SAND FLY BIOLOGY AND MANAGEMENT

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WHY SAND FLY BIOLOGY SUFFERS?

Ordo: Diptera

Family: Psychodidae

Subfamily: Phlebotominae

Genus: ***Lutzomyia***, *Brumptomyia*, *Warileya* — New World

Phlebotomus, *Sergentomyia*, *Chinius* — Old World

- Small size
- Morphological similarity
- Difficult to rear in the laboratory conditions
- Difficult to find immature stages in the field conditions (Munstermann, 2005)

SAND FLY BORNE DISEASES

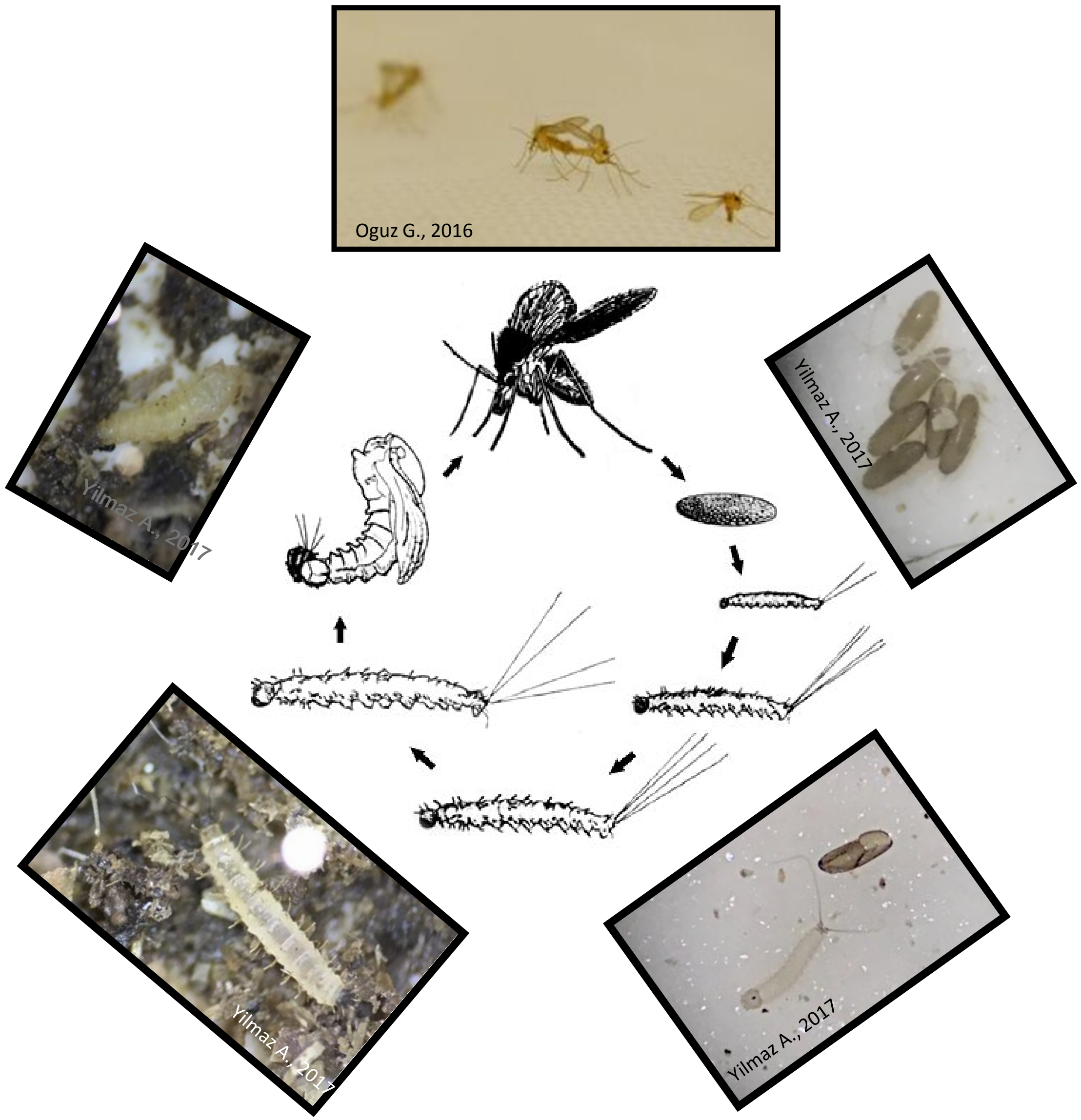
Bartonellosis

Vesicular Stomatitis
Sand Fly Fever

Leishmaniasis

LIFE CYCLE

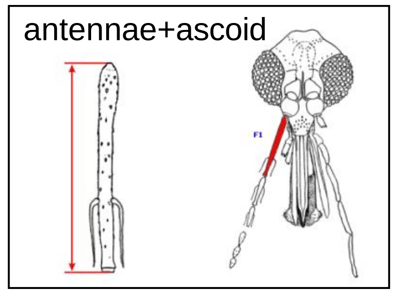
- Holometabolous
- Longer life cyle (6 weeks or more)
  > Species
  > Temperature, humidty, rainfall
- Oviposition takes place in humid, dark and organic material enriched habitats (Terrestrial)
- 20-100 eggs per female
- Detrivorous four instar larvae
  > 2-10 mm (1^{st}- 4^{th} instar)
  > Thick, sclerotized cuticle
  > Diapause in fourth instar
- Immobile pupa

