

## SCIENCE &amp; TECHNOLOGY

## Diversity Blankets A Park In Bolivia

By JAMES GORMAN

Madidi National Park in Bolivia goes from lowland to mountaintop, from 180 meters to around 6,000 meters above sea level. It covers more than 18,000 square kilometers of wildly different habitats. It is, says Rob Wallace, an ecologist with the Wildlife Conservation Society in Bolivia, “a place where the Amazon meets the Andes.”

It has cloud forests, lowland jungle, rivers, streams, wetlands. It even has glaciers.

“Madidi was put together on the hypothesis that it could be the world’s most biologically diverse protected area,” Dr. Wallace said. And, he said, it is — for mammals, birds, plants and butterflies.

In June 2015, a team of scientists, almost all Bolivian, set out on a three-year survey of life in the park, concentrating on 15 sites. The search, supported by the conservation society, was complemented by an investigation of scientific literature. The goal of the project, Identidad Madidi, was to identify as many species that lived in the park as they could.

The results are in: The total number of species documented for Madidi is now 8,524. The team in the field found about 4,000 species, 1,362 of them never before recorded in Madidi. They estimate, based on other information of how species are distributed, that there are probably 11,395 living in the park, even though some have not yet been spotted. That includes all creatures with backbones, all plants and butterflies. Tackling all the insect species was a step too far.

Among the finds were 124 species and eight subspecies believed to be new to science, like the spiny rat, whiptail lizard, and 13 new species of butterfly.

Of course, the conclusion of the survey raises a question: Why does it matter which park is most diverse? Bolivia is not headed for a World Cup-style confrontation with other pro-



ABOVE AND BELOW RIGHT, ROB WALLACE/WILDLIFE CONSERVATION SOCIETY; BELOW LEFT, OMAR TORRICO/WILDLIFE CONSERVATION SOCIETY.



ABOVE AND LEFT, MILENIUSZ SPANOWICZ/WILDLIFE CONSERVATION SOCIETY  
From the top: a royal flycatcher, Madidi titi monkeys, a tiger leg monkey frog, and a rice rat in Bolivia’s Madidi National Park.

ected areas, like Manu National Park in Peru, which has been considered the most diverse up to now, or Yasuni National Park in Ecuador, which is still ahead of Madidi in amphibians and reptiles like the Bolivian coral snake.

But national pride can be a motivator for conservation, and Dr. Wallace said that the survey was initiated largely

because “people in Bolivia did not know how special Madidi really was.”

The survey made scientific sense because having a baseline record of diversity in any protected area is important for understanding what happens as climate and development around the area change. For researchers interested in how species interact with one

another and their environment, the first step is knowing about the species themselves.

Species counts are never definitive, however. How many people are counting, what areas they choose to sample, time of year, changes in environment over time — all can affect the final totals.

The point is to protect as many species as possible.

## Pushing Limits Of Fetal Therapy

By DENISE GRADY

SAN FRANCISCO — In the three months before she was even born, Elianna Constantino received five blood transfusions and a bone-marrow transplant. All were carried out with a needle passed through her mother’s abdomen and uterus, into the vein in her umbilical cord.

Elianna, born February 1, has a genetic disease that usually kills a fetus before birth. The condition, alpha thalassemia major, leaves red blood cells unable to carry oxygen around the body, causing severe anemia, heart failure and brain damage. The transfusions in the womb kept her alive, but only treated her illness. The bone-marrow transplant has the potential to cure it. Whether it will succeed is still too soon to tell.

Elianna and her mother, Nichelle Obar, were the first patients in an experiment that pushes the limits of fetal therapy.

If the treatment works, it could open the door to using bone-marrow transplants before birth to cure not just Elianna’s blood disease but also sickle cell anemia, hemophilia and other hereditary disorders, some so severe that the prenatal diagnosis may lead parents to end the pregnancy.

Bone marrow is considered a potential cure because it teems with stem cells, which can create replacements for cells that are missing or defective.

“This line of work moves the field of fetal surgery, which currently consists of big operations for anatomic disorders, in a new direction of molecular and cellular therapies given non-invasively,” said Dr. Tippi MacKenzie, a pediatric and fetal surgeon who is leading the study at the U.C.S.F. Benioff Children’s Hospital San Francisco.

Ms. Obar, 40, and her husband, Chris Constantino, 37, are healthy but learned during her first pregnancy that they are thalassemia carriers.

Worldwide about 100,000 children a year are born with severe cases. Millions of people are carriers, most commonly those from Asia, the Mediterranean, Africa or the Middle East.

