Watch for what they ate

The food habits of people in ancient times can tell us quite a few things about how they lived

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A digital reconstruction of the port (Courtesy the Portus Project)

An amphora used to transport fish sauce from southern Spain to Rome (Courtesy the Portus Project)

Site of the excavations

A representational map of the Portus port in Imperial Rome

The dietary habits of the inhabitants of a settlement are a reflection of its economy. In research into the history of ancient communities, information about what people ate helps interpret available evidence about politics, land use and trade.

Sheila Hamilton-Dyer, Evi Margaritis, Samantha Oxford, Walter Pantano, Martin Millett and Simon J Keay, from institutes of archaeology in the Universities of Cambridge and Southampton, Southampton, Chelmsford, Nicosia and Rome, describe in the journal, *Antiquity*, published from Durham University, UK, their study of plant, animal and human remains found at a well-known archaeological site. And they explain how the study of eating habits helps reconstruct and verify the commercial and political changes during the period that they cover.

The Portus Project, a detailed archaeological study undertaken by the University of Southampton, began with the mapping, in 1998, of 220 hectares in and around Portus, a large artificial harbour that served ancient Rome. The work continued from 2006 to 2011 with funding by the UK Government's Art and Humanities Research Council and has brought multi-disciplinary and international attention to research into aspects of the history of Imperial Rome.

The harbour of Portus Romae was situated on the northern bank of the mouth of the river, Tiber, which flows through Rome to the Mediterranean Sea in the western coast of Italy. The emperor, Claudius, of the first century AD, built Portus as an alternative to the existing port of Ostia, four km to the south. The object, largely attained, was to protect ships from the southwestern wind that blew at the mouth of the Tiber. The facility consisted of a large harbour basin, enclosed by curving breakwaters, and was connected to the Tiber by two wide canals. While the canals also served to drain the Tiber and save Rome from flooding, Portus itself had elaborate facilities for the reception of ships, handling merchandise and dispatch imports up the Tiber. The harbour even had an artificial lighthouse in the centre. Portus was developed and expanded in the following reign of Emperor Trajan and through the first half of the millennium, it received most of the imports from the Mediterranean for Rome, and exports from the Tiber valley.

The widest of the canals, 90 metres wide, discovered with the help of magnetic anomalies, "was so big that there seems to have been an island in the middle of it," said a news report of 2010. "The dig, which is being carried out in partnership with Italian archaeologists, is shedding light on the extraordinary trading network that the Romans developed throughout the Mediterranean basin, from Spain to Egypt and Asia Minor... The archaeologists have found evidence that trading links with North Africa in particular were far more extensive than previously believed. They have found hundreds of amphorae, which were used to transport oil, wine and a pungent fermented fish sauce called garum, to which the Romans were particularly partial, from what is now modern Tunisia and Libya," the news report goes on to say.

"Plant and animal remains provide direct evidence for food, traded goods, building materials, fuels and the local environment", the report in *Antiquity* says. The authors hence analysed plant and animal remains, from rubbish heaps, and human skeletons from burial grounds. Of plant and animal remains, found in rubbish, the samples were mostly recent, the report says, and earlier periods were underrepresented.

One of the first things observed is that the remains included exotic varieties, like charred black pepper seeds, imported via Egypt from India and containers made from African ostrich egg-shell, clear evidence of extensive maritime trade. There were also remains of exotic animals, like bears, and what appears to be a rib from a crocodile of the Nile. While the exotica were clearly for display in the spectacles of Rome, the focus of the study is on charred grain and the bony remains of larger domestic animals, used for food. As the samples were available only at some locations, however, the food refuse examined is mainly of the daily lives of port workers, rather than households.

The plant remains contained ample seeds of grain, preserved, as grain is baked, rather than boiled, but there were little traces of chaff. The absence of chaff suggests that the sources were not nearby cultivation, but came from a distance, the paper says. And there were other indications that the wheat was sourced from different parts of the Mediterranean. It was also seen that the nature of the wheat grains changed from the "free-threshing" kind in the early centuries to the "processed" kind from the mid-fifth century onwards. This could be a result of a change in maritime networks, and could be a response to changes in religious customs, which are recorded, the paper says.

An interesting observation arises from the analysis of human remains, in the main cemeteries in the area. While the bones in one cemetery showed signs of manual labour, and were hence of the workers who handled cargo, the other cemetery was for the leisure class. Both classes, however, between the second and mid-fifth centuries, appeared to follow the same kind of diet, rich in animal protein, imported wheat, olive oil, fish sauce and wine. The diet of the local populations, however, changes during the later stages, to more plant protein and lesser imports, more a "peasant diet".

