

Monitoring and ecological factors associated with the invasive mosquito *Aedes koreicus* in the Province of Trento

Arnoldi D.¹, Marini G.¹, Inama E.¹, Rosso F.¹, Da Re D.¹, Tagliapietra V.¹, Dagostin F.¹, Rizzoli A.¹.

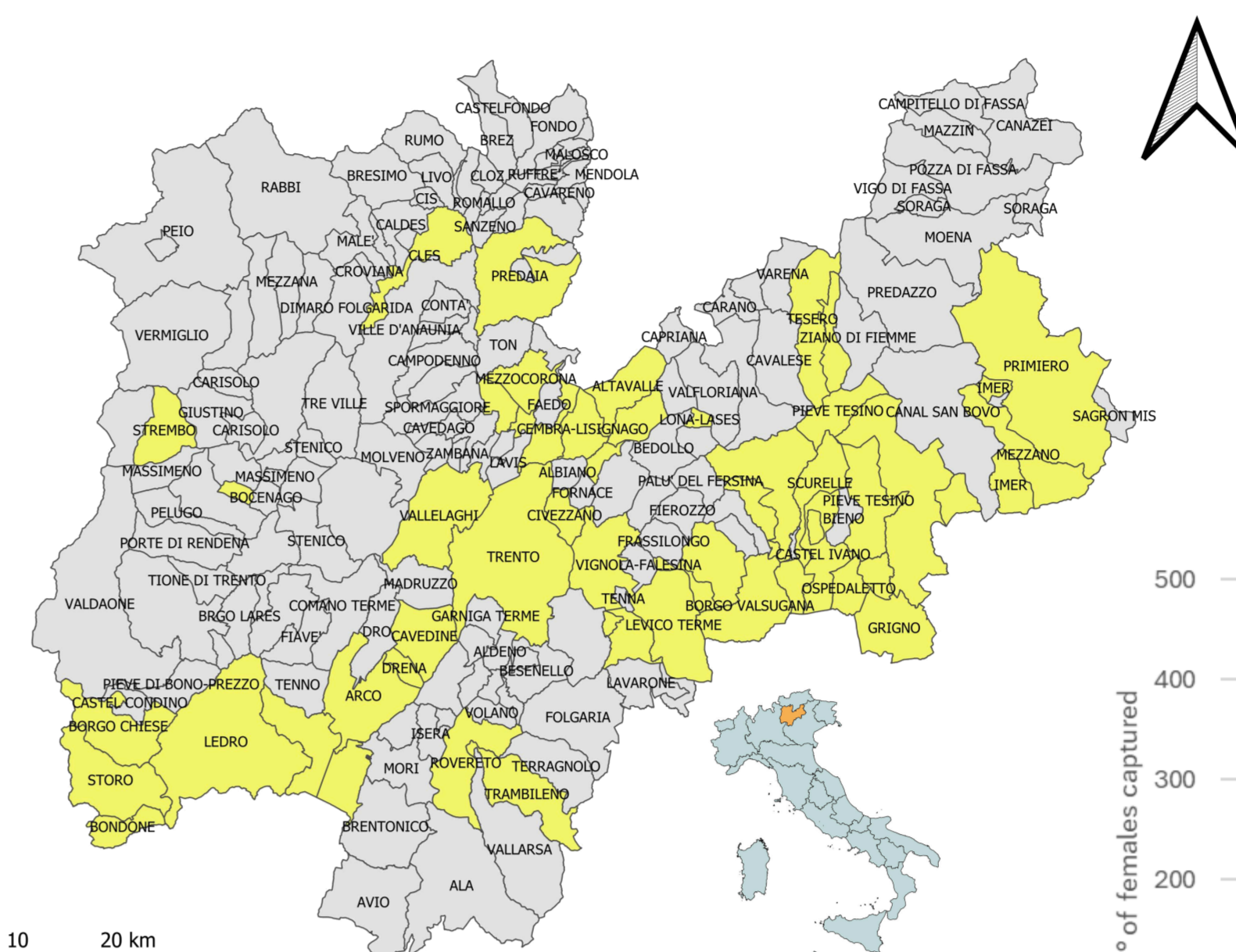
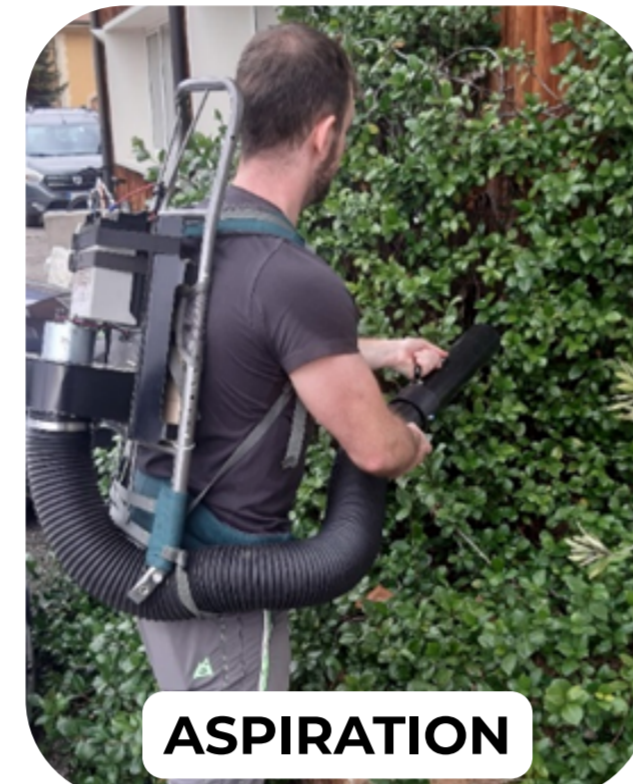
¹ Research and Innovation Centre, Fondazione Edmund Mach, San Michele all'Adige, TN, Italy

