Figure 1. Claire Beynon, *Explorers Cove Sea Ice, New Harbour Camp, Antarctica* (2008), photograph.

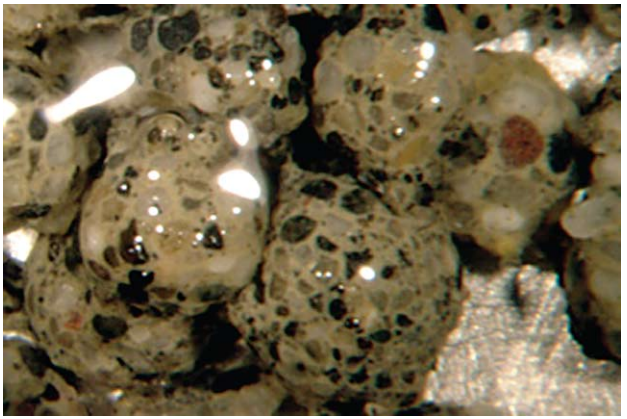


Figure 2. Jack Harris, *Agglutinated (testate) foraminifera* (2005), photograph. Reproduced with permission.

CLAIRE BEYNON

Nature's Little Masons[1]: Seven Meditations on Two Antarctic Seasons

1.

Advances in human technology are not all that terrifically impressive when compared to the enduring ingenuity demonstrated by the engineers and architects of the natural world. Take, for example, the complex structure of coral reefs; and the kilometres upon kilometres of chalk cliffs, temples of honour to indeterminable generations of calcareous foraminifera and coccolithophors.

Edward Heron-Allen (b. London, 17 November 1861, d. 1943) was a fascinating man: a true polymath.[2] His expertise ranged from violin-making to cheiriosophy, linguistics to archeology, marine zoology to meteorology, and esoteric studies to the successful cultivation of asparagus. He wrote extensively on each of these subjects, contributing significantly to our current understanding of foraminifera, a group of ancient unicellular aquatic organisms.

When Heron-Allen wasn't writing academic papers, investigating the paranormal or lecturing on the intricacies of violin-making, he was studying Persian. He translated the Persian classic *Rubaiyat of Omar Khayyam* into English and, too, *The Lament of Baba Tahir* (from its original, obscure dialect, Luri). As if that wasn't more than enough to keep one man busy for a lifetime, Edward Heron-Allen adopted a pseudonym, Christopher Blayre, and set about becoming a prodigious writer of short stories ranging from science fiction to the supernatural and quasi-erotica. In his ordinary everyday life, he was a lawyer, husband and father to two children.

The primary reasons I'm mentioning Edward Heron-Allen here are firstly because he was – and still is – a highly respected protistologist and secondly because he is one of many scientists who was also an artist; or was he an artist who was also a scientist? Is it, in fact, necessary to make a distinction?

Time and again it strikes me that, although the current tendency is to herald artscience as an exciting new field, the conversation between art and science is far from new. To the contrary, the humanities and sciences have been kindred disciplines right from the start. They are as vital to each other as blood is to bone. As research processes, wonder and doubt drive art and science both forward in search of knowledge and meaning, their common purpose to illuminate and communicate.

Figure 3. Samuel Bowser, *Pilulina Beynonae* (2008), watercolour, 150 x 210mm.

Figure 4. Samuel Bowser, *Crithionina cf. mamilla* (2008), watercolour, 150 x 210mm.

Figure 5. Samuel Bowser, *Astrammina Rara* (2008), watercolour, 150 x 210mm.

2.

I have been privileged to spend two summer research seasons (2005 and 2008) in Antarctica, each time accompanying a team of scientists and divers headed by New York-based polar biologist and protistologist Dr. Samuel Bowser.[3] Explorers Cove field camp (a site chosen specifically for its unusual abundance of foraminifera) sits like an awkward visitor on the transition between the Taylor Dry Valleys and McMurdo Sound. To the southwest, a desert wasteland of wind-scoured rock offers just enough nourishment to sustain shy colonies of microscopic blue-green algae; to the east, a craggy labyrinth of frozen waves and heaving pressure-ridges punctuates the sounds as far as the eye can see.

