



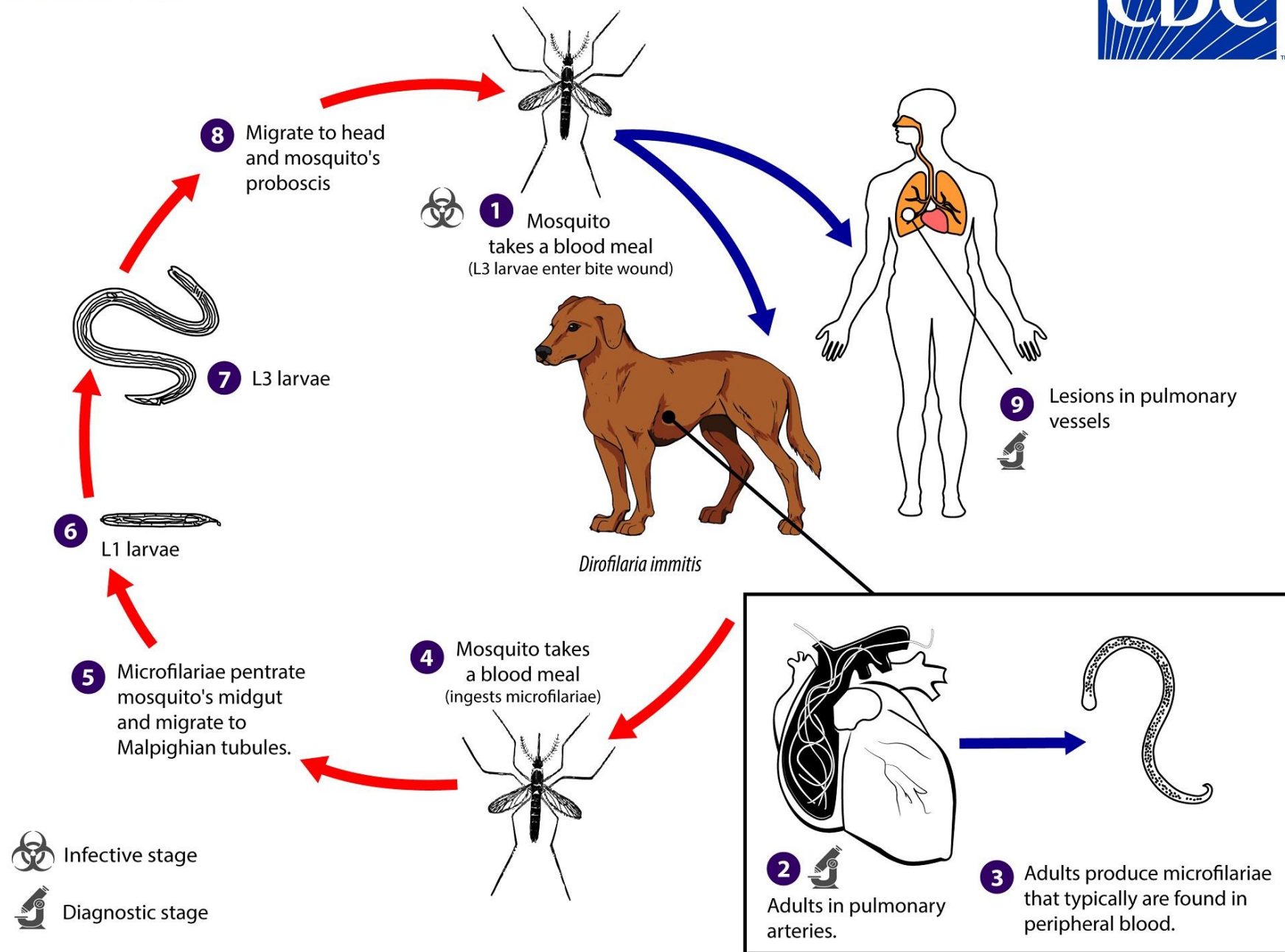
3RD INTERNATIONAL JACKAL  
SYMPOSIUM  
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GÖDÖLLŐ, HUNGARY

# New data on heartworm disease in jackal population in Serbia

Aleksandra Penezić, Neda Bogdanović, Duško Ćirović

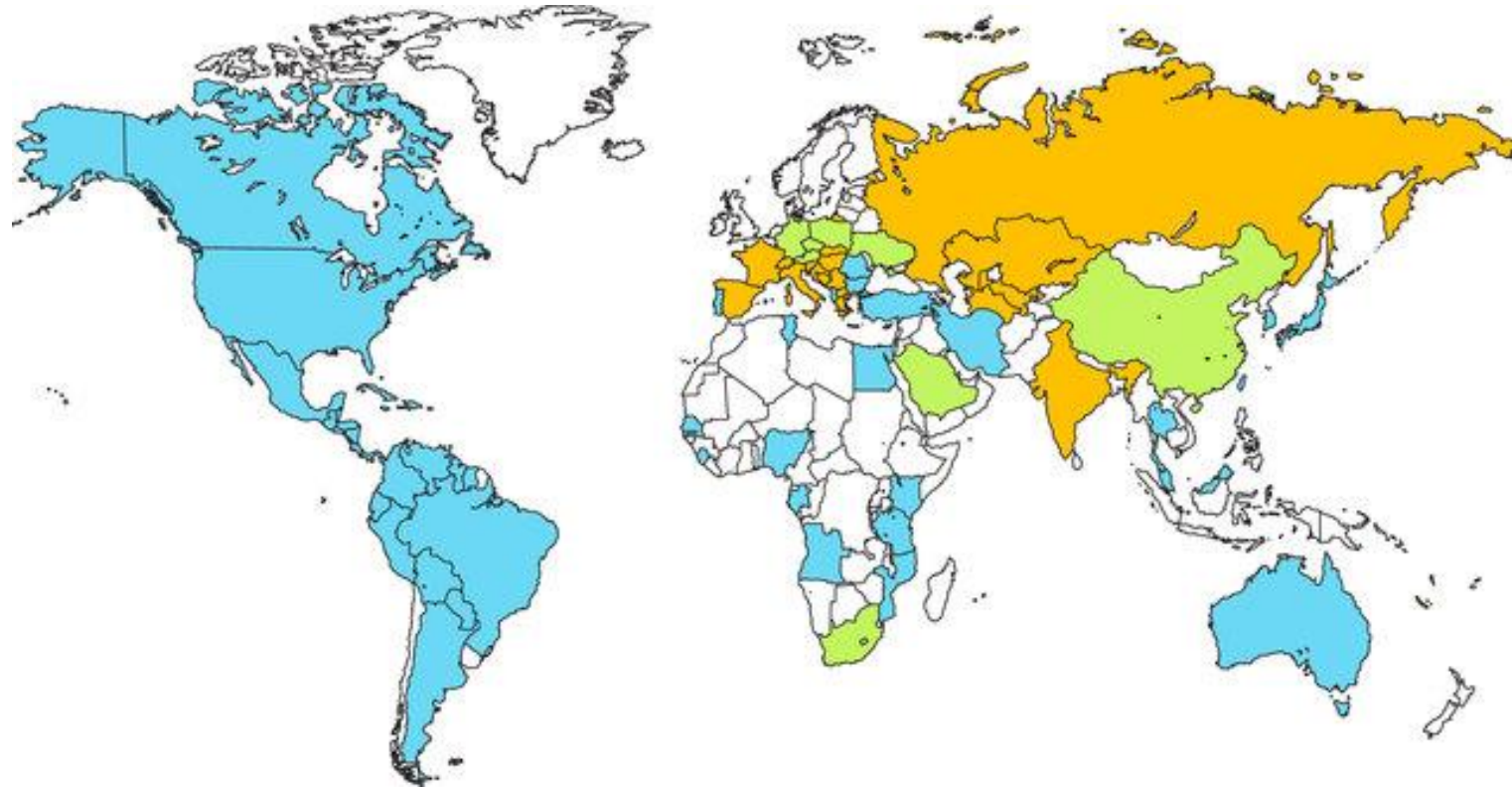
University of Belgrade, Faculty of Biology





