Valorisation des coproduits de la pêche : la réussite d'une collaboration entre Entreprise et Université

The use of marine by-products to develop innovative ingredients: a successful collaboration between SME and University

1: ICV, Equipe ProBioGEM, Université de Lille, Villeneuve d'Ascq
2 : Société COPALIS Boulogne sur Mer
2: ICV, Equipe QSA, Université d'Artois, Lens.
4 : Laboratoire de Stress Périnatal, Université de Lille, Villeneuve d'Ascq

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COPALIS is at the heart of the marine resource as a source of constant innovation…

Located in the 1st European centre for the transformation, commercialization and distribution of seafood products

for animal nutrition

nutraceuticals, cosmetics

and food applications

A few figures...

- ✓ Cooperative organization: 100 shareholders are Copalis raw material suppliers
- ✓ 75 employees
- ✓ Turnover: 22,000 k€
- ✓ Created in 1960 to add value to fish by-products: production of fishmeal

From fishmeal to high added-value ingredients

- ✓ Observation in the 60s: how to better use the protein resources to meet the increasing need in protein?

  ⇒ Protein solubilization to reach protein bound to non-protein substances (lipids, carbohydrates, …)

- ✓ Development of enzymatic hydrolysis process on an industrial scale: patented process

  ⇒ 1968: launch of a patented fish protein hydrolysate CPSP®

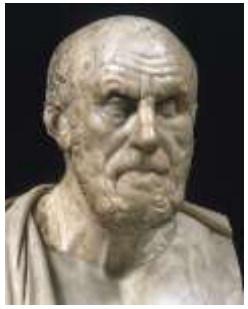
  Increased nutritional value of protein from fish by-products: +15 to 35%

A demanding raw material

- Filleting by-products:

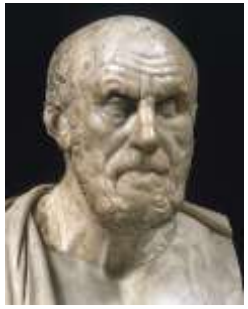
- **40 000 T** of by-products are generated in Boulogne/mer:
  - Collected by Copalis dedicated service (5 trucks)
  - Feed raw material in stainless steel tank
  - Food raw material in refrigerated container

  (same conditions as fish fillets transportation)



General context:

- Hippocrates : Let food be thy medicine and medicine be thy food
- Molecules from natural origin
- Need to upgrade the 'waste' => by-products



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- Growing number of publications on bioactive peptides
- Peptides from Milk (Meisel and Fitzgerald, 2000. *Br. J. Nutr.)*
- Isolation, characterization (Ngo *et al*., 2012. *Int. J. Biol. Macromol.*)
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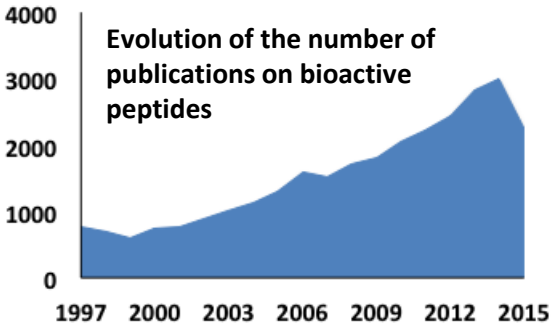
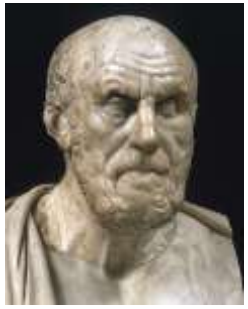
- Resistance to gastro intestinal digestion (GI)=> BIOLOGICAL ACTIVITIES





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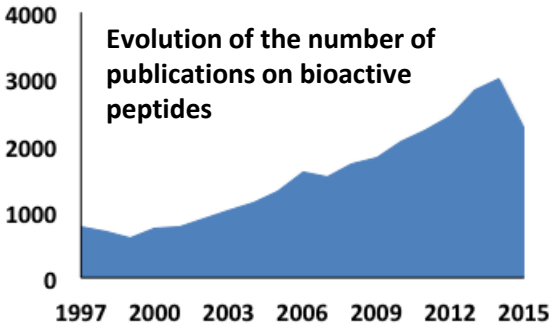


