

Thrifty Genotype and Inactivity

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Ossabaw pigs are found wild (feral) in America on Ossabaw Island, Georgia (Figure 1). These pigs were left on this isolated island about 500 years ago by Spanish explorers. They evolved to accommodate the extreme environment, which includes thick woods and underbrush, freshwater swamps, and saltwater marshes (Figure 2). Through natural selection the pigs that could tolerate consumption of sea water during drought survived. Their kidneys adapted to excrete higher concentrations of salt and retain water. The salt that is not excreted is tolerated at higher concentrations in the blood. Perhaps the most outstanding trait of the Ossabaw pig is their "thrifty" utilization of food, which enabled them to store large amounts of fat during times of feasting and then survive periods of famine.

The thrifty genotype (1) or genetic predisposition to obesity (2), is clearly shown by the 5 times greater fat content compared to lean pigs (for example, commercial hogs or the Yucatan breed research pigs). Generally, Ossabaw are miniature pigs and are only around 200 lbs when full grown in captivity, compared to a 700 lb commercial pig. On Ossabaw Island the pigs remain very physically active and lean, but if inactive they will develop gross obesity (Figure 3). Humans similarly acquired the obesity trait to survive famine, but this thrifty trait is detrimental in these modern times of plentiful food supply and minimal exercise. Indeed, obesity very often leads to type 2 diabetes, which afflicts nearly 50% of adult Pima Indians in the southwest U.S. and is largely the result of lifestyle changes, that is, modern western society with too much food and too little exercise compared to their former active lifestyle (reference 3, Figure 4).

The detrimental aspect of the thrifty genotype in sedentary, obese Ossabaw pigs and humans is the "metabolic syndrome", also known recently as "pre-diabetes" (4). The metabolic syndrome is characterized by central obesity ("beer belly"), increased blood glucose, high blood cholesterol and triglycerides, and high blood pressure. If obesity is maintained long-term, Ossabaw pigs, like humans, will develop type 2 diabetes. Long duration, excessive obesity and type 2 diabetes lead to four times more heart disease in diabetic humans compared to non-diabetics. Since the hearts of pigs and humans also are nearly identical, Ossabaw pigs are an excellent animal from which to learn the underlying causes of these diseases and could facilitate development of new therapies to prevent type 2 diabetes and heart disease.

There is a resurgence of interest in Ossabaw pigs because of the obesity epidemic in the U.S. (5). Until recently, there were fewer than about 40 Ossabaws in captivity. The Georgia Department of Natural Resources is eradicating the pigs from Ossabaw Island (6), thus Ossabaw pigs are rare and vanishing. Scientists conducted an expedition to Ossabaw Island to remove pigs and now Indiana University School of Medicine and Purdue University scientists have the only research and large scale breeding colony of Ossabaw pigs in the world that are certified to express the metabolic syndrome phenotype and heart disease.

SUMMARY: Ossabaw pigs have a "thrifty genotype" that predisposes them to obesity, but if they exercise they do not become obese nor develop type 2 diabetes and heart disease. Ossabaw pigs teach humans how to live ...

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1. Neel, J.V. Diabetes mellitus: a "thrifty" genotype rendered detrimental by "progress"? *Am.J.Hum.Genet.* 14:353, 1962
2. Martin, R.J. et al. Characterization of an obese syndrome in the pig. *Proc. Soc. Exp. Biol. Med.* 143:198, 1973
3. Marx, J. Unraveling the Causes of Diabetes. *Science* 296:686, 2002
4. <http://www.diabetes.org/main/info/pre-diabetes.jsp>
5. <http://www.cdc.gov/nccdphp/dnpa/obesity/trend/metabolic.htm>
6. http://www.state.ga.us/dnr/wild/game_mgmt/theplan.pdf; page 41



Figure 1. Ossabaw Island, Georgia, USA



Figure 2. Habitat of Ossabaw Island
Left—thick woods, underbrush; center—swamp; right—salt marsh



Figure 3. Active, lean and inactive, obese Ossabaw

Figure 4. Active, lean and inactive, obese Pima Indians