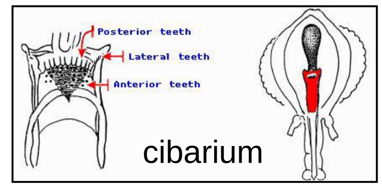


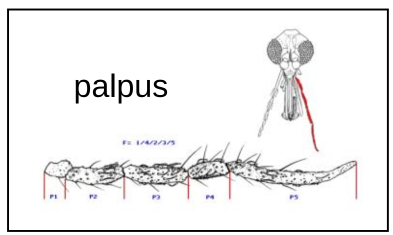
ADULTS

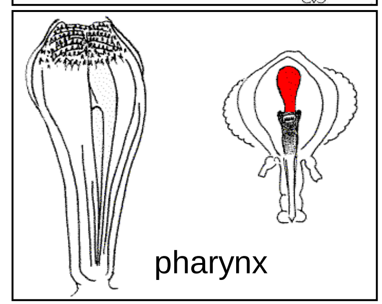
MORPHOLOGY

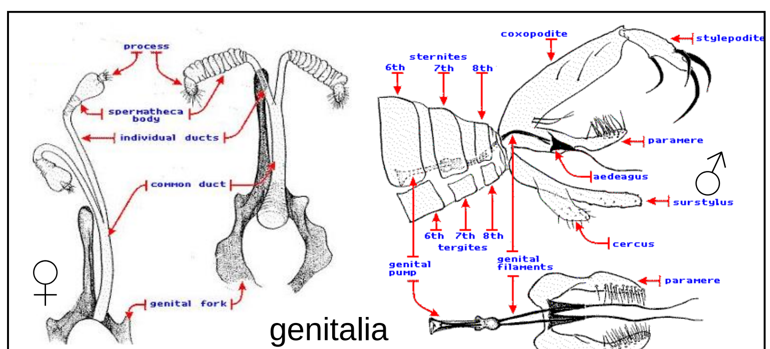
- Small in size (2- 4 mm).
- Dense covering of scales on body
- V shape erected wings
- Morphology based taxonomy
- Keys are avalible only for adults
- Problems with species complexes
- Complementary tools (DNA barcoding, etc) have been widely used.











ADULTS

FEEDING BEHAVIOUR

- Females and males feed on several plant species.
- Only females feed on vertabrate hosts.
- Autogeny (*P. mascitii* ?)
- Opportunistic feeders (chicken to human).
- Antropophilic species
- Zoophilic species

- Mixed bloodmeal source
  > *P. tobbi* (Turkey, human-cattle, human - vole)
- Nocturnal feeding activity.

ADULTS

MATING

- Mating occurs

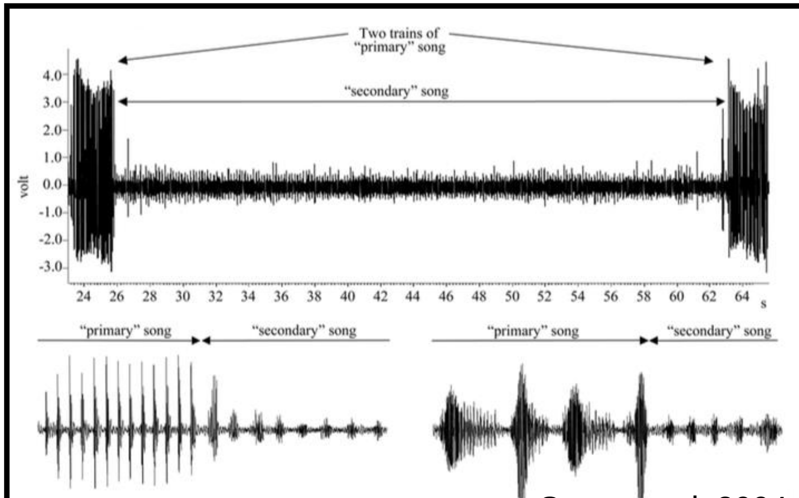
  > Near or on the hosts

  > Before, after or during the boold feeding

- Species spesific pheromones and courtship songs help conspecific sexes find each other.

  > *Period* and *cacophony* genes controls the courtship behaviour

  > *Period* gene also important for circadian activity and speciation



Souza et al, 2004.

Gizem Oğuz

E. Rowton

ADULTS

BREEDING SITES

- Antennal ascoids play an important role for finding a suitable oviposition site.
  > Conspesific eggs (dodecanic acid)
  > Organic material like chicken and rabbit faeces (hexanal and 2-methyl-2-butanol)
- First report of an immature sand fly in 1907 by Grassi, in a cellar (*P. mascittii*)

- Time consuming, difficult and inefficient techniques:
  > Direct visual search
  > Emergence traps
  > Soil extraction via flotation
  > Soil incubation

ADULTS

BREEDING SITES

Domestic
abondened buildings
basements and cellars
cracks in floors and walls

Peridomestic
animal shelters
caves, embankments
rotted manure, wells

Sylvatic
ant nests, termite hills
rodent burrows, rocks
leaf litter
roots and holes of trees

