

Allevamento della Mosca Soldato (*Hermetia illucens*)

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BEF Biosystems, Torino, Italia,

BACKGROUND

LAUREA IN SCIENZE NATURALI
2008-2011



TITOLO TESI:
Primi dati sulla presenza nella comunità
Autonoma di Madrid (spagna) di *Coenonympha
pamphilus lyllus* (c. Lyllus) esper 1805, (Lepidoptera,
Nymphalidae, satyrinae)

LAUREA IN BIODIVERSITA' E
CONSERVAZIONE DELLA
NATURA
2011-2013



TITOLO TESI:
Analisi comparativa della fauna
collembologica di due cenosi
Psammofile lungo la costa tirrenica

Isotomodes tirrenicus
Nuova specie

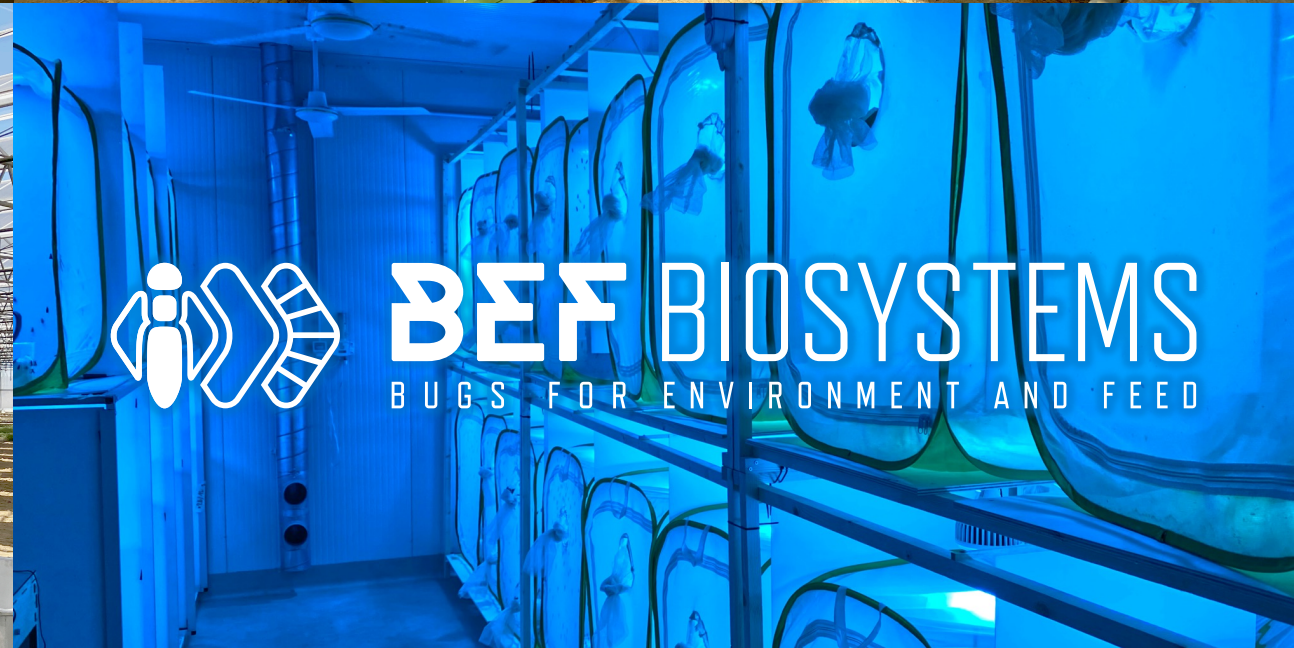
DOTTORATO DI RICERCA IN
SCIENZE AGRARIE, FORESTALI
ED ALIMENTARI
2015-2019



TITOLO TESI:
Insects as feed:
a case study on Black Soldier Fly
(*Hermetia illucens*).

**PUBBLICAZIONI
SU GIORNALI PEER REVIEW:**
13

LAVORO PRESSO BEF BIOSYSTEMS COME RESPONSABILE R&S DAL 2019, AZIENDA DEL SETTORE ALLEVAMENTO INSETTI





+ 1!! (REG. 2021/1925)

REG. 2017/893 CE

7 specie per produrre PAT



Mosca soldato (*Hermetia illucens*)

Black soldier fly (BSF)



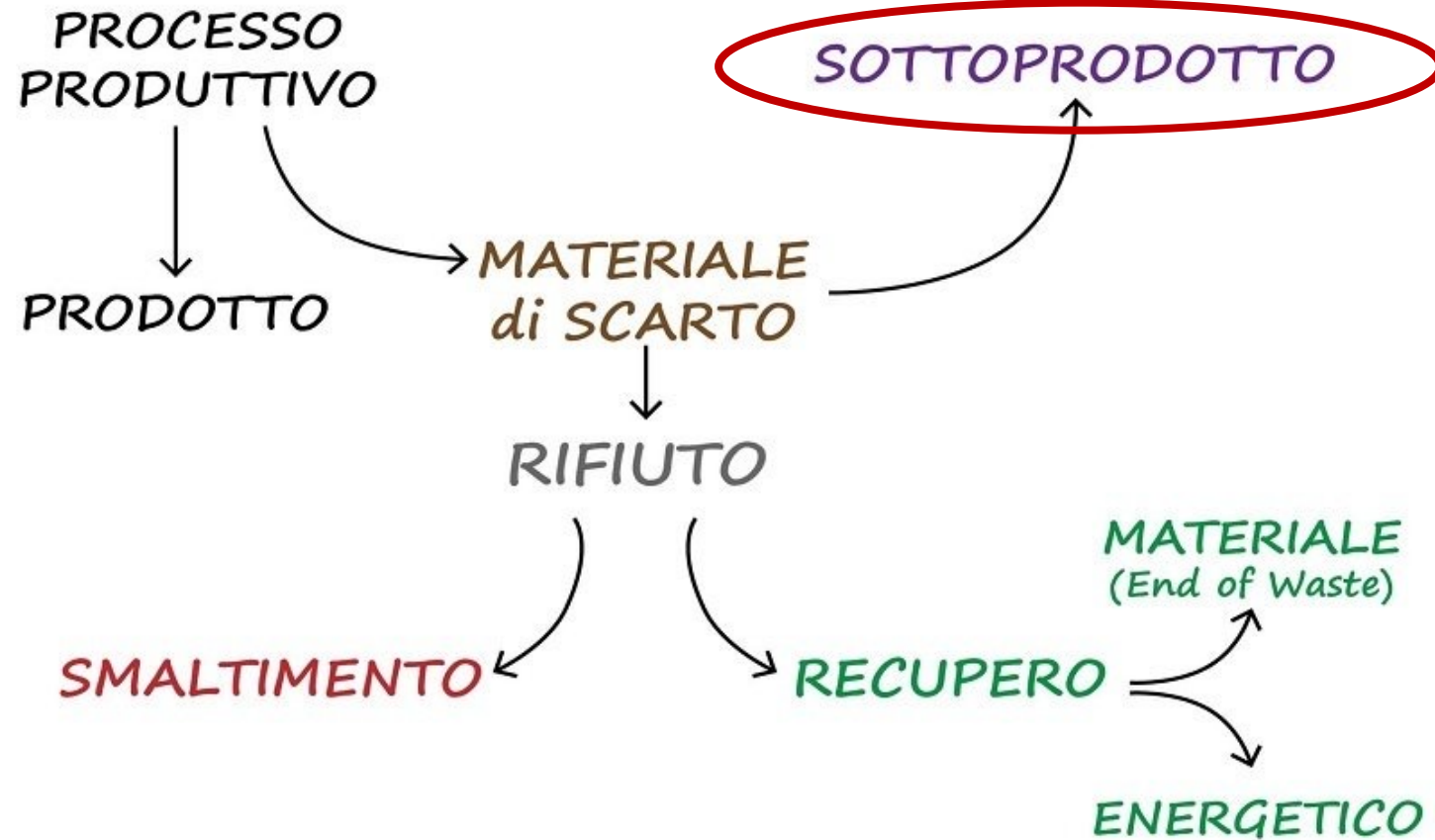


- **Perché?**
- **Distribuzione**
- **Biologia**
- **Allevamento**
- **Rischi**
- **Problematiche legislative**
- **Conclusioni**

- **Perché?**
- **Distribuzione**
- **Biologia**
- **Allevamento**
- **Rischi**
- **Problematiche legislative**
- **Conclusioni**



REG. 1017/2017 EC
CATALOGO DELLE MATERIE PRIME



<https://www.nexteco.it/lab/sottoprodotti-una-vera-giungla>

COSA
MANGIANO?





LARVE SAPROFAGHE

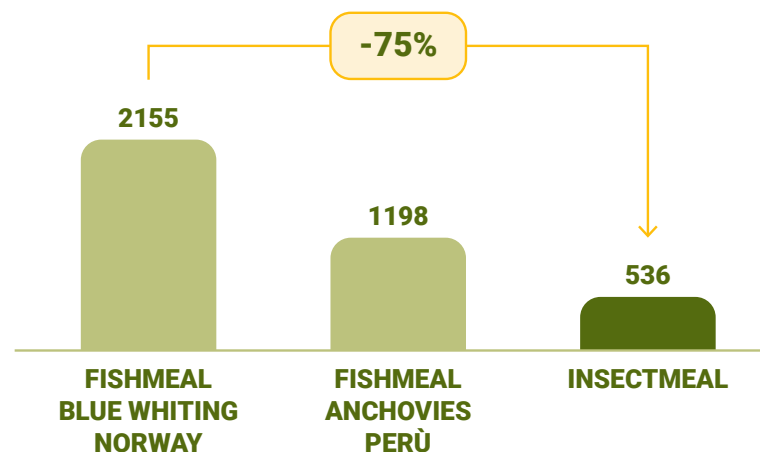
....

VALORE AMBIENTALE

I prodotti a base di insetto derivati dalla bioconversione sono proteine e grassi di elevata qualità e a basso impatto ambientale

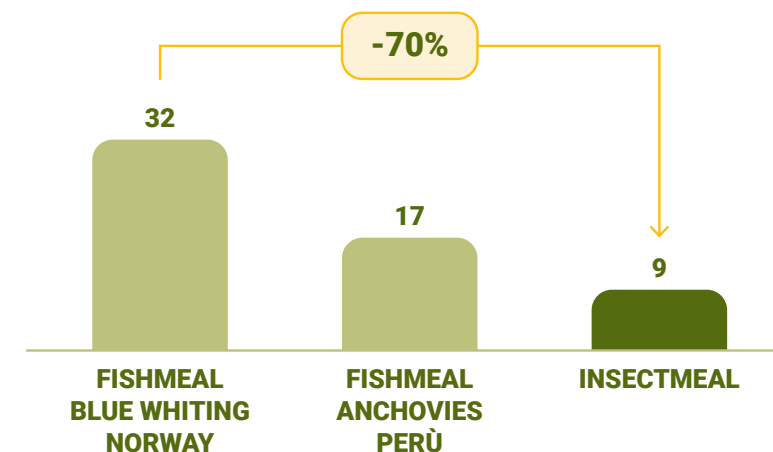
CLIMATE CHANGE

Kg CO₂ eq



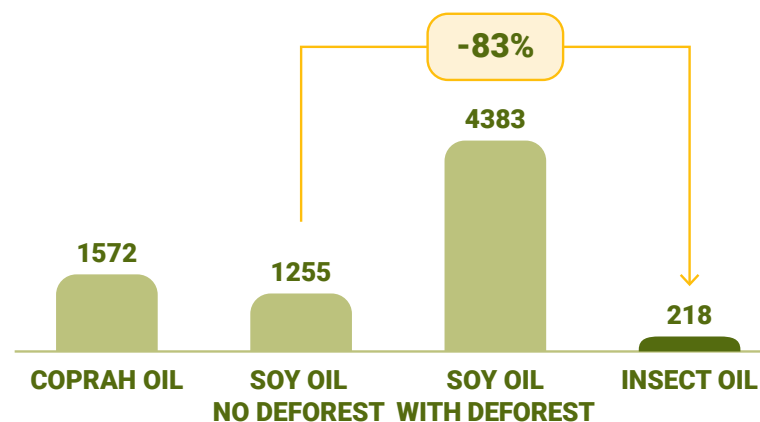
FOSSIL RESOURCES DEPLETION

GJ



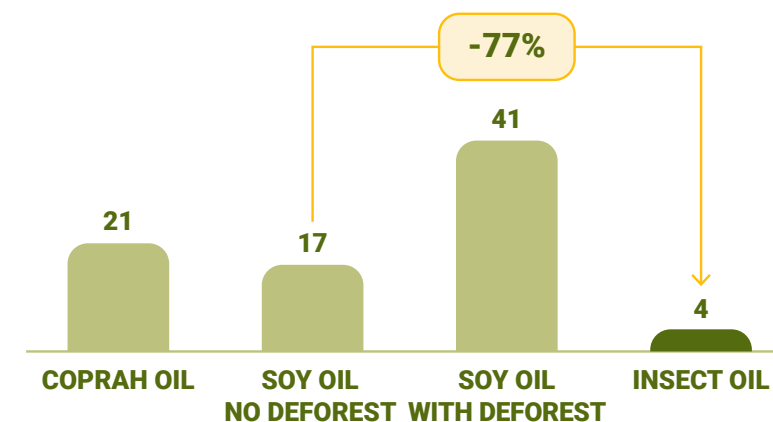
CLIMATE CHANGE

Kg CO₂ eq



FOSSIL RESOURCES DEPLETION

GJ



Fonte: Sustainability 2020, 12, 10333; doi:10.3390/su122410333

Symbiosis in Insect - Production—A Sustainable Eco-Efficient and Circular Business Model

