



Primatology (ape studies) and DNA research unlock the answers...

Where Do Human Beings Come from, and Where Are We Heading?

Yamagiwa Juichi, President of Kyoto University & Fukuoka Shin-Ichi, Biologist

Racial discrimination, sex, the aging population...

Watching gorillas gives us insight into the future of human society



Yamagiwa Juichi, President of Kyoto University



Fukuoka Shin-Ichi, Biologist

Fukuoka: Professor Yamagiwa, you were recently appointed president of Kyoto University. I myself too started my gene research at Kyoto University's Faculty of Agriculture as a junior of yours, but later transferred to Aoyama Gakuin University, and now live life as a researcher in New York. I'm what you might call a kind of stray monkey wandering from troop to troop. I guess that makes you the boss monkey, doesn't it (laughs)?

Yamagiwa: When you say "boss monkey" I think you're probably picturing something like a Japanese macaque or other monkey, but actually I'm a gorilla (laughs). They're completely different, you know.

Because Japanese macaque society is a power system, the boss must retain constant authority. They live in a world where the line between winning and losing is clear-cut, where the rule is that



the subordinate must give way to the dominant. In contrast to this, gorilla society is leader-based rather than boss-based. In other words, the leader is carried by the other gorillas. In the case of Japanese macaques, if a stronger monkey comes along, the boss has to surrender his position to the stronger rival, but once a gorilla becomes a leader—at least for a time—he will not be driven from his position. However, when the leader receives various “tributes” from the other gorillas, he cannot keep them to himself. It is the leader’s role to reapportion these fairly amongst the others. In that sense, it is not a power system by any means. I think of myself as being a gorilla-type leader. It’s my role to take on board the opinions of those in the field and to go on to reflect those opinions.

Fukuoka: But what happens if a gorilla leader makes a mess of everything?

Yamagiwa: A band of gorillas consists of a male leader surrounded by a number of females and young gorillas, but if the females start to dislike the male then they leave the band and go off somewhere to be with another male. Being a male gorilla is tough work. At first glance they seem big and strong, but are actually just putting on a show of bravado as they do various things.

Human beings, who will have sex with any partner regardless, will eventually eradicate racial discrimination

Fukuoka: I have considered human beings from the perspective of the very smallest world: the world of genes. I think that the ultimate objective of your primatology, too, is to get to know about humans. That means that what is important is to what extent we can extract the characteristics of the problems we face now in the present day from apes, or from DNA and so on.

For that reason, the first thing I would like to ask is about the problem of racial discrimination. I’m currently living in the United States, and as expected I do get a real sense that there are people suffering because of racial issues. But when you think about what race really is, it’s often quite hard to understand, isn’t it.

For example, President Obama is said to be the first black president of the United States, his mother is white, and he is in actual fact of mixed race. But because his father is black he too is regarded as a black man. As for the golfer Tiger Woods, he is actually a mix of white, black, native American and Asian, and is therefore only one-quarter black, yet he too is treated as a black man. In the United States, too, there have historically been various debates over exactly what it is that makes a person black, but for a long time the “one drop rule”—in other words, if even a single drop of “black” blood flows in a person’s veins then that person is regarded as black—has been applied.

But if we were to regard any person whose blood contains a single drop of “black” blood as black then in actual fact the entire human race, including white people, would be classified as black. This is because we all originally came from Africa. Amongst the modern humans (*Homo sapiens*) that were born in Africa some 200,000 years ago, there appeared some “white” people, who found it



difficult to produce skin pigment. Eventually these people travelled north and settled in Europe, and it was from there that the ancestors of the Asian peoples came also. For this reason, if we investigate people's bloodlines or such using DNA, we find that those most closely related to black people are white people, and that the "yellow" races are somewhat distant. However, when it comes to the question of whether we can distinguish between white and black people by their DNA, the answer is that it's virtually impossible. Rather, the variations between the genes of two fellow white people are greater than the variations between white people and black people. In other words, DNA cannot explain race.

On that note, I have a question for you: do gorillas distinguish between our (human) races? I've heard that the late Dian Fossey, the famous female American gorilla-studier, forbade anybody other than white researchers from approaching the gorillas. Why was that?

