Cultivation of Corn Caused Pro...arly Humans, Says Clark Larsen

Thu, Oct 26, 2023 1:02PM 28:20

SUMMARY KEYWORDS

work, record, years, health, project, bones, infectious diseases, people, study, ohio state university, agriculture, human remains, terms, skeleton, interested, focus, population, college, site, pathogen

SPEAKERS

David Staley, Eva Dale, Janet Box-Steffensmeier, Clark Larsen

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E **Eva Dale** 00:00

From the heart of the Ohio State University on the Oval, this is Voices of Excellence from the College of Arts and Sciences with your host, David Staley. Voices focuses on the innovative work being done by faculty and staff in the College of Arts and Sciences at The Ohio State University. From departments as wide ranging as art, astronomy, chemistry and biochemistry, physics, emergent materials, mathematics and languages, among many others, the college always has something great happening. Join us to find out what's new now.

D **David Staley** 00:33

Clark Larsen is Distinguished University Professor of Anthropology at The Ohio State University College of the Arts and Sciences, serving as Chair of the Department of Anthropology from 2001 to 2017. He is a Research Associate in Anthropology at the American Museum of Natural History, and has served as Vice President and President of the American Association of Physical Anthropologists, Chair of the Anthropology section of the American Association for the Advancement of Science, and the Editor-in-Chief of the American Journal of Physical Anthropology, he's a member of the National Academy of Sciences. Welcome to Voices, Dr. Larsen.

C **Clark Larsen** 01:07

Thank you.

D **David Staley** 01:08

Your specialty is biological anthropology with a particular interest in bioarchaeology. First of all, I'd like you to define for us biological anthropology.

C Clark Larsen 01:18

Yes, biological anthropology, also known as physical anthropology, is the study of human variation and human evolution.

D David Staley 01:26

Okay.

C Clark Larsen 01:27

So, everything biological. And it's influenced by culture - past, present - is the focus.

D David Staley 01:35

And so bioarcheology would be...?

C Clark Larsen 01:38

Bioarcheology is a study of human remains from archaeological settings. So basically, the past, mostly covering the last 10,000 years or so. And so we're interested in health, lifestyle, disease; pretty much the record of variation in evolution in the past.

D David Staley 01:59

And we can find this out through the study of human remains, how so?

C Clark Larsen 02:02

Human remains are a remarkable record of our individual histories. Health issues, our diet, our lifestyle is all wrapped up in our skeletons. For example, physical activity is expressed in the way some of our bones are shaped, owing to mechanical forces. We'll eventually, we;ll have osteoarthritis, not exclusively caused, but highly influenced by the degree of our physical activity. So those of us who have heavy labor tend to have more arthritis than those who don't, so we studied that record as well.

D David Staley 02:43

This sounds like forensics, or what I see on CSI. Is this the same sort of area?

C Clark Larsen 02:48

Well, CSI... forensic anthropology is a branch of biological anthropology, it's not bio-archaeology. On the other hand, we share interests in skeletons and what they mean. Forensic science, forensic anthropology is interested in identifying who is this person, what is the cause of death, usually focusing on a single individual, but sometimes it's multiple, and can be hundreds of individuals in mass disaster. But they're interested in why did they die and who are they, what is their name, what's their age, what's their sex? Bioarchaeology could be interested in that, but we're really mostly focusing on what health and lifestyle... reconstructing health and lifestyle in past populations, looking at the population level, usually,

D David Staley 03:38

How far back in time do bio archaeologists study? How far have we gone back in time?

C Clark Larsen 03:45

It's pretty much defined by the Pleistocene, Holocene boundary at the end of ice ages when people began to settle down.

D David Staley 03:53

So roughly what are the dates for that, roughly?

C Clark Larsen 03:56

About 10 to 12,000years to the present. So if someone was found in archaeological context leading to 200 years ago, we're interested, because that opens up a whole other realm of what lifestyle and health and living conditions were like 200 years ago. Prior to 10,000 years ago, prior to the Pleistocene Holocene boundary, then we get into the area known as paleoanthropology, pretty much to study the fossil record. So there is a boundary there, we share some common interests, but it's pretty much more recent versus more past.

D David Staley 04:33

Can paleoanthropologists make similar sorts of claims on things like health and lifestyle in the way that a bioarchaeologist can?

