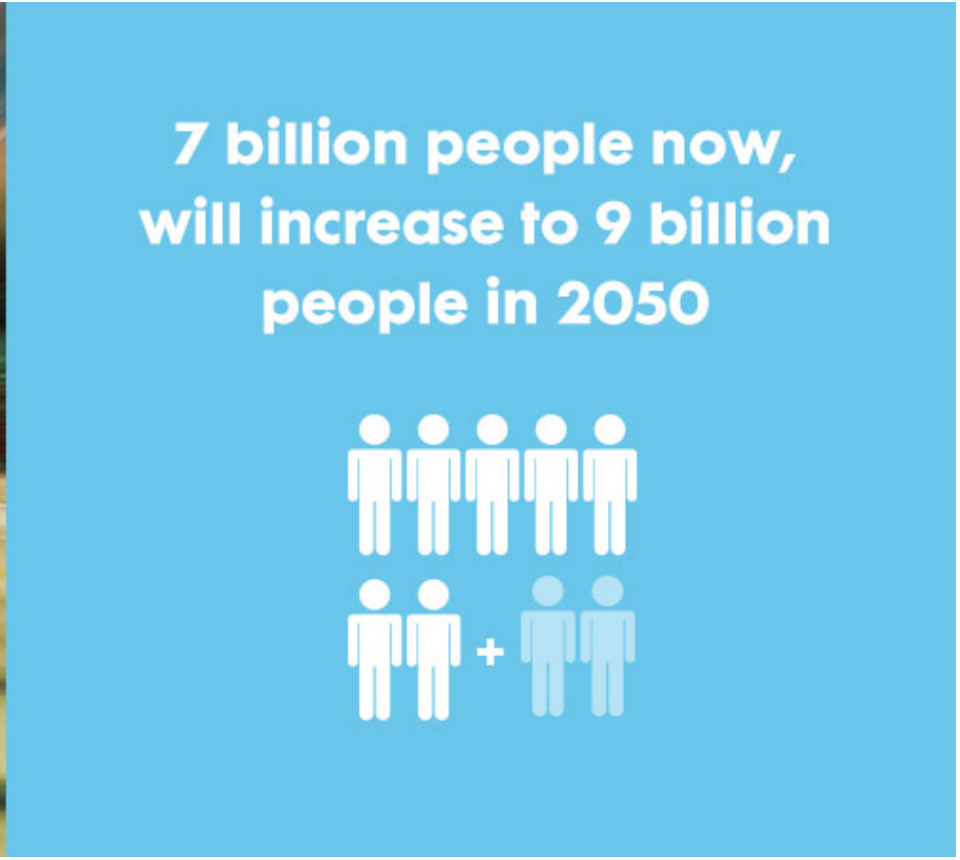
Allevamento degli insetti per l'alimentazione animale: stato dell'arte e potenzialità

Laura Gasco – Achille Schiavone

laura.gasco@unito.it

Dipartimento Scienze Agrarie, Forestali e Alimentari

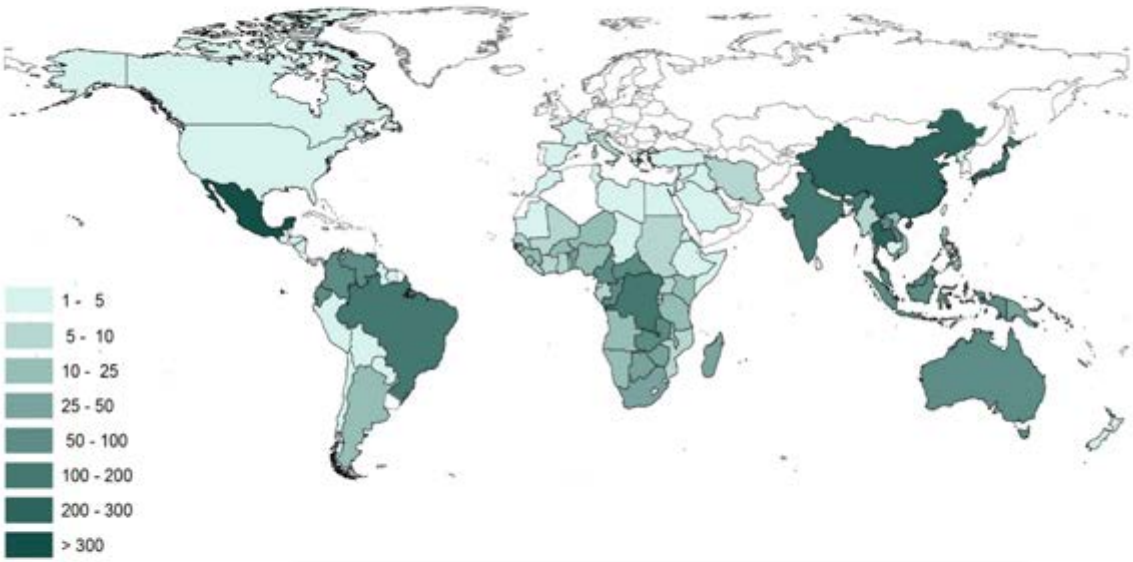
DISAFA
Università degli studi di torino



Per fare fronte all'aumento dei consumi si stima che entro **2050** la produzione di carne (avicoli/suini/bovini) e d prodotti lattiero caseari dovrà raddoppiare mentre la produzione di pesce (acquacultura) dovrà essere triplicata

IFIF, 2014. http://www.ifif.org/pages/t/The+global+feed+industry
FAO, 2011. World Livestock 2011 – Livestock in Food Security. Food and Agriculture Organization of the United Nations (FAO), Rome

Recorded edible insect species, by country



Specie commestibili: 2037

Source: Centre of Geo information by Ron van Lammeren, Wageningen University, based on data compiled by Yde Jongema, 2015 version: 150518

2 miliardi di persone

FAO FORESTRY PAPER
171

Edible insects

Future prospects for food and feed security

WAGENINGEN UR
For quality of life









Ketchup: 30 uova di insetto ogni 100 g

Mais in scatola: 2 larve di insetto ogni 100 g

Mirtilli:2 vermi ogni 100 bacche

Burro di arachidi: 50 frammenti di insetti ogni 100 g

Polvere di Curry: 100 frammenti di insetti ogni 100 g

Semi di sesamo: 5% di semi infestati

Caffè: 10% di chicchi infestasti

500 g/anno

“GIANIN”

UTILI

1/3 produzione alimenti naturali (impollinazione)

Insetti come materie prime nell'alimentazione delle specie di interesse zootecnico

Innovative???

