

Relazioni tra clima caldo e stato sanitario

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- Qualità degli alimenti
- Sopravvivenza parassiti e/o vettori

Rischio morte

Metabolismo

Problemi sanitari nella bovina da latte in ambiente caldo

Meccanismi difensivi

Stress ossidativo

MECCANISMI DIFENSIVI

- ◆ Martin et al., 1975: mortalità elevata nei vitelli nati in estate
- ◆ Stott, 1980: alterazione dell'assorbimento di Ig nei vitelli nati in ambiente caldo
- ◆ Donovan et al., 1986: livelli plasmatici di Ig bassi nei vitelli scolostrati nati in estate

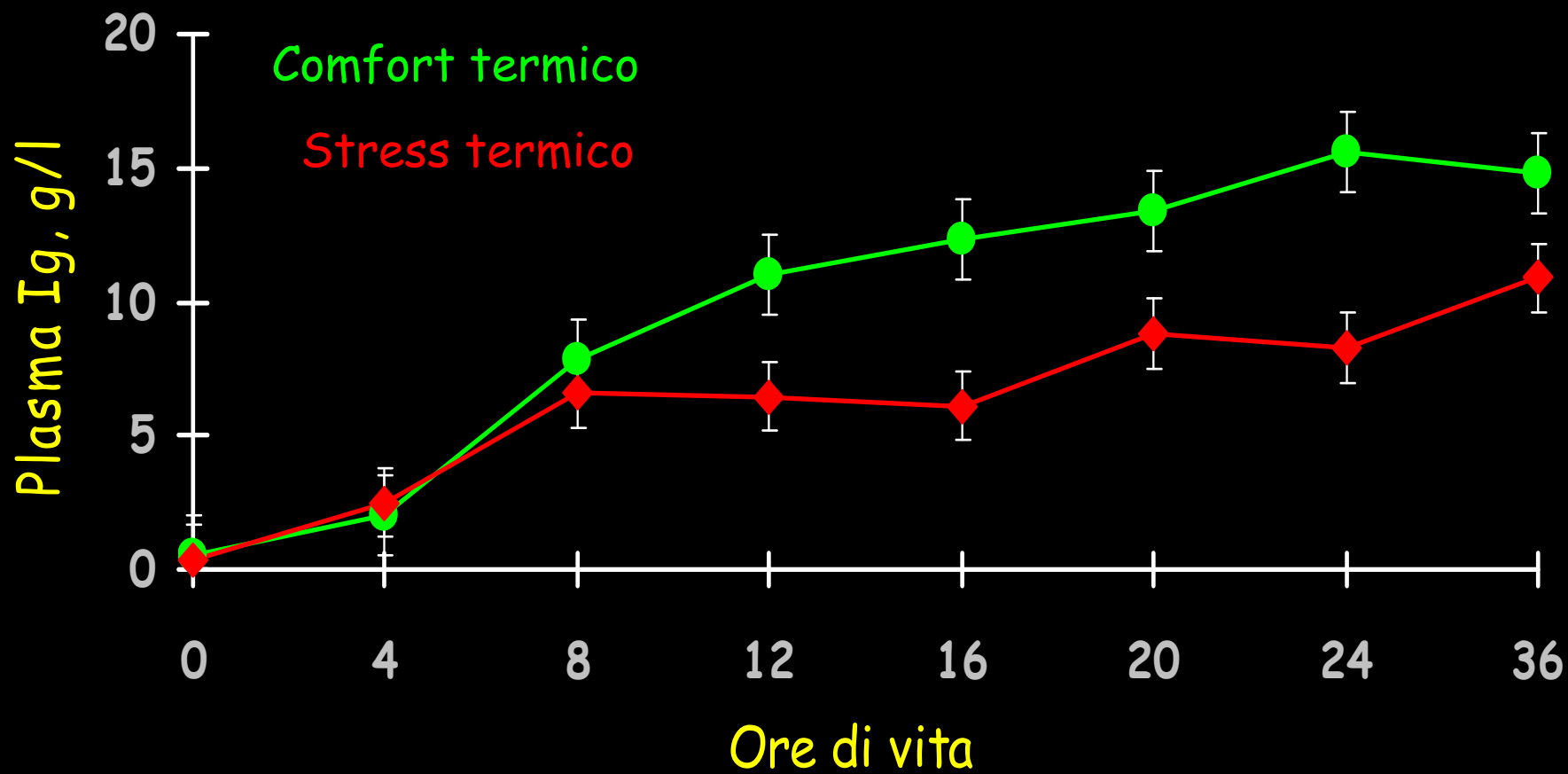
Colostrum protein fractions in cows exposed to thermal comfort (TC) or high air temperatures (HAT) (*Nardone et al., 1997*).

Item	Hours after calving							
	1		12		24		36	
	TC	HAT	TC	HAT	TC	HAT	TC	HAT
IgG, mg/dl	7.925 ^b	6.400 ^a	5.100	4.615	3.357	2.437	1.586	1.260
IgA, mg/dl	400 ^d	210 ^c	238	150	131	107	94	77
CN, %	5.3 ^b	4.3 ^a	3.5 ^b	1.1 ^a	1.6	1.4	1.9	1.7

Ig: immunoglobulins

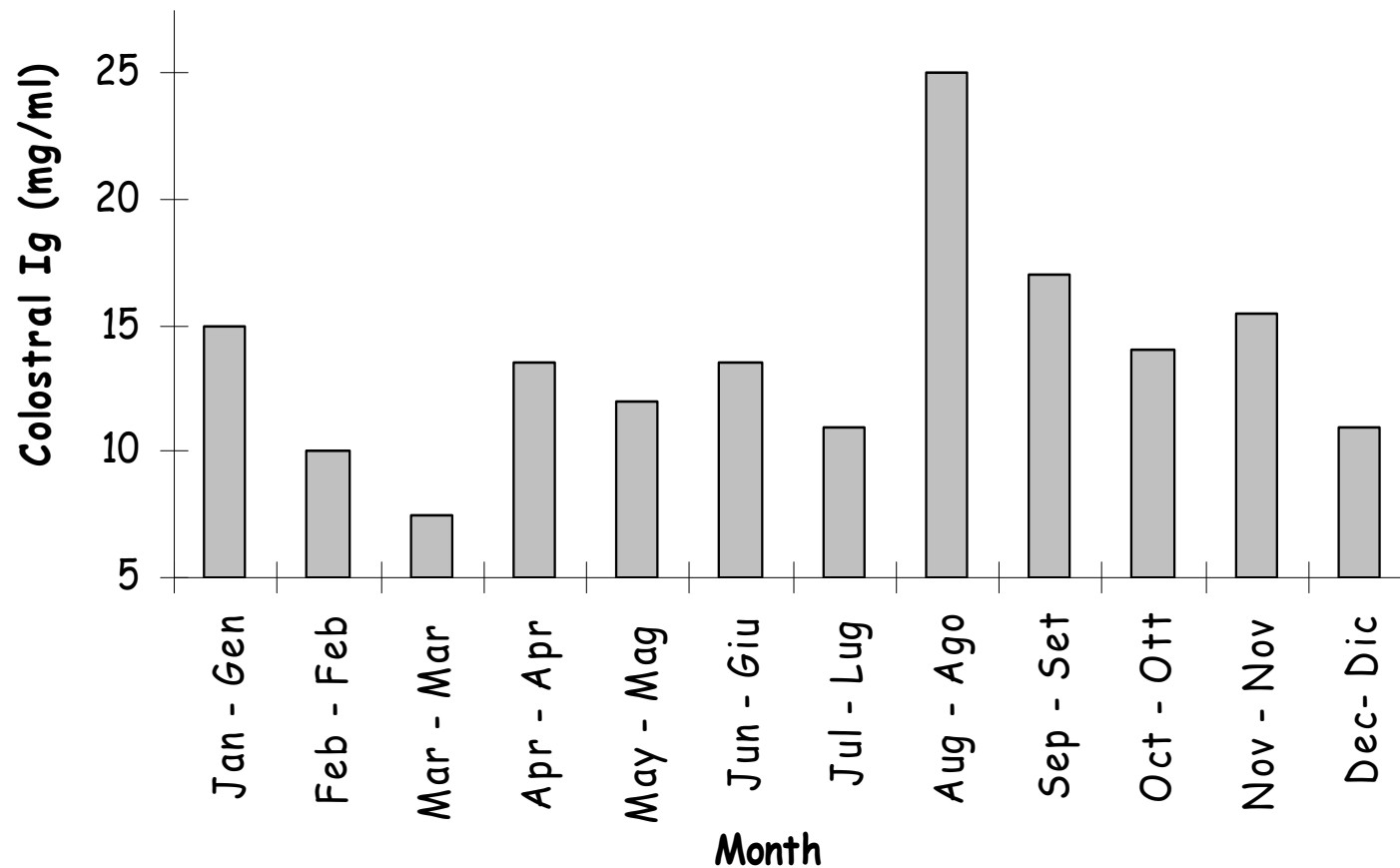
CN: casein

a, b: P < 0.05; c, d: P < 0.01.



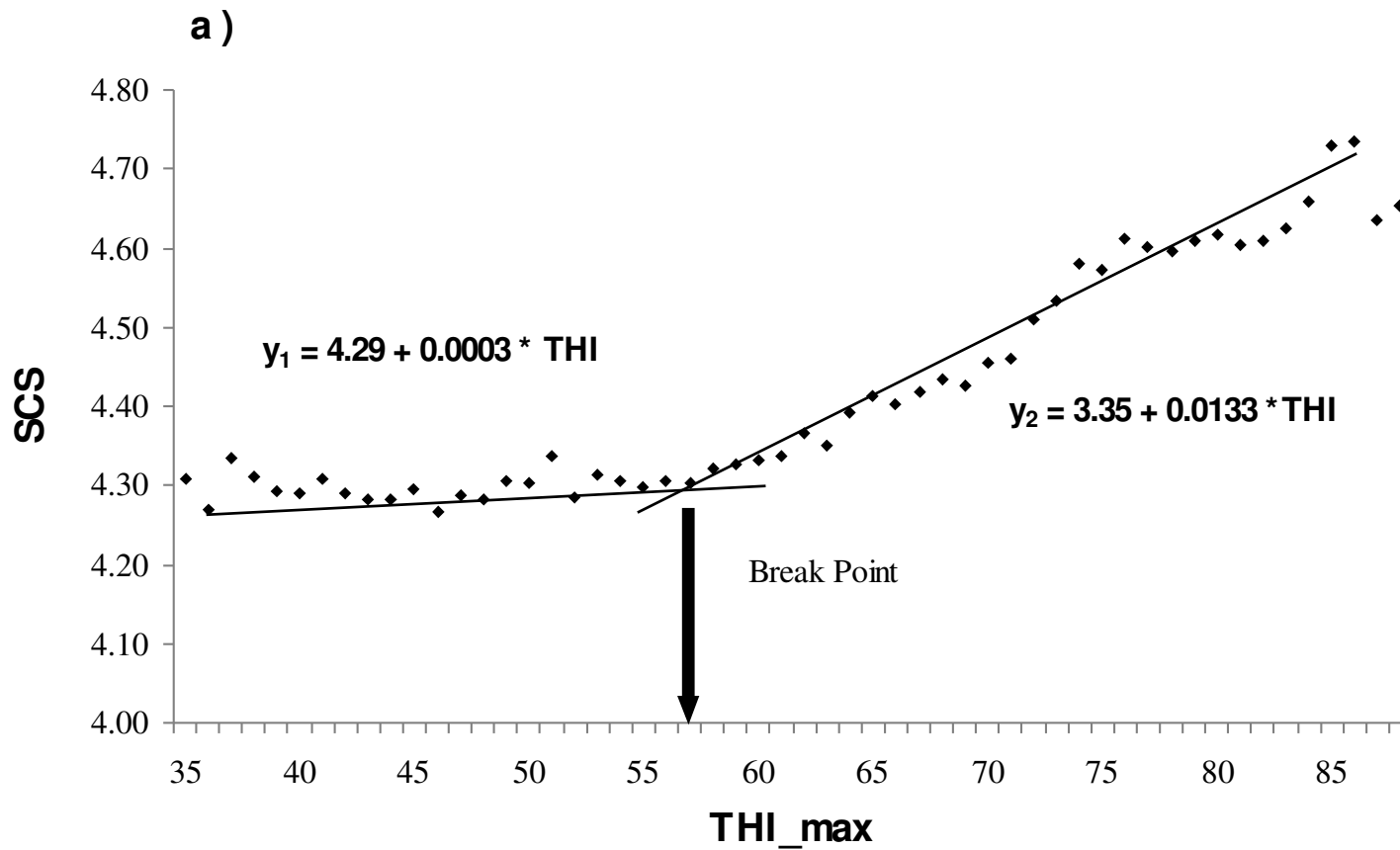
Lacetera, 1998

Lacetera et al., 2002: moderate heat stress in dairy cows was not associated with changes of colostral Ig or passive immunisation of calves