Yamagiwa: The reason why Dian Fossey did that was because, since almost all of the local poachers were black, she worried that if the gorillas grew accustomed to black trackers (study assistants) then they would become unable to distinguish between them and the poachers, and would approach them and be captured. Only, I think that gorillas are not that stupid. It is thought that the criteria is whether or not the person has a familiar face or not, rather than racial differences such as whether a person is black or white. Even if we are the same Japanese, the gorillas might look at my face and feel safe and secure, but see another person and become very wary and guarded. I think that their classifications of people they can feel secure around and people who they perceive to be a danger are well defined, and that they do not distinguish between people by their race, i.e. whether they are black or white or so on.

The Neanderthal blood that remains within us

Fukuoka: Thinking about gorillas amongst themselves, are there ever, for example, cases where white individuals—like white people—are suddenly born amongst gorillas?

Yamagiwa: Yes, there are. In the past, there was an albino gorilla at Barcelona Zoo named Snowflake.

Fukuoka: What kind of treatment do individuals like that receive?

Yamagiwa: I don't know how he was treated in the wild, but in his natural habitat being bright white would really make him stand out, so he was probably given special treatment. Among primates there are species for which the young are a completely different color to the adults. For example, with silvery lutungs, the parents are silver but their offspring are bright yellow. It's thought that while the young are still yellow that not only their parents but also the rest of the troop



give them special treatment. Standing out and attracting interest amongst the other monkeys is not something that draws aggression.

Fukuoka: When white people—close to albinos—appeared amongst the small groups of the first humans in Africa, how were those people treated? Considering the fact that they were forced to move away from there, I think that they must have induced aggression or, in other words, met with some kind of persecution.

Yamagiwa: Only, amongst white people there are some people with blonde hair, aren't there. If a blonde person doesn't choose another blonde person as their partner for reproducing, then that hair will become darker and darker and eventually the blonde hair will disappear. It is said that there is some kind of artificial selection at work there.

Fukuoka: You mean that white people also came into existence due to the work of sexual choice. If that's the case, it means that there was some kind of mutual acknowledgment of (each other's and their own) whiteness, a shared consciousness between the partners that they were "special" in some way, and that consciousness may, for example, have wiped out the Neanderthals. If we ask why it is for human beings—for which it should originally have been possible for there to be diversity—that now only the one *Homo sapiens* species remains and why the others all disappeared, if we consider the quite violent things that Columbus and his successors who were the first to cross over to the Americas from Europe did to the indigenous inhabitants there, I can believe that those white ancestors did a similar kind of thing to the Neanderthals.

Yamagiwa: There are various conceivable reasons why for modern humans only the single *Homo sapiens* species remains, but one big one is that, no matter how much racial discrimination there was, reproductive isolation did not occur. In other words, we will have sex and make children even with people who are considered "gross" by our own culture. The Spaniards and French people who colonized Africa made more and more babies, and even in the case of the conquest of South America that we just touched upon, they made many children. This is a distinguishing feature of *Homo sapiens*, and it is thanks to this voracious and wide-ranging sexual proclivity that we are incapable of reproductive isolation. Human beings will have sex with not only other human beings, but there are cases of bestiality, too, aren't there. If reproductive isolation took place, then I think that over the course of a few tens of thousands of years that branching would occur and a new species would have emerged, but we are incapable of that, and are constantly intermixing. Recently, there is also talk that the blood of Neanderthals is also mixed in with our (*Homo sapiens*') blood.

Fukuoka: That means that in spite of the fact they drove the whole species to extinction, some of them were still unflinchingly having sex and making babies; not only was there elimination, but



there was also assimilation taking place too. If so, then is it right to consider that we humans will eventually be set free of the racial problems we are currently facing thanks to this insatiable sexual proclivity?

Yamagiwa: I believe so. Even looking at Japan, the number of international marriages is greatly increasing, and since it's now said that around the Tokyo area between one in five and one in ten class members are children born as the result of an international marriage, nationality aside, the Japanese as a race will surely become more and more diluted.

Fukuoka: It's true, in places like New York too, you certainly see couples of various different races. Only, although Japanese girls are incredibly popular with the opposite sex, the boys are not very popular, as they're not good talkers (laughs).

