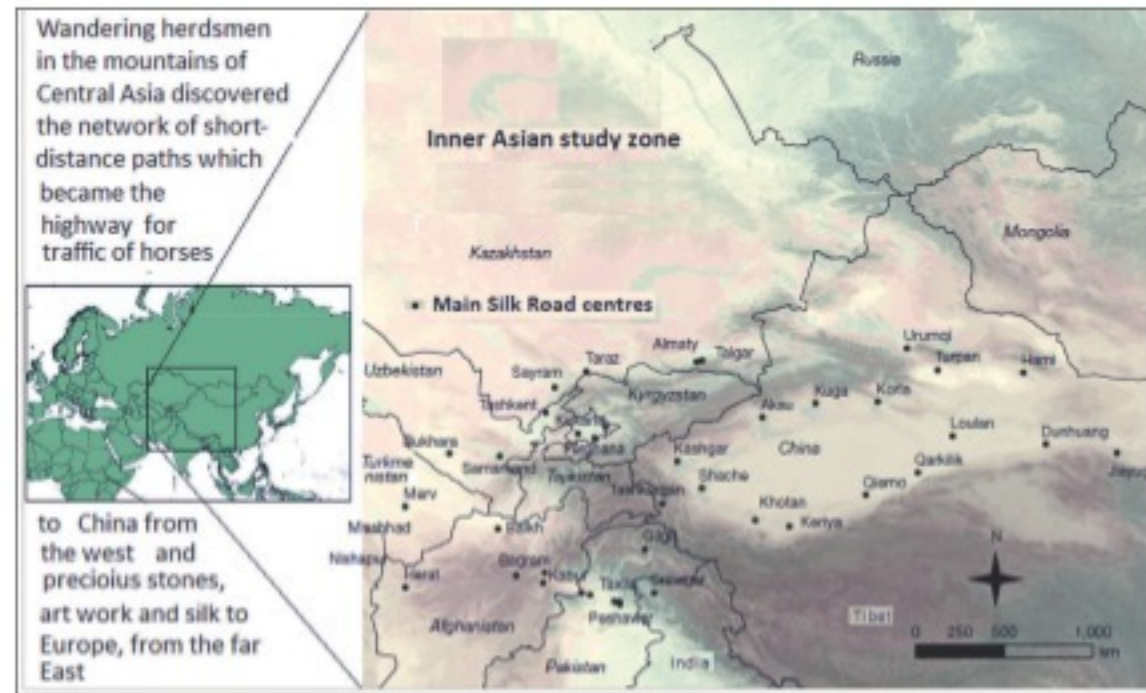


How herdsman showed the way

IT WAS THE QUEST FOR PASTURE THAT DROVE HUMAN MOVEMENTS AND SHAPED THE WAY TRADITIONAL TRADE ROUTES, LIKE THE SILK ROAD, EMERGED, WRITES S ANANTHANARAYANAN



The seasonal migration of herdsman in present day China



their communications has not been studied, the paper says.

The team carried out computer studies of the flows of domesticated herd animals in an area that lies between elevations of 750 m and 4,500 m, within a broader area in highland inner Asia (see map). Modelling of population flows has been successfully used to simulate the seasonal wandering of Bronze Age herders between foothills and high altitude pastures in Kazakhstan, with the help of archaeological and environmental data, the paper says.

The seasonal herding patterns in the study area were hence computer simulated, over 500 iterations, to derive reasonably persistent pathways that the herders used. And to assess whether these nomadic routes affected the connectivity at a continental

scale, these derived pathways were compared with 258 historical Silk Road sites, within the area studied, to see if there was a correlation.

As the location of these sites had not been fed into the system when the pathways were generated, they embody an independent check to verify if the herder flow patterns compare with the actual, high altitude Silk Road, the paper says.

The results of the studies were first that the seasonal movements of sparse herding groups result in a network of interconnected paths that covers the area. When this modelling is iterated 500 times, which represents evolution over twenty generations, the network takes the form of nearly-continuous pathways. And along these pathways are found to lie, over 74 per cent of the historical Silk Road



Michael D Frchetti

sites present in the region.