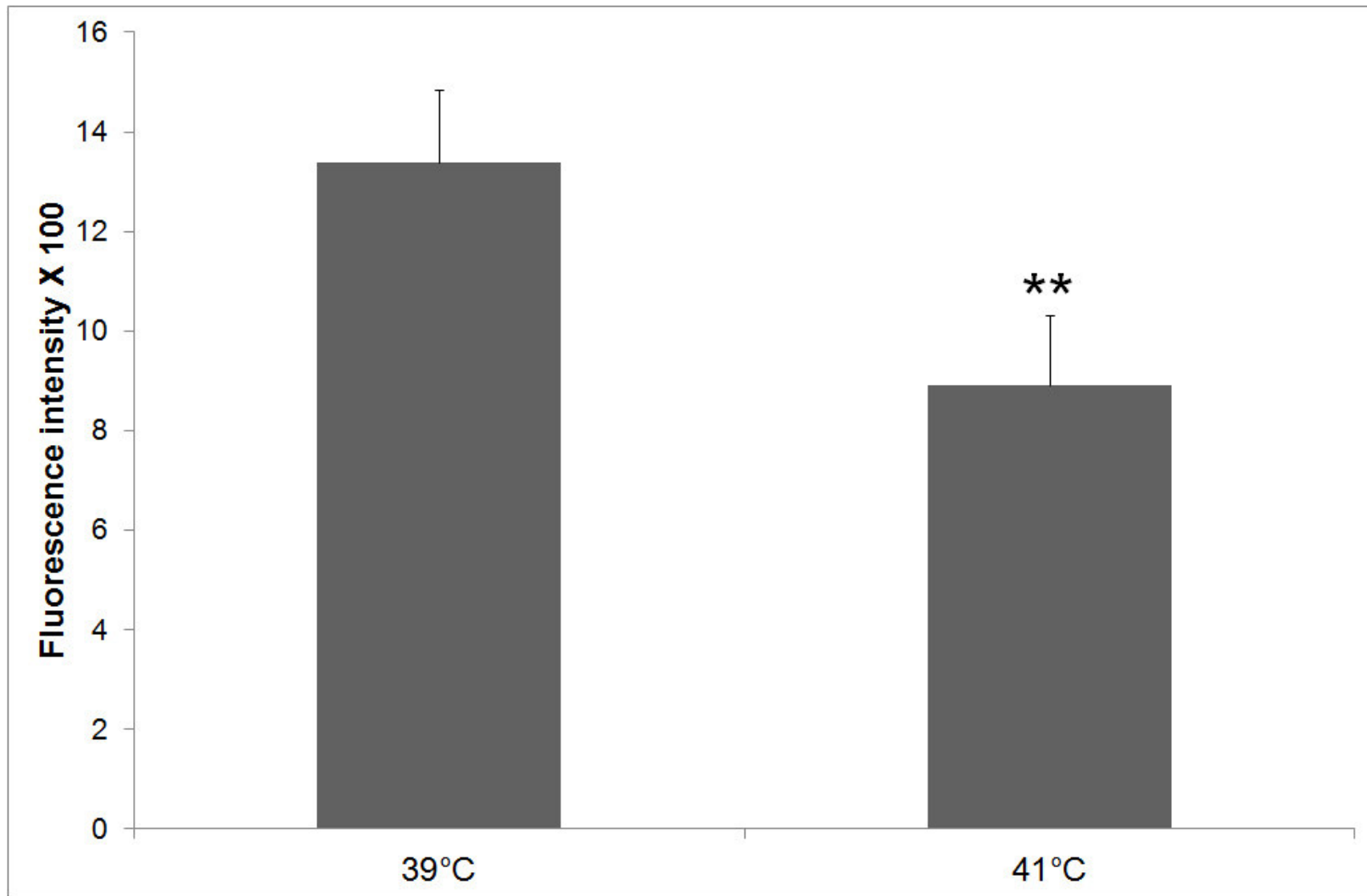


(Shearer et al., 1992)

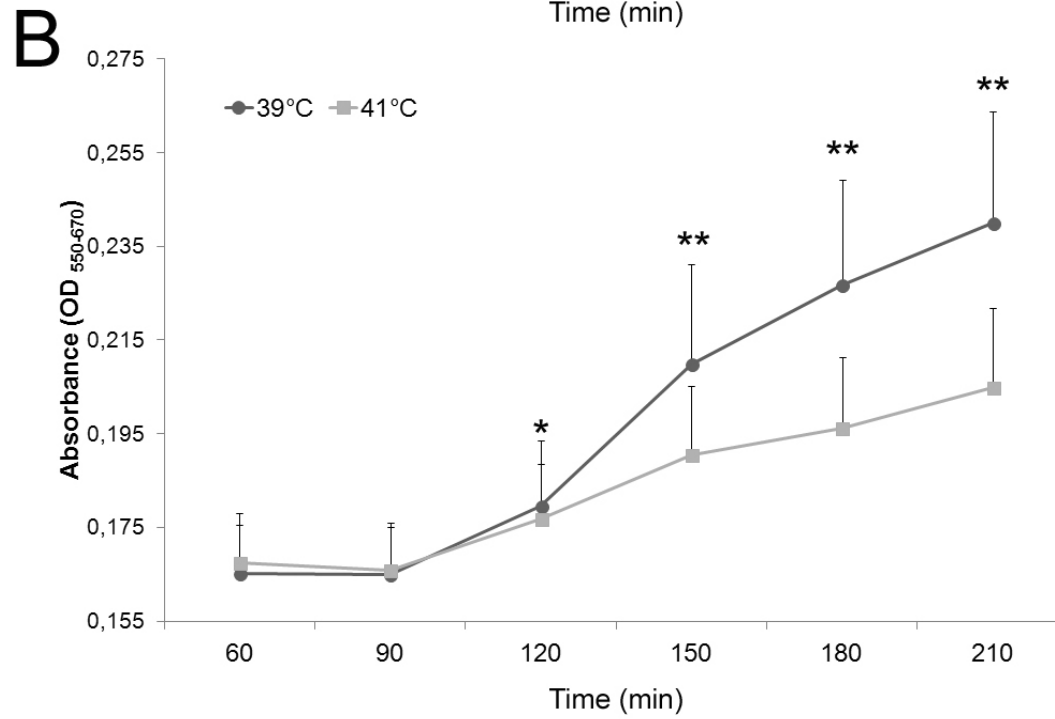
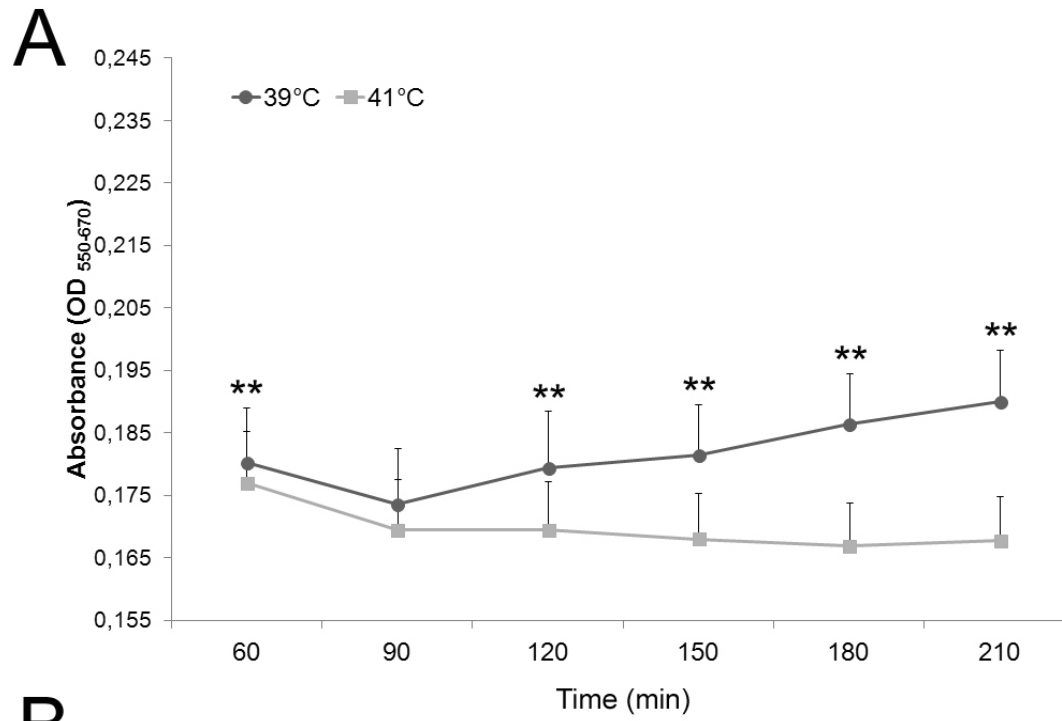
A series of studies carried out in dairy cows indicated a higher occurrence of mastitis during periods of hot weather (Giesecke 1985; Smith et al. 1985; Morse et al. 1988; Waage et al. 1998; Cook et al. 2002; Yeruham et al. 2003).

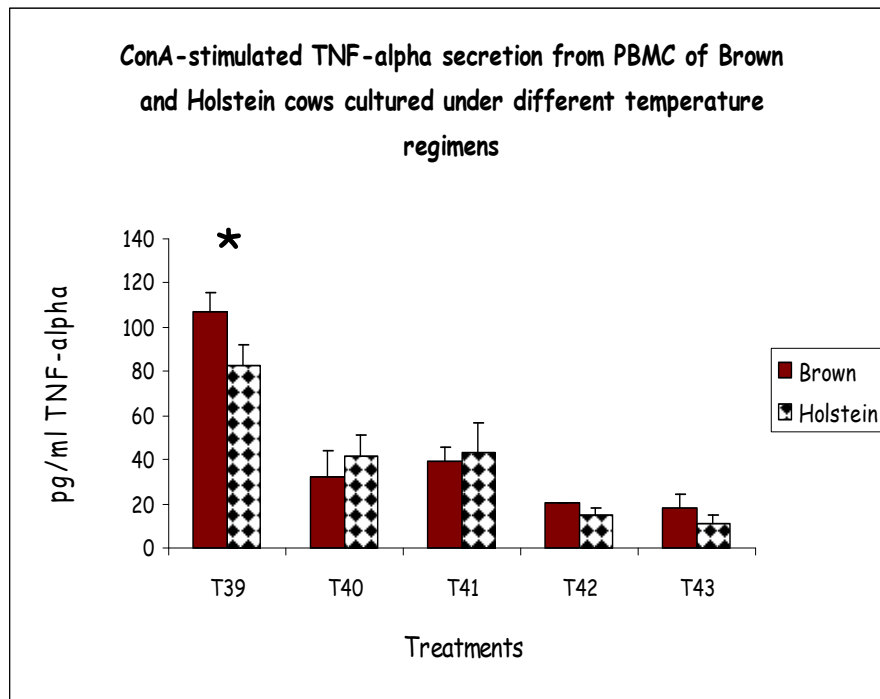


(Bertocchi et al., 2014)