It was in Antarctica that my personal research focus turned to foraminifera. Startling as it may seem, I had neither seen nor heard the word 'foraminiferan' before the 2005 research season in New Harbor. This ancient group of aquatic organisms underpins our evolutionary pyramid and dates back 650 million years. There are four main types – naked, soft-bodied, calcareous and testate – each of these characterised by long, fine pseudopodia that extend outwards from a soft, cytoplasmic body (for the purpose of motility and food capture).

Forams are largely marine and are considered amongst the most abundant organisms that "package their DNA in a nucleus;" as such, they play a major role in the marine environment, contributing significantly to the cycling of our Earth's carbon.[4] Benthic (bottom-dwelling) foraminifera occur in almost every marine system, thriving particularly in deep-sea and outer continental shelf mud.

3.

In Antarctica, foraminifera can be seen with the naked eye; this makes sample sorting at Explorers Cove less daunting, especially for me, a laboratory novice. And so I began my work. After doing an initial 'rough sort,' we'd place the forams under the microscope the better to identify the various species' distinguishing features. A whole new world opened up beneath the lens. Forams are truly remarkable creatures, heroic in their shell-building efforts and methods. They construct exquisite, complex structures around their single-celled bodies, creating shells that are both functionally and ornamentally impressive – easy competition for any architect, engineer or stained-glass artist.

Explorers Cove foraminifera are an important living archive. Their shells are formed out of a range of different materials: sand grains, calcium, sponge spicules and other foram shells are base essentials. Certain species – *Astrammina rara*, for example – demonstrate a deliberate and quite staggering process of selection. They repeatedly select opaque sediment grains of a consistent shape and size, which they proceed to glue together to form a compact sphere. They then complete their elegant structure with the addition of one large red stone. Why is this? How do they differentiate scale and colour? Is it possible that unicellular organisms possess intelligence? A sense of aesthetic?

A source of ongoing frustration to scientists is the impressive organic cement that foraminifera secrete for the purposes of binding their various building materials together; the recipe for this impressive waterproof glue eludes them to this day. Studies thus far have not only stubbornly refused to yield up the ingredients, but the glue has damaged expensive laboratory equipment en-route.[5] It effectively gums up the technology and instruments required to analyse the substance. It seems probable that medical technology and industry have a while to wait before this substance can be put to any alternative uses.

I find it reassuring to think that one-celled creatures might still have the upper hand here.

Figure 6. Claire Beynon and Samuel Bowser, *InterfaCE* (2008), detail. Photograph by Claire Beynon.

Figure 7. Claire Beynon and Samuel Bowser, *InterfaCE* (2008), 3048 x 3048mm, floating installation. Tang Museum, Saratoga Springs, 2008. Photograph by Claire Beynon.

4.

My first trip down to the ice in 2005 gave rise to a number of artscience collaborative projects, the major one being a 10 by 10 feet floating installation titled *InterfaCE* (2008).[6]

At first glance, viewers encounter this floating installation as pure artistic expression; closer examination reveals it to be a full and accurate record of a legitimate scientific investigation. One hundred and twenty-seven images – a combination of photography, Scanning Electron Microscope (SEM) imagery and hand-drawn charcoal and pastel drawings – are arranged sequentially (according to our combined research processes) in seven concentric circles. Each image is mounted atop a glass laboratory beaker. My drawings are echoes of the images used in Samuel Bowser's microscopy and microlithography processes; the resultant composition brings to mind the lens of the camera and the microscope, the petri dish, the iris of the eye (ways of seeing and perceiving), music notes and our globe, *inter alia.*

InterfaCE is effectively a large mandela. Our circular drawings and SEM images are also suggestive of the Antarctic ice and sediment cores integral to global climate change research. The word 'Interface' is a fusion of '*inter'* meaning 'between' and '*facio*,' 'to make' or 'to do.' In everyday language, it means 'to bring into relationship.' The word '*ICE'* is embedded within the concept 'interface,' making this a pertinent title referencing both Antarctica and the parallels between image-making and scientific processes.

