The Ancestral Human Microbiome: From Traditional Production and Consumption to the Impact of Modern Practices in Nutritional Health among Amazonian peoples

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Temporal trend of diseases in developed countries

Bach 1999
Obesity trends

Source: CDC Behavioral Risk Factor Surveillance System
BMI changes with urbanization

115 adults (>19y) and 80 children (2-18y)
The Nutrition Transition in the Venezuelan Amazonia: Increased Overweight and Obesity with Transculturation

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MANOVA
Wilks' lambda = 0.280; p<0.001

Fig. 1. Bioimpedance vector analysis (BIVA) of 37 adults from Maheceto, Platanillal, and Coromoto villages. (●) Maheceto (n: 7), (○) Platanillal (n: 13) y (▲) Coromoto (n: 17).
Consequences of modern urban practices
Antibiotics lead to increased fat deposition

Cox et al, Cell 2014

>50 years of antibiotic use for growth promotion
Diet

Later

Bone
Muscle
Fat

Mesenchymal stem cell differentiation

Microbial Immune Signals

Nature-driven evolution

Human Microbiome

Origin of Earth 4.8 billion Y ago
Origin of life 3.8 billion Y ago
Multicellular life 2.1 billion Y ago
Homo sapiens 0.2 million years ago

BACTERIA

Costello et al. 2009, Science
The microbiome is the interface between the exterior and our human cells.
Human development and natural exposures

Vaginal seeding

Maternal
milk – strict lactation

Environmental

Newborn  |  1 month  |  2 months  |  4 months  |  7 months
Human development and *decreased* natural exposures

Maternal
- Vaginal seeding
- Milk – strict lactation

Environmental

0-6 months
- Newborn
- 1 month
- 2 months
- 4 months
- 7 months

>6 months
Diseases associated with C-section

**Type 1 diabetes**
Algert, McElduff et al. 2009
Aumeunier, Grela et al. 2010
Bonifacio et al. 2012

**Celiac disease**
Decker, Engelmann et al. 2010
Marild, Stephansson et al. 2012

**Asthma**
Kero, Gissler et al. 2002
Kero et al. 2002
Thavagnanam et al. 2007
Roduit et al. 2009
Couzin-Frankel 2010
Ege et al. 2011
Azad et al. 2012

**Obesity**
Blustein et al. 2013
Mueller et al. 2014
Delivery mode and the primordial microbiota

- Acinetobacter
- Bacillales
- Coriobacterineae
- Corynebacterineae
- Haemophilus
- Lactobacillus
- Micrococcineae
- Neisseria
- Pasteurellaceae
- Prevotella
- Propionibacterineae
- Sneathia
- Staphylococcus
- Streptococcus
- Other

Dominguez-Bello et al. PNAS 2010

Glida Hidalgo, CAICET
Monica Contreras, IVIC
Magda Magris, CAICET
Antibiotics, birth mode, and diet shape microbiome maturation during early life

Ecological consequences of compounded impacts

Robert Paine
1933-2016

Paine et al 1998, Ecosystems

Resilience

Extinctions

Extinctions
The urbanite microbiome
Fecal microbiome alpha diversity across cultures

Clemente et al. 2015 Science Advances

Oscar Noya
CAICET

Jose Clemente
Mount Sinai SM

Rob Knight,
UCSD

Westernization

Clemente et al. 2015 Science Advances
Gut bacterial taxa under extinction?

Clemente et al. 2015 Science Advances
Consequences of modern urban practices

Obesity, Autism, Alzheimer

[Diagram showing the effects of modern urban practices on health outcomes.]
How the ways of life of indigenous peoples in the Amazon contribute to a more diverse microbiome?

What can we learn from Yanomami foodways and sustainable diets?
Foodways and sustainable diets

**Foodways**
The modes of feeling, thinking and behaving about food that are common to a cultural group (Jack Goody, 1982)

**Sustainable Diets**
Are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. (FAO, 2010).

Also:
- Protective of biodiversity,
- Culturally acceptable,
- Economically affordable
- Nutritionally adequate,
- Safe and healthy (FAO, 2010).
Yanomami indigenous people and their habitat
Yanomami Population

- **Total population**: 34,567
  - Yanomami in Venezuela: 15,229 (2011)
  - Yanomami in Brazil: 19,338 (2011)

- Area of occupancy in the Amazon rainforest: 190,000 km² in Brazil and Venezuela

- Their village *(shapono)* contain between 20 and 300 native people. There are around 200 *shapono* in Venezuela.

- The *shabono*, a collective housing, constitutes the perimeter of the village.

- From the rainforest *(urihi)* they obtain the means for their subsistence.
Yanomami subsistence activities

- Agriculture
- Hunting
- Fishing
- Gathering
When the Yanomami are hungry ....

- **Ya ohi**
  - “I am hungry”, in general

- **Ya naiki**
  - “I am hungry of game or fish” (protein)
Agriculture

Preparing the garden (*hikarimou*)

Slash and burn

Plantain trees (*Musa paradisica*) *Kuratha*

Manioc or cassava (*Manihot esculenta* Cranz) *Nashi*
### Agriculture

#### Technics
- Slash and burn of gardens
- Shifting cultivation
- Steel tools

#### Crops
- Plantains and bananas
- Manioc or cassava
- Papaya
- Taro
- Sweet potatoes

#### Cooking
- Boiled
- Roasted in the hot coals of the hearth
- On a griddle

#### Food
- Roasted and boiled plantain
- Casabe bread
- Mañoco (toasted flour)
- Variety of fruit pulp
Hunting
Hunting

| Food (protein) | • Roasted, smoked and boiled a variety of animal food |
| Game          | • Large game birds  
|               | • Wild pigs  
|               | • Monkeys, tapir, armadillos, alligators, deer, rodents |
| Cooking       | • Roasted  
|               | • Smoked  
|               | • Boiled |
| Technics      | • Bow and arrow  
|               | • Shotgun  
|               | • Types: *rami huu* and *heniyomi huu* |
Fishing
**Fishing (yurimou)**

| **Technics**                          | • Fish hooks and nylon  
|                                      | • Nets and baskets  
|                                      | • Buoys  
| **Fish**                             | • Yaraka  
|                                       | • Pavon  
|                                       | • Bocon  
|                                       | • Rayado  
| **Cooking**                          | • Boiled  
|                                       | • Smoked  
| **Food (Protein)**                   | • Roasted, smoked and boiled a variety of fish  

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Gathering
Gathering

Technics
- Collecting

Crops
- Palm fruit
- Honey
- Fat palm-pith groups

Cooking
- Boiled
- Roasted

Food
- Palm fruits
- Honey
- Insects
Relationship between traditional cultures and a more diverse microbiome

Indigenous peoples ways of life

Diverse microbiome

Foodways

Sustainable diet
Conclusions

• Traditional cultures harbor a more diverse microbiome than in peoples living in industrialized societies.

• The challenge is the future use of sustainable diets and lifestyles that does not increase the risk of inflammatory and metabolic diseases.