What makes sense about Paleo diets in a modern world?

S. Boyd Eaton, MD
Emory University
Atlanta, Georgia
Before considering the nutrition-sustainability interaction, let’s assess the current status of health promotion/disease prevention.

Are we promoting health or not?
Are we progressing?
Smoking cessation has been a “success.”

Trends in Current Cigarette Smoking by High School Students* and Adults** — United States, 1965-2011

58% reduction
In 46 years

*Percentage of high school students who smoked cigarettes on 1 or more of the 30 days preceding the survey (Youth Risk Behavior Survey, 1991-2011).
**Percentage of adults who are current cigarette smokers (National Health Interview Survey, 1965-2011).
Still, 17.8% of American adults were smokers in 2013.

And $170 billion was spent on tobacco-related healthcare costs that year.
Coronary mortality is down.

20% reduction
In 30 years
Total Serum Cholesterol, mmHg

NH White

1988-94: 206
2007-12: 196

NH Black

1988-94: 204
2007-12: 191


3% reduction in 24 years
But the decline is largely the result of early diagnosis, prophylactic drugs and improved treatments – not primary prevention.

- 41 million statin prescriptions in 2011
- 5 million CT calcium scans in 2014
- 560,000 Angioplasties in 2011
Hypertension Prevalence
Adults, 1988-2012

Whites
- 1988-94: 24.3%
- 2007-12: 28.9%

Blacks
- 1988-94: 37.9%
- 2007-12: 41.5%

Mozaffarian D, et al
Circulation 2015;
131: e29-e322
(NHANES 2009-12)

19% increase in 24 years
9.5% increase in 24 years
Obesity in Adults, 20-74 (1960-2012)

171% increase since 1960

(only 4.7% increase since 2003)

Mozaffarian D, et al Circulation 2015; 131: e29-e322 (NHANES 2009-12)
Type 2 Diabetes Prevalence

42% Increase in 24 Years

(Six-fold increase since 1960)

1988-94: 8.4%
2009-12: 11.9%

The pace of American death rate decline is slowing.

Mortality is rising for non-Hispanic Whites.


Case A, Deaton A. PNAS 2015 Early Edition
How has nutrition science contributed?
Have findings and recommendations been consistent?
“The ups and downs of nutrition advice have come to seem as capricious as the fluctuations of the stock market.” Consumer Reports, September, 1994

Advice to the public about what to eat...and basically how to live, seems to do an about-face every time a new study is published in a medical journal. New York Times, March 22, 1998

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Why almost everything Dean Ornish says about Nutrition is wrong.
Scientific American April 22, 2015
Has the public been enlightened – or confused?
“Consumers today are deluged with constantly shifting health messages....instead of educating health care consumers, these shifting scientific studies often serve to confuse.” USA Today, June 12, 1998
One might argue that nutrition science:

• Has made suboptimal progress,
• Suffers from frequent disagreements,
• And has led to public confusion.
Thomas Kuhn would consider nutrition science as a Pre-paradigmatic Emerging Discipline.

The belief that nutrition scientists keep changing their minds may lead people to doubt nutrition and health recommendations.

Kuhn did for conceptions of science what Copernicus and Einstein did for astronomy and physics.

Kuhn: Mature sciences operate under the aegis of a governing paradigm.

Foundation for a research tradition.

Essential for selection of potentially fruitful investigative efforts.

Establishes gestalt through which investigators view natural phenomena.

At present there is no such paradigm for health promotion.
In epidemiology there is no consensus on what constitutes a **unifying body of principles** for explaining the distribution of disease in populations.

Koopman JJ, Weed DL.

Theorists must derive basic postulates from nature.

Absent such principles, the separate results of empirical research defy deductive reasoning.

A. Einstein
*Ideas and Opinions*
New York: Bonanza Books; 1954:221
“Nothing in biology makes sense except in the light of evolution.”