Table 2. List of species eaten by wild boar in Europe

Animals	References	Animals	References
Amphibians		*Melolontha* sp.	2, 5
Bufo bufo	6	*Nebria* sp.	2
Bufo viridis	5	*Necrophorus vespilloides*	2
Bufo sp.	11	*Osmoderma eremita*	8
Pelobates fuscus	2	*Panolis flammea*	2
Rana arvalis	2	*Phyllopertha* sp.	2
Rana esculenta	2	*Polietes lardaria*	5
Rana temporaria	2	*Polyphylla fullo*	2
Reptiles		*Prionus coriarius*	2
Anguis fragilis	2	*Pterostichus niger*	2
Blanus cinereus	19	*Pterostichus oblongopunctatus*	2, 5
Lacerta agilis	2	*Pterostichus vulgaris*	8
Natrix natrix	2, 11	*Pterostichus* sp.	8
Psammodromus algirus	19	*Rhaphidia* sp.	8
Fish		*Rhagio lineola*	2
Cyprinus carpio	5	*Rhizotrogus* sp.	8, 19
Birds		*Scolopendra* sp.	19
Alectoris rufa	19	*Selatosomus aeneus*	5
Anas platyrhynchos	6	*Sphinx pinastri*	5
Anser cygnoides domestica	17	*Spondylis buprestoides*	5
Columba palumbus	6	*Staphylinus caesareus*	8
Corvus sp.	2	*Staphylinus similis*	8
Cygnus olor	2	*Staphylinus* sp.	2, 5, 8
Erithacus rubecula	2	*Stenobothrus* sp.	8
Ficedula hypoleuca	2	*Tapinoma nigerrimum*	19
Fringilla coelebs	2, 6	*Tenebrio* sp.	2
Gallus domesticus	5	*Tetropium* sp.	5
Gallus gallus	2	*Thanatophilus* sp.	8
Garrulus glandarius	2	*Tipula cziezki*	5
Phasianus colchicus	5	*Tipula hartulana*	5
Scolopax rusticola	10	*Tipula livida*	5
Turdus philomelus	2	*Tipula nubeculosa*	5
Turdus sp.	6, 17	*Tipula paludosa*	6
Mammals		*Tipula rubripes*	2
Apodemus agrarius	5	*Tipula scripta*	2, 5
Apodemus flavicollis	2, 5, 20	*Tipula vittata*	5
Apodemus sylvaticus	5, 20	*Tipula* sp.	5
Capra hircus	17	*Xylodrepa quadripunctata*	2, 8
Capreolus capreolus	2, 5	*Zabrus tenebrioides*	2
Cervus elaphus	2	*Zabrus* sp.	2
Clethrionomys glareolus	2, 6, 20	**Other invertebrates**	
Cricetus cricetus	2	*Allolobophora caliginosa*	2
Crocidura sp.	19	*Arion rufus*	6, 11
Dama dama	2	*Arion* sp.	2
Hystrix cristata	9	*Cepaea* sp.	2
Lepus europaeus	2, 20	*Dendrobaena octaedra*	2
Microtus agrestis	2	*Dendrobaena* sp.	5
Microtus arvalis	2, 11, 20	*Eisenia foetida*	11
Mus musculus	11	*Glomeris* sp.	2
Oryctolagus cuniculus	6, 19	*Helix pomatia*	2, 5, 11
Sorex araneus	20	*Julus* sp.	2, 8
Talpa europaea	2, 5, 6, 11	*Lithobius* sp.	2, 8
Insects		*Lumbricus rubellus*	2
Acantholyda nemoralis	2	*Lumbricus terrestris*	6, 11, 20
Agonum viduum	5	*Lumbricus* sp.	5, 19
Agriotes sp.	2		

Lindner (1919)
Production protein and fat by housefly from human excreta

1969

JOURNAL OF ECONOMIC ENTOMOLOGY

House Fly Pupae as Food for Poultry[1]

C. C. CALVERT,[2] R. D. MARTIN,[2] and N. O. MORGAN[3]
Agricultural Research Service, USDA, Beltsville, Maryland 20705

1972

Biological Value of Rangeland Grasshoppers[1] as a Protein Concentrate[2]

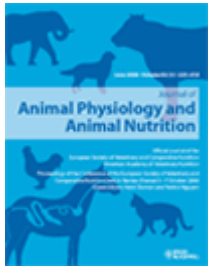
D. N. UECKERT, S. P. YANG, and R. C. ALBIN[3]
Texas Tech University, Lubbock, Texas 79409

DRIED *HERMETIA ILLUCENS* LARVAE MEAL AS A SUPPLEMENT FOR SWINE

G. L. Newton, C. V. Booram, R. W. Barker and O. M. Hale[1]

JOURNAL OF ANIMAL SCIENCE, Vol. 44, No. 3, 1977

Abdel Gawaad A.A & Brune H. (1979)
Insect Protein as a Possible Source of Protein to Poultry



"dimenticate"

Nuova attenzione

INSECTS to feed the world

PROteINSECT
INSECTS AS SUSTAINABLE SOURCES OF PROTEIN

PROteINSECT - Enabling the Exploitation of Insects as a Sustainable Source of Protein for Animal Feed and Human Nutrition

This initiative is co-financed by the EC under FP7.

2 miliardi di persone
2037 specie commestibili

FAO FORESTRY PAPER
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Edible insects

Future prospects for food and feed security

WAGENINGEN UR
For quality of life

FAO

Ottimo valore nutritivo

- tenore proteico elevato (fin al 70%)
- proteine altamente digeribili e di ottimo valore biologico
- aminoacidi essenziali
- ricchi in grassi (energia)
- fonte di fibra grazie (elevato contenuto in chitina)
- alto contenuto in vitamine e minerali

Do they eat insects?

YES, they do









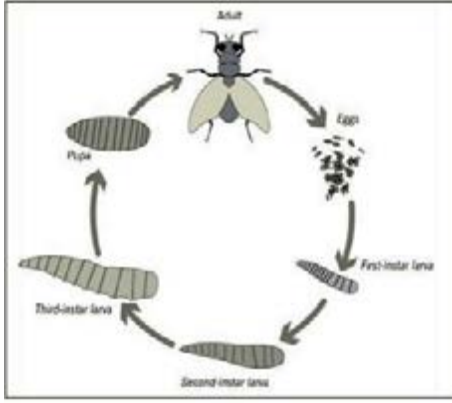
Insetti promettenti come FEED

Tenebrio molitor

- coleottero (Tenebrionidae)
- ospite indesiderato nell'industri agro alimentare
  - farine, crusca, pasta, …
- onnivoro: si alimenta di vari substrati (Ramos-Elorduy et al., 2002
- larva comunemente usata per alimentare uccelli, rettili e pesci di acquario
- valore nutrizionale:
  - ss: 40%
  - PG: 40-60% ss
  - EE: 25-45% ss
  - ceneri: < 5%
  - basso tenore in Ca (possibilità di modificare con substrato; Klasing et al., 2000)
- ciclo di vita variabile (T°) (40 – 90 sett; Makkar et al., 2014)
- da uova a larve mature: 8-10 settimane – peso medio: 0.14 g / larva