Alencar et al., 2011

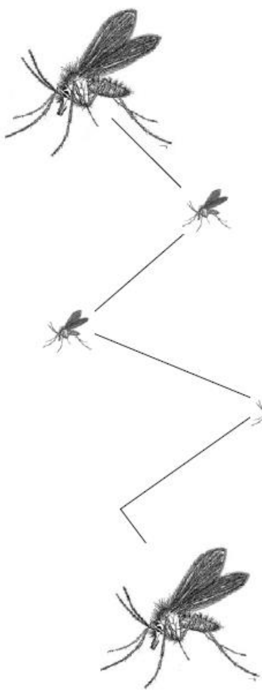
Haouas et al., 2017

M.D. FELICIAGELI, 2004, Med. Vet. Entomol.

ADULTS

DISPERSAL

Characteristic 'hopping movement'



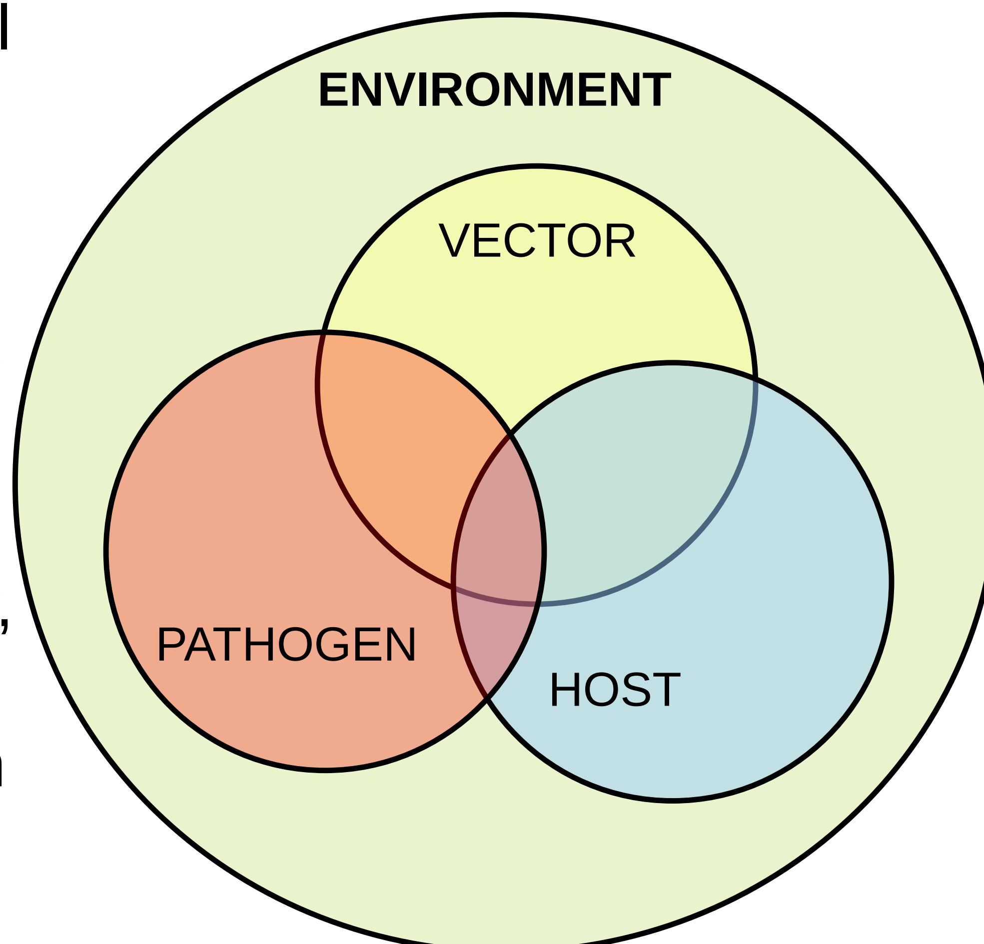
Y.Özbel

- Good indicator for breeding sites and important for planning control strategies
- Known as poor fliers
  > Average flight range ~ 300 m
  > Forest species are less active
- *P. ariasi* in France: ~ 2 km (Killick Kendrick et al., 1984)
- *P. papatasi* in Israel: ~ 2 km (Orshan et al., 2016).

Orshan et al., 2016

FACTORS AFFECTING SAND FLY SURVIVAL AND BIONOMICS

- Many invastigations on the influence of the environmental factors on the bionomics in several countries.
- Temperate regions: temperature, relative humidity and wind velocity
- Tropic-Sub tropical regions: temperature, relative humidity, rainfall.
- Results varies depending on the species, population and the geographical origin.
- Limited number of laboratory experiments.



Reisen, 2010

WHAT DID WE LEARN FROM LABORATORY STUDIES?

- Adult longevity decreased as the temperature increased.
- No oviposition at 15 °C.
- Negative correlation between the oviposition period and the tempearture.
- Extreme temeparatures had negative effect on fecundity.
- The highest r_m at 28 °C.
- Negative correlation between the generation time and the temperature.

Age spesific mortality and fecundity for *P. papatasi* at six different constant temperature conditions.