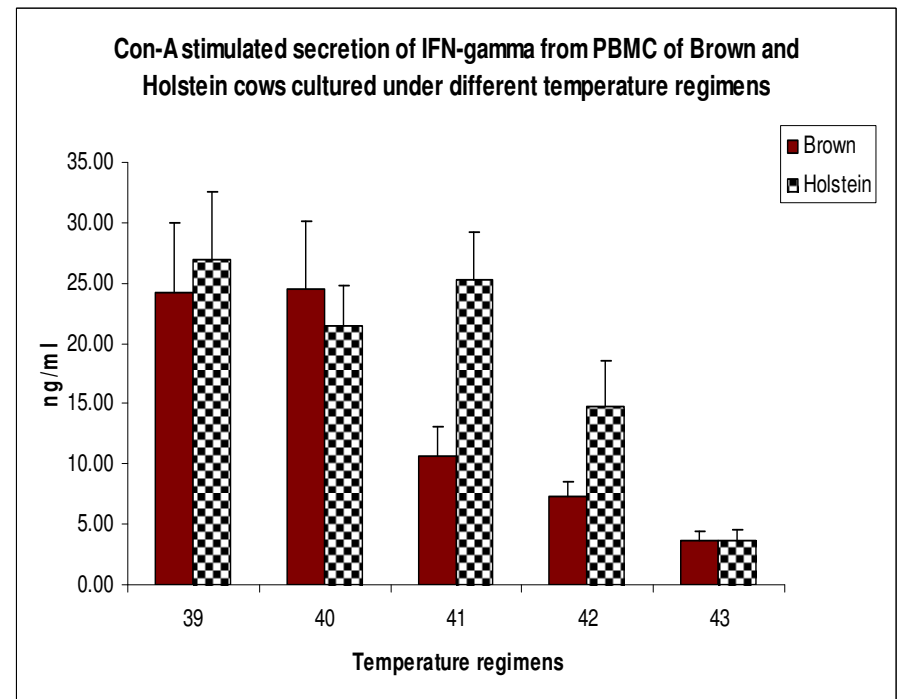


Lecchi et al., dati non pubblicati





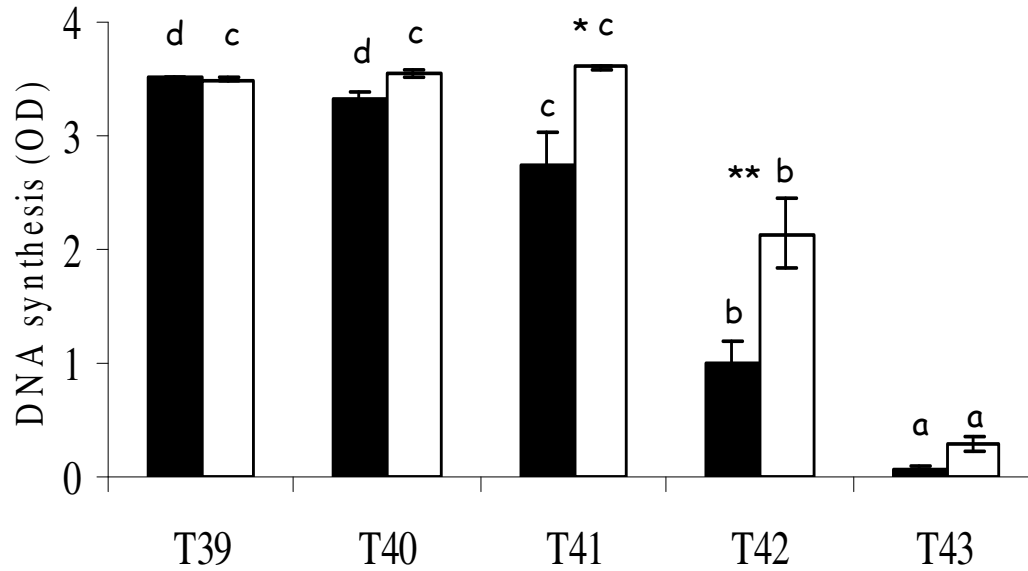
Both breeds: 39 °C vs 40, 41, 42 and 43 °C.



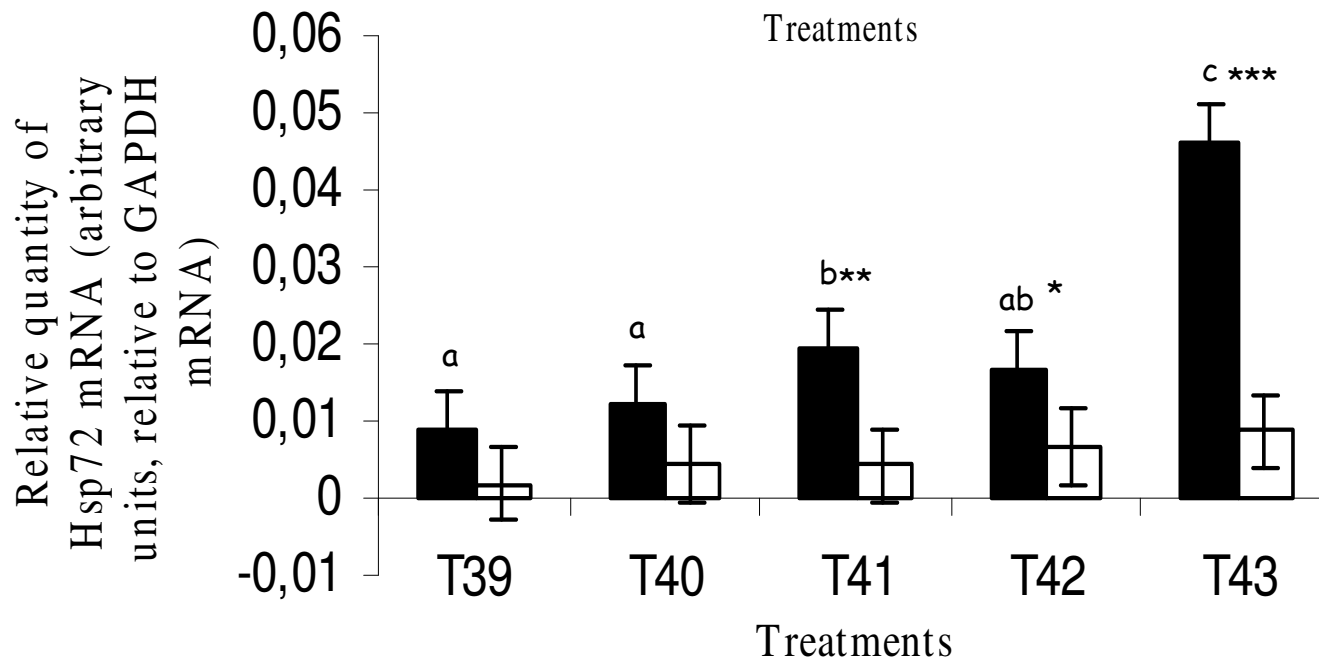
Brown: 39 °C vs 42 and 43 °C.
 Holstein: 39°C vs 43

Lacetera et al., dati non pubblicati

(Lacetera et al., 2006)



Open bars: Holstein
Solid bars: Brown Swiss



Correlation between DNA synthesis and Hsp72 mRNA = - 0.70 (P < 0.001)

Effects of moderate heat stress in summer cows on peripheral blood mononuclear cells (PBMC) proliferation (*Lacetera et al., 2002*)

PBMC proliferation (optical density)

Mitogens	Spring cows	Summer cows
Unstimulated	0.05 ± 0.01	0.07 ± 0.02
PHA (30 µg/ml)	0.33 ± 0.08	0.42 ± 0.10
ConA (5 µg/ml)	0.84 ± 0.17	0.80 ± 0.16
PWM (0.4 µg/ml)	0.46 ± 0.10	0.60 ± 0.12

Day-time (9-20 h) THI: 75.2 (SD 2.6)
RT: 39.6 (SEM 0.3) °C
RR: 59.7 (SEM 14.8) breaths·minute⁻¹

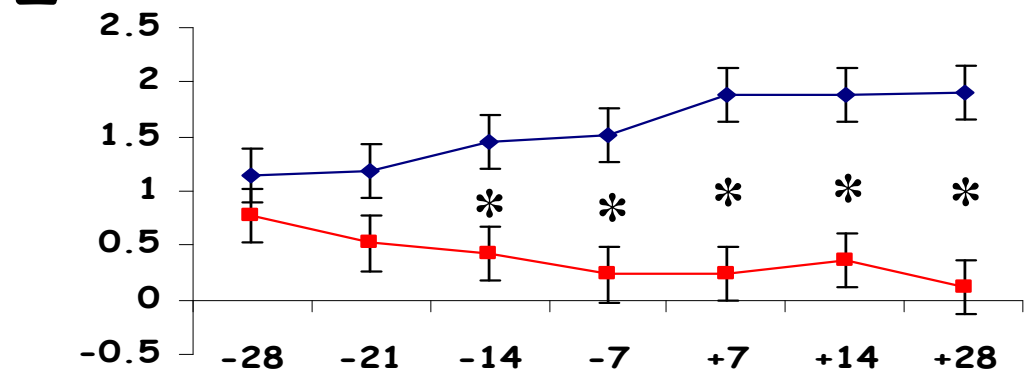
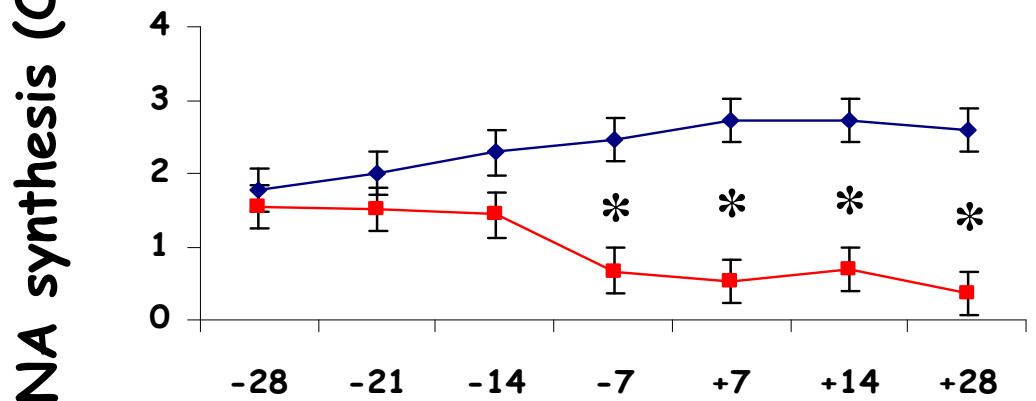
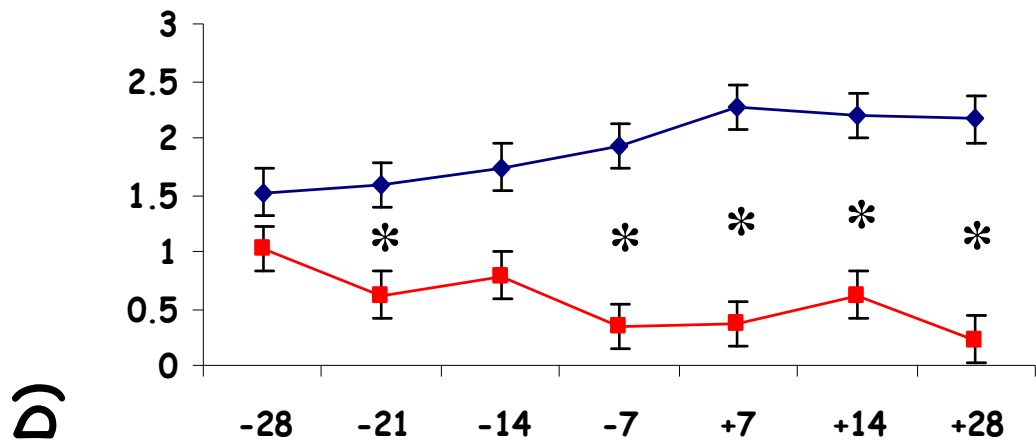
THI data

- SP: either day-time (9-20 h) or night-time (21-8 h) THI were below the UCTHI (72)
- SU: daytime and night-time THI were 79.5 ± 2.9 and 70.1 ± 4.7 , respectively

Heat wave - Duration (d) - Max THI - Mean THI > 72

1	5	83.4	78.9
2	6	85.8	79.1
3	15	90.5	79

(Modified from *Lacetera et al., 2005*)



