

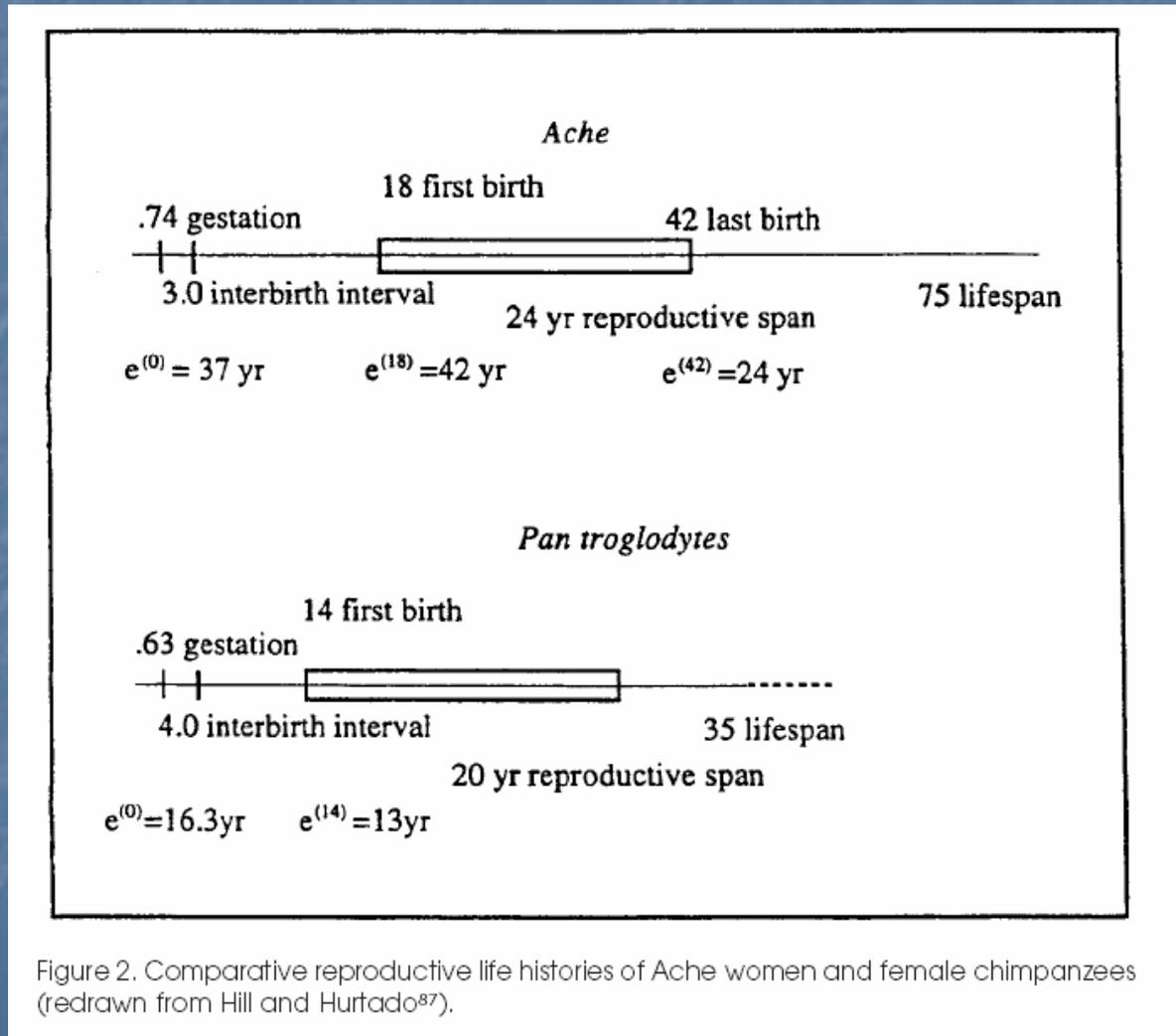
The “Evolution” of Menopause

Why does life continue after
reproduction ceases?

