CCHF- Vector ecology

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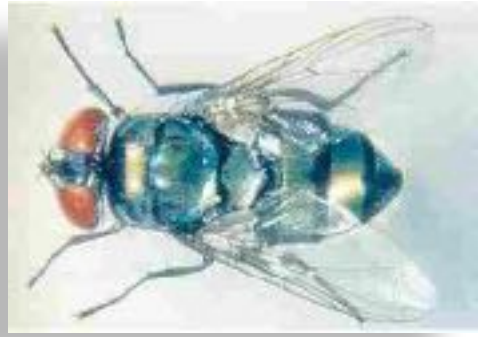
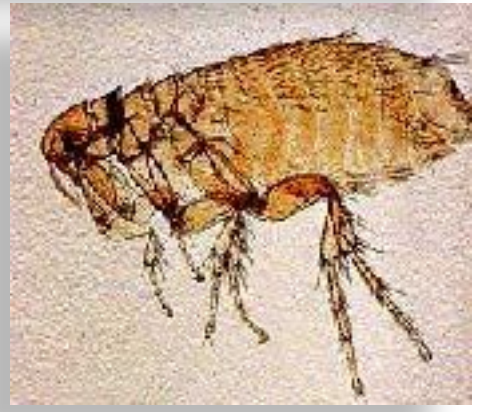
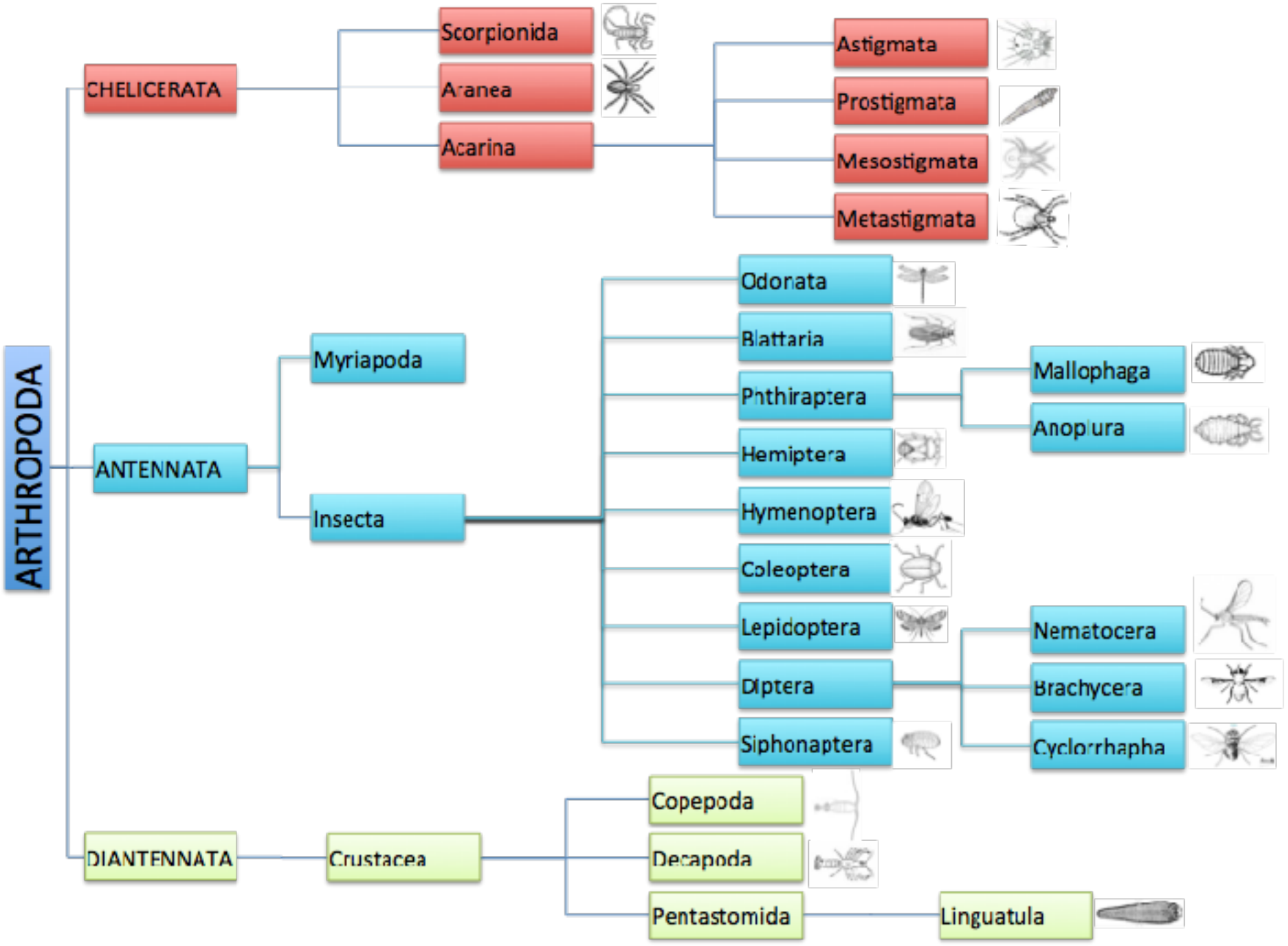
Ticks are NO Insects

- Arachnida
  - Cephalothorax

- Insecta
  - caput, abdomen, thorax

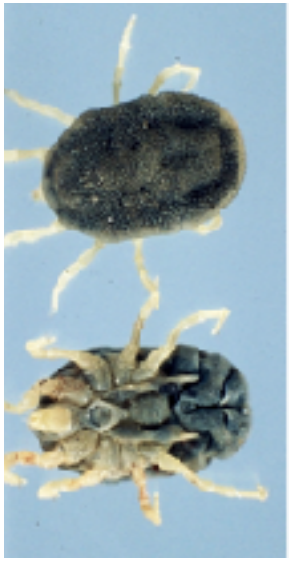





ARTHROPODA
CHELICERATA
Scorpionida
Aranea
Acarina
Astigmata
Prostigmata
Mesostigmata
Metastigmata
ANTENNATA
Myriapoda
Insecta
Odonata
Blattaria
Phthiraptera
Mallophaga
Anoplura
Hemiptera
Hymenoptera
Coleoptera
Lepidoptera
Diptera
Nematocera
Brachycera
Cyclorrhapha
Siphonaptera
DIANTENNATA
Crustacea
Copepoda
Decapoda
Pentastomida
Linguatula

Ticks

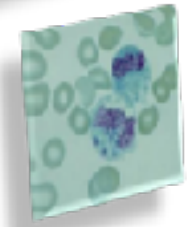
- 900 known species
- Vectors of more than 200 pathogens
- Tick-pathogen relations = 800

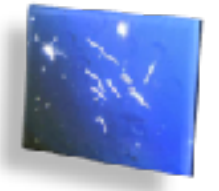


Tick-borne diseases (human perspective)

Ticks as very (most) efficient vectors

- Rikettsia (Ehrlichia, Coxiella, Anaplasma, Rickettsia)
- Bakteria (Borrelia, Francisella, Klebbsiella, Dermatophilus)
- Viruses (Flaviviridae, Bunyaviridae, Recviridae, Rhabdoviridae)
- Protozoa (Theileria, Babesia, Hepatozoon)





- Tick-borne encephalitis, TBE
  - Europe, Asia
    - %400 increase in incidence
- Lyme borreliosis
  - Europe, Russia, USA
    - USA: 25000 cases/year; Germany: 10000 cases/year
- Crimean-Congo Haemorrhagic Fever (CCHF)
  - Turkey, Russia, Balkans, Iran, Afghanistan, Pakistan etc

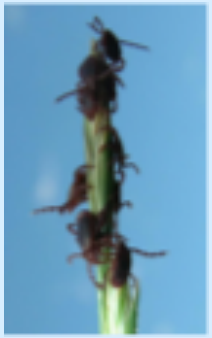
Tick population dynamics

- Biotic factors
  - Obligatory blood-suckers
    - Need vertebrate host to feed
      - Variable host preference
- Abiotic factors
    - Spend 85-90% of their life off-host
  - Climate and landscape define distribution range of the species