DNA synthesis (OD)

Time relative to parturition (d)

PHA

Con-A

PWM

Spring

Summer

RT: > 40 C°
RR: > 80 breaths·minute

(Modified from *Lacetera et al., 2005*)

RISCHIO MORTE

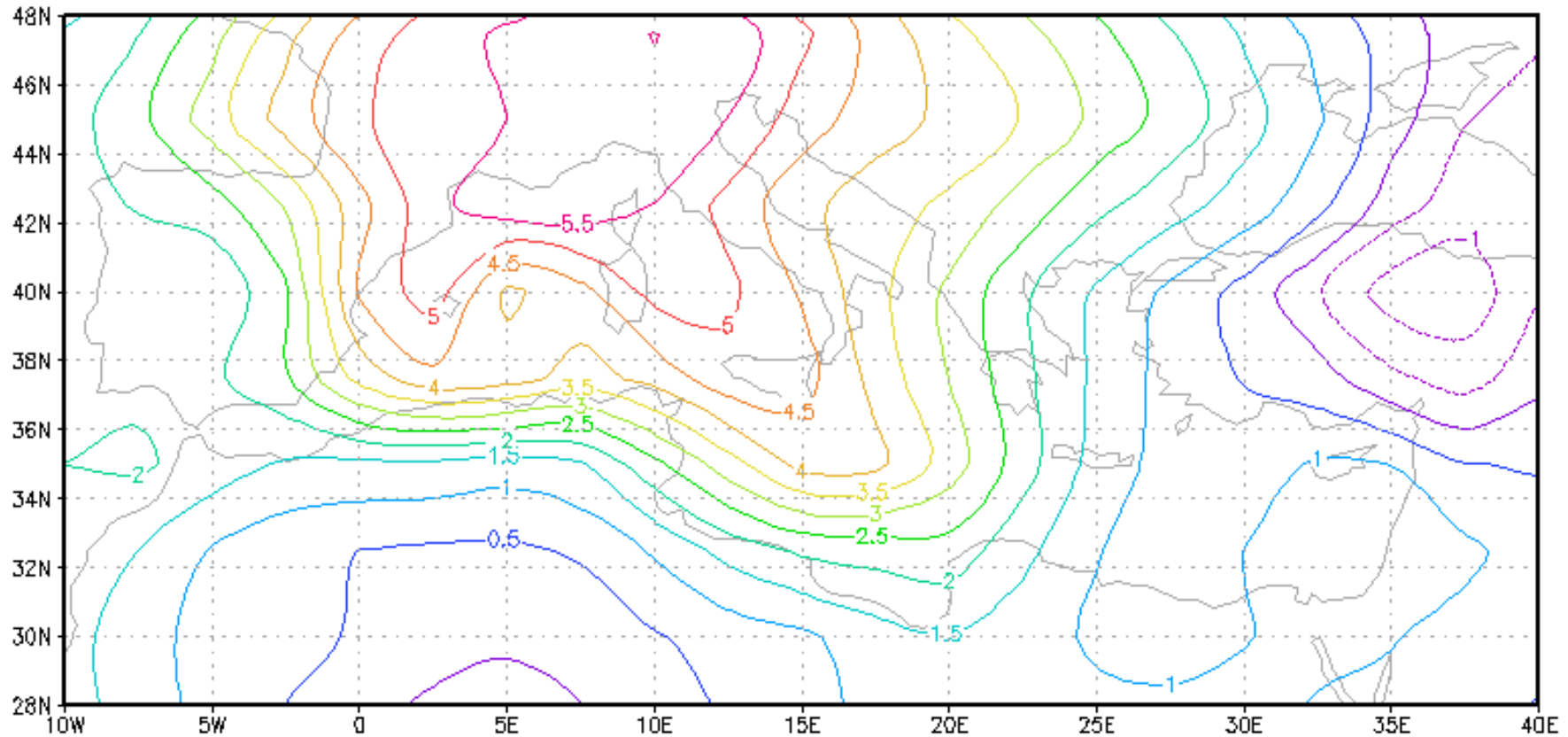
Cosa comporta > rischio morte

- Riduzione delle aspettative di vita
- Danno economico da mancata produzione / mancata nascita vitello / macellazione
- Spese veterinarie / farmaci
- Costi/danno ambientale per smaltimento delle carcasse
- Aumento quota di rimonta (> costi e impatto ambientale)
- Rallentamento del progresso genetico

Numero di morti e rischio relativo (in parentesi) per stagione

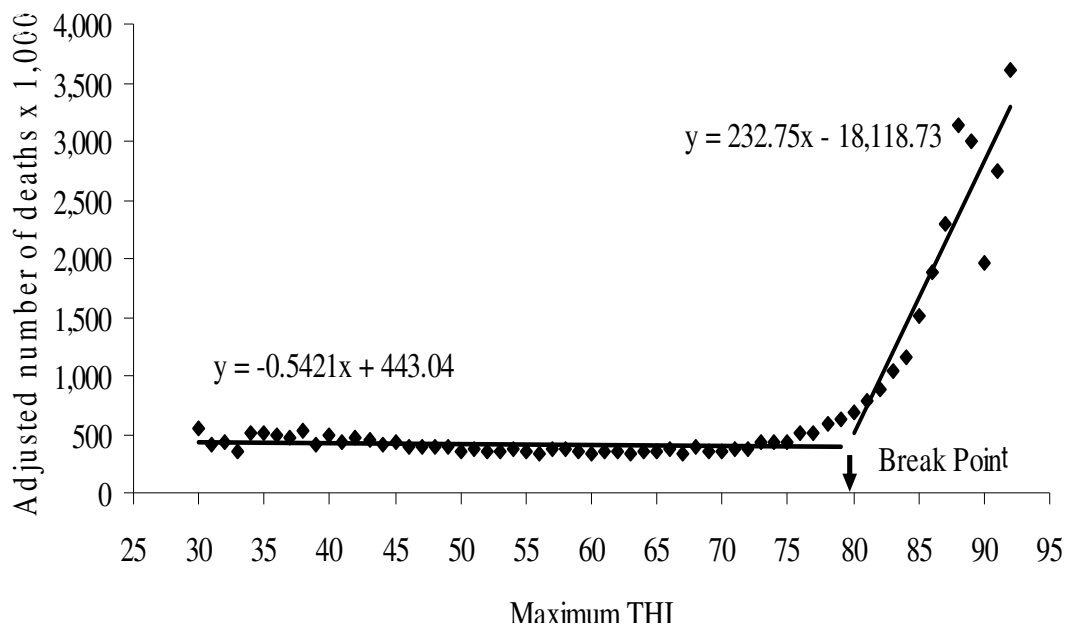
Anni	Inverno	Primavera	Estate	Autunno	Totale
2002	12.562	11.773 (0,87)	15.652 (1,16)	14.180	54.169
2003	13.850	13.077 (0,83)	21.830 (1,39)	14.106	62.836
2004	13.095	11.947 (0,90)	15.020 (1,13)	13.264	53.326
2005	11.930	11.063 (0,93)	12.773 (1,07)	11.982	47.748
2006	11.529	10.579 (0,86)	14.200 (1,16)	12.778	49.086
2007	11.259 (0,85)	11.275	15.165	15.229 (1,15)	52.928
02-07	74.225	69.716 (0,87)	94.640 (1,18)	81.539	320.120

JJA 2003

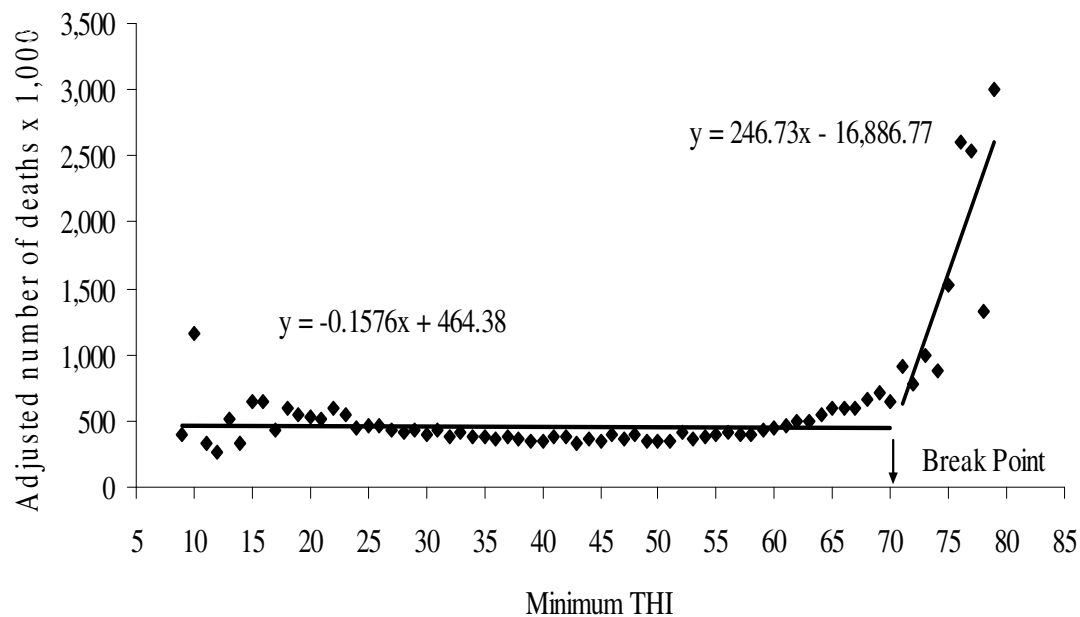


Isolines of summer temperature humidity index (THI) anomalies for the year 2003 versus CliNo (Climate Normal, 1961-1990 period)

