



**LIÈGE université**  
**Gembloux**  
**Agro-Bio Tech**

**FÉDÉRATION**  
**FCCWB**



Pr Dr ir Frédéric FRANCIS

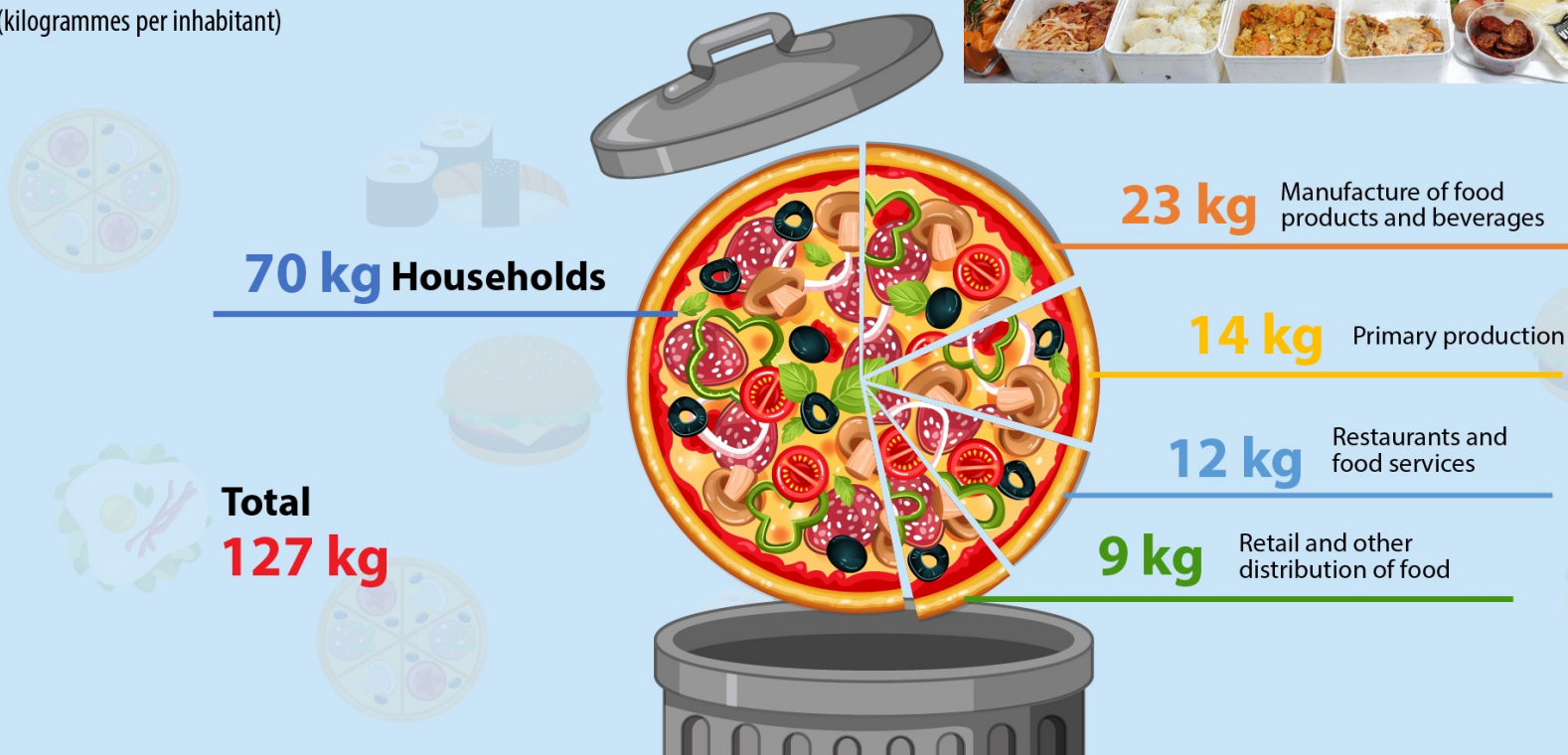
# **Gaspillage alimentaire et valorisation des déchets dans les cuisines de collectivités**

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# Gaspillage alimentaire

## Food waste in the EU by main economic sectors, 2020

(kilogrammes per inhabitant)

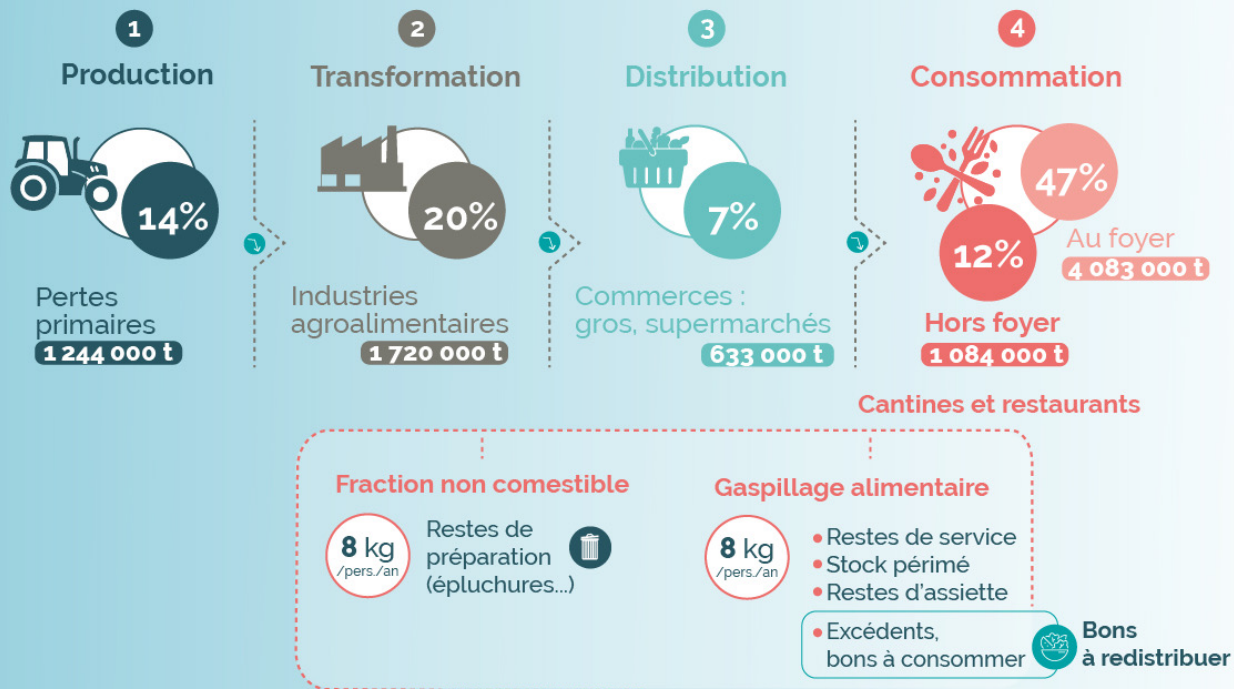
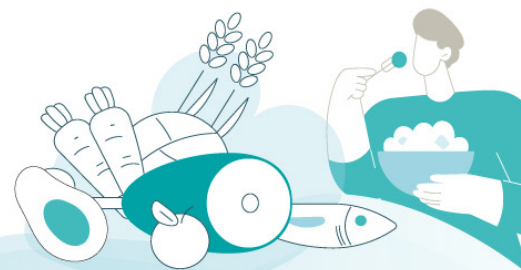


Belgium, Latvia, Malta and Romania: data not available. Czechia, Lithuania, Portugal and Sweden: data are estimated. Cyprus: definition differs (see metadata). As a result, the EU aggregates are estimated.

Combien et  
quand réduire le  
gaspillage  
alimentaire ?

# Gaspillage alimentaire

En France



# Gaspillage alimentaire

## TYPES D'ALIMENTS JETÉS

Base : Qui ont consommé le produit

Ont jeté

■ Au moins une fois par jour

■ Au moins une fois dans la semaine

2022:

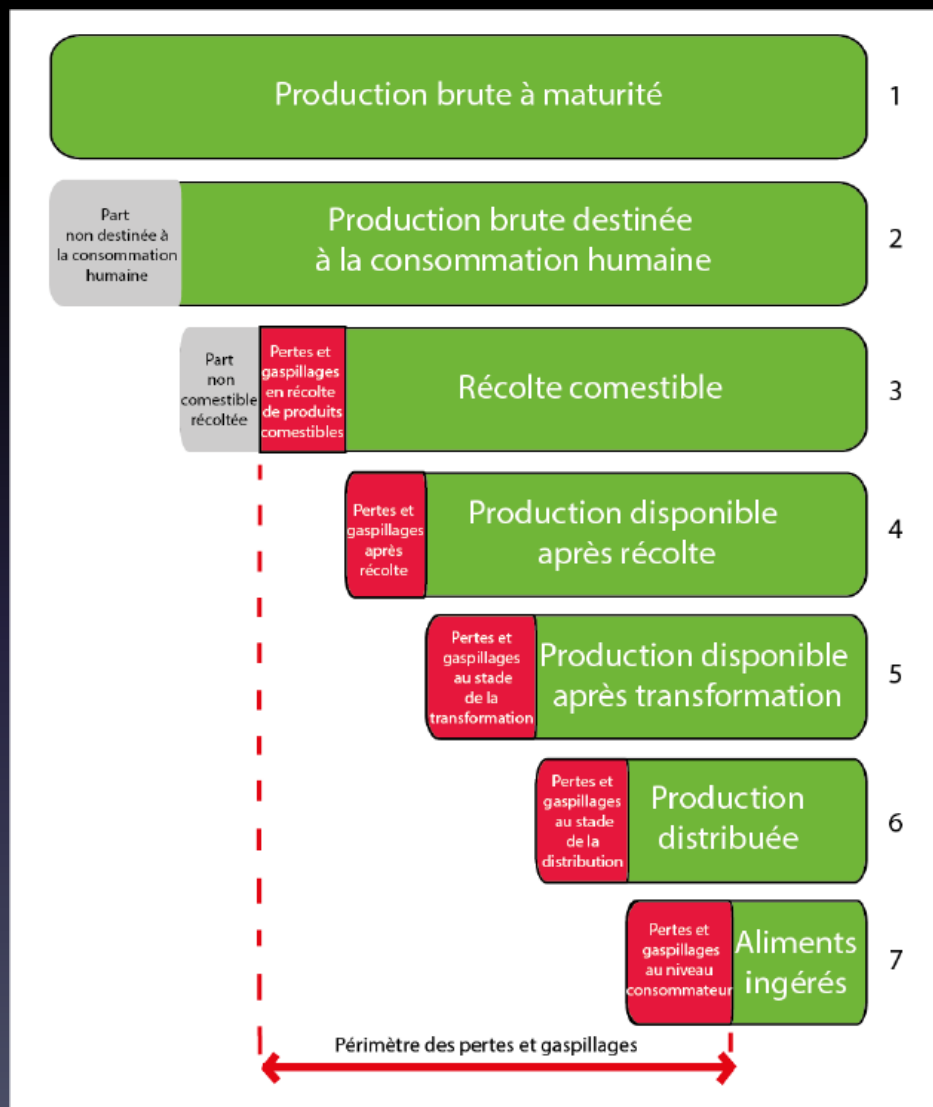
2018:

	2022:		2018:
Restes de repas	12	37	49
Pains et pâtisseries	12	29	41
Légumes	12	23	35
Fruits	10	24	34
Sauces, huiles, matières grasses	12	20	32
Viandes et charcuteries	9	21	31
Pommes de terre	9	20	28
Produits laitiers	11	17	28
Plats préparés conditionnés	7	16	24
Produits secs	7	15	21
Œufs	6	15	20
Poissons et autres produits de la mer	5	15	20
Autres aliments	8	21	30

Coût gaspillage alimentaire : **entre 250 et 450 € par personne et par an**

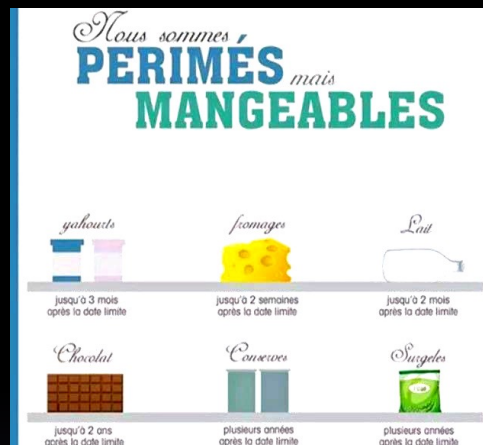
Réduction en Europe du gaspillage alimentaire de **50% d'ici 2030**

# Gaspillage alimentaire



Selon FAO, belges 2<sup>ème</sup> plus gros gaspilleurs en Europe avec **345 kg de nourriture jetés par an et par personne**

1/3 budget shopping finit à la poubelle



***DLC ou DDM « A consommer jusqu'au" ou "à consommer de préférence jusqu'au » ?***

Date limite de consommation (DLC) ou date de durabilité minimale (DDM). Produits frais au frigo ou secs et/ou en conserve ?

*Malgré DDM dépassée, consommation en toute sécurité*

**Que faire si la DLC approche? le congélateur**

Deux types  
d'aliments  
gaspillés : les  
périmés et  
les préparés  
mais non  
consommés

## Le gaspillage alimentaire dans la restauration collective

### Quantités jetées

EN MOYENNE PAR CONVIVE ET PAR REPAS

**115g**

DANS LES ÉTABLISSEMENTS  
SCOLAIRES  
(de la maternelle au lycée)

**100g**

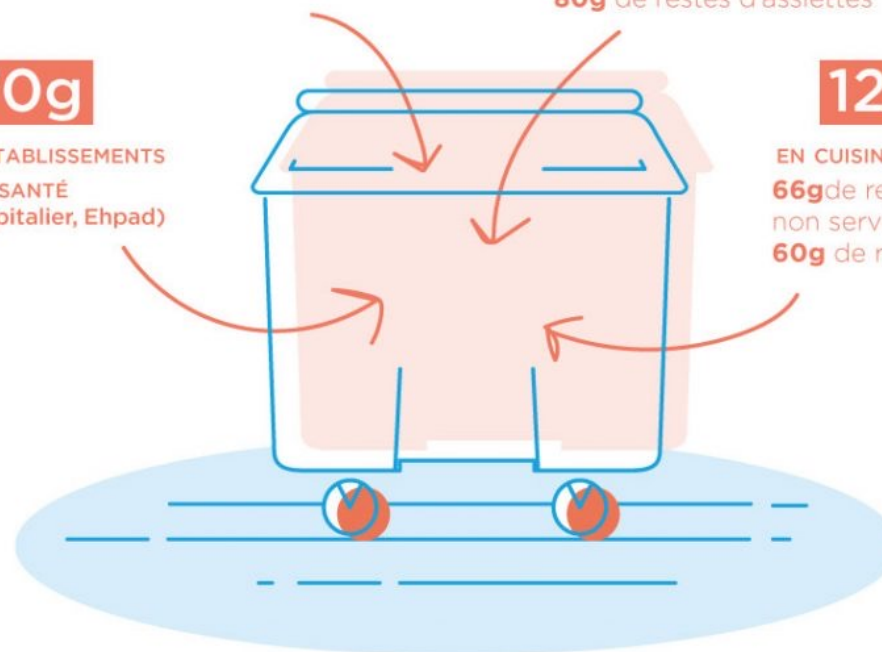
EN CUISINE AUTOGÉRÉE  
**20g** de restes préparés  
non servis  
**80g** de restes d'assiettes

**170g**

DANS LES ÉTABLISSEMENTS  
DE SANTÉ  
(Centre hospitalier, Ehpad)

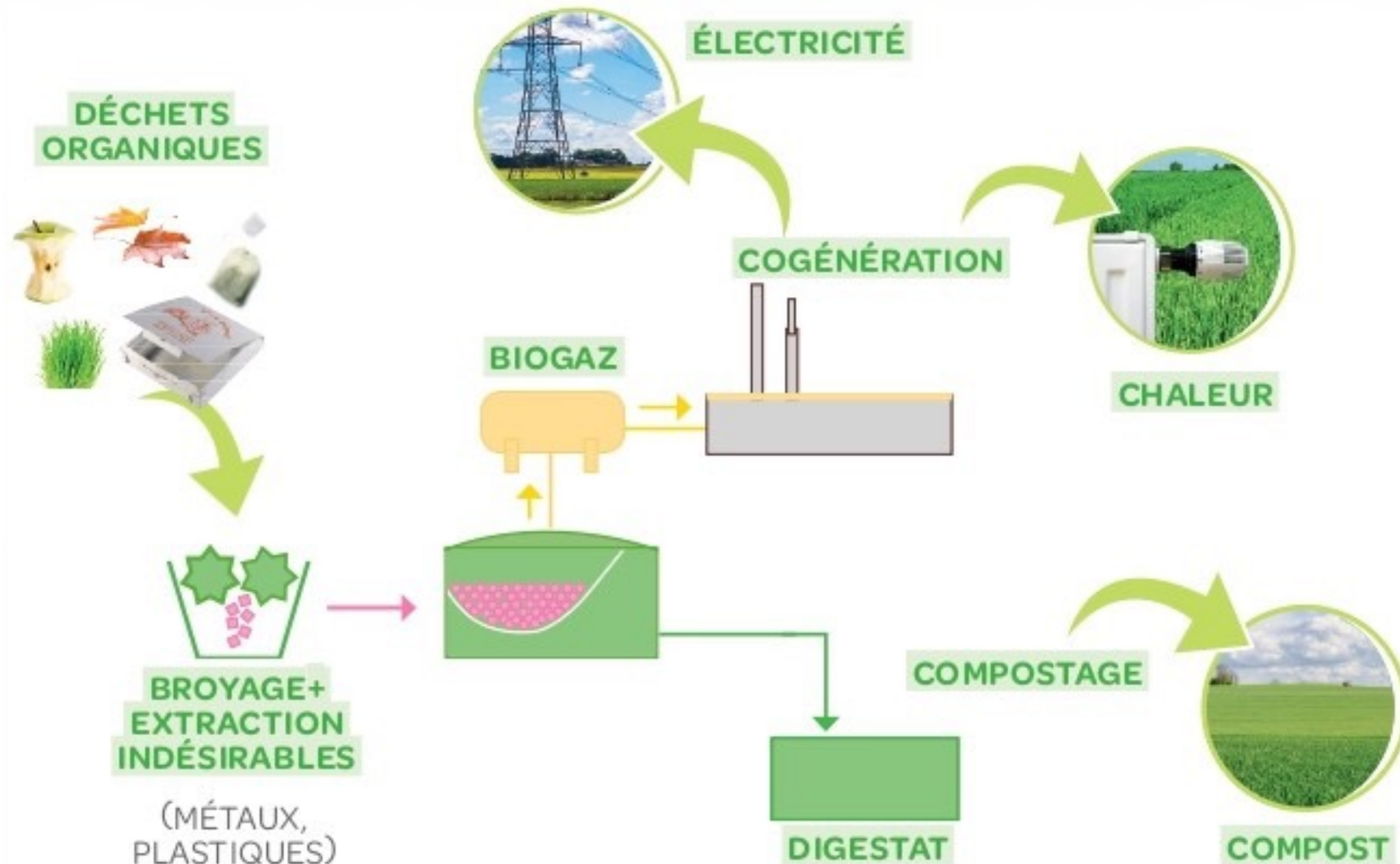
**126g**

EN CUISINE CONCÉDÉE  
**66g** de restes préparés  
non servis  
**60g** de restes d'assiettes