Tick ecology & host finding strategies

Argasidae and
Some Ixodes spp
Hyalomma anatolicum
Hy. (detritum)
scupense

nidicolous



0-2m

Ambush

1-10m

Humidity

Ixodes spp
Haemaphysalis spp

Rhipicehalus spp
Dermacentor spp
Amblyomma spp

Non-nidicolous

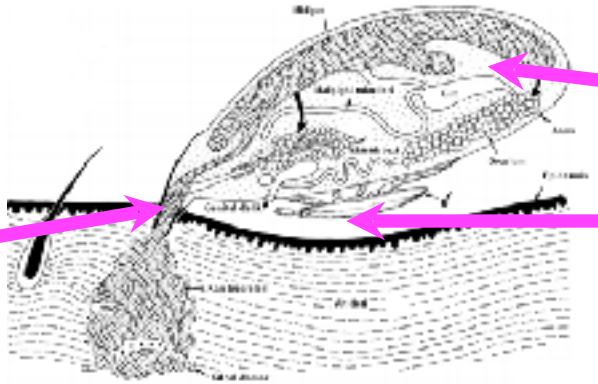
No vertical movement

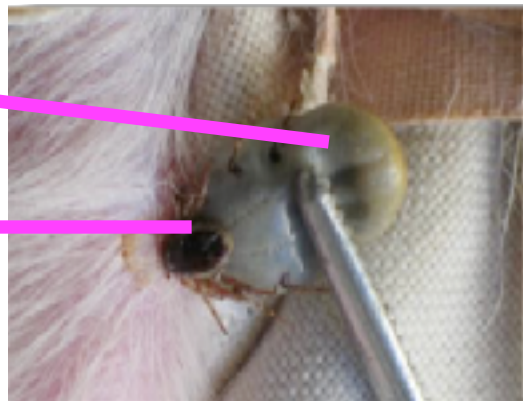
Hunter

50-500m

Hyalomma spp

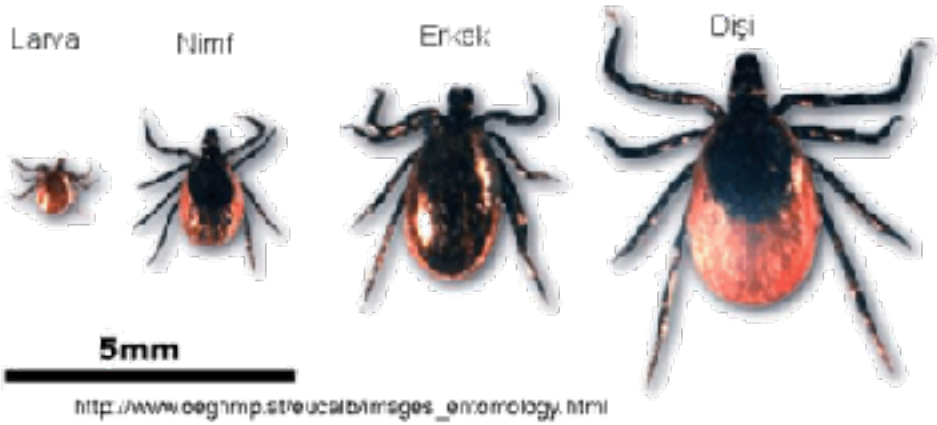
Ixodidae





Development in Ixodid ticks

- Egg, larvae, nymph, adult
- Parasitising vertebrate animals
  - Obligatory blood feeders
- 2 Moultings
  - 1. from fed larva to flat nymph
  - 2. from fed nymph to flat adult



Development in Ixodid ticks

Three types of life-cycle

- Three hosts
  - vast majority of species
  - **all stages moult in the environment**
- Two hosts
  - some species of *Hyalomma*, *Rhipicephalus*, *Dermacentor*
  - **larvae moult to nymphs on the host**
  - **nymphs moult to adults in the environment**
- One host
  - some species of *Rhipicephalus*, *Hyalomma* and *Dermacentor*
  - **all moults take place on the host**

Ixodidae

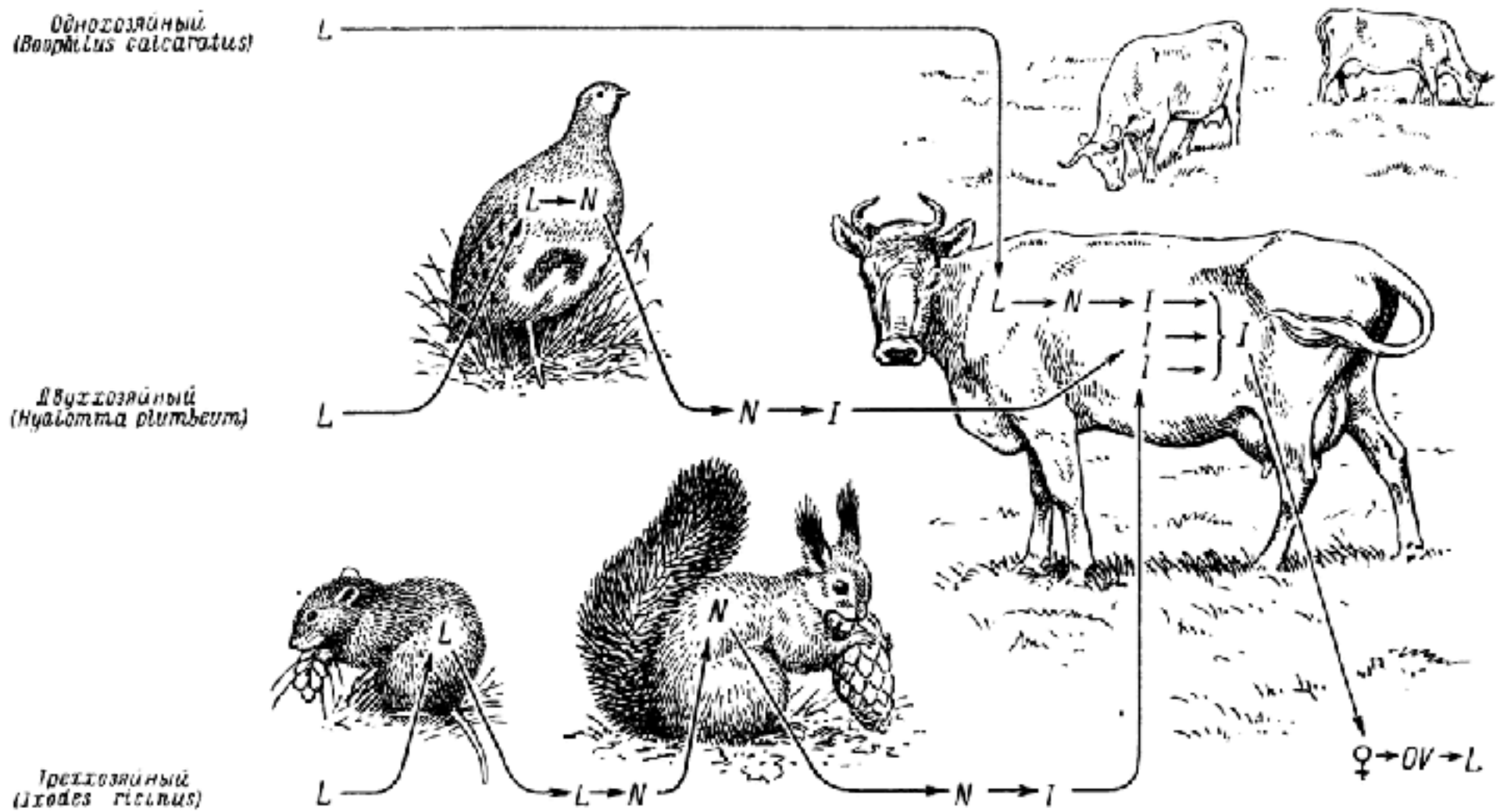


Рис. 27. Схема типов паразитизма у иксодовых клещей. (Сердюкова, 1955б).