Aedes koreicus is an invasive mosquito native to Eastern Russia, Northern China, and the Korean Peninsula⁽¹⁾, which has been detected in Italy since 2011⁽²⁾. It poses a potential threat to human and animal health in Europe, due to its potential vectorial competence for *Dirofilaria immitis*, *Chikungunya* and ZIKA⁽³⁾. In Trento Province, *Ae. koreicus* was detected for the first time in 2013⁽⁴⁾. To gain insight into the ecological processes affecting its ability to establish in new areas and to obtain parameters useful for developing risk maps and predictive mathematical models, we carried out a series of investigations combining field monitoring and laboratory experiments. The results obtained so far are summarised below.

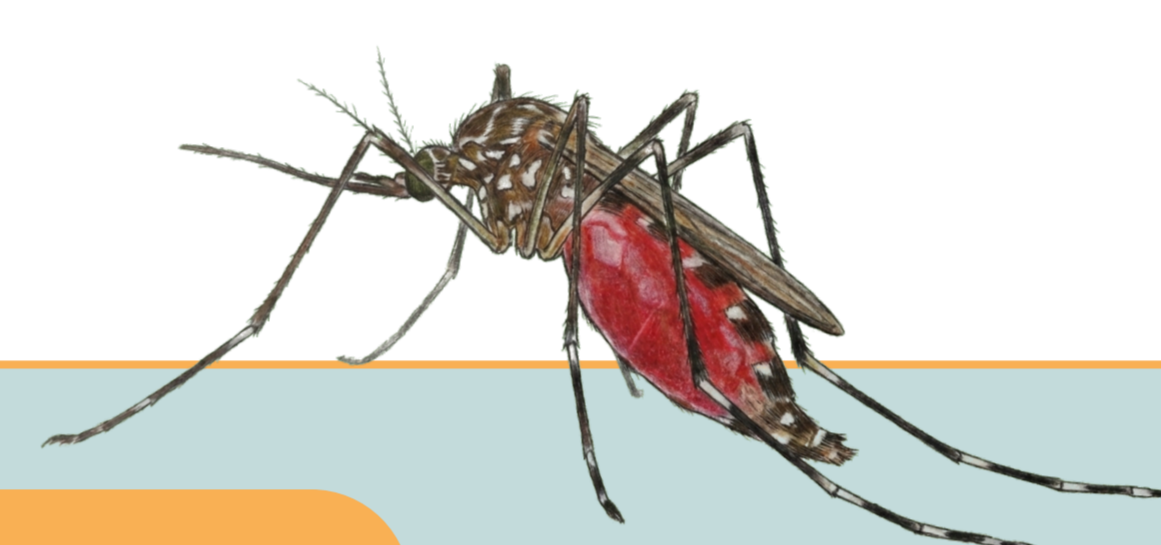
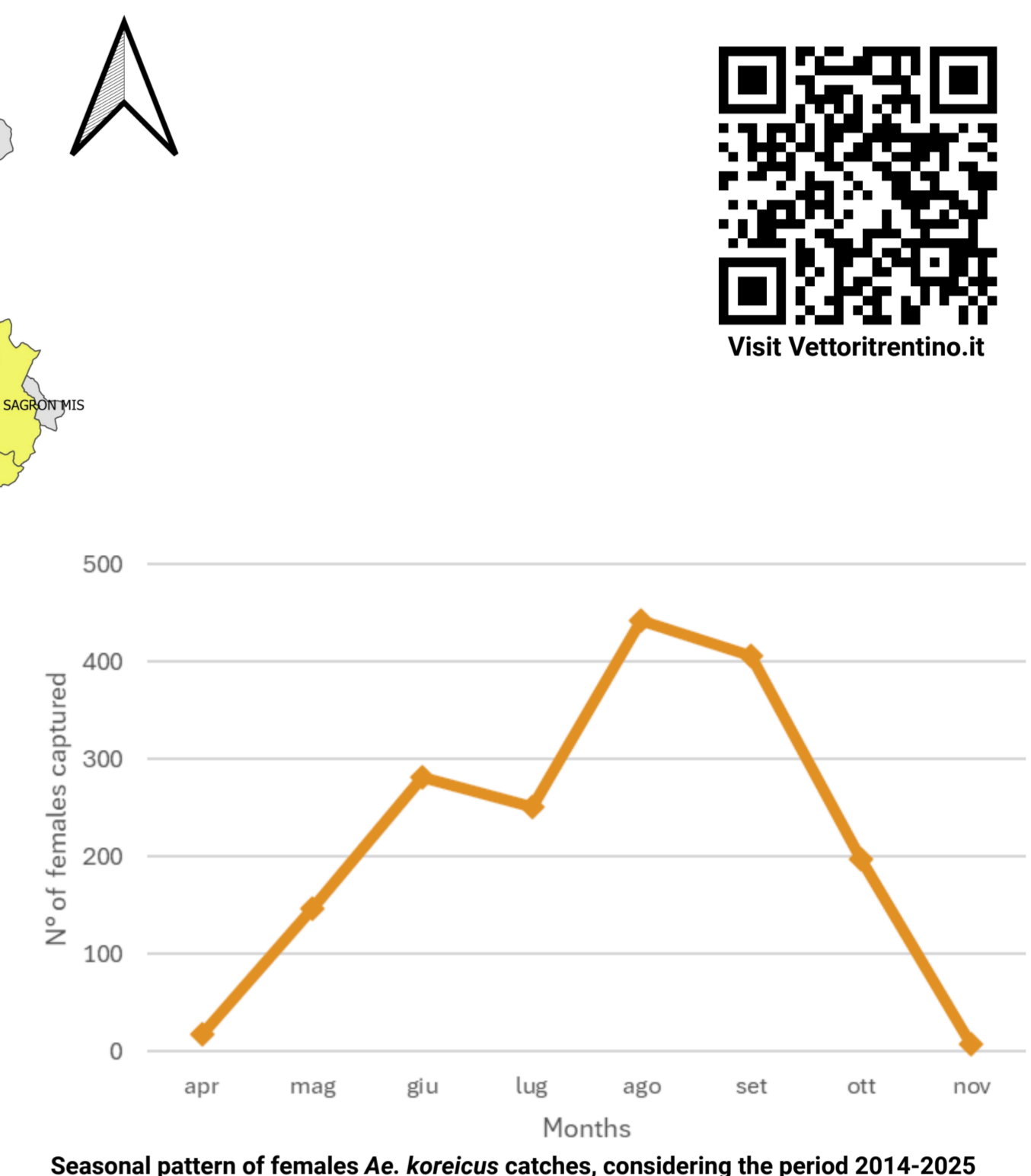
MONITORING AND DISTRIBUTION