Evolutionary Health Promotion – Basic Postulate

An organism’s biology functions best when it operates under conditions similar to those for which its genome was originally selected through evolution.
The Evolutionary Health Promotion Paradigm

We are genetic Stone-Agers.

Deviation from the Stone-Age lifestyle increases chronic disease risk.

Reversion towards the Stone-Age lifestyle reduces chronic disease risk.
Criticism:

Evolution can be “rapid.” We’re genetically different from Stone Agers.
Recent genetic changes have involved traits controlled by single genes.

- Lactase Persistence
- CFTR (cystic fibrosis)
- Blue Eyes
- Hemoglobin S
- Pale Skin
- Blonde Hair
Traits affected by multiple genes are “conserved” over time.

Most of the genes involved in basic cellular processes are ancient and fundamental. Their expression seems to have remained consistent across the primate lineage for 70 million years.

An Example of Genetic Conservation

The ancestors of humans and cats diverged 70+ million years ago, but we remain similarly susceptible to obesity and Type 2 diabetes.

-ergo-

The genes underlying these conditions were present in our common ancestor and have been conserved for 70+ million years.
Criticism:

We cannot know the Past.

Who?
Where?
When?
What?
Humanity’s homeland was Africa. We remain adapted for lifestyle, including diet, as it was there 100,000 – 50,000 years ago.

What?

Paleo Nutrition Data Sources

- **Human Skeletal Remains**
  - Gross Anatomy
  - Microscopic anatomy
  - Biomechanics
  - Radioisotopic and DNA analyses (bones, teeth, plaque etc.)

- **Archeological Finds**
  - Bones of animals/fish consumed
  - Botanical remains (including EM of pollen, spores, seeds, husks, etc.)
  - Implements
  - Cave and rock wall paintings

- **Recent Hunter-Gatherers**
  - Subsistence patterns
  - Physical activity
  - Biomarkers (e.g. blood pressure, serum cholesterol, BMI, glucose responsiveness, etc.)

- **Proximate Nutrient Analyses**
  - Wild game animals, fish, shellfish
  - Uncultivated plant foods
# Late Paleolithic Macronutrients

<table>
<thead>
<tr>
<th>% Energy Consumption</th>
<th>1985 Estimate</th>
<th>2015 Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>34</td>
<td>30</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>45</td>
<td>35</td>
</tr>
<tr>
<td>Fat</td>
<td>21</td>
<td>35</td>
</tr>
</tbody>
</table>
Paleo Dietary Recommendations

Strong Form

- More fruits and vegetables
- No sugar
- No dairy for adults
- No refined grains
- Modest whole grain intake
- More fiber
- Much less sodium
- More potassium
- More long-chain PUFA
- More protein
Paleo Dietary Recommendations
Strong Form

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- **Much** less sodium
- More potassium
- More long-chain PUFA
- More protein
Paleolithic

DHA+EPA

6 g/d

Contemporary

DHA+EPA

AA

500 mg/d

125 mg/d

AA

DHA, EPA and AA

Long Chain PUFA Intake and Brain Size
Correlation does not necessarily indicate causation, but I’m just sayin’

Eskimos & Cro-Magnons
Cranial Capacity ~1550 cc
LC PUFA Intake  EPA + DHA ~6g/d
               AA ~3g/d

Current Westerners
Cranial Capacity ~1350 cc
LC PUFA Intake  EPA + DHA ~500mg/d
               AA ~200mg/d
Total CHO Consumption
American vs Paleo

American CHO 50% Total kcal
- Whole Grains: 2%
- Refined Grains: 15%
- Fruits & Vegetables: 14%
- Sugar: 20%

Paleo CHO 35% Total kcal
- Whole Grains: 33%
- Fruits & Vegetables: 2%
- Refined Grains: 2%
- Sugar: 20%
- Honey: 2%
Fruit and Vegetable Consumption
% Total Energy

Current USA: 14%
Paleolithic: 48%
Added Sugar – % Total Energy

Contemporary: 15%

Wild Honey: 2-3%

Paleolithic
Cereal Grains in the Stone Age

Readily available, but consumed only in times of shortage.