The Problem

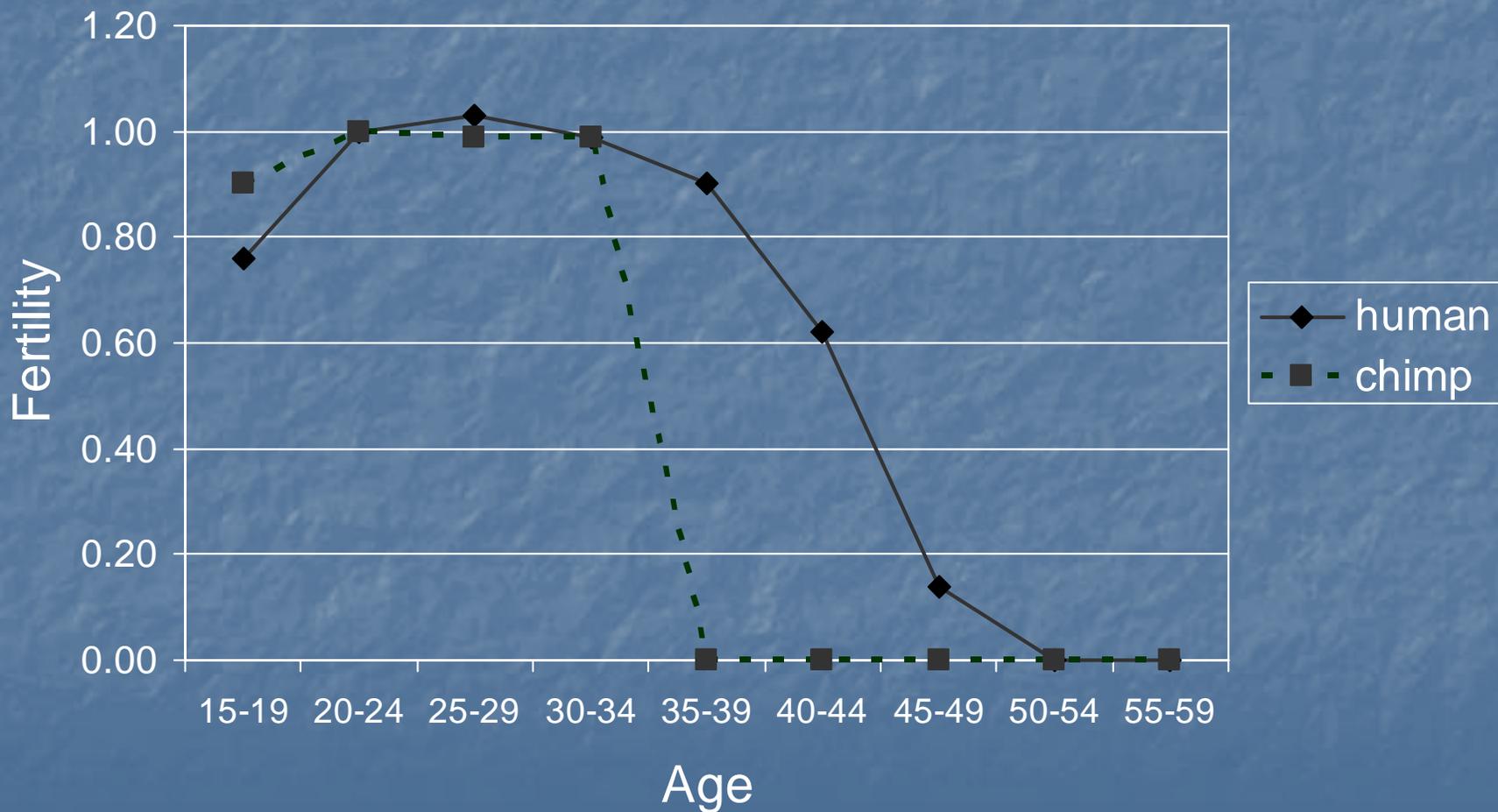
Menopause is equivalent to genetic death. We only know of a single other animal (short-finned pilot whale) that lives significantly (1/3 of its life) beyond menopause