- 92 monitored municipalities
- 49 positive municipalities
- 33 municipalities with *Ae. koreicus* in cohabitation with *Ae. albopictus* and/or *Ae. japonicus*
- The highest positive site at 1500 a.s.l
- Adult traps activated 24h every 15 days from May to October
- Ovitrap checked every 15 days
- Urban and rural sites surrounded by vegetation
- To increase the number of fed mosquitoes, aspirators were used



Map of the presence of *Ae. koreicus* in the Province of Trento: In yellow are represented the positive municipalities in the period 2014-2025. All sampling methods are included.



T° AND LIFE CYCLE

First report of the influence of temperature on the bionomics and population dynamics of *Aedes koreicus*, a new invasive alien species in Europe⁽⁵⁾

Materials and methods

- Adult longevity and gonotrophic cycle (see Tab 1):
 - Adults tested at 18, 23, 28 and 33 °C
- Hatching rate (see Tab 2):
 - Eggs tested at 8, 13, 23, 28 and 33°C.
- Survival rates and developmental times (see Fig 1):
 - Larvae tested at 4, 13, 18, 23, 28 and 33°C

Rate	18°C	23°C	28°C	33°C
LONGEVITY	52.33 (29.06-75.61)	46.77 (30.55-62.99)	66.33 (58.30-74.37)	5.87 (4.6-7.14)
GONOTROPHIC CYCLE	14.75 (8.10-26.40)	9.21 (7.12-11.30)	10.81 (7.55-14.06)	-a

Tab 1) Average female adult longevity and gonotrophic cycle length (days). Numbers in parentheses represent the 95% CI
* All females died before completing the gonotrophic cycle.