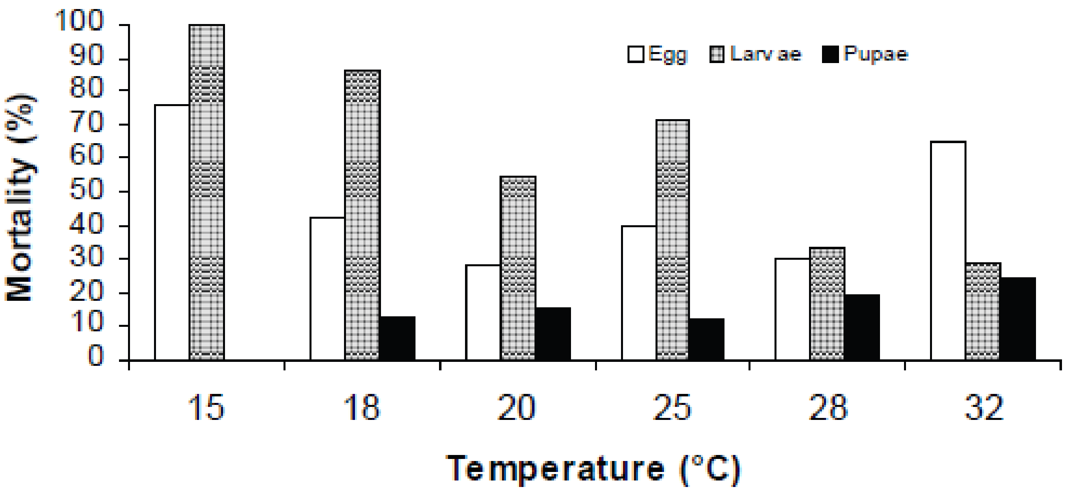
Temperature (°C)	Oviposition period (days)*	number of eggs per female*	Adult longevity (days)**	
			female	male
15	-	-	19.04 ± 6.94	17.84 ± 7.11
18	13.00 ± 2.83	2.80 ± 0.90	11.64 ± 3.89	14.96 ± 4.00
20	8.27 ± 2.00	22.24 ± 3.32	9.92 ± 2.48	10.00 ± 2.68
25	6.33 ± 1.53	20.28 ± 3.73	7.72 ± 1.94	7.72 ± 1.53
28	7.68 ± 2.26	44.08 ± 7.79	10.08 ± 3.04	11.00 ± 3.46
32	4.00 ± 0.00	3.60 ± 1.55	5.76 ± 1.12	6.20 ± 1.52

Temperature (°C)	Intrinsic rate of increase (r_m)*	Net reproductive rate (R_0)	Generation time (T)
18	0.007	2.660	271.365
20	0.031	6.780	123.485
25	0.050	8.710	54.415
28	0.098	15.870	56.218
32	0.011	1.210	36.00

Erişöz Kasap and Alten, 2006

WHAT DID WE LEARN FROM LABORATORY STUDIES?

Degree-day developmental requirements of *P. papatasi*



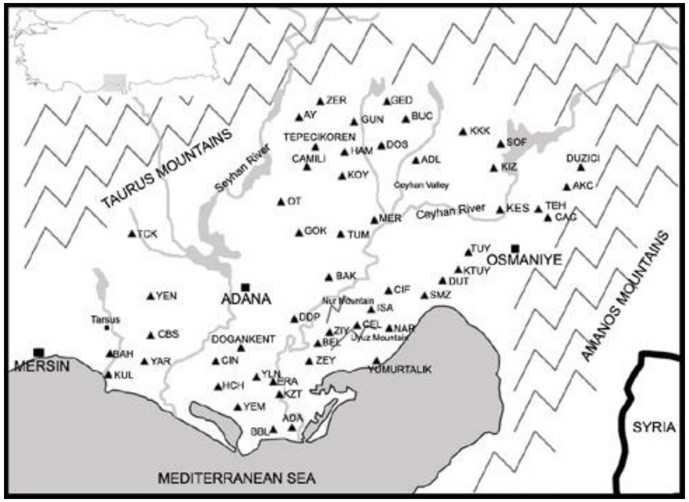
Stage	Slope	Intercept	r^2	z (°C)	DD (day)
Egg	0.01010	- 0.11753	0.59	11.60	98.97
Larva	0.00302	- 0.05984	0. 32	19.81	330.66
Pupa	0.01260	- 0.22216	0.61	17.63	79.36
Egg to adult	0.00226	- 0.04597	0.25	20.25	440.55

