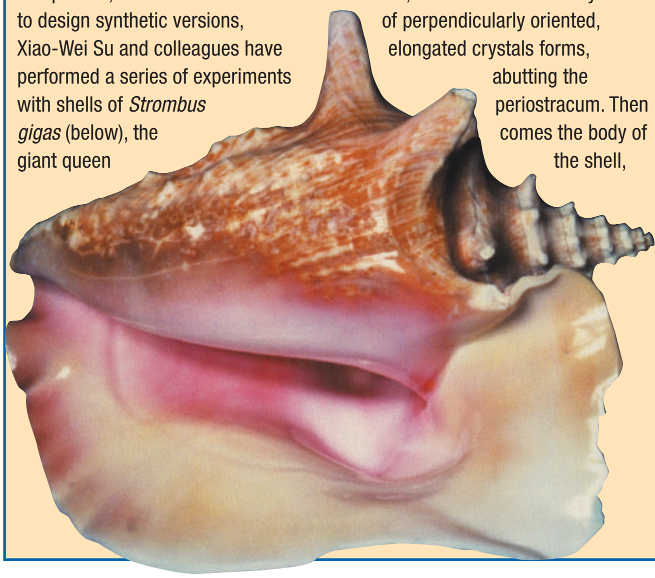
Materials science

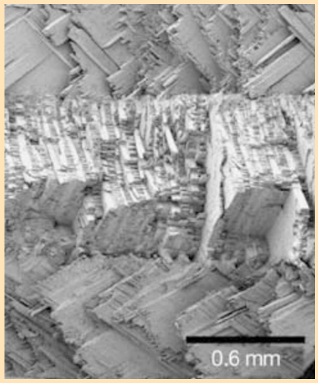
Give a shell a break

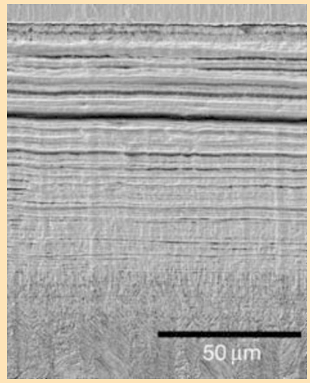
Giant conches are seldom treated with the respect they deserve. Their impressive shells are prized as holiday souvenirs, but size and aesthetics are only half the story. At the microscopic scale, they are one of nature's greatest engineering masterpieces: a stunningly intricate hierarchical architecture of inorganic crystals, interwoven with organic molecules.

In search of fresh insight into the synthesis of such biomineral composites, and clues for how to design synthetic versions, Xiao-Wei Su and colleagues have performed a series of experiments with shells of *Strombus gigas* (below), the giant queen conch of the Caribbean. They drilled holes in the shells of live juvenile specimens, then, through X-ray diffraction and electron microscopy studies, monitored how the animals repaired their shell tissue (*Chem. Mater.* **16,** 581–593; 2004).

In natural shell growth, an organic outer layer (the periostracum) is deposited first. It remains unmineralized but provides a base on which the mineralized shell is deposited. First, a micrometre-thick layer of perpendicularly oriented, elongated crystals forms, abutting the periostracum. Then comes the body of the shell,







which grows to a thickness of a few millimetres and has a three-layer 'crossed-lamellar' structure (left image, above).

Su *et al.* found that the process of shell repair is somewhat different from natural growth. In a wounded conch, 24 hours after damage, a transparent organic membrane was deposited over the drilled hole. Once the membrane was in place, Su *et al.* saw that fine crystallites of aragonite — a particular crystal form of calcium carbonate — nucleated rapidly on the organic membrane. Each conch generated a 100-μm depth of such abnormal tissue in the damaged area (right image). After 6–8 days, elongated crystals were deposited, oriented perpendicular to the direction of shell growth. As in normal shell development, the setting down of these elongated crystals preceded the formation of the crossed-lamellar microstructure (seen at the bottom of the image).

In uncovering the development of the unusual organic–inorganic layers in shell repair, Su *et al.* have provided a window onto the complex process of shell formation. It remains to be discovered how the interplay of organic and inorganic components is controlled at the molecular level, in conch shells as well as in other mineralized structures. **Rosamund Daw**

malaria (as opposed to epidemics at unstable fringes) at coarse scales and is in operational use throughout the continent.

Using this index, Small *et al.* calculated the annual transmission suitability for each half-degree latitude–longitude grid cell (about 55 km × 55 km) across Africa from 1911 to 1995. Time-series analysis revealed that both positive and negative trends were restricted to a few limited zones, with only one (southern Mozambique) showing a consistent increase in climatic suitability for transmission. Obviously, a model at this spatial resolution will miss finer-scale patterns, for instance in climatically varied mountain areas, and will produce transmission suitability maps specific to the index used. Nonetheless, it might be expected that more widespread positive changes would have been found if climate has been a major driver of change in transmission in this period.

A notable finding, however, was that in those areas showing positive significant trends, precipitation, not temperature, drove most changes. Mathematical models of malaria transmission, often used to project events under changed climate conditions, are based mainly on temperature-dependent processes and incorporate precipitation only as a simple global threshold sufficient for mosquito breeding[5]. Clearly this needs to be improved, but we have very little empirical understanding of how rainfall, humidity and their interactions with temperature influence vector populations. Moreover, owing to natural variability, it is difficult to identify robust signals in precipitation patterns from climate models. This is particularly so in Africa[14] — a landmass that is strongly influenced by El Niño, the episodic disruption of the ocean–atmosphere system in the tropical Pacific which has a large-scale influence on weather and climate.

As far as climate change is concerned, then, the main message from Small *et al.*[3] is that malaria transmission needs to be understood in terms of precipitation as well as temperature. No doubt climate models will continue to improve and we can look forward to refinement in the projection of these parameters. Regrettably, however, knowledge of the basic ecology of malaria transmission lags behind — for instance, we cannot yet relate absolute mosquito abundance to climate[6]. The urgent need is for progress on the entomological front to guide future modelling work on transmission. ■

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