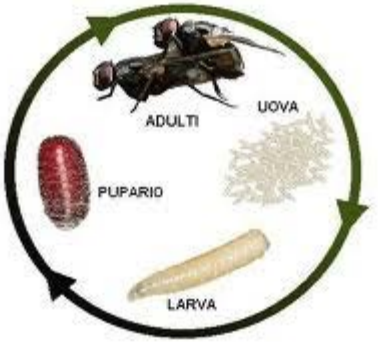

Insetti promettenti come FEED



Hermetia illucens

- dittero (Stratiomyidae)
- adulti: solo compito di riproduzione (importanza luce)
- prediligono il materiale organico (frutta, versura, letame, scarti vari…)
- larve: ruolo significativo in entomologia forense (Lord et al., 1994)
- larve migrano autonomamente al momento dell'impupamento
- valore nutrizionale:
  - ss: 55-65%
  - PG: 40-45%ss
  - EE: 15-50%
  - ricche di CA e P (≠ TM) (5 – 8% e 0,6 – 1,5%)
  - ceneri: 11-28%
- ciclo di vita variabile (6 – 30 settimane) (T°) (Makkar et al., 2014)
- da uova a larve matureminimo 14 gg (min) – peso medio: 0.2 g / larva

Insetti promettenti come FEED



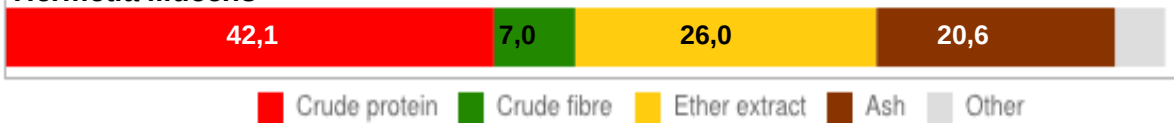
Musca domestica

- dittero (Muscidae)
- adulti: si alimentano (≠ *Hermetia*)
- noiosi per uomo
- portatori di agenti patogeni
- prediligono il materiale in decomposizione di qualsiasi origine (frutta, versura, letame, scarti vari…)
- valore nutrizionale larve:
  - SS: 40 – 50%
  - PG: 37,5 - 60%ss
  - EE: 9 – 25% ss
  - ceneri: 5 – 25%
  - CA: 0,3 – 0,8%
- ciclo di vita variabile (5 – 10 gg / 45-50 gg) (T° ottimale: 35°C) (Makkar et al., 2014)
- da uova a larve mature: 4 -13 giorni – peso medio: 0.02 g / larva

Composizione chimica insetti (%SS)

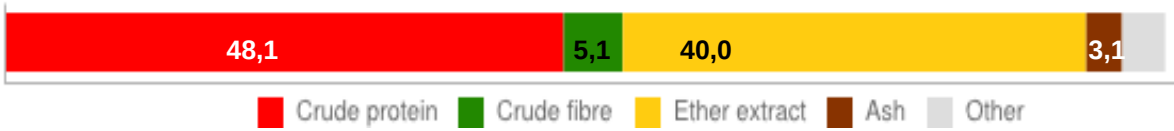
Feedipedia Animal Feed Resources Information System

Hermetia illucens



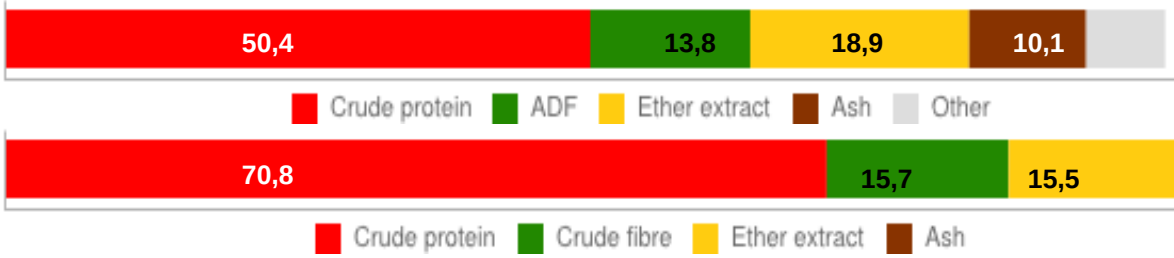
Larva

Tenebrio molitor



Larva

Musca domestica



Larva

Pupa

Bombix mori

Larva

http://www.feedipedia.org

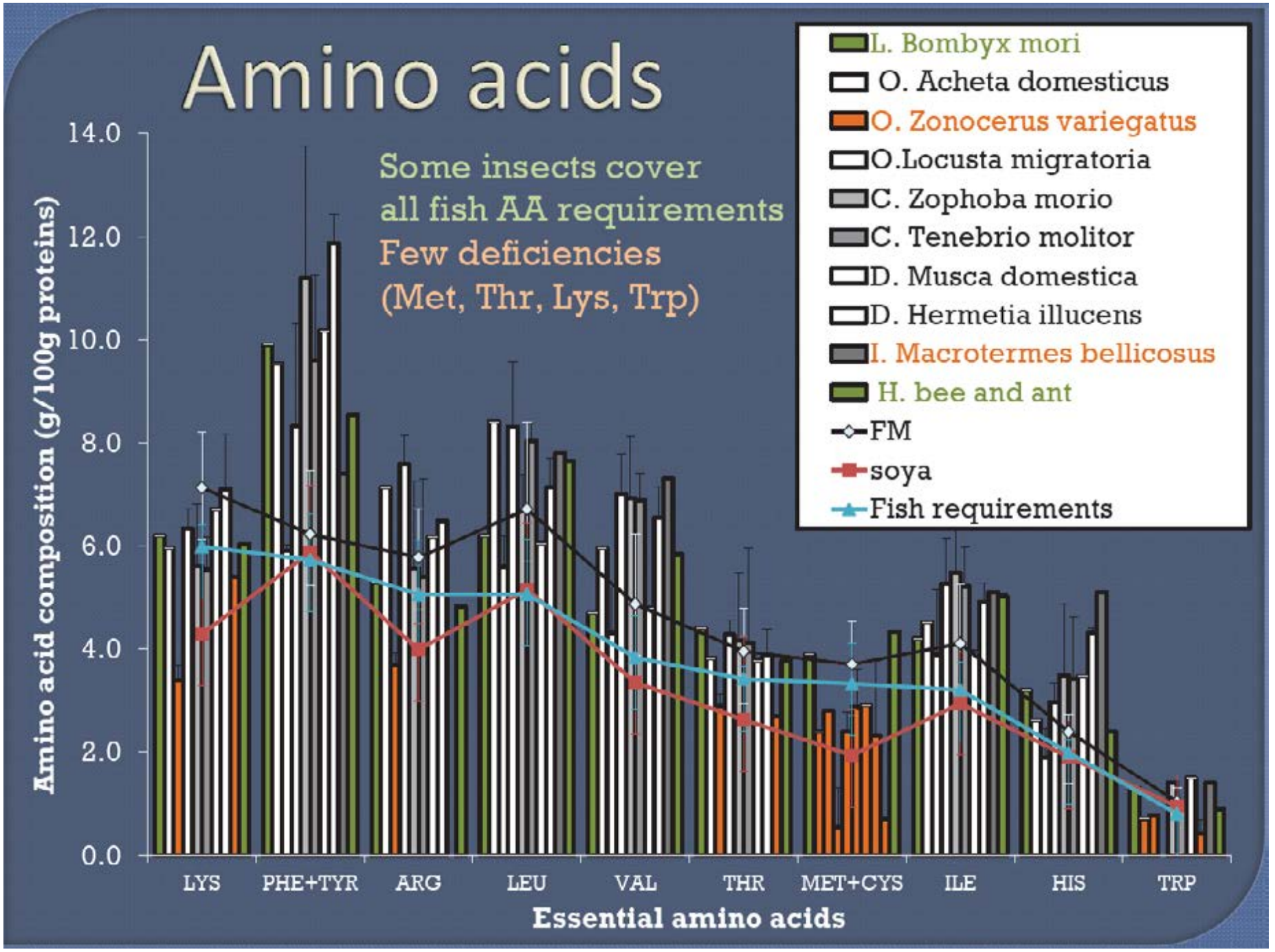
composizione chimica (%ss) insetti, FP e FS