Infective stage  
 Diagnostic stage

# Geographical distribution of canine dirofilariasis



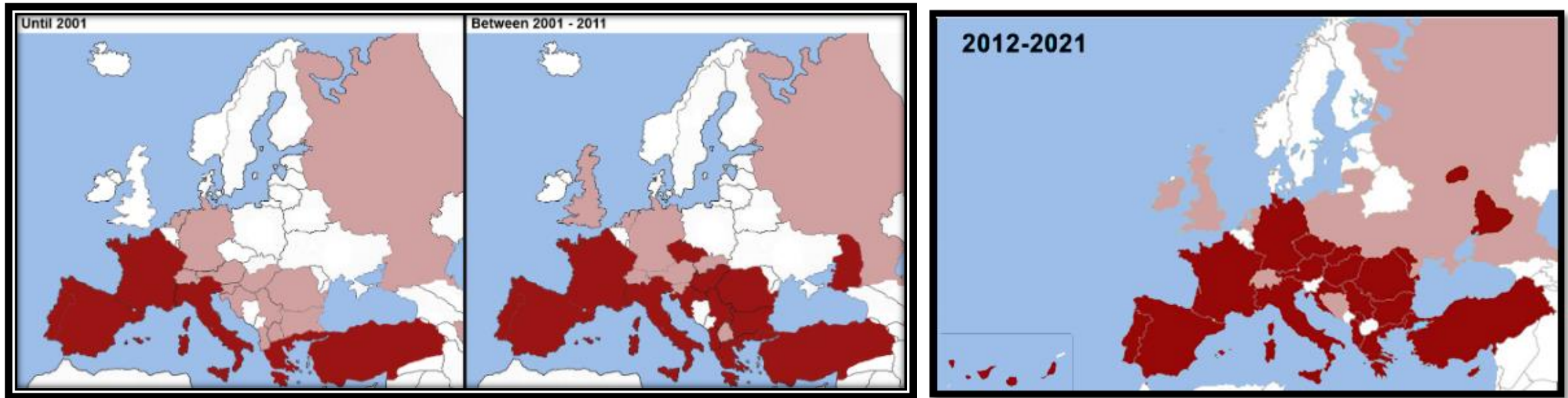
Blue: *D. immitis* infections

Green: *D. repens* infections

Orange: presence of both species.

Simon, Fernando, et al. Human and animal dirofilariasis: the emergence of a zoonotic mosaic. *Clinical microbiology reviews*, 2012, 25: 507-544.

# Comparison of geographical distribution in Europe of heartworm disease observed in dogs between 2001 and 2021.



Red : Endemic areas.

Pink: Sporadic cases reported

\*Illustrated map taking into account Genchi et al. (2005, 2009) and data from the referenced literature. Morchón Rodrigo, et al. Heartworm disease (*Dirofilaria immitis*) and their vectors in Europe—new distribution trends. *Frontiers in physiology*, 2012, 3: 196.