How we compare to our closest relative

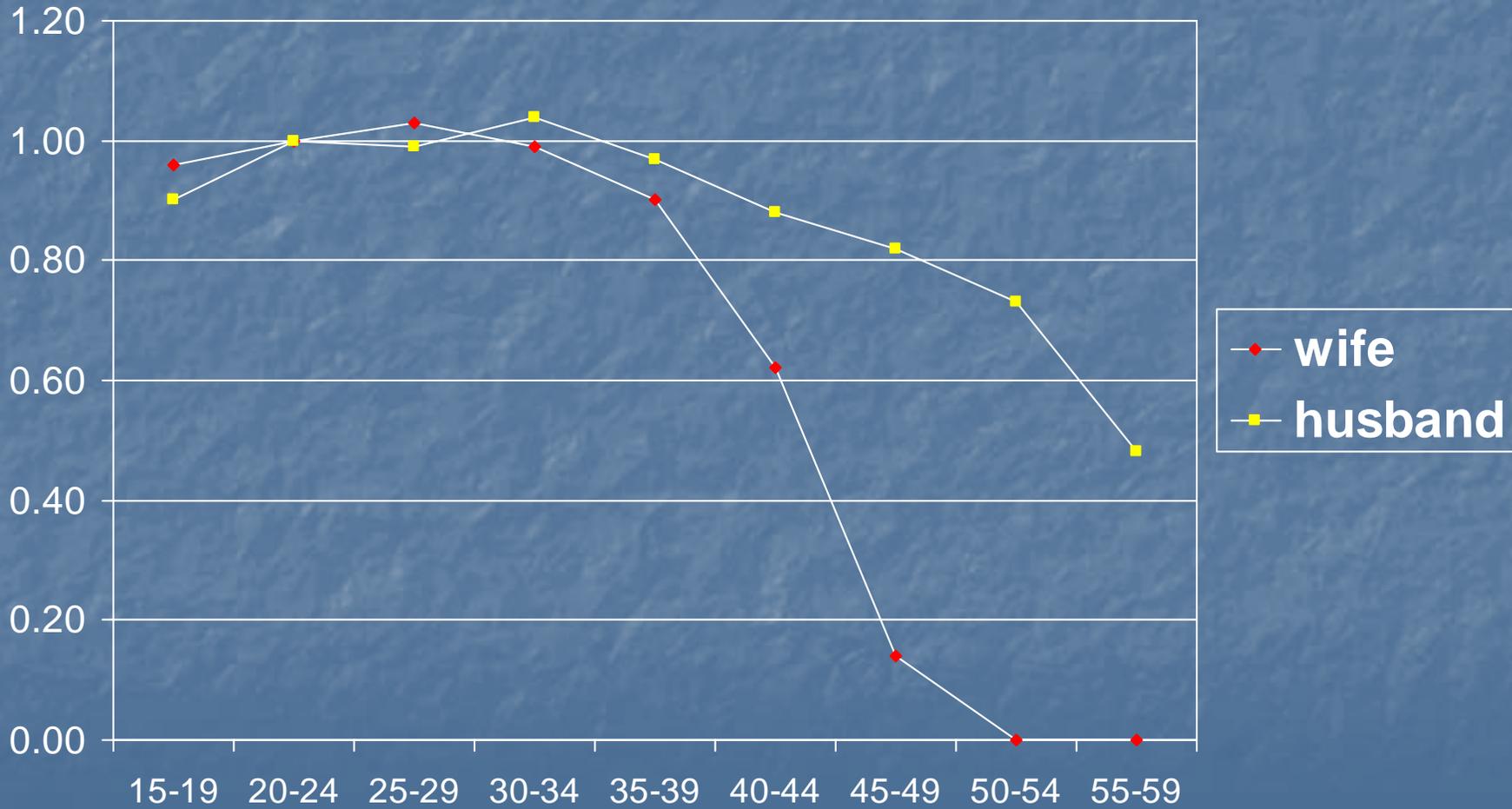


Source: Pecci 2001

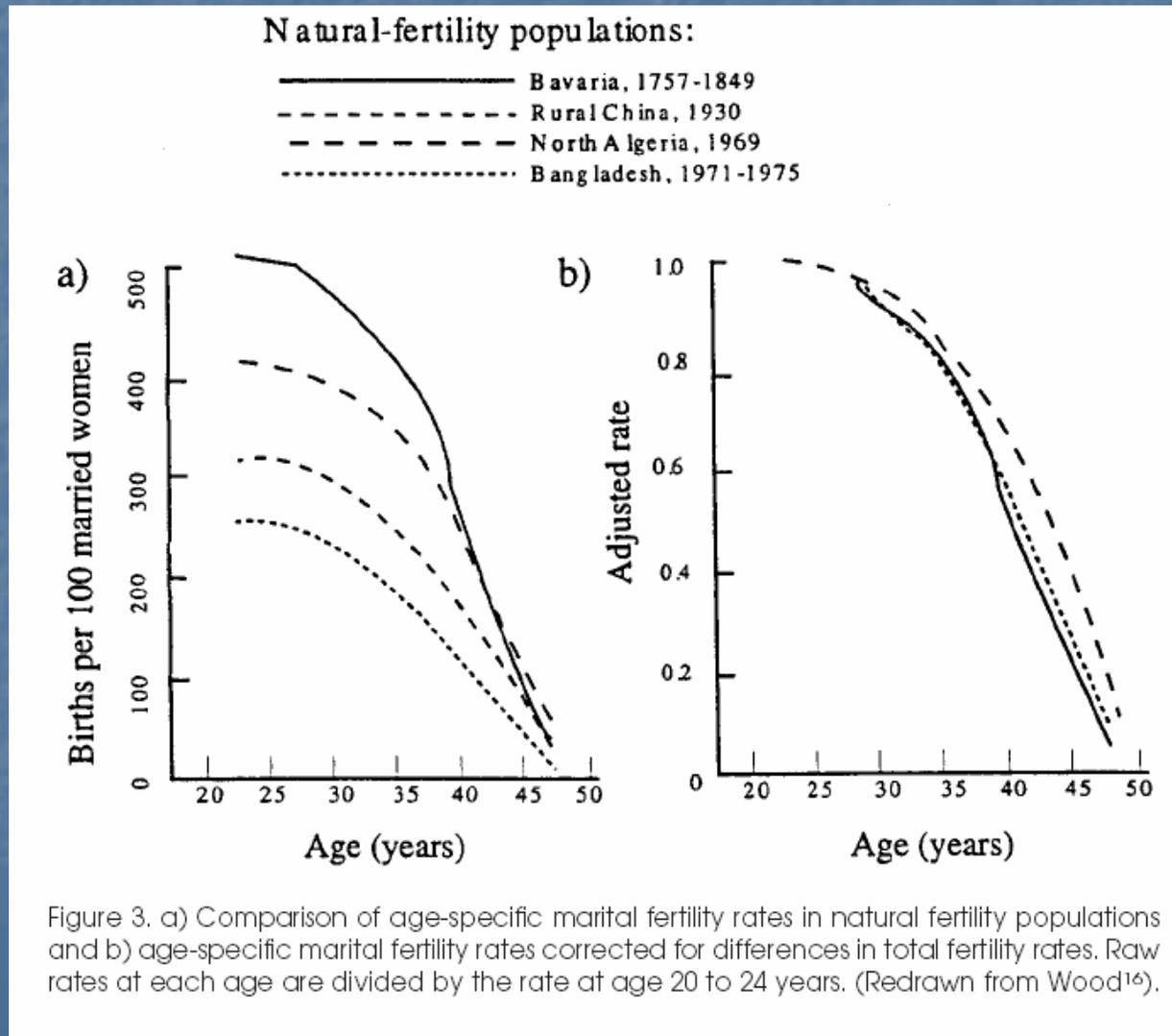
Chimp and Human Age Specific Fertility



Mormon Age Specific Fertility

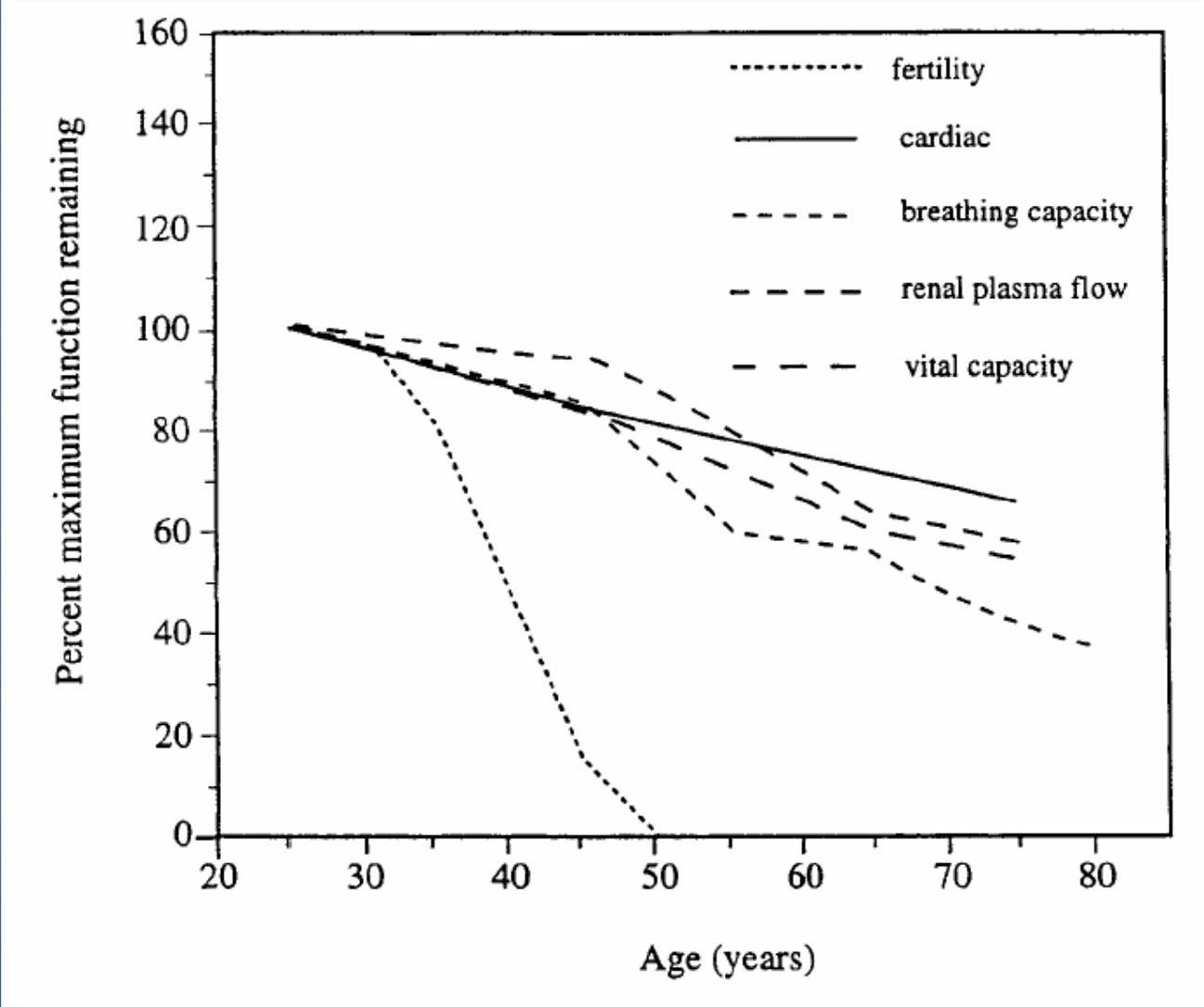


Fertility Decline in 4 Natural Fertility Populations



Source: Pecci 2001

Fertility Senescences Faster than other Abilities



Menopause and the end of fertility

- World-wide, menopause (the cessation of ovulation) occurs between the ages of 43 and 51.
- Menopause seems to occur earlier in tribal populations and later in well nourished western populations.
- Infertility consistently occurs at about the age of 47.
- Mean age at last birth is about 40 years

Theories of Menopause

- An artifact of recent increases in longevity
- The grandmother hypothesis (K. Hawkes)
 - Cessation of fertility to become a helpful grandmother
 - Increases in longevity to become a grandmother with cessation of fertility as a side-effect
- The Patriarch Hypothesis (F. Marlowe)
- The Mother Hypothesis (J. Peccei)
 - Cessation of fertility in order to help children and ensure that the last one born survives