This, the paper notes, is around 455 AD, the year of the Sack of Rome by the Vandals and the decline of the Roman influence over the Mediterranean. "We are able to observe political effects playing out in supply networks. The politics and the resources both shift at the same time," the paper says. The change continues until the Gothic wars of the sixth century.

A press release from the University of Cambridge quotes the director of the project, professor Simon Keay, "Our excavations at the centre of the port provide the first archaeological evidence of the diet of the inhabitants of Portus at a critical period in the history of Imperial Rome. They tell us that by the middle of the fifth century AD, the outer harbour basin was silting up, all of the buildings were enclosed within substantial defensive walls, that the warehouses were used for the burial of the dead rather than for storage, and that the volume of trade that passed through the port en route to Rome had contracted dramatically."

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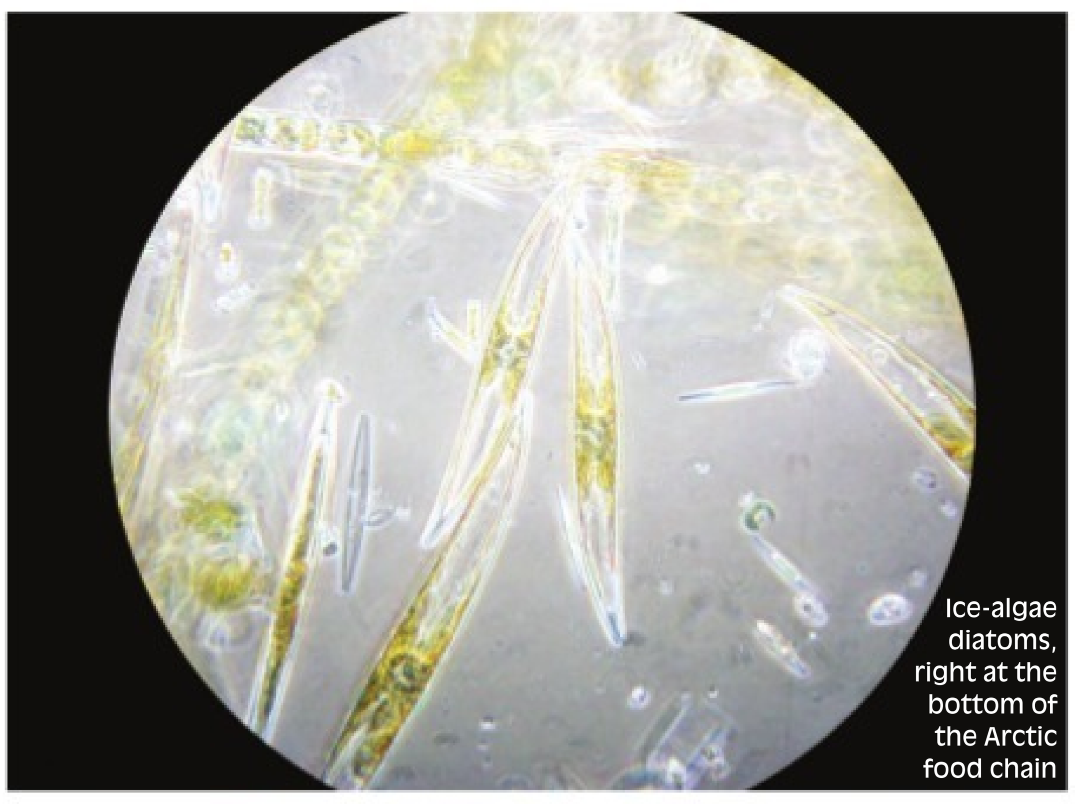
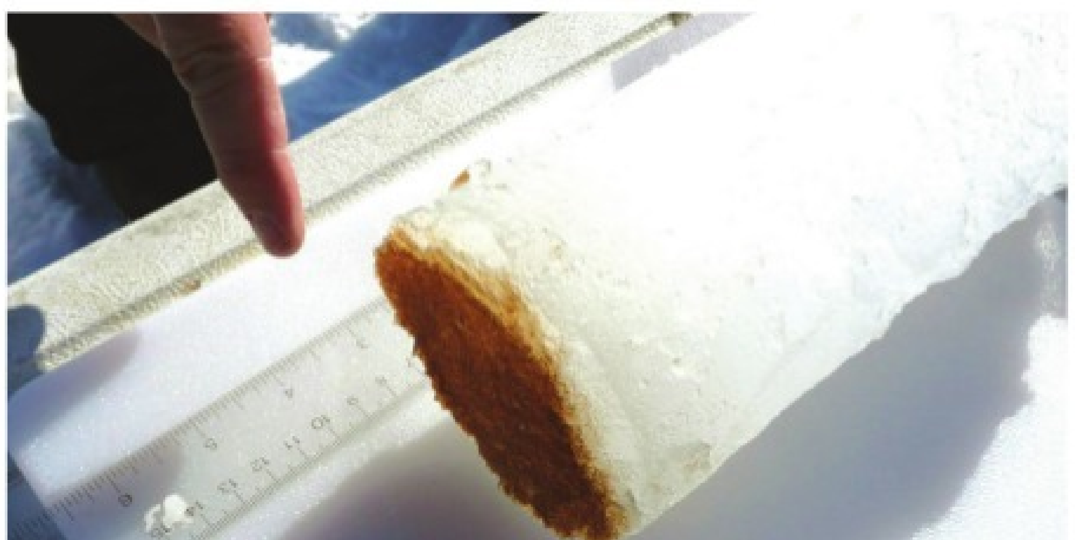
Our impact is unmistakable