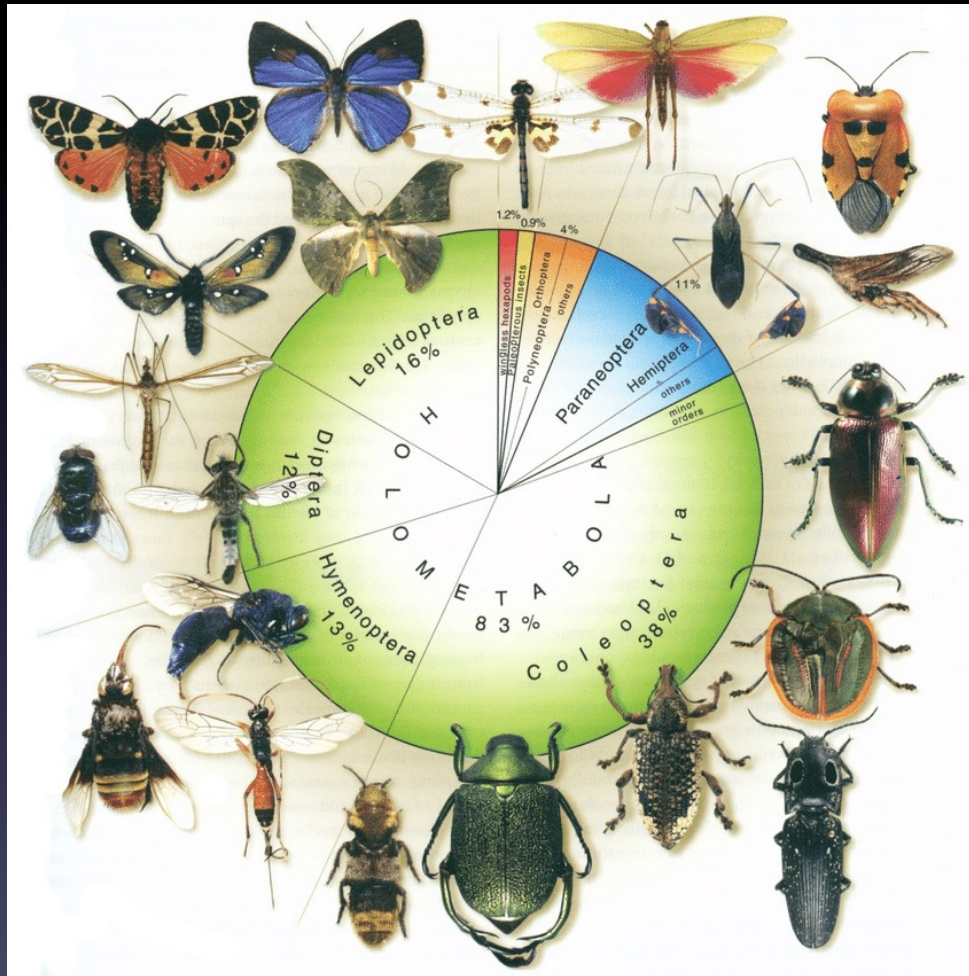
Source : ADEME

# Valorisation des déchets – entomo-compostage





# Diversité des insectes et comportements alimentaires



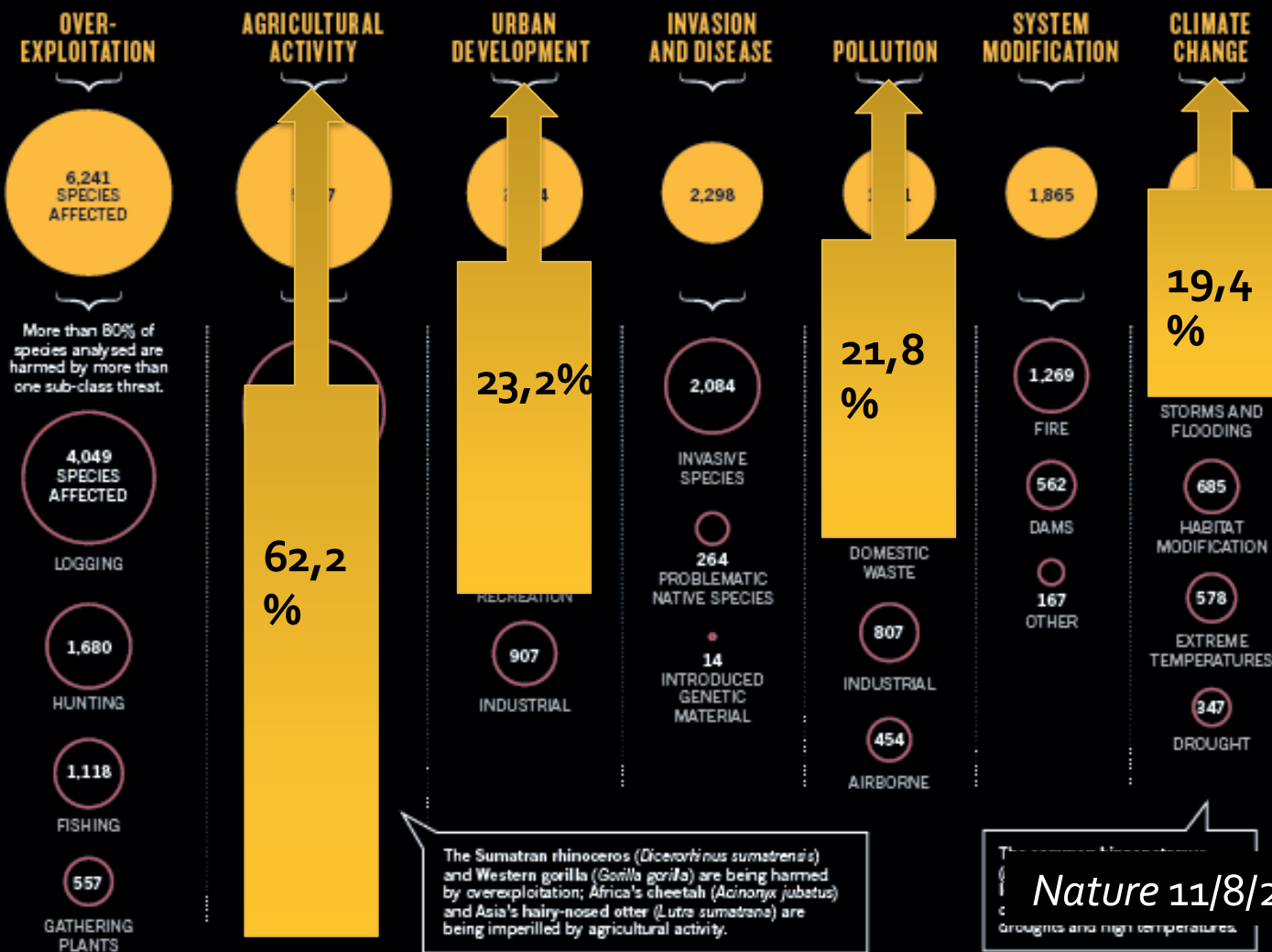
# The ravages of guns, nets and bulldozers

The threats of old are still the dominant drivers of current species loss, indicates an analysis of IUCN Red List data by **Sean Maxwell** and colleagues.



# BIG KILLERS

Overexploitation and agriculture are the most prevalent threats facing the 8,688 threatened or near-threatened species from comprehensively assessed species groups on the IUCN Red List.