Yamagiwa: One other thing, on the topic of sex: from a gorilla's point of view, it must appear that humans are falling into a great illusion sexually, because humans are under the assumption that sex creates a bond between men and women. If you were to ask a gorilla, this is total fantasy. This is because gorilla couples are basically sexless. Even during the mating season they only have sex around two days a month, and since once the female becomes pregnant they don't have sex during the lactation period it means that for around four years, even if a male and female stay snuggled together, they are sexless. The same goes for chimpanzees. Despite that, I wonder why it is with just humans—and regardless of race—that if they do it once it becomes such that they feel that they have to continue doing it (laughs). It still remains unsolved as to what reproductive physiology of humans this comes from.

Fukuoka: Certainly, for humans, being sexless is regarded as being a crisis for couples.

The dream that a young insect-lover told to a “stink bug larva”

Yamagiwa: By the way, why did you become interested in biology, Mr. Fukuoka?

Fukuoka: As a young boy I was originally an insect enthusiast. My dream as a boy was to discover a new species of insect and for it to be given a scientific name with my own name in it, like “something-something Fukuoka” or something similar. I had actually caught a bug, too, that made me think, “This is it! This is a new species!” No matter how much I tried to look it up it didn't appear in my picture guides, so I excitedly took it along to the National Museum of Nature and Science in Tokyo; whereupon the girl on duty—without making a face whatsoever—said, “We have someone who's an authority, so let's go and have him take a look at it,” and took me along to the research building at the back of the museum. There was a person who would later become a famous



entomologist, Professor Kurosawa Yoshihiko.

“Where did you catch this? With bug collecting the situation is important, you know,” Professor Kurosawa asked me, so I absorbedly explained to him that “The day after a typhoon I found that a big tree had fallen sideways, and I thought that if I looked at the top end of the tree which would normally be out of reach there was sure to be something, so I searched there,” and so on. But the end result was the professor telling me “Unfortunately, my boy, this is the larva of a common stink bug.” Stink bugs are hemimetabolous (metamorphic), and go through several stages of shedding their skin and changing their color and shape, but their intermediate forms are not shown in picture books or the like. It was in this way that my dream of discovering a new species of insect crumbled away. Instead, though, I made the great discovery that there are academics who make a living by studying insects (laughs).

Yamagiwa: Was that when you were about junior high school age?

Fukuoka: I was a fifth-grader at elementary school. Then later I went on to enter the Faculty of Agriculture at Kyoto University, but at the time there was virtually nobody there that was collecting bugs in a natural-historical manner like Fabre or Doctor Dolittle, and it was around the time when the molecular biology boom came rushing along. There were many new genes and proteins to be found out there. I threw away my bug-catching net and transformed from a bug-collector into a gene-hunter, and although I wasn’t able to make any major discoveries I was able to make some small ones.

But in the United States, something called the Human Genome Project was underway. At first everyone laughed scornfully that it was like trying to dig the Seikan Tunnel (a railway tunnel under the sea between Aomori and Hokkaido) by hand, but America being America they used money and sheer force of numbers and—just like leveling the land with a bulldozer—by around 2003 they had written every single gene into a database. This was the second setback in my life. The first was that there were no more new species of insects. The second was that there were no new genes to be found.

However, although the riddles of life that had once been an infinite mystery should have been contained in this finite number of genes, and if we knew all of the twenty-something-thousand types of genes then we should have been able to understand everything, we found that when we tried to understand everything that actually, on the contrary, we couldn’t understand anything. In other words it’s the same as the way that, even by watching the end roll of a movie and knowing all the actors who appear in it, we cannot tell what kind of drama unfolds in that movie. Even if we have the basic elements, if we cannot describe their relationships then we cannot understand anything. That is the current state of twenty-first-century biology, and thinking variously about the principles of those relationships is the topic of my current research.



By the way, Professor Yamagiwa, do you not like bugs very much?

Yamagiwa: As a young girl, my older sister was an insect hunter too.

Fukuoka: A bug-loving princess, huh?

Yamagiwa: Actually she was a bit of a strange girl, always carrying around a bottle of poison so that whenever she caught an insect she could turn it into a specimen (laughs). That was unbearably upsetting to me, and became a trauma, so I never went down the insect route.

Fukuoka: But you wrote that when you were doing your fieldwork you ate the same things as the gorillas, so you have eaten bugs, haven't you?