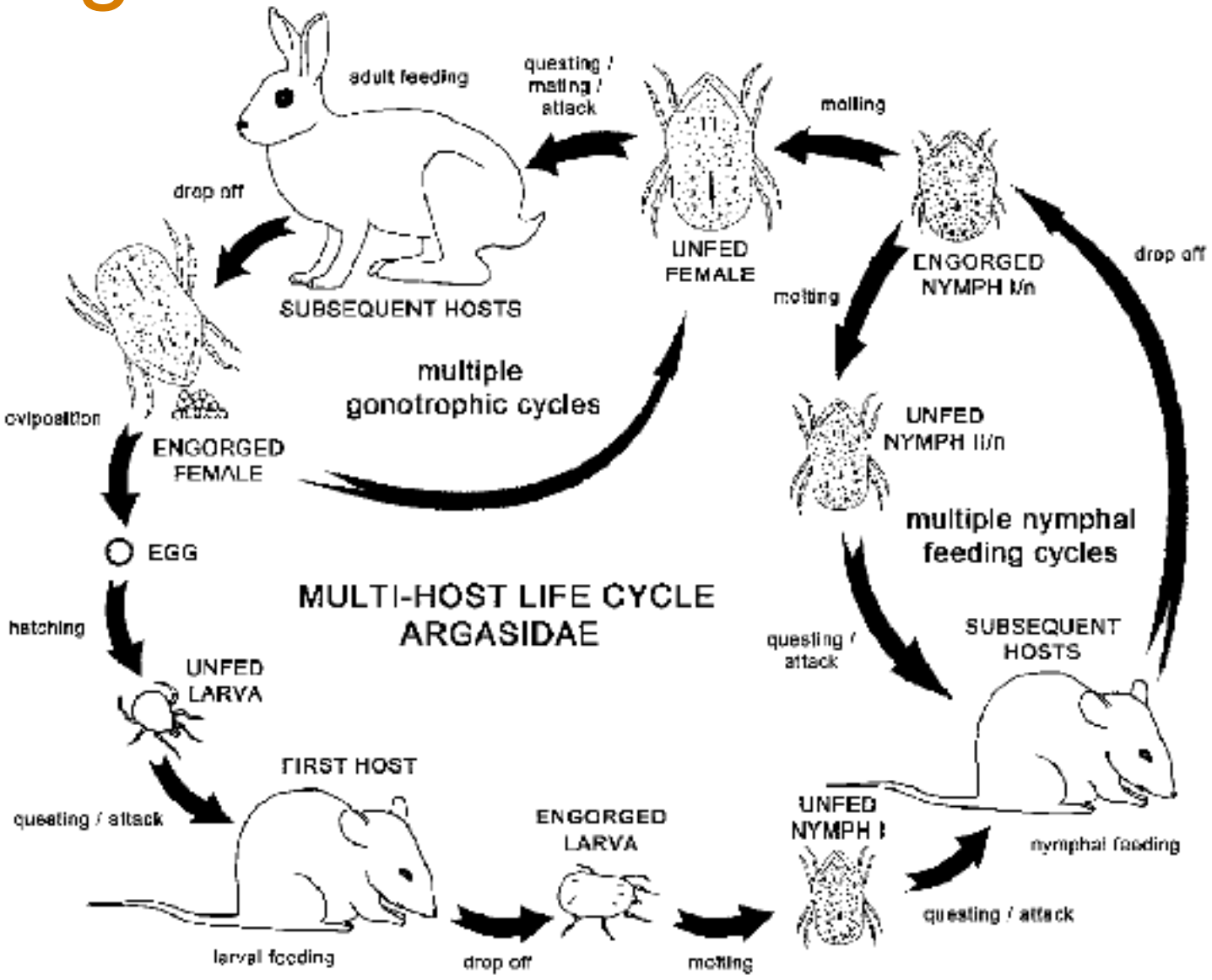
I—взрослые клещи, *Ov* яйца, *L* личинки, *N* нимфа.

Argasidae

- **Life cycle is highly variable**
- **Same developmental stages, but usually with repeated feeding**

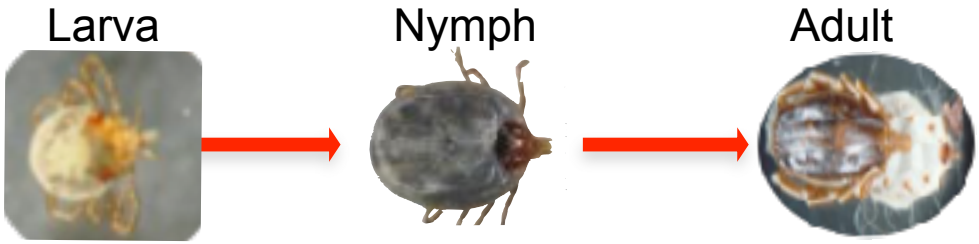
- **Always more than one nymphal instar:**
  - ***Otobius*: 2 nymphal instars**
  - ***Ornithodoros lahorensis*: 3 nymphal instars**
  - **Other *Ornithodoros* spp.: 3-8 nymphal instars**
- **Number of nymphal instars depends on:**
  - **Species**
  - **Degree of engorgement of previous instars/stages**
  - **Temperature**

Argasidae


adult feeding
questing / mating / attack
molting
drop off
UNFED FEMALE
ENGORGED NYMPH I/n
drop off
SUBSEQUENT HOSTS
molting
multiple gonotrophic cycles
oviposition
ENGORGED FEMALE
UNFED NYMPH II/n
multiple nymphal feeding cycles
EGG
MULTI-HOST LIFE CYCLE
ARGASIDAE
hatching
questing / attack
SUBSEQUENT HOSTS
UNFED LARVA
FIRST HOST
questing / attack
ENGORGED LARVA
UNFED NYMPH I
nymphal feeding
questing / attack
larval feeding
drop off
molting

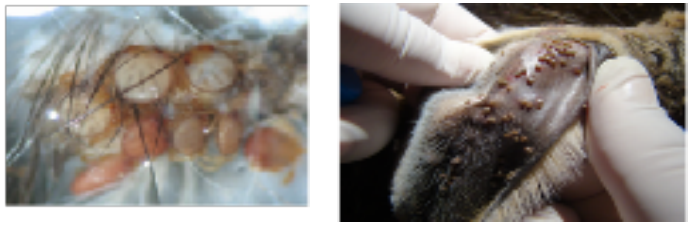
Pathogen maintenance and transmission

-Trans-stadial (horizontal)

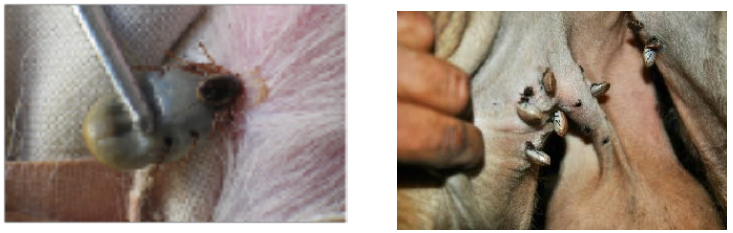


-Trans-ovarial (vertical)