One of the focuses of the Bowser laboratories in both Albany and Antarctica is the functioning of both modern and ancient marine ecosystems.[7] Foraminifera are key to these studies since they produce vast fossil deposits that aid paleontologists in the interpretation of past ocean and atmospheric conditions. This information is key to understanding contemporary issues such as global climate change and its impact on the environment, human health and the economy.

It is understood that the life habits of forams are strongly influenced by characteristics of the sediment in which they live. Sediment grain size is thought to be the principal factor governing the biology of foram species, but other parameters – particularly the surface properties of sediment grains – are undoubtedly important. Indeed, it is the microtopology of the grains that the organisms interact with directly, so on first principles one might expect microtopology to be a primary factor. To our knowledge, however, no investigators have examined the influence of sediment grain surface microtopologies on foram biology. This lack of knowledge is primarily due to the absence of experimental approaches to tackle the problem.

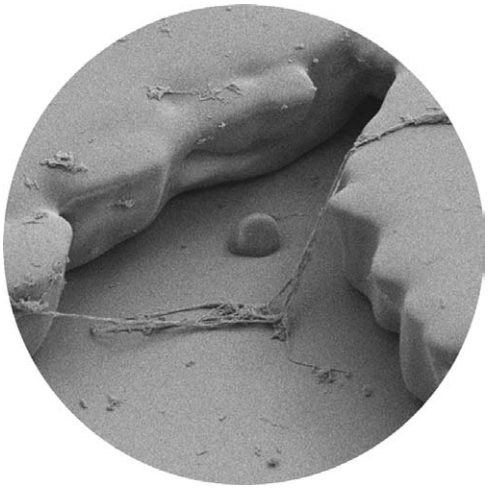
Thanks to recent technological advances in fabricating surface topologies on silicon and glass surfaces (driven primarily by the electronics industry) we now have the tools available to address this question. It is, for example, now possible to produce fields of micro- to nano-scale pegs or grooves on silicon; forams can be incubated on these surfaces and their physiological responses observed.

5.

In our preliminary work on *InterfaCE,* Samuel took my series of nine charcoal and pastel 'wind' drawings titled *Katabatikos* and miniaturised their 7-metre sweep down to nano-lithographic scale, so that they fitted ten times over onto a silicon plate measuring 10 by 10 millimetres. Using sophisticated micro-lithographic methods (the laboratory equivalent to a fine-art etching process) he produced a feature-rich three-dimensional growth substrate. Antarctic foraminifera collected during our field season were subsequently incubated on these substrates in his New York lab. The purpose in this was to provide these living organisms with an environment whose topographic features were similar in scale to those of their native sea floor (as opposed to placing them on a typical, incongruously

Figure 8. Samuel Bowser, Typical nano-scale topology, 2008.

Figure 9. Samuel Bowser, Katabatikos mask for feature-rich 3D growth substrate, 2008.



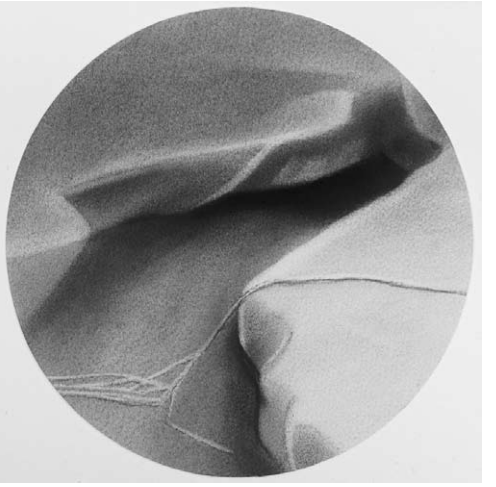


Figure 10. Samuel Bowser, *InterfaCE,* 19mm diameter, SEM photograph, 2008.