Proximate analysis (% dry matter) of selected insects, fish meal and soybean meal.

Specie		ASH %	EE %	CP %	NFE %
Phyllognathus excavatus	PeA C	7.8 ± 0.2	15.9 ± 1.4	65.7 ± 1.3	10.6 ± 0.1
Rhynchophorus ferrugineus	RfL C	6.6 ± 0.6	11.8 ± 1.5	34.6 ± 0.3	47.0 ± 1.3
Tenebrio molitor	TmL C	3.5 ± 0.2	30.1 ± 0.7	58.4 ± 0.4	8.0 ± 0.2
Zophobas morio	ZmL C	2.5 ± 0.3	38.0 ± 0.3	53.5 ± 0.4	6.0 ± 1.1
Calliphora vicina	CvL D	8.0 ± 0.1	20.1 ± 0.7	48.3 ± 0.9	23.6 ± 0.1
Chrysomya megacephala	CmL D	7.2 ± 0.1	27.0 ± 3.2	61.8 ± 0.3	4.0 ± 3.4
Chrysomya megacephala	CmP D	6.1 ± 0.1	16.5 ± 0.0	46.8 ± 1.1	30.6 ± 1.1
Eristalis tenax	EtL D	13.9 ± 0.4	5.8 ± 0.6	40.9 ± 0.9	39.4 ± 1.1
Hermetia illucens	HiL D	9.3 ± 0.3	18.0 ± 1.6	36.2 ± 0.3	36.5 ± 1.0
Hermetia illucens	HiP D	19.7 ± 0.1	15.6 ± 0.1	40.7 ± 0.4	24.0 ± 0.7
Lucilia sericata	LsL D	4.9 ± 0.9	28.4 ± 1.5	53.5 ± 4.4	13.2 ± 4.6
Lucilia sericata	LsP D	4.9 ± 0.2	26.6 ± 1.0	59.0 ± 1.5	9.5 ± 0.1
Musca domestica	MdL D	6.5 ± 1.5	31.3 ± 1.6	46.9 ± 4.1	15.3 ± 4.0
Musca domestica	MdP D	8.4 ± 2.9	33.7 ± 0.7	40.1 ± 0.4	17.8 ± 0.3
Protophormia terraenovae	PtL D	3.9 ± 0.1	28.3 ± 0.6	46.3 ± 0.6	21.5 ± 0.1
Protophormia terraenovae	PtP D	8.8 ± 0.1	23.6 ± 0.3	56.0 ± 2.0	11.6 ± 2.2
Acheta domestica	AdA O	5.6 ± 0.0	15.9 ± 0.2	73.1 ± 3.3	5.4 ± 0.3
Anacridium aegyptium	AaA O	3.7 ± 0.1	17.6 ± 0.2	66.0 ± 5.0	12.7 ± 4.8
Gryllus assimilis	GaA O	4.8 ± 0.1	23.2 ± 0.6	64.9 ± 0.5	7.0 ± 0.3
Heteracris littoralis	HlA O	5.1 ± 0.1	8.8 ± 0.0	74.4 ± 1.0	11.7 ± 1.0
Locusta migratoria	LmA O	4.0 ± 0.0	29.9 ± 0.5	58.5 ± 0.5	7.6 ± 0.1
Fish meal	FM	18.0 ± 0.2	8.2 ± 0.0	73.0 ± 0.8	0.8 ± 0.7
Soybean meal	SM	7.8 ± 0.0	3.0 ± 0.0	50.4 ± 0.2	38.8 ± 0.3

Values are means ± SD of triplicate determinations. EE—Crude fat. CP—Crude protein. NFE—Nitrogen-free extract.