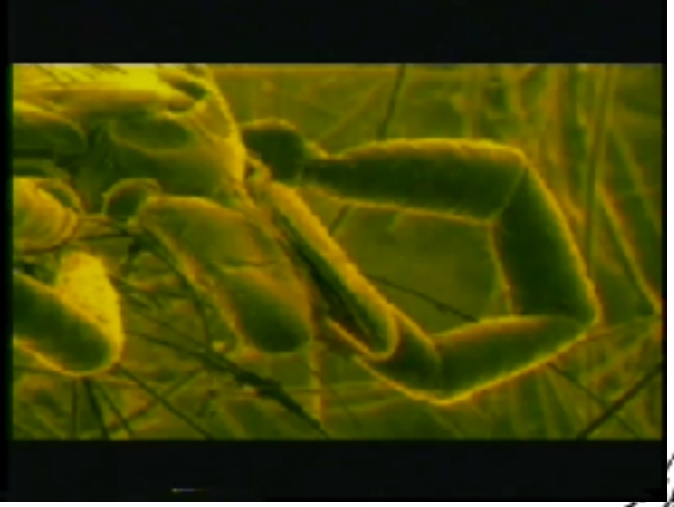
-Nonviremic transmission by co-feeding



-Venereal



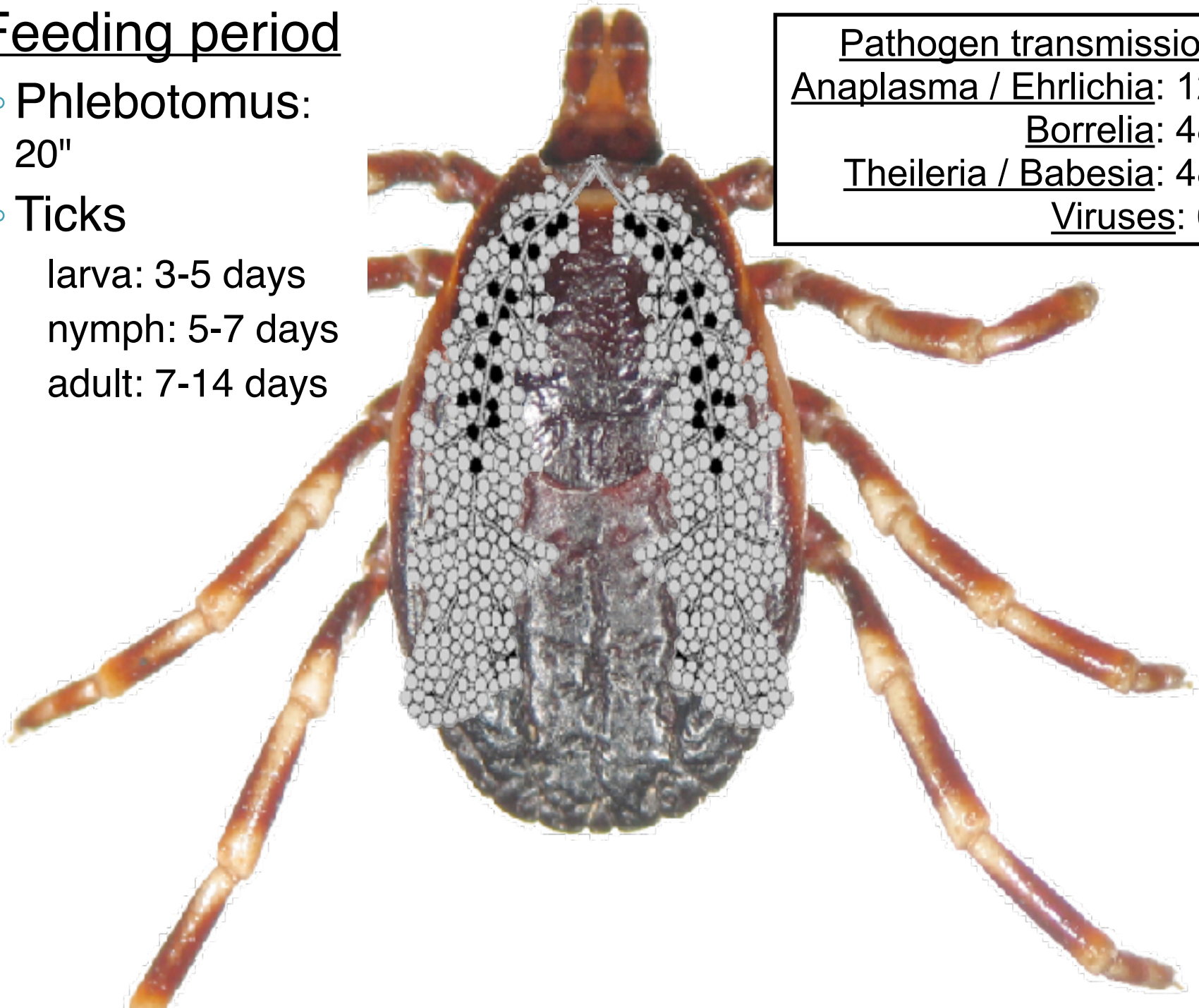
Ixodidae



Midgut
Malpighi tubulleri
Gut
Anus
Tükürük bezi
Ovarium
Epidermis
Genital delik
♂
Kan hücreleri
Alt deri
Kılcal damar

Feeding period

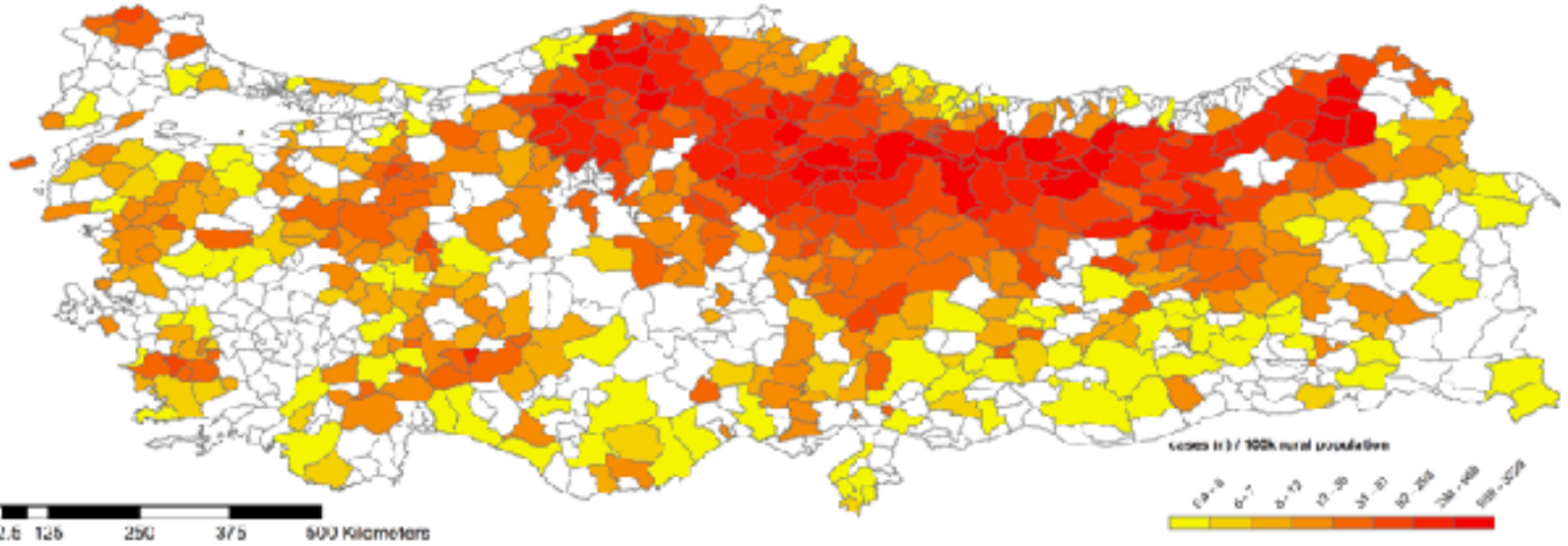
- Phlebotomus: 20"
- Ticks
  - larva: 3-5 days
  - nymph: 5-7 days
  - adult: 7-14 days



Pathogen transmission time
Anaplasma / Ehrlichia: 12-24 h
Borrelia: 48-66 h
Theileria / Babesia: 48-72 h
Viruses: 6-12 h

Crimean-Congo Haemorrhagic fever

- **Most widespread tick-borne viral disease of humans**
  - More than 30 countries are affected
- **Recent outbreaks in Eurasia**
  - Southern Federal districts of RF (since 1999)
  - Balkans (Kosovo, Albania, Bulgaria, Greece)
  - Turkey (since 2002)
  - Iran, Afghanistan, Pakistan,
  - SPAIN …



CCHF in Animals

- No clinical symptoms in animals (Not known in Vet. Med.)
  - Viraemia lasts for 7-14 days
- Virus isolation and serology
  - Hare, hedgehog, cattle, goat, sheep, ostriches, rooks





CCHF is in the OIE list of notifiable animal diseases since 2006

CCHF: transmission to humans

- Tick associated
  - Tick bite
  - Crushing of infected ticks
- Contact with viraemic animal's tissues & fluids
- Nosocomial
  - Patient contact
  - Tissue & body fluids contact
- Laboratory

CCHFv vectors

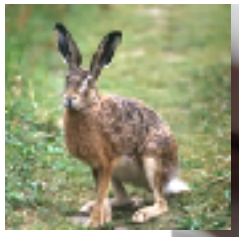
- **Virus is isolated from 30 tick species**
- **Proven competent vectors**
  - *Hyalomma marginatum*
  - *Hy. rufipes*
  - *Hy. turanicum*
  - *Hy. asiaticum*
  - *Hy. truncatum*
  - *H. impeltatum*
  - *Hy. anatolicum*
  - *Dermacentor marginatus*
  - *Rhipicephalus rossicus*
  - *Rh. evertsi*
  - *Amblyomma variegatum*