C Clark Larsen 04:41

Yes. Paleoanthropoligists, there are a few who are interested in health in particular, but using the fossil record is pretty limited. There's usually a handful of individuals, sometimes many more at some of these sites, but the record is mostly focused on the evolution of humans, what

the record is. On the other hand, there is an area of paleoanthropology that is interested in activity of movement, for example, the origins of bipedalism, when an ancient ape began to walk on two feet and two legs. And then to the record, how mobile were these guys, were they doing a lot of running and walking? So we can reconstruct that from the record, so we share those common interests.

D David Staley 05:26

So you specifically study farming, or agriculture, specifically the origins of agriculture in the Neolithic, around 10,000 or so. And you study specifically the site at Ã‡atalhÃ¶yÃ¼k in modern day Turkey, right? Tell us what you've studied at Ã‡atalhÃ¶yÃ¼k.

C Clark Larsen 05:44

Yeah, so I was invited a decade and a half ago to collaborate with Ian Hodder, who's the overall director of this long term project, and it was a 25 year project, which is wrapping up this year. And I'd always been interested in the transition from hunting-gathering to farming and what that impact was; my dissertation project and later research focused on North America. So what I discovered in that study is that, in much of North America anyway, wherever corn agriculture happens, relatively late in prehistory, health begins to decline, owing to a focus on corn - known as maize to the rest of the world - and its dietary deficiencies. It's low in essential amino acids, it's a carbohydrate, it's a factor in causing tooth decay, dental caries. People begin to settle down, living in larger populations, larger communities, more closely crowded together. So, it's a period of time we're going to begin to see the beginnings of infectious diseases, crowd diseases. So with that knowledge in mind, and the invitation to participate in the Ã‡atalhÃ¶yÃ¼k project where they're excavating, literally hundreds of skeletons, in wonderful context. These individuals are buried in their house floors, so we know where they lived, who they're with, and the preservation of the skeletons is truly incredible. So I agreed to participate in the project and head up the human remains team, which is a dozen of us with different specialties. One person deals with dietary reconstruction based on stable isotope analysis of bones and teeth.

D David Staley 07:36

What does that mean?

C Clark Larsen 07:37

Well, our body directly reflects the foods we eat. So if we eat foods that are of a high carbon-13 content, or carbon-12 content, we can look at the ratios of these stable isotopes, these elements in our bones and teeth, and pretty much reconstruct in many instances what people were eating. So for example, corn, heavy corn eaters have a very different stable isotope ratio than those who don't eat corn. So in Ã‡atalhÃ¶yÃ¼k where they're eating wheat, barley, and rye, raising sheep and goats and cattle, but a big focus of the diet is on domesticated plants. They were domesticated first in the Fertile Crescent to the east, and then spread into Turkey by about 9 or 10,000 years ago. So what we're studying is, as this community becomes larger and

largerand more and more settled, we're very interested in, what is the impact of that on their diet. So we've been looking at, with one of our collaborators, the stable isotopes in sheep and goats from the archaeological remains, and looking at those distribution to see if their grazing patterns have changed. Because over time, we suspected or our hypothesis was, that as this community continues to grow, at its peak population, it was 8,000 people - that's a lot of people to be concentrated in one place. So they're depleting resources close to the community, and as they deplete these resources they are going further and further out to graze these animals, and to hunt and gather, and to collect food. So the stable isotopes in sheep and goats reflect those changing grazing places. And so humans are eating those sheep and goats, so the chemistry, the stable isotope chemistry of the sheep and goats appears in humans. So we're looking at the stable isotope record in humans as well, and they show the same pattern, that they're moving further and further...not moving, per se, but collecting resources further and further from the site. Probably the agricultural fields are fairly close by, but nevertheless a whole composite picture shows a changing record of a stable isotopes.

D David Staley 10:05

And the impact of these changes, of settlement, of agriculture - you look specifically at the impact on human health.

C Clark Larsen 10:13

Right.

D David Staley 10:13

What was that impact on human health?