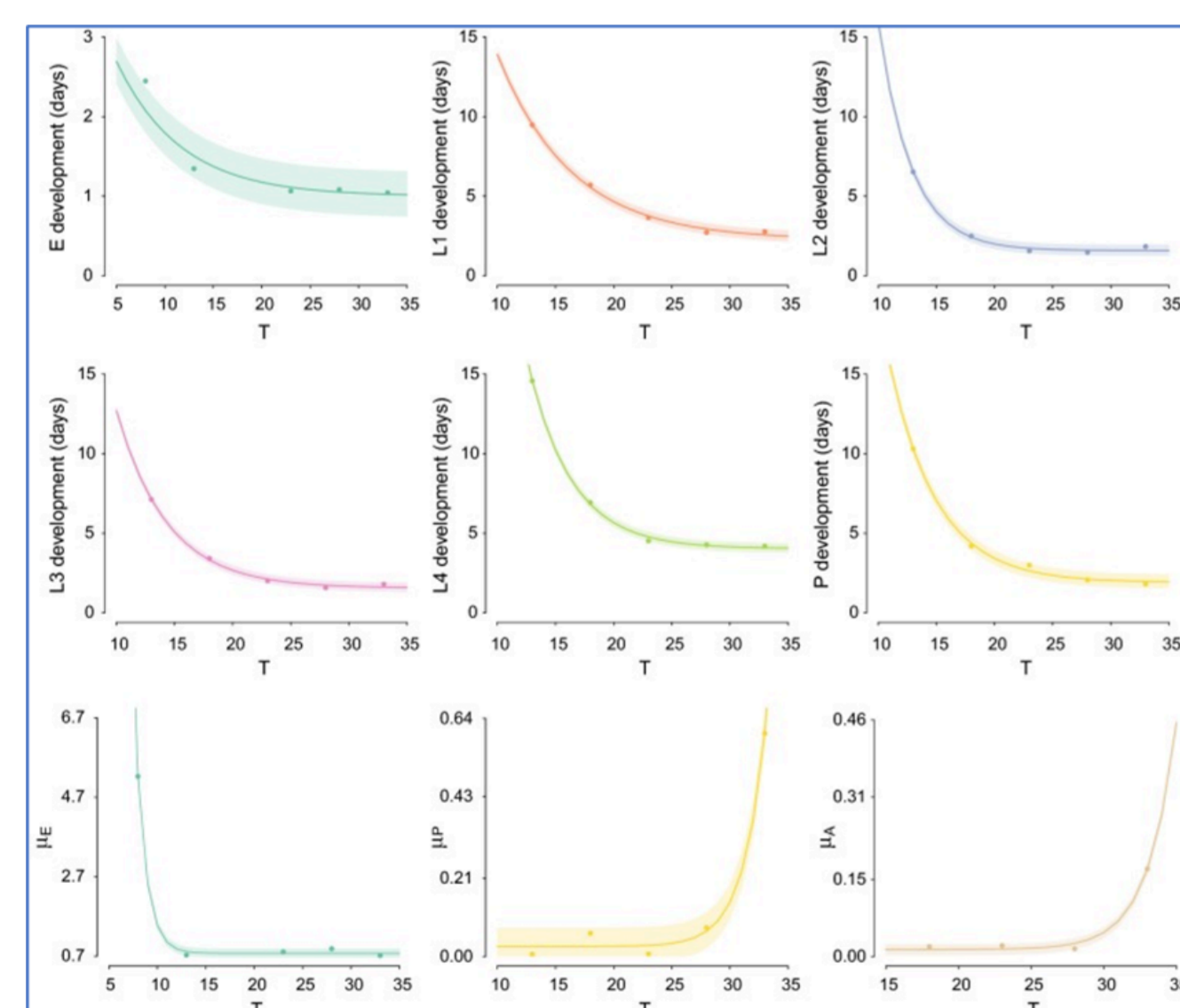


Fig 1) Temperature-dependent functions. Dots represent the experiments observations; the shaded area represents 95% CI of predicted values. E, L, P and A represent Egg, Larvae, Pupa and Adult, respectively. μ represents the daily death rate



Main results

The temperature interval of 23–28 °C seems to be particularly favourable, explaining the recent success of *Ae. koreicus* at establishing into new temperate areas. Our results indicate that *Ae. koreicus* is less adapted to local climatic conditions compared to *Ae. albopictus*.

DIAPAUSE

Diapause characterisation⁽⁶⁾ and cold tolerance assessment in diapausing and non-diapausing eggs in *Aedes koreicus* mosquitoes^(7 submitted)

Materials and methods

- **Diapause characterisation:**
Eggs were tested for hatching after 1 to 5 months after oviposition.