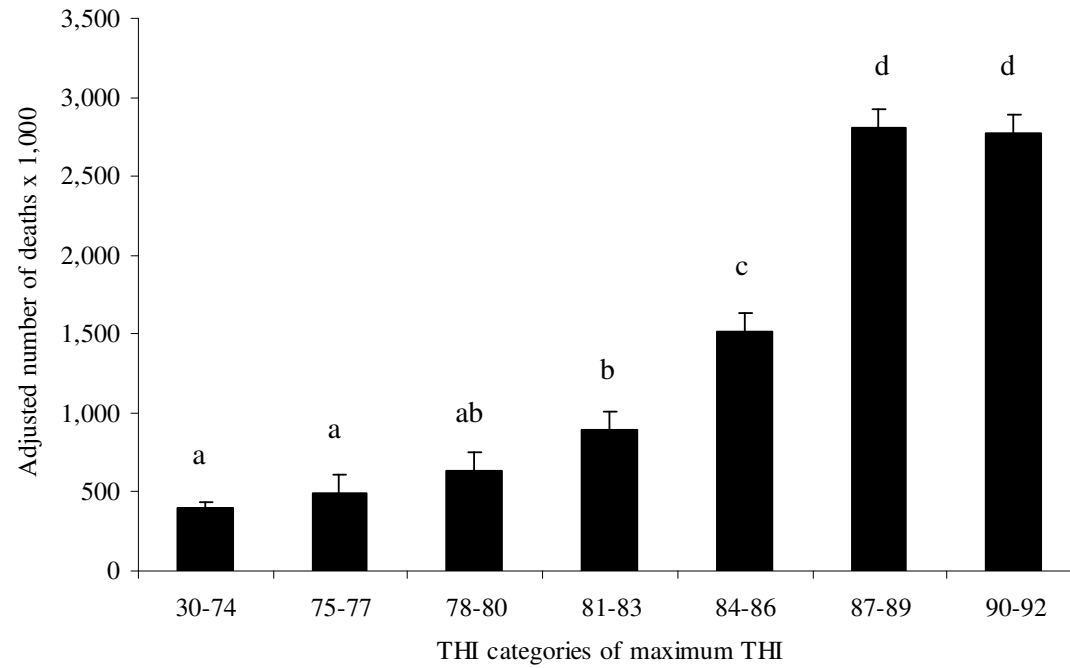
Segnalini et al., 2011



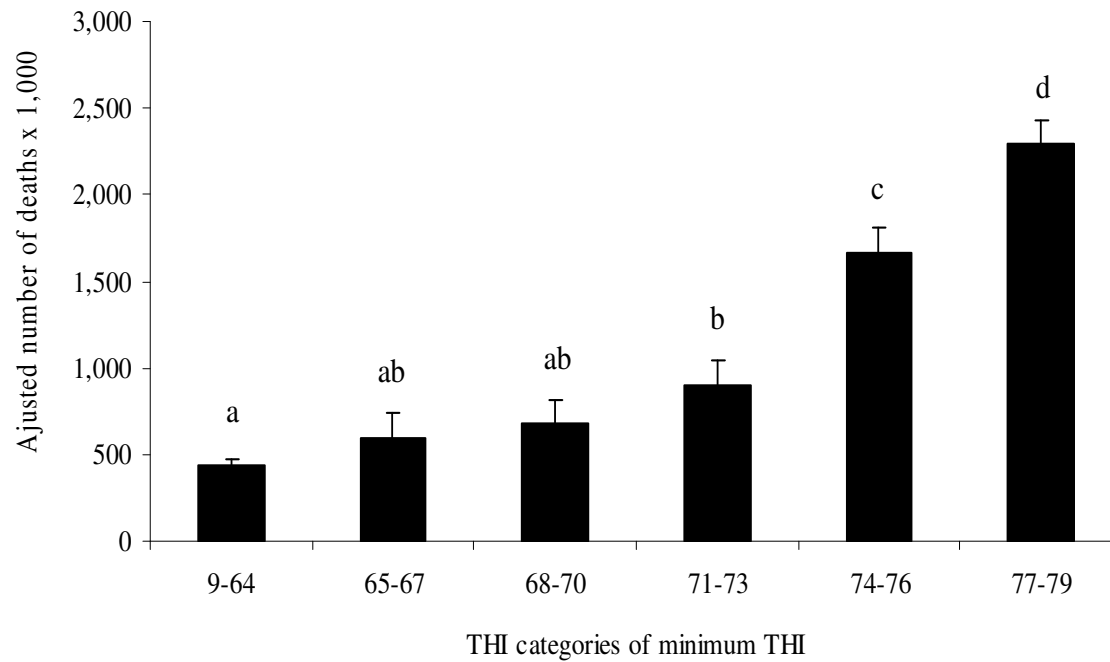
THI	Mortalità
<u>80</u>	<u>1.0</u>
81	1.5
82	1.9
83	2.4
84	2.9
85	3.3
86	3.8
87	4.3
88	4.7
89	5.2
90	5.7
91	6.1
92	6.6



THI	Mortalità
<u>71</u>	<u>1.0</u>
72	1.4
73	1.8
74	2.2
75	2.6
76	3.0
77	3.4
78	3.7
79	4.1



THI Massimo



THI minimo

RH (%)

THI MASSIMO

T (°C)

	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
20	63	63	63	64	64	64	64	65	65	65	66	66	66	66	67	67	67	67	68	68
21	64	64	64	65	65	65	66	66	66	67	67	67	68	68	68	69	69	69	69	70
22	64	65	65	66	66	66	67	67	67	68	68	69	69	69	70	70	70	71	71	72
23	70	66	66	67	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73	73
24	72	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73	74	74	75	75
25	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75	76	76	77
26	68	69	69	70	70	71	71	72	73	73	74	74	75	75	76	77	77	78	78	79
27	69	69	70	71	71	72	73	73	74	74	75	76	76	77	77	78	79	79	80	81
28	70	70	71	72	72	73	74	74	75	76	76	77	77	78	78	80	80	81	82	82
29	71	71	72	73	73	74	75	76	76	77	78	78	79	80	81	81	82	83	83	84
30	71	72	73	74	74	75	76	77	78	78	79	80	80	82	83	84	84	85	85	86
31	72	73	74	75	76	76	77	78	79	80	80	81	82	83	84	85	85	86	87	88
32	73	74	75	76	77	77	78	79	80	81	82	83	84	84	86	86	87	88	89	90
33	74	75	76	77	78	79	79	80	81	82	83	84	85	86	87	88	89	90	90	91
34	75	76	77	78	79	80	81	82	83	84	84	85	86	87	88	89	90	91	92	93
35	76	77	78	79	80	81	82	83	84	85	86	87	88	89	91	91	92	93	94	95
36	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	93	94	95	96	97
37	77	79	80	81	82	83	84	85	86	87	89	90	91	92	93	94	95	96	97	99
38	78	79	81	82	83	84	85	86	88	89	90	91	92	93	95	96	97	98	99	100
39	79	80	82	83	84	85	86	88	89	90	91	92	94	95	96	97	99	100	101	102
40	80	81	82	84	85	86	88	89	90	91	93	94	95	96	98	99	100	101	103	104
41	81	82	83	85	86	87	89	90	91	93	94	95	97	98	99	101	102	103	104	106
42	82	83	84	86	87	89	90	91	93	94	95	97	98	99	101	102	104	105	106	108
43	83	84	85	87	88	90	91	92	94	95	97	98	100	101	102	104	105	107	108	109
44	83	85	86	88	89	91	92	94	95	97	98	99	101	102	104	105	107	108	110	111

Rischio nullo

Rischio minimo

Allerta

Emergenza

RH (%)

THI MINIMO

T (°C)

	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
9	53	53	53	53	52	52	52	51	51	51	51	50	50	50	50	49	49	49	48	48
10	54	54	54	54	53	53	53	53	52	52	52	52	52	51	51	51	51	50	50	50
11	55	55	55	55	54	54	54	54	54	54	53	53	53	53	53	52	52	52	52	52
12	55	56	56	56	55	55	55	55	55	55	55	55	54	54	54	54	54	54	54	54
13	56	57	57	57	56	56	56	56	56	56	56	56	56	56	56	56	56	56	55	55
14	58	58	58	58	58	58	57	57	57	57	57	57	57	57	57	57	57	57	57	57
15	58	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
16	59	59	59	60	60	60	60	60	60	60	60	60	60	60	60	60	61	61	61	61
17	60	60	60	61	61	61	61	61	61	61	61	62	62	62	62	62	62	62	62	63
18	61	61	61	62	62	62	62	62	62	63	63	63	63	63	64	64	64	64	64	64
19	62	62	62	63	63	63	63	63	64	64	64	64	65	65	65	65	66	66	66	66
20	63	63	63	64	64	64	64	65	65	65	66	66	66	66	67	67	67	67	68	68
21	64	64	64	65	65	65	66	66	66	67	67	67	68	68	68	69	69	69	69	70
21	64	64	64	65	65	65	66	66	66	67	68	68	68	68	68	69	69	69	69	70
23	65	66	66	67	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73	73
24	66	67	67	68	68	69	69	70	70	70	71	71	71	72	73	73	74	74	75	75
25	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75	76	76	77
26	68	69	69	70	70	71	71	72	73	73	74	74	75	75	76	77	77	78	78	79
27	69	69	70	71	71	72	73	73	74	74	75	76	76	77	77	78	79	79	80	81
28	70	70	71	72	72	73	74	74	75	76	76	77	78	78	79	80	80	81	82	82
29	71	71	72	73	73	74	75	76	76	77	78	78	79	81	81	82	83	83	84	84
30	71	72	73	74	74	75	76	77	78	78	79	80	81	81	82	83	84	84	85	86

Rischio nullo

Rischio minimo

Allerta

Emergenza

Ondate di calore e mortalità in allevamento

Luglio 1995, Stati Uniti-Stati centrali:

aumento significativo della mortalità di bovini da carne con un danno economico complessivo derivante anche dalla riduzione delle performance pari a circa 28 milioni di dollari

Luglio 1999, Nebraska:

perdite economica per oltre 20 milioni di dollari derivanti dalla morte di oltre 3000 bovini da carne e dal peggioramento delle performance e dello stato di salute

Agosto 2003, Europa:

aumento della mortalità di suini, avicoli e conigli nelle regioni Francesi della Bretagna e della Loira quantificabile in migliaia di capi

The effect of heat waves on dairy cow mortality

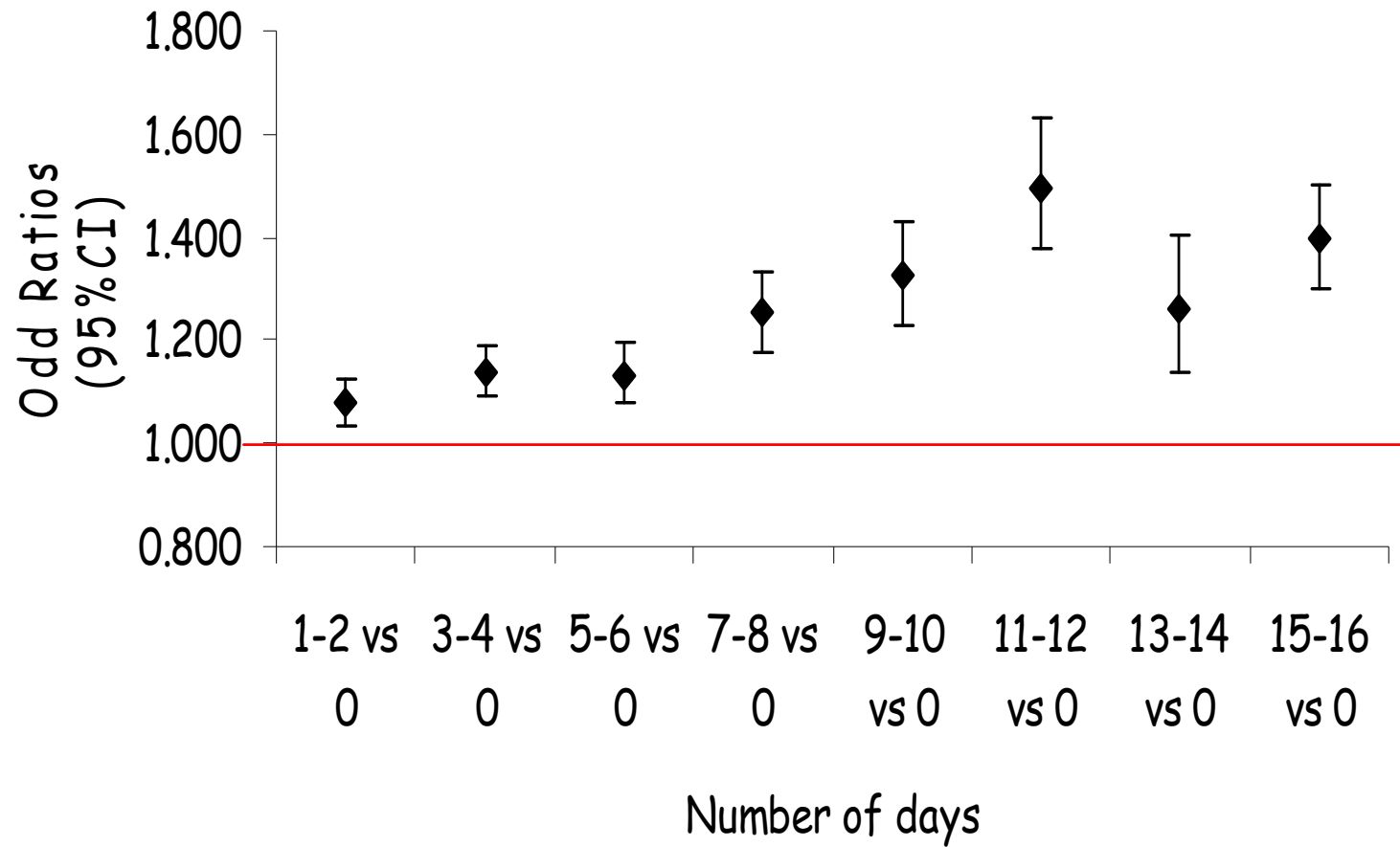
(Vitali et al., 2015)