6 dicembre 2022

IZS Lazio e Toscana M. Aleandri - Sezione di Viterbo

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BEF BIOSYSTEMS
BUGS FOR ENVIRONMENT AND FEED

**SCARTI E
RESIDUI
ORGANICI**

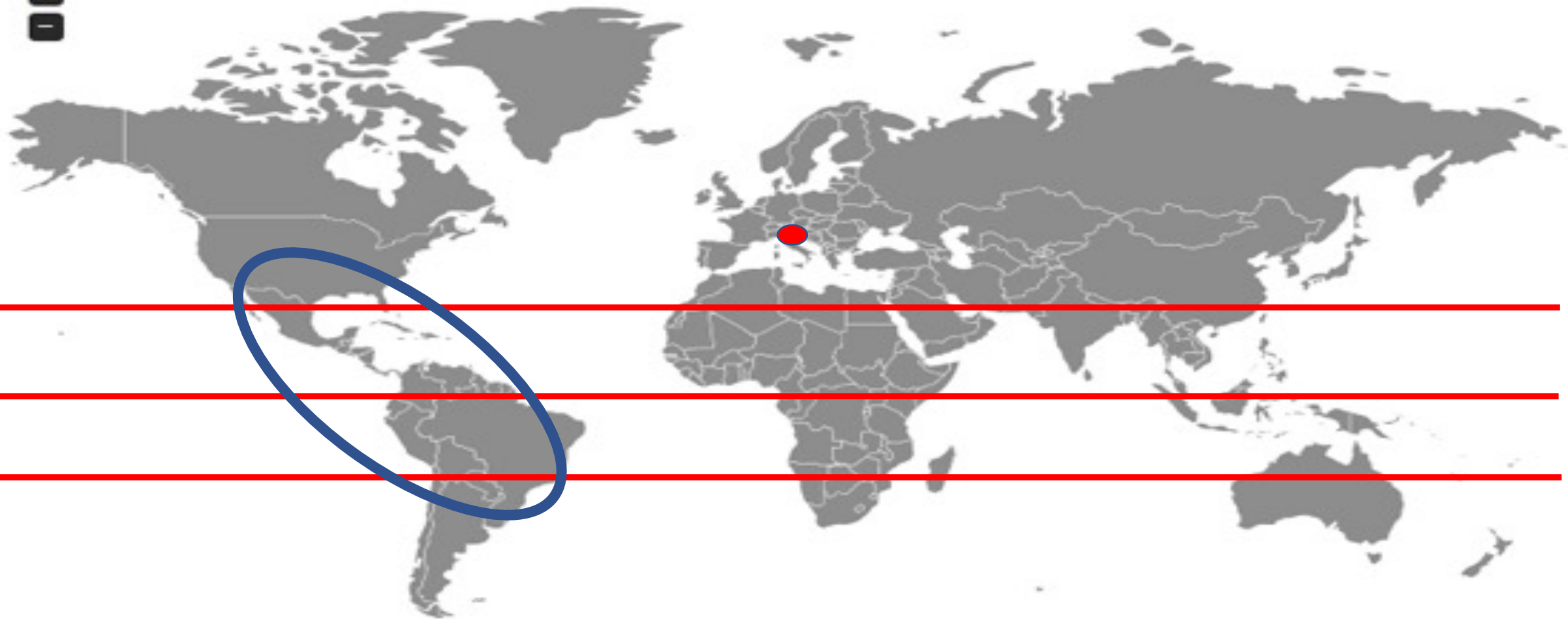


**PRODOTTI
AD ALTO
VALORE
AGGIUNTO**

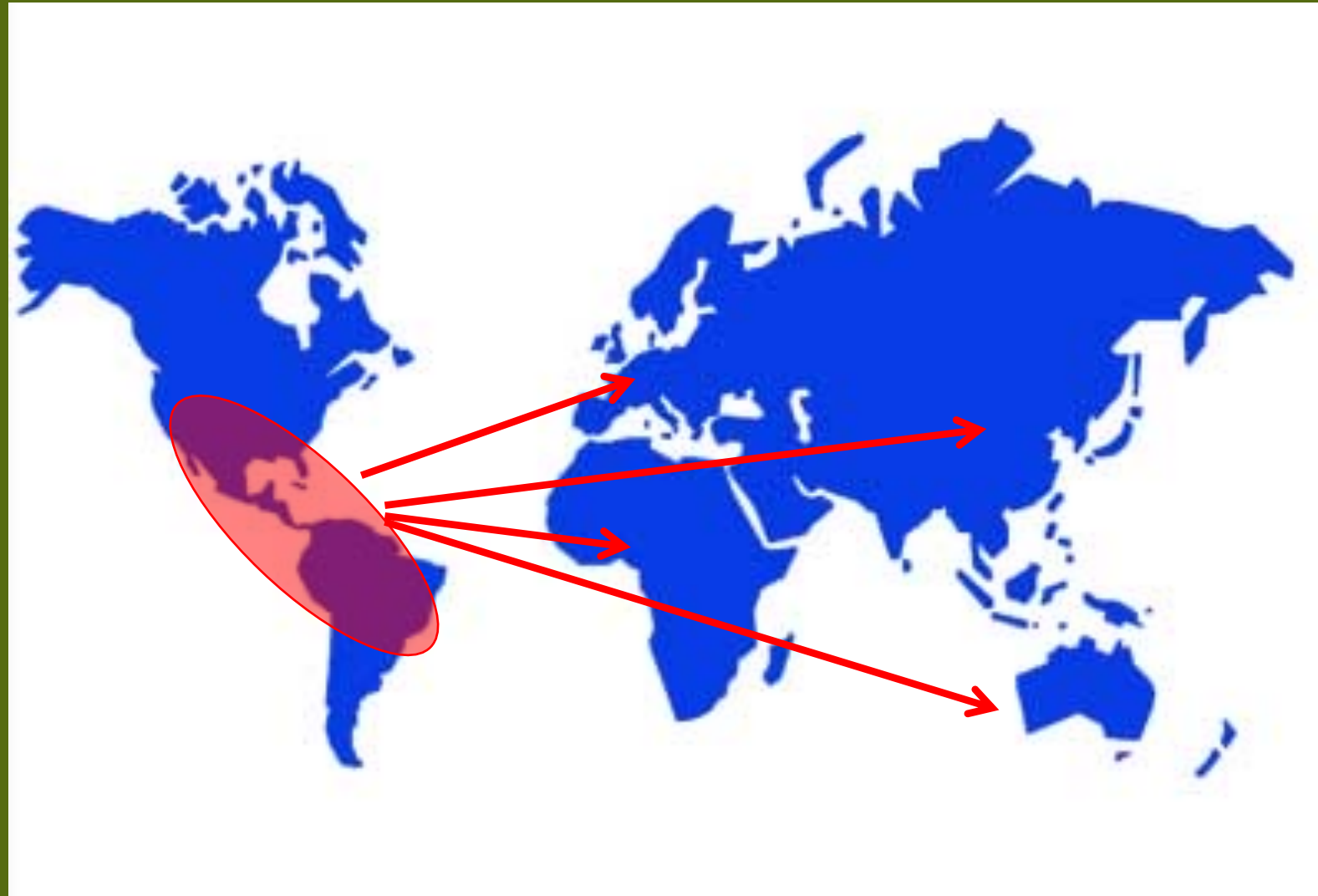
6 dicembre 2022

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- Perché?
- **Distribuzione**
- Biologia
- Allevamento
- Rischi
- Problematiche legislative
- Conclusioni



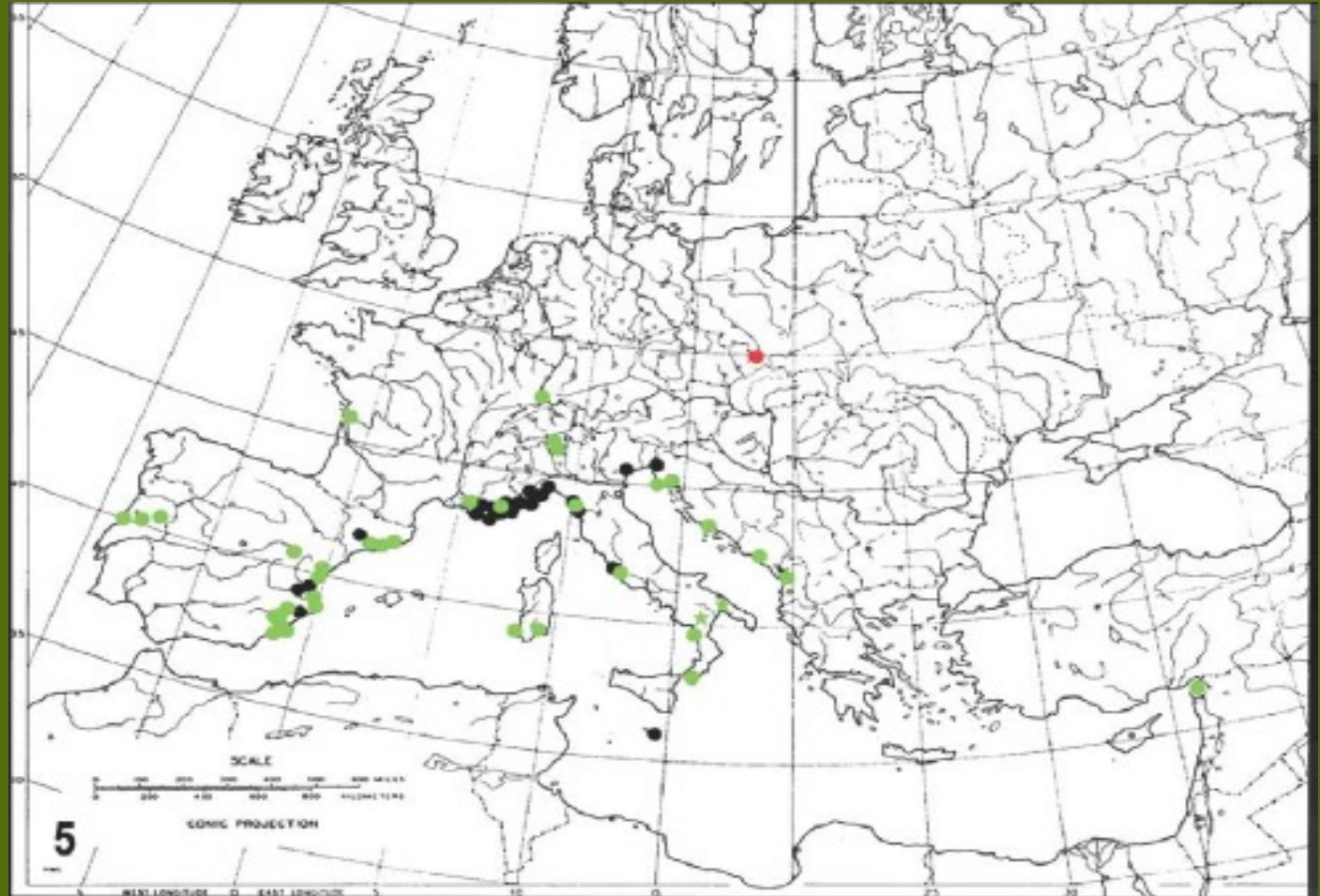
Cosmopolita



Cosmopolita

ITALIA

Prima descrizione di Venturi
in Toscana e nel LAZIO 1956



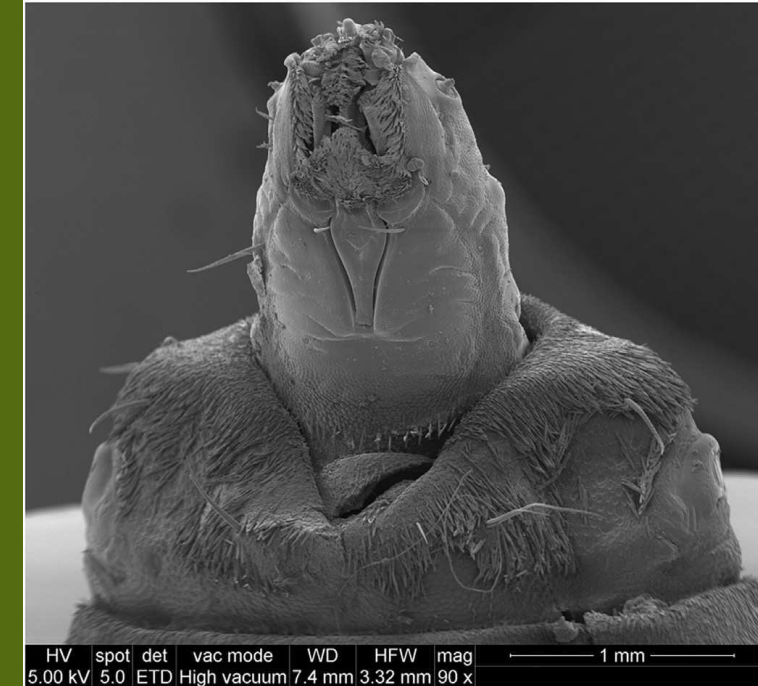
(Roháček and Home, 2013)

Cosmopolita

Primo ritrovamento in
principessa Isabella
d'Aragona (1470-1524†)

(Benelli *et al.*, 2014)

Prima descrizione di Venturi,
1956



- Perché?
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UOVA

- SCHIUDONO IN 72H
- >60% UMIDITA' PER AVERE UNA SCHIUSA MIGLIORE
- TEMPERATURA TRA 27°C E 30°C (Tomberlin *et al.*, 2009)
- VENGONO DEPOSTE IN ANFRATTI E CREPE VICINO AL SUBSTRATO



©Alberto Zamproga

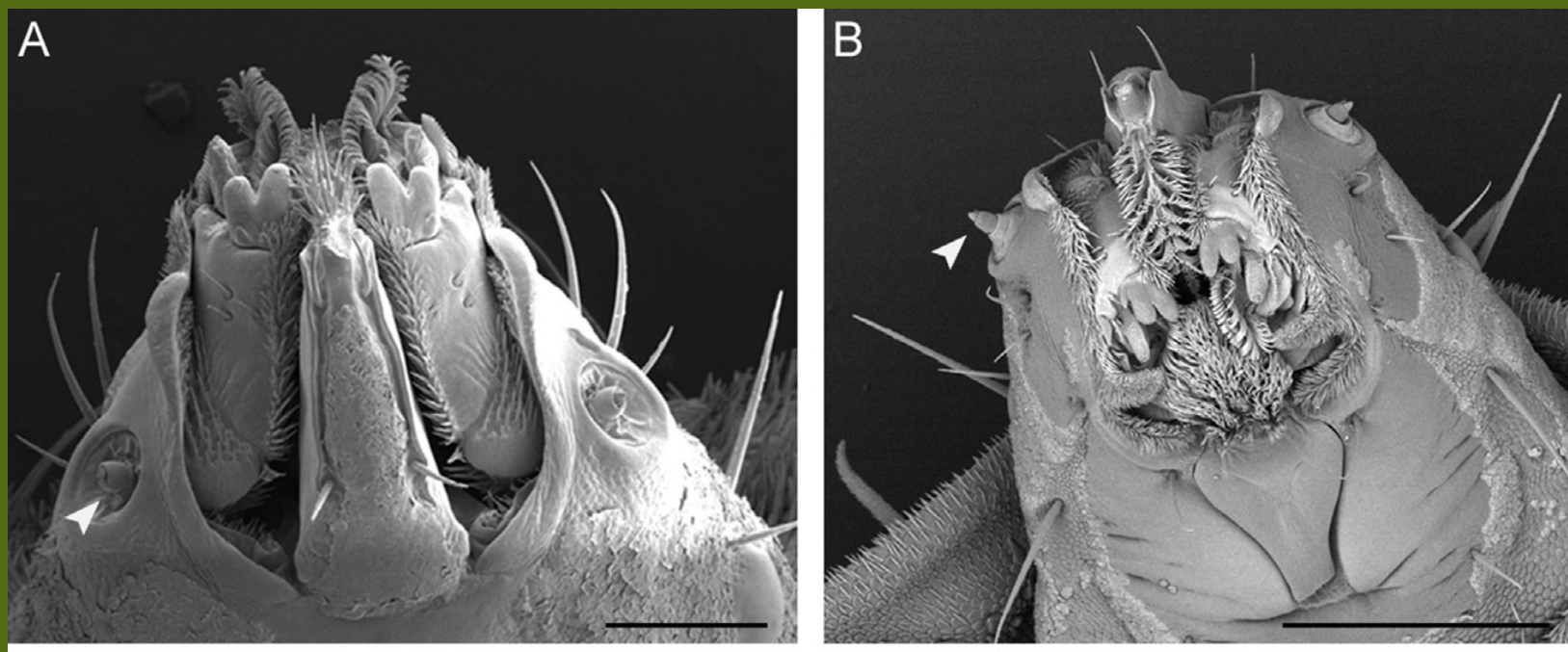
LARVA

- CIBO UMIDO
- >50% UMIDITA' NELLA DIETA (Cammack and Tomberlin, 2017)
- TEMPERATURA TRA 27°C E 30% RH (Tomberlin *et al.*, 2009)
- 6 STADI LARVALI – RICONOSCIBILI DALL'APPARATO BOCCALE