Erişöz Kasap and Alten, 2005

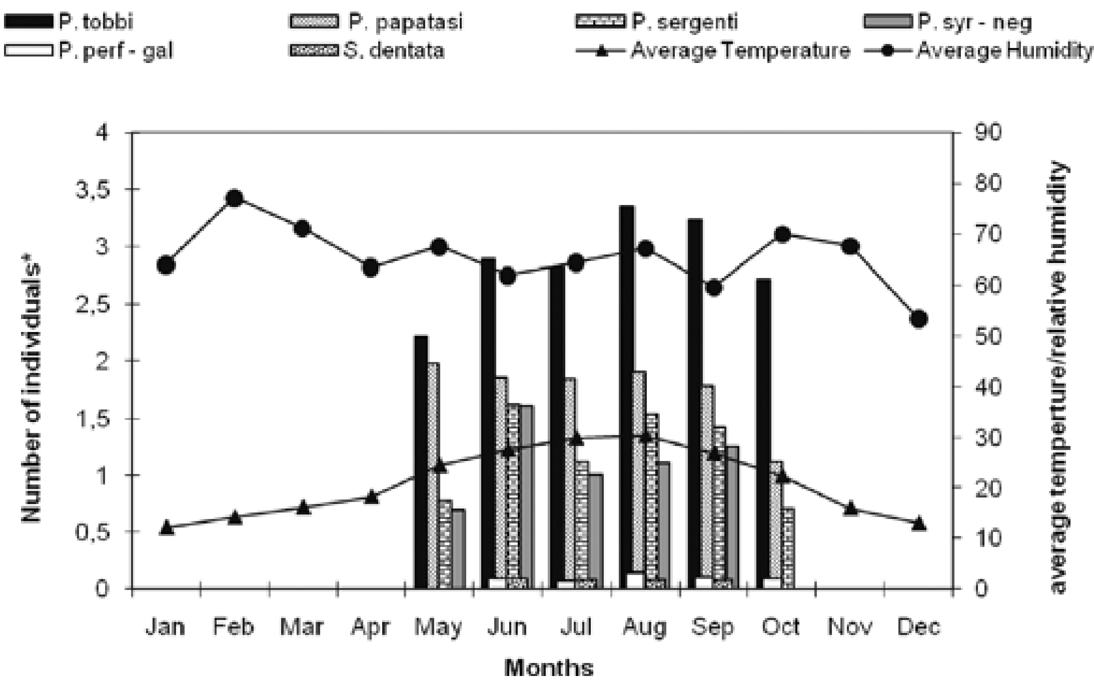
- No adult emergence was observed at 15 °C.
- Reduction in development time with increasing temperature.
- Egg stage was more sensitive to higher temperatures, larval stage was more sensitive to lower temperatures.
- 20.25 °C as a threshold for complete development (egg to adult).
- Useful in predicting the seasonal dynamics in the field conditions?

WHAT DID WE LEARN FROM THE FIELD?

- Adana: CL focus in Turkey. $T_{avr} < z_{egg\text{-}adult}$ (20.25 °C) before May and after October.

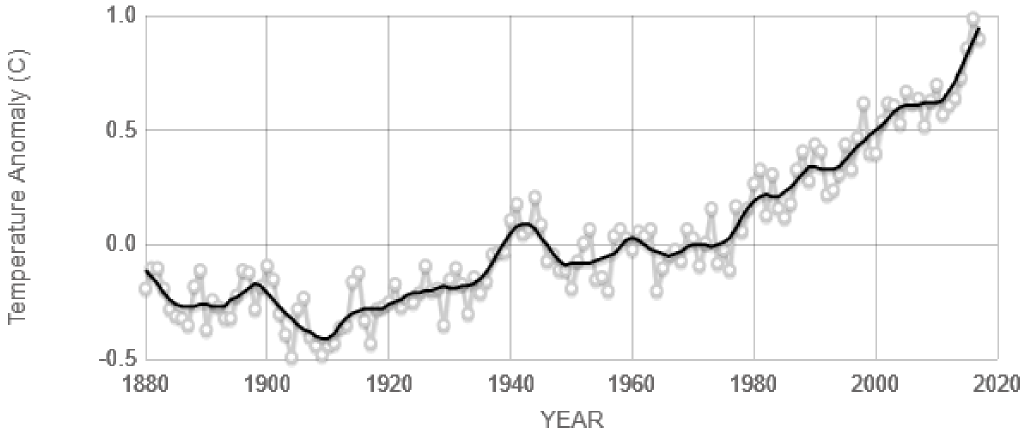


- 52 villages were investigated (78 – 530 m asl)
- First adult activity start in May.
- Adults disappeared after October.
- No correlation observed between the monthly temperature, RH and adult density.