Figure 11. Claire Beynon, *InterfaCE,* 19mm diameter, charcoal interpretative drawing, 2008.

flat and featureless glass slide whose surface would bear no resemblance to the 3D landscapes they ordinarily inhabit). Samuel taught me to operate his light and Scanning Electron Microscopes so that together – with our very different ways of seeing – we could observe and record the forams' interactions with these tiny micro-Antarctic landscapes. The resultant information was then used by Samuel to generate hypotheses regarding specific topologies for more formal experimental tests. Meantime, I used the scientific data and imagery we had gathered as prompts for further artistic interpretations.

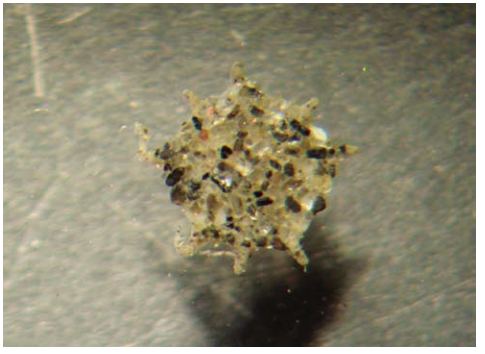
Essentially, what we did here was to cycle information through artistic, scientific, and microbial processes in a way that is analogous to the way energy and resources flow through the Antarctic ecosystem. The imagery is allusive and, as such, acts as a link between human and microbial experiences. Samuel's conjecture is that the research reflected in this installation has potentially important scientific and educational outcomes. Biomedical researchers, for example, have recently demonstrated that nano-scale surface topography influences the growth and behaviour of human cells. The possibility here is that the behaviour displayed by the Antarctic foraminifera on these 'random-yet-specific' substrates could have profound medical implications (for example, when it comes to cancer research and, the development of prosthetics and implants) as well as hold keys to our current environmental concerns.[8]

6.

For the 2008 season, our collaborative focus shifted. Advancing Samuel's foraminifera research remained a constant, but this return trip provided me with a range of exciting new possibilities. For one thing, I was returning to a place that was familiar – a place that had captured my heart and that I often feel an ache of homesickness for. In addition to 'givens' such as drawing, photography and writing, this second visit allowed me to consolidate my previous experience of the ice and to roam further in my explorations. In 2008, I prepared differently for my weeks in Explorers Cove; my idea to make a film became insistent, so I upgraded my camera and invested in a good-quality sound recorder. Samuel and I also invited two South African porcelain artists (Katherine Glenday and Christina Bryer) to link up with us as a way of extending the reach of our artscience conversation. There is a particular intensity – and, too, a directness and intimacy – that seems to me to be synonymous with Antarctica as a collaborative space. As colleagues and collaborators, Samuel, Katherine, Christina and I quickly identified a shared ethos of inclusiveness. Each of us prefers working in non-hierarchical partnerships, where our common focus is on making our work accessible to as wide an audience as possible.

Katherine Glenday has worked in porcelain for the past 27 years.[9] She is drawn to this medium for its translucency and fragility, for the way it holds light and sound – and offers both back. She created a set of fragile porcelain 'bell vessels' for us to take down to Antarctica, the idea being that we play and record them in a range of different locations around the continent. When struck with a soft-headed drumstick, they emit a sound like that of a Tibetan gong or cathedral angelis. The vessels' relationship to the Antarctic landscape is reinforced by the fact that the clay body Katherine made up for these pieces (a proportion of which came from the White Cliffs of Dover) contains fossil remnants of foraminifera and coccolithophors. Katherine also embedded pictorial clues to the scientific research that has been carried out in the vicinity of the Explorers Cove site for the past 25 years. Samuel and I transported Katherine's fragile vessels to a wide range of sites, playing and recording them in amphitheatres of pristine wilderness in the company of nothing but ice, air and rock. The resulting tracks have since been incorporated in our experimental film titled *Hidden Depths – Poetry for Science* (2010).[10]

Figure 12. Katherine Glenday, *Porcelain Vessels, in situ* Ferrar Fiord, Antarctica, 2008. Photograph by Claire Beynon.