Barroso et al., 2014



Henry et al., 2014

Composizione AG FP- FS *vs* insetti

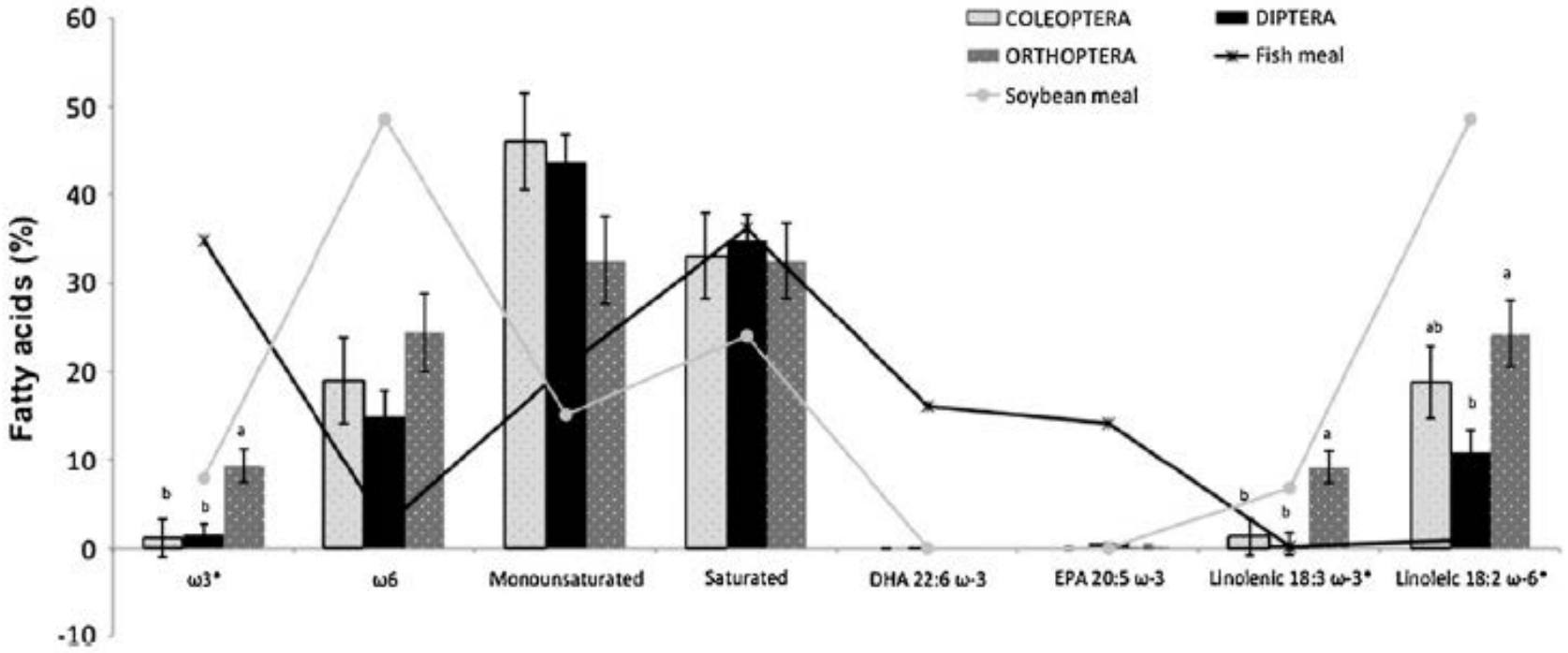
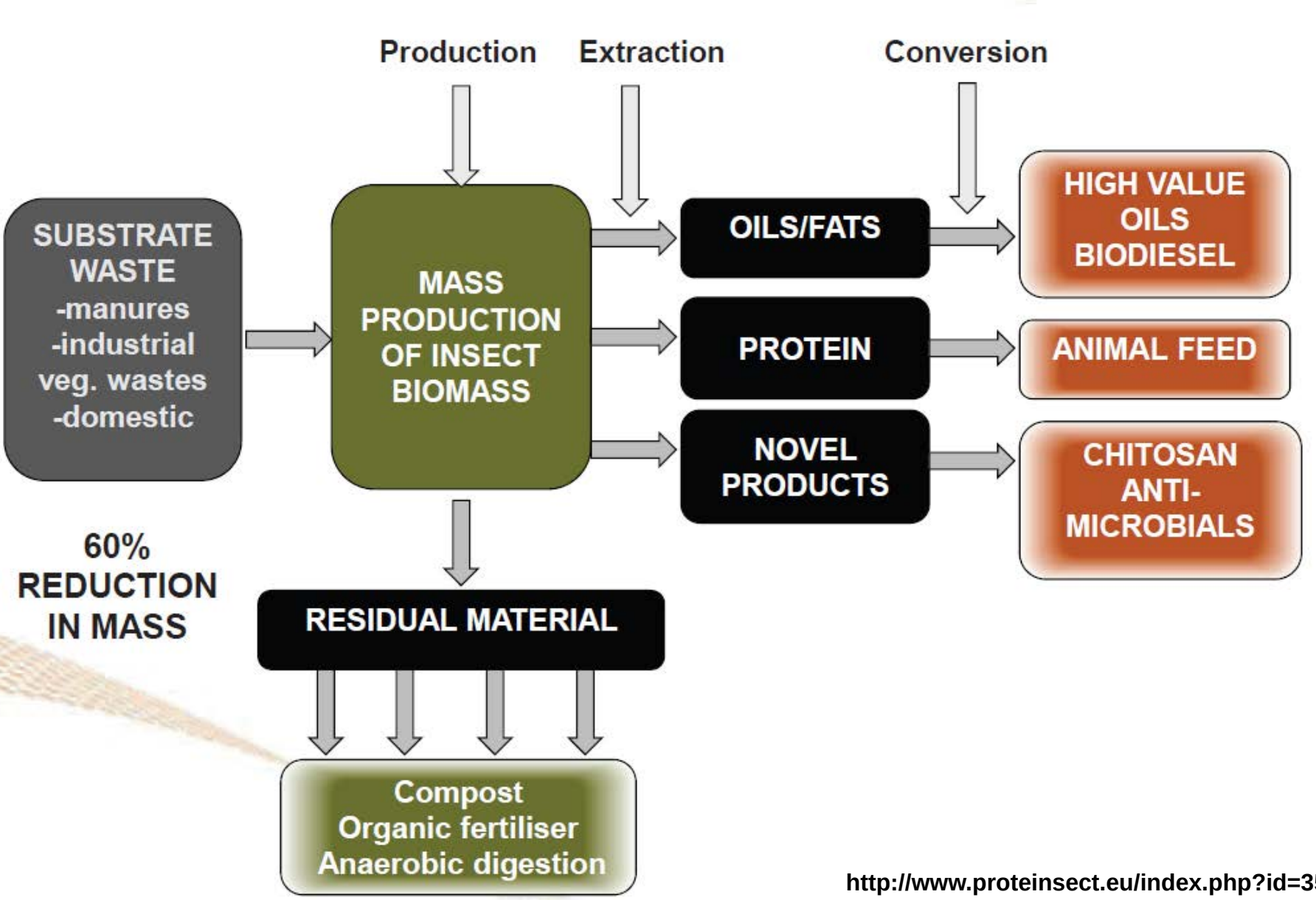


Fig. 3. Differences between insect orders studied in the percentage of fat acids (using fish meal and soybean reference).

- AGPI ω6: FS (50%) > Insetti (fino a 30%) > FP (2,5%)
- Insetti: minore contenuto in AGPI ω3 *vs* FP
- C18:2 ω6: FS > Insetti > FP
- C18:3 ω3: FS ≥ Insetti > FP
- EPA e DHA (insetti terrestri): assenti (grande limite!) (AGE x pesci marini)
  - possibilità di modulare la composizione AG via alimentazione
- Influenza su qualità dei prodotti!

Barroso et al., 2014

Produzione di massa



http://www.proteinsect.eu/index.php?id=35

Produttori

fondata nel 2009

AgriProtein technologies

2015 (/j): 7 ton di MagMeal™
3 ton di MagOil™
20 ton di MagSoil™

Substrati: “clean” organics, vegetable food processing & restaurant waste

www.agriprotein.com

AgriProtein technologies

Sustainable Feed Ingredients

“If a chicken was meant to eat fish it would be called a seagull”

Jason Drew - The Protein Crunch

Method of Preparation:

Our larvae are washed and then dried under strict environmental conditions at a very gentle heat to yield the highest quality protein. The protein contents of the final product are higher than whole dreid larvae and have a fat content below 12%.

Guaranteed Analysis:

Crude protein (min)	500 g/kg
Moisture (max)	100 g/kg
Crude fiber (max)	130 g/kg
Crude Fat (max)	100 g/kg
Calcium (max)	5 g/kg
Phosphorus (max)	30 g/kg

MagMeal™

Description:

MagMeal™ is our core product consisting of dried defatted larvae that is ground into a high protein larvae meal.