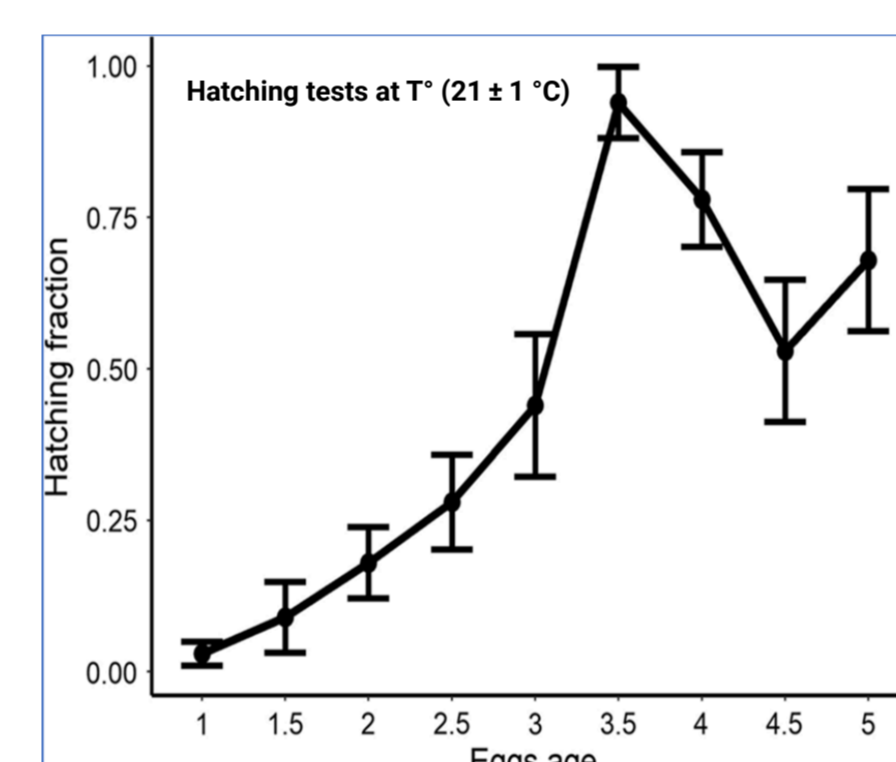


Fig 1) Fraction of hatched eggs for each tested age (in months). Points: average values. Vertical lines: 95% Confidence Intervals (average \pm 1.96-standard error, SE)



- **Cold tolerance assessment in diapausing and non-diapausing eggs:**
Hatching success in diapausing and non-diapausing eggs exposed to 5 fluctuating cold regimes for 2–30 days

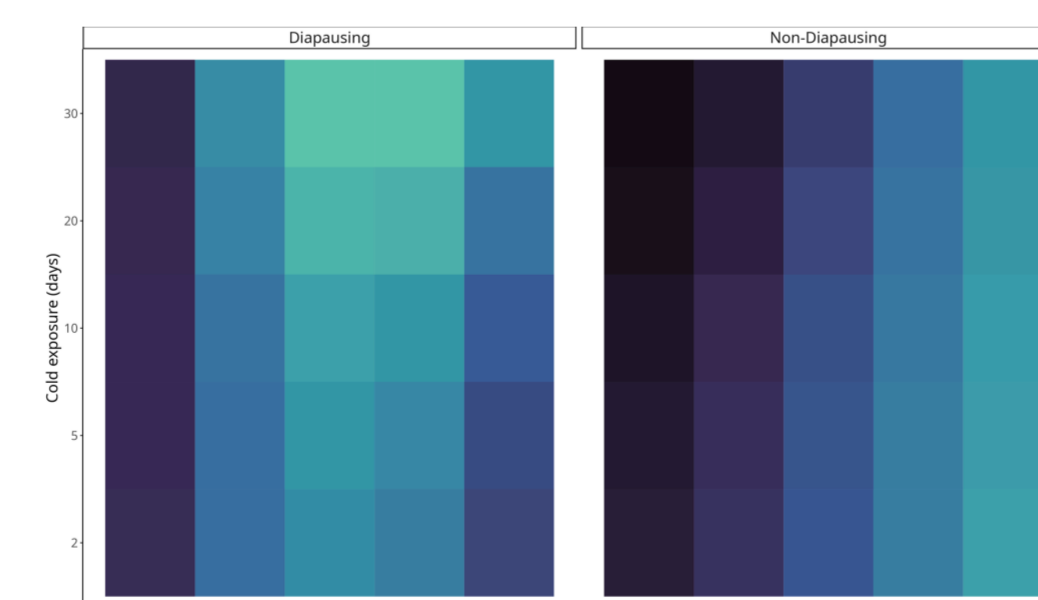


Fig 2) Model-predicted hatching probability of *Aedes koreicus* eggs as a function of temperature and cold exposure periods, derived from EMMs of the beta-binomial model. Colours represent the predicted proportion of eggs hatched, with warmer tones indicating higher hatching success.



Main results

Ae. koreicus diapausing eggs require at least 3 months in order to hatch with substantial success. The optimal age for successful hatch (0.94 probability on average) seems to be around 3.5 months (about 100 days). Exposure to cold treatments markedly reduced hatching success, with non-diapausing eggs showing a stronger decline (0.343 ± 0.029 SE) than diapausing eggs (0.487 ± 0.031 SE) Diapausing eggs exhibited a hatching peak at intermediate subzero temperatures (-5 °C to -10 °C).