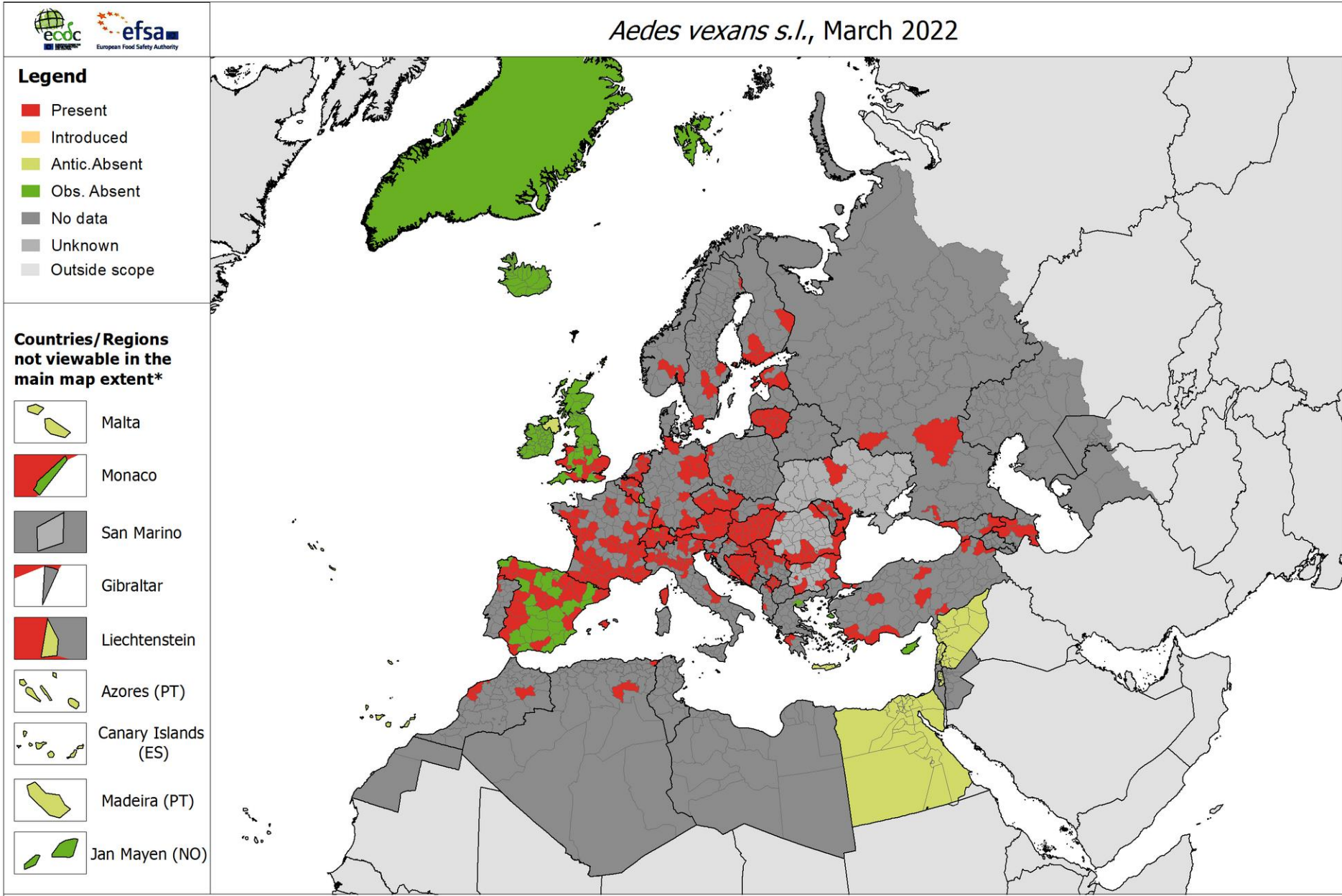
Morchón Rodrigo, et al. What Has Happened to Heartworm Disease in Europe in the Last 10 Years?. *Pathogens*, 2022, 11:9: 1042.

- ❖ Carnivores with peridomestic habits, such as coyotes and jackals, may constitute an excellent sentinel for the spread of *D. immitis*
- ❖ The transmission of *Dirofilaria* spp. in a given region depends on the presence of a minimum number of dogs infected with adult worms producing microfilariae and on the presence of one or more mosquito species capable of transmitting the parasite. Therefore, dirofilariasis transmission is influenced by two factors that affect each of the two components of the worms' life cycle: (1) human behavior with respect to pets and (2) climatic factors that allow for the presence of competent vector populations and *Dirofilaria* sp. larval development in these vectors.

# Species of mosquitoes whose vector capacities for *D. immitis* have been demonstrated in Europe

Mosquito species	Country
<i>Aedes albopictus</i>	Italy
<i>Aedes caspius</i>	Italy, Portugal
<i>Aedes punctor</i>	Italy
<i>Aedes vexans</i>	Turkey, Serbia
<i>Aedes detritus</i>	Portugal
<i>Anopheles maculipennis</i>	Italy, Portugal
<i>Anopheles atroparvus</i>	Portugal
<i>Culex pipiens</i>	Spain, Italy, Turkey, Portugal, Serbia
<i>Culex theileri</i>	Portugal (Madeira)

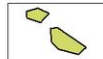






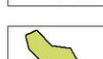

- 🦟 Native and invasive mosquito species
- 🦟 The presence of new competent vectors that increase the time of exposure to the parasite (daytime and crepuscular/nocturnal mosquitoes) and that widen the risk zones (mosquitoes more resistant to low temperatures, overwintering eggs, etc.).



*Aedes vexans s.l.*, March 2022

- Legend**
- Present
  - Introduced
  - Antic. Absent
  - Obs. Absent
  - No data
  - Unknown
  - Outside scope

**Countries/Regions not viewable in the main map extent\***

-  Malta
-  Monaco
-  San Marino
-  Gibraltar
-  Liechtenstein
-  Azores (PT)
-  Canary Islands (ES)
-  Madeira (PT)
-  Jan Mayen (NO)

