Author's Note to Readers: Science? Or Fiction?

First of all I want to thank you, dear reader, for reading this story! I hope you enjoyed reading it as much as I enjoyed writing it.

You may be left wondering if any of it is true.

Are we really in danger of being replaced as a species the way Neanderthals were just 40,000 years ago? Could we be headed into another glacial period or is global warming a real concern?

While it has been asserted that humans are increasing atmospheric CO2 levels and thus artificially warming the planet, I maintain two things: 1) the earth is warming due to a natural cycle of warming and cooling, and 2) when the next glacial period comes, no amount of CO2 that humans can generate will stop it.

Consider the following information as seen from one anthropologist's point of view (namely, me).

THE SCIENCE
Glacial Periods

An **ice age** is a period of long-term reduction in the temperature of Earth's surface and atmosphere, resulting in the presence or expansion of continental and polar ice sheets and alpine glaciers.

A **glacial period** is an interval of time **within** an ice age that is marked by colder temperatures and glacier advances.

An **interglacial period** takes place between glacial periods. It is an interval of time within an ice age that is marked by periods of a warmer climate.

Currently, we are living in an interglacial period of an ice age called the Quaternary (aka, "Pleistocene"). This ice age started 2.5 million years ago and is still taking place. The ice sheets of Greenland, Arctic, and Antarctic have existed throughout this ice age.

During the coldest episodes (glacial periods) of this ice age, large ice sheets at least 2.5 miles thick at their maximum existed in Europe, North America, and Siberia (and, of course, Antarctica).

Over the past 700,000 years there have been roughly four glacial periods and four interglacials.[2] When these occurred, and how long they lasted, is determined through the analysis of ice cores.

The following is a table of climate change patterns over this time period[1]:

Changing Climate Patterns of the Pleistocene Epoch				
Epoch	**Climate**	**Years Ago * (approximate)**	**Regional Name for Climate Stage**	
			European Alps	**North America**
Holocene	interglacial	10,000 to the present		
Pleistocene	glacial	110-70,000 to 12-10,000	Würm	Wisconsin
	interglacial	130-125,000 to 110,000	Riss-Würm	Sangamon
	glacial	200,000 to 130-125,000	Riss	Illinoian
	interglacial	380-300,000 to 200,000	Mindel-Riss	Yarmouth **
	glacial	455-410,000 to 380-300,000	Mindel	Kansan **
	interglacial	620,000 to 455-410,000	Günz-Mindel	Aftonian **
	glacial	680,000 to 620,000	Günz	Nebraskan **
	Evidence of glacial and interglacial episodes during the early Pleistocene is less clear. However, it is believed that there were 2 or more glacials with intervening interglacials. Between the Pleistocene and the preceding Pliocene Epoch was a long period of gradual cooling.			

The last glacial period lasted from 110,000 to 12,000 years ago and is commonly referred to as "The Ice Age." This misnomer is probably due to the fact that it's the coldest period on record since modern humans came on the scene 50,000 years ago.

As mentioned above, we are currently in an interglacial period (called the Holocene epoch). You will recall that interglacial periods are periods of warming between glacial periods. This means that the climate is warming – and will likely continue to warm – until the next glacial period begins.

The last interglacial period only lasted about 15,000 years. We're approximately 12,000 years into this one. It may take another few thousand years, but another glacial period **will** come.

Human Evolution

The dates of human evolution are based on the fossil record as we know it. The three major human species of the last million years were *Homo heidelbergensis*, *Homo neanderthalensis*, and *Homo sapiens*.

The dates for these species are as follows:

H. heidelbergensis 700,000-200,000 years ago
H. neanderthalensis 400,000-40,000 years ago (also known as *H. sapiens neanderthalensis)*
H. sapiens 200,000 to present

Marcus Greene, the anthropologist in the novel, hypothesized that, "After each glacial period, a new species of human starts to flourish. This is known as Punctuated Equilibrium, or bursts of evolutionary change among long periods of stability. It is my belief, and that of many other anthropologists, that interglacial periods are one major trigger for evolutionary change."