Symon's Artifact

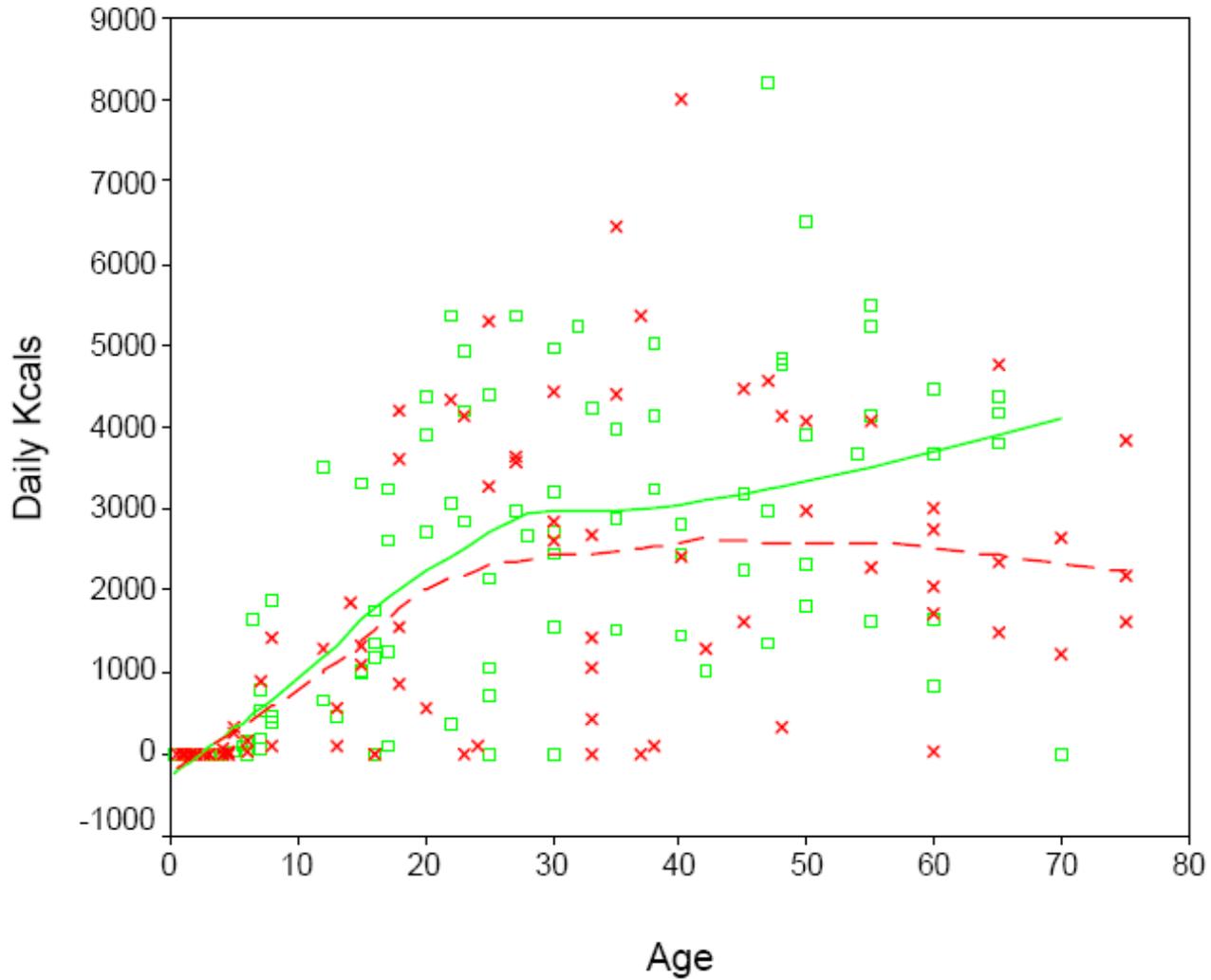
- Based on the accurate observation that life expectancy at birth for foragers is about 35-40 years.
- Therefore, through out most of human history women died as they were going through menopause. Menopause is not an adaptation but a side-effect of recent increases in longevity.
- However, the average life expectancy of a 20 year old forager woman is 20-30 years past menopause.
- Up to 20% of forager women in a group are post-menopausal.



Grandmother Hypothesis (Hawkes)

- Humans require heavy investment up to age 18 (i.e., they are not not producers until then).
- This task is largely borne by mothers. According to this model, fathers produce food for mating, not parenting.
- Grandmothers are able to assist in the provisioning and care of grandoffspring.
- Such provisioning allows daughters to reduce birth intervals and increases survivorship and fertility.