Yamagiwa: Yes, that's right. Gorillas eat ants and termites, so I ate them too. As you'd expect, ants have a strong formic acid taste and didn't taste good, but termites are really delicious.

Fukuoka: Is that so? We insect-lovers can't eat bugs because we love them.

Yamagiwa: Oh, really? That's intriguing. You can pierce their dead bodies and make them into specimens but you can't eat them.

Fukuoka: For sure, when we make them into specimens we make a real mess out of them... Be that as it may, what was it that made you pursue gorillas?

Yamagiwa: At Kyoto University, I joined the research lab created by Imanishi Kinji, the founding father of Japanese primatology. The tradition of this research lab, carried on from Professor Imanishi to his disciple Professor Itani Junichiro, is basically that of "Hey, you. Go and become an ape." You go and join a troop of gorillas or chimpanzees or so on, and look at various things standing in their point of view. Primatology is the only thing that allows you to do this. Their five senses are extremely close to those of humans. What's more, because they are diurnal, you can walk as they do and feel and experience their every action with your own senses. If it's a fish or an ant or something that you're studying then that's impossible.

It's by viewing apes like this through your own bodies that we gradually start to understand how our present bodies have been created over the course of the 7 million year "experiment" of evolution. Put simply, people have often perceived human beings as being civilized and apes as being uncivilized savages, but that isn't the case at all. You come to discover that much of our bodies and the senses that we humans use now have been passed on directly, as they are, from apes.

But it's not the case that our nimble fingertips evolved for the purpose of tapping the keys on a



piano. Things that originally served a different purpose and then evolved now work to create an environment that answers to the needs of we present day humans. If you think about it like that, then surely isn't there a natural limit there? And where is that limit? Wanting to see that, even in some vague way, is what my research is about.

While the phenomenon of evolution is something that is achieved over an extremely long period of time, at the same time it also must be something that can be explained at the microscopic level. But these two things have not yet properly matched up. What makes our society move is not a 100% correct answer, but rather the discourse that "it very much seems that way." It's the theory of interpretation. In that sense, our academic discipline is probably quite intimately connected with modern society, and overlaps with fields such as social science, humanities and philosophy. It is for precisely that reason that I get the feeling that it is becoming an age where biologists have to speak out to society.

The menopause and nursing care The wisdom generated by humanity upon attaining long-life

Fukuoka: One of the problems faced by modern society is the aging population. The thing that I always remember with regard to this problem is the incident of (Japanese politician) Ishihara Shintaro's so-called old hag comments. Apparently the original source for the comments was Matsui Takafumi, but he said that "the worst, most harmful thing that civilization has brought is old women," and that "old women who continue to live after they have lost their reproductive function are useless and are committing a sin." Are there any other primates that continue to live on for a long time after they go through the menopause?

Yamagiwa: Apparently there are some whales that do, but as for primates there are none except for humans. For the most part, for primates other than humans the menopause itself doesn't even exist. In other words, they continue to give birth to offspring until they die. Recently, there is some research that suggests that chimpanzees may go through it, but it's quite difficult to investigate.

Fukuoka: But I can't agree with the idea that that is placing a burden on society. Isn't it conceivable that women came to live on long past the menopause precisely because—even if old women can't give birth themselves—helping their daughters to give birth and so on has some benefit to the continuation of the species, or that passing on wisdom to the next generation fulfills some kind of social function?

Yamagiwa: There are arguments both for and against, but you certainly make a valid point. To begin with, I think it started out from the fact that childbirth became difficult for human females. In comparison to gorillas and chimpanzees, humans take a ridiculously long time to give birth to



their children. By the shape of our pelvic bones changing and becoming plate-shaped due to us humans walking upright on two legs, it became impossible to make the birth canal wide. Since because of this there is a need to pass a large-headed child through a narrow canal it takes time, and there is also a risk to the lives of both the mother and child, as the baby's head must also be squeezed to enable it to come out. So it became impossible for humans to give birth by themselves, and became necessary for someone to have to provide help.

For that reason, it was the fact that human females came to stop giving birth while they still have the physical strength and stamina, and then for the rest of their lives shifted to the role of assisting in their daughters' and granddaughters' generations giving birth, and that this heightened the continuity of the species as a result that was the impetus for it. Since humans also have high birth rates in comparison to other primates this may have been the effective strategy.