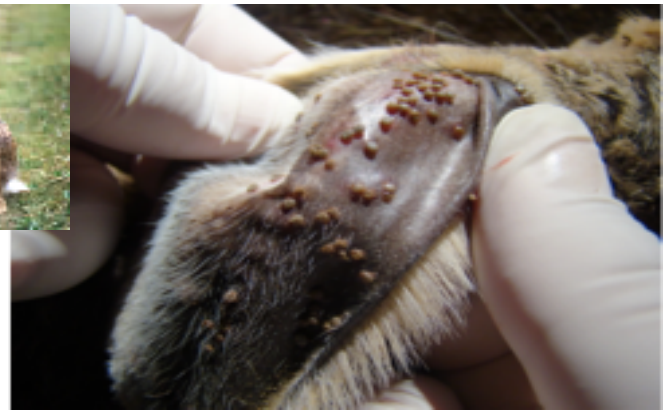
The tick: *Hyalomma marginatum*

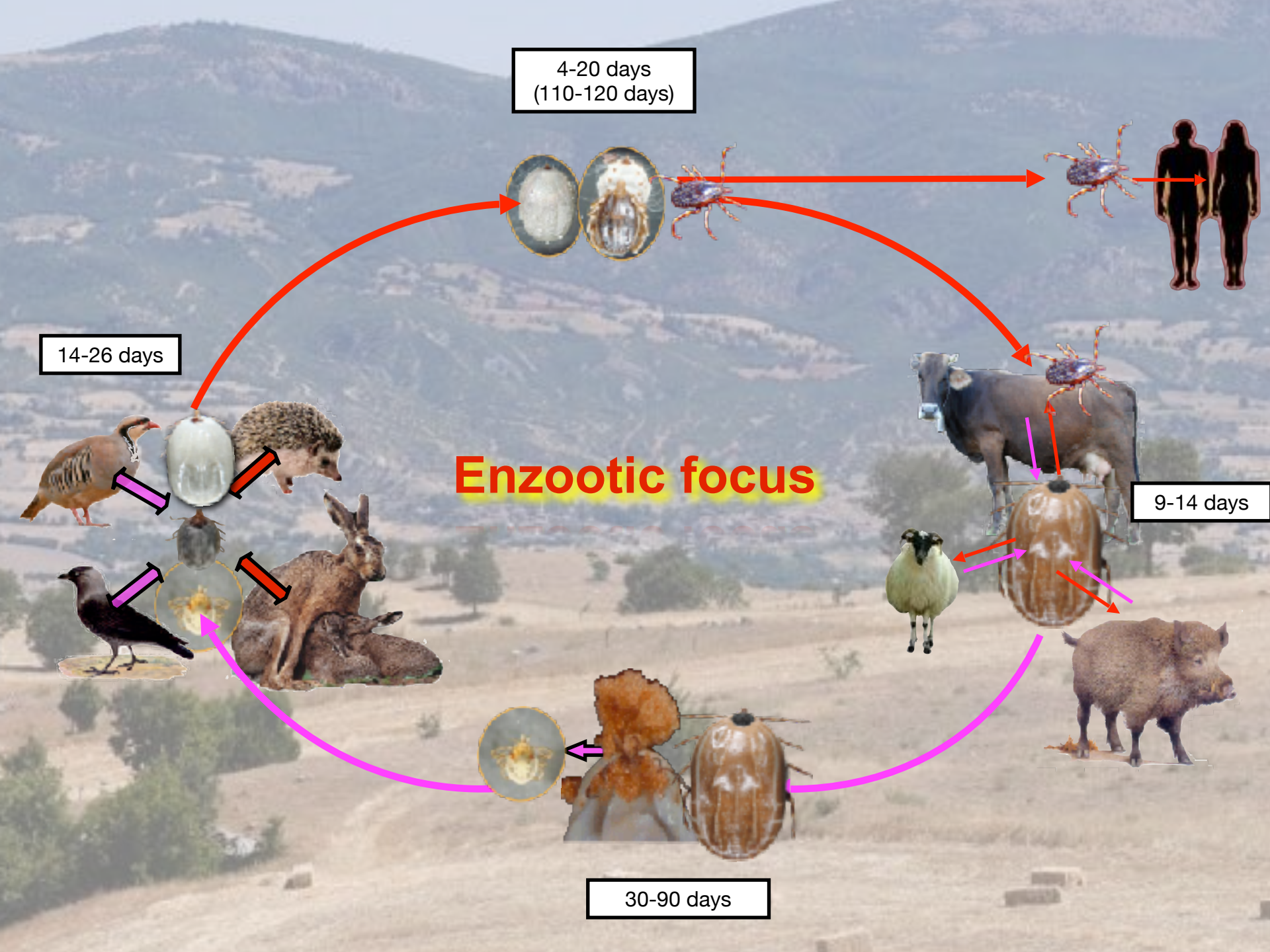
-Two-host exophilic tick,
-1 year (from egg to egg) life cycle

– Adults feed on Artiodactyla (cattle, horses, sheep, goats, wild boars) (peak in May-June)

– Immatures feed on small wildlife; hares, hedgehogs and ground-feeding birds (Corvidae, Phasianidae, Passerinae) (Peak in July-August)





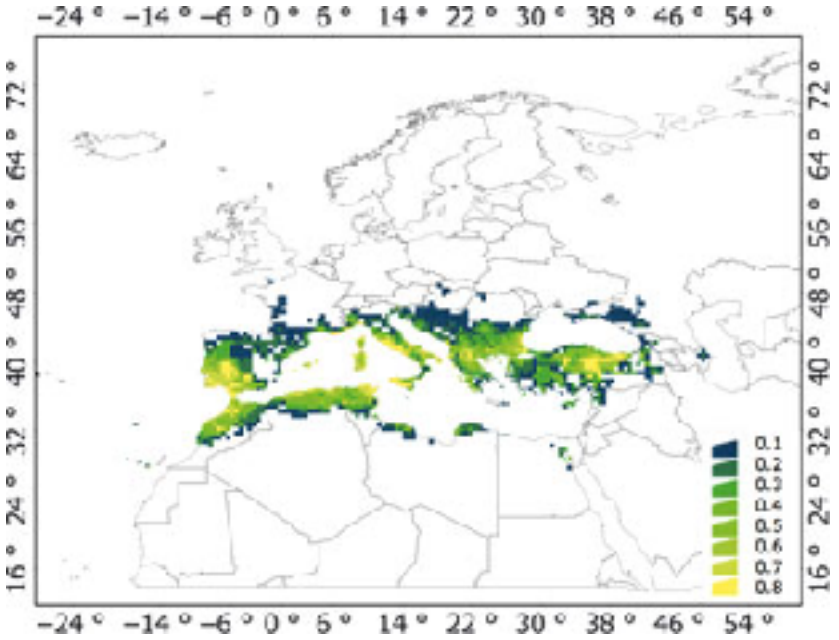

4-20 days
(110-120 days)
14-26 days
Enzootic focus
9-14 days
30-90 days

H. marginatum

- Adapted to mediterranean/steppe climate
  - hot and dry summers, cold winters
    - High humidity adversely affects embryonal development

J. Med. Entomol. 37(6): 807-814 (2000)

- Does not exceed parallel 47°N
  - "Populations north of the parallel 47°N are subjected to low developmental rates because of low temperatures"
    - below 3000 °C of accumulated temperatures



Estrada-Peña et al. Transboundary and Emerging Diseases 58, 213-223, 2010

H. marginatum

- Hunter tick
- Agresively attacks hosts
  - Very fast and continuous horizontal movement (50-500m)
    - No vertical movement
- Active in summer months
  - Activity starts in spring (temp > 10°C)
  - Optimal activity at 22-27°C and 75-100% RH
  - Hides under vegetation or in cracks when ground temperature reaches 45°C
- Overwinters as unfed adult
  - in cattle pastures, fallow land and bush (not in livestock shelters)

CCHF Epidemics (Russia, Balkans, Turkey)