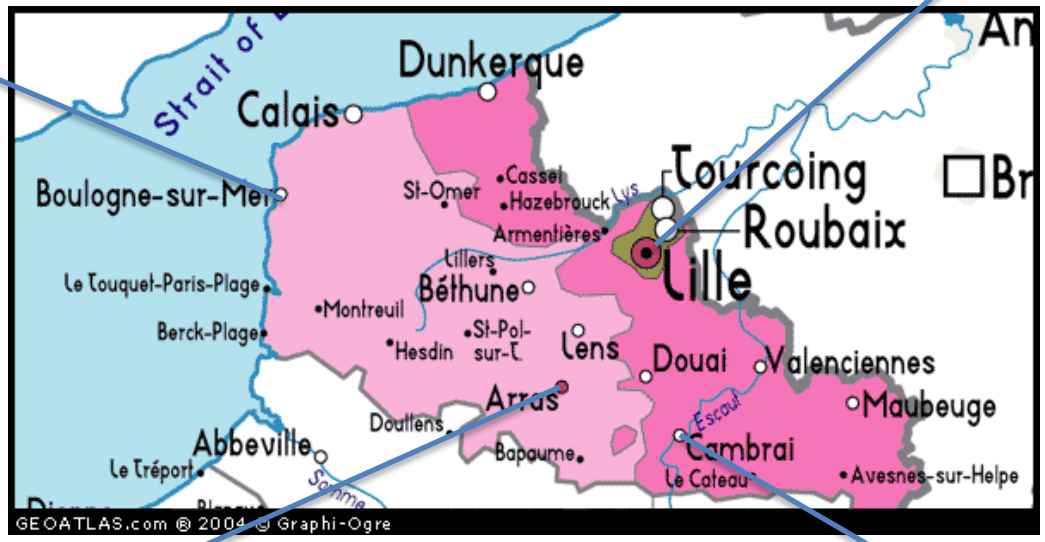
Project and network context :

- Europeen (Hydrofish, Seafood)

Clean processes and natural substances for food and nutrition

Lille1
Lille 2
ISA

Ulco



Artois

UVHS

Biotechnologies and eco-design processes for clean transformation and sustainable development of agricultural resources.

- **Upgrading of food proteins by enzymatic methods**

Technical Platform : BIOLOGICAL ACTIVITIES STUDIED

- Antihypertensive (*functional ingredients*)
- Anti DPP-IV (*functional ingredients : T2DM*)
- Opioïds (*functional ingredients : anti-stress, metabolic syndrom*)
- Regulation of intestinal hormones secretion (*functional ingredients: obesity and associated symptoms*)
- Antioxydants (*functional ingredients : food conservation, healthy food*)
- Anti-inflammatory
- Cytotoxicity
- …

SEQUENCE => BIOLOGICAL ACTIVITIES => PHYSIOLOGICAL MECANISM

→ **Development of new methodologies**

→ **Characterisation of the biological activities (identification and metabolic pathway)**