Fukuoka: I do hope that that's the case.

Yamagiwa: Only, it isn't only women for whom life expectancy increased. It increased for men too. For that, we need a new condition that hadn't applied to humans until that time. That's where "caring" comes in. This is also true for gorillas, but as they get older, they get periodontal/gum disease. Since they consume a lot of carbohydrates and foods with high sugar content this is inevitable. There are many cases where they end up dying from this. The only things that old-aged, toothless individuals can do to survive are to either have the other gorillas bring them special foods, or be carried by the others. In order for efforts to be made to go so far as to give nursing care to keep old people—who cannot go on living by themselves—alive, a cognizance or awareness must be born in society that says that these old people are important, and possess some skill or ability that is different from that of normal people. I think that this was probably inconceivable before the emergence of language. If it wasn't for things such as old people telling tales of past events that the current young generation had not experienced, and this being reflected in society, I think that this kind of caring would never have come into existence.

Currently, the oldest evidence that the number of human beings living into old age had increased rapidly is from around 30,000 years ago, which is comparatively recent.

Fukuoka: So as you'd expect, it's related to the emergence of language?

Yamagiwa: Another thing is that the value of existence of people in their old age is on a different scale of time from those in their prime. Humans in their prime live their time thinking that they have to give birth in order for the species to go on living, in other words sloping upwards (i.e. if you plotted it on a graph). However, old age people live with a sense of time sloping down or running horizontally. In actual fact, this matches perfectly with children's sense of time. The reason that old people started to display power as educators was that the sense of time they have is extremely



laid back and relaxed. Put reversely, as civilization developed more and more, in an age where the way of life took on a more and more upward sloping pitch, the existence of old-aged people started to become important. I think, if I can say it, that they took on the role of a cushion, or should I say safety valve for society.

We're always and forever playing around like children... But that's humanity

Fukuoka: Since the topic of children came up, there's one thing I'd like to ask you about: the period up until humans reach sexual maturity is unusually long, isn't it?

Yamagiwa: It's the longest amongst primates.

Fukuoka: What does it mean for the period that we are children to be long? I imagine that the fact that this period before we mature and enter into sexual conflict with other males—the period for which we can continue to play, so to speak—is long is what made us human.

Yamagiwa: Firstly, as for the reason why the period of youth grew longer, this is probably a by-product of our brains becoming enlarged.

Evolution is strongly constrained by the order in which characteristics appeared. In the case of humans, first of all, 7 million years ago we started to walk upright on two legs. It was 2 million years ago when our brains became bigger. When humans' brains started to become larger, we were already walking upright on two legs, and therefore our birth canals had become narrow and it had already become difficult for children with large heads to be born. Because of this, the only option was for the head to become bigger after birth.

The size of a gorilla's brain when it is born is half that of an adult's brain. That doubles over the course of four years, and the gorilla becomes an adult at 10 to 13 years of age. With humans it rapidly grows to twice the size over the course of one year, and then the brain is completed slowly up to between the age of 12 and 16. Because the growing brain requires an enormous amount of energy initially this is almost all passed on to the brain, and then when the brain is completed an adolescent spurt in body growth occurs, and girls go on to become womanly and boys go on to become manly. I think it is for this reason that the period of youth grew longer.

There's an interesting phenomenon related to this, which is that the ways in which the bodies of boys and girls grow and develop after this adolescent spurt are a little different. For girls, their breasts appear right away, their bottoms grow larger and their bodies become womanly, but they do not yet become able to give birth to children. Their menstrual periods have only just begun, and their ovulatory cycles are unstable. It takes another three years or more for their ovulation frequency to reach that of an adult. This period is called adolescent sterility, and even if they have



sexual intercourse they cannot produce children. On the other hand, boys can produce sperm and impregnate women straight away. But unlike girls, because their muscles haven't beefed up yet their appearance is still that of a child.

Fukuoka: I had the feeling that girls looked grown up and boys were forever children, but as for their reproductive abilities it's the opposite, then, isn't it?