Appearance:

Dark rich texture with a slightly nutty flavour. Product can be supplied either crushed or milled for blending into animal feeds.

Uses:

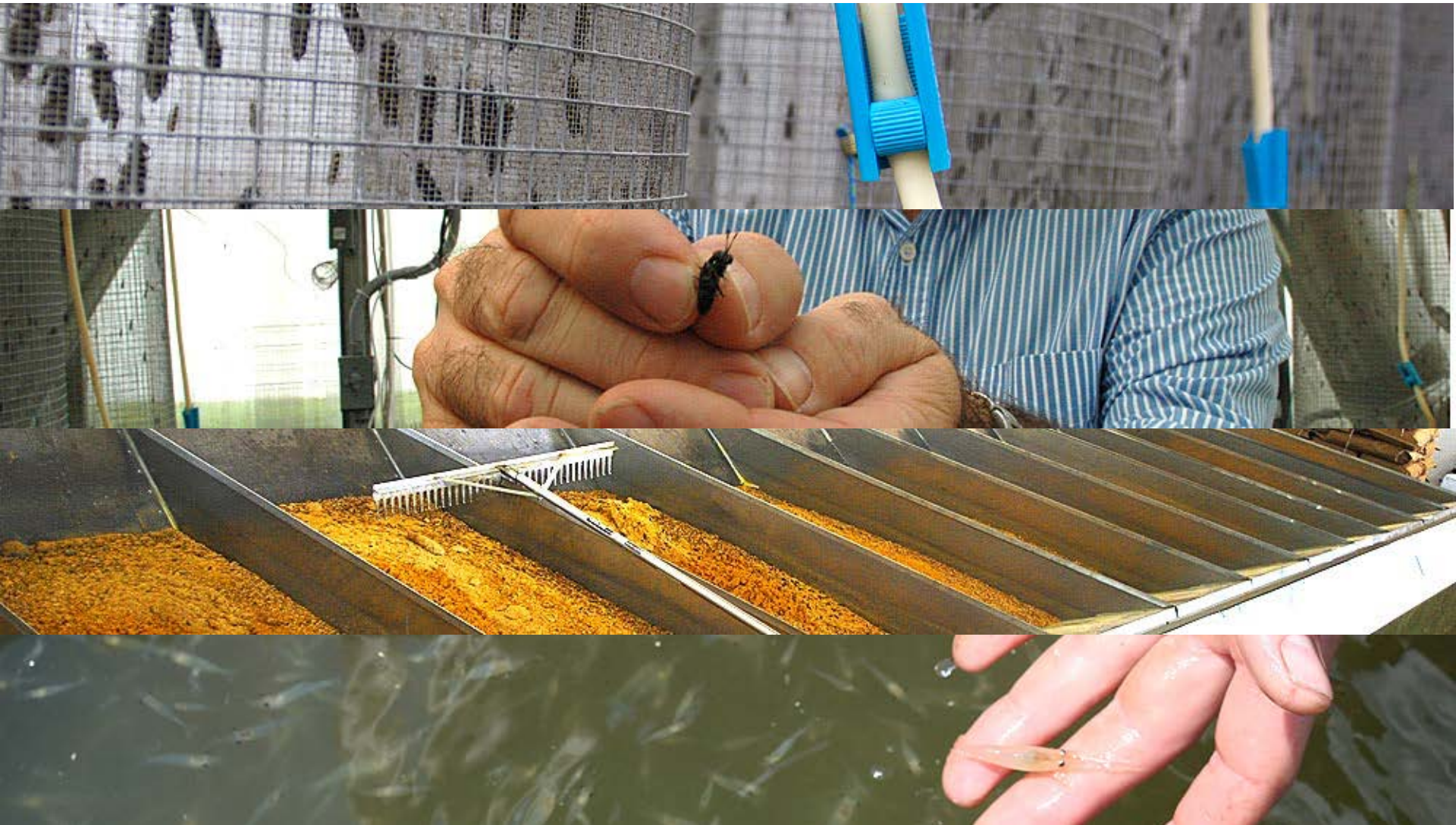
MagMeal™ can be blended into a variety of animal feeds and used just like any other protein such as fishmeal its nearest nutritional equivalent. It is specifically useful for the feeding of monogastric animals including chickens, pigs and fish

ENVIROFLIGHT

USA

fondata nel 2009

EnviroFlight, LLC focus is on producing environmentally sustainable plant and animal feeds by processing waste distillers grains using black soldier fly larvae



Black soldier fly. A, Adult female. B, Larva. C, Puparium.

Substrates: traceable organics (grocery stores, food processors, stale dated includes fruits, vegetables, bread, fish & seafood)

Enterra

Renewable Food™
For Animals and Plants



Enterra Meal Product (20 kg bags)

Enterra Feed produces sustainable ingredients for food production, including high quality protein and fatty acids that are used in animal feed, and an organic natural fertilizer used for soil conditioning.

Our unique process deploys the larvae of a common beneficial insect, the Black Soldier Fly, grown in a fully controlled environment using a fixed feedstock recipe sourced from clean, traceable streams of pre-consumer fruits, vegetables, fish and grains.

Enterra provides:

- high-quality feed products with a consistent nutrient profile
- guaranteed quantities, available through all seasons
- predictable, stable prices

Enterra Feed Corporation
134—887 Great Northern Way
Vancouver, British Columbia
604.888.4327
info@enterrafeed.com

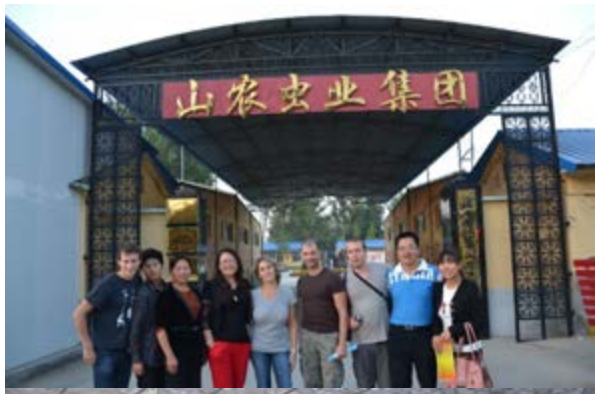
Enterra Meal™

Product Specifications

Description:	A dry, powder product derived from larvae of the Black Soldier Fly (*Hermetia illucens*).
Intended use:	A source of crude protein and fat for use as a feed ingredient in aquaculture, poultry feed, and other animal feed.
Chemical Analysis:	Protein: 60% Fat: 15 % Ash: 10 % Carbohydrates: 15% Energy: 1,800 to 2,200 kJ/100g
Physical Standards:	Colour: Light to tan Texture: Free flowing powder Odour: No foreign odours Moisture: 8-10%
Storage:	The product is to be stored in a cool dry area.