Processing with available technology was too labor intensive for routine use.
Daily Fiber Intake

Paleolithic: 100 gms

USA: 15 gms
Fiber in Edible Plants

4.2 g/100 g  13.3 g/100 g

Cultivated  Wild
## Mineral Intake

<table>
<thead>
<tr>
<th></th>
<th>Paleolithic (^1)</th>
<th>Current U.S. (^2)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>1,622</td>
<td>920</td>
<td>1.8</td>
</tr>
<tr>
<td>Copper</td>
<td>12.2</td>
<td>1.2</td>
<td>10.2</td>
</tr>
<tr>
<td>Iron</td>
<td>87.4</td>
<td>10.5</td>
<td>8.3</td>
</tr>
<tr>
<td>Magnesium</td>
<td>1,223</td>
<td>320</td>
<td>3.8</td>
</tr>
<tr>
<td>Manganese</td>
<td>13.3</td>
<td>3.0</td>
<td>4.4</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>3,223</td>
<td>1,510</td>
<td>2.1</td>
</tr>
<tr>
<td>Potassium</td>
<td>7,500</td>
<td>2,500</td>
<td>3.0</td>
</tr>
<tr>
<td>Sodium</td>
<td>~1000</td>
<td>4,000</td>
<td>0.25</td>
</tr>
<tr>
<td>Zinc</td>
<td>43.4</td>
<td>12.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

1. Based on 3000 kcal/d, 35% animal; 65% plant subsistence
2. Average of U.S. men and women; Food and Nutrition Board, 1989
Sodium and Potassium, mg/d

Paleolithic

Sodium: ~1000
Potassium: 7500

Current USA

Sodium: 4000
Potassium: 2500

Potato chips have 47 times the sodium, but only half the potassium of baked potato.
# Vitamin Intake

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Paleoolithic $^1$</th>
<th>Current U.S. $^2$</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascorbate</td>
<td>604</td>
<td>93</td>
<td>6.5</td>
</tr>
<tr>
<td>Folate</td>
<td>0.36</td>
<td>0.18</td>
<td>2.0</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>6.49</td>
<td>1.71</td>
<td>3.8</td>
</tr>
<tr>
<td>Thiamin</td>
<td>3.91</td>
<td>1.42</td>
<td>2.8</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>17.2</td>
<td>7.8</td>
<td>2.2</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>32.8</td>
<td>8.5</td>
<td>3.9</td>
</tr>
</tbody>
</table>

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Dietary Protein

<table>
<thead>
<tr>
<th></th>
<th>% total kcal</th>
</tr>
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<tbody>
<tr>
<td>Contemporary</td>
<td>15%</td>
</tr>
<tr>
<td>Paleolithic</td>
<td>30%</td>
</tr>
</tbody>
</table>
The acceptable micronutrient distribution range (AMDR) for protein is 10 to 35% of energy for adults. The IOM found no convincing association between protein intake and osteoporosis, urolithiasis, renal failure, coronary atherosclerosis, obesity or cancer.

Red meat is “probably carcinogenic.” Eating 100 grams of unprocessed beef, lamb, veal, pork, etc. every day “probably” increases lifetime risk of colorectal cancer from 5% (i.e. the background rate) to 6%.

Bouvard V, et al. (for IARC) Carcinogenicity of consumption of red and processed meat. Lancet Oncology 2015
“...people who are trying to eat right... are buffeted by health recommendations that seem prone to being overturned years later. “  
TIME November 9, 2015

WHO/ IARC  2015
analyzed 800 studies

AICR/WCRF  1997
analyzed 3500 studies
Non-starchy vegetables and fruits “probably” protect against several types of cancer.

Fruit and vegetable consumption not associated with reduced cancer incidence.