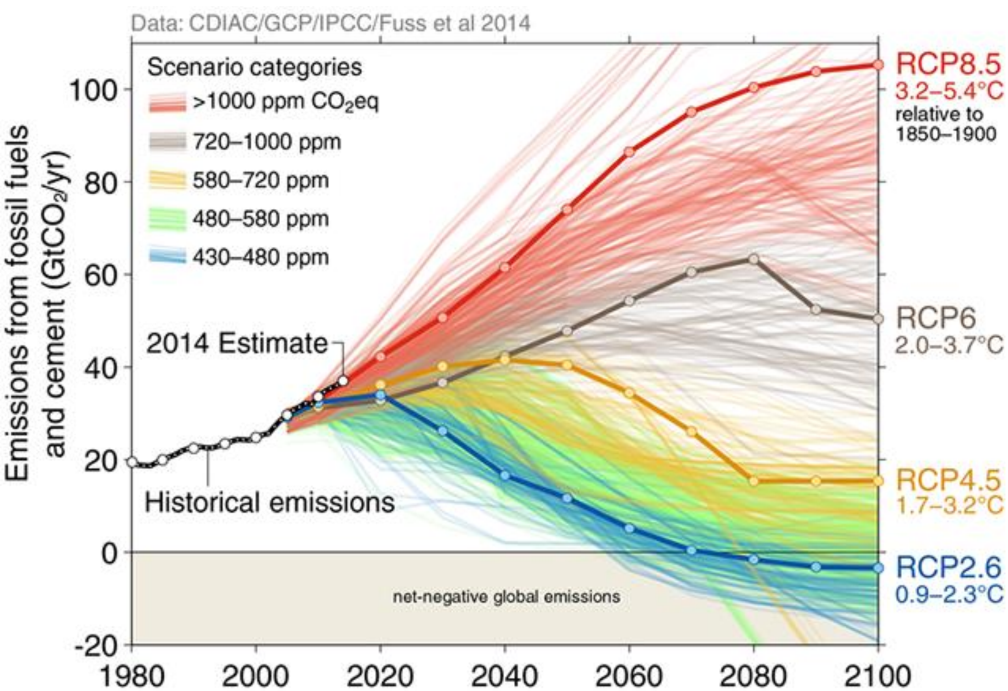


Belen and Alten, 2010

SAND FLIES AND GLOBAL WARMIG



Source: climate.nasa.gov



- Surface temperature has already risen 1.1 °C.
- Mediterranean is more vulnerable.
- An increase in average temperature (2.2 – 5.1 °C) and a decrease in precipitation is espected.

1. Change in distribution area.
   > shift towards northern latitudes and higher altitudes
   > range expansion
2. Change in phenological events.
3. Reduction in body size.

EUROPEAN SAND FLIES IN THE 21st CENTURY

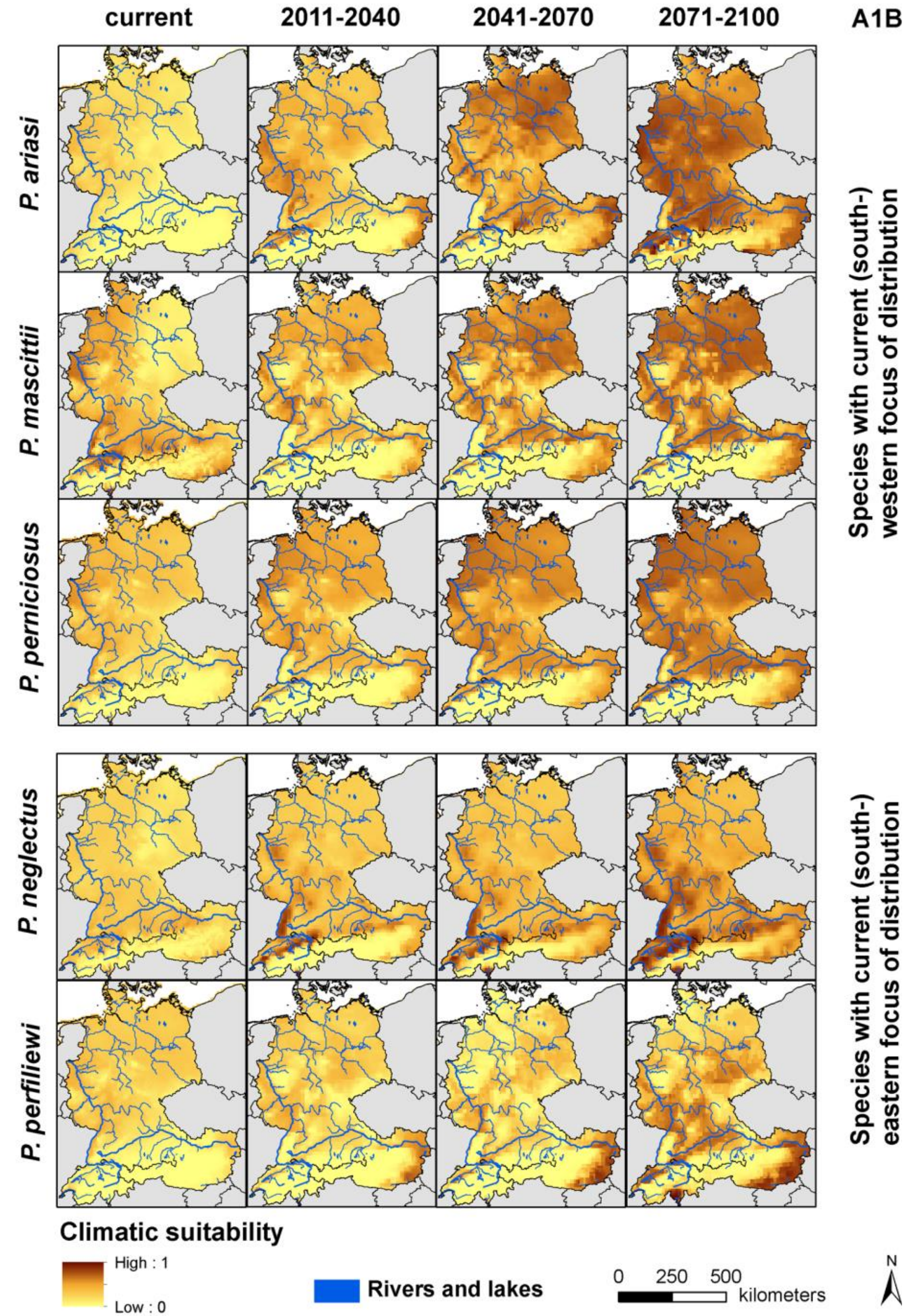
• Increase in temperature will provide suitable niches for all of the species.