www.enterrafeed.com

Gaobeidian Shannong Biology CO., LTD (Cina)



Produttori EU

ipiff

International Producers of Insects for Feed and Food

AgriProtein technologies

bioflytech

entomos

Hermetia

KOPPERT BIOLOGICAL SYSTEMS

NGN new generation nutrition

Protix Biosystems BV

Ynsect

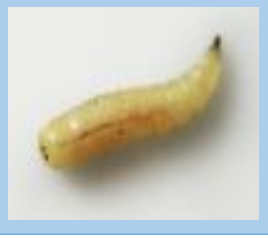
SUBSTRATI EU

Reg. 68/2013 - Reg. 999/2001 – Reg EC 56/2013 – Reg EC 1069/2009 – Reg EC 767/2009

prodotti di origine vegetale
ex-prodotti (incl. prodotti lattiero-caseari e uova)



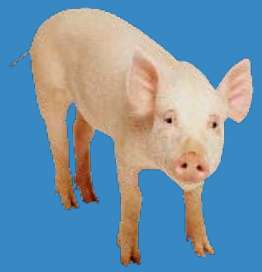


ANIMALI ALLEVATI

POTENZIALI DESTINATARI



Protix Biosystems BV

Re-feeding the planet

http://www.protix.eu/

Ynsect

Ynsect is a biotech company. We design, build, and operate insect production and processing facilities, to create high-value products for several applications.

Our first lead product is a Protein-Rich Insect Material (PRIM). This product is aimed at livestock nutrition, and especially aquaculture. Not only is our product composed of high-quality proteins with high digestibility, but it also has very interesting bioactive functions.

Products

The main nutritional product developed by Ynsect is a Protein Rich Insect Material obtained from insect larvae. It is a mix of high-quality proteins, and bioactive molecules to improve fish growth and survivability. Our product also have very interesting nutritive properties, with a high digestibility ratio.
Our range of products is actively growing. Due to the European regulatory framework, we exclusively focus on animal feed.

http://www.ynsect.com

Hermetia

Insektenproteine auf der Basis von Fliegenlarven sind hochproteinreich und erfüllen die ernährungsphysiologischen Ansprüche karnivorer (räuberischer) Fischarten, wie sie die meisten der geschätzten Speisefische (Lachse, Steinbutt, Forellen, Grouper, Snapper, Wolfsbarsch, Dorade, Adlerfisch, Kabeljau etc.) darstellen. Auch für die Geflügelzucht und die Schweinemast sind Insektenproteine sehr gut geeignet. Die stoffwechselphysiologische Eignung eines solchen Proteins für Geflügel und Schweine steht außer Frage. Auch für Vögel, Reptilien, Hunde und Katzen sind diese Eiweiße, die reich an essentiellen Aminosäuren sind, bestens geeignet. Somit stellt ein Futtermittel auf der Basis von Insektenlarven eine geradezu optimale Alternative zum Fischmehl dar.

Adresse: ***An der Birkenpfuhlheide 1015837 Baruth / Mark+49 (0) 33704 675 50***
info@hermetia.de

http://www.hermetia.de/

addEnto
Enjoy the food revolution

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INSECTA

MICROVITA
2050

UNCONVENTIONAL Food
NEW IDEAS FOR A BETTER WORLD

Stratio meal
55-65% PG
10-15% EE

DIPTERA

FRANCO

HVAC technologies

Larvae production

DANISH TECHNOLOGICAL INSTITUTE

Poultry manure: 80 kg

+

Fly eggs: 1 mio (100 mL)

+

Water: 20 L

3-4 days
@ 25-40 °C

Theoretic outcome:
10 gram larvae pr.
hen pr. day

Compost: 50 kg

+

Larvae: 8 kg

Black Soldier Fly larvae production

bioflytech

Alicante, Spain

100 Kg brewery waste

0,4 kg seed larvae

Bio digester

10 days
25ºC

33 kg fertilizer

33 kg larval biomass

=

12 kg fly meal

Black Soldier Fly larvae production

MILLIBETER

www.millibeter.be
Belgium

Supermarket waste
1 ton fresh vegetables
(13 % Dry Matter)

+

1 Million BSF eggs

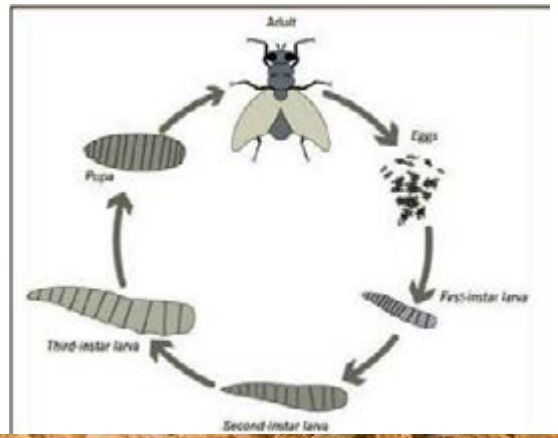
17 days @ 25°C

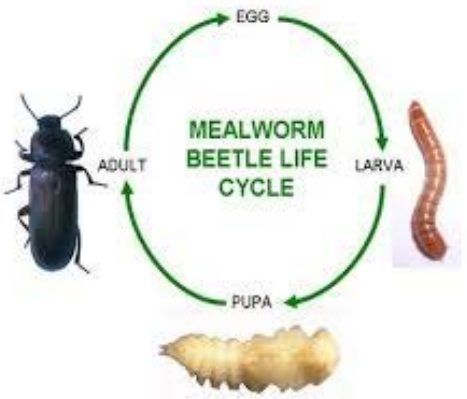
Frass
100 kg fresh
(70% DM)

Larvae
160 kg fresh
(~40% DM)

54 kg dry

- Protein (27 kg)
- Lipids (21 kg)
- Chitosan (5 kg)