Key TJ. Fruits, vegetables and cancer risk. Brit J Cancer 2010; 104: 6-11. “No protective effects have been firmly established.”
In today’s world, rational nutrition advice has to be consistent with sustainability.
The FAO projects that a 70% increase in food production will be required to feed Earth’s 9.1 billion people in 2050. This will magnify sustainability concerns.
Nutrition science should devise a program that offers:

- Sustainability
- Paleolithic Nutritional Content
Land Use, Energy Use, Water Use and CO₂ Emission
Per Edible Ton

<table>
<thead>
<tr>
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<th>Land, ha</th>
<th>Energy, TJ</th>
<th>GHG, tCO₂</th>
<th>Water, 1000m³</th>
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<tbody>
<tr>
<td>Wheat</td>
<td>0.14</td>
<td>2.5</td>
<td>0.8</td>
<td>3.6</td>
</tr>
<tr>
<td>Soybeans</td>
<td>0.42</td>
<td>3.0</td>
<td>1.3</td>
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<tr>
<td>Maize</td>
<td>0.14</td>
<td>2.4</td>
<td>0.7</td>
<td>1.4</td>
</tr>
<tr>
<td>Field Beans</td>
<td>0.30</td>
<td>2.0</td>
<td>1.0</td>
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</tr>
<tr>
<td>Beef</td>
<td>4.30</td>
<td>52.5</td>
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</tr>
<tr>
<td>Cheese</td>
<td>0.72</td>
<td>20.0</td>
<td>8.8</td>
<td>5.2</td>
</tr>
</tbody>
</table>
# Mangrove Loss due to Shrimp Aquaculture

<table>
<thead>
<tr>
<th>Country</th>
<th>% Mangrove Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>87%</td>
</tr>
<tr>
<td>Thailand</td>
<td>65%</td>
</tr>
<tr>
<td>Philippines</td>
<td>50%</td>
</tr>
<tr>
<td>Vietnam</td>
<td>80%</td>
</tr>
</tbody>
</table>
Environmental Impact

1 lb beef = 2,500 gallons H₂O
= 55 ft² rainforest
= 16 lbs grain
= 80 kg CO₂

Comparing Carbon Foodprints (t CO₂e)

- Meat Lover: 3.3 t CO₂e
- Average: 2.5 t CO₂e
- No Beef: 1.9 t CO₂e
- Vegetarian: 1.7 t CO₂e
- Vegan: 1.5 t CO₂e

Shrink That Footprint
Sustainability: A Conflict

Red meat is incompatible with environmental health in the contemporary world.

However, humans have an innate desire for meat.
My favorite animal is steak.

Why is it delicious?

It’s in our genes!
Desire for meat is a built-in human drive:

Robert Foley in *Meat-Eating and Human Evolution*:
“Meat-eating has played a significant role in the evolution of Homo....”

Ann Gibbons in *National Geographic*:
“...hunter-Gatherers around the world crave meat more than any other food.... “

Leland Allbaugh in *Crete: a Case Study* (Rockefeller Foundation, 1948)
“A large majority of the respondents (72%) listed meat as their favorite food.”

USDA, 2013:
“As income rises, consumers in low- and middle-income countries....[increase] their consumption of meat, dairy products [and] eggs....”
Per capita meat consumption and income, by country, 3-year average centered on 2010**
Ergo – There’s a market for new “meat” products

**Fortune** May 11, 2015
“Sales of meatless meat are soaring; some companies are doubling their business annually. “

**Atlantic** August 19, 2013
“No saturated fat, no heme iron, no growth hormone – cultured meat seems to have many potential benefits.”