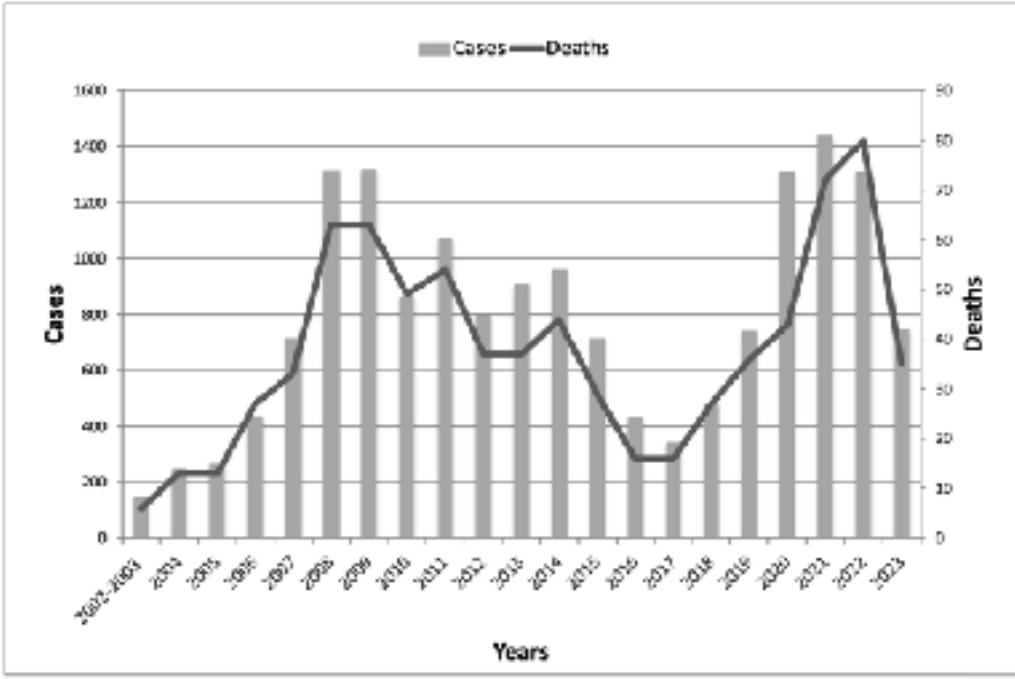
-Ecological changes (regeneration)

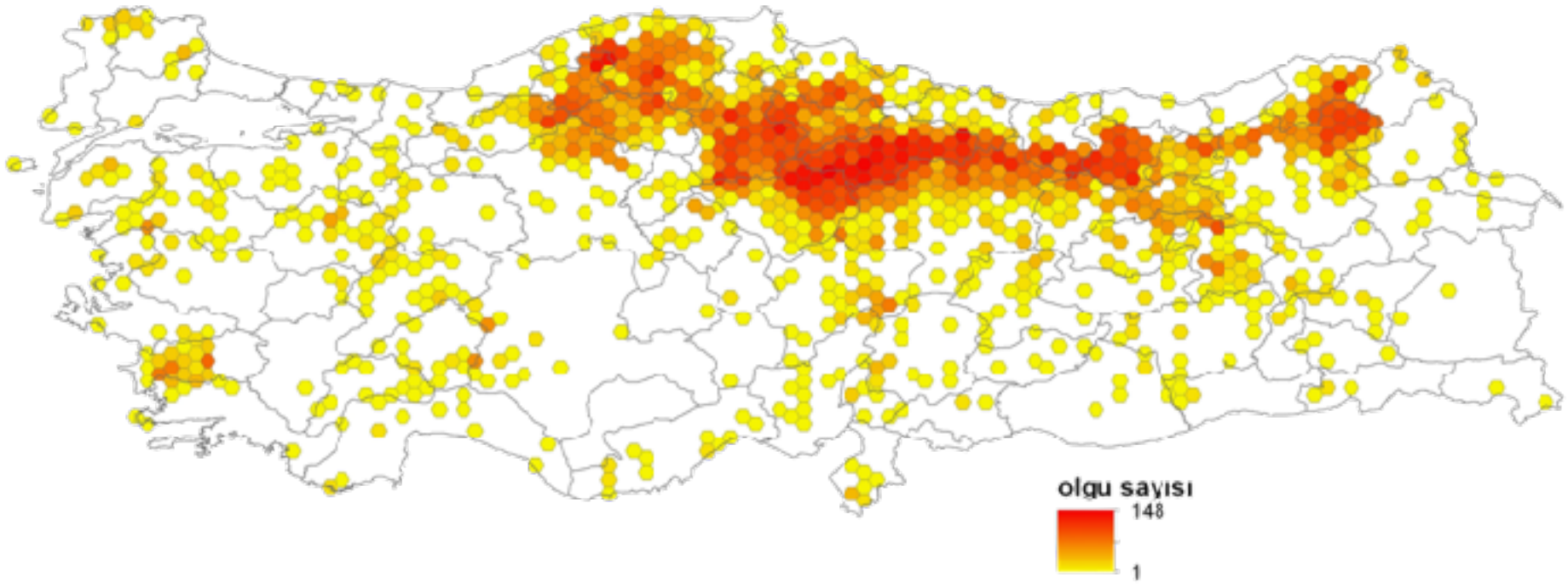
-Increase in wild animals and ticks (Hyalomma)

CCHF in Turkey

Largest epidemic in the World

- 2002-2023
  - 3700 villages in 300 districts
  - 16578 cases
  - 793 deaths (%4.8)