**The 12 provinces were selected on the basis of completeness of weather data and numerosness of dairy cows.*

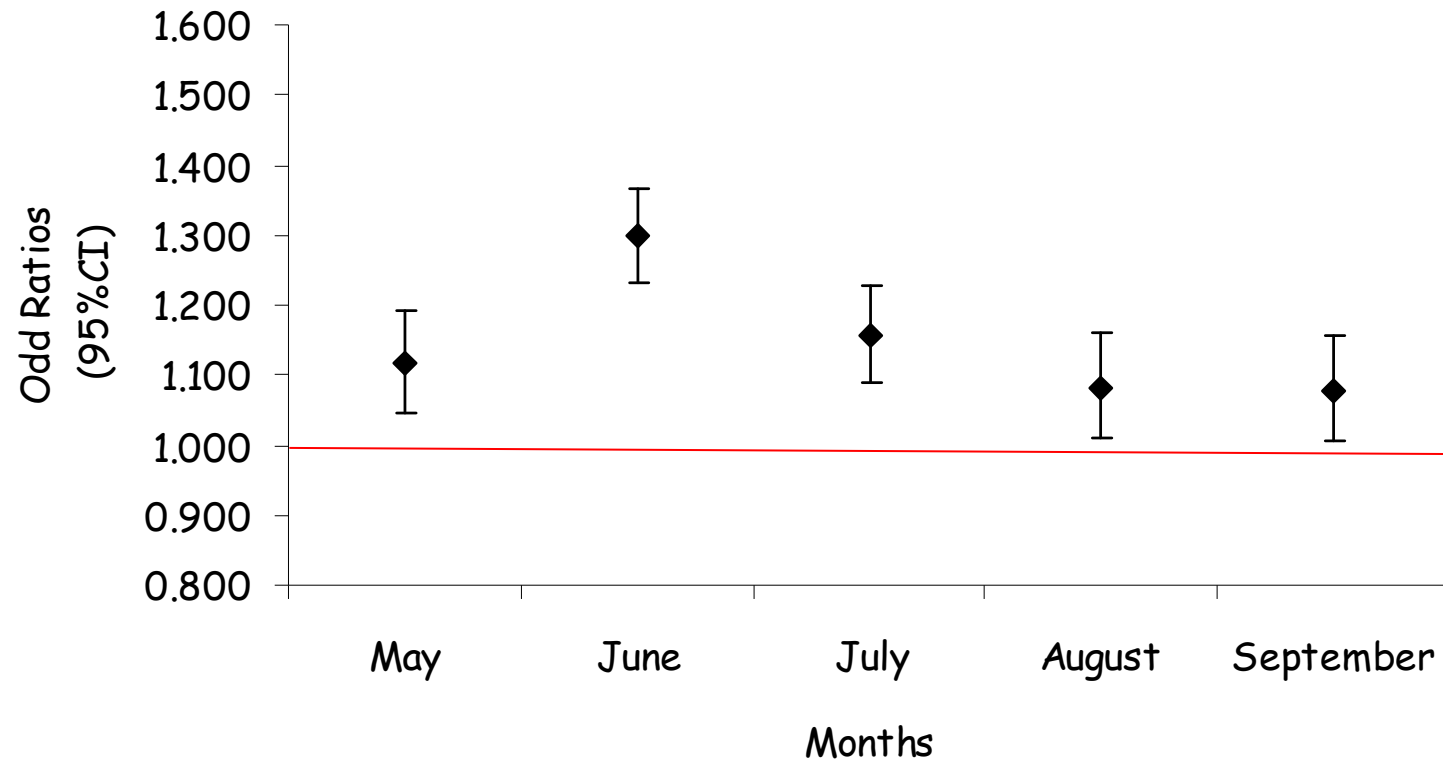
Results

Area	OR	p-value	C.I. 95%
Pooled	1,163	< 0,0001	1,132 - 1,196
Northern	1,186	< 0,0001	1,149 - 1,225
Central	1,105	< 0,003	1,036 - 1,179
Southern	1,075	< 0,178	0,968 - 1,194