→ **Numerous models of cells and animals**

Enzyme

Proteins

Hydrolysis

Peptides

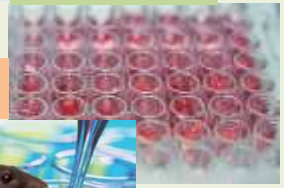
Intermediate Peptides

Enzyme

Free amino acids

Sources

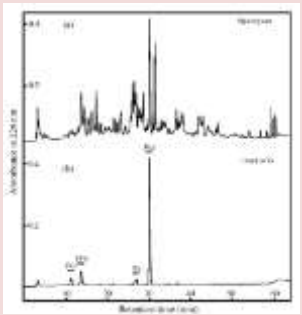
Hydrolysis



Screening

Biological activities

Purification and identification



Valorization

Sequences/active Fractions and/or synergistic

Step of purification/MS

Relationship structure-function

SeafoodPlus Project : background

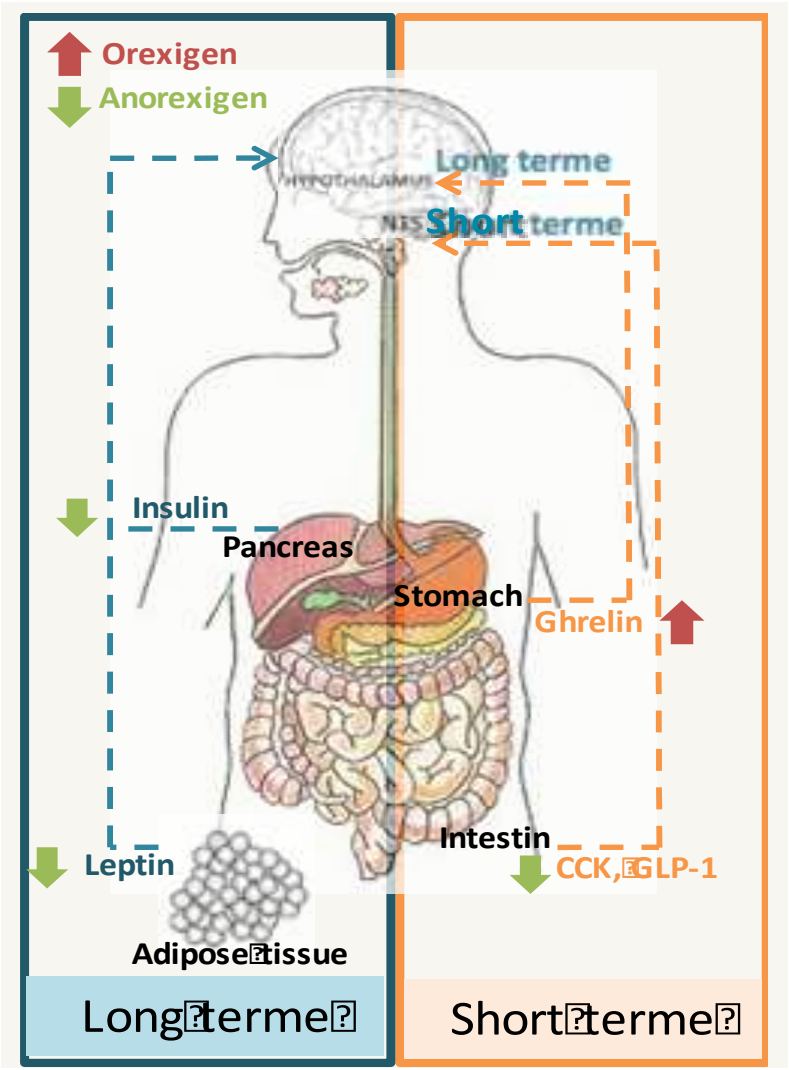
HYDROFISH (1997 to 2000 « The search of biologically active compounds in hydrolysates of fish and crustaceans) => reproductibilty of the peptidic population

=> SEAFOODPLUS Project 2004-2008 : more than 18 countries and 67 partners

=> Evidence of *in vivo* satietogen effect in rats of fish hydrolysates produce at industrial scale

- **H1 : Siki (dogfish) hydrolysate (*C. squamosus*)**
- **H2 : Saithe fermented hydrolysate *(P. virens*)**
- **H3 : commercial product Nutripeptin**

Background - protein digestion and intestinal hormones



- Cholecystokinin (**CCK**)

Produced by **I cells** (duodenum) in response to lipids and **proteins**.
Promotes **satiation**: increase gastric secretion, decrease gastric emptying, induces satiety feeling by vagal afferents

Ingestion orogastric of peptide fractions

4 groups of 8 rats : control T(0.5 ml distilled water) and 3 hydrolysates H (50 mg/0.5 ml)