C Clark Larsen 10:15

Yeah, so the record for human health is reflected in the teeth. We hypothesize that they're eating more cultigens, increasing focus on plants, that we're going to see a change in the oral health based on looking at teeth, that is the record of tooth decay or dental caries. And so we have found that that record, they have a moderately high frequency of dental caries through the whole sequence. But what's especially interesting, though, is we know that based on the study of biomechanical properties of their limb bones, like the leg bones, the femur, the thigh bone. The shape of that bone changes over time, reflecting mechanical demands on the skeleton, so we have the record of humans also exploiting further and further from the site. The other records are bone infections, and these are called periosteal reactions, basically infection, and so those increase over time as well. So the record of iron deficiency, anemia, there's a skeletal record of that, and we're looking at, especially during the period of peak population, which is in the middle period of the site, that all these elements - of disease and iron deficient anemia and activity - peak at that time when population is highest and most concentrated and when they're really depleting resources, when that record begins.

D David Staley 11:53

So how did the health of the inhabitants of Ã‡atalhÃ¶yÃ¼k compare say, to hunters and gatherers? I guess, can we make a comparison between the health of settled society versus nomadic society?

C Clark Larsen 12:05

Yeah, unfortunately, there's a very small record of hunter gatherers in this region. So the record reflects, it's in the Neolithic when that transition, foraging to farming, happens. So the population size, pre-Neolithic in the region is very, very small. So for whatever reason, people are gathering in one place. Probably started out as a very, very small community, a few families, and we have a record based on the skeleton of increasing fertility, so that's a driver in population increase. But we also think that, based on the record of ancient DNA, which is an incredible resource as well now, that people are moving into the community, so there is some record of increase in size based on movement into the community. But that movement appears to be largely women, men are staying in the community, so it'sf a patrilocal social organization. So marriage patterns occur with women coming into the community, and mostly men staying. So we're documenting that record as well, who's coming into the community. And Janet Box-Steffensmeier, Interim Executive Dean and Vice Provost for the Ohio State University College of Arts and Sciences. Did you know that 23 of our programs are nationally ranked as top 25 programs, with more than ten of them in the top 10? That's why we say the College of Arts and Sciences is the intellectual and academic core of the Ohio State University. Learn more about the college at artsandsciences.osu.edu.

J Janet Box-Steffensmeier 13:16

You used the term before to describe these crowd diseases, I think it's interesting. Tell us more about what you mean by crowd diseases.

C Clark Larsen 13:48

Yeah, so crowd diseases are modern diseases like tuberculosis, various infectious diseases, cholera is a crowd disease. So wherever you put crowds together -

D David Staley 14:02

Large concentrations of people.

C Clark Larsen 14:04

Right. That was my next question, why do it? Exactly. So that creates circumstances for the pathogen that causes the infectious disease to do quite well, because our hosts, if it's not this person, the other... a future host is very close by. So the record of infectious diseases and its influence on health really starts with agriculture. It's present before, but it's extremely sparse in

terms of the bone changes that you expect to see, and dental changes you expect to see in the record. So the wonderful thing about agriculture, because there's always that question, why did they do it? If it's so bad for you, why do it in the first place? The key issue is that it's much more efficient in providing calories, energy, per unit area of land. So hunting and gathering requires movement, it doesn't provide as many calories in terms of plants and animals.

D David Staley 15:04

Is the range wider as well, for hunting and gathering?

C Clark Larsen 15:06

The range is also wider, so they're moving around a lot more. It's a little bit simplistic to say that hunter gatherers are always very small populations, always moving around, versus agriculturalists, but in general, that is the case. So with agriculture, concentrating resources into a limited area of land is far more efficient and can support more people. So a human evolution is all about success, in terms of reproduction and producing more of us. So those that are being reproduced may not be as healthy, but if they survived to the reproductive age and they're producing, then it's successful in that regard, in terms of evolutionary change, but there's a cost. But the benefit, and we see the origins of population increase beginning 10,000 years ago with agriculture, and it hasn't stopped. So population 10,000 years ago globally: maybe a million people, that might be an underestimate. But today, it's approaching 8 billion and there's no end in sight. So the key will be, kind of going into the future, is how are we going to deal with it? And so the wonderful thing about this record we look at is the trajectory starting 10, 12,000 years ago, and what we have today. So what's important about that too, why it's important, is that it provides that historical record, how we came to where we are today, and what are the lessons. So we know the lessons, but how are we going to address those lessons? Care to speculate about where we're going, care to speculate about the future? Yeah. And 10,000 years ago, a handful of people were eating domesticated plants and animals. Over time, that increased to the present day where virtually everybody in this planet has some kind of agricultural product in their diet. And most everybody in the planet is... we're dependent on it. So imagine, if we didn't have agriculture, we wouldn't be around. So what I see taking place - and I'm not offering a solution, I'm just describing what we can predict if something else doesn't happen - we can predict this rapid global increase in population size. So the key will be, how do we accommodate that?