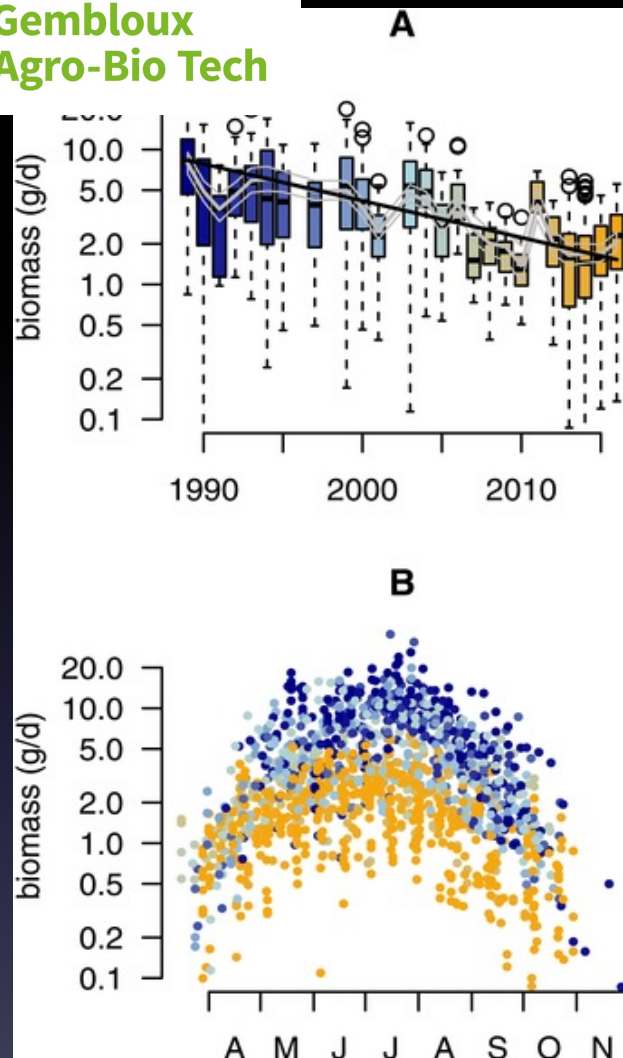




## More than 75 percent decline over 27 years in total flying insect biomass in protected areas

Hallmann CA, Sorg M, Jongejans E, Siepel H, Hofland N, et al. (2017) PLOS ONE 12(10): e0185809.  
<https://doi.org/10.1371/journal.pone.0185809>

Fig 1. Examples of operating malaise traps in protected areas in western Germany, in habitat cluster 1 (A) and cluster 2 (B)



**Fig 2. Temporal distribution of insect biomass.**

(A) Boxplots depict the distribution of insect biomass (gram per day) pooled over all traps and catches in each year ( $n = 1503$ ). Based on our final model, the grey line depicts the fitted mean (+95% posterior credible intervals) taking into account weather, landscape and habitat effects. The black line depicts the mean estimated trend as estimated with our basic model. (B) Seasonal distribution of insect biomass showing that highest insect biomass catches in mid summer show most severe declines. Color gradient in both panels range from 1989 (blue) to 2016 (orange).

Hallmann CA, Sorg M, Jongejans E, Siepel H, Hofland N, et al. (2017) More than 75 percent decline over 27 years in total flying insect biomass in protected areas. PLOS ONE 12(10): e0185809. <https://doi.org/10.1371/journal.pone.0185809>

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0185809>



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## Review

# Worldwide decline of the entomofauna: A review of its drivers

Francisco Sánchez-Bayo<sup>a,\*</sup>, Kris A.G. Wyckhuys<sup>b,c,d</sup>

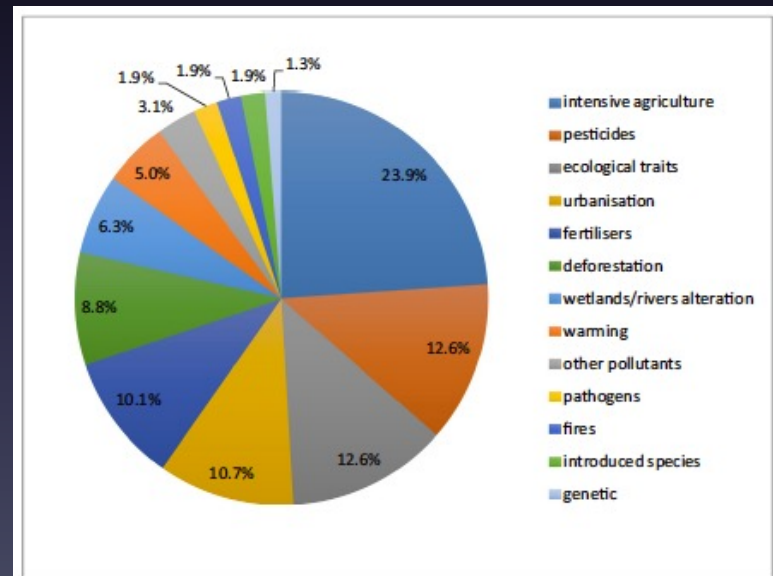
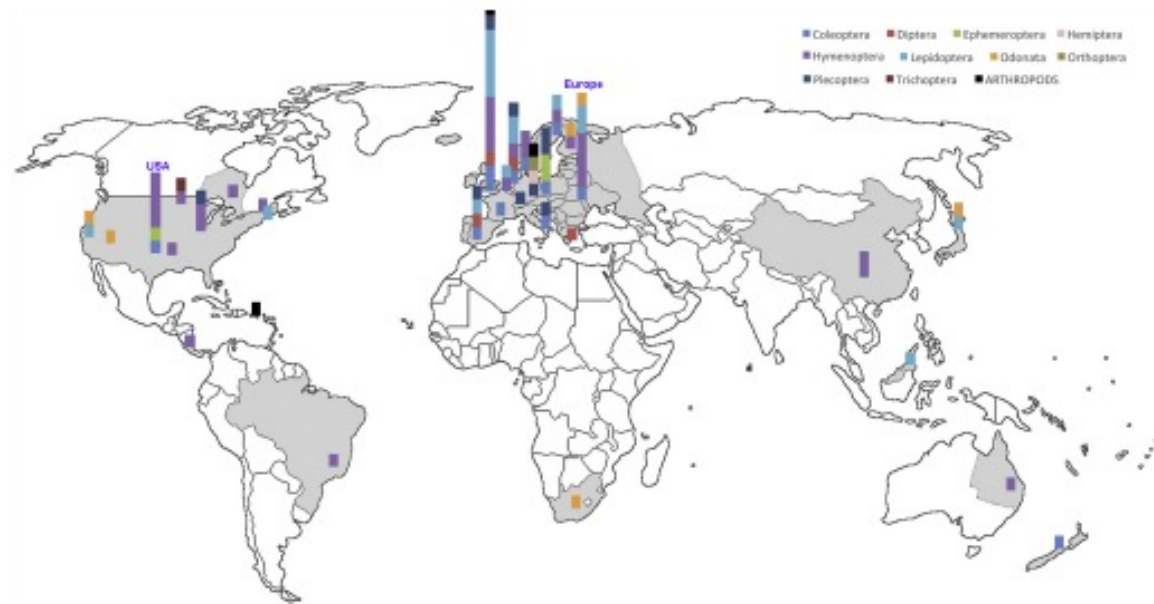


Fig. 6. Main factors associated with insect declines – see also Fig. 5.

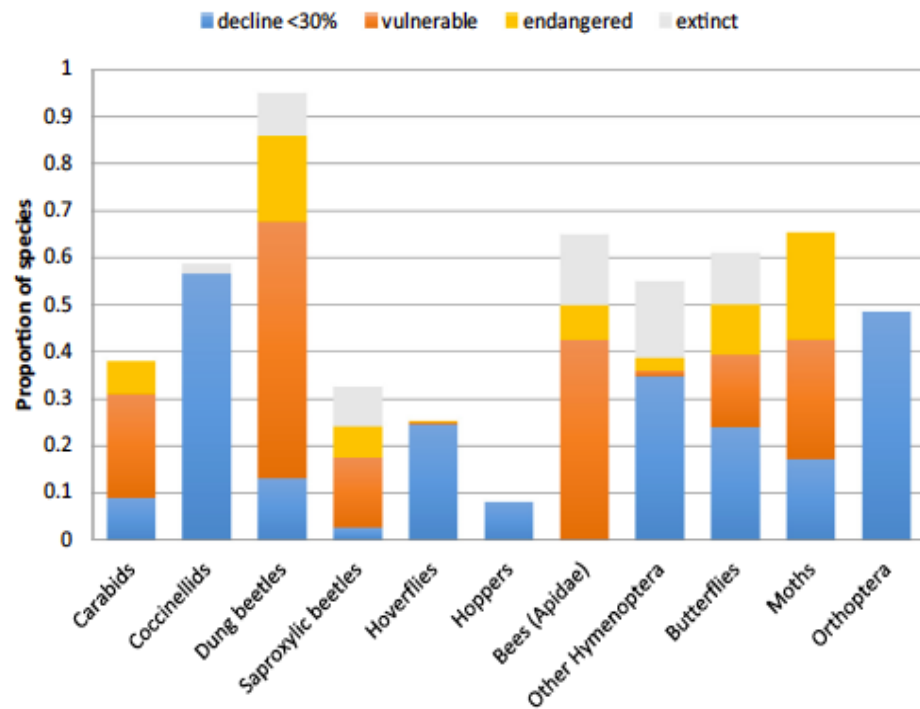


Review

## Worldwide decline of the entomofauna: A review of its drivers

Francisco Sánchez-Bayo<sup>a,\*</sup>, Kris A.G. Wyckhuys<sup>b,c,d</sup>

### A) Terrestrial taxa



Taxon	Declining (%)	Threatened (%)
A) Insects	41	31
Coleoptera	49	34
Diptera (Syrphidae)	25	0.7 <sup>§</sup>
Ephemeroptera	37	27
Hemiptera (Auchenorrhyncha)	8 <sup>§</sup>	n.a.
Hymenoptera	46	44
Lepidoptera	53	34
Odonata	37	13
Orthoptera	49	n.a.
Plecoptera	35	29
Trichoptera	68	63
Terrestrial	38	28
Aquatic	44	33
B) Vertebrates	22	18
Amphibians	23	23
Birds	26	13
Mammals (land)	15	15
Mammals (Chiroptera)	27	n.a.
Reptiles	19	19