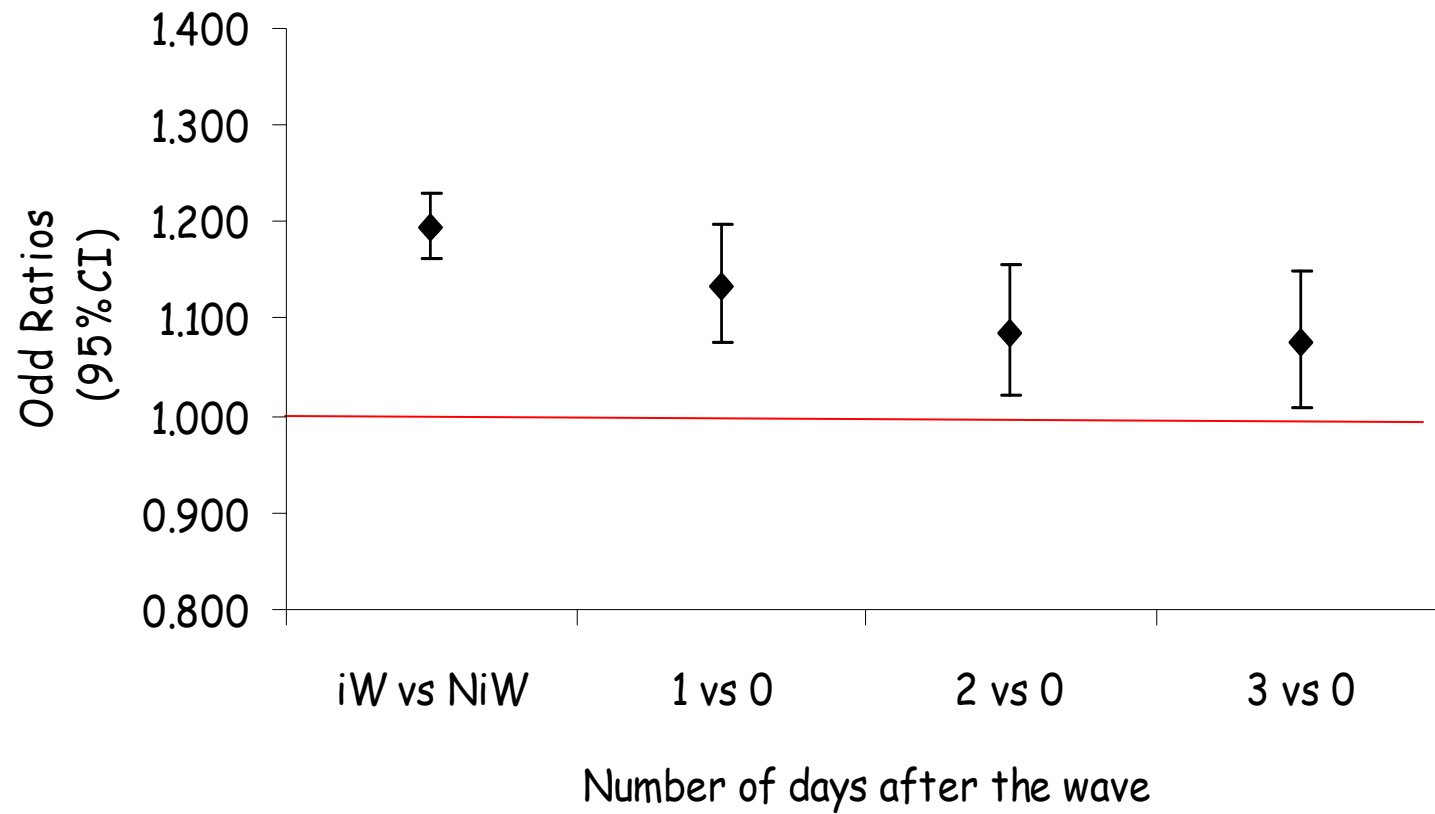
Risk of death/wave length



Risk of death/month of wave occurrence



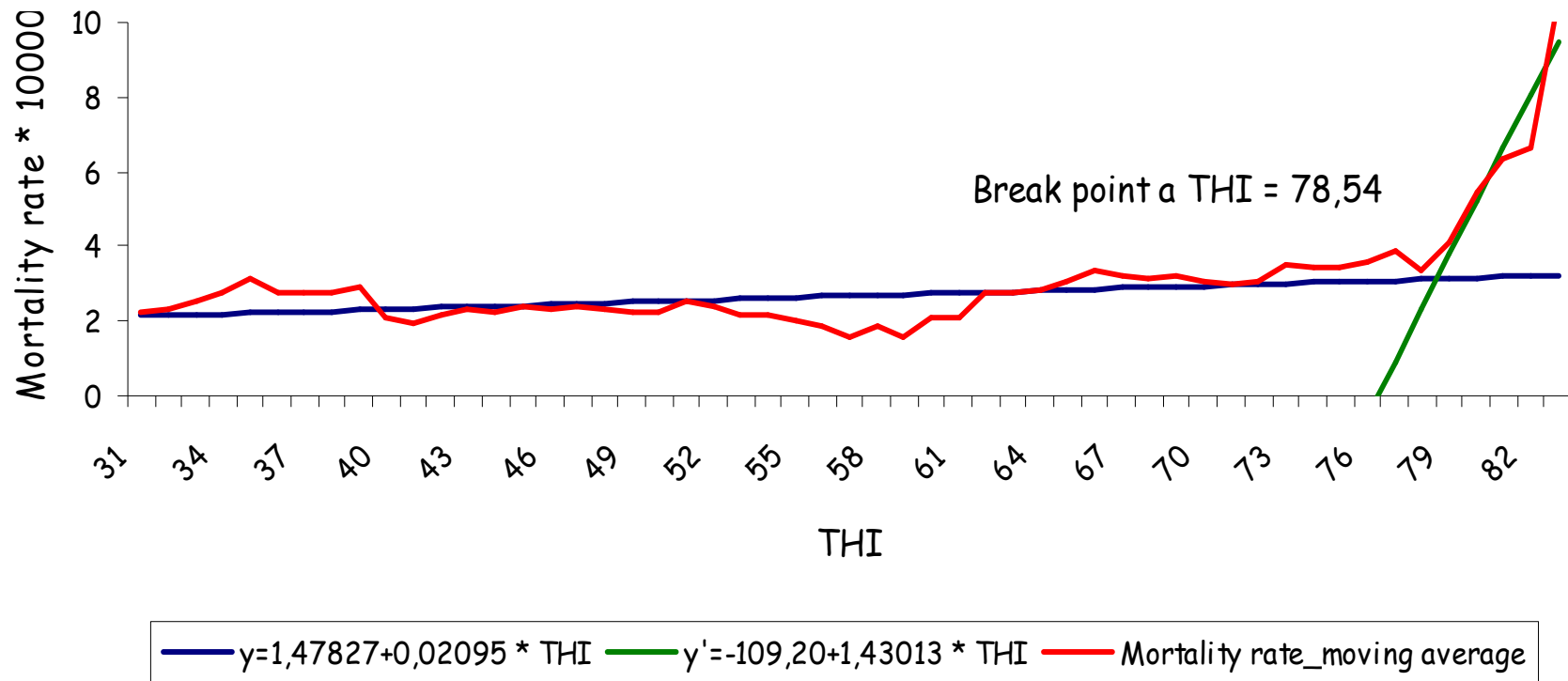
Risk of death/days after the wave



Summary

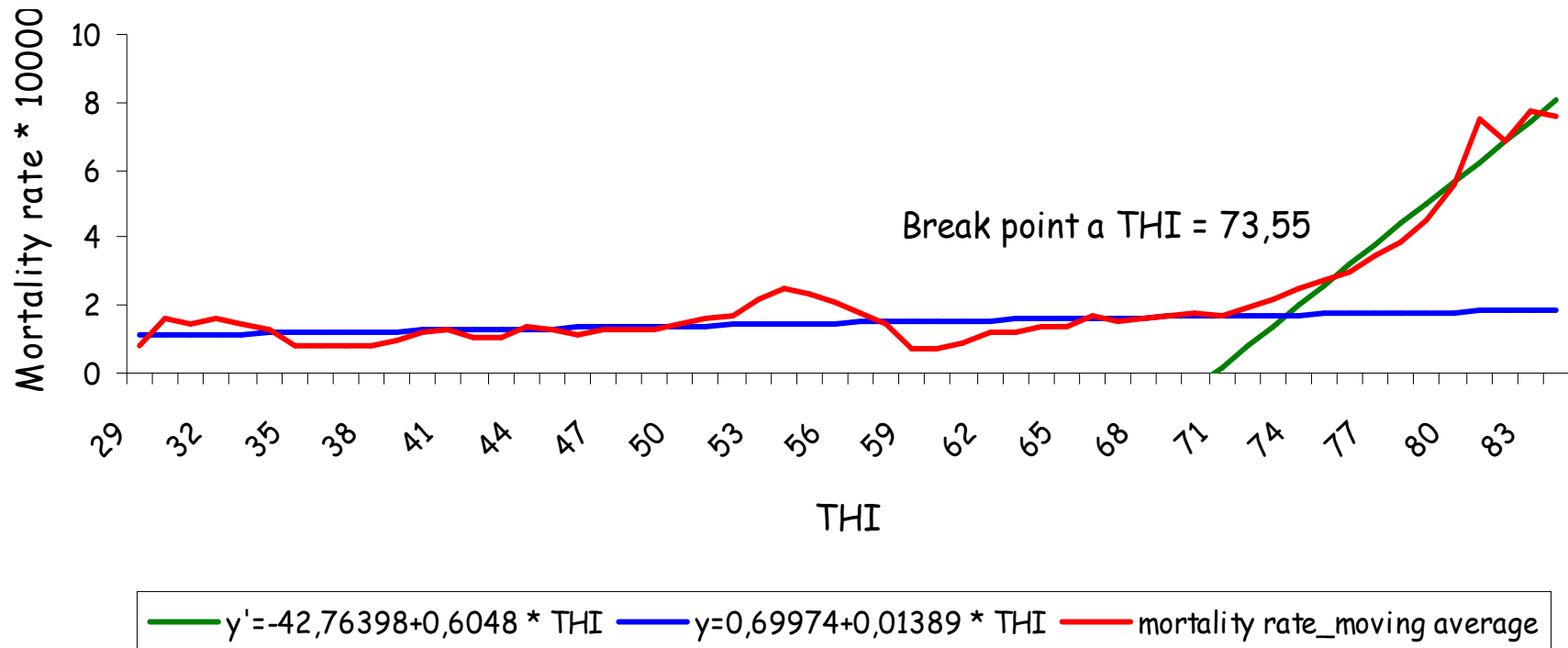
- Increase of risk varies with the length of the wave and with the age of the cows
- The risk of death tends to be higher for waves occurring in early summer
- The risk of death remains high during the days which follow the wave

Two phases regression_in transit pigs losses



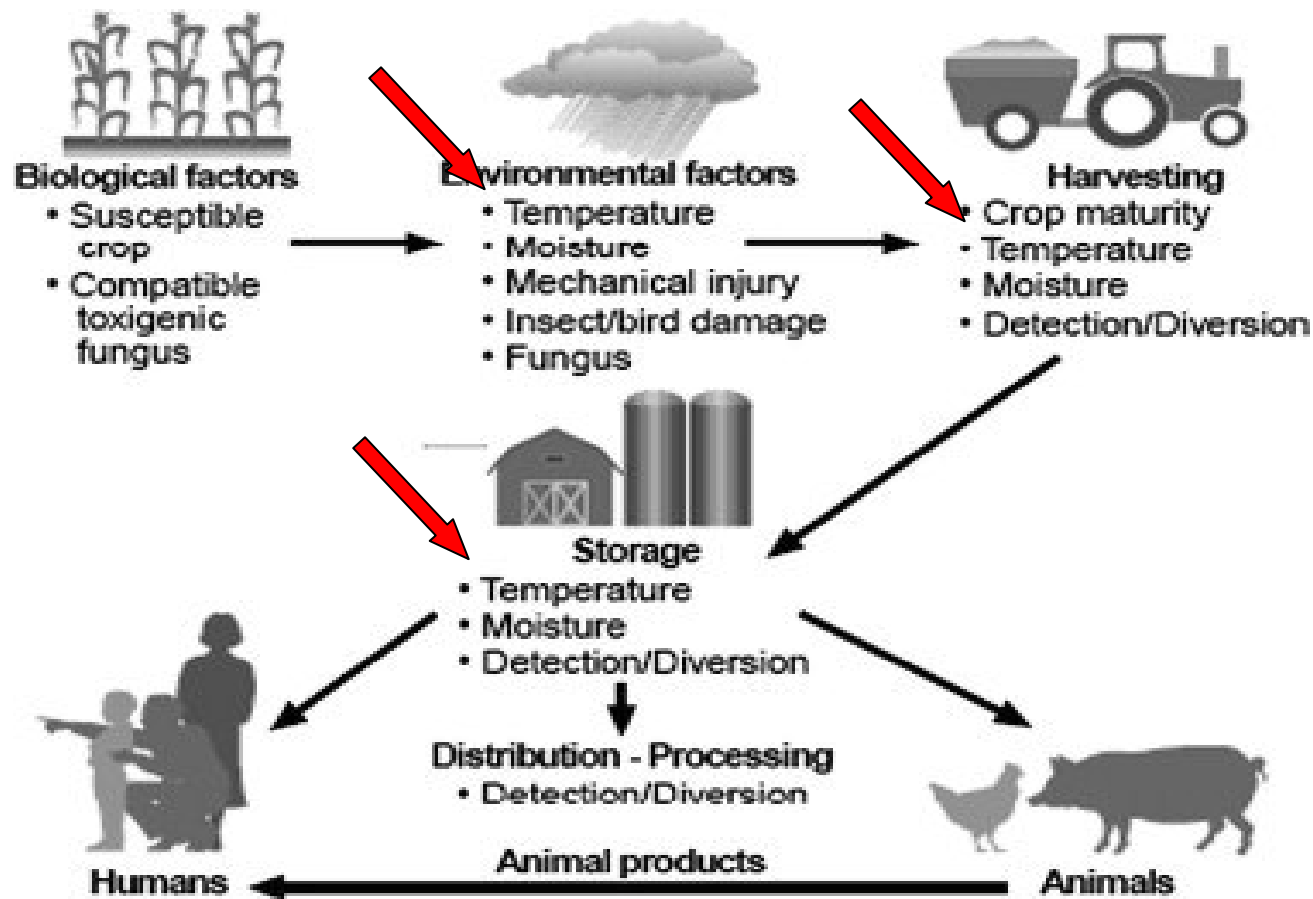
In-transit mortality rate of pigs in relation to temperature-humidity index (THI)

Two phases linear regression_lairage pigs losses

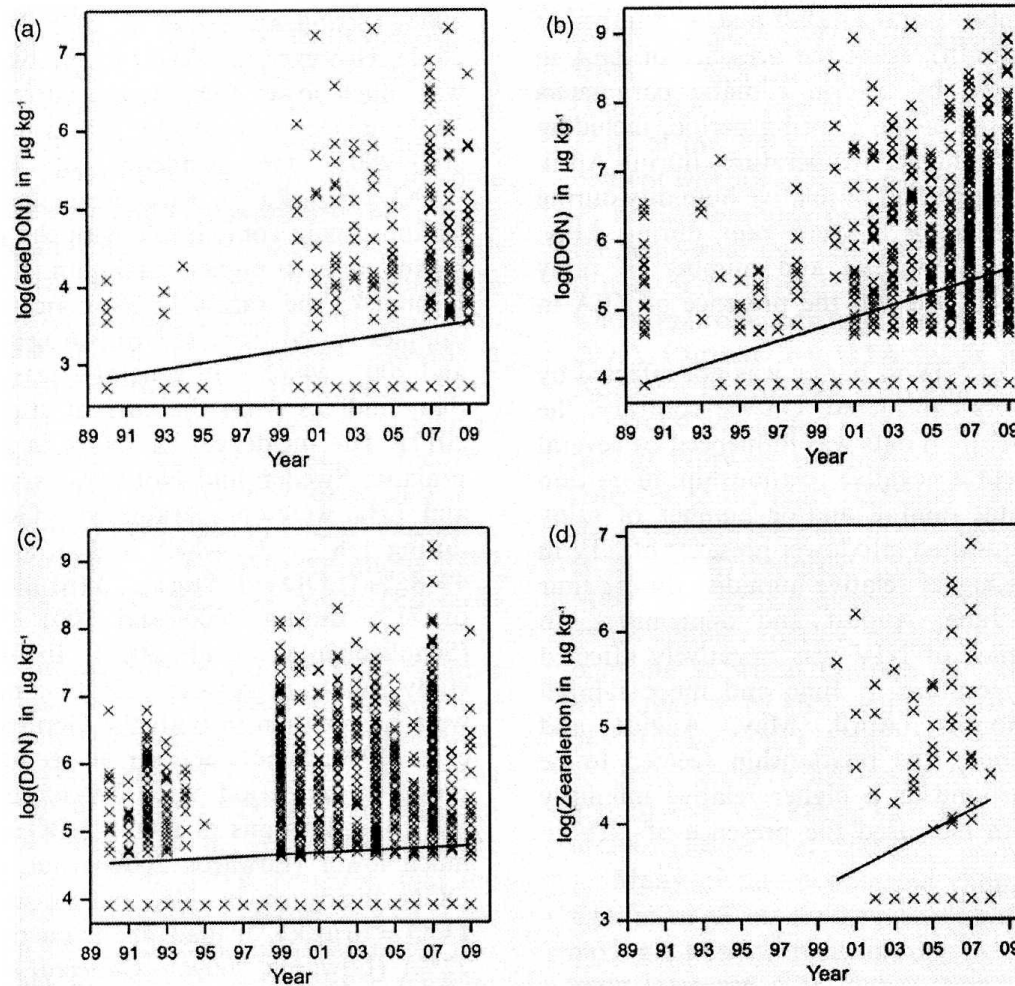


Mortality rate of pigs at lairage in relation to temperature-humidity index (THI)

Effetti indiretti

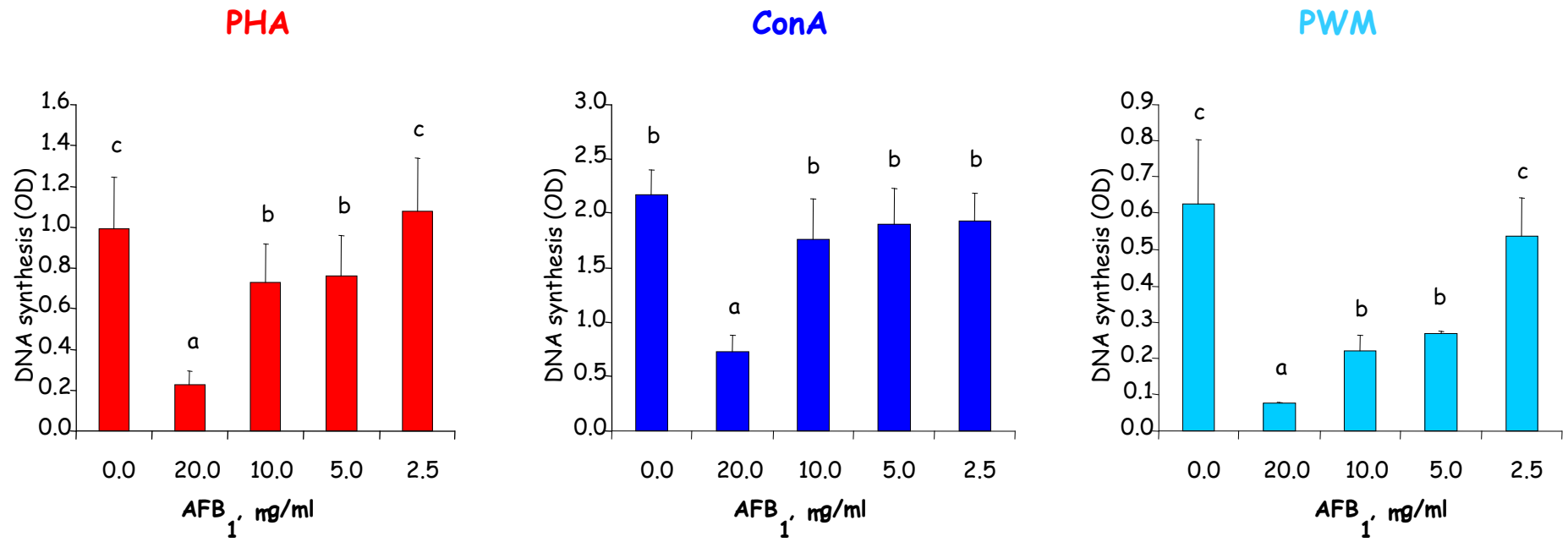


Factors affecting mycotoxin occurrence in the food chain (Russell et al., 2010)

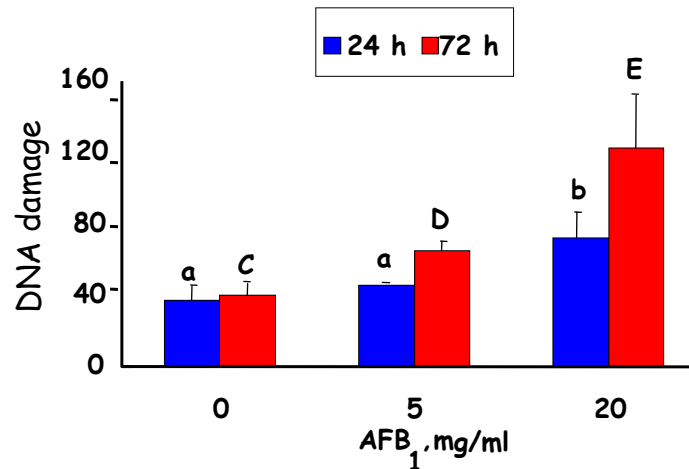


Trends of the presence of mycotoxins in cereal grains in North Western Europe over the period 1989-2009 for 3-acetyl-deoxynivalenol (3-Ac-DON) in oats (a), deoxynivalenol in oats (b) and wheat (c) and of zearalenone in maize (d). The presence of mycotoxins is indicated by the percentage of samples that contained the toxin above the level of detection. Except for the presence of DON in wheat, the effect of year on the presence of the toxin was significant.