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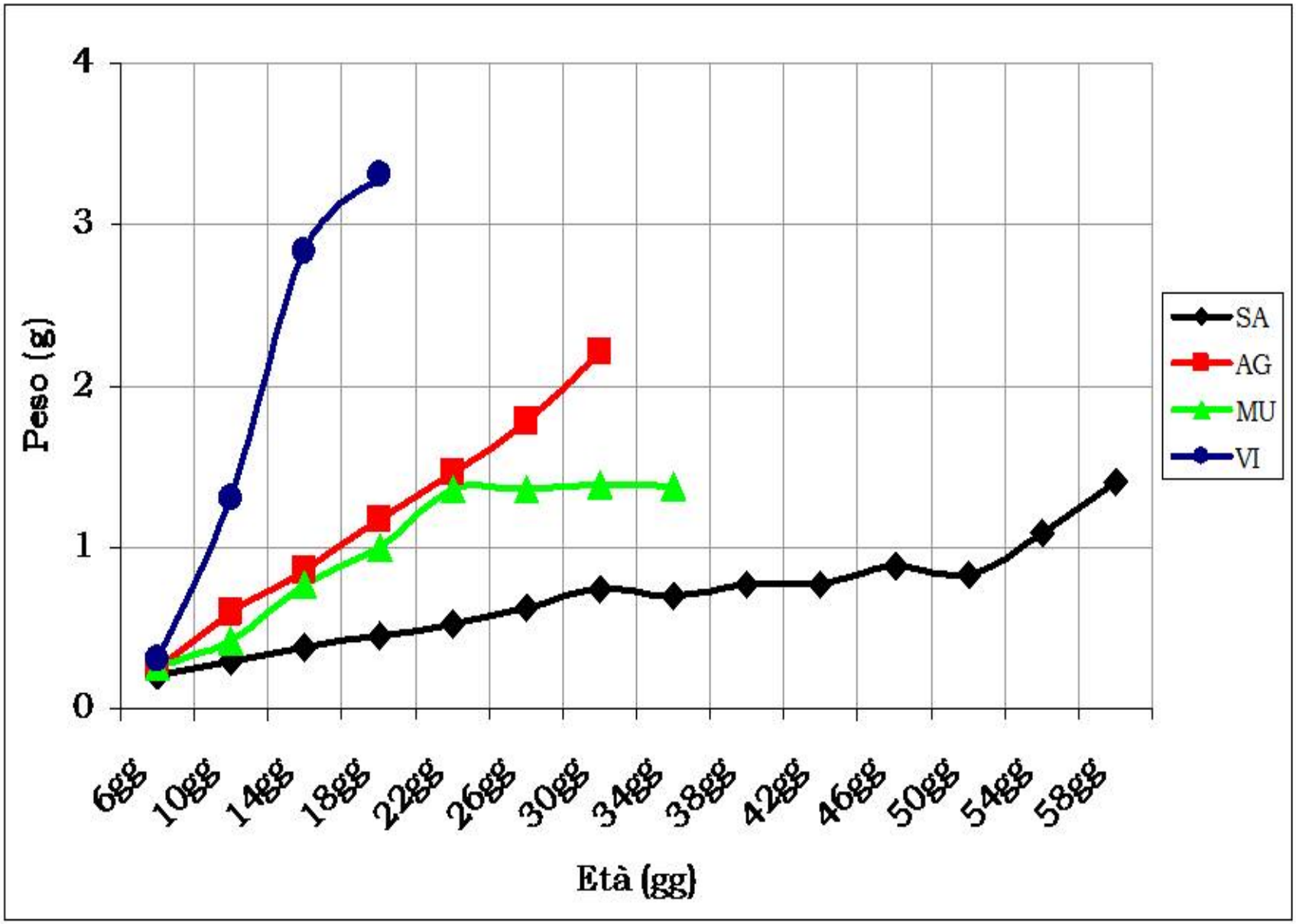
Research on insects

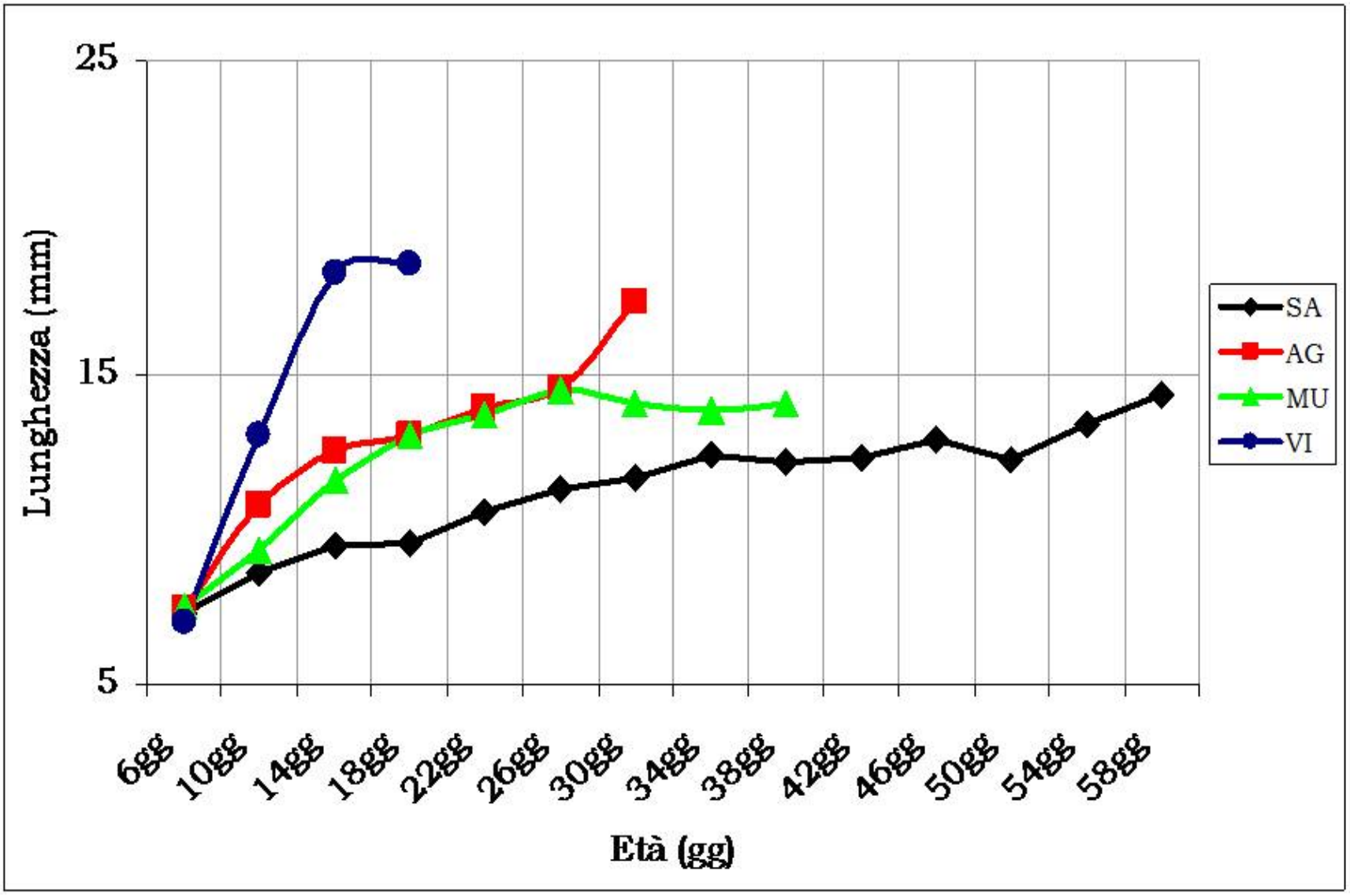
HI: accrescimento su substrati diversi


VI 2

Accrescimento larve HI: relazione peso (g) – età delle larve (giorni)



Accrescimento larve HI: relazione lunghezza (mm) – età delle larve (giorni)



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UNICAM
Università di Camerino
1336