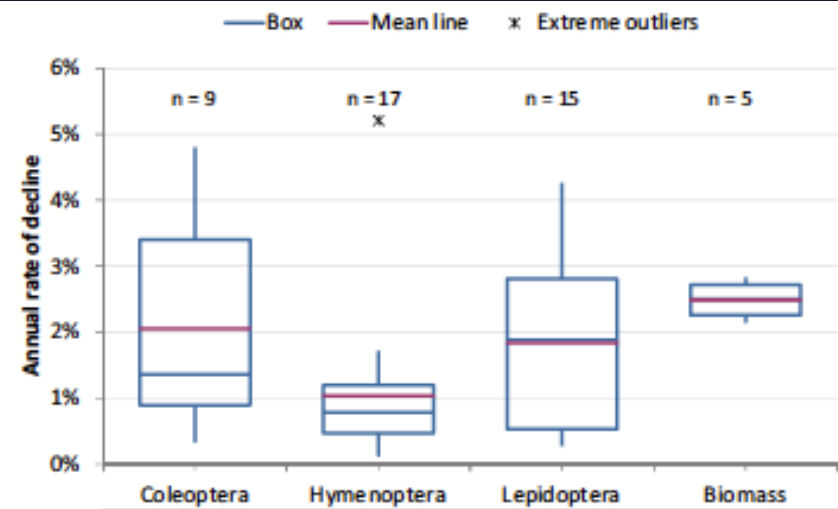


Fig. 2. Annual rate of decline of the three major taxa studied (percentage of species declining per year) and of insect biomass.

**AVEC LES ABEILLES**



**SANS LES ABEILLES**



**AVEC ABEILLES**



**SANS ABEILLES**



# Y a-t-il des alternatives au steak



Tofu (soja), de seitan (gluten de blé), de tempeh (soja fermenté), de Quorn



Micro-algues (spiruline, Chlorella)

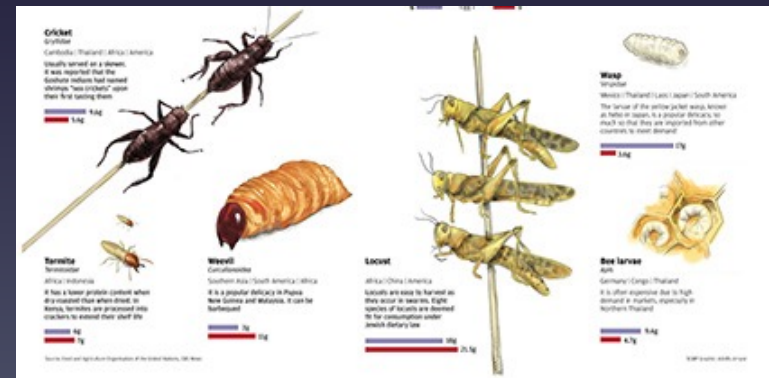
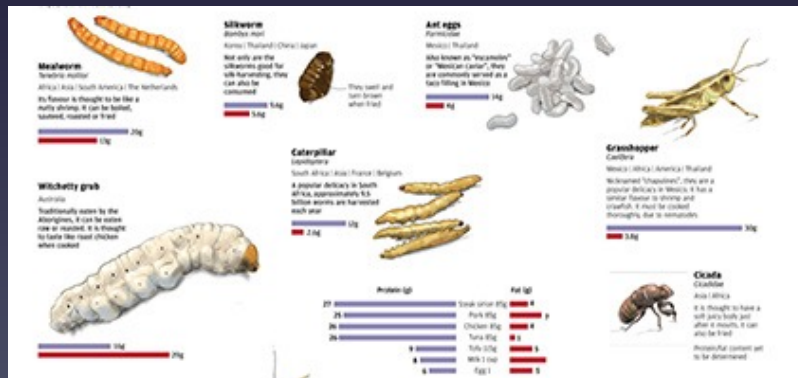


Mark Post  
« Mister Frankfurter » et « Frankensteak »