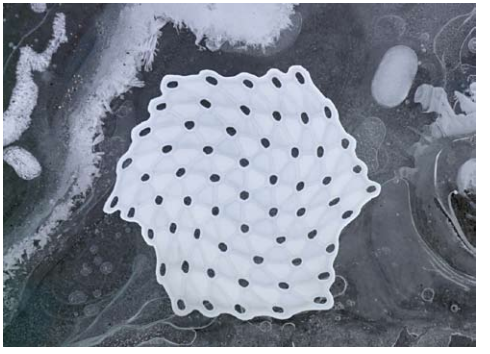


Figure 13. Samuel Bowser, *Astrammina Triangularis,* photograph, 2008.
Figure 14. Christina Bryer, *Porcelain foram*, 270mm diameter. Photograph by Claire Beynon, 2008.

Figure 15. Shawn Harper, *Notodendrodes Antarctikos,* photograph, 2008.
Figure 16. Shawn Harper, *Notodendrodes Antarctikos,* tree foram with Christina Bryer's porcelain piece, foram approx 15mm, porcelain piece 40mm diameter, 2008.

Christina Bryer is a mathematician as well as an artist.[11] Periodicity is the keystone of her work. When we first sent her images of foraminifera – specifically, *Astrammina triangularis* – she delighted in the mathematical 'blueprints' employed by the forams in the design and construction of their shells and embarked on the creation of a series of exquisite sculptural tributes to the unicellular creatures. Christina's porcelain sculptures accompanied us to the ice in 2008. Several of the smaller pieces are still in Antarctica where they are embedded in the ocean floor, 80 feet below the ice. They are acting as 'place markers,' highlighting a rare species of 'tree' foraminiferan named *Notodendrodes antarctikos.* New information regarding growth and motility will be gleaned from these specimens when they are observed again *in situ* when Samuel and his dive team return to Explorers Cove for the 2010 season.

Despite our taking the greatest care, a small number of these fragile porcelain objects were damaged during our 2008 season. There is, however, no cause for despair. As so often happens during creative processes, so-called 'mistakes' become prompts for new explorations; our obstacles can become our opportunities. In a bid to understand more about the foram's masonry skills (including the process of selection they employ whilst building their shells), experiments have been carried out in the laboratory for some time. The forams have been given a range of alternative building materials to work with instead of their customary ocean-floor sediment grains – amongst these, glass beads of varying sizes and colours. Drawing a circle back to my first meditation where I mentioned 'the kilometres upon kilometres of chalk cliffs, temples of honour to indeterminable generations of calcareous foraminifera and coccolithophors,' it made sense to offer the foraminifera Katherine and Christina's porcelain bodies to 'sculpt' with.

The shards have since been crushed down to particles relative in size to the Explorers Cove sediment. They have been tumbled in a high-tech machine so as to smooth down the rough, crystalline surfaces and round off all the sharp edges. Soon they will be given to the foraminifera who will embark on a novel form of microcosmic sculpture.

The innate purpose of the shells foraminifera build is for the protection of their vulnerable cytoplasmic bodies. Their shells are also their dwellings. Earlier on in this essay, I raised a question regarding whether or not they might be exercising some form of aesthetic judgement during the shell-building construction. Our gesture of providing the foraminifera with porcelain to build with serves several purposes; on an emotive level, it is a way of acknowledging the skill and refinement of their building processes and, in the process, attributing to it the characteristics of sculpture, architecture, environmental installation – 'artwork.' On a scientific level, observing the forams making choices regarding size and shape of material will shine light on more of the whys and wherefores of their construction methods, which may in turn have implications regarding their success in terms of survival.