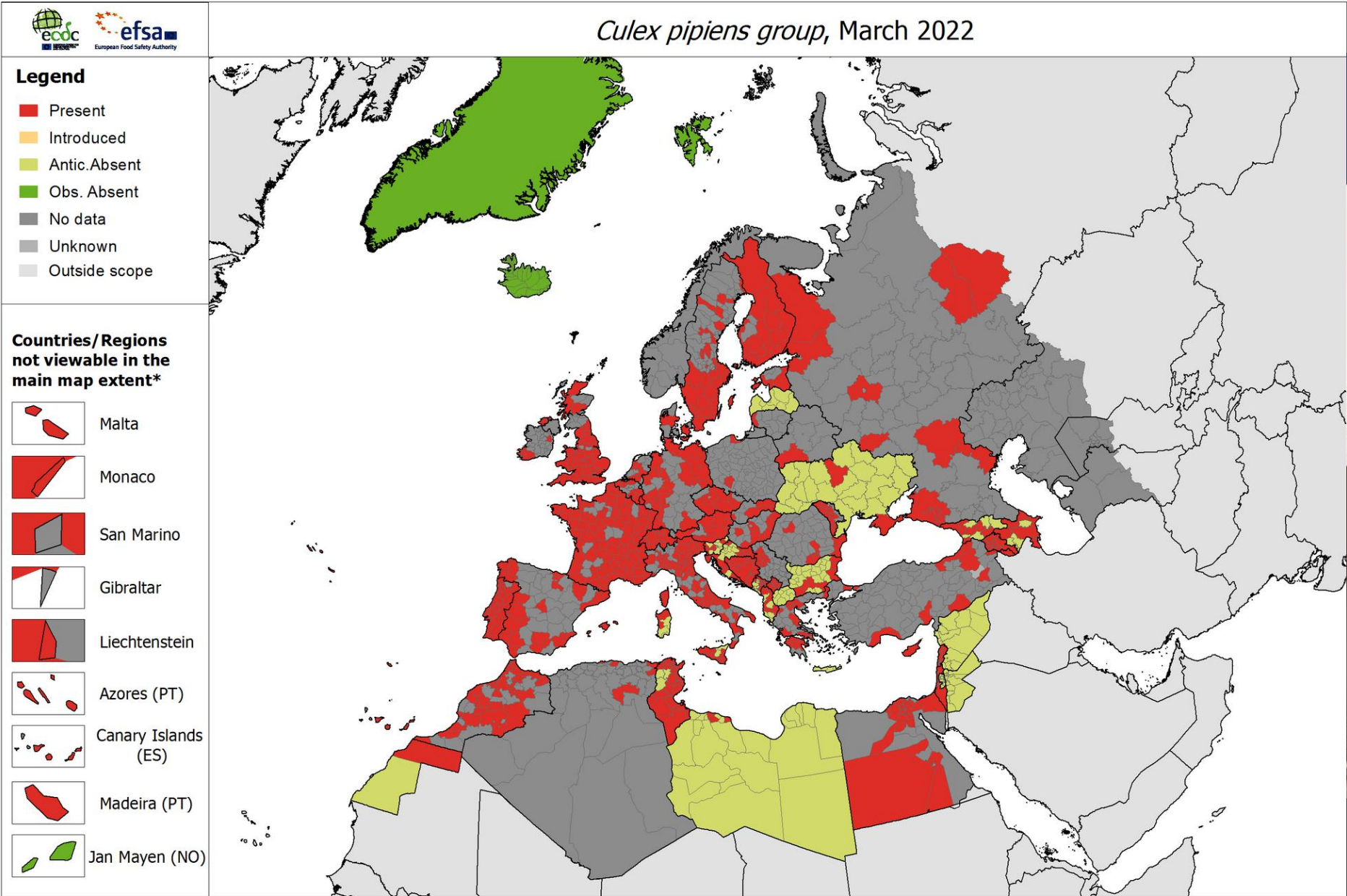


*Aedes vexans*

*Aedimorphus vexans*

Native

ECDC and EFSA, map produced on 9 Mar 2022. Data presented in this map are collected by the VectorNet project. Maps are validated by external experts prior to publication. Please note that the depicted data do not reflect the official views of the countries. \* Countries/Regions are displayed at different scales to facilitate their visualisation. The boundaries and names shown on this map do not imply official endorsement or acceptance by the European Union. Administrative boundaries © EuroGeographics, UNFAO.