Hadza Calorie Production: grandmothers produce most



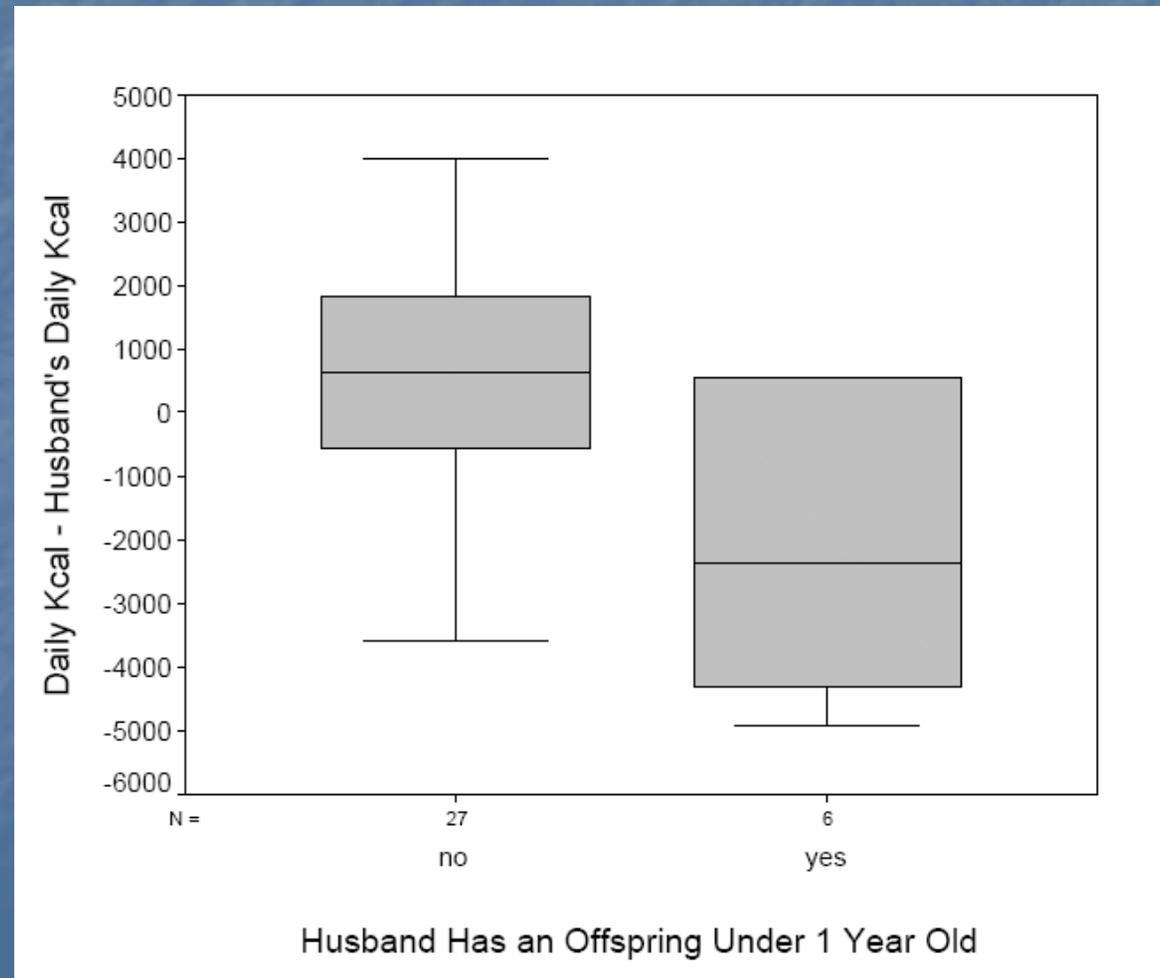
green=females
red=males

Evidence for Grandmother Hypothesis

- Hadza children who had maternal grandmother showed positive weight gains compared to those who did not
- Gabbra children who had maternal grandmothers had
 - higher survivorship rates
 - better nutritional status
 - But only during toddlerhood (12-23 months) and not during infancy or in later childhood
- Aché children with grandparents had higher survivorship but not significantly higher than those who did not
- However, contemporary and historic data from a variety of places show having a mother during reproductive years enhances a woman's fertility and the survivorship of her children
 - Finland (Lumma)
 - England (Ragsdale)
 - Germany (Voland)
 - India (Leonetti)
 - Gambia (Mace)

Contradictory Hadza Data: as women produce less during pregnancy their husbands produce more

Figure 1. Daily kcals a woman takes back to camp, minus her husband's, for couples (age 18-65) with and without a child < 1 yr old.



Hadza men do more than just hunt: men produce more non-game food

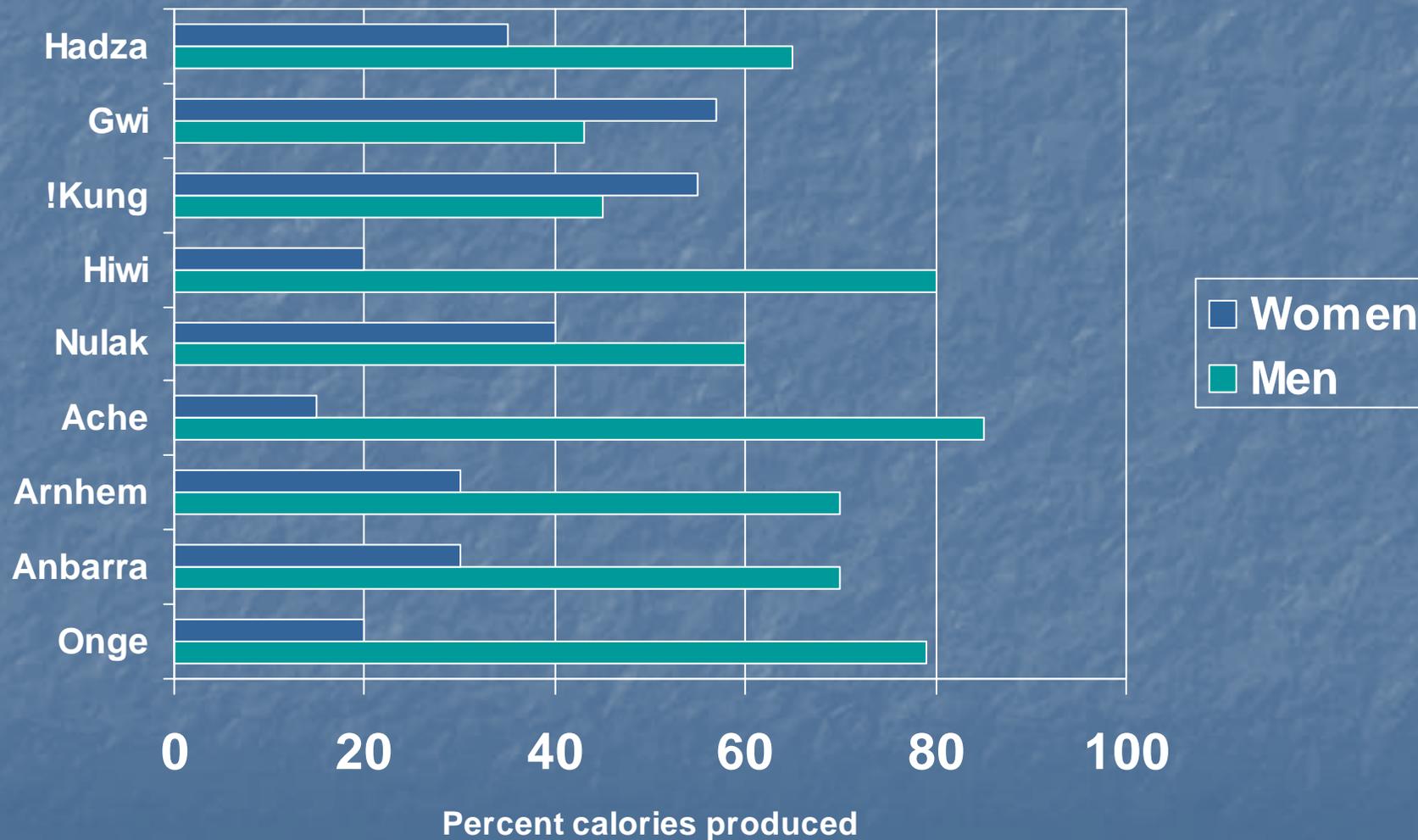
Table 1. Of food brought into camp (n = 183 individuals), percent of daily kilocalories by food type.