• Dispersal ability is important for future expansion.

> *P. ariasi* seems to disperse a wider range of area.

> A limited expansion is expected for *P. perfiliewi* (Fisher et al., 2011).

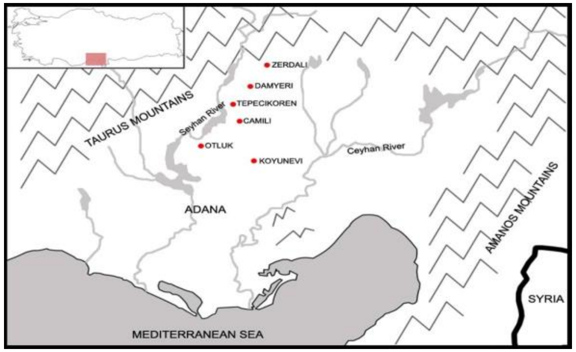
• Reduction in distribution and shift to higher altitudes for Colombian *Lu. evansi* and *Lu. longipalpis* (Gonzales et al., 2013)



PHENOLOGY OF MEDITERRANEAN SAND FLIES

Alten et al., 2016

- 8 partners from Mediterranean countries (Georgia, Turkey, Cyprus, Greece, Italy, France, Spain, Portugal)
- Entomological investigations in locations *L. infantum* has been reported.



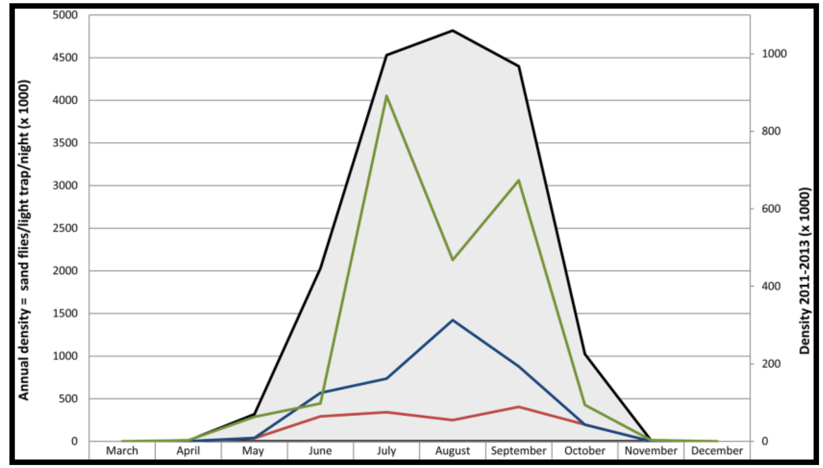
- Standart protocol for sampling:
  > CDC + sticky traps.
  > Monthly sampling (2 nights) during consecutive 2 - 3 seasons at the same station.

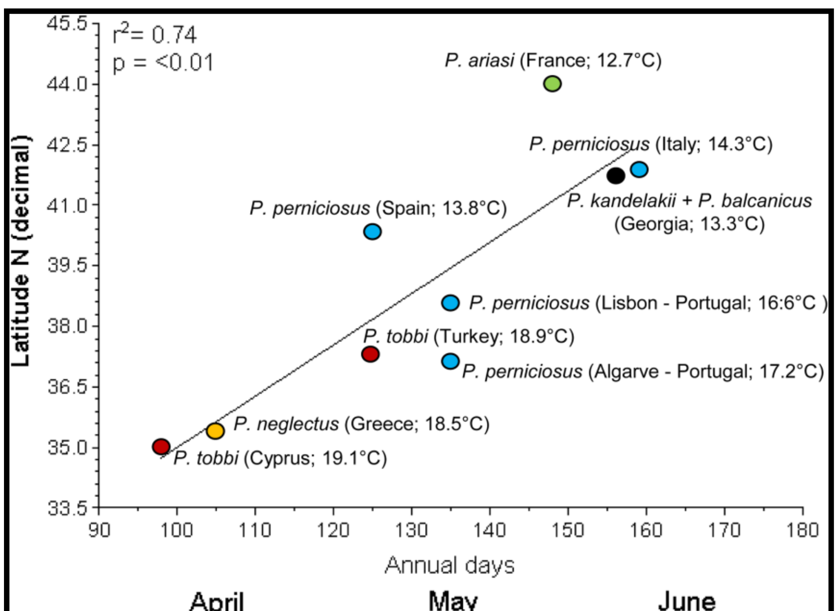
EDENext
Biology and control of vector-borne infections in Europe