Finding a good proportion of known Silk Road sites on the map of pathways, generated based on pasture-driven herding groups, supports the idea that the longer routes through mountainous regions more likely grew along short-distance stretches of herding paths. Short-distance paths being rooted in the knowledge of local conditions and the availability of resources, food and water; would make for tree-like interconnection of pathways that makes up the Silk Road.

The model, as opposed to routes between known sites based on "ease of travel" and "connecting the dots", would also chart out a path along which to seek new, undiscovered Silk Road sites and other forms of Silk Road research and exploration, the paper says.

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PLUS POINTS

Accelerated warming



The world's oceans are warming 13 per cent faster than scientists previously thought, a study has warned.

The research, published in the journal *Science Advances*, also found the rate of ocean warming had changed significantly over the last 60 years. The warming rate from 1992 was found to be almost twice as great as the warming rate from 1960. "In other words, the planet is warming quite a lot more than we thought," Keven Trenberth, a co-author of the study, said.

Scientists are concerned by such an increase, as 90 per cent of the extra heat absorbed by greenhouse gasses ends up in the ocean, meaning it is considered one of the most important measurements of global warming.

"We know the oceans are much warmer now and they contain the memory of climate change. Higher sea surface temperatures are continually reinforced by the extra heat beneath the ocean surface," the team wrote in a press release.

"The oceans are affecting weather and climate through more intense rains. This process is a major reason why 2016 was the hottest year ever recorded at the Earth's surface, beating out 2015, which was the previous record.

"Additionally 2015 was a year with record hurricanes, heat waves, droughts, and wild fires around the world."

SAMUEL OSBORNE/THE INDEPENDENT

Mona Lisa smile



The subject of centuries of scrutiny and debate, Mona Lisa's smile is routinely described as ambiguous. But is it that hard to read? Apparently not.

In an unusual trial, close to 100 per cent of people described her expression as unequivocally "happy", researchers revealed recently. "We were astonished," neuroscientist Juergen Kornmeier of the University of Freiburg in Germany, who co-authored the study, said. He and a team used what is arguably the most famous artwork in the world in a study of factors that influence how humans judge visual cues such as facial expressions.

Mona Lisa is often held up as a symbol of enigma. Using a black-and-white copy of the early 16th-century masterpiece by Leonardo da Vinci, a team manipulated the model's mouth corners slightly up and down to create eight altered images — four marginally, but progressively "happier", and four "sadder" Mona Lisas.

A block of nine images were shown to 12 trial participants 30 times. In every showing, for which the pictures were randomly reshuffled, participants had to describe each of the nine images as happy or sad.

"Given the descriptions from art and art history, we thought that the original would be the most ambiguous," Kornmeier said. Instead, "to our great astonishment, we found that Da Vinci's original was... perceived as happy" in 97 per cent of cases, he added.

A second phase of the experiment involved the original Mona Lisa with eight "sadder" versions, with even more nuanced differences in the tilt of the lips. In this test, the original was still described as happy, but participants' readings of the other images changed. "They were perceived a little sadder" than in the first experiment, said Kornmeier. The findings confirm that "we don't have an absolute fixed scale of happiness and sadness in our brain" — and that a lot depends on context, the researcher explained.

Another interesting discovery was that people were quicker to identify happier Mona Lisas than sad ones. This suggested a slight preference in human beings for happiness, said Kornmeier.

As for the masterpiece itself, the team believes its work has finally settled a centuries-old question. "There may be some ambiguity in another aspect," said Kornmeier, but "not ambiguity in the sense of happy versus sad".

THE STRAITS TIMES/ANN

OUR HOMES IN THE SKY

Thousands of people could be living in floating space colonies orbiting the Earth in 20 years' time, according to the head of a project by the British Interplanetary Society.

And, while life in space might sound unappealing to some, Jerry Stone believes it could actually be healthier than on Earth, enabling people to live longer and, eventually, grow taller. Stone, author of *One Small Step* about the moon landings, and other members of the BIS have been updating research carried out in the US in the 1970s into how humans could start living in space in large numbers.