First step : 21 days

Measurement of the food intake and of the body weight

Second step : after 24 hrs of fasting

Measurement of the food intake and of plasmatic molecules

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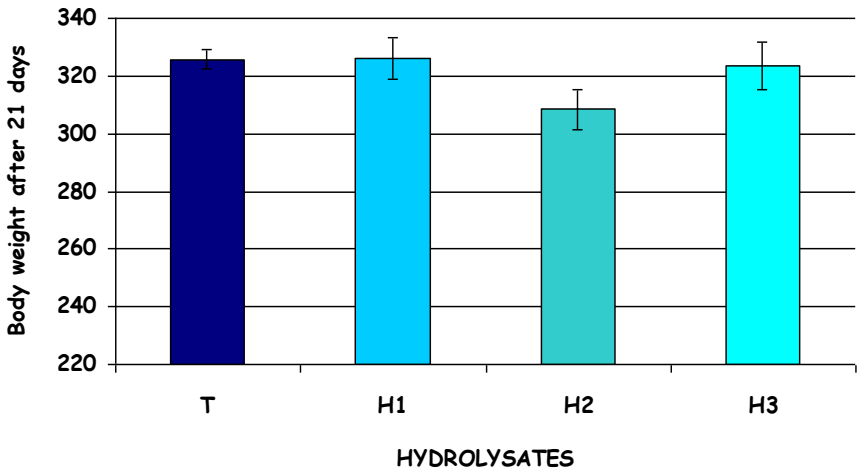
Measurement of the food intake and of the body weight (3 weeks)

With H2 : - less body weight after 21 days of stuffing
- less food intake during the 3 weeks



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Measurement of the food intake and of the body weight (3 weeks)

With H2 : - less body weight after 21 days of stuffing
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Measurement of the food intake and of plasmatic molecules

With H2 : - tendency to reduce food intake and glycemia
- high level of CCK

Copalis

- **H1 : Siki (dogfish) hydrolysate (*C. squamosus*)**
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SEAFOOD plus

Measurement of the food intake and of the body weight

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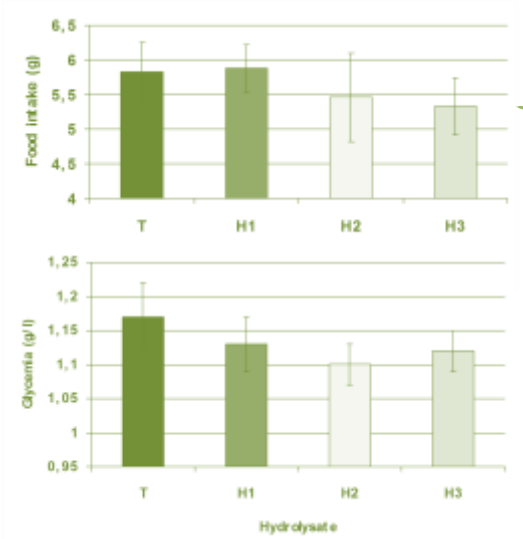
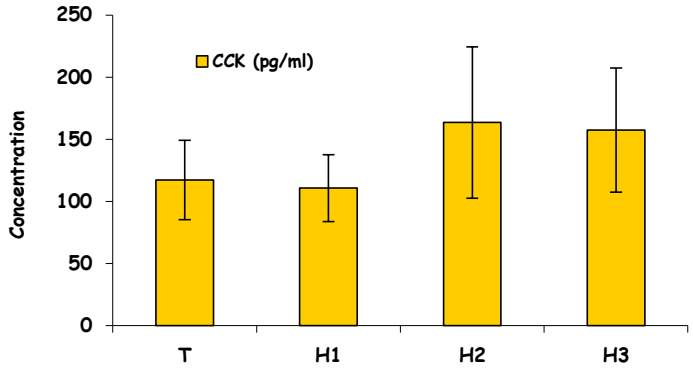


Plasma glucose level after 1 h of food intake

Measurement of the food intake and of plasmatic molecules



From an academic point of view :

- 3 publications (with one book chapter)
- several communication in international congress (WEFTA 2007, MIS 2011)
- Development of innovative techniques

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Effect of daily gavage with a collagen hydrolysate containing calcitonin gene-related peptide (CGRP)-like molecules on plasma CGRP-levels in rats

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18 – Mild processing techniques and development of functional marine protein and peptide ingredients

Research Article

SCI

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(www.interscience.wiley.com) DOI 10.1002/jsfa.4020

Impact of ultrafiltration and nanofiltration of an industrial fish protein hydrolysate on its bioactive properties

