles were few and not considered in the experiment



Different seasonal trampling

The estimated trampling was divided in level low-medium-high

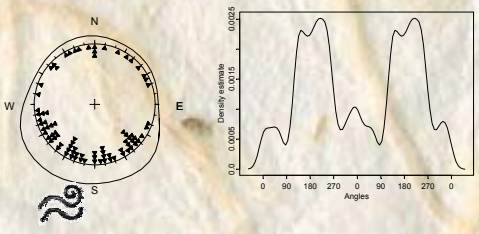
	Autumn	**Spring**
3000	high	low
4000	low	low
5000	medium	medium
6000	low	low

Maremma Regional Park

Orientation ~ season** + sun** + ampm** + trampling** + distance from river mouth** + air humidity + sex

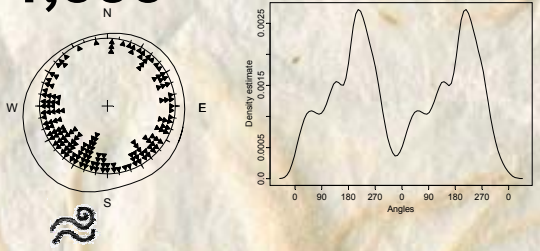
3,000

Sept 2002



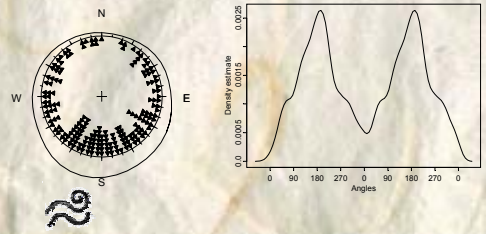
Mean 198.5°
r 0.3549**
N 82
IC 95% ± 22° TED included

4,000

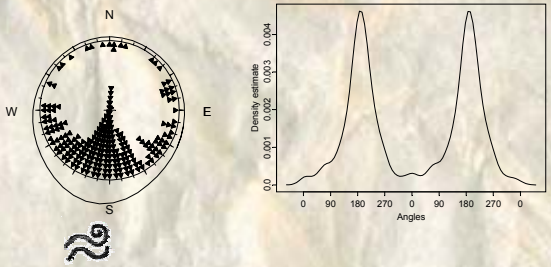


Mean 201.1°
r 0,3208**
N 163
IC 95% ± 24° TED included

May 2003



Mean 179.6°
r 0.3409**
N 191
IC 95% ± 22° TED included



Mean 189.5°
r 0,6493**
N 250
IC 95% ± 8° TED not included

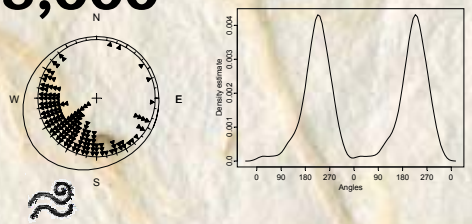
Maremma Regional Park

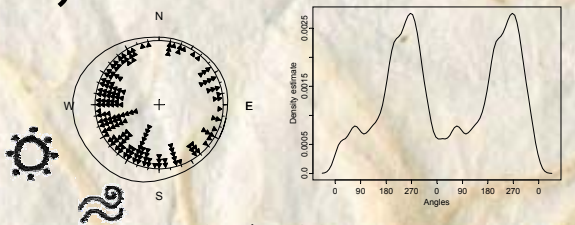
Orientation ~ season** + sun** + ampm** + trampling** + distance from river mouth** + air humidity + sex

5,000

6,000

Sept 2002

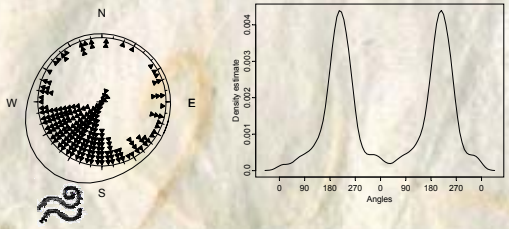


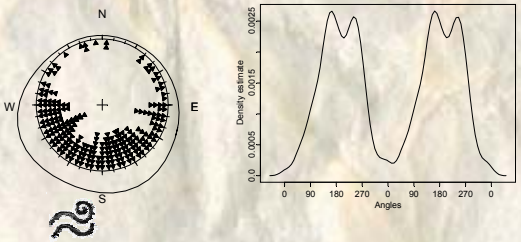


Mean 179.6°
r 0.6974**
N 166
IC 95% ± 10° TED not included

Mean 247.1°
r 0.3862**
N 166
IC 95% ± 19° TED not included; azimuth pm included

May 2003





Mean 179.6°
r 0.6464**
N 231
IC 95% ± 8° TED not included

Mean 192.8°
r 0.4784**
N 245
IC 95% ± 13° TED not included

conclusions

The use of sun vision could be different, depending of the stability of environmental conditions:

- The sun compass mechanism is used in cases of environmental stability, when the population can fix in its behaviour the directions towards safety, being sure that they will not change through time.

Sun compass use can also be combined with environmental experience, to face sudden but temporary disturbances.

- The phototaxis is mainly used in cases of environmental instability, co-occurring with less precision, because it is more plastic than the sun compass and often related with fringe populations or explorative behaviour.

conclusions

Landscape vision is also a cue for orientation, but with a minor weight in the choice of the escape direction.

Differences in behaviour regarding sex and age of the individuals were also observed.

Such differences are related with the precision of the direction, not with the direction chosen.

acknowledgements

MECO and MEDCORE projects

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Thank you for your attention