Disappearing sea ice is changing the whole ecosystem of the Arctic Ocean

GRAHAM JC UNDERWOOD



Ice-algae diatoms, right at the bottom of the Arctic food chain



Ice algae growing on the bottom of an ice core

I drafted this while looking north over the frozen Lincoln Sea, at the northernmost tip of Ellesmere Island in Canada. I was at Alert, a Canadian Forces Station which, at 82°N, is the most northerly permanently inhabited place on Earth. Just 815km away, across the Arctic Ocean, lay the North Pole.

It was May, and the sea should have still been frozen, but this year the bridge of sea ice between Ellesmere and Greenland broke up early, and Arctic ice began flowing down the narrow Nares Channel and south into Baffin Bay. All across the Arctic Ocean, the amount and persistence of sea ice is declining — September ice cover has fallen around 30 per cent since 1980.

The Arctic is warming at twice the rate of the rest of the planet, and images of polar bears on small ice floes capture the imagination. But those images represent (excusing the pun) only the tip of the iceberg — the consequences of ice loss are profound and start from the very bottom of the food chain, in the microbial processes that drive the biology of the ocean.

Arctic food chains sometimes start in sea ice

Sea ice forms when seawater temperature falls below -1.8^{o} C. As the ice crystals form, salt is forced out and ice brines and other dissolved constituents become trapped in a honeycomb of small channels in the ice. Cold salty water draining from the ice also sinks deep to the bottom of the oceans and drives water circulation across the globe.

As the air grows colder, the ice thickens downwards and, in the brine channels and across the ice bottom, specialised algae and bacteria grow. When sunlight returns to the Arctic in the spring and penetrates through the ice (which is rarely more than a few metres thick) these ice-algal communities start to photosynthesise, producing algal biomass and abundant dissolved organic matter.

This feeds a wide range of microscopic creatures known as zooplankton, which graze across the bottom of the ice. These zooplankton in turn feed larger animals and drive the food chain throughout spring.

When the ice melts more of this material flows out into the seas, providing more food resources at the bottom of food chains. In a recent study published in *Nature Climate Change*, colleagues and I showed how the different components of this organic matter derived from ice-algae are used by different species of bacteria and at different rates in underlying seawater, so that more melting ice will change the patterns of organic matter turnover in surface waters during spring.

Different food chains may develop

Not all sea ice melts each summer — or at least it didn't. Multi-year ice can go through a number of years of melting and growing, getting thicker and more structurally complex. But, over time, this multi-year ice has become rarer. In the 1980s, around one-third of the Arctic's ice cover was more than four years old — today, such ice is almost non-existent. Instead, more first-year ice will form and completely melt each year, providing new food inputs into areas of ocean that were previously permanently covered in ice.

This has significant consequences. Less ice cover in summer means more open ocean water, which — as it is darker — absorbs more sunlight and heat, making it harder to freeze in the autumn. Open water also means the wind can stir up the sea and slow the process of refreezing. More open water in summer will change the plankton communities, and then the animals that feed on them.

Some species are moving north. Already the Barents Sea between Norway and Svalbard is now rarely covered in ice in winter — and North Atlantic species such as cod and top predators such as orca are moving in. Specialist species that rely on ice such as polar bears, ringed seals, walrus and Arctic cod are losing their habitats, while non-indigenous species are expanding their range.

For some, a warmer Arctic brings opportunities. Reduced ice cover means ships can use the north-east and north-west passages, significantly shortening journey times between the Atlantic and the Pacific. New fisheries may develop, and less ice means access to oil and gas resources becomes possible.