# Entomophobie - entomophagie

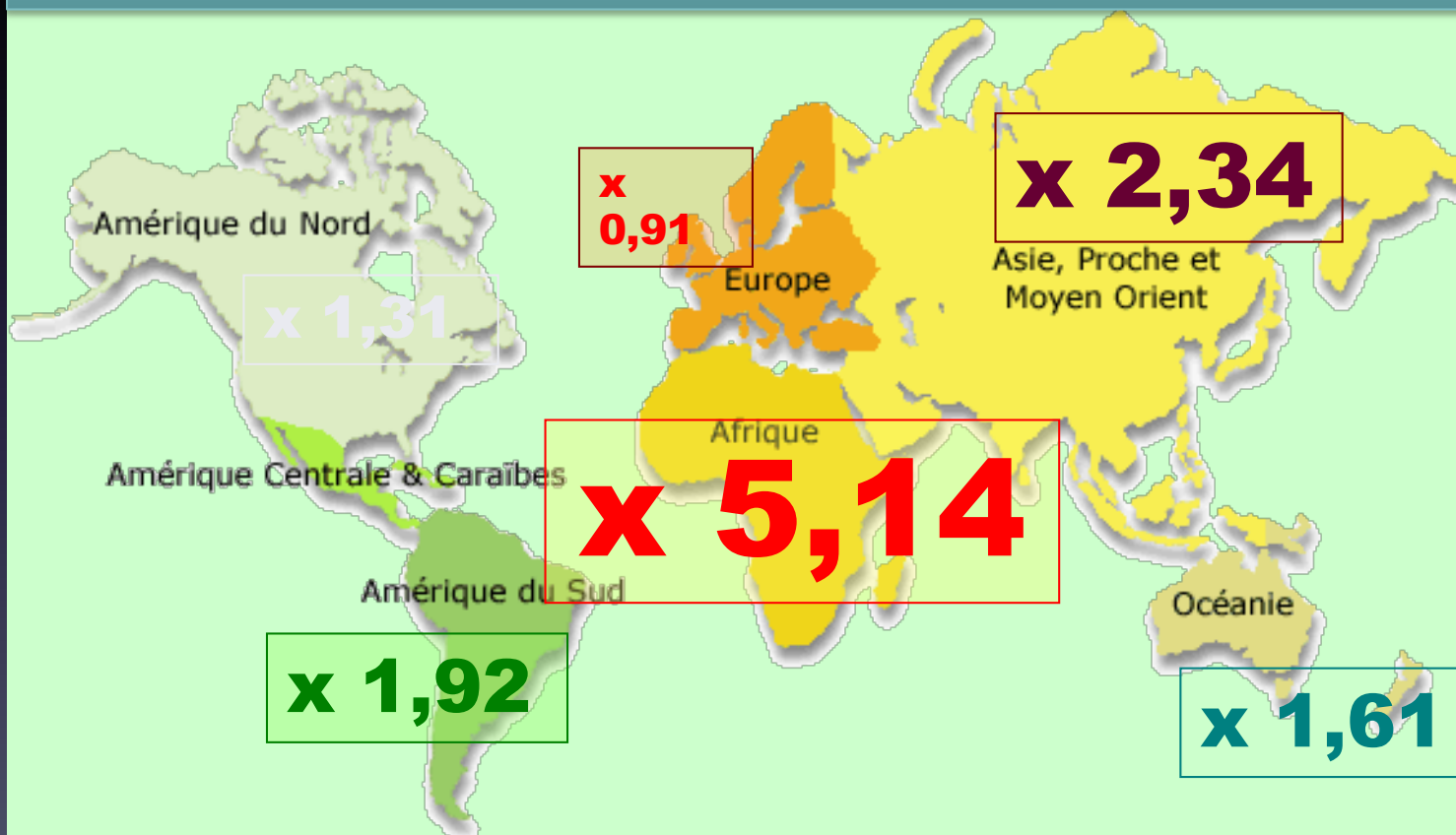


2000 espèces comestibles, surtout en Afrique et Asie



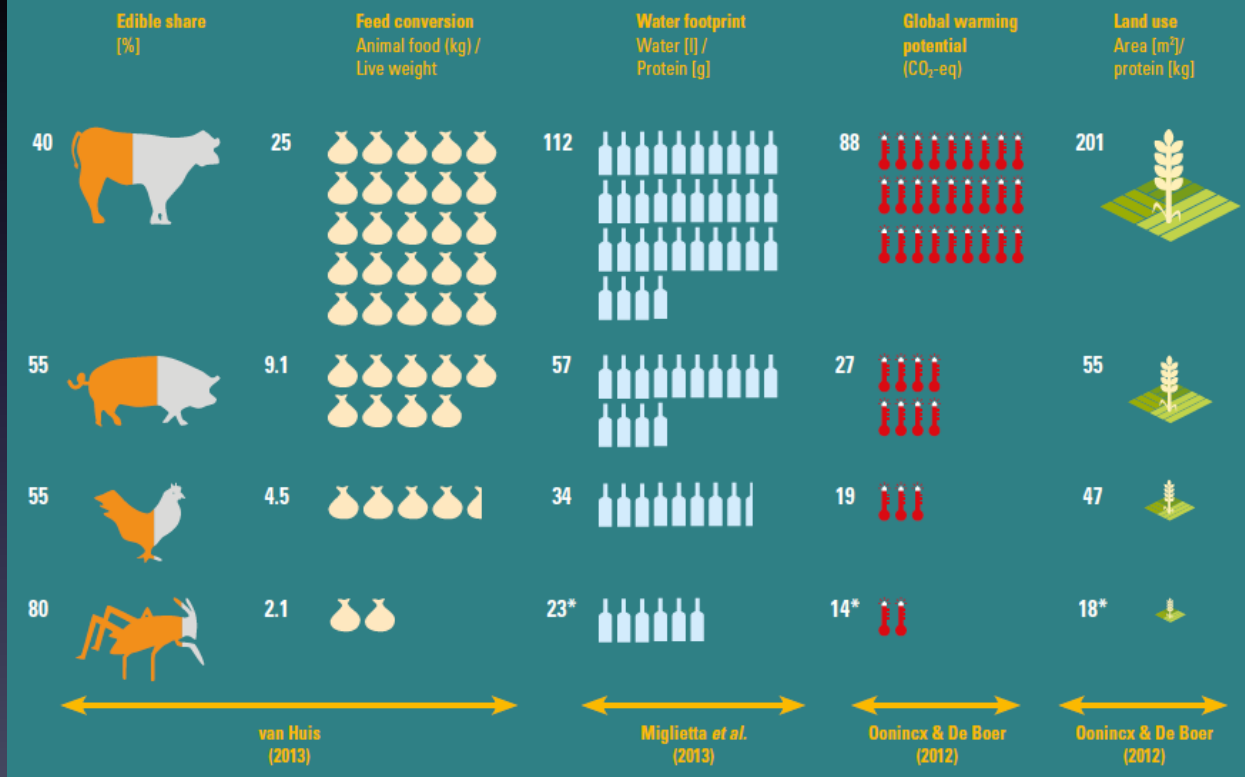
## Les besoins alimentaires

Il faudrait augmenter de 70% la production agricole pour que tout le monde mange assez en 2050



# Pourquoi produire / manger des insectes ?

FIGURE 2. COMPARISON OF FEED CONVERSION, WATER, GLOBAL WARMING POTENTIAL, AND LAND NEEDED TO PRODUCE 1 KG OF THE LIVE ANIMAL. ALSO SHOWN IS THE PERCENTAGE OF EACH ANIMAL THAT IS EDIBLE.



Pour 10 kg de nourriture :

- 1 kg de bœuf



- 3 kg de porc



- 5kg de poulet



- 7-8 kg d'insectes

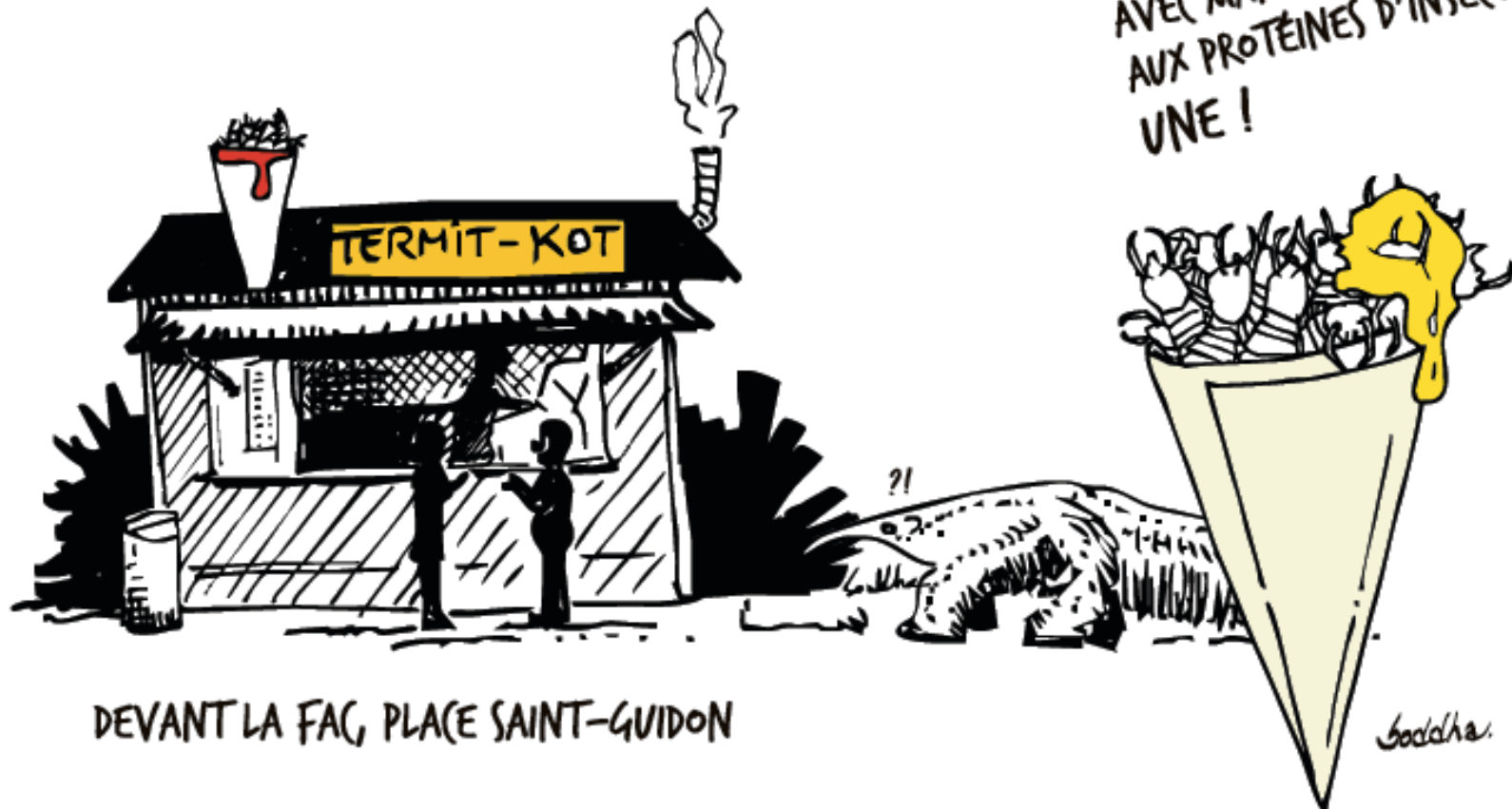


# Collecte ou élevage ?



# Entomophagie à Gembloux

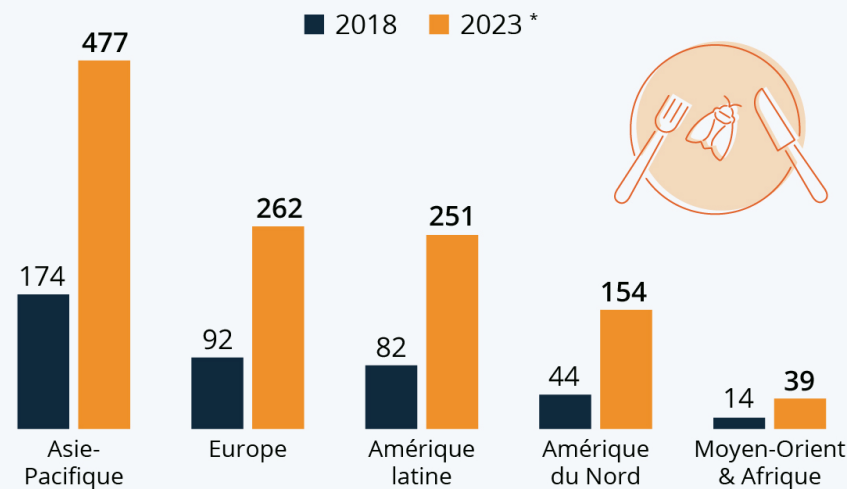
ILS L'ONT DIT, ILS L'ON FAIT !



# Perspectives dont valorisation de déchets organiques

## Les insectes arrivent dans nos assiettes

Estimation du chiffre d'affaires du marché des insectes comestibles par région, en millions de dollars



\* Prévisions, données arrondies.