Carriers are generally healthy, but when two have children together, the children are at risk for the disease. Ms. Obar’s ancestry is Filipino and Puerto Rican; her husband’s is Filipino. They live in Hawaii.

Their first child, Gabriel, now 3, is healthy. But each child they conceive has a 1 in 4 chance of being affected. An ultrasound at 18 weeks showed that Elianna’s heart was twice the size it should have been, and fluid was accumulating around her lungs and other organs. Blood flow through her brain was abnormally rapid, a sign of severe anemia.

Everything pointed toward alpha thalassemia major — the worst form of the disease. Some medical references describe the illness as “incompatible with life,” and most fetuses die in the womb from heart failure. The pregnancy may end in miscarriage, and parents may not know why. Many do not know they are carriers.

Transfusions into the umbilical cord during pregnancy can save the fetus and may prevent brain damage. The child will then require transfusions every three or four weeks for life; the procedures cost about \$50,000 a year and pose their

Treating hereditary disorders at the molecular level.

own risks.

A bone-marrow transplant after birth can cure the disease, but only if a matching donor is found. The transplant also has dangers, and costs about \$150,000.

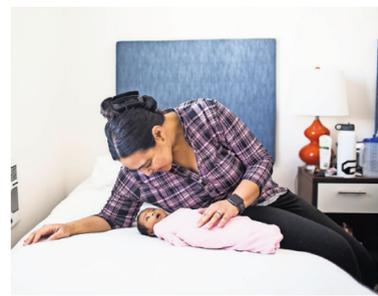
Some doctors are wary of transfusions because they think that even if the child survives, there is still too high a risk of significant brain damage. A report last year on an international registry of survivors found that 20 percent (11 of 55) had serious delays in their neurological development. Another article found delays in 29 percent (4 of 14).

Ms. Obar’s genetic counselor mentioned termination — but also transfusions. She and her husband chose transfusions.

The general goal of fetal therapy is to act early enough to minimize or even prevent lasting harm from severe problems that start in the womb. With a bone-marrow transplant, the added advantage of giving it before birth is that the fetal immune system is not yet fully developed, so it is unlikely to reject the transplant.

In contrast, when transplants are given after birth, the child first needs an arduous course of chemotherapy to wipe out the immune system and prevent rejection. That treatment itself can be fatal: The death rate is about 7 percent, mostly from infection.

Bone-marrow transplants in



BRYAN MELTZ FOR THE NEW YORK TIMES

Nichelle Obar with her daughter, Elianna, who has a disease that was treated before she was born.

fetuses were first tried in the 1990s. Some worked, but most failed, and doctors mostly abandoned the procedure, Dr. MacKenzie said.

But research uncovered a key finding. The mother, not the fetus, was rejecting transplants that came from fathers or other donors.

“Everybody has a perfect donor when they’re a fetus, and that’s the mom,” Dr. MacKenzie said.

So far for Elianna, there has been no obvious benefit from the transplant. Like all children with her blood disorder, she needs a transfusion every three weeks.

But tests have found some of her mother’s stem cells in her blood. Whether they will start to help her is unknown. If they do not, her parents could opt for a bone-marrow transplant to cure the disease and free her from a lifetime of transfusions.

In that case, if some of her mother’s cells persist, they may make it possible for her to accept another transplant from Ms. Obar with less chemotherapy than the procedure usually requires.

Those decisions are a long way off.

“Elianna’s doing great,” Ms. Obar said. “I’m not disappointed at all. If it works, great. If it didn’t, we’re O.K. with it. We’ll celebrate all the little accomplishments. I’m glad we did it.”

## In a Warming World, Less Nutritious Food

By BRAD PLUMER

WASHINGTON — Climate change researchers have begun in recent years to realize that the extra carbon dioxide that humanity is pumping into the atmosphere isn’t just warming the planet, it’s also making some of our most important crops less nutritious.

In a new study, researchers have found that rice exposed to elevated levels of carbon dioxide contains lower amounts of important nutrients.

The potential health consequences are large, given that there are already billions of people around the world who don’t get enough protein, vitamins or other nutrients.

“When we study food security, we’ve often focused on how climate change might affect the production of crops,” said Lewis H. Ziska, a plant physiologist at the United States Department of Agriculture and a co-author of the study. “But the quality of those crops and their nutritional content can be just as important, and that hasn’t always gotten the close scrutiny it deserves.”

In the study, published in May in Science Advances, Dr. Ziska and his colleagues exposed experimental rice fields in China and Japan to the same elevated levels of carbon dioxide that are expected to occur later this century as a result of human activity.