Effetti della [AFB1] sulla proliferazione linfocitaria e sui danni a carico del DNA



(a,b,c and C,D,E:
P < 0.01)



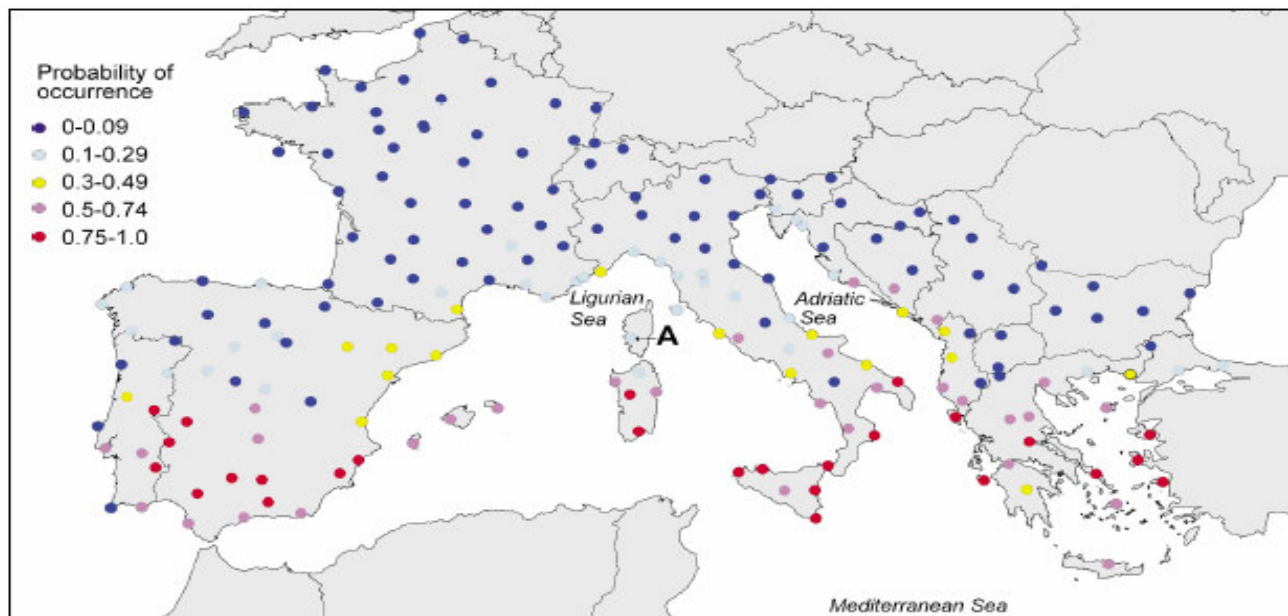


Fig. 2
Suitability of sites in Europe for the occurrence of *Culicoides imicola*, based on the logistic regression model established for Iberia
Labelled site (A) is Ajaccio

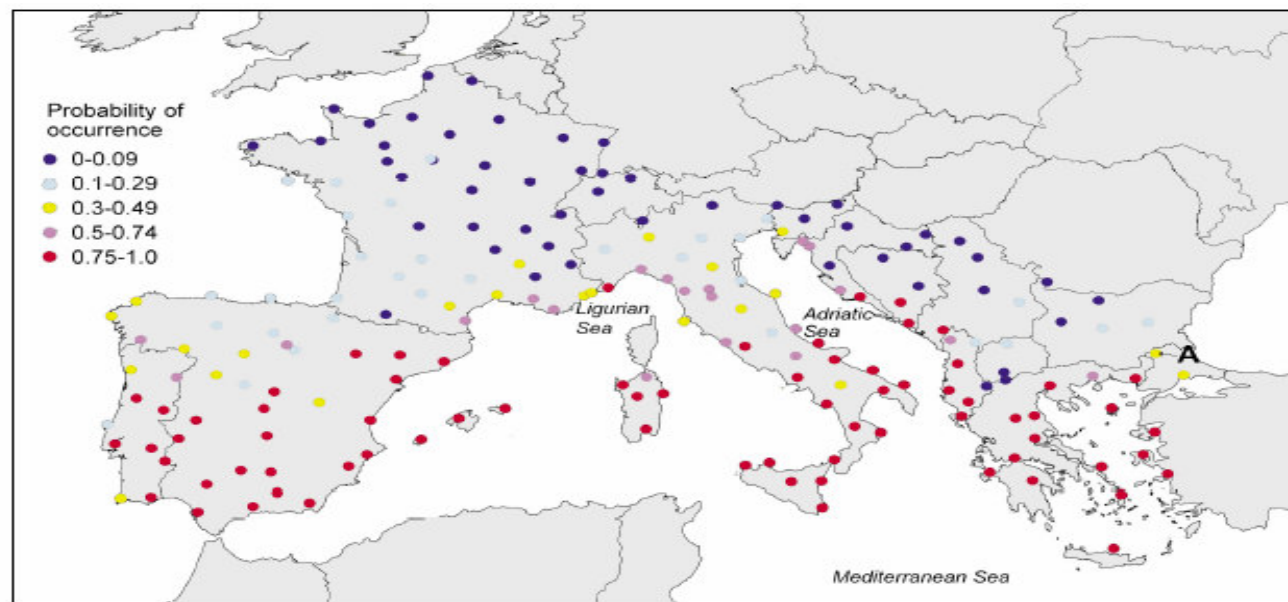


Fig. 3
Suitability of sites in Europe for the occurrence of *Culicoides imicola*, based on the logistic regression model established for Iberia
with a 2°C increase in temperature
Labelled site (A) is Edime

Wittmann et al.,
(2001)
Rev. Sci. Tech. OIE

Has climate change caused a northwards extension, in Europe, of *Culicoides* midge vectors?

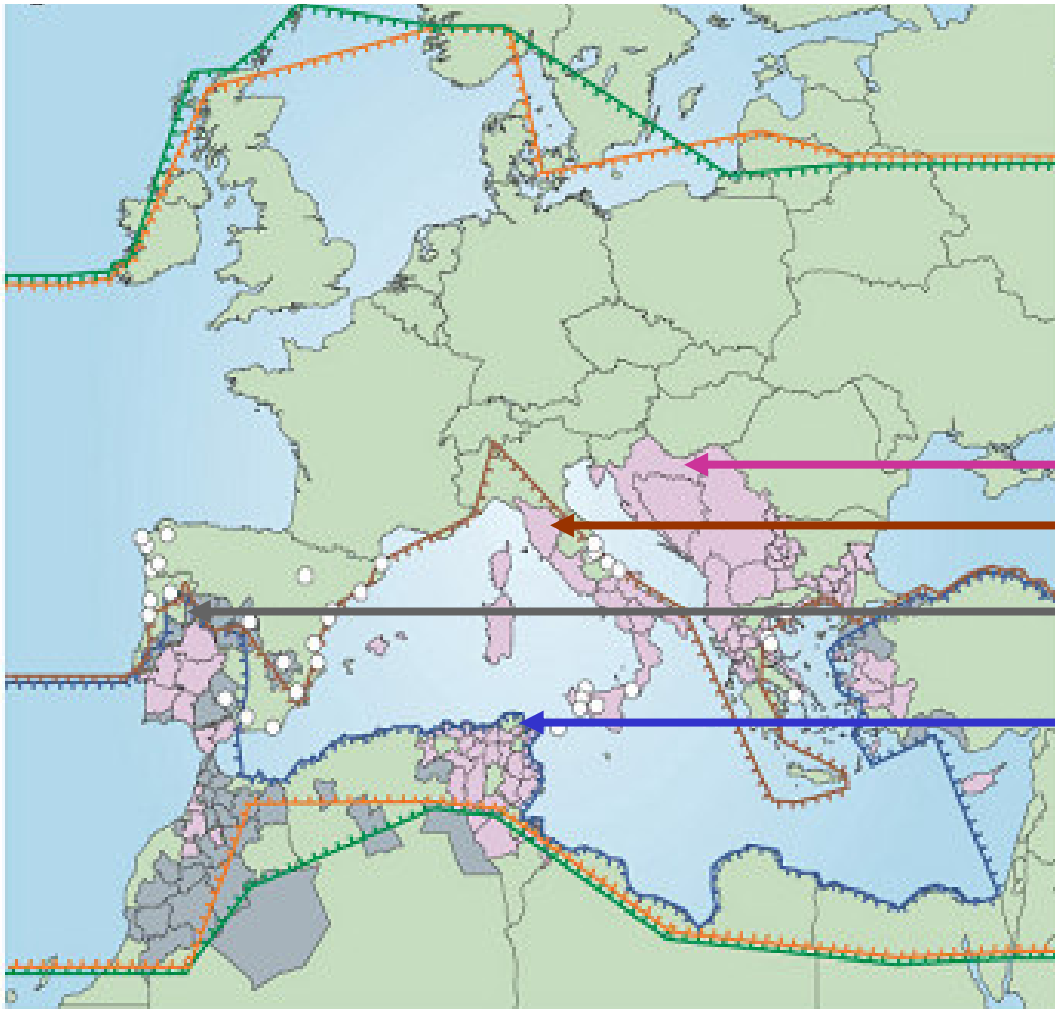
2004: Northern range* of virus (in sheep)

2004: Northern limit *C. imicola* midge

1998: Northern range of virus (in sheep)

1998: Northern limit *C. imicola* midge

Source: Purse et al, 2005
Nature Reviews Microbiology



Midge species: potential vectors of BT Virus

<i>C. pulcaris</i>	<i>C. obsoletus</i>	<i>C. imicola</i>
Northern limit	Northern limit	Current northern limit
Southern limit	Southern limit	Northern limit < 1998

["European" Midge species]

Conclusioni

- Necessità di studi epidemiologici che consentano di prevedere quali rischi (vecchi, nuovi, esotici) per la salute della bovina da latte potranno derivare dal cambiamento climatico;
- in relazione a quanto riportato sopra, individuazione degli interventi di adattamento più idonei per consentire il mantenimento dello stato di salute delle bovine da latte allevate in condizioni climatiche sfavorevoli;
- utilità di predisporre sistemi assicurativi che prevedano la copertura dei danni economici derivanti dalla compromissione dello stato di salute/morte degli animali riconducibili alle condizioni climatiche/eventi climatici estremi.

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Daniela Scalia

Maria Segnalini

Andrea Vitali

CNR

MiPAF (Agriculture)

MIUR (Research)

UNITUS

MinSal (Health)

EU