In a speech in Aberdeen as part of British Science Week, Stone will claim humanity is now close to the point where such colonies could be built using material taken from the Moon and asteroids. Speaking to The Independent, he said the space colonists would initially build and maintain solar panels that would be used to provide power on Earth. That, he said, was much more efficient than collecting the sun's energy on the Earth's surface after it has passed through the atmosphere. But other industries might later move into space to take advantage of the weightlessness and huge supply of energy from the sun.

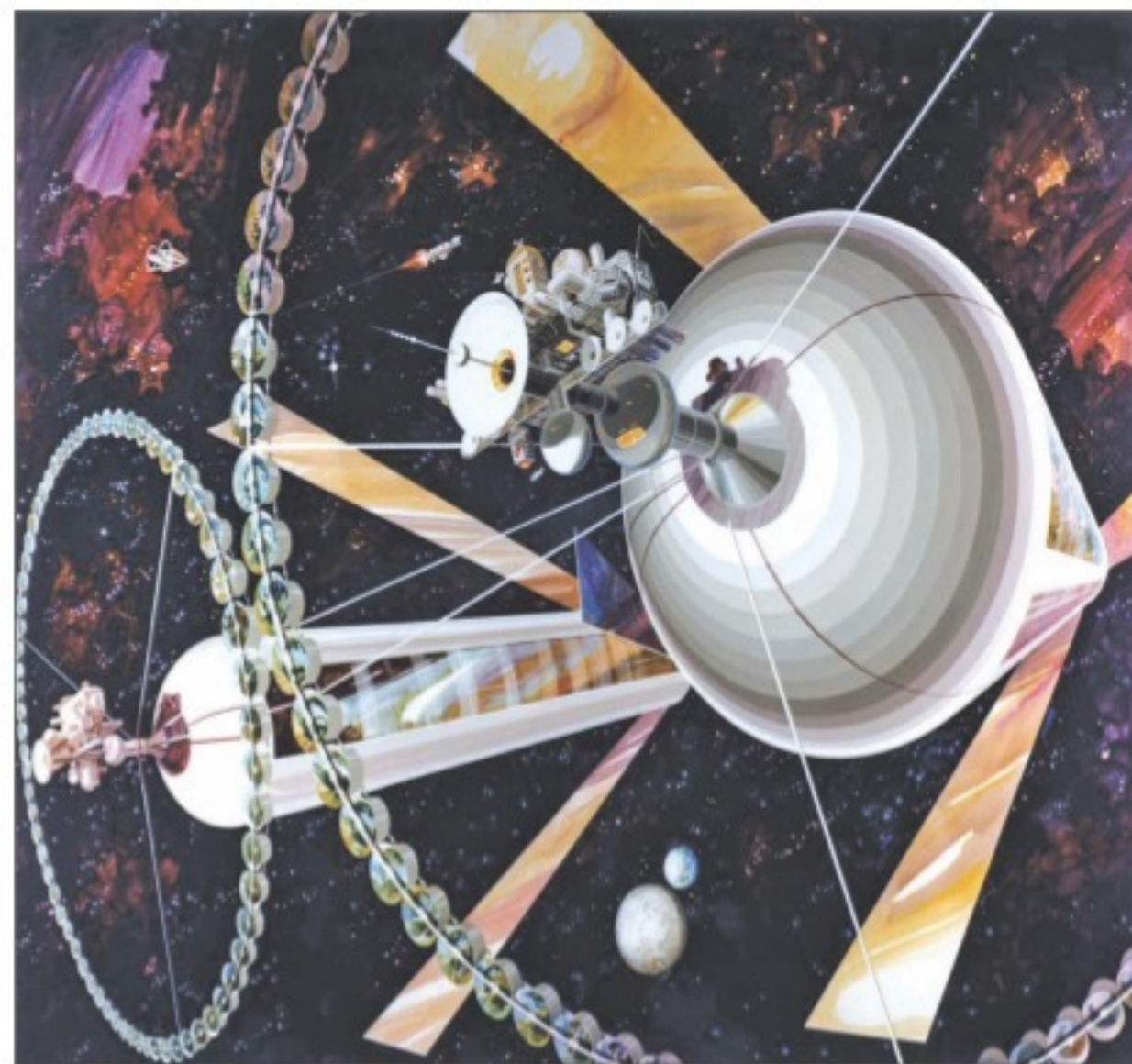
The colonies would consist of a vast hollow cylinder, which would rotate to provide gravity for the people who would live on the inside. Stone said that much would depend on private companies developing spacecraft that provided cheap and reliable access to space. But asked when he thought the first major colony might be created, he said, "If we were to say start in 10 years' time, we could potentially have this up and finished in 20 years from now, which is pretty amazing, isn't it?"