House mosquito, Northern house mosquito  
*Culex pipiens*

Native



ECDC and EFSA, map produced on 9 Mar 2022. Data presented in this map are collected by the VectorNet project. Maps are validated by external experts prior to publication. Please note that the depicted data do not reflect the official views of the countries.  
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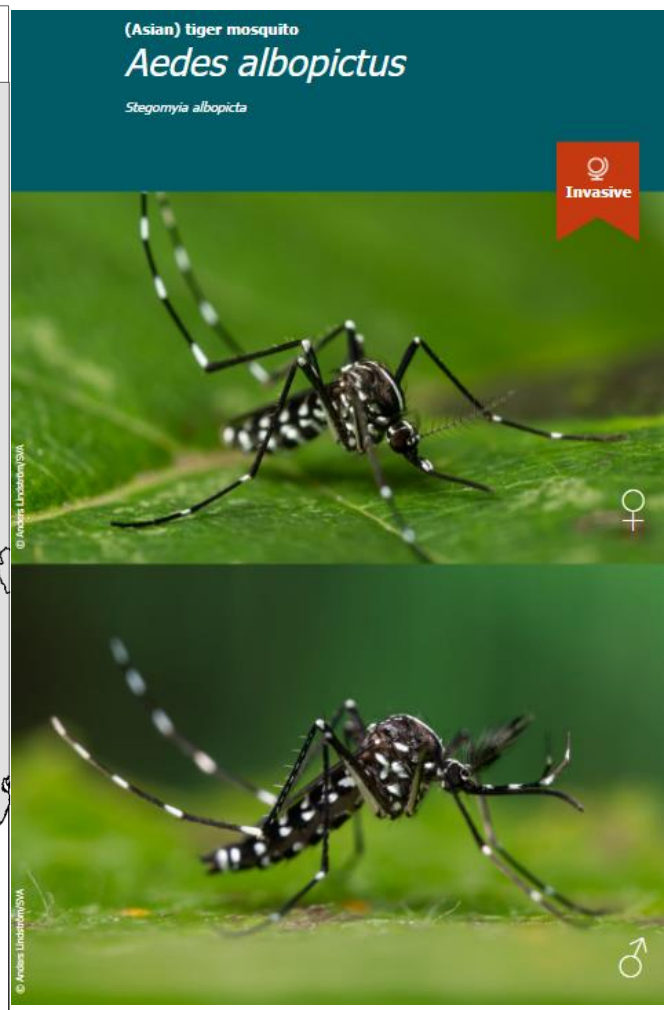
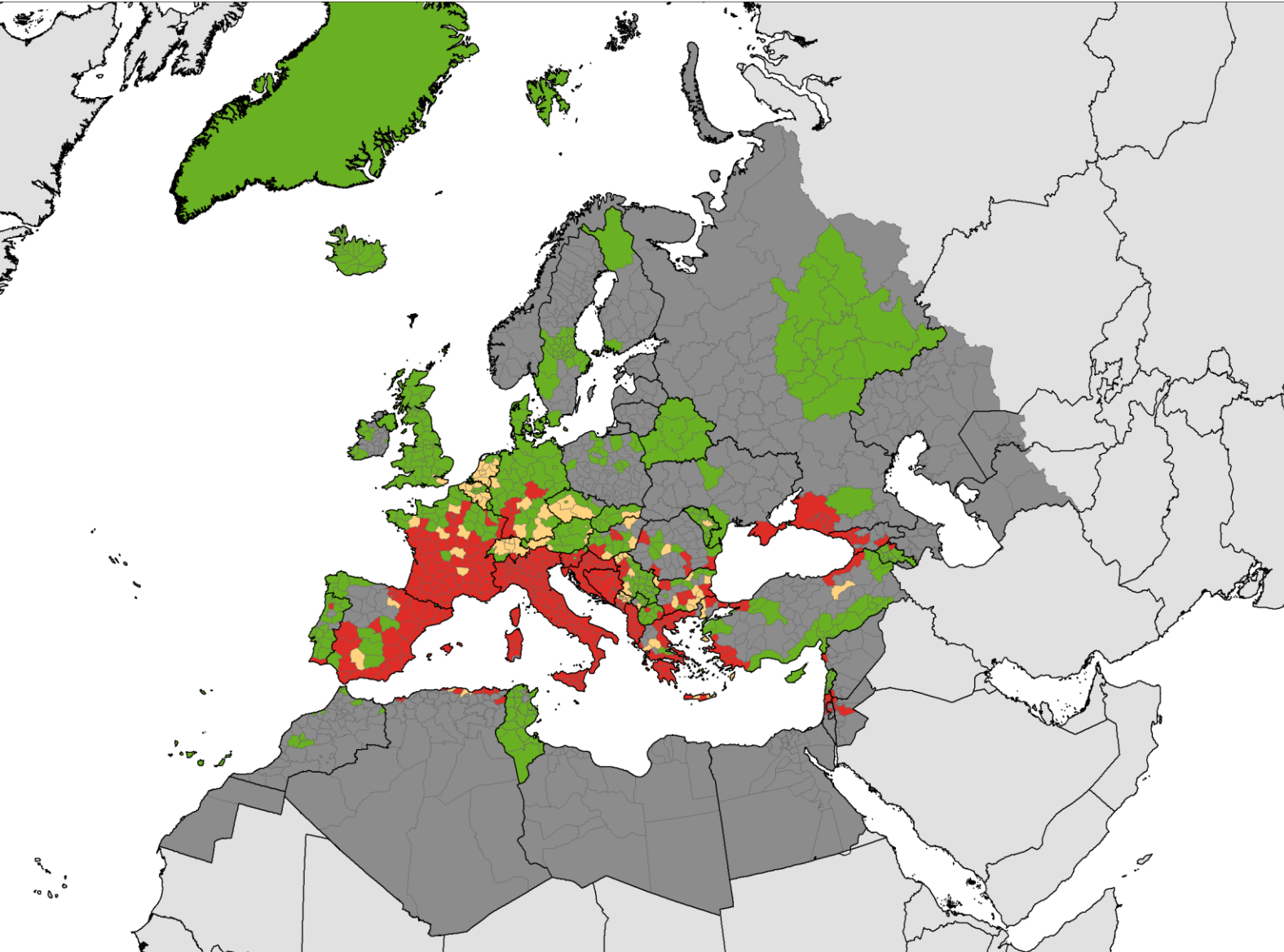
## *Aedes albopictus*, March 2022