Was Marcus correct? Let's have a look at the dates of human evolution as they relate to the interglacial periods:

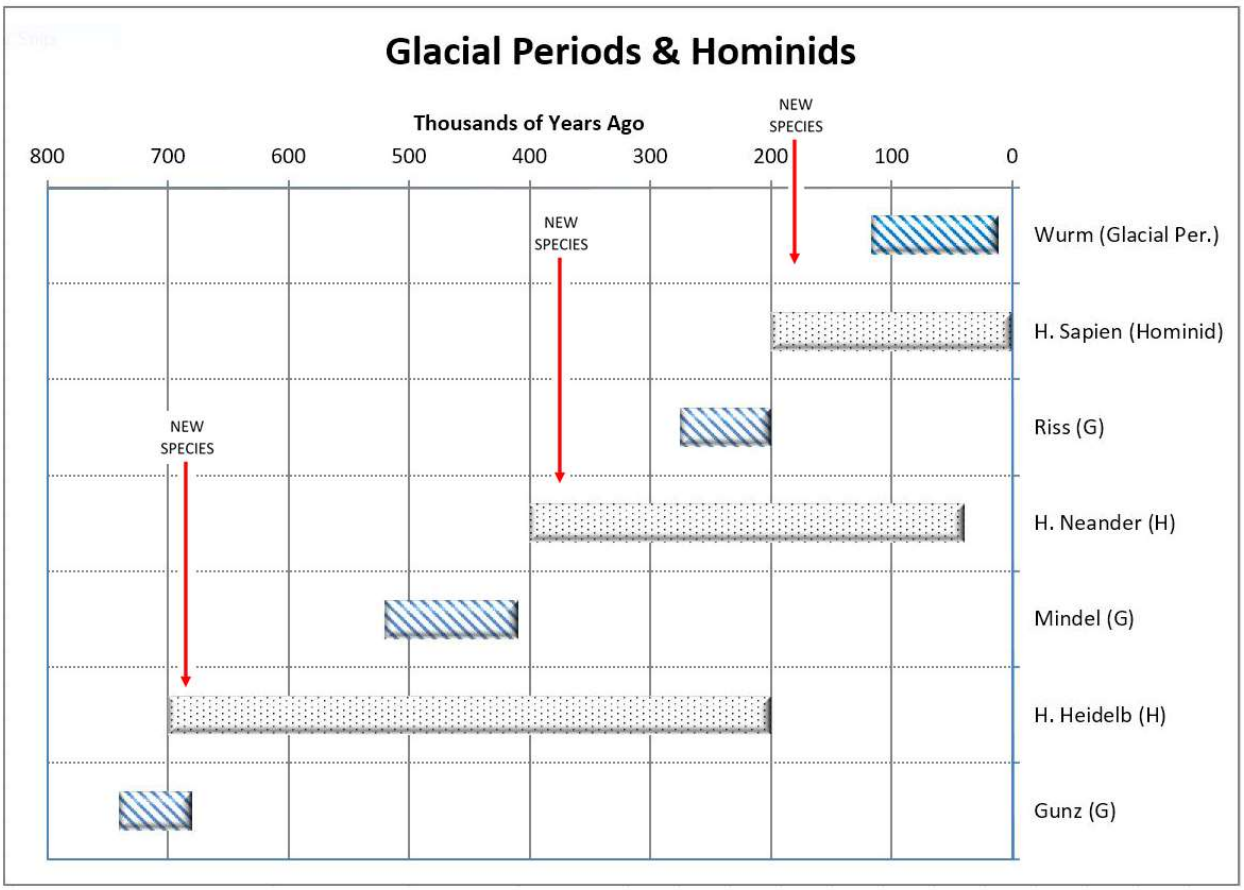
H. heidelbergensis was a species of humans that lived in Africa, Europe and West Asia. With a brain nearly as large as modern humans, they are thought to be the evolutionary ancestor of Neanderthals and humans. They buried their dead and there's evidence of hunting, tools and possibly even rudimentary language. This species showed up during the **Gunz-Mindel interglacial** period and reigned for five hundred thousand years.

The remains of *H. neanderthalensis* have been found in Eurasia, from Western Europe to Central and Northern Asia and the Middle East. Commonly known as "Neanderthals," they appeared during the **Mindel-Riss interglacial** period and lasted through the Riss glacial period as well as much of the next (called the Wurm). They were designed for cold-weather living. They had barrel chests and stocky limbs which helped store body heat. That species went extinct around 40,000 years ago.