The biotic characteristics of CCHF foci

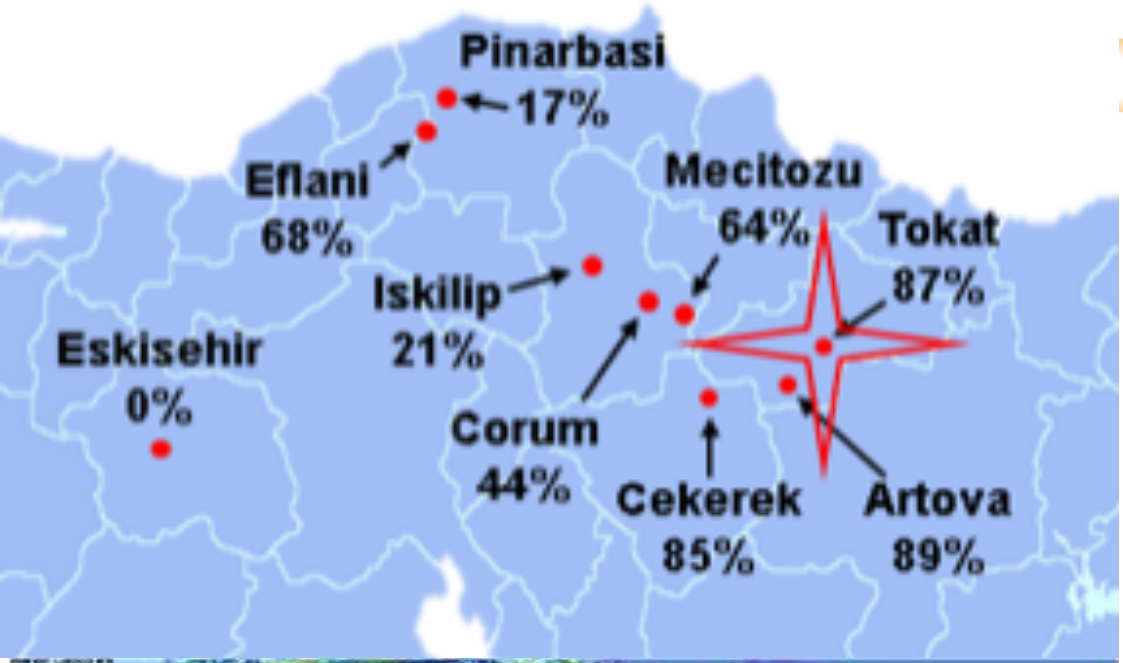
Livestock

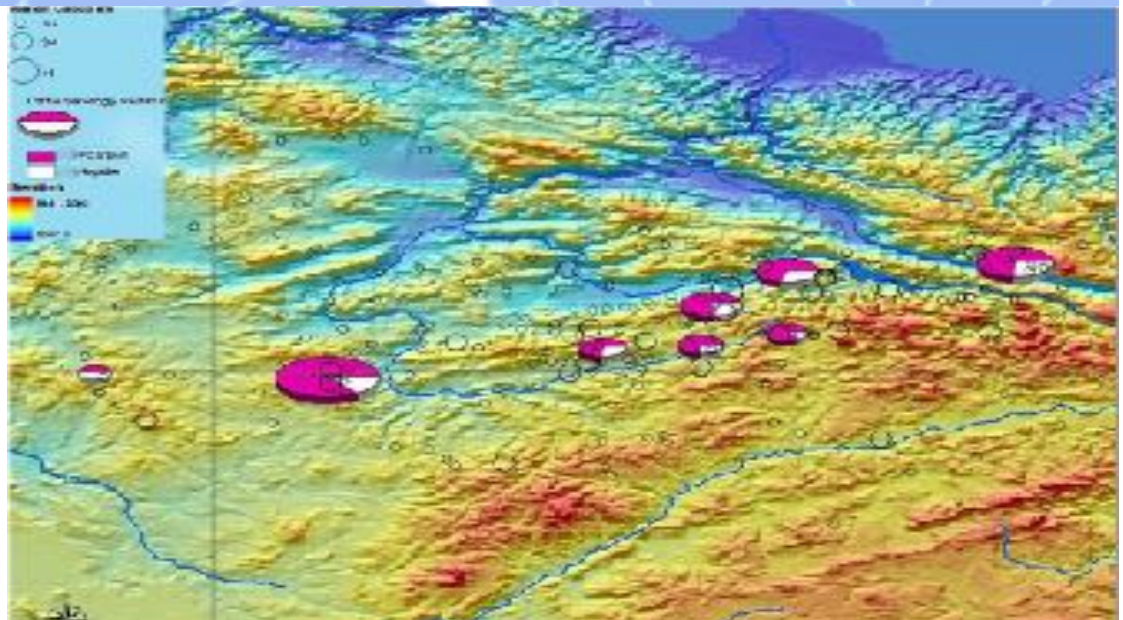
- Cattle
  - The main host for adult ticks
    - 36 female ticks per cattle/season
      - 250 000 larvae per cattle/season
  - Have role in transovarial transmission of the virus

- Sheep
  - Remarkable decrease in population (50-70%) Russia &Turkey
  - Might caused increase in hare* and *Hyalomma* population

*Smith, R.K., Jennings, N.V., Robinson, A. & Harris, S. (2004) *Journal of Applied Ecology*, 41, pp 1092–1102.

Seroprevalance in cattle





İlçe	sampled	Prevalance%
2011		
Eskisehir	7	0
Eflani	118	68
Pinarbasi	42	17
Iskilip	29	21
Corum	71	44
Mecitozu	28	63
Cekerek	60	85
Artova	36	89
Tokat	69	87
Erzurum	37	0
Total 2011	**497**	**57**
2005		
Boğazkale	3	33
Almus	6	33
Artova	8	63
Reşadiye	35	74
Tokat	110	76
Zile	5	80
Sorgun	15	87
Çekerek	43	88
Yeşilyurt	3	100
Yıldızeli	6	100
Total 2005	**234**	**78**

CCHFv prevalence in ticks from livestock*

	Animal (feeding ticks)			
Species	MLE%	nTicks	nPools	nPosPools (qPCR)
D.marginatus	33.33	3	3	1
Hae.punctata	4.12	24	17	1
Hae.sulcata	0.00	1	1	0
Hy.asiaticum	0.00	161	92	0
Hy.excavatum	6.09	17	11	1
Hy.marginatum	6.21	1942	898	116
Hy.rufipes	N/A (100)	2	1	1
Ix.ricunus	0.00	1	1	0
Rh.bursa	2.49	40	35	1
Rh.turanicus	0.00	42	32	0
Total	5.81	2233	1091	121

*Positivity in ticks collected from animals is NOT an indicator of vectorial capacity!

Transovarial transmission

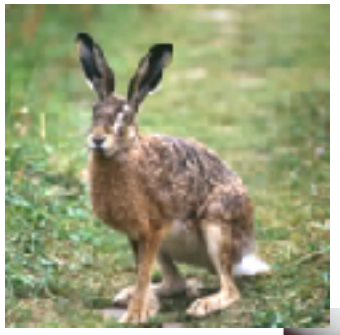
- Problems in maintaining oviposition in lab
- 41400 larvae from 22 engorged females from 11 cows
  - 246 larval pools (50-250 larvae/pool)
- 2 female carcases from 2 cows tested positive
- 6 out of 7 larval pools of those ticks were also positive

	Female	qPCR	nLarvae	npools	nPos
cow1	Hy. marginatum1	N	3400	17	0
	Hy. marginatum2	N	3300	17	0
	Hy. marginatum3	N	3500	18	0
	Hy. marginatum4	N	1700	9	0
	Hy. marginatum5	P	700	4	4
cow2	Hy. marginatum6	P	600	3	2

The biotic characteristics of CCHF foci

Wildlife

- Wild boars
  - Host for adult ticks
  - May play role in viral circulation



- Hares & hedgehogs
  - Main host for immature ticks
  - Play role in viral circulation
    - 17.5% of detached* ticks from hares tested CCHFv (+)

- Partridges/rooks
  - Hosts for immature ticks
  - May play role in non-viraemic transmission
    - 10.8% of detached* ticks from partridges teste CCHFv (+)

* collected as engorged nymphs, molted to adults in the lab and tested with PCR

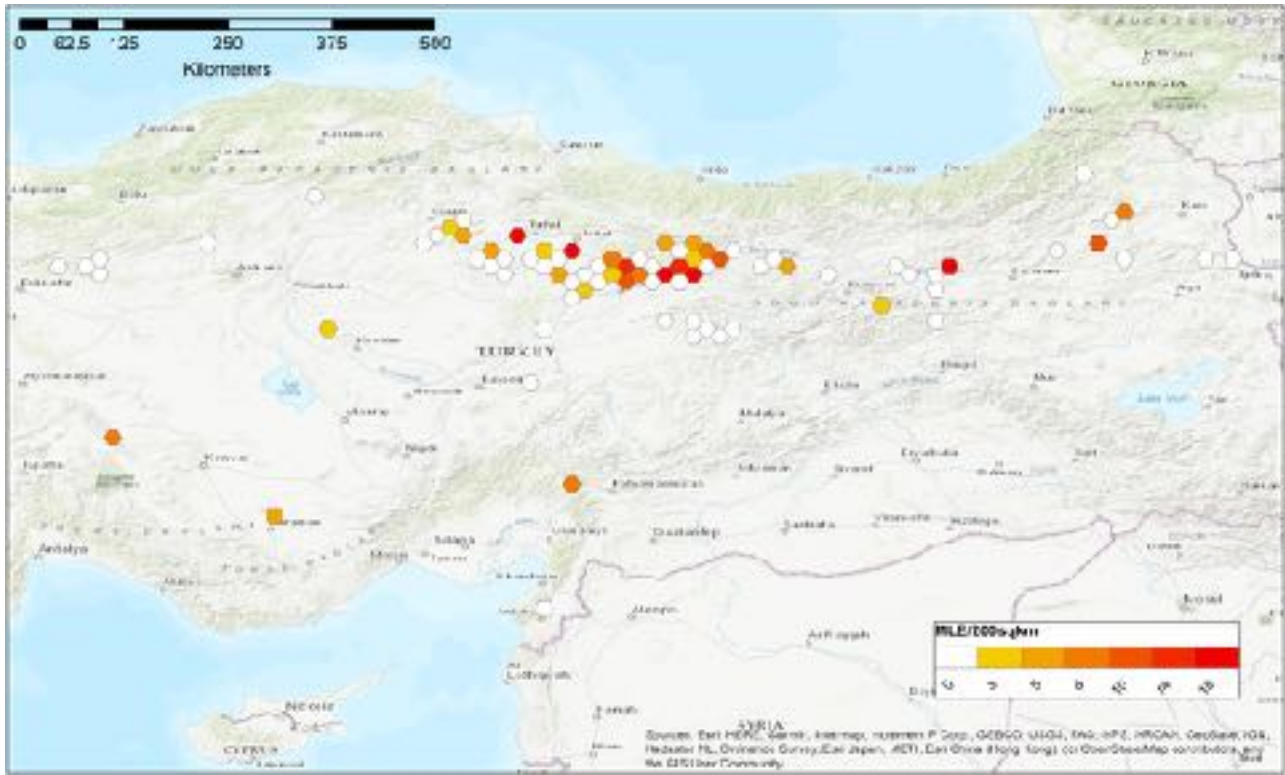
Hares

- 5 out of 59 (8.47%) rtPCR positive
- Heavy tick (Larvae/Nymphs) infestation (94.72%)
  - Dermacentor spp. (L/N) 913
  - Hyalomma spp. (L/N) 4394
  - Hyalomma/Dermacentor cofeeding (4/1)