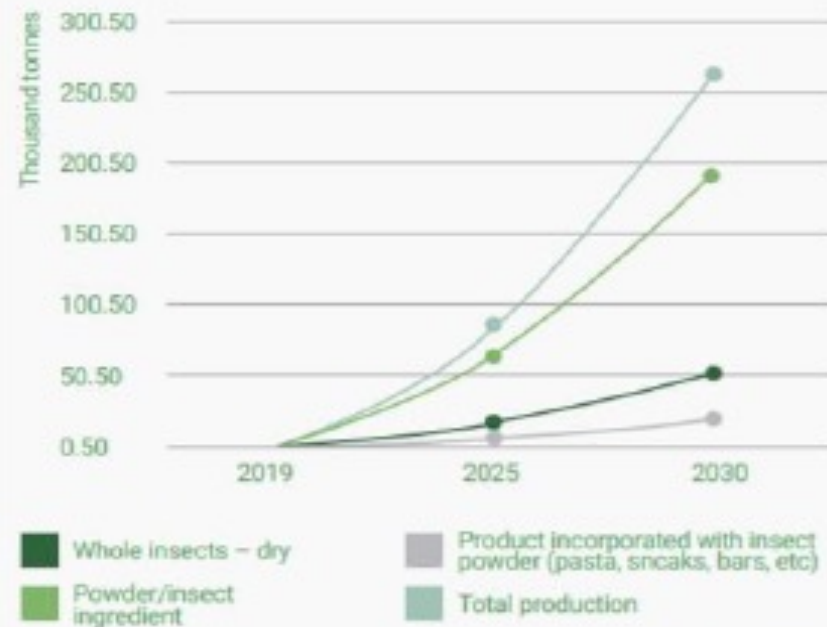
Sources : Meticulous Research, Bloomberg



In 2019, the European iFBOs accounted for about 500 tonnes of insect-based products<sup>5</sup>

### Insect Food Business Operators' (iFBOs)

#### iFBOs production and forecasts



# Comportements face aux insectes



bonheur



tristesse



surprise



colère



dégoût



peur

**Insecte**



phobie  
peur  
appréhension  
inquiétude  
anxiété  
malaise  
terreur  
panique



# Phobies des hexapodes



Invasion maison



Transmission  
maladies



Piqûres



Mouches sur  
cadavres -  
aliments

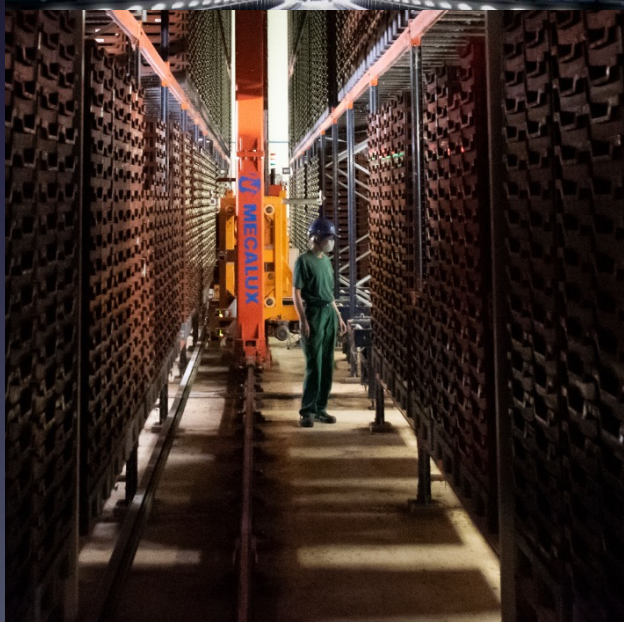


# Insectes & smart rearing



Depuis 2020, 15000 t protéines  
d'insectes / an pour alimenter  
400000 poissons, poulets et porcs  
Surface élevage : 25 000 m<sup>2</sup>

# Insectes & smart rearing



Surface élevage : 45 000 m<sup>2</sup>,  
36m hauteur

# Situation en Belgique

- Décembre 2013



Federal Agency for the Safety of the Food Chain



## Circular concerning the breeding and marketing of insects and insect-based food for human consumption

House cricket	<i>Acheta domesticus</i>
African migratory locust	<i>Locusta migratoria migratorioides</i>
Giant mealworm	<i>Zophobas atratus morio</i>
Mealworm	<i>Tenebrio molitor</i>
Buffalo worm	<i>Alphitobius diaperinus</i>
Wax worm	<i>Galleria mellonella</i>
American desert locust	<i>Schistocerca americana gregaria</i>
Tropical house cricket/banded cricket	<i>Gryllodes sigillatus</i>
Lesser Wax Moth Worm	<i>Achroia grisella</i>
Silkworm	<i>Bombyx mori</i>

# Situation en Belgique

## 4. Conditions for marketing

### 4.1. Registration of activities








The activity "breeding of insects" is inserted into the activity tree of the FASFC. The activity belongs to primary production; the direct sale of live animals by the producer is considered as an implicit activity of breeding. The operators, who breed insects, must be registered at the FASFC as mentioned under point 4.1.1. The sale of dead insects or the preparation and marketing of insect-based foodstuffs are activities which need to be registered or authorised by the FASFC. Depending on the exercised activities, registrations or authorisations associated with the codes-place-activity-product under points 4.1.2. to 4.1.4. apply. This is a non-exhaustive list with the most relevant activities. If insects are incorporated in special foodstuffs, other activities can apply. In this case, one refers to the activity tree of the FASFC.

### 4.2. Main principles of food legislation

For the activities 'breeding and placing on the market insects or insect-based foodstuff for human consumption', the general rules of food legislation are in force and inter alia, in particular the application of the good hygiene practices, the traceability, the obligatory notification, the labelling,... and the implementation of HACCP based self-checking system.

# Situation UE

EU Regulatory Possibilities for Insects Use in Animal Feed

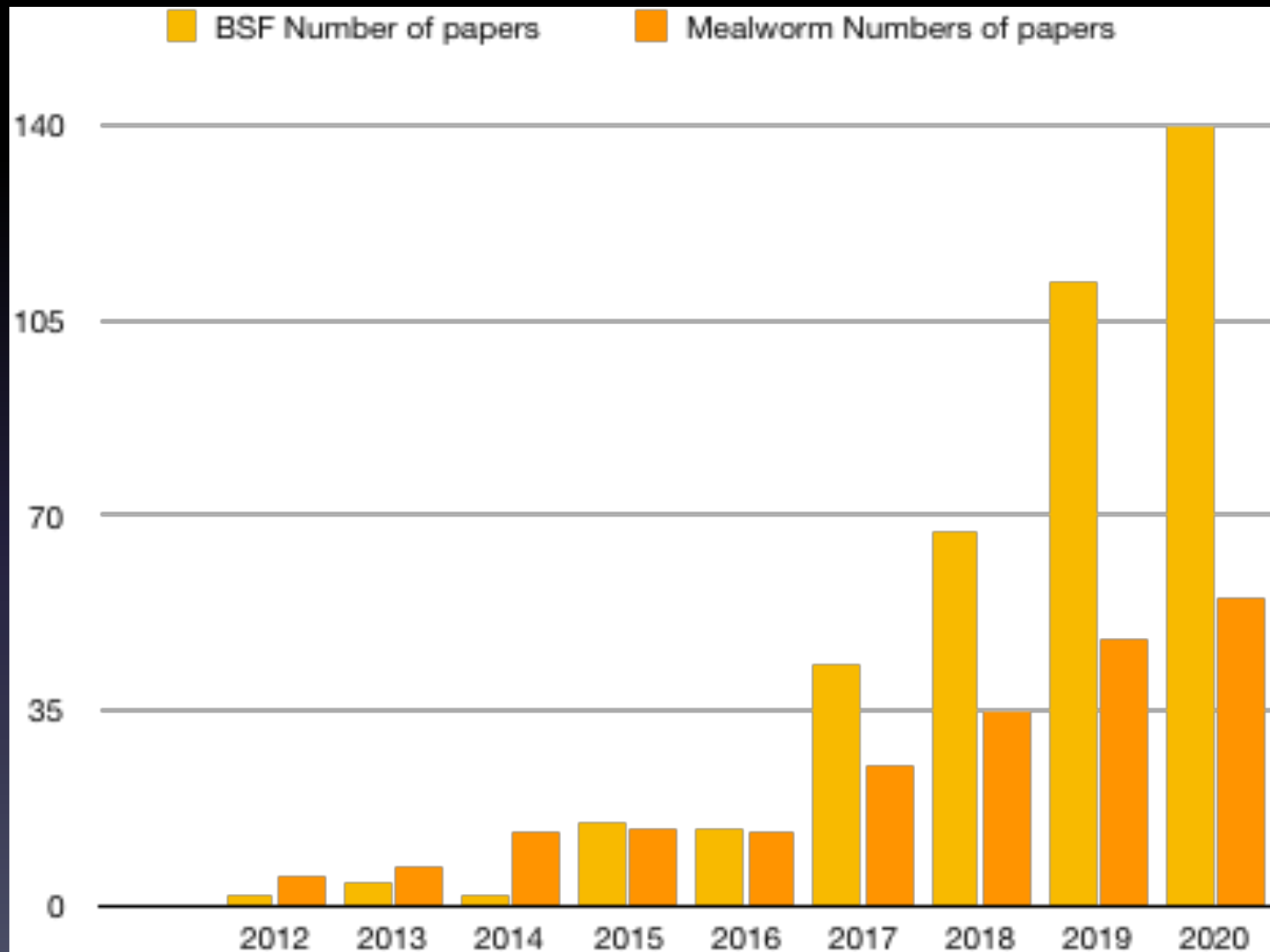
FEEDSTOCK	REGULATORY APPROVAL	INSECT PRODUCTION	TARGET SPECIES	PROTEIN*	FAT	LIVE LARVAE*
Vegetal substrates	✓	 Black Soldier Fly		✓	✓	✓
Unprocessed former waste: dairy and eggs	✓			✓	✓	✓
Unprocessed former waste: meat and fish	✗	 Mealworm		✗	✓	✓
Catering waste & Slaughterhouse products	✗			✗	✓	✓
Animal manure	✗	 Cricket		✗	✓	✓

- \* Non-hydrolysed protein (if classified "hydrolysed" all markets would be allowed)
- \* Permitted under national legislation in certain EU member states.
- \* Permitted under national legislation in certain EU member states.