D David Staley 17:43

How do we feed that many people?

C Clark Larsen 17:44

You had said at the beginning of this at this research at Ã‡atalhÃ¶yÃ¼k with Ian Hodder has been going on for 25 years. Why so long? How do we feed them? How do we handle the infectious diseases that are taking place, the crisis in Africa with Ebola, it's not going to stop. And these pathogens are rapidly evolving, so we're barely keeping ahead of what that

pathogen evolution is doing, that at least - I'm not an expert on this, but that's what I'm observing. And so are cholera epidemics, the appearance of new brand new infectious diseases; we had never heard of Zika a decade ago or so. So that record of feeding the world with - and I'm not saying this is bad, so I'm not evaluating this, I'm just saying what appears to be the case. I think with modern technology, the things we do, for example, here at Ohio State, in terms of food production, those are all the right things to do. And so, putting resources into that area is important. And even though I don't study it, I think what I do know, based on my own work with past populations, is there's a story here. How do we get here? And I think that's important to know, Here's the thing. It is a huge site, it covers about four football fields, to about 60 feet high - it's a tell, which is basically a huge pile of debris and dirt. And it is a very, very slow, meticulous process, archaeological recovery. We don't go in there with shovels and pickaxes, we go in there with small tools and trowels, and it's a very slow, slow work. So if you're going to do this right, in terms of really getting at that record, you have to have a reasonable sample of the site. And over that 25 years, Hodder said, here's what I need to do this work. And so, with appropriate funding and his selection of individuals participating in the project, because my group is one of a dozen groups that work on the site - one focuses on plants, one focuses on animals, one on the material culture. So we designed the project, here's the ideal. Arnd so he and the team have been very successful in getting the resources to do this work. So it needs this long periods of time. And we're actually not the first group that worked there, it was discovered back in the late 1950s and they worked there for about a half dozen years, revealing that this is a huge, huge deal. It's a settled community, there are houses, there are lots of people living there. So he chose 25 years in order to really do the job - at this point, still something like 5% to 8% of the site has been excavated, to give you a sense on... during the summers, there are teams of more than 100 excavators and scientists like me working at the site. So, huge teams, slow process, but the result is way worth the effort.

D David Staley 20:57

So you mentioned working in teams at this site, do you have a lab?

C Clark Larsen 21:02

Yeah.

D David Staley 21:02

Tell us about your lab.

C Clark Larsen 21:03

Yeah. So at the site, there's a laboratory where we process the human remains. In Turkey and in many areas of the world, remains cannot be shipped out of the country, which is completely understandable. So we do a lot of the work there, in terms of estimating age of death, in determining what the sex of the individual was. And it's long, complicated work, but it's not a high tech work in terms of identifying, here's the age, here's the sex. It's almost like CSI, we did the same thing. Okay, this person's eighteen, we know that from the skeleton, this person is

male, we know that fromthe skeleton, so that work can be done. The work that can't be done there is the work on stable isotope chemistry, there isn't yet a nearby appropriate laboratory. So we take small bone samples, and that work has been done at the University of Liverpool. We take photographs of bones and teeth in order to study them more appropriately in the lab. So I also have a laboratory here, and so we continue to work on, mostly, the study of the data we collected at Ã‡atalhÃ¶yÃ¼k. And it's a huge volume of work. I've been involved in the project since 2004, 2005, and the record of data that we have, growing in a large part because on my own team there are about a dozen people working on oral health, skeletal health, and the connection between the two. We now know that, and this is based on modern oral health science, that what happens in the mouth in terms of poor oral health, which there's a strong record of it at Ã‡atalhÃ¶yÃ¼k and elsewhere, that that directly influences systemic health. So your overall health, it's just not holes in your teeth that are the problem, but the infection that then transfers the bone supporting the teeth and the whole body. So we're studying that as well. So the lab here is mainly focused on that kind of analysis.