**Legend**

- Established
- Introduced
- Absent
- No data
- Unknown
- Outside scope

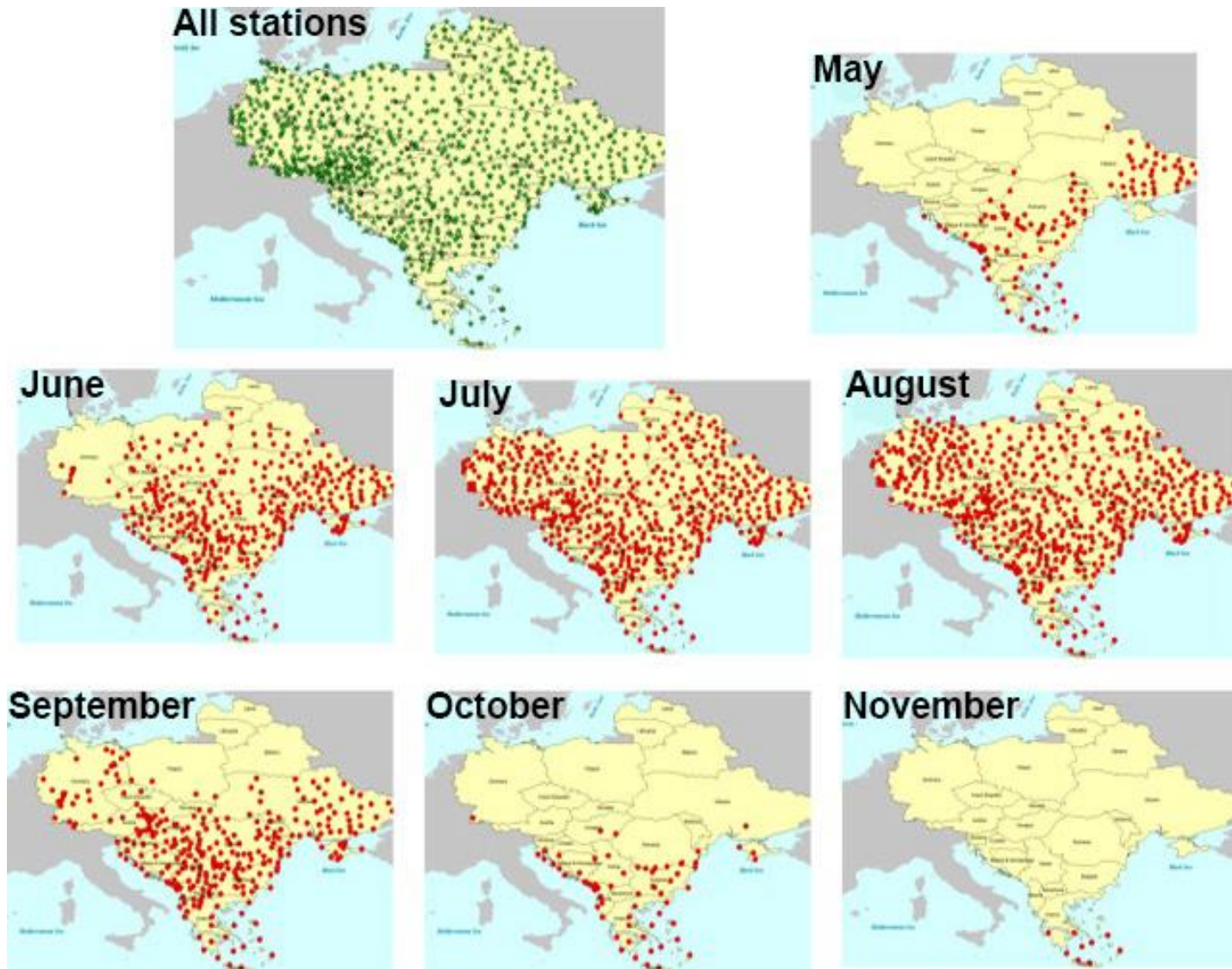
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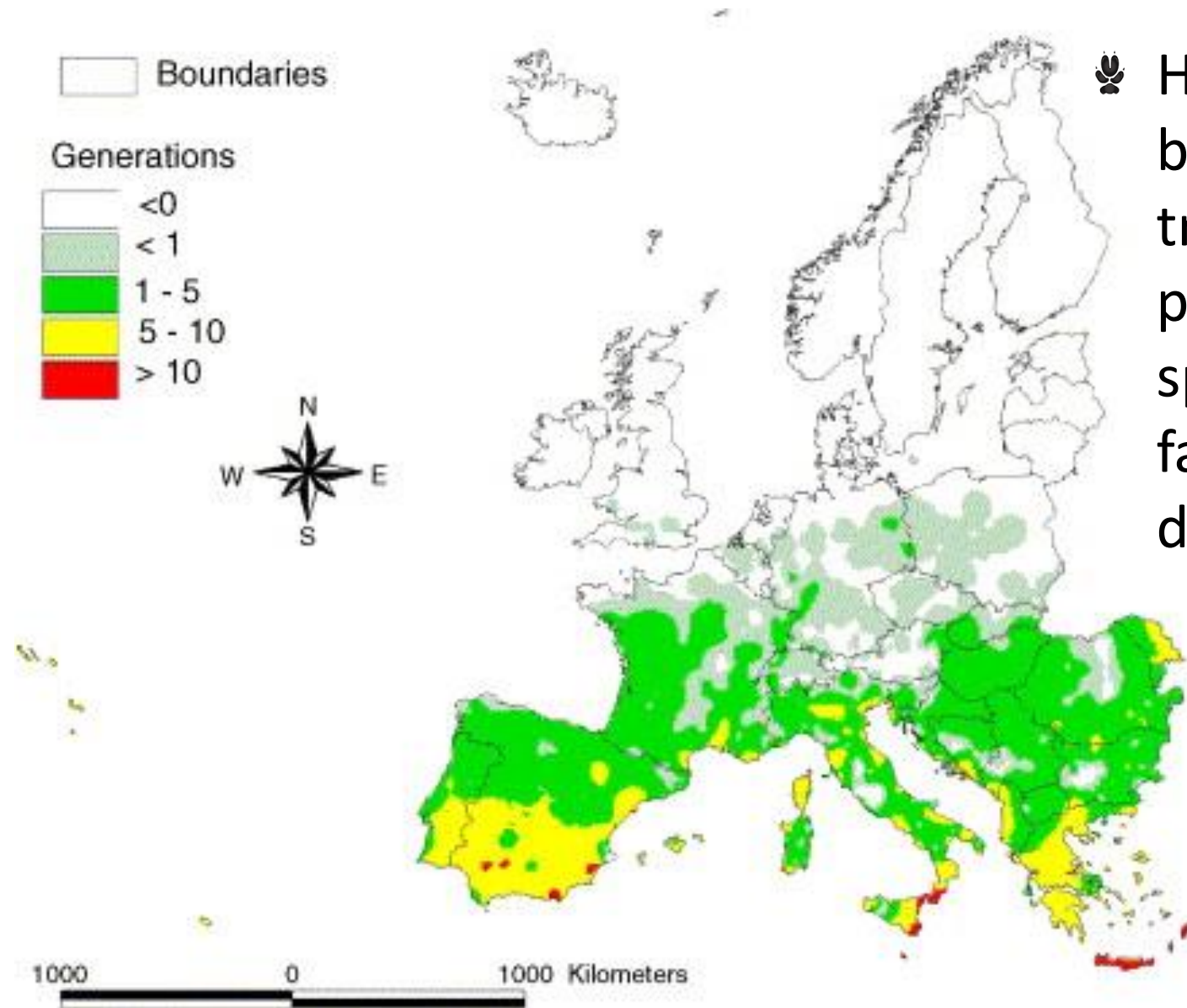
ECDC and EFSA, map produced on 8 Mar 2022. Data presented in this map are collected by the VectorNet project. Maps are validated by external experts prior to publication. Please note that the depicted data do not reflect the official views of the countries.  
\* Countries/Regions are displayed at different scales to facilitate their visualisation. The boundaries and names shown on this map do not imply official endorsement or acceptance by the European Union. Administrative boundaries © EuroGeographics, UNFAO.

# Climate change and distribution change



Climate dictates the seasonal occurrence of HW transmission in temperate latitudes. The rate of *D. immitis* maturation to infective L3 in the mosquito vector(s) depends, mainly on the environmental temperature, and there is a threshold of approx 14 °C, below which development will not proceed. The total environmental heat required for development may be expressed in terms of degree-days in excess of this threshold (heartworm development units—HDUs). The seasonal HW transmission model assumes a requirement of 130 HDUs for larvae to reach infectivity and a maximum life expectancy of 30 days for a vector mosquito.

Dots indicate stations that reached 130 DDUs based on the average temperature of 29 years (1971–2000) at 854 stations in Europe. 112 meteorological stations reached the 130 DDUs in May, 365 in June, 548 in July, 550 in August, 299 in September, 65 in October, and 9 in November.



🦟 Heartworm disease is a vector-borne transmitted disease, thus transmission depends on the presence of competent mosquito species, which is directly related to favorable climate conditions for its development and survival

Yearly average predicted number of heartworm generations obtained by linear Kriging interpolation.

Genchi Claudio, et al. Is heartworm disease really spreading in Europe?. *Veterinary parasitology*, 2005, 133: 137-148.