The research in the 1970s was led by Princeton University physicist professor Gerard O'Neill, who asked his students to come up with designs for space colonies. They decided it would be better for them to float in space, rather than be attached to the Moon, for example. They came up with a number of designs, calling them Island One, Two and Three.

While the project might sound far-fetched, Stone said it could actually have been done 40 years ago. "They (the Princeton team) deliberately restricted the design to the technology of the period, so nobody could say 'this is very nice, but it depends on this, and this and that hasn't been invented yet,'" he said. "They could have done all this with 1970s technology.

If we were to do this now we could probably do it far more efficiently than

A BRITISH EXPERT HAS CLAIMED THAT THOUSANDS OF PEOPLE COULD LIVE IN SPACE COLONIES ORBITING EARTH IN A MERE 20 YEARS' TIME. IAN JOHNSTON FINDS OUT MORE



back in the 1970s — that's why I started this project at the British Interplanetary Society.

"We're not just playing around with it. Some of our group have been working specifically on the Island One design. They have decided that a short cylinder would be better than a sphere." The BIS team's adapted design has been dubbed Island Zero. As the gravity is created artificially, this led them to question whether the colonies should have the same level as found at sea level on Earth, 1G. "Do they need to rotate to give 1G? How about 0.9G or 0.8G? That would mean less stress on the structure and less stress on the inhabitants," Stone said, "They would probably live longer. And over longer periods of time, the inhabitants would be taller than those on Earth.

"But also at what point does lower gravity become a problem? The answer to that is nobody knows. On the International Space Station, people are completely weightless but that's not what we want. For most of the time, (the colonists) will be working and liv-

ing under simulated gravity, which will be much better for their health-wise."

Stone said the BIS had looked at such plans before. "What makes this different to all the other previous studies by the BIS is they have pretty much been focussed, 99 per cent, on the technology," Stone said. "But when you are building a space settlement, you are also involved in a huge range of topics — such as town planning, housing, offices, administration, parkland and so forth, agriculture... ecology is a huge thing.

"Plus there are the political and legal aspects of it. If a consortium is set up to manufacture this settlement, will they actually be allowed to take material from the moon?"

Stone said the potential to harvest solar energy in space was one of the main drivers behind the project. "A number of countries are looking at the possibility of doing that," he said. "Power from space is far, far more efficient than generating power on Earth."

THE INDEPENDENT

Carbon dioxide fixation

TAPAN KUMAR MAITRA EXPLAINS THE PROCESS OF THE HATCH-SLACK CYCLE IN PLANTS

In many tropical grasses, including economically important plants such as maize, sorghum, and sugar cane, the isolation of rubisco is accomplished by a short carboxylation/decarboxylation pathway referred to as the Hatch-Slack cycle, after Marshall D Hatch and C Roger Slack, two plant physiologists who played key roles in the elucidation of the pathway. Plants containing this pathway are referred to as C4 plants because the immediate product of carbon dioxide fixation by the Hatch-Slack cycle is the four-carbon organic acid oxaloacetate. This term distinguishes such plants from C3 plants, in which the first detectable product of carbon dioxide fixation is the three-carbon compound triose-phosphoglycerate.