Laurent Picot,[a]* Rozenn Ravallec,[b] Martine Fouchereau-Péron,[c] Laurent Vandanjon,[d,e] Pascal Jaouen,[d] Maryse Chaplain-Derouiniot,[d] Fabienne Guérard,[f] Aurélie Chabeaud,[f] Yves LeGal,[c] Oscar Martinez Alvarez,[c,g] Jean-Pascal Bergé,[h] Jean-Marie Piot,[a] Irineu Batista,[i] Carla Pires,[i] Gudjon Thorkelsson,[j,k] Charles Delannoy,[l] Greta Jakobsen,[m] Inez Johansson[m] and Patrick Bourseau[d,e]

Fish, a source of active ingredients

Whole by-product

Skin

Cartilage
Fishbone

Fish muscle

Liver
Roe

Enzymatic hydrolysis process

CPSP®: *soluble fish protein concentrate*

Collagen

Elastin

Chondroitin sulfate

Bioavailable Calcium

Anti-stress peptides

GI lowering peptide

Anti-hypertensive peptides

Flavouring extract

Omega 3

DNA rich extract

Aquaculture
Petfood
Milk replacer

Food supplements
Nutricosmetics
Topical cosmetics

Food supplements
Food industry

Collaborative research efforts: the basis of a successful new product launch

From fish by-products to the international market of nutricsometics

- Increasingly educated consumers

- Growing competition with actives of different origin

- Increasingly demanding regulation

New reasearch programm PepSeaNov:

Characterisation of active peptides from fish by-products and development of new ingredients for human and animal nutrition based on innovative technics

A project led by Copalis and including 5 partners including Institut Charles Viollette

Overall budget: 1 944 117,09 €

Duration: 36 months

ICV → **Anti stress activity and peptide identification**

FUI Pepseanov : Experimental design

saliva

Mouth
t = 5 min
pH = 6.5

gastric juice

Stomach
t = 30 min
pH = 2 -3

duodenal juice
whithout bile

Small intestine
t = 15 - 60 min
pH = 6.5 - 6.8

Stop digestion
(100°C, 15 min)

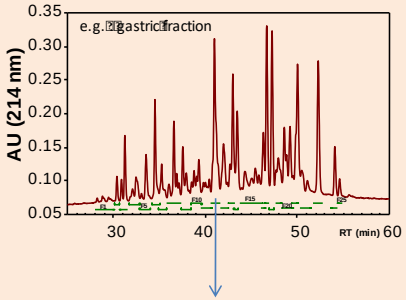
hydrolysis stop (100 °C)
centrifugation (9500 g)

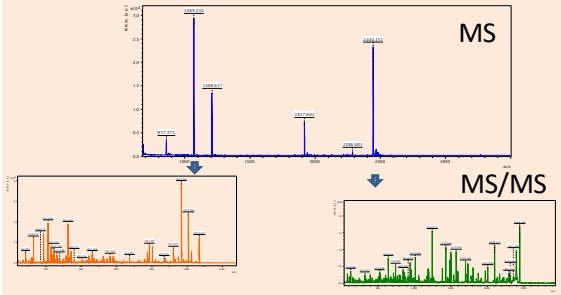
supernatants

sample collection

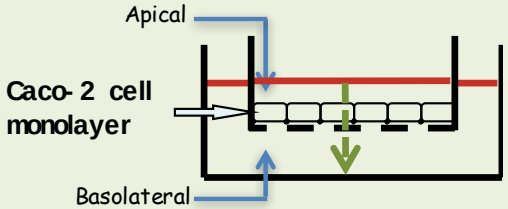
***In vitro* digestion**

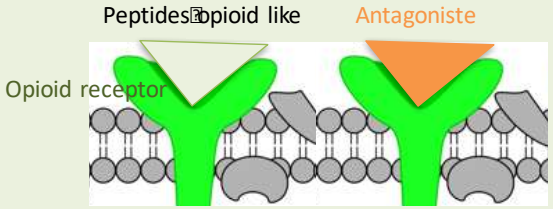
Resistance and identification of active sequences





Highlighting the physiological mechanism





Brings catalysis over lightspeed
REALCAT

Success story of 20 years of collaboration

- Market need
- Regulatory developments
- Industrial expertise

- Scientist expertise
- Innovative techniques

Trust and openness

Successful collaborative applied research programs between the industry and academic research lab