APPARATO BOCCALE

6 stadi larvali – riconoscibili dall'apparato boccale



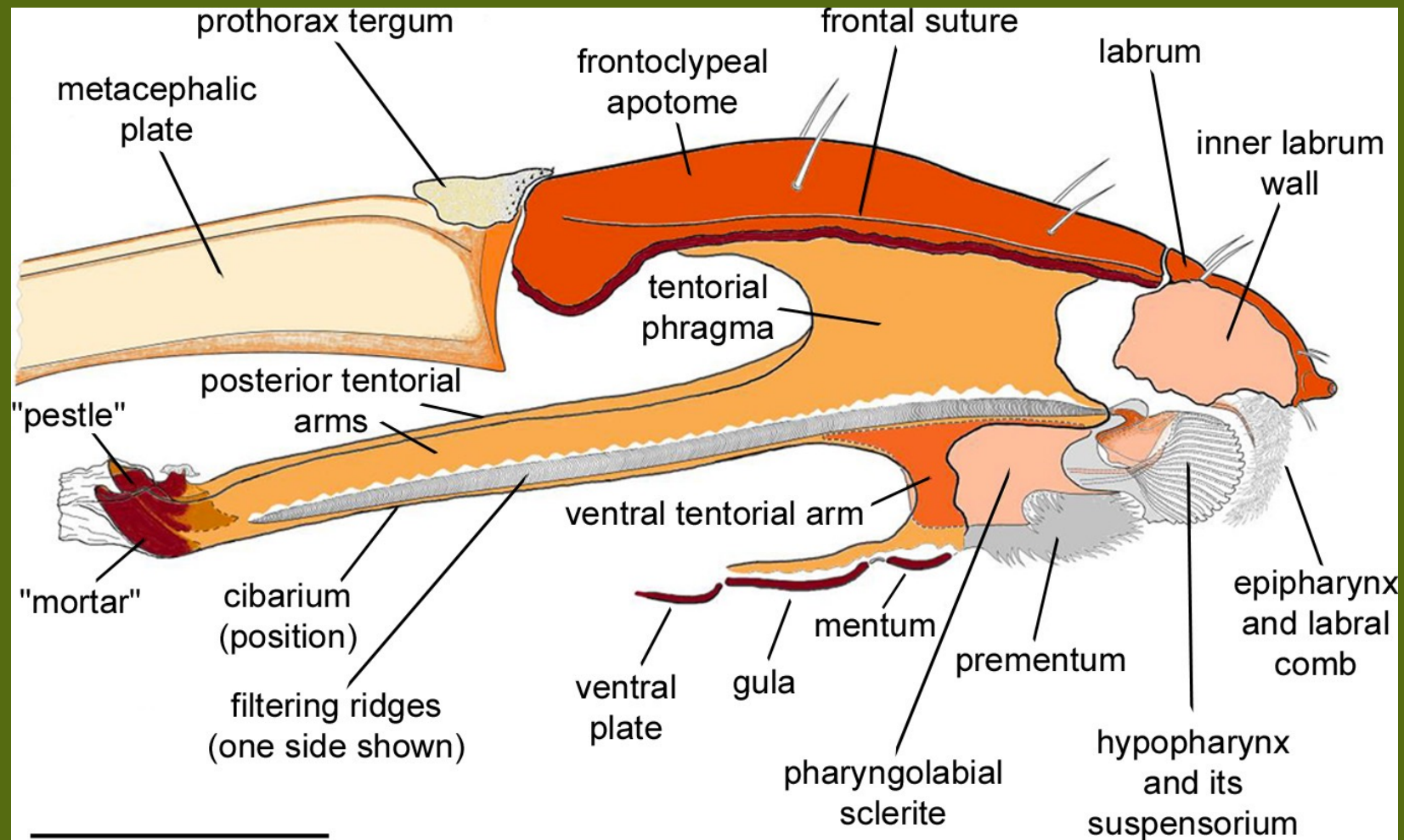
A. Visione dorsale

B. Visione ventrale

Ultimo stadio larvale

(Bruno *et al.*, 2020)

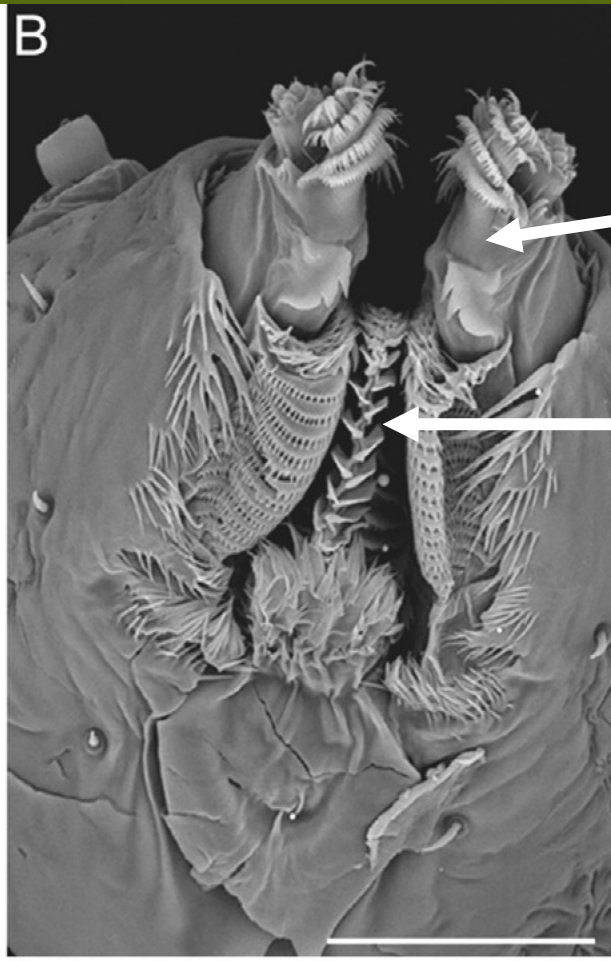
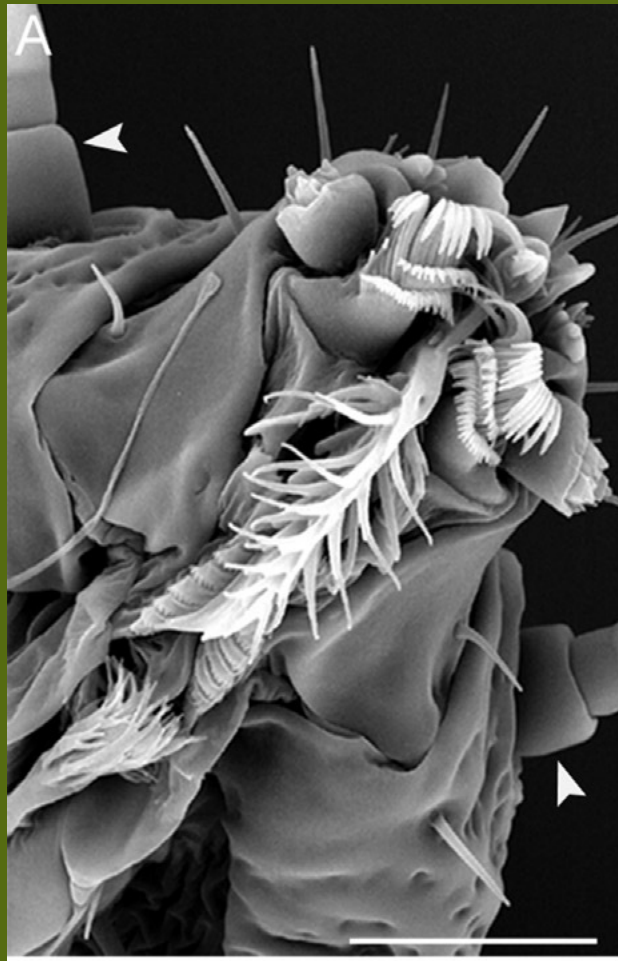
APPARATO BOCCALE



(Bruno *et al.*, 2020)

APPARATO BOCCALE

A. Primo stadio larvale



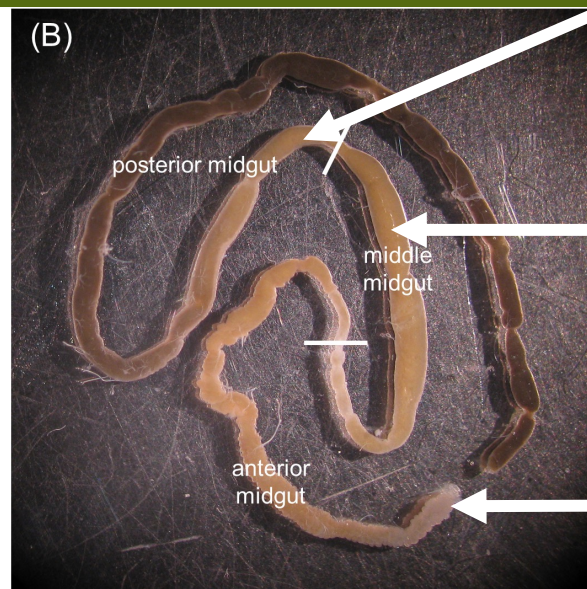
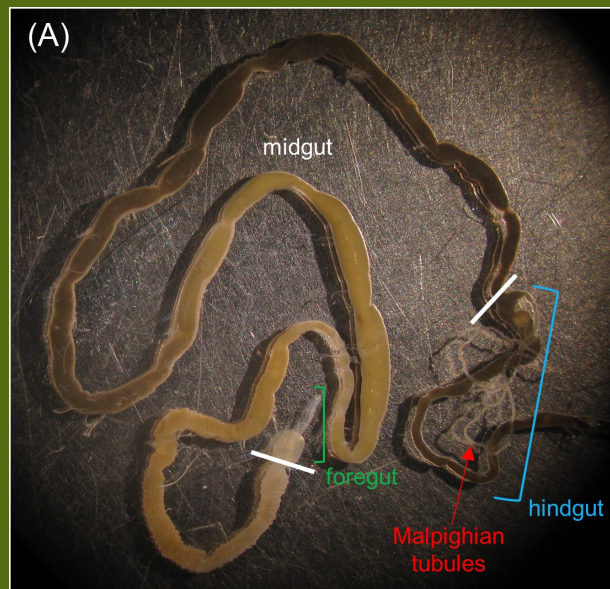
B. Secondo stadio larvale

Organo scavatore

Macina il cibo in particelle più piccole.

(Bruno *et al.*, 2020)

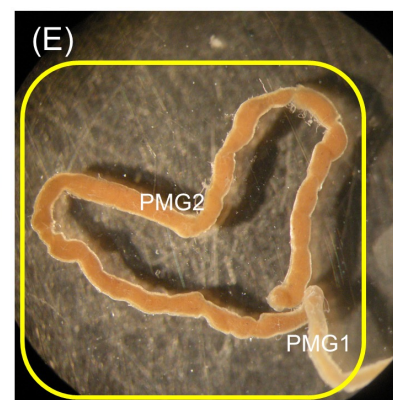
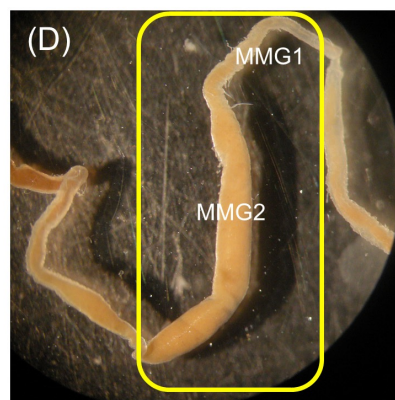
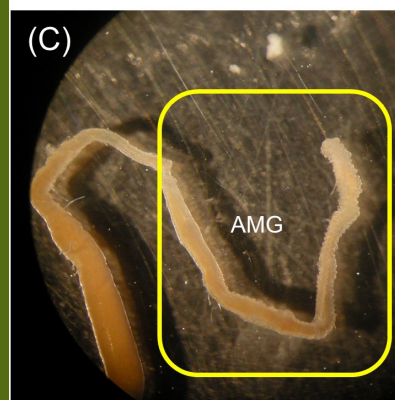
INTESTINO



Intestino posteriore

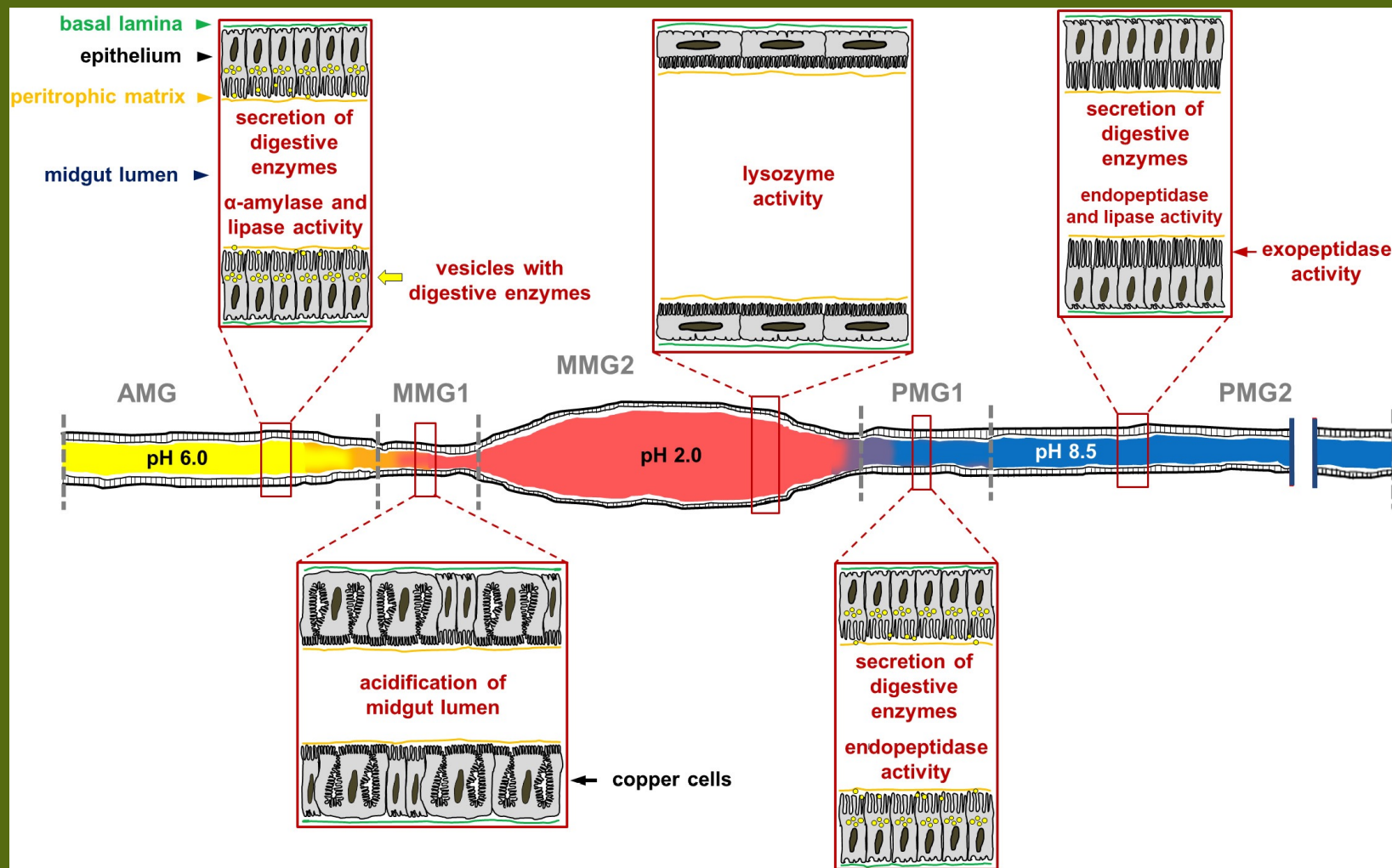
Intestino medio

Intestino anteriore



(Bonelli *et al.*, 2019)