Food contributed by:	Berries	Tubers	Honey	Baobab	Meat	Maize/millet
1) Both sexes of all ages	17.2%	23.5%	14.2%	19.2%	19.3%	6.6%
2) Women (\geq 18 yrs old)	24.8%	38.8%	.7%	25.6%	1.2%	8.9%
3) Men (\geq 18 yrs old)	6.3%	5%	30.2%	13.8%	39.6%	5.1%

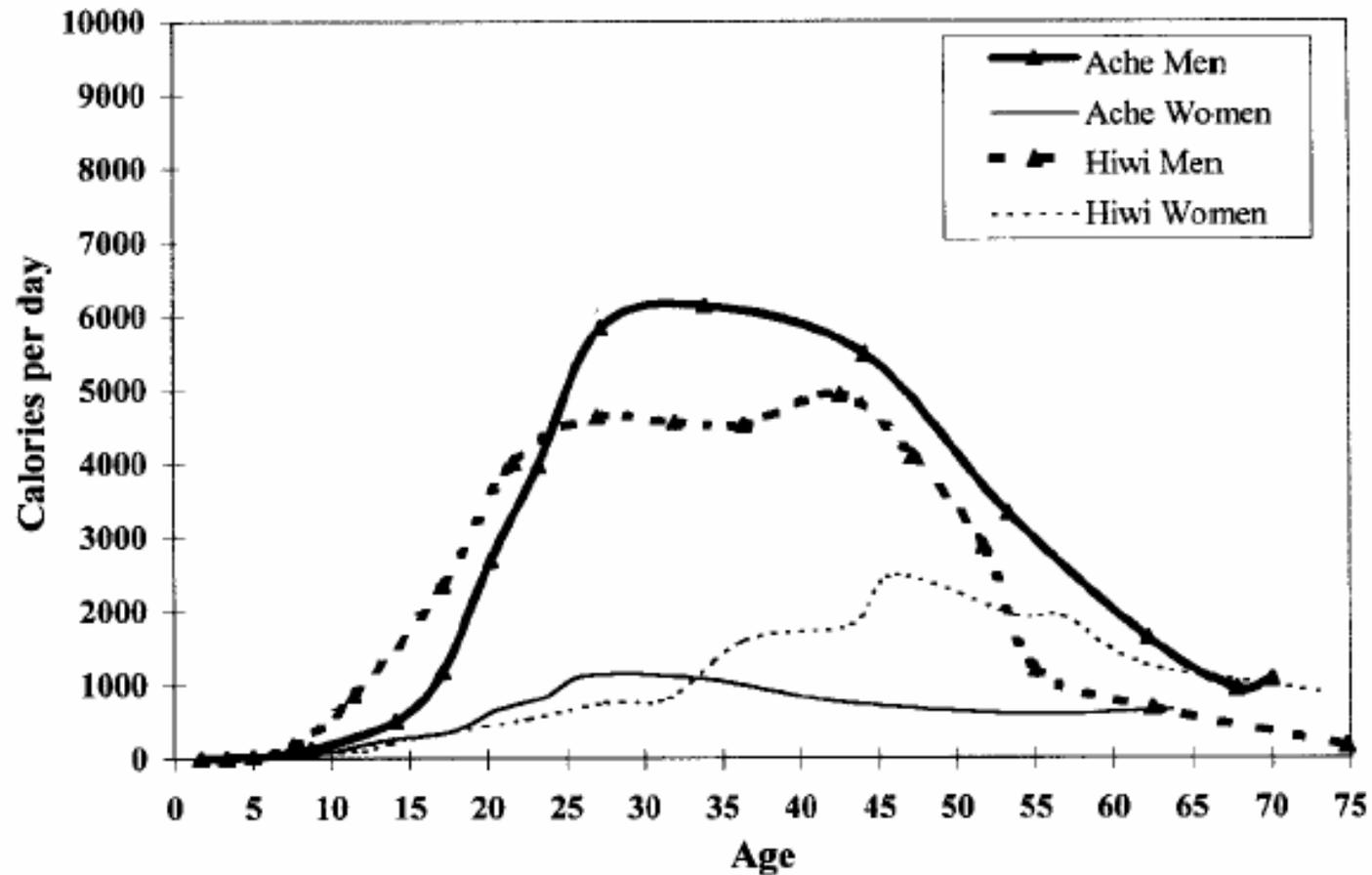
and men produce more total food when their wives are pregnant or lactating:

On the whole, [men] contribute 43% of all daily kilocalories arriving in camp, but 50% among married couples, and 69% among those with nursing infants (Marlowe 2003a)

Males do produce: further evidence against the grandmother hypothesis



Forager Productivity by Sex: males produce more nearly all of the time



Hadza are an exception

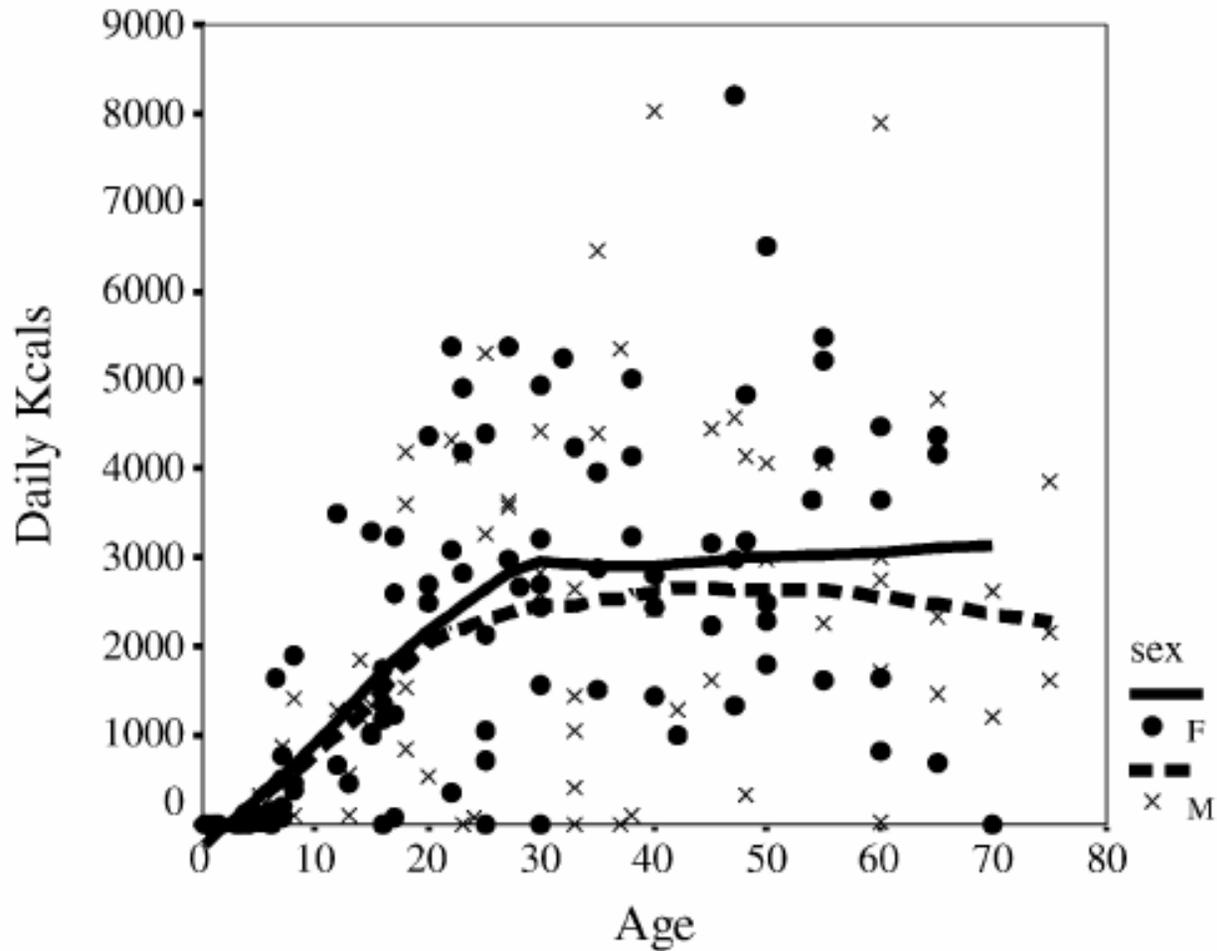


Fig. 1. Daily Kilocalories Brought Into Camp by Hadza Males and Females By Age. Note: Regression lines are lowest smooth.

The grandmother hypothesis presupposes matrilocality (or female philopatry)

- If grandmothers are to help their daughters (as predicted by the model) they must live in the same place.
 - However, only 17% of foraging societies are matrilocal
 - Still, even in a patrilocal or bilateral situation a grandmother may be able to shift her residence to her daughter's after the death or divorce of her husband

Marlowe's Patriarch Hypothesis

The patriarch hypothesis proposes that once males became capable of maintaining high status and reproductive access beyond their peak physical condition, selection favored the extension of maximum life span in males. Because the relevant genes were not on the Y chromosome, life span increased in females as well. However, the female reproductive span was constrained by the depletion of viable oocytes, which resulted in menopause.

- **Selection for male longevity because**
 - Male economic productivity (total calories brought back to camp) begins to decline after 50 but it is not steep.
 - One's ability to mate is not strongly dependent on strength (which does decline with age) because of weapons.
 - Male status does not decline much with age.
 - Productive males are attractive to females because of the investment they can provide.
- **If gene for longevity is on X chromosome, females are dragged along as a by-product of continued male fertility**