Source: IPIFF, Nutrition Technologies

# *Hermetia illucens*, le futur de la nutrition animale ?







# *Hermetia illucens*, le futur de la nutrition animale ?



Déchets organiques



Elevage d'insectes



Traitement des insectes



Pour la volaille ou  
l'aquaculture



Consommateur



# *Hermetia illucens*, le futur de la nutrition animale ?



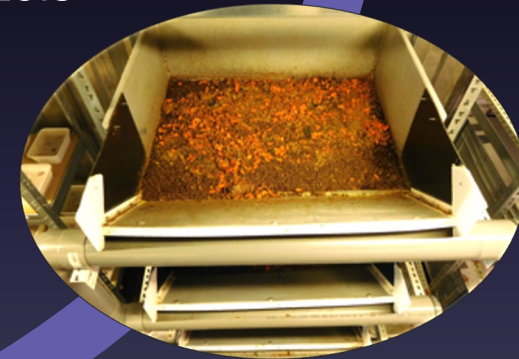
Adultes



Œufs



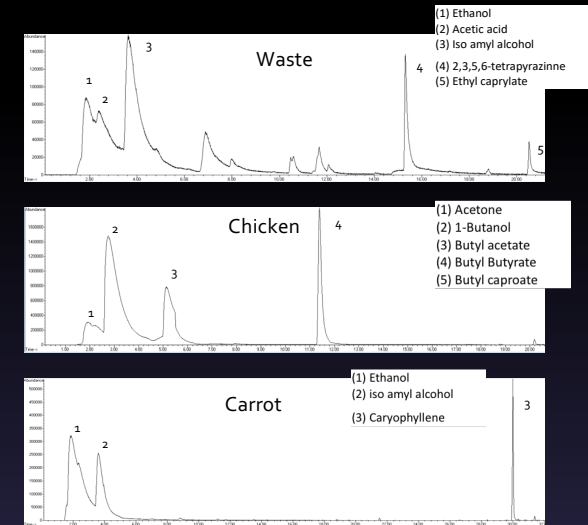
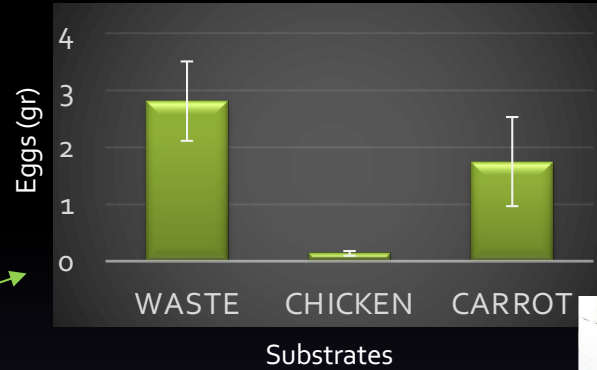
Pré-pupes



Larves



# Hermetia illucens : la reproduction



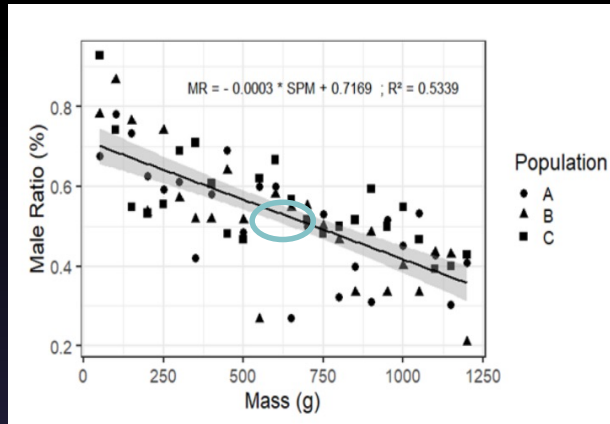
27,5-37,5°C;  
>65% HR

- Site d'oviposition
- Centralisation des œufs
- Collecte des œufs

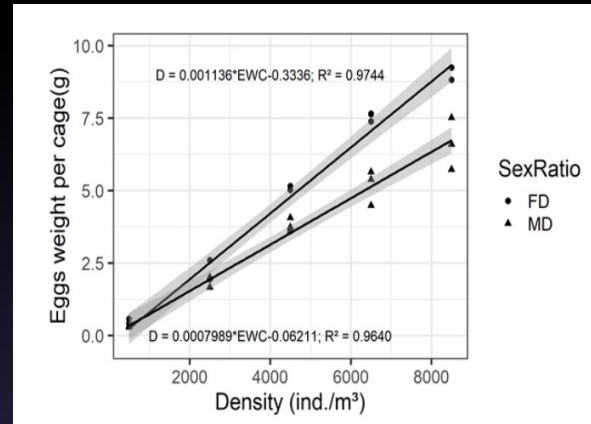


# Hermetia illucens : la reproduction

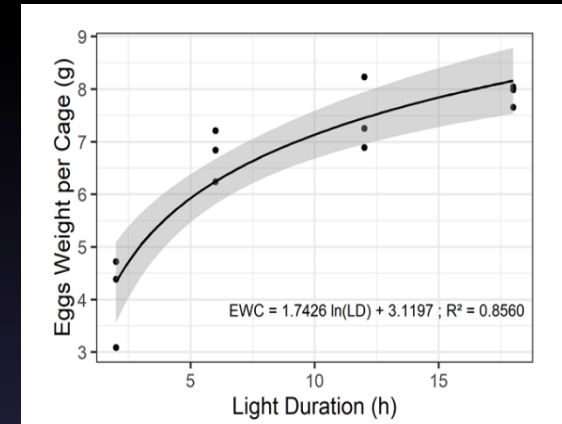
Sexe ratio



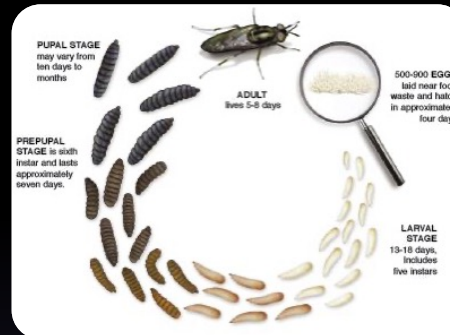
Densité d'élevage



Temps d'illumination

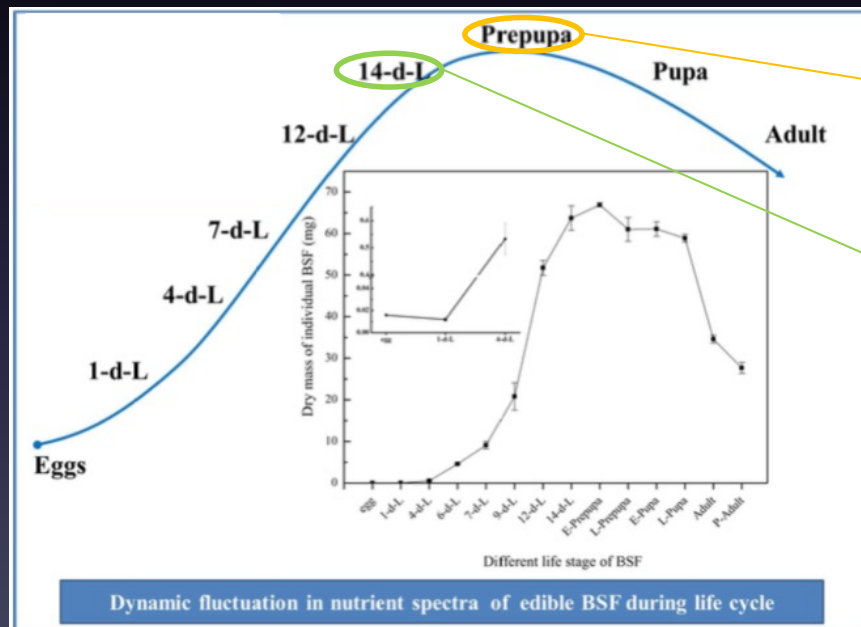


# Hermetia illucens : le développement larvaire



<https://12stepstofarming.net/12-steps-millibeter-2016/life-cycle-of-bsf/>

Stade de développement



Liu et al., 2017. Dynamic changes of nutrient composition throughout the entire life cycle of black soldier fly

# *Hermetia illucens* Formulation

Table 2. Ingredients of experimental trout diets.

	FD	BSFD	$\omega$ 3-BSFD
Ingredients (g/kg on dry matter basis)			
Fish meal <sup>1</sup>	400	100	100
BSF prepupal meal	0	300	0
$\omega$ 3-enriched BSF prepupal meal	0	0	300
Wheat meal <sup>2</sup>	280	195	200
Gluten meal <sup>2</sup>	60	205	200
Pregelatinized wheat meal <sup>2</sup>	150	150	150
Fish oil <sup>3</sup>	95	35	35
Premix <sup>4</sup>	15	15	15

FD = fish-based diet; BSFD = standard BSF prepupal meal-based diet;  $\omega$ 3-BSFD =  $\omega$ 3-enriched BSF prepupal meal-based diet.



Farine de poisson



BS



Oméga 3-BSF



Hoc et al., 2020. Production of rainbow trout (*Oncorhynchus mykiss*) using black soldier fly (*Hermetia illucens*) prepupae-based formulations with differentiated fatty acid profiles

# *Insectarium J. Leclercq Hexapoda à Waremme*