INTESTINO



(Bonelli *et al.*, 2019)

PREPUPA

- NON SI ALIMENTANO
- HANNO INTESTINO ATROFIZZATO
- SI DISPERDONO IN TUTTE LE DIREZIONI
- TEMPERATURA TRA I 27 ED I 30°C
- CERCANO UN LUOGO DOVE COMPLETARE LA METAMORFOSI (MAY, 1961;)



ADULTO

- NON SI ALIMENTANO
- TRA 50 E 75% DI UMIDITA'
- (Holmes et al., 2012)
- TEMPERATURA TRA I 27 ED I 30°C
- LUCE NATURALE O LUCE ARTIFICIALE (Zhang et al., 2010)
- I MASCHI CERCANO UNA FEMMINA, SI ACCOPPIANO E LE FEMMINE DEPOSITANO LE UOVA IN ANFRATTI E BUCHI VICINO AL SUBSTRATO

(Tomberlin and Sheppard, 2002; Sheppard *et al.*, 2002; Meneguz *et al.*, 2022)



ADULTO

COMPORTAMENTO A LEKKING

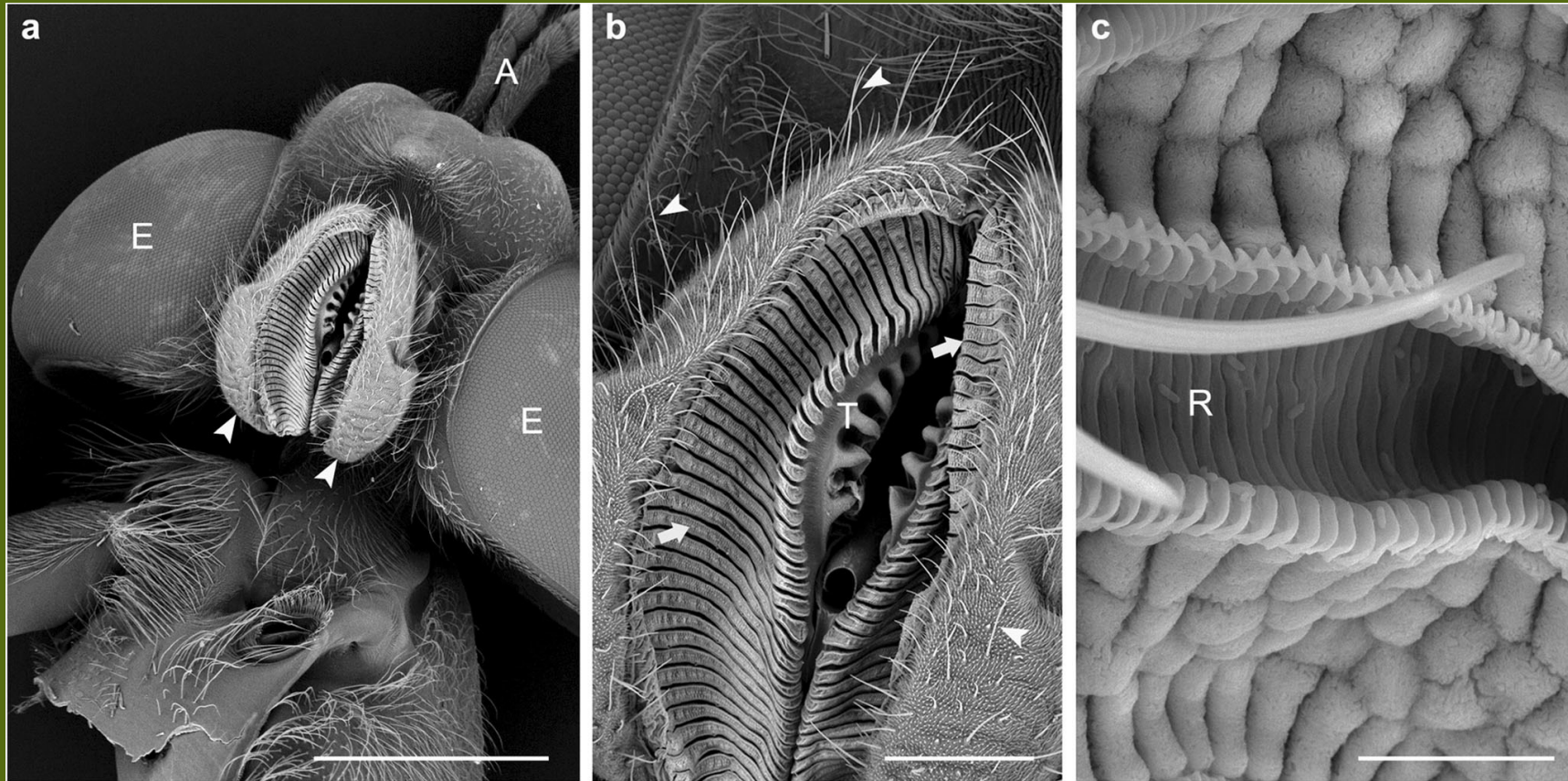
(Tomberlin *et al.*, 2001;

Meneguz *et al.*, 2022)

(Picasa 3.0)



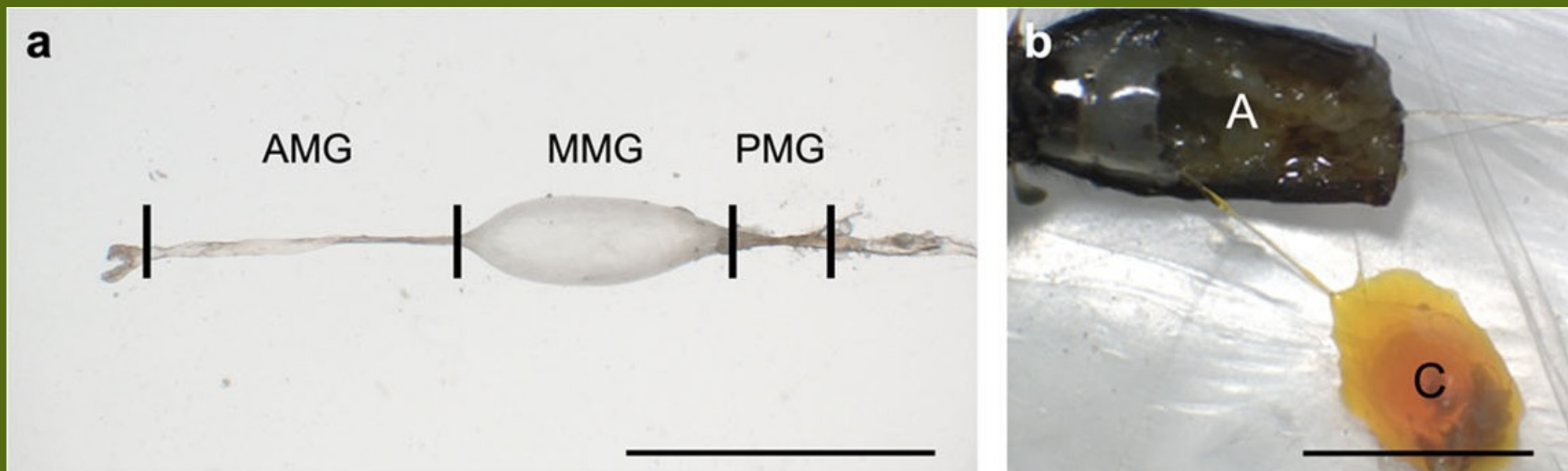
APPARATO BOCCALE



Possono ingerire
liquidi

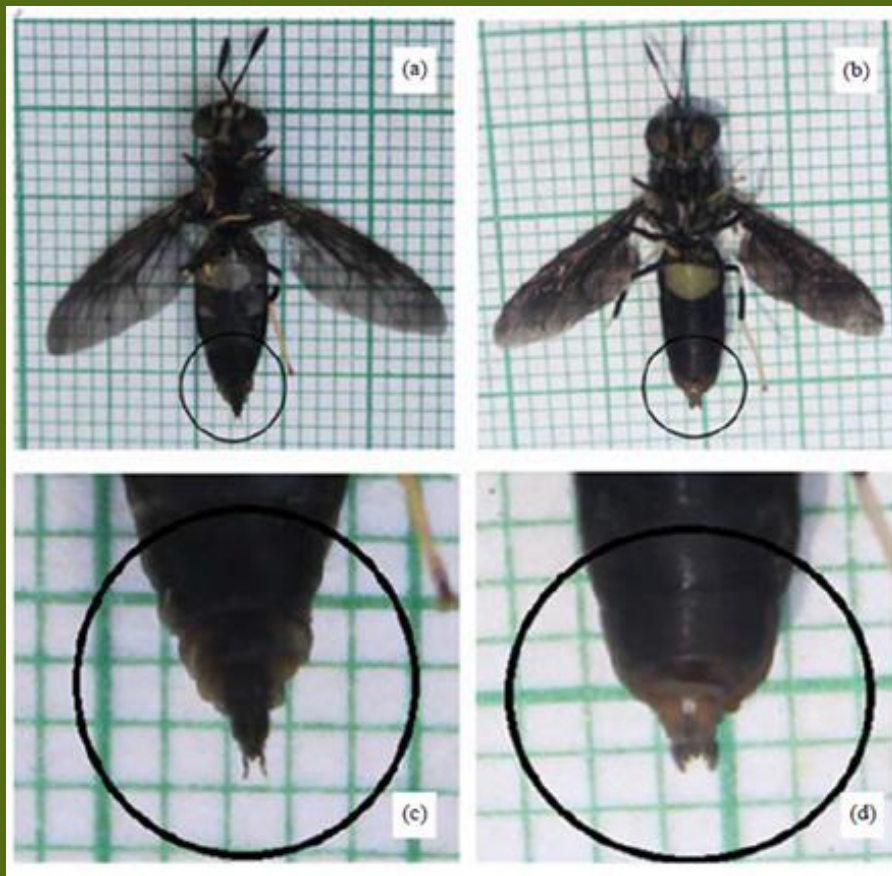
(Bruno *et al.*, 2019)