FEEDING PREFERENCE

First report of the blood-feeding pattern in *Aedes koreicus*, a new invasive species in Europe⁽⁸⁾

Materials and methods

- Mosquitoes were collected in 23 sites in northern Italy by manual aspiration and BG-sentinel traps (2013-2020)
- The source of blood meals was identified using a nested PCR and by targeting and sequencing the cytochrome c oxidase subunit I gene
- 352 *Ae. koreicus* engorged females were collected and host blood meals were determined from 299 blood-fed mosquitoes (84.9%)

Province	2013	2014	2015	2016	2017	2018	2019	2020	TOTAL
Belluno	23 (37)	5 (6)	3 (3)	-	-	-	-	-	31 (46)
Trento	-	1 (1)	8 (21)	36 (36)	4 (14)	78 (80)	1 (2)	140 (152)	268 (306)
Total	23 (37)	6 (7)	11 (24)	36 (36)	4 (14)	78 (80)	1 (2)	140 (152)	299 (352)

Tab 1) Number of identified blood meals and engorged females (between brackets) by year and Province

Province	Human	Dog	Fox	Cattle	Horse	Goat	Chamois	Roe deer	Red deer	Lizard	Lizard
Belluno	27	2	0	0	0	0	0	0	0	1	1
Trento	19	3	3	1	1	2	12	189	37	0	0
Total	46 (15,4)	5 (1,7)	3 (1,0)	1 (0,3)	1 (0,3)	2 (0,7)	12 (4,0)	189 (63,2)	37 (12,4)	1 (0,3)	1 (0,3)

Tab 2) Identified blood meals per host species in each province (2013–2020). N. of blood meal sources (% of total blood meals)

Main results

Eleven host species were identified, with the highest prevalences being observed for roe deer (*Capreolus capreolus*) (N= 189, 63.2%) and humans (N= 46, 15.4%). Blood meals were mostly taken from roe deer in forested sites and from humans in urban areas, suggesting that this species can feed on different hosts according to local abundance. *Ae. koreicus*' mammalophilic feeding pattern suggests that it may be a potential vector of pathogens establishing transmission cycles among mammals

References

- 1) Seok, Sangwoo, Motoyoshi Mogi, and Yooosok Lee. "Resolving confusion in the native distribution of *Aedes* (*Hulecoetomyia*) *koreicus* (Diptera: Culicidae)." *Journal of Medical Entomology* 61.4 (2024): 1077-1080.
- 2) Capelli, G., Drago, A., Martini, S. et al. First report in Italy of the exotic mosquito species *Aedes* (*Finlaya*) *koreicus*, a potential vector of arboviruses and filariae. *Parasites Vectors* 4, 188 (2011)
- 3) Ganassi, Sonia, et al. "The new invasive mosquito species *Aedes koreicus* as vector-borne diseases in the European area, a focus on Italian region: What we know from the scientific literature." *Frontiers in Microbiology* 13 (2022): 931994.
- 4) Montarsi, F., Drago, A., Martini, S. et al. Current distribution of the invasive mosquito species, *Aedes koreicus* (*Hulecoetomyia koreica*) in northern Italy. *Parasites Vectors* 8, 614
- 5) Marini, Giovanni, et al. "First report of the influence of temperature on the bionomics and population dynamics of *Aedes koreicus*, a new invasive alien species in Europe." *Parasites & vectors* 12.1 (2019): 524.
- 6) Marini, Giovanni, et al. "Diapause characterization in the invasive alien mosquito species *Aedes koreicus*: a laboratory experiment." *Parasites & Vectors* 15.1 (2022): 315.
- 7) Da Re, D., Arnoldi, D., Rizzoli, A., & Marini, G. Cold tolerance and egg diapause shape overwintering success in *Aedes koreicus* mosquitoes. Available at SSRN 6101679.
- 8) Montarsi, Fabrizio, et al. "First report of the blood-feeding pattern in *Aedes koreicus*, a new invasive species in Europe." *Scientific Reports* 12.1 (2022): 15751.