But these benefits to some, come at potentially huge costs. In addition to the changes in the ocean, a warmer Arctic could disrupt ocean circulation and global weather systems, while permafrost will continue to thaw, potentially releasing greenhouse gases currently locked up in frozen soils.

A whole ecosystem, rich in specialist species — many barely studied — is changing before our eyes. The Arctic is a beautiful and harsh place, posing serious logistical challenges for scientific investigation. But even there, on the top of the world, far from centres of human population, our impact is evident.

The Arctic is warming at twice the rate of the rest of the planet

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PLUS POINTS

Nano-capsules for cancer

A research team from the Indian Institute of Technology, Mandi, has developed complex nano-dimensional capsules that can be used for multimodal imaging and treatment of tumours. Their work paves the way for better understanding and development of theranostic techniques for cancer and other diseases, and was recently published in the *Journal of ChemNanoMat*.

Theranostics is an emerging field in medicine, especially in oncology, and combines "diagnostics" — the detection of abnormalities and maladies — with "therapeutics"— treatment of the malady. It involves the use of a single multifunctional agent that can diagnose ailments, deliver drugs and monitor treatment efficacy. The promise of theranostics is that it could enable treatment options that are individual-specific, which can conceivably result in better prognoses. This research, however, does not imply a cure for cancer.

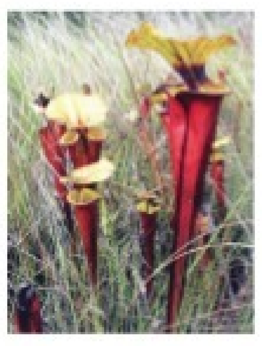
"Nano-materials — materials that are approximately few thousand times smaller than the thickness of a single human hair — have brought the concept of theranostics closer to reality", said Amit Jaiswal, assistant professor, School of Basic Sciences, IIT-Mandi, who led the team. The unique size scale of the particles can result in enhanced-permeability-and-retention effect in tumour targeting and treatment.

Jaiswal and his team have developed a "smart" nano-material that can serve as an effective theranostic agent. Their plasmonic nano-capsules have functionalities that make them useful in diagnosis through a technique called Surface-Enhanced Raman Spectroscopy in addition to carrying a cancer drug in it, which can be released simultaneously. Their nano-capsules comprise a solid gold core, which is surrounded by a porous gold layer, the two layers forming what they term a "gold nano-rattle". This nan-orattle has electromagnetic hotspots, in addition to being able to bind to a Raman-active compound called BDT, and together serve as a Raman reporter, the diagnostic part of the functionality. This ensemble is further encapsulated, first by a solid silica layer, which keeps the underlying BDT from leaching out. Surrounding this is a porous silica layer, into which is loaded, the chemotherapy drug, Doxorubicin — the therapeutic part of the theranostic agent.

The team is excited about this development. The smart core-shell type nanocapsules "enable an extraordinary nanotheranostic platform that can perform bimodal SERS and fluorescence-based bioimaging, and at the same time function as an efficient drug delivery vehicle for therapeutic applications", the researchers write in their recently published paper. The nanostructured capsules developed by Jaiswal and his research students, Shounak Roy, Ankita Sarkar (*in photo*) and Monika Ahlawat, can potentially extend the existing paradigms in therapeutic procedures by allowing imaging to be performed not only before and after, but also during a treatment regimen.

Challenges, however, remain, including understanding the toxicity issues involved in using nano-sized materials in biological domains, and specific targeting issues, which must be addressed before theranostics can transition from the lab to clinical practice. That said Jaiswal and his team's work offers a launch pad in India for more extensive research that can eventually enable the transition.

Salamander feast



Flesh-eating pitcher plants living in a bog in Canada have, for the first time, been spotted regularly feasting on salamanders. The carnivorous plant — also known as a "turtle sock plant" — was previously believed to feed almost exclusively on spiders and small insects, who fell into their bell-shaped leaves and drowned in small pools of water. When researchers found creatures like rats and frogs in pitcher plants they assumed it was an accidental one-off.

However, biologists from the University of Guelph found these plants regularly devour young spotted salamanders, which they can digest in less than two weeks.

Twenty per cent of pitcher plants surveyed in a bog in Ontario's Algonquin Provincial Park had salamanders in — and many traps contained more than one, according to the study published in the journal *Ecology*. These amphibians — each around the length of a human finger — are highly nutritious for the plants that like growing in nutrient-poor acidic bogs.

Some trapped salamanders died within three days, while others lived for up to 19 days.

The independent