INTESTINO



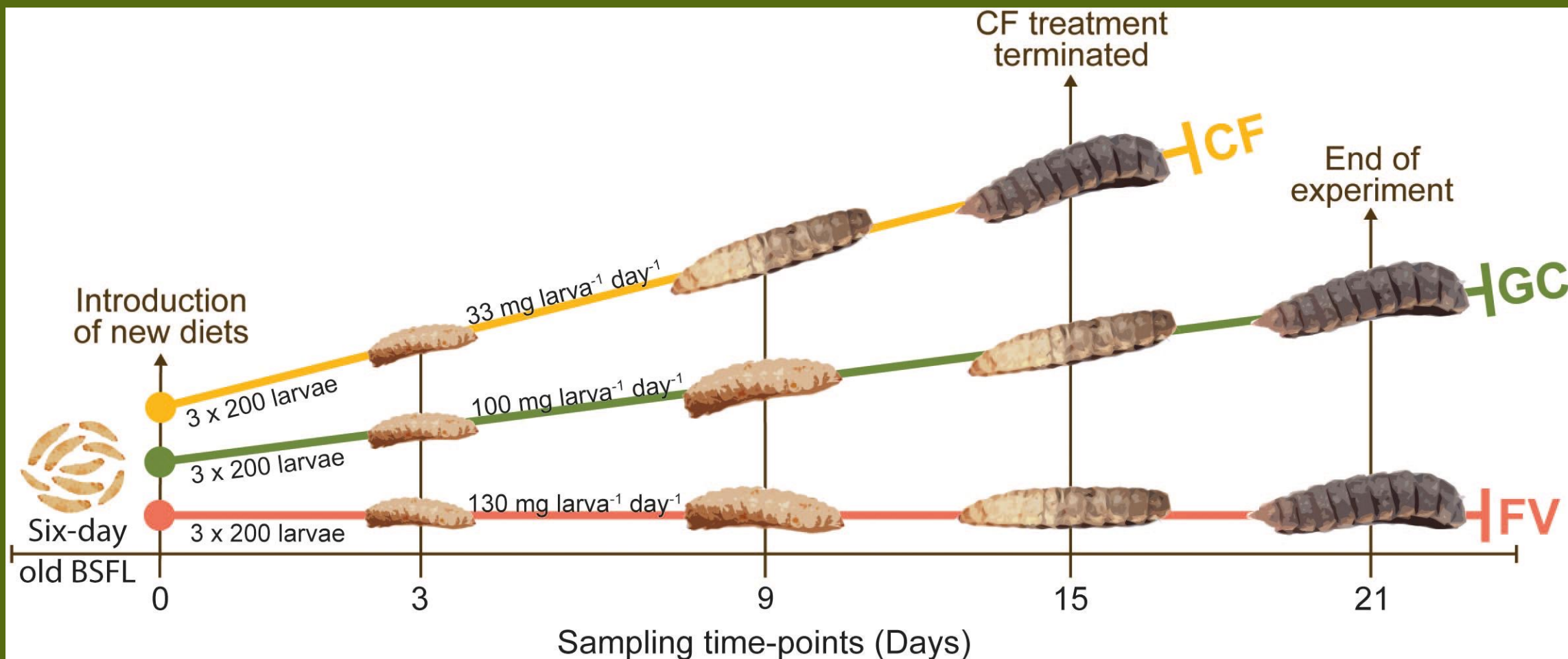
APPARATO RIPRODUTTIVO

Femmina



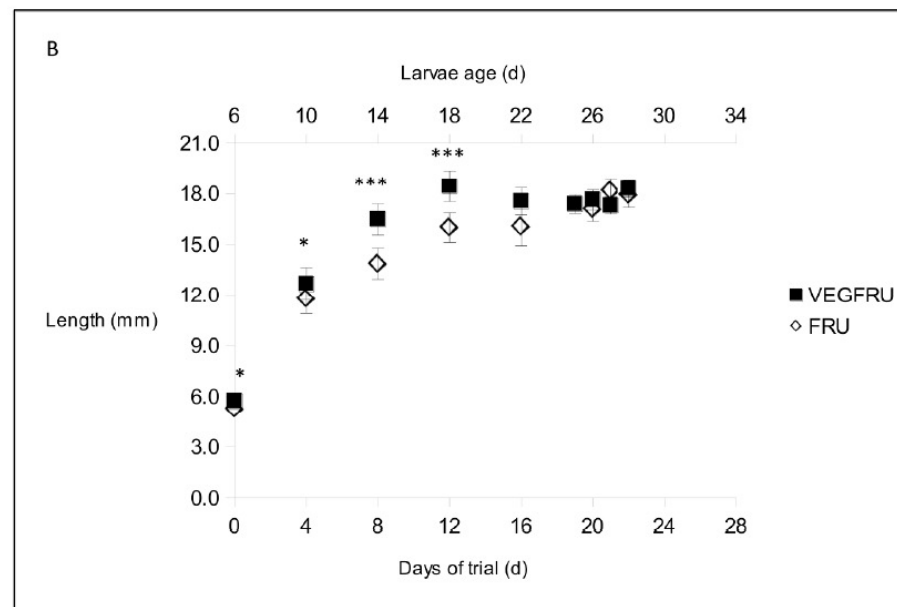
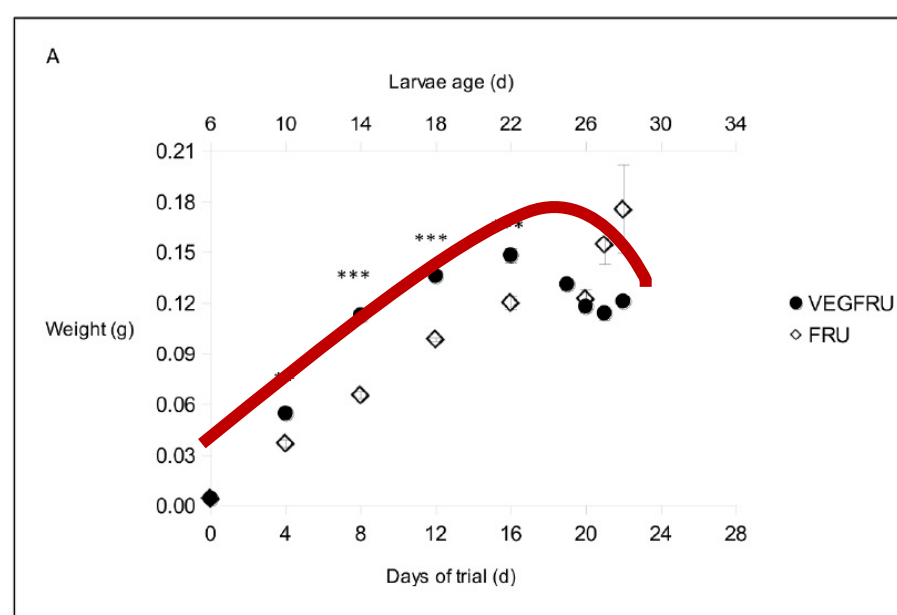
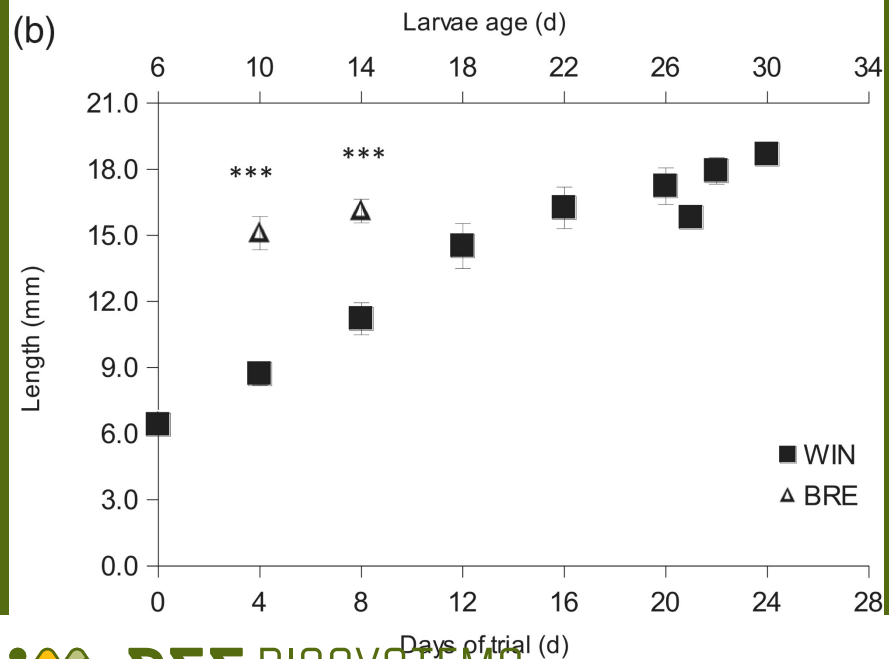
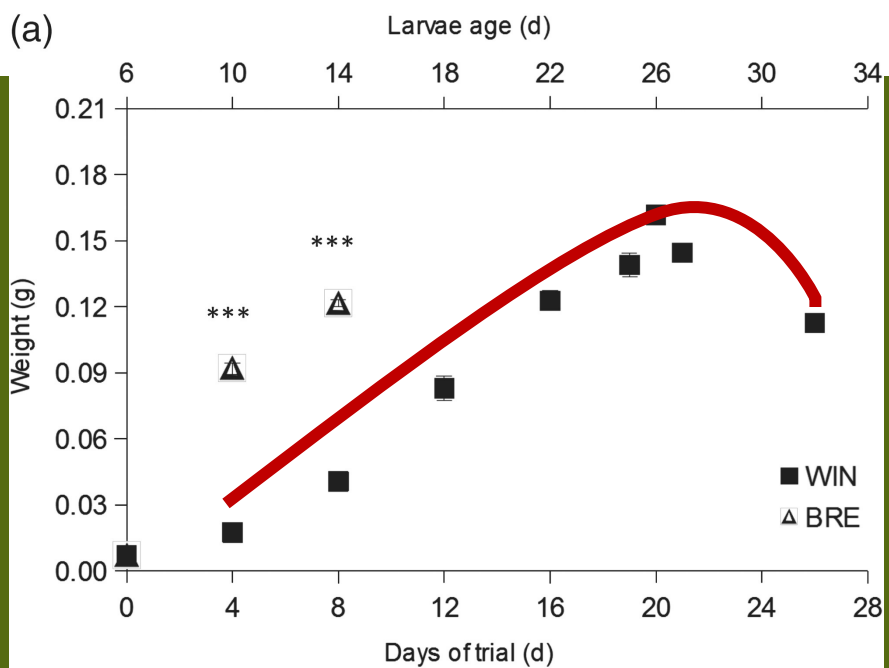
Maschio

(Chiabotto *et al.*, unpublished)



GC = taglio dell'erba and FV = frutta/vegetali mix)

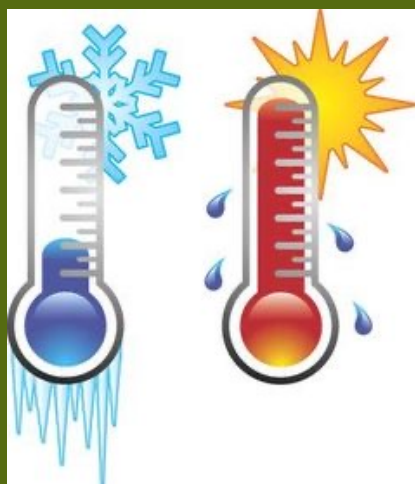
(Klammsteiner *et al.*, 2020)



(Meneguz *et al.*, 2018)

FATTORI ABIOTICI

27-30°C



pH

Luce



Fotofobiche



70% RH e
umidità
dieta

pH iniziale:

2,0 - 4,0 - 6,1 - 7,0 - 7,5 - 8,0 - 9,5-10,0



pH finale:

7,5 - 9,2 (Ma *et al.*, 2018; Meneguz *et al.*, 2018b)

Specie polifaga, BSF può modificare il pH acido durante lo sviluppo

- Perché?
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(Sheppard *et al.*, 1984 ;
Newton *et al.*, 2005;
Nguyen *et al.*, 2015;
Spranghers *et al.*, 2017;
Niakery *et al.*, 2017;
Meneguz *et al.*,
2018°; Barragan-Fonseca
et al., 2018; Lander *et al.*, 2019;)





SOTTOPRODOTTI
VEGETALI
AUTORIZZATI
COME ALIMENTO
PER MOSCA
SOLDATO



INVENDUTO COMMERCIALE?





Supermarket waste

1 ton fresh vegetables
(13 % Dry Matter)



1 Million BSF eggs

17 days @ 25°C



Frass

100 kg fresh
(70% DM)



Larvae

160 kg fresh
(~40% DM)

54 kg dry

- Protein (27 kg)

- Lipids (21 kg)

- Chitosan (5 kg)



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INIZIO
GIORNO 0
24/10/2022

6 dicembre 2022

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INIZIO
GIORNO 3
27/10/2022

6 dicembre 2022

IZS Lazio e Toscana M. Aleandri - Sezione di Viterbo
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INIZIO
GIORNO 7
31/10/2022

6 dicembre 2022

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Strada Terme – 01100 Viterbo