D David Staley 23:03

Why did you decide to become a bioarchaeologist?

C Clark Larsen 23:06

Yeah, so I've always been, since a child, lots of us are like that, interested in old stuff. My parents took me to... I grew up in Nebraska and small town, and it's the site of the the first homestead after the Homestead Act. There's a museum there that my parents took me to when I was a kid, and I saw this stuff on the shelves, I'm thinking, wow, that is cool stuff. So by... starting then, I was interested in archaeology. So the summer before college, I got on an archaeological project in Nebraska, excavating an early military fort, and it was fun. It was incredibly hard work, I mean, imagine 100 degree weather and so forth every day. But because it was just so interesting, I didn't pay much attention to that. So, I went to college at Kansas State University where a friend of mine locally who was an archaeologist said, you need to go there to work with the group there, so I went to college there. The first year, my professor said, you know, if you want to be an archaeologist, you really need to take osteology, study bones and teeth and be able to identify bones. And it just so happened that William Bass, a very prominent bioarchaeologist, biological anthropologist, was their first semester teaching osteology. So I took this course along with a bunch of seniors my freshman year, and did well. So he got me on a dig that summer in South Dakota, working with a prominent bioarchaeologist. And from there, I just took off, went and had a fellowship undergrad as a "RU", Research Experiences Fellowship there, and it just took off.

D David Staley 23:17

Tell us what's next for your research.

C Clark Larsen 24:48

There are different parts of it, I'm involved in several pretty big projects.Ã‡atalhÃ¶yÃ¼k - the field work is finished, but we will be analyzing the record for years to come. I'm now preparing

field work is finished, but we will be analyzing the record for years to come. I'm now preparing an article for PNAS, Proceedings of the National Academy of Sciences, giving an overview of that 25 years of work, so we're wrapping that up. And we still have a project going on in North America where we're looking at this foraging, hunting-gathering to farming transition, and what happens with the arrival of the Spanish, so we're studying that record. But probably the biggest thing coming up, I've been involved for the last 20 years in a big project called the Global History of Health Project. And I was involved in the first part of it on the Western Hemisphere, headed by Rick Steckel, here in the Economics Department. And so, he brought me into the project as one of the contributors looking at North America. So that project finished up in the late 90s, and so we thought, hey, this worked out so well, why don't we take on Europe? We were naive. So we said, who do we need to build this team? So we put our heads together and identified, who are the most prominent bioarchaeologists, biological anthropologists in Europe. So we pulled together a list and started contacting people, and most of them said, yes, this is a good project. So virtually the day I moved here to Ohio State, we had a big conference here inviting all the potential players to Ohio State, and from Germany, virtually every country of Europe, and people we knew, people who knew them, and said, what do you think of this idea? And they said, yeah, let's do it. So up until last year, well over the last 20 years since, well, less than 20 years since coming here, each of these teams in Europe worked with the skeleton collections that they had at their institutions, collecting data from a protocol that we had developed on health, lifestyle, behavior, and all kinds of stuff related to history of health in Europe. And so we just finished that project several years ago, and have been working on a major book called The Backbone of Europe, which just came out by Cambridge University Press, of all these players in the project. And so that project was done, and that seemed to work out so well that colleagues I know who work in China asked me if I would head up with them, Asia as the next module. And I said, you know, frankly, I'm pooped. I don't think I have the energy to do this really good, but I'll work with you on that. So we organized a conference held at Jilin University last summer and inviting all the key players across Asia, and it was a wonderful conference. So we're now looking at the history of health across Asia, from China to India, Turkey, the whole continent. So that's going to probably be another 20 years, but I'm in a leadership role, but not in charge, yeah.

D David Staley 27:59

Clark Larsen. Thank you.

C Clark Larsen 28:01

You're welcome, glad to be here.

E Eva Dale 28:04

Voices from the Arts and Sciences is produced and recorded at The Ohio State University College of Arts and Sciences Technology Services Studio. Sound engineering by Paul Kotheimer, produced by Doug Dangler. I'm Eva Dale.