# Previous findings of adult heartworms in jackals in Serbia

- ✿ First finding of an adult heartworm specimen was in an adult male jackal on 28.2.2009. in Smederevo area (Kulič)
- ✿ During the period 2009–2013, the prevalence in golden jackals was 7.32 %

Original Paper | [Published: 21 June 2014](#)

First findings and prevalence of adult heartworms (*Dirofilaria immitis*) in wild carnivores from Serbia

[Aleksandra Penezić](#) , [Sanja Selaković](#), [Ivan Pavlović](#) & [Duško Ćirović](#)

[Parasitology Research](#) **113**, 3281–3285 (2014) | [Cite this article](#)

# Previous findings of *D.immitis* in jackals in Serbia from blood samples

- ✿ In northern part of the country (Vojvodina region) the molecular survey detected the prevalence of 3.1% in jackals (N=32).<sup>1</sup>

# Material and methods

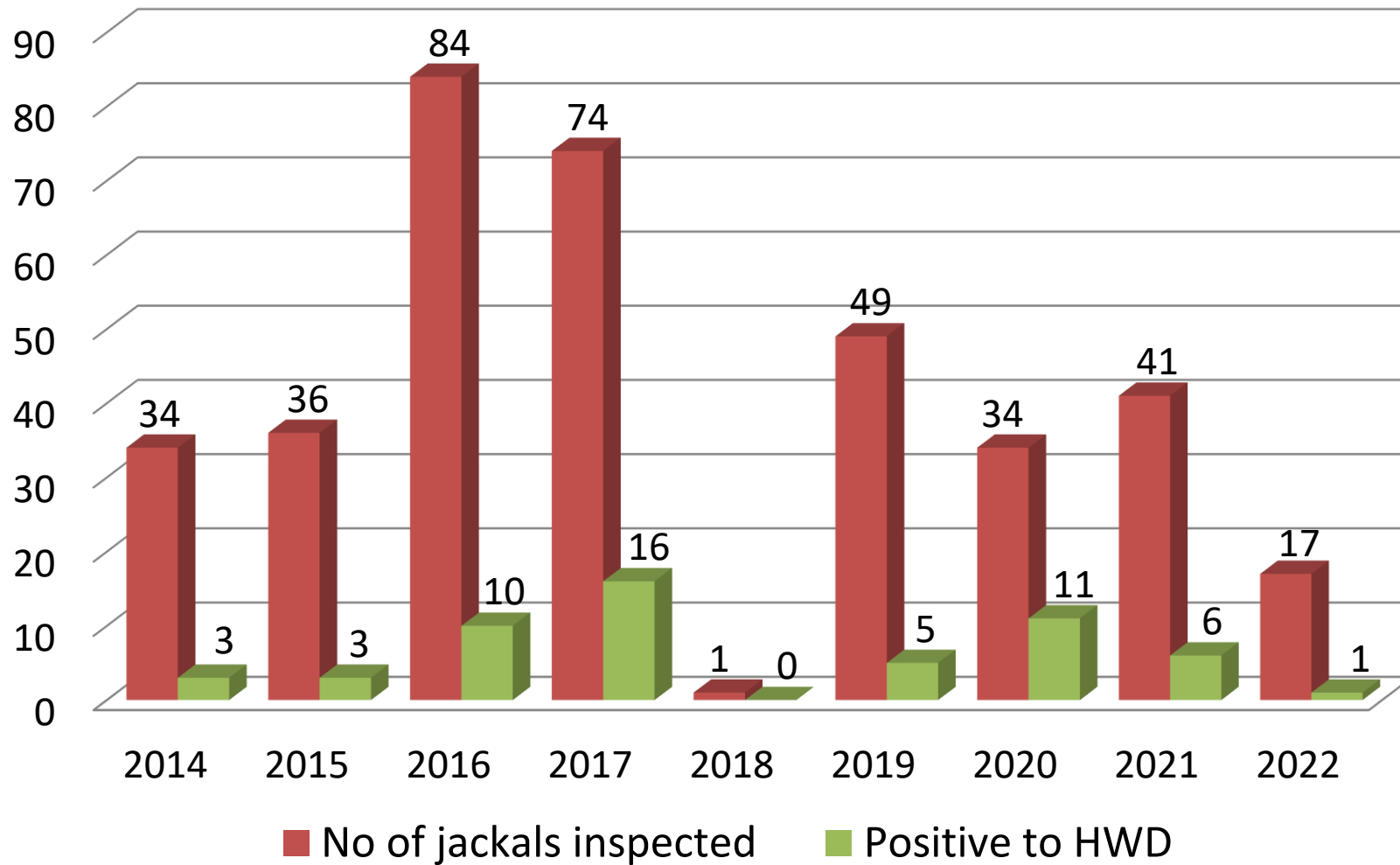
- 🦅 In cooperation with local hunting clubs, legally hunted jackal specimens were obtained
- 🦅 From 2014 to 2022, **370** jackal hearts and lungs were inspected on the presence of adult heartworms

# Results

- 🐾 55 adult jackals had adult *D.immitis* in their hearts and pulmonary arteries
- 🐾 32 males and 23 females
- 🐾 Most hosts harbor up to ten parasites
- 🐾 Maximal load was 36