Yamagiwa: If I say something a little bold, I wonder whether this isn't due to the fact that males and females were exposed to selection differently. Because the cost of giving birth to a child is greater for a woman than it is for a man, they have to build a relationship of trust with a partner who will protect them and their child. If they make a careless mistake in choosing the partner they have their child with, then a terrible burden is placed on them. For this reason, they underwent the process of selection of finding a partner before giving birth, using their own body as capital. For men, on the other hand, if they develop into an adult body too early then the possibility of being injured or killed in a fight with other adult males is high, and so it is more advantageous for them to study and build up their experience of society while their body is still that of a child and then to develop into an adult body later.

Fukuoka: As I thought. But why did humans' brains grow bigger in the first place?

Yamagiwa: I don't know if this is 100% correct, but I think that what is called the social brain hypothesis is correct to at least some extent. From around 2 million years ago, the scale of human groups started to become larger and larger. As humans began to hunt and use fire, what had originally been multiple family groups started to gather together and form regional communities. They had to exploit "double standard" social skills to avoid losing sight of how they should live. What I mean by double standard is that the care and consideration given to those within one's own family and that given to those within the community consisting of several families are different. So the complexity of changing this for each and every person caused the human brain to grow larger.

Fukuoka: In other words, differentiating between one's true intentions and what one says on the surface (the Japanese concepts of *honne* and *tatemae*) caused the human brain to get bigger, then?

Having "aspirations" is the distinguishing feature of humans

Yamagiwa: It's also certain that play also had an important part to play. Not only is the developmental period for humans long in comparison to other primates, but we also give birth to more children. This is thought to be an auxiliary action in response to the fact that infant fatality rates increased because humans moved away from other anthropoids (apes) and left the tropical



rainforests behind and started living on the savannah; because there are many predators there. What came about as a result of humans giving birth to many children that take a long time to grow up, was social play. Gorillas play quite a lot too, only in their family-type groups the age gaps between their children tend to be large so it tends not to be an everyday occurrence, but in the case of humans there are many children of around the same age within the group, so there are many opportunities to play. The simulated social behavior that came out of this play became widespread amongst adults, and went on to become the basis for society.

What's important in play is synchrony, or harmonization. It's my opinion that music also came from there, but to take a rhythm is to do the same thing as the other person. The feeling that that is fun or enjoyable is important. In addition, by changing roles with the other person part way through and doing the same thing that the other person had just been doing up until that time, humans went on to develop various different games. What is important with these kinds of games is that it's not the case that there are rules in place from the beginning. Rather, the participants make up rules on the spot, while making allowances for the other person's ability and feelings. It would be more interesting if we did this. If we did that it would be even more fun. The games change more and more as the players make these kinds of suggestions. The feeling of enjoying this is something that is inherent to primates, particularly in apes.

The act of distributing food has been verified in primates, but it is thought that this is due to what was originally the act of parents giving food to their children going on to become widespread between adults also. In the same way, it is possible to imagine an evolutionary history where play also spread from children to adults, and eventually went on to hold a different meaning.

Fukuoka: Synchrony is something that forms the basis in a variety of biological phenomena, isn't it. The way in which the light-emitting movements of fireflies are synchronized, too, is because they adjust their own movements while referring to those of other fireflies, and go on to create the same synergy. I think this is a very important characteristic of the principle of life. That this was something created through play is a very big thing indeed, isn't it. Of course, it's important that our brains became bigger and our number of brain cells increased, but after all time is necessary for the linkage of the synapses in there to be consolidated and developed. For that, after all I guess we have to play (laughs).

Yamagiwa: The biggest difference when you compare human children and the young of gorillas and chimpanzees is that they have "aspirations." Human children have strong aspirations for what kind of person they want to become in the future. Gorillas and chimpanzees don't have that. In the end, that's because humans have the ability to work their way in amongst others whilst synchronizing/harmonizing with them.



Fukuoka: You too, Professor Yamagiwa, are the inspiration to aspiring young biologists, and I heard that a movement took place amongst the students to stop you from being elected, saying that if you became something like university president then world primatology research would grind to a halt. What will you do about your research in the future?

Yamagiwa: When I asked the university if I could continue to use my research lab as I had done until now I was told to get out of there quick time and move into the presidential office (laughs). But I still have topics I want to study, so even if it's little by little I still intend to continue my research.

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