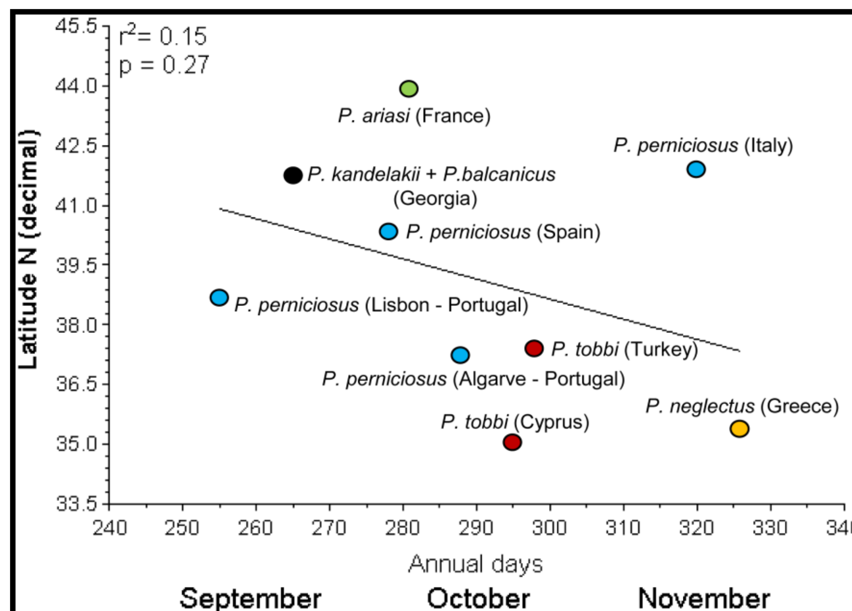
PHENOLOGY OF MEDITERRANEAN SAND FLIES

- Significant correlations between latitude/mean annual temperature and the first appearence of sand flies
  - > except for *P. ariasi*
- No correlation for lattitude/ temperature and the disappearance of sand flies
- No transmission risk from Decemcer to March.

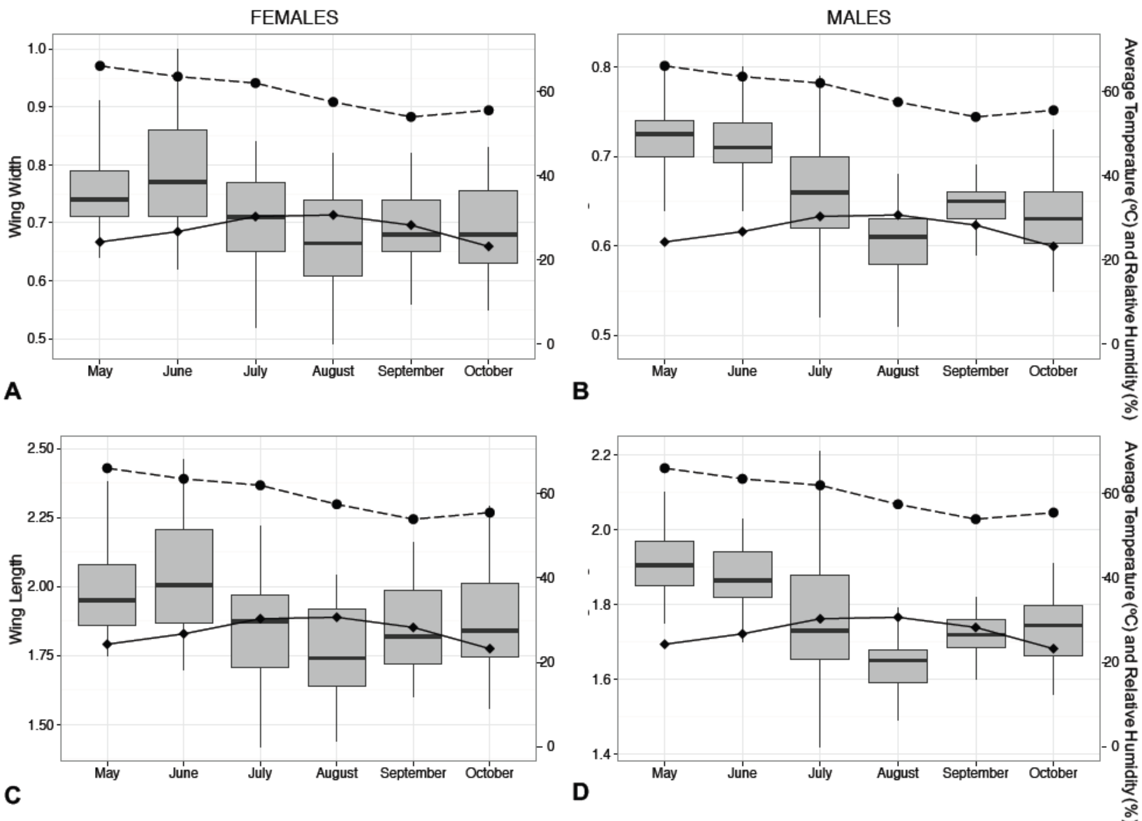
No. of specimens collected: 99.195.
No. of *L. infantum* vector specimens: 56. 101







SEASONAL BODY SIZE VARIATION IN *P. TOBBI*



- Specimens collected in 2011 from Adana.
- 30 females and 30 males at each month.
- Geometric morphometry and lineer measurements.

- Bigger females collected at the begining of season
- Negative correlation between wing size and temperature for females
- Positive correlation between wing size and RH for both sex

Oğuz, Erişöz Kasap and Alten, 2017

WHERE SHOULD WE FOCUS ON?

• Robust species identification for better understandig of species specific ecological requirements and vector – pathogen interactions

• Dispersal activity

  > Habitat fragmenation, reservoir distribution and species interactions

• Breeding sites

  > Developing new, efficient techniques

THANK YOU !!