# Results



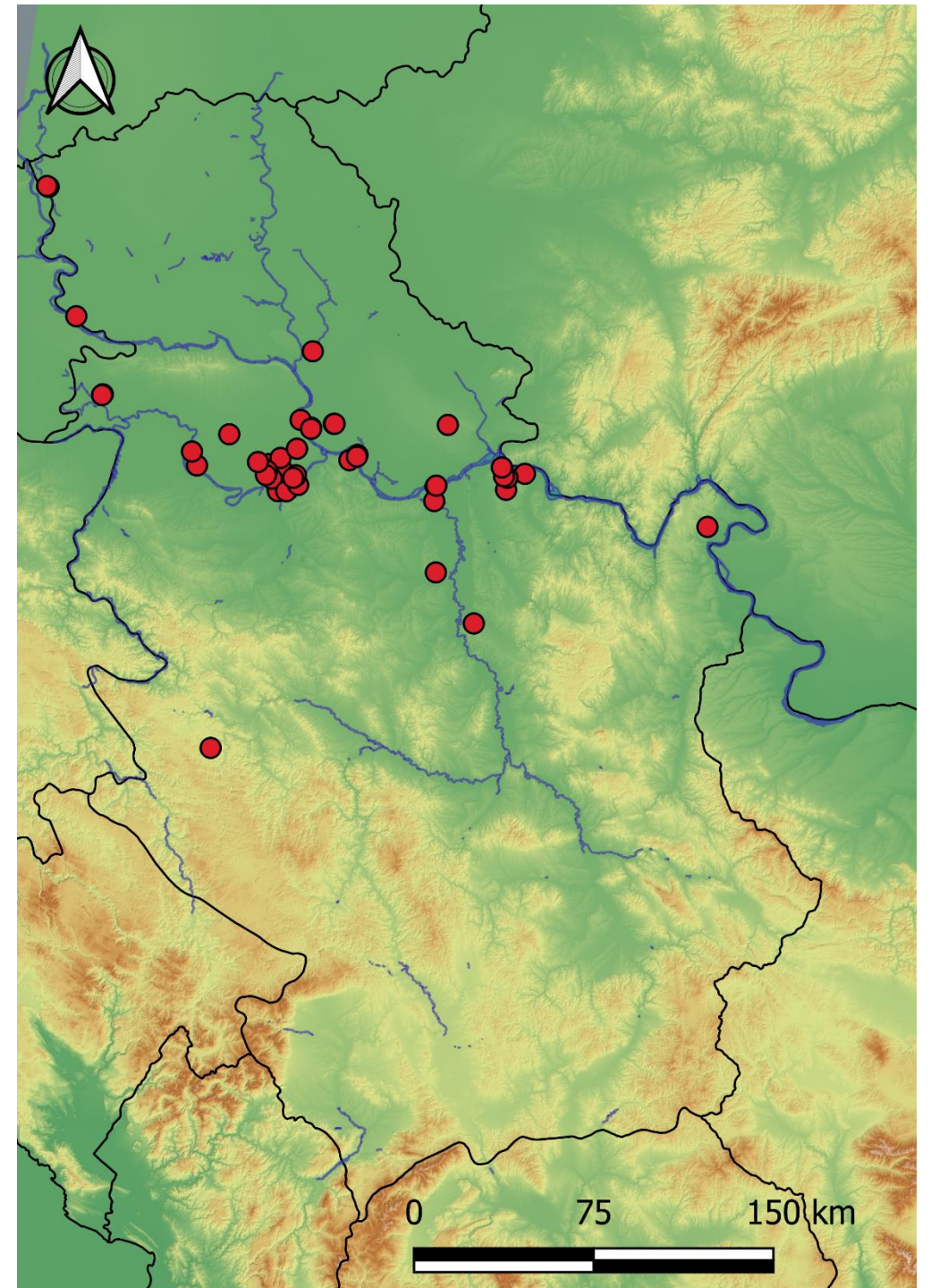


# Results

Year	Prevalence (%)
2014	8.82
2015	8.33
2016	11.90
2017	21.62
2018	0.00
2019	10.20
2020	32.35
2021	14.63
2022	5.88
2014-2022	<u>14.86</u>

# Geographical distribution of jackals positive to HWD 2014-2022


- 🌿 Proximity to river valleys:  
Danube, Sava, Tisa, Morava
- 🌿 Zlatibor mountain in western  
part of the country



# Unusual location

Case report | [Published: 19 May 2022](#)

Heartworm Disease in Jackals:  
Unusual Location of *Dirofilaria immitis*

[Aleksandra Penezić](#) , [Milica Kuručki](#), [Neda Bogdanović](#), [Ilija Pantelić](#),  
[Vanja Bugarski-Stanojević](#) & [Duško Ćirović](#)

[Acta Parasitologica](#) **67**, 1412–1415 (2022) | [Cite this article](#)

- 🐾 In 2020 two cases of heartworm infection with unusually located adult heartworms were diagnosed.
- 🐾 First case is an adult female jackal harvested in the vicinity of Bački Monoštor. Six adult specimens of *D. immitis* were found in the right atrium of the heart and six more adult specimens were located at an atypical site, in the vena cava caudalis.
- 🐾 The second case was in an adult female jackal harvested in the vicinity of the capital city of Belgrade. In this case three adult specimens of *D. immitis* were found in the right atrium of the heart, as well as nine adult specimens in the vena cava caudalis.

# Discussion

- 🐾 *D. immitis* is a parasite which can seriously affect an animal's health depending on its number and location, especially when forming an occlusion of blood vessels such as the pulmonary artery and the right ventricle of the heart.
- 🐾 Among dogs and cats, a serious complication of chronic HWD is known as the canine and feline caval syndrome with many clinical features of which most common are: acute anorexia, dyspnea, weakness, heart murmur, jugular vein distention, anemia, hemoglobinuria, as well as both forward and backward heart failure

# Discussion

- ❖ The prevalence of pulmonary dirofilariasis in jackals in Serbia is increasing
- ❖ 200 000 sterile tiger mosquitoes were released this year. Male mosquitoes are sterilized by radiation (gamma or X-rays)
- ❖ The technique is applied in Italy and Spain, and preliminary research has begun in Montenegro, Germany, France, Croatia, Serbia, Switzerland and Portugal.

# Discussion

- ❖ The rapid spread of the golden jackals throughout Europe opens a question of involvement of this species in the sylvatic cycle of pathogens in the colonised territories
- ❖ During last 10 years, in the traditionally endemic countries of southern Europe, prevalence in dogs has continued to increase, except for some territories where the control measures adopted have achieved a decrease in prevalence.

# Neighbouring countries

- 🐾 Romania<sup>1,2</sup>: Adult specimens of *D. immitis* were found in 18.52 % of jackals, originating from the southern part of Romania. The molecular prevalence in blood samples from the same animals was 9.26 % for *D. immitis* in 2014 and 2015. During the period 2016-2022 authors report the 19.05% prevalence of adult heartworms in jackals
- 🐾 Hungary<sup>3</sup>: a prevalence of 3.7% in red foxes and 7.4% in golden jackals was reported

<sup>1</sup>Ionica, Angela Monica, et al. Role of golden jackals (*Canis aureus*) as natural reservoirs of *Dirofilaria* spp. in Romania. *Parasites & Vectors*, 2016, 9: 1-6.

<sup>1,2</sup>Ionica, Angela Monica, et al. The European Badger as a New Host for *Dirofilaria immitis* and an Update on the Distribution of the Heartworm in Wild Carnivores from Romania. *Pathogens*, 2022, 11.4: 420.

<sup>3</sup>Tolnai, Z., et al. *Dirofilaria immitis*: an emerging parasite in dogs, red foxes and golden jackals in Hungary. *Veterinary parasitology*, 2014, 203: 339-342.

# Conclusion

The knowledge of heartworm disease in free ranging wild canid populations is still limited. As it is very difficult to monitor this disease in live animals, sporadic findings are mostly obtained by examining culled individuals of game species.

Several factors can affect the spreading of the disease:

- 🦟 movement of infected animals,
- 🦟 the climate change
- 🦟 increasing abundance of mosquitoes as well as the introduction of new species of mosquitoes able to act as vectors
- 🦟 abundance of wild reservoirs

Further research and monitoring of wild carnivores, especially canids, is needed



Thank you for your attention