FINE
GIORNO 9
02/10/2022

6 dicembre 2022

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INIZIO GIORNO 0



GIORNO 4



GIORNO 7





RIPRODUZIONE CON LUCE ARTIFICIALE



500 Watt-
quarzo iodio

Luci
fluorescenti
per crescita
piante

Nuove
sperimentazio
ni in corso

RIPRODUZIONE CON LUCE ARTIFICIALE ARTIFICIALE



Luci sviluppate
apposta

RACCOLTA UOVA



Abbiamo 72
ore prima che
schiudano

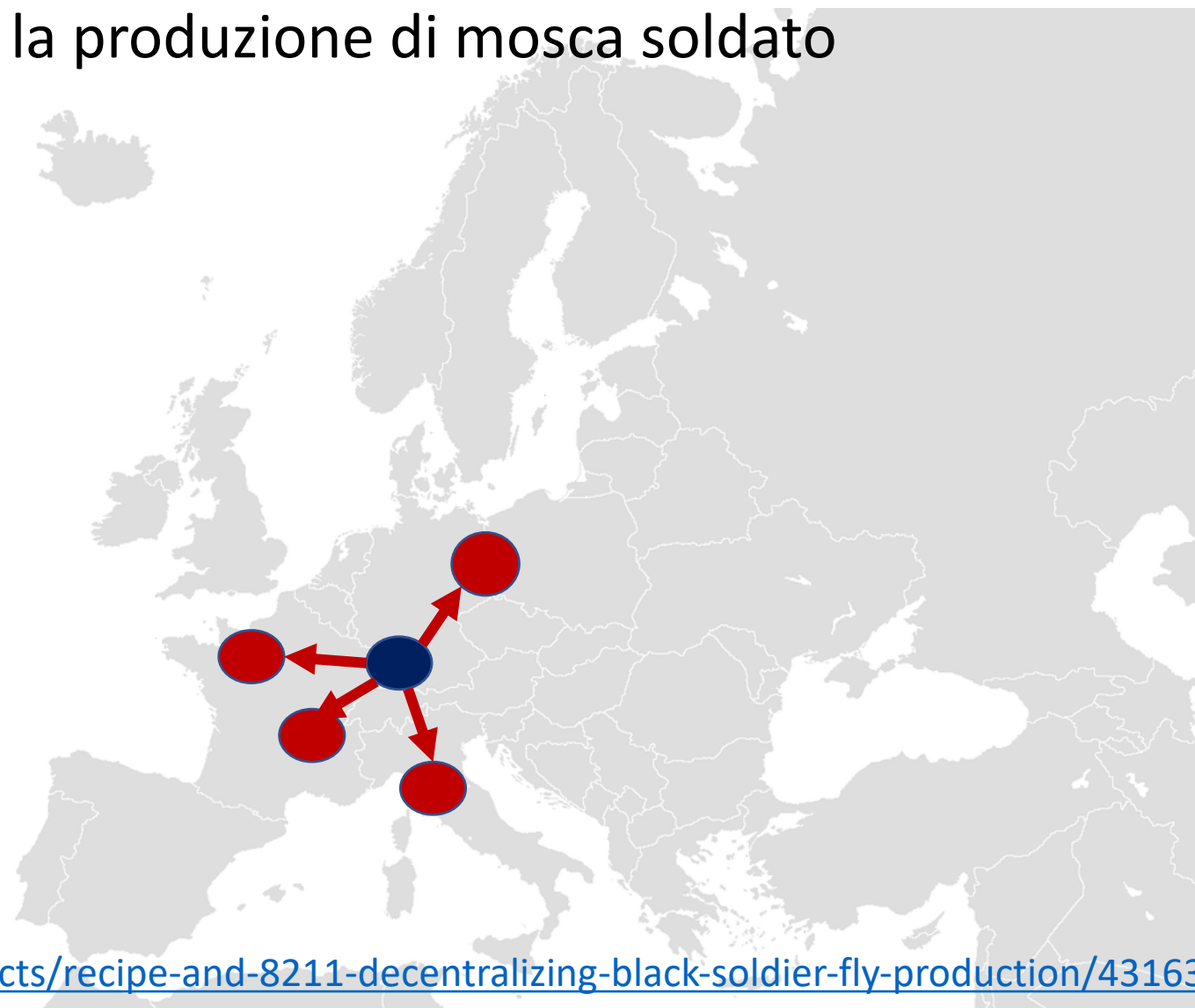
GRANDI IMPIANTI CENTRALIZZATI IN EUROPA



65.000 tonnellate anno di sottoprodotti

RECIPE PROJECT HORIZON 2020-

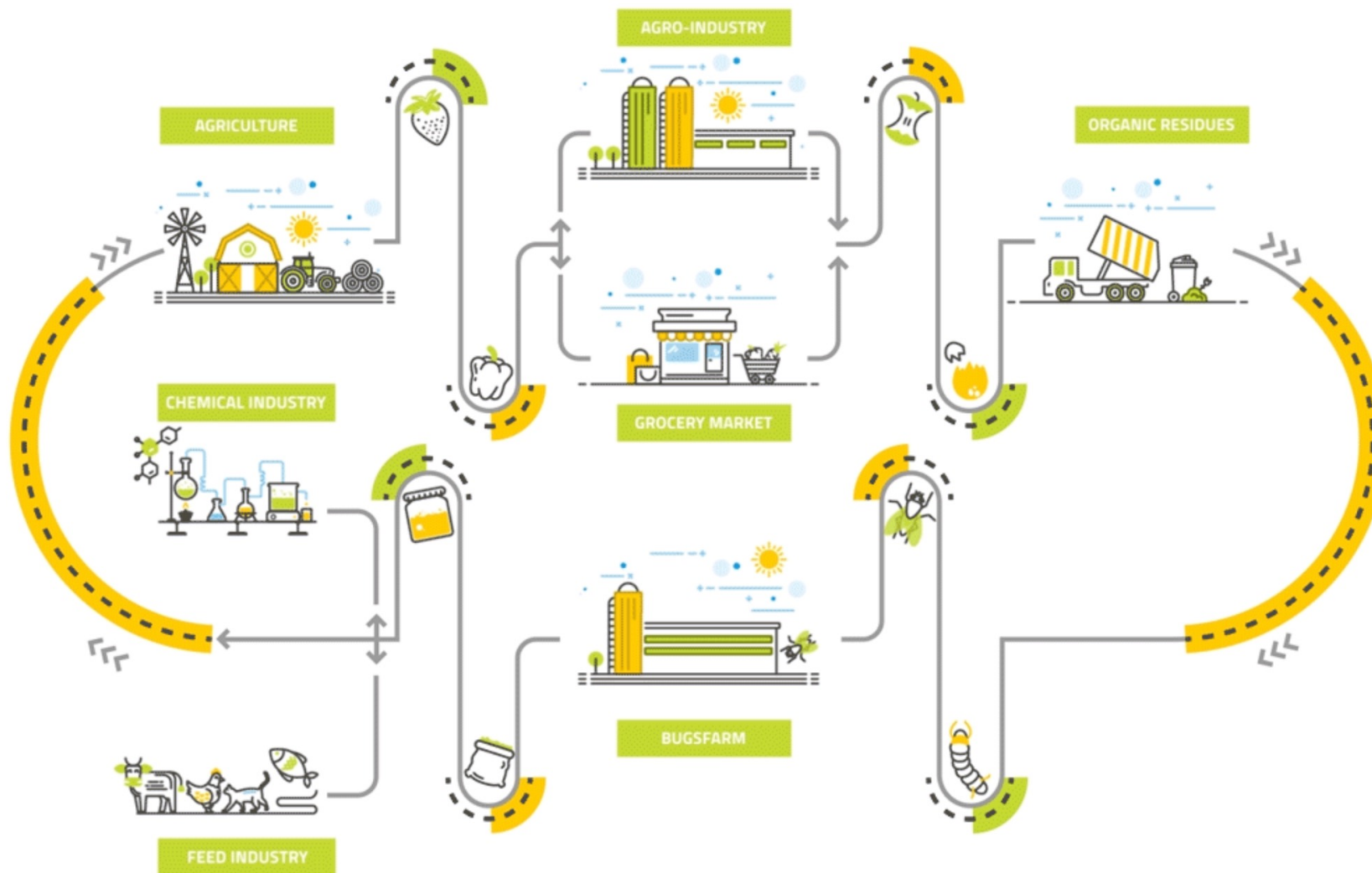
Decentralizzare la produzione di mosca soldato



● PRODUZIONE
UOVA

● INGRASSO
DELLE LARVE

<https://www.dti.dk/projects/recipe-and-8211-decentralizing-black-soldier-fly-production/43163>



- Perché?
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RISCHIO MICROBIOLOGICO

- *Salmonella* sp (Erickson *et al.*, 2004; Lalander *et al.*, 2013, Lalander *et al.*, 2015, Liu *et al.*, 2008, Lopes *et al.*, 2020) riduzione in letame e scarto di acquacoltura
- *Escherichia coli* (Erickson *et al.*, 2004)

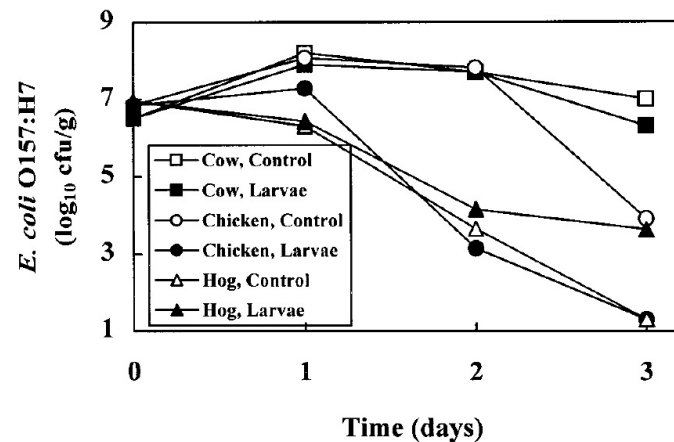


FIGURE 4. Reduction of *E. coli* O157:H7 by soldier fly larvae in different types of manure. Two independent trials were conducted for both chicken and hog manure ($n = 2$), whereas only one trial ($n = 1$) was conducted for cow manure systems. All samples contained 75 g of manure, and treated samples also contained 7 g of soldier fly larvae. Samples were stored at 27°C.

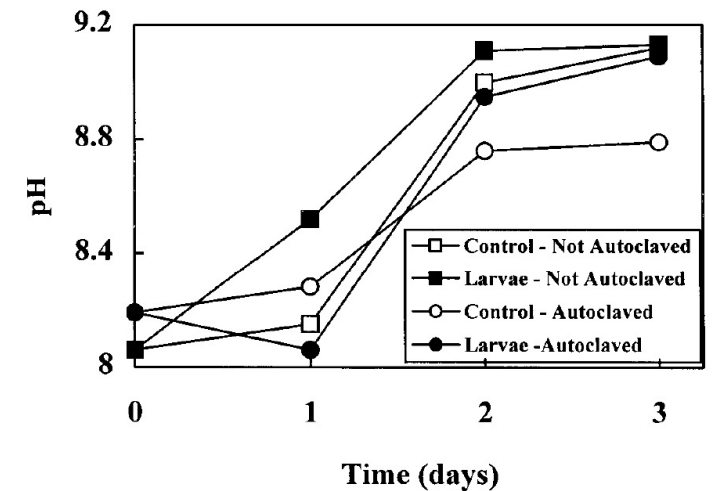


FIGURE 5. Influence of indigenous microflora on pH of stored chicken manure. Each point represents the mean of six different trials ($n = 6$). All samples contained 75 g of chicken manure and were held at 27°C. Treated samples contained either 7 or 10 g of 10- or 11-day-old soldier fly larvae.

RISCHIO MICROBIOLOGICO

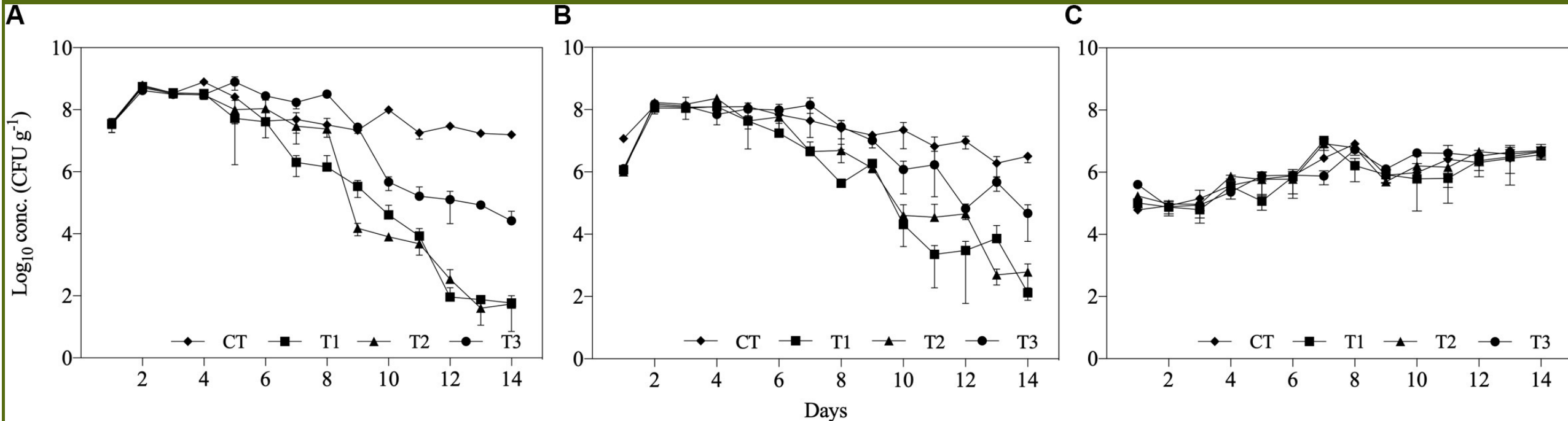


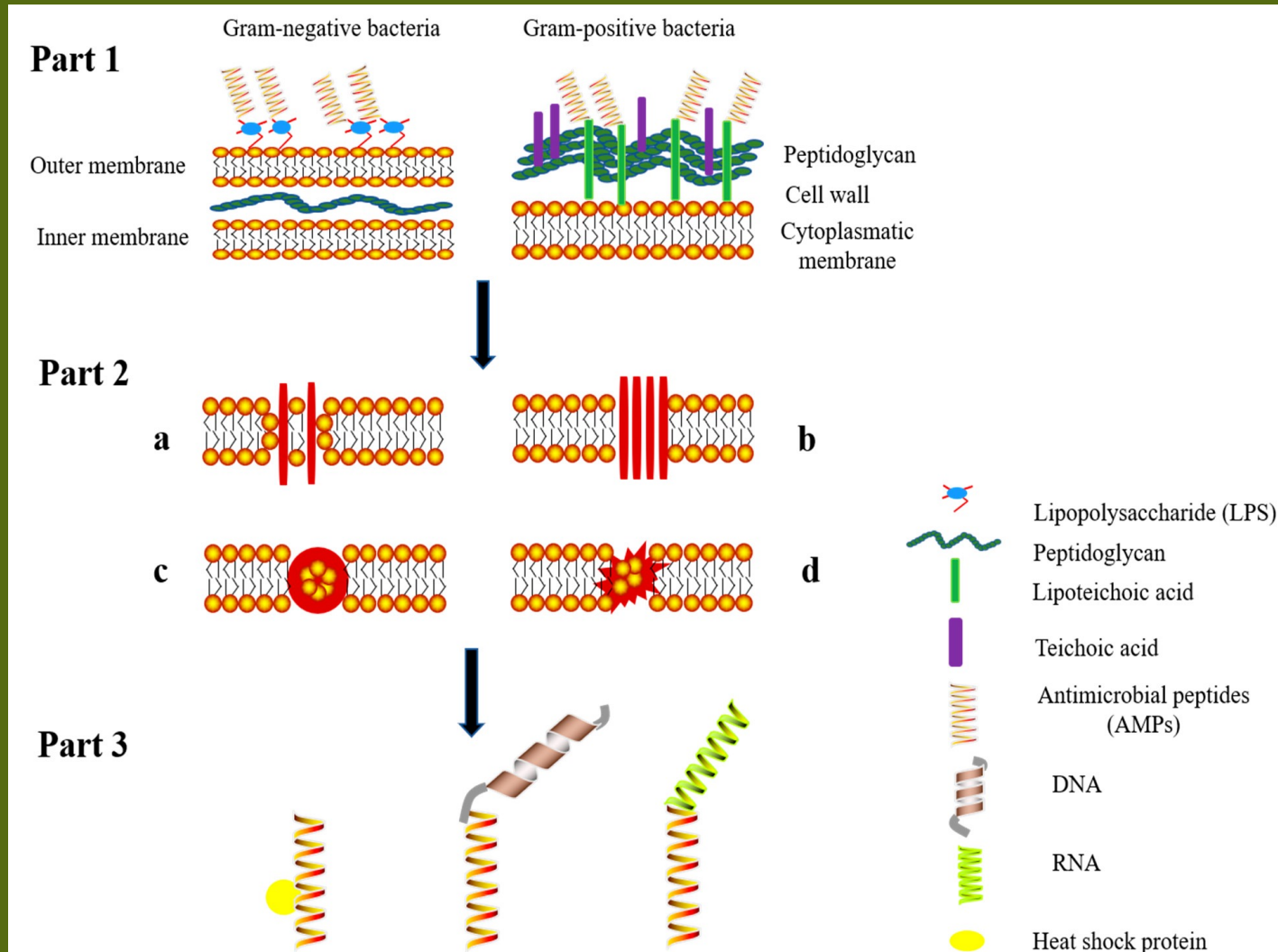
FIGURE 3 | Log₁₀ concentrations (CFU g⁻¹) of (A) *Salmonella* spp., (B) *Escherichia coli*, and (C) *Enterococcus* spp. over 14 days of treatment of aquaculture waste and bread treated with black soldier fly (BSF) larvae. CT, wastes inoculated with pathogens without larvae; T1, larvae fed once with inoculated wastes; T2, larvae fed three times, with wastes inoculated only the first time; T3, larvae fed three times, with waste inoculated all three times.

PEPTIDI ANTIMICROBICI

Table 1. Antimicrobial peptides from *Hermetia illucens*.