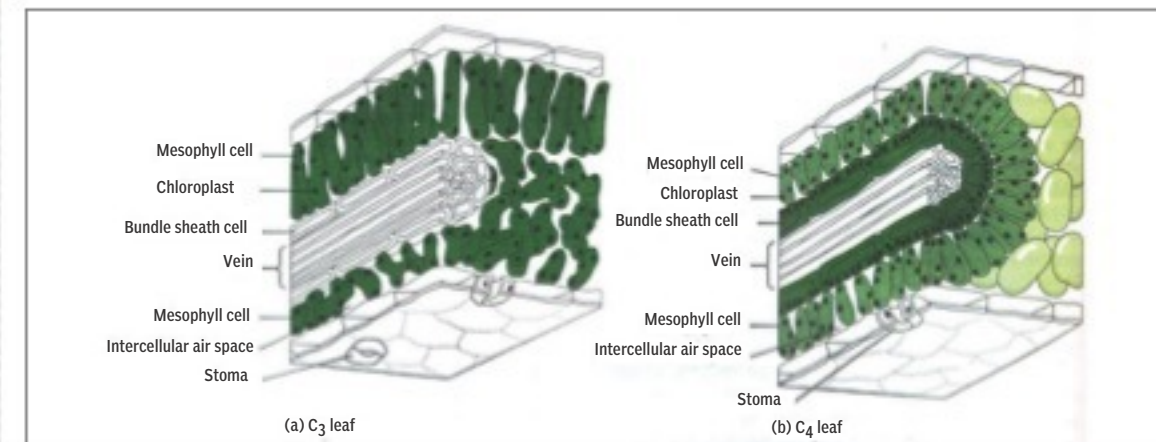
To appreciate the advantage of the Hatch-Slack cycle, one must first consider the arrangement of the Hatch-Slack and Calvin cycles within the leaf of a C4 plant. C4 plants, unlike C3 plants, have in their leaves two distinct types of photosynthetic cells: mesophyll cells and bundle sheath cells that differ in their enzyme composition and hence their metabolic activities.

The first steps of carbon dioxide fixation within a C4 plant are accomplished by the Hatch-Slack cycle in mesophyll cells, which are exposed to the carbon dioxide and oxygen that enter a leaf through its stomata. The carbon dioxide that is fixed in mesophyll cells is subsequently released

(a low Km) for its substrate, bicarbonate (HCO⁻), and operates very efficiently even when the concentration of bicarbonate is quite low. (Bicarbonate forms when carbon dioxide dissolves in water; its concentration therefore reflects the availability of carbon dioxide gas.)

In one version of the Hatch-Slack pathway, the oxaloacetate generated by PEP carboxylase is rapidly converted to malate by an NADPH-dependent malate dehydrogenase. Malate is a stable four-carbon acid that carries carbon from mesophyll cells to chloroplasts of bundle sheath cells, where decarboxylation by NADP+ malic enzyme releases CO₂. The liberated carbon dioxide is then refixed and reduced by the Calvin cycle.

Because decarboxylation of malate is accompanied by the generation of NADPH, the Hatch-Slack cycle also conveys reducing power from mesophyll to bundle sheath cells. This might limit the demand for non-cyclic electron flow from water to NADP+ in the bundle sheath cells, thereby minimising the formation of oxygen by PSII complexes and fur-



in bundle sheath cells, which are relatively isolated from the atmosphere.

The entire Calvin cycle, including rubisco, is confined to chloroplasts in the bundle sheath cells. Because of the activity of the Hatch-Slack cycle, the carbon dioxide concentration in bundle sheath cells may be as much as 10 times the level in the atmosphere, strongly favouring rubisco's carboxylase activity and minimising its oxygenase activity.

The Hatch-Slack cycle begins with the carboxylation of phosphoenolpyruvate to form oxaloacetate. Not only does this carboxylase lack rubisco's oxygenase activity, it is an excellent scavenger for carbon dioxide. In other words, it has a high affini-

ty favouring rubisco's carboxylase activity.

Although less than one per cent of the plant species investigated depends on the Hatch-Slack cycle, the pathway is of particular interest because several economically important species are in this group. Moreover, C4 plants such as maize and sugar cane are characterised by net photosynthetic rates that are often two or three times those of C3 plants such as cereal grains.

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