Given the tragic state of our world's oceans – in particular, the environmental catastrophe that has been unleashed after the explosion of the Deepwater Horizon oil rig in the Gulf of Mexico – foraminifera have much to teach us. In recent years, a great deal of attention has been paid, appropriately, to the destruction of our rain forests and to diminishing fossil fuel reserves. We are being cautioned to also pay close attention to the microcosmic world. Unicellular organisms are the foundation of all known life. Persistent neglect of our earth's 'larger,' more overtly popular resources could threaten the stability of this foundation – an insidious process, and more likely the one that could bring the house down.

7.

QUANDRY

For Samuel Bowser and research team B-043

How odd you've not seen
these crater stars before, Sam.

Perhaps *Astrammina rara's* intelligence
leads them to consider
there may be some sense in beautifying
their sterile laboratory environment.

Well, why not, Sam?
Why not?

We place them in our time frame but
Explorers Cove is *their* domain.
550 million years ago, the same purple
scallops and luminous white
sea stars graced the forams' seabed.

We are the newcomers here, strangers passing
through. We haul them to the surface,
intent on finding answers to the universe
and yes, they show us many things.

But here we are now
talking, and there they are, ancient
and silent as always.

We translate what we think
they know into what they know
we cannot understand. And
as for these crater stars, Sam?

Imagine the ripples through the science community
when you say you've discovered the world's oldest
one-celled creature designing wallpaper for the heck of it
in your petri dish in Albany, New York?

But wait. There's another possibility. Perhaps
your forams miss the old Antarctic
sea stars, and these strange shapes
are simple expressions of their dreams for home.

1 The phrase "Nature's Little Masons" was coined by naturalist and clergyman A. M. Norman in 1878. See Eric L. Mills, "One 'Different Kind of Gentleman': Alfred Merle Norman (1831–1918), Invertebrate Zoologist," *Zoological Journal of the Linnean Society* 68, no. 1 (January 1980): 69–98, http://onlinelibrary.wiley.com/doi/10.1111/j.1096-3642.1980.tb01919.x/abstract [accessed 12 Oct 2010].

2 *Edward Heron-Allen Society*, UK, http://www.nhm.ac.uk/hosted_sites/heronallen/society.htm [accessed 28 Oct 2010]. See also Claire Beynon, *Icelines Blog*, http://icelines.blogspot.com/2009/01/curiosities-congruences-heron-allen.html [accessed 28 Oct 2010].

3 Claire Beynon blogs: http://www.clairebeynon.co.nz and http://www.watersihaveknown.blogspot.com; Samuel Bowser, *Antarctica Blog* (2009), http://icelabyrinth.blogspot.com/2009/01/cellular-masonry-and-intelligence.html [accessed 28 Oct 2010].

4 In conversation with Samuel Bowser.

5 Peter West, *National Science Foundation*, (2010), http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=110631 [accessed 28 Oct 2010].

6 *InterfaCE* was first shown at the Tang Museum in Saratoga Springs in 2008, has been shown in various iterations in the US and New Zealand since, and in early 2010 was mounted as part of the Wadsworth Centre's permanent collection in the State Plaza Building, Albany, New York.

7 *The Bowser Laboratories*, http://www.bowserlab.org/ [accessed 28 Oct 2010].

8 In conversation with Samuel Bowser.

9 Katherine Glenday, http://www.katherineglenday.com/ [accessed 28 Oct 2010].

10 *Hidden Depths – Poetry for Science* was selected for screening at the PolarCINEMA event at the International Polar Year Science Conference in Oslo, June 2010.

11 Christina Bryer, http://www.beatrixbosch.co.za/christina/resume.html [accessed 28 Oct 2010].