Peptide	Amino Acid Sequence	Immune-Induced Strains	Reference
Defensin			
Defensin-like peptide 1 (DLP1)	MRSVLVLGLIVAAFAVY TSAQPYQLQ YEEDGLDQAVELPIEEEQLPSQVVEQH YRAKRATCDLLSPFKVGHAACALH CIALGRRGGWCDGRAVCNCRR	<i>Staphylococcus aureus</i> KCCM 40881	[59]
Defensin-like peptide 2 (DLP2)	MRSILVLGLIVAAFAVY TSAQPYQLQY EEDGPGYALELPSEEEGLPSQVVEQH YRAKRATCDLLSPFKVGHAACALH CIAMGRRGGWCDGRAVCNCRR	<i>Staphylococcus aureus</i> KCCM 40881	[59]
Defensin-like peptide 3 (DLP3)	MRSILVLGLIVAVFGVY TSAQPYQLQ YEEDGPEYALVLPISSEELPSQVVEQH YRAKRATCDLLSPFGVGHAACAVHC IAMGRRGGWCDDRAVCNCRR	<i>Staphylococcus aureus</i> KCCM 40881	[56,59]
Defensin-like peptide 4 (DLP4)	MVHCQPFQLETEGDQLEPVVAEVD DVVDLVAIPEHTREKRATCDLLSPFK VGHAACAAHCIARGKRGGWCDK RAVCNCRK	<i>Staphylococcus aureus</i> KCCM 40881	[59]
Defensin 1 (HiDef1)	unknown	<i>Lactobacillus casei</i>	[57]
Cecropin			
CecropinZ1	GWLKKIGKMKFILGTTLAIVIAIFGQCQ AATWSYNPNGGATVTWTANVAATAR	<i>Escherichia. coli</i> and <i>Staphylococcus aureus</i>	[29]
Cecropin 1 (Hic1)	unknown	<i>Lactobacillus casei</i>	[57]
Cecropin-like peptide 1 (CLP1)	MNFTKLFVVFVAVLVAFAGQSEAGWRKR VFKPVEKFGQVRDAGVQGIQAQQGA NVLATARGGPPQQG	<i>Staphylococcus aureus</i> KCCM 40881	[55]
Cecropin-like peptide 2 (CLP2)	MNFAKLFVVFVAVLVAFSGQSEAGWWKR VFKPVEKLGQVRDAGIQGLEIAQQGAN VLATARGGPPQQG	<i>Staphylococcus aureus</i> KCCM 40881	[55]
Cecropin-like peptide 3 (CLP3)	MNFTKLFVVFVAVLVAFSGQSEAGWW VFKPVEKLGQVRDAGIQGLEIAQQGAN	<i>Staphylococcus aureus</i> KCCM 40881	[55]

PEPTIDI ANTIMICROBICI



NO AGENTI
PATOGENI VIRALI
O BATTERICI
IDENTIFICATI
SPECIE-SPECIFICI
PER BSF

RISCHIO METALLI PESANTI



Scarto di mensa in
Sannazzaro de' Burgondi

Esperimento: da Ottobre 2020 a Settembre 2021
25 l / mese in fusti di plastica alimentari

RISCHIO METALLI PESANTI



Il cibo è stato tritato e usato negli
stesso giorno come cibo per le
larve di BSF

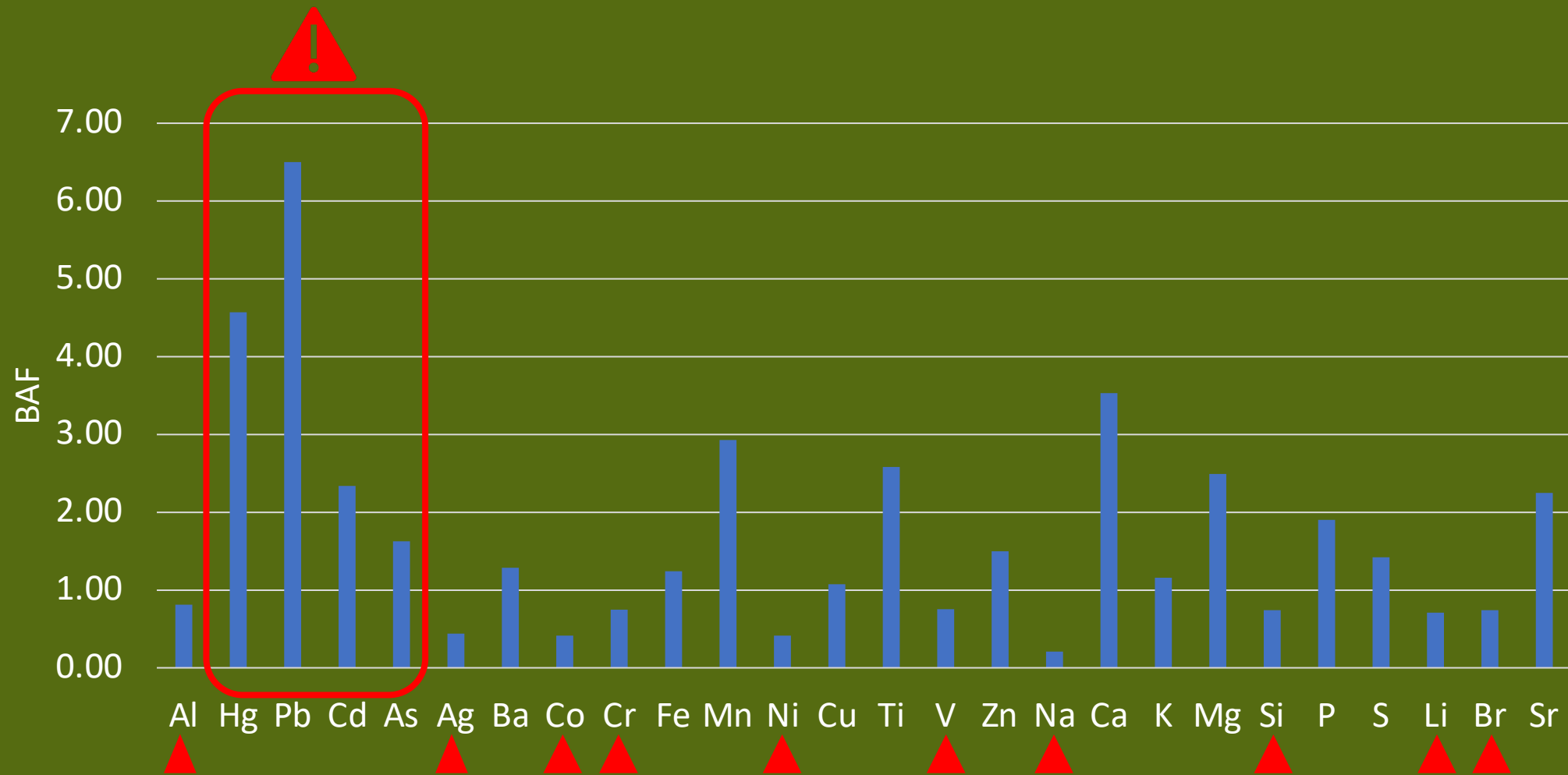


2000 g di CW e 2000
di larve
(5 giorni di età)

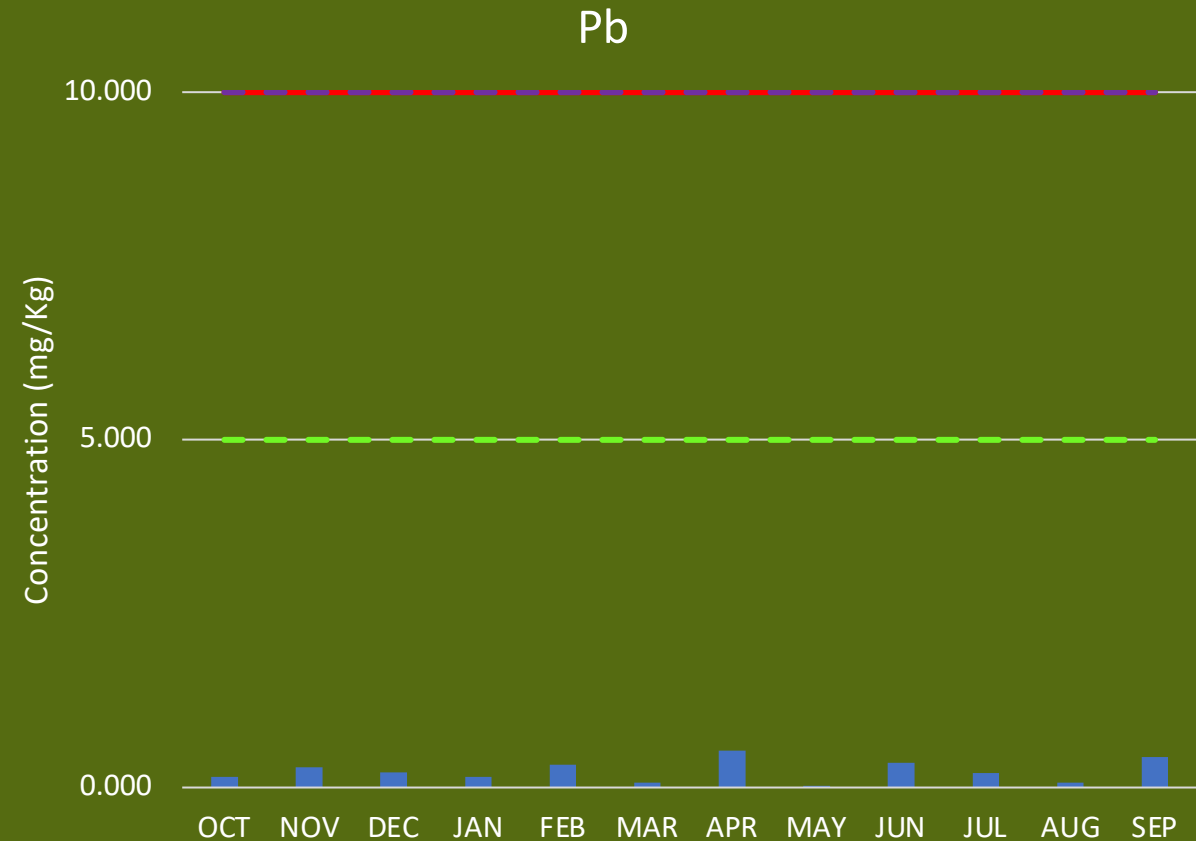
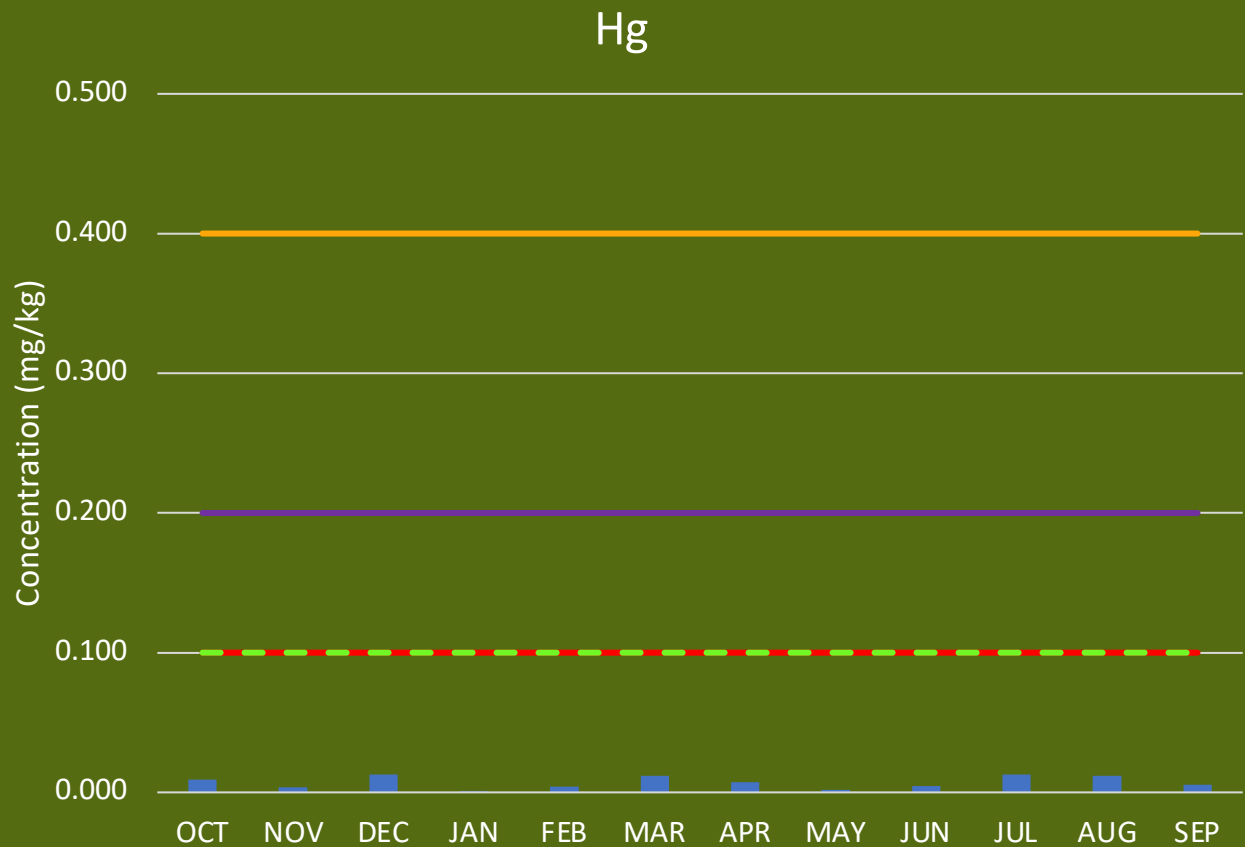


