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Of lice and men (and chimps): Study tracks pace of molecular evolution

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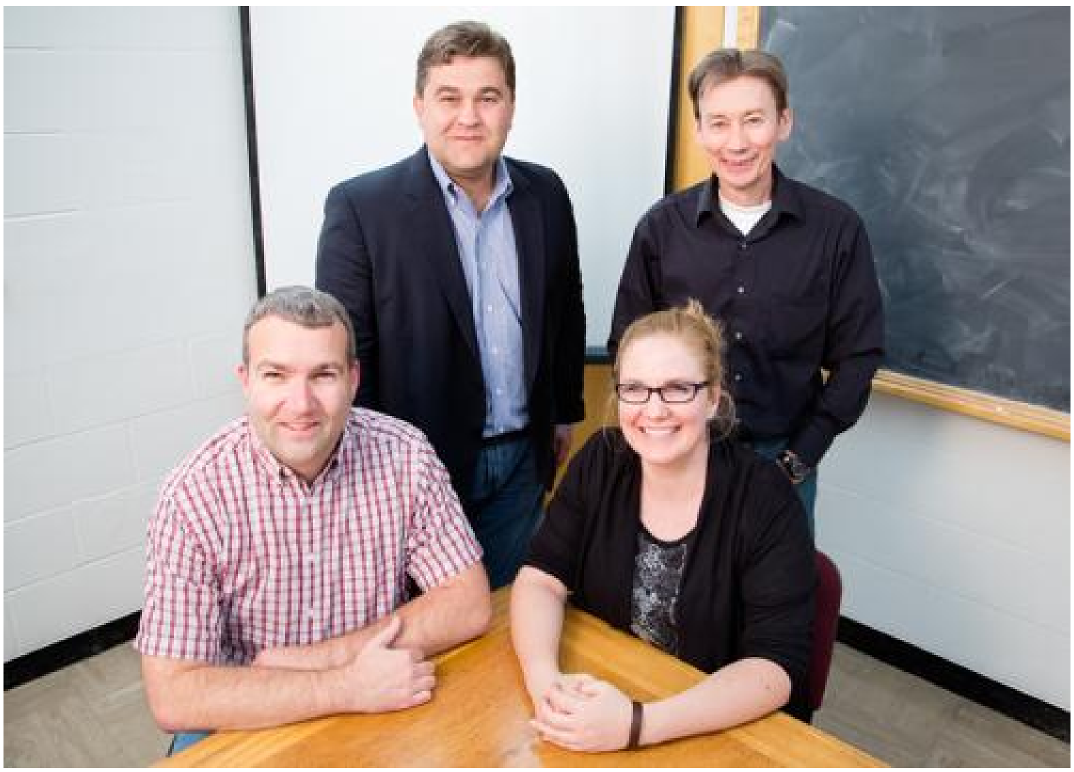

A new study led by Kevin Johnson of the Illinois Natural History Survey (seated, at left), with (from left to right) entomology professor Barry Pittendrigh, animal biology professor Ken Paige and postdoctoral researcher Julie Allen, indicates lice are evolving faster than their human and chimpanzee hosts. Credit: L. Brian Stauffer

A new study compares the relative rate of molecular evolution between humans and chimps with that of their lice. The researchers wanted to know whether evolution marches on at a steady pace in all creatures or if subtle changes in genes – substitutions of individual letters of the genetic code – occur more rapidly in some groups than in others.

A report of the study appears in the *Proceedings of the Royal Society B*.

The team chose its study subjects because humans, chimps and their lice share a common historical fate: When the ancestors of humans and chimps went their separate ways, evolutionarily speaking, so did their lice.

"Humans are chimps' closest relatives and chimps are humans' closest relatives – and their lice are each others' closest relatives," said study leader Kevin Johnson, an ornithologist with the Illinois Natural History Survey at the University of Illinois. "Once the hosts were no longer in contact with each other, the parasites were not in contact with each other because they spend their entire life cycle on their hosts."

This fact, a mutual divergence that began at the same point in time (roughly 5 million to 6 million years ago) allowed Johnson and his colleagues to determine whether molecular evolution occurs faster in primates or in their parasites.

Previous studies had looked at the rate of molecular changes between parasites and their hosts, but most focused on single genes in the mitochondria, tiny energy-generating structures outside the nucleus of the cell that are easier to study. The new analysis is the first to look at the pace of molecular change across the genomes of different groups. It compared a total of 1,534 genes shared by the primates and their parasites. To do this, the team had to first assemble a rough sequence of the chimp louse (*Pan troglodytes schweinfurthii*) genome, the only one of the four organisms for which a full genome sequence was unavailable.

The team also tracked whether changes in gene sequence altered the structure of the proteins for which the genes coded (they looked only at protein-coding genes). For every gene they analyzed, they determined whether sequence changes resulted in a different amino acid being added to a protein at a given location.

They found that – at the scale of random changes to gene sequence – the lice are winning the molecular evolutionary race. This confirmed what previous, more limited studies had hinted at.

"For every single gene we looked at, the lice had more differences (between them) than (were found) between humans and chimps. On average, the parasites had almost 15 times more changes," Johnson said. "Often in parasites you see these faster rates," he said. There have been several hypotheses as to why, he said.

Humans and chimps had a greater percentage of sequence changes that led to changes in protein structure, the researchers found. That means that even though the louse genes are changing at a faster rate, most of those changes are "silent," having no effect on the proteins for which they code. Since these changes make no difference to the life of the organism, they are tolerated, Johnson said. Those sequence changes that actually do change the structure of proteins in lice are likely to be harmful and are being eliminated by natural selection, he said.

In humans and chimps, the higher proportion of amino acid changes suggests that some of those genes are under the influence of "positive selection," meaning that the altered proteins give the primates some evolutionary advantage, Johnson said. Most of the genes that changed more quickly or slowly in primates followed the same pattern in their lice, Johnson said.

"The most likely explanation for this is that certain genes are more important for the function of the cell and can't tolerate change as much," Johnson said.

The new study begins to answer fundamental questions about changes at the molecular level that eventually shape the destinies of all organisms, Johnson said.

"Any difference that we see between species at the morphological level almost certainly has a genetic basis, so understanding how different genes are different from each other helps us understand why different species are different from each other," he said. "Fundamentally, we want to know which genetic differences matter, which don't, and why certain genes might change faster than others, leading to those differences."

More information: "Rates of Genomic Divergence in Humans, Chimpanzees and Their Lice," rspb.royalsocietypublishing.or … .1098/rspb.2013.2174

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