Most of the 18 varieties of rice that were grown contained significantly less pro-

tein, iron and zinc than rice that is grown today. All of the rice varieties saw dramatic declines in vitamins B1, B2, B5 and B9, though they contained higher levels of vitamin E.

The researchers focused on rice because more than two billion people worldwide rely on it as a primary food source. “In a country like Bangladesh, rice provides 70 percent

of the calories and there aren’t a lot of other opportunities to get those nutrients,” said Kristie L. Ebi, a professor of public health at the University of Washington and a co-author of the study.

The paper builds on a study published in Nature in 2014, finding that elevated levels of carbon dioxide reduced the amount of zinc and iron found in wheat, rice, field peas and soybeans.

In plants like rice and wheat that undergo what is known as C3 photosynthesis, higher levels of carbon dioxide may spur plants to produce more carbohydrates, which dilute some of the more nutritious components. But scientists are still trying to understand why some compounds, like vitamin B, get diluted and others don’t, or why some varieties of rice see sharper declines in vitamin B than others.

With further research, scientists might try to breed or genetically engineer new crop varieties that preserve much of their nutritional value in the face of rising carbon dioxide. But this could prove challeng-

ing, Dr. Ziska said, given that all of the tested rice lines in their study showed significant declines in vitamin B.

If crop scientists can’t solve the problem, larger changes may be needed to blunt the negative effect on nutrition worldwide. “The bottom line is that people will need more diverse diets with a range of quality food sources,” Dr. Ebi said. “That’s already a major challenge.”

Another possible solution would be to reduce the amount of carbon dioxide that humanity emits.

“The idea that food might become less nutritious was a surprise, it’s not intuitive,” said Samuel S. Myers, a research scientist at the Harvard University Center for the Environment who worked on the 2014 Nature study. “But I think we should continue to expect surprises. We are completely altering the biophysical conditions that underpin our food system, and we still have very little understanding of how those disruptions will ripple through ecosystems and affect human health.”

## Prehistoric Brains, Small but Potent

By NICHOLAS ST. FLEUR

What makes humans so intelligent — big brains? New research into the tiny heads of a human relative called Homo naledi suggests that, when it comes to brain complexity, size isn’t all that matters.

In 2013 scientists excavating a cave in South Africa found remains of Homo naledi, an extinct hominin thought to have lived 236,000 to 335,000 years ago. Based on the cranial remains, the researchers concluded it had a brain only about the size of an orange. But the imprints left behind by the brain suggest that despite its size, Homo naledi’s brain

shared a similar shape and structure with that of modern human brains, which are three times as large.

“We’ve now seen that you can package the complexity of a large brain in a tiny packet,” said Lee Berger, a paleoanthropologist at the University of the Witwatersrand in South Africa and an author of the paper published in the journal Proceedings of the National Academy of Sciences. “Almost in one fell swoop we slayed the sacred cow that complexity in the hominid brain was directly associated with increasing brain size.”

Not every scientist agrees.

Since its remains were first retrieved, Homo naledi has puzzled scientists. From head to toe the ancient hominin displays a medley of primitive, apelike features and more advanced, humanlike characteristics.

“It’s this mosaic that is unlike anything we have seen or expected,” said Dr. Berger, who discovered Homo naledi in the Dinaledi Chamber in South Africa’s Rising Star cave system. So far, researchers have found more than 2,000 fossils belonging to the human relatives.

After examining the imprints, or endocasts, from five Homo naledi skull fragments,



JOHN HAWKS

the team found that the species had a frontal lobe that was similar to that of modern humans and unlike that of an ape’s. The scientists also found that Homo naledi had an asymmetrical brain, with the left brain appearing more forward than

the skull of Homo naledi, a hominin that had a brain with human-like characteristics.

the right, which is also seen in humans. Asymmetry in the brain is associated with higher levels of behavioral complexity, the team said.

Based on the regions of the brain that Homo naledi shared with modern humans, the authors suggested that it may have exhibited complex behavior.

The finding does not mean that brain size is not important to creating a complex brain. Rather, size alone does not tell

the whole story. “There’s something about shape that actually matters too,” said John Hawks, a paleoanthropologist at the University of Wisconsin, Madison, and an author of the paper.

Simon Neubauer, a physical anthropologist at the Max Planck Institute for Evolutionary Anthropology in Germany, said the finding supported the idea that both brain size and brain organization are important to human evolution. But he added Homo naledi might be an outlier in a general hominin trend toward increasing brain sizes.

Emiliano Bruner, a paleoanthropologist in Spain, agreed.

“Exceptions are, as always, expected,” he said. “But this does not break the rule.”