Institut Charles VIOLLETTE

Université de Lille 1 SCIENCES ET TECHNOLOGIES

UNIVERSITÉ D'ARTOIS

Christophe Flahaut
Barbara Deracinois
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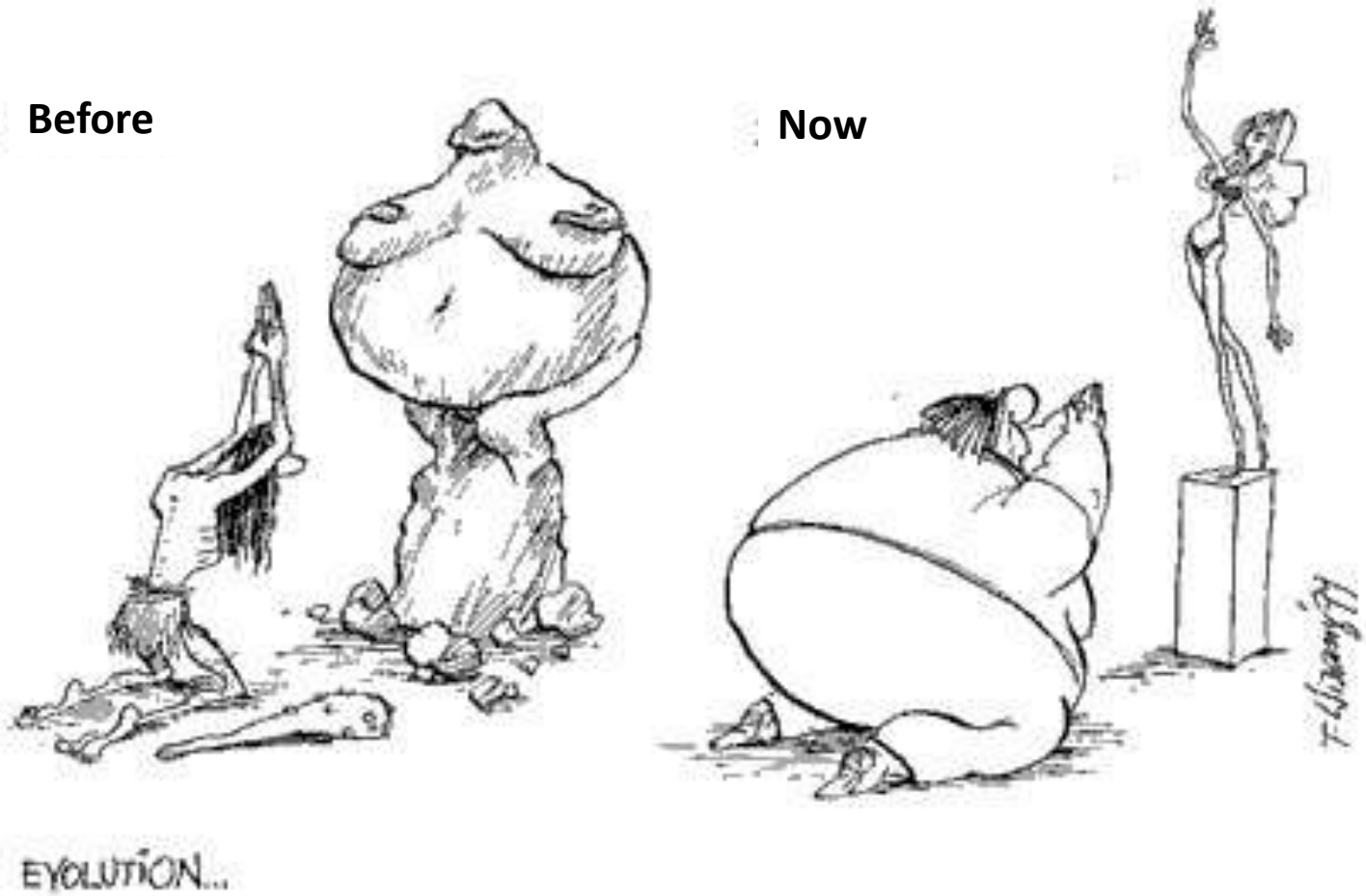
Before

Now

And next…..



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Merci de votre attention !