**Beast Burger**
(Beyond Meat, pea protein, Bill Gates)

**In Vitro Burger**
(Modern Meat, stem cells, Sergey Brin)
## Land Use, Energy Use, Water Use and CO₂ Emission

### Per Edible Ton

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<td>3.8</td>
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<tr>
<td>Cultured Meat</td>
<td>0.02</td>
<td>31.7</td>
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<td>0.5</td>
</tr>
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<td>Eggs</td>
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Why should a sustainable diet deliver Paleolithic level nutrients?
Paleo Dietary Recommendations

Sustainability Form

• More fruits and vegetables
• No sugar
• Some fat-free dairy
• No refined grains
• Moderate whole grain intake
• More fiber
• Less sodium
• More potassium
• More long-chain PUFA
• More protein – chiefly plant, some poultry & sea food
Advice based solely on epidemiological statistics has limited effect on public behavior. What is needed to complement statistical insights—to maximize their impact—is a model, a theory of disease.

Paleo could be that theory.
The Paleo concept resonates with the public.
Statistics-based Recommendations:
Highly “scientific,” but confusing for public
Strong research, no paradigm

Paleoanthropology-based Recommendations:
  Investigatively-challenged, but attractive to public
  Limited research, plausible paradigm

Paleoepidemiology-based Recommendations:
  Combine attractive theory with investigative rigor
  Evidence-based, gut-resonant advice

Sustainability-informed Recommendations:
  Modified paleoepidemiological stance
  Adaptive, not mitigative; hence “temporary”
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Highly “scientific,” but confusing for public
Strong research, no paradigm

Paleoanthropology-based Recommendations:
Investigatively-challenged, but attractive to public
Limited research, plausible paradigm

Paleoepidemiology-based Recommendations:
Combine attractive theory with investigative rigor
Evidence-based, gut-resonant advice

Sustainability-informed Recommendations:
Modified paleoepidemiological stance
Adaptive, not mitigative; hence “temporary”
**Adaptation** – addresses symptoms
10 Billion humans existing
Earth’s other life forms ↓
2100 C.E.

**Mitigation** – addresses causes
100 Million humans flourishing
Earth’s other life forms ↑
2200 C.E.
Nonsustainable  
(Now)

Adaptation  
(Near Future)

Mitigation  
(Far Future)
Current
–Unsustainable, unhealthful diets
  2015 C.E.

Near Future
–Sustainable, pseudo-Paleo diets
  2100 C.E.

Far Future
–Sustainable, true Paleo diets
  2200 C.E.
Overpopulation, climate change, and socioeconomic inequality – those are the megaproblems.

When world citizens address these issues, then nutrition scientists can advocate a true Paleo diet.
## Mangrove Loss due to Shrimp Aquaculture

<table>
<thead>
<tr>
<th>Country</th>
<th>% Mangrove Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>87%</td>
</tr>
<tr>
<td>Thailand</td>
<td>65%</td>
</tr>
<tr>
<td>Philippines</td>
<td>50%</td>
</tr>
<tr>
<td>Vietnam</td>
<td>80%</td>
</tr>
</tbody>
</table>
## Wild-caught Seafood – CO₂ Emissions

<table>
<thead>
<tr>
<th>Variety</th>
<th>tCO₂/t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sardines</td>
<td>0.2</td>
</tr>
<tr>
<td>Mackerel</td>
<td>1.1</td>
</tr>
<tr>
<td>Scallops</td>
<td>1.4</td>
</tr>
<tr>
<td>Salmon</td>
<td>2.9</td>
</tr>
<tr>
<td>(Farmed)</td>
<td>(2.2)</td>
</tr>
<tr>
<td>Albacore</td>
<td>4.2</td>
</tr>
<tr>
<td>Sole</td>
<td>7.4</td>
</tr>
<tr>
<td>Shrimp/Lobster</td>
<td>7.6</td>
</tr>
</tbody>
</table>
Cereal Grains, CO$_2$ Emissions

<table>
<thead>
<tr>
<th>Variety</th>
<th>tCO$_2$/t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>0.60</td>
</tr>
<tr>
<td>Oats</td>
<td>0.25</td>
</tr>
<tr>
<td>Maize</td>
<td>0.45</td>
</tr>
<tr>
<td>Rice</td>
<td>3.50</td>
</tr>
</tbody>
</table>