Host seeking ticks

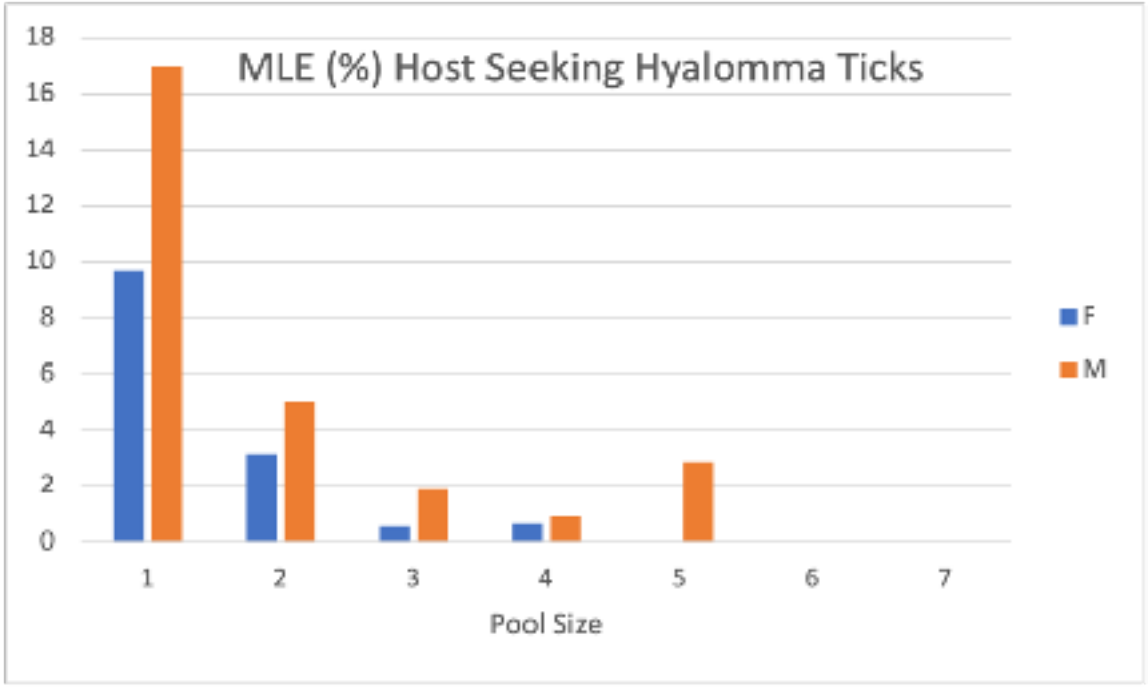
- Viral RNA
  - –16.43% (2008, rtPCR)
  - –5.77% (2010, AgELISA)
  - –MLE prevalence 0-18% per 200km² (2023, qPCR)

- qRT-PCR
  - Different viral loads in ticks
    - 4.88x10¹/ml
    - 2.63x10³/ml
    - 4.5x10³/ml,
    - 3.72x10⁴/ml
    - 8.64x10⁴/ml



Host seeking ticks (qPCR)

	Ground (host seeking ticks)			
Species	MLE%	nTicks	nPools	nPosPools
Hae.punctata	0.00	7	6	0
Hae.sulcata	0.00	1	1	0
Hy.asiaticum	0.00	1	1	0
Hy.excavatum	0.00	19	10	0
*Hy.marginatum***	4.49	1446	690	64
*Rh.bursa**	25.00	4	4	1
*Rh.turanicus**	8.19	38	30	3
Total	5.38	1516	742	68



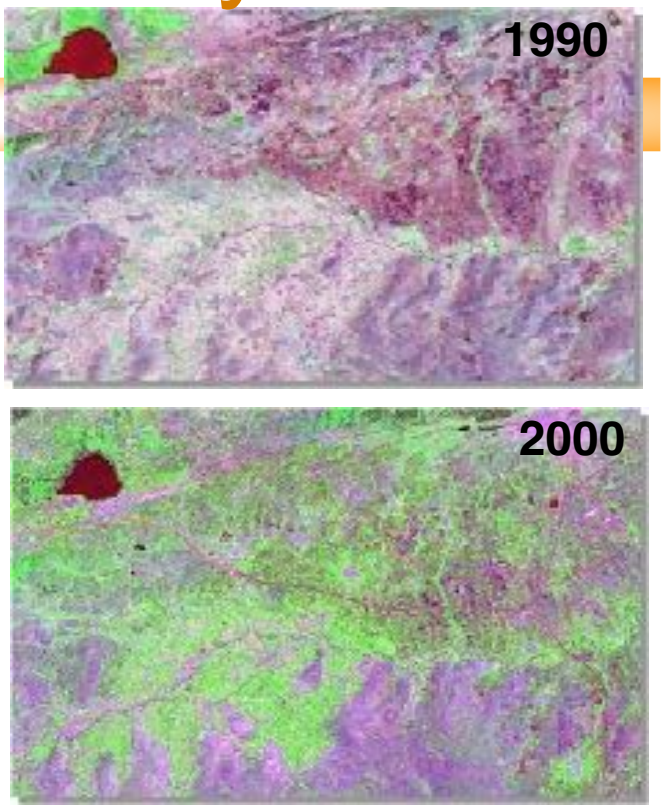
Socio-economic factors

- Russia (USSR) & Balkans
  - Post WWII
    - Return to the abandoned lands (Crimea)
    - Transformation of natural areas into agricultural lands (Rostov & Bulgaria)
    - Prevention of floods (Astrakhan)
  - Post Gorbachov…
    - Political conflicts (Bosnia, Kosovo)
    - Collapse of Soviet system
      - Radical changes in agriculture

Socio-economic factors, Turkey

- **Landscape & agriculture**
  - Undulated and fragmented landscape
  - Crop rotation
    - Wheat/Vetch, Wheat/fallow
- **Ecological regenaration**
  - Increase in bush type habitat (Increase in wildlife population)
    - *Forestration, ban of sheep grazing*
    - *Abondon of the fields due to migration*

Gerede, Bolu, TR

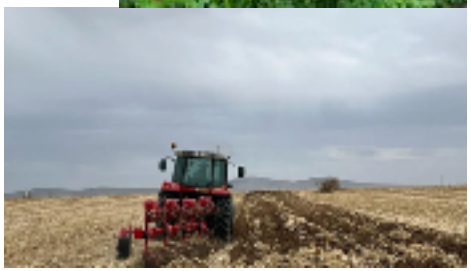


Primitive agriculture

Fragmented habitat/Crop rotation

Forestration, Ban of sheep/goat grazing

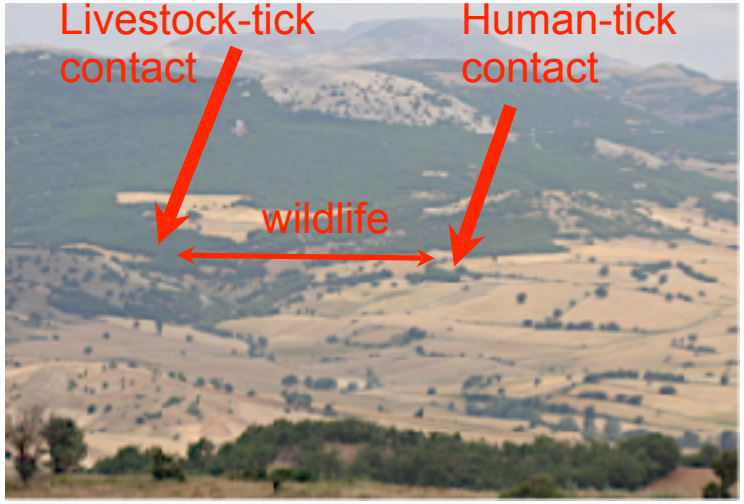
Crop rotation



CCHF risk

Cases are associated with

Hyalomma presence and habitat fragmentation



Safety first…

Thank you