Esperimento di 7 giorni

Fattore di bioaccumulo (BAF) Rubio et al., 2021



Bioaccumulo larve

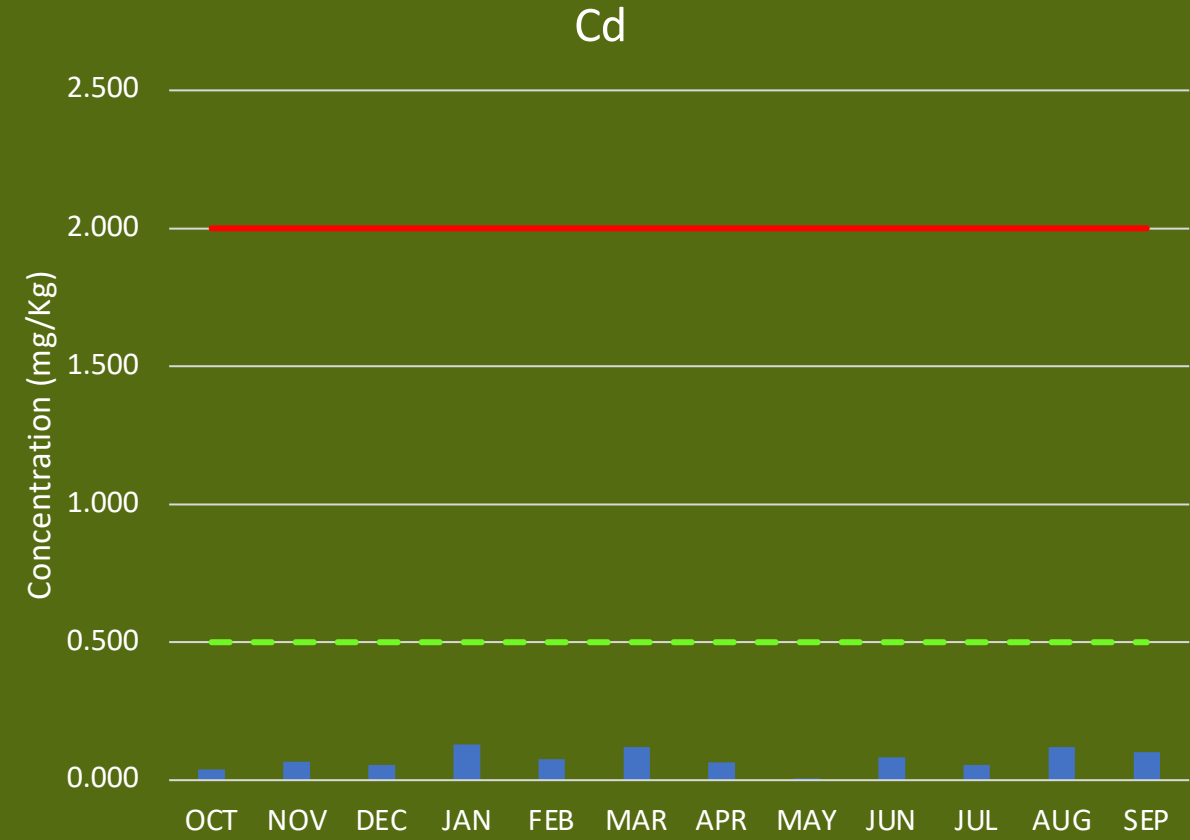
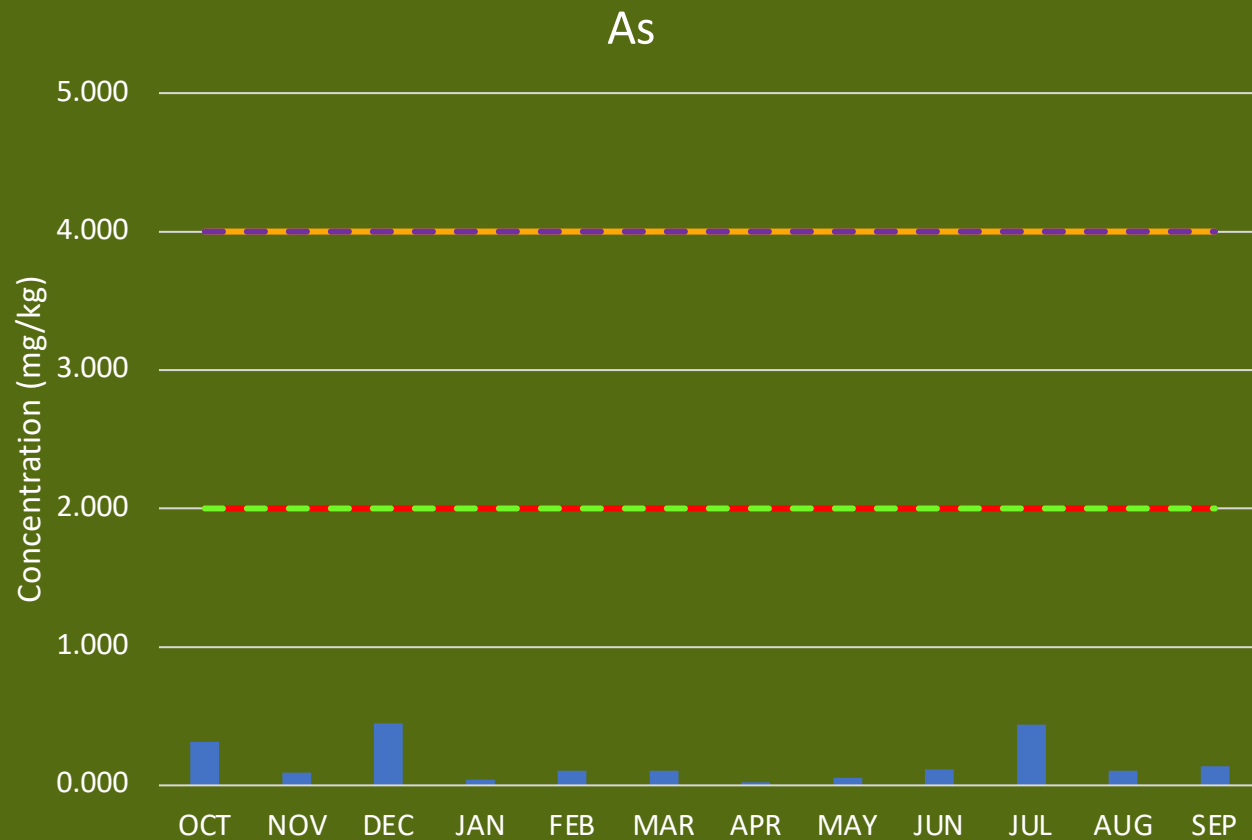


Law material ————
Complete food - - - - -

Complete food for pet food ————
Complementary feed ————

Dir. 2002/32/CE

Bioaccumulo larvae

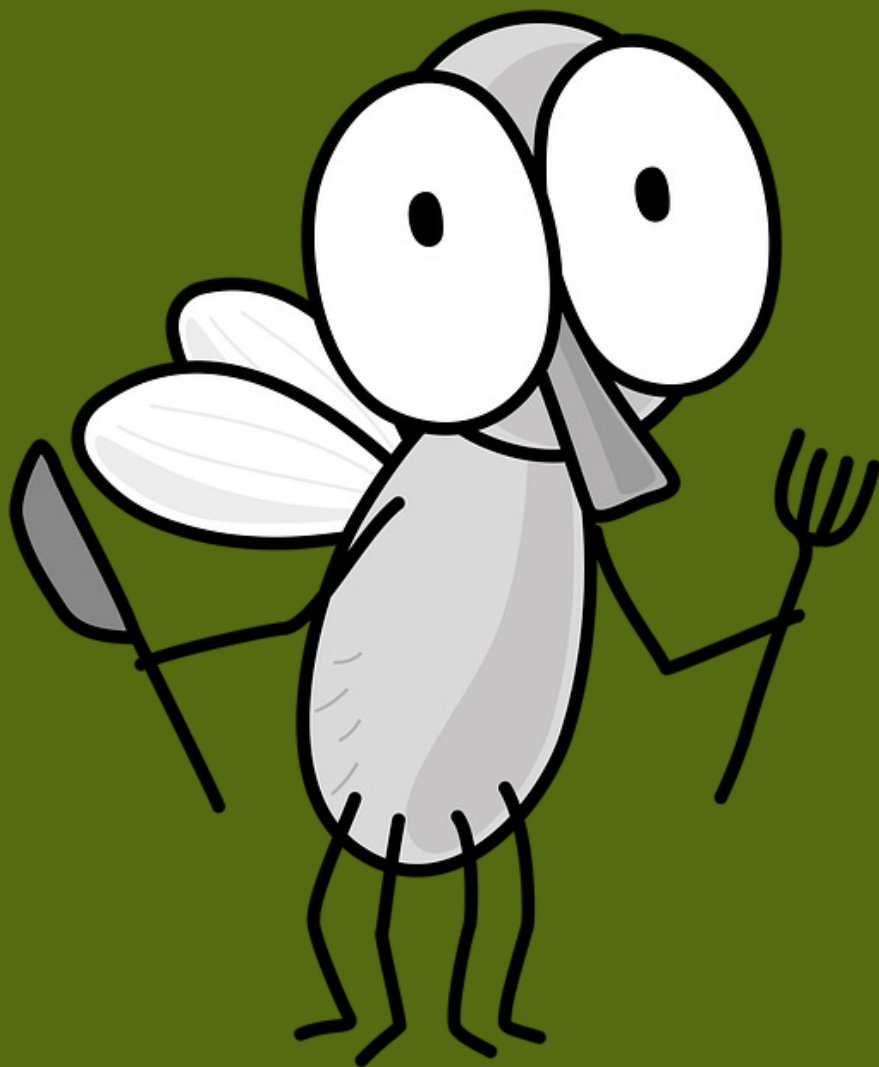


Law material ————
Complete food - - - - -

Complete food for pet food ————
Complementary feed ————

Dir. 2002/32/CE

- Perché?
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- Conclusioni



	ALIMENTI PER INSETTI
✓	SUBSTRATI VEGETALI
✓	SOTTOPRODOTTI VEGETALI, LATTICINI E UOVA
✗	SOTTOPRODOTTI A BASE DI CARNE E PESCE
✗	SCARTI DI RISTORAZIONE
✗	FECI ANIMALI

PERCHE' E' POSSIBILE ALLEVARE LE LARVE DI MOSCA CARNARIA PER LA PESCA SU PRODOTTI ANIMALI E NON LE LARVE DI MOSCA SOLDATO?



IL REGOLAMENTO 1017/2017 INDICA AL PARAGRAGO 9.16.1:
“INVERTEBRATI TERRESTRI VIVI, IN TUTTI GLI STADI DI VITA,
DIVERSI DALLE SPECIE AVENTI EFFETTI NOCIVI PER LE PIANTE,
GLI ANIMALI E LA SALUTE UMANA.”

IL LOMBRICO È UN INVERTEBRATO E LO POSSO ALLEVARE
SUL LETAME, PERCHÈ NON POSSO ALLEVARE LA MOSCA
SOLDATO SU UN LETAME SE È UN INVERTEBRATO?



NO LIMITAZIONI GENERICHE PER I RIFIUTI

SCOPI NON ALIMENTARI COME NON-FOOD: CHITINA,
BIOPLASTICA

SELEZIONARE I RIFIUTI PER CODICI CER PER AUTORIZZARLI
CON UN END OF WASTE PER PRODUZIONI NON FOOD

POSSIBILE USARE GRASSI, PROTEINE E FIBRE (CHITINA) DI BSF
PER APPLICAZIONI INDUSTRIALI

- **Perché?**
- **Distribuzione**
- **Biologia**
- **Allevamento**
- **Rischi**
- **Problematiche legislative**
- **Conclusioni**

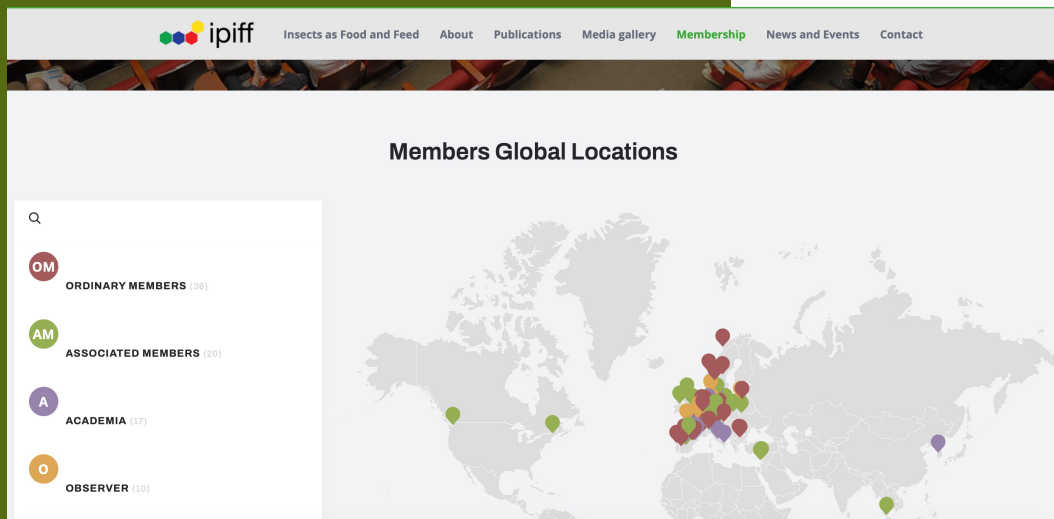
European institutions & other EU stakeholders.

[LEARN MORE](#)



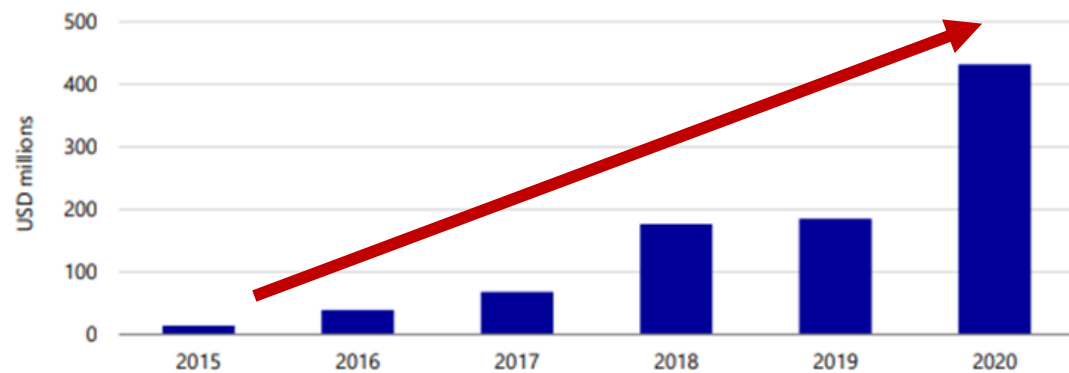
International Platform of Insects for Food and Feed (IPIFF)

IPIFF is an EU non-profit organisation which represents the interests of the insect production sector towards EU policy makers, European stakeholders and citizens. Composed of 85 members, IPIFF promotes the use of insects for human consumption and insect-derived products as a top tier source of nutrients for animal feed.



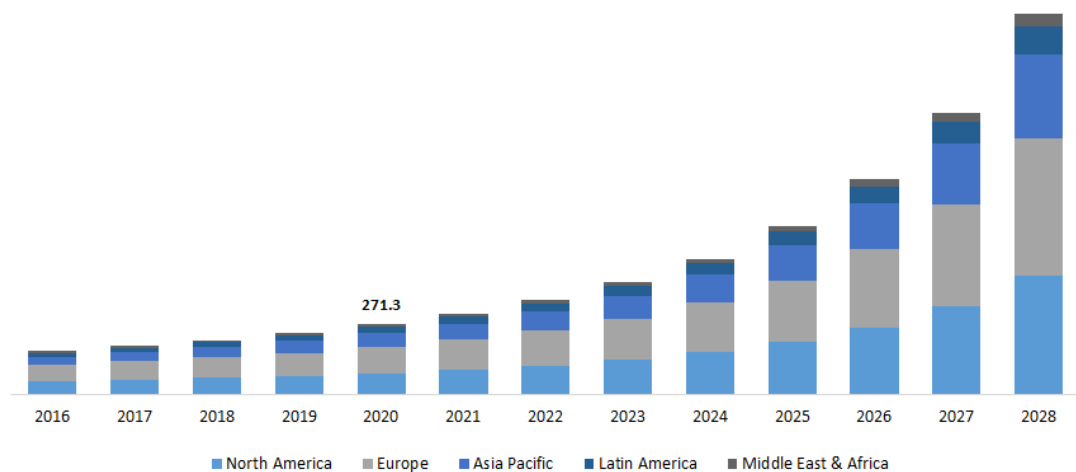
INVESTIMENTI

Figure 4: The exponential increase in capital flowing to insect farming companies



Source: Crunchbase, Dealroom, Rabobank 2021

Insect Protein Market Size, By Region, 2016 - 2028
(USD Million)



Source: Polaris Market Research Analysis

A market potential of half a million metric tons for insect protein is possible by 2030

			Animal feed					
			Total	Pet food	Aquaculture	Poultry - Layers	Poultry - Broilers	Piglets
								
Estimated market size (metric tons)	Scale-up phase: EUR 3,500–EUR 5,500/metric ton	120,000	65,000	20,000	20,000	10,000	5,000	
	Wider-use period: EUR 2,500–EUR 3,500/metric ton	200,000	85,000	55,000	30,000	20,000	10,000	
	Maturity phase: EUR 1,500–EUR 2,500/metric ton	500,000	150,000	200,000	70,000	50,000	30,000	

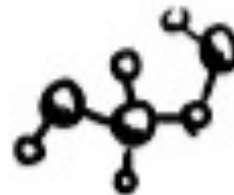
Source: Rabobank 2021

POCHE MIGLIAIA DI TONNELLATE PRODOTTE IN EU NEL 2022



PROTEIN TRANSITION

Can Science & the Business of Food
Solve our Consumption Equation?





Grazie per l'attenzione



BEF BIOSYSTEMS
BUGS FOR ENVIRONMENT AND FEED

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