Homo sapiens originated in Africa and now cover the globe. Our species came on the scene around 200,000 years ago and co-existed with Neanderthals for almost 160,000 years. We sprung up during the last interglacial called the **Riss-Wurm interglacial**.

Modern humans (which is what you and I are) are technically a subspecies of humans called *Homo sapiens sapiens.* We emerged around 50,000 years ago and are the only species of humans left on earth. Scientists have recently added the term "*sapiens*" to the Neanderthal species classification because we now know that they interbred with us. This is why the character Marcus Greene classified New Man as *Homo **sapiens** provectus*. He knew we had been interbreeding.

The following is a chart showing 800,000 years of human evolution and glacial periods:



In this chart, one can see the evolution of a new human species each time a glacial period had ended.

THE FICTION
DNA and Evolution

In the story, Marcus Greene says, "It was only about five years ago that anthropologists learned our DNA seems to know what's coming evolutionarily before we ourselves even know." When Marcus says this, the date in the story is 2025. So "five years ago" would be 2020. As of the date of this book's publication, that is still four years into the future. Scientists don't really have enough evidence in the way of DNA (e.g., mapped genomes) nor fossils of hominid species to know which comes first. We hypothesize that environmental change selects for certain evolutionary traits which are then passed down through our DNA via the process of natural selection. However, it's not a complete stretch to suggest that DNA might actually anticipate evolutionary change, rather than be the end result of it. This concept may touch on the realm of science- or speculative-fiction, but it's certainly an idea that I found interesting. One of the joys of being a fiction writer is to weave in bits of speculation such as these.

Homo sapiens provectus

Provectus is a Latin adjective meaning "advanced." While technically it translates to advanced as in *age* or *moving forward*, I liked the word and thus appropriated it for my own purposes.

Neanderthal gestation periods

Due to Neanderthal pelvic morphology and the large brain (and thus skull) size of Neanderthal babies, it has been suggested that females were pregnant anywhere from 10 to 14 months, rather than 9. However, there is some disagreement between anthropologists on this subject. There currently isn't enough data in the fossil record to make an accurate determination.

Genetic Bombs

Stainer's biological weapon – one which "unzips" a targeted strain of DNA – does not really exist. And I hope it never does.

In Summary

Based on ice cores and fossil records, it would appear that each new species of human over the past million years did in fact evolve during an interglacial period. We are now in a new interglacial period. As Marcus said, "We are about due for an evolutionary change."

Scientists claim that human behavior has raised CO2 levels from 300 parts per million to 400 ppm[2]. An analogy for this would be if your friend had a million dollars, and he gave you "400 parts per million," you would have 400 dollars. This is the ratio of CO2 to the rest of the atmosphere.

We also know that interglacial periods are periods of warming. It is not unreasonable to think that the earth may even get warmer before it gets cooler again – all independent of human activity.[3]

You're free to take what you want from all of this, but I would like to encourage you to **think for yourself**. Think critically. Don't blindly take my word for it. Don't blindly believe what you hear on TV and in the news. Do the research. Just be aware that there are some scientific journals that – as a matter of editorial policy – will not publish any articles which contradict anthropogenic global warming. To me, this goes against the very fabric of scientific inquiry. And this will make your research job harder, should you choose to accept the challenge.

I believe in you. Readers of science-based fiction are intelligent and have inquiring minds.

Remember that the earth's climate is an intricate system which we've been studying for fewer than 200 years. Science takes time and by definition is never settled.

Bibliography

1. These time ranges are approximations and do not reflect the fact that temperature changes between glacials and interglacials usually occurred over thousands of years. (principal sources: P. Gibbard and T. Van Kolfschoten (2004) "The Pleistocene and Holocene Epochs", ch. 22, in F.
2. http://www.onearth.org/earthwire/carbon-dioxide-400ppm
3. Steig, Eric J. *et. al.*, Recent climate and ice-sheet changes in West Antarctica compared with the last 2,000 years. *Nature Geoscience*, 6, 372-375 (2013).