size classes? The answer is once again a power law: A is proportional to $r^{-1.94}$.

They show elsewhere that, with a few assumptions that are not frightening, this relationship within size classes will generate the overall power-law relation between numbers of species and numbers of individuals. So if we possessed a theoretical understanding of how power laws might reasonably arise in this context, then Siemann and colleagues would be in a position to offer a pre-cooked explanation of both discoveries. However, power-law rank–abundance relations are largely neglected in the canonical literature on the subject[6,7], which is otherwise well equipped with models. Two previous studies of insects also found such a relationship across their entire sample[8,9]. But these were studies of tropical insect communities, and the greater diversity of the tropics, combined with much smaller sample sizes, means that it is difficult to know whether one is observing a genuine power-law distribution, or simply the tail of a distribution, such as a log–normal, that can mimic a power law. The present study gives greater confidence that there is some worthwhile theorizing to be done, because existing models for power law rank–abundance relations in other areas of biology[10] do not have an obvious relevance in this context.

Unusually for studies of insects, we have considerable confidence in this case that the sample is large enough to reveal true community patterns. Within each body-size class, by taking ever-larger subsamples of the data, it is possible to construct so-called species-accumulation curves, which show how the numbers of species in the sample increase with sample size. Here, for almost all body-size classes, the accumulation curves appear to be levelling off towards an asymptote, which would be the true number of species in the community. The results are robust when the analyses are repeated using estimated, asymptotic, species richness rather than the observed numbers of species.

Leaving aside the striking patterns revealed by this pioneering study, there are at least two further messages to be drawn from it. Our guesstimates of the total number of species on Earth received a shocking upward revision from studies of tropical insects[11]. Siemann and colleagues present a sanguine view that their study may incline us to the lower end of the 10–50 million range of estimates. But the only body-size class that did not exhibit an asymptote in their species accumulation curve was the smallest, which means that it is impossible to develop a reasonable statistical estimate of the total numbers of small insect species, even in this enormous study in the temperate zone.

Second, the evidence presented in the paper[2] makes another macroecological observation more robust. It is known for many groups of animal — birds, mammals and fish — that the distribution of body sizes is skewed, so there are more relatively small species than large ones[12,13]. This right skewness is also evident in the five orders of insects studied here (Fig. 2*a*, page 705), but there is no obvious reason why this should be the case.

Sweep-netting insects in a field may not look like hard science. But this remarkable study shows that bug hunting produces more than just endless lists of species, and poses some hard problems for theoreticians to muse over. □

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CLIMATE VARIATION

Cycling around the South Pole

Xiaojun Yuan, Mark A. Cane and Douglas G. Martinson

MANY of the variations in climate we all observe (and enjoy, or suffer) seem to be randomly distributed in time and space. While this view has an irreducible element of truth, there is increasing evidence that much of the Earth's climate variability arises from a structured, global, interconnected system. On page 699 of this issue[1], White and Peterson provide a striking example, with evidence for an interannual 'Antarctic Circumpolar Wave' (ACW). This is not a water wave but a disturbance in sea-ice extent, in sea surface temperature, in surface wind speed, and in atmospheric pressure at sea level. Although the short history of measurements in the Antarctic region rules out a definitive description, the data available from the past 15 years show a two-wavelength ACW propagating around Antarctica (see Fig. 1) with a frequency of about 4–5 years. This wave in the ocean, atmosphere and cryosphere (ice) is a strong and significant part of the interannual variability in the southern polar region.

Interannual variability in the Antarctic region may affect the global climate by altering the Equator-to-pole temperature gradients which drive the dynamics of the atmosphere and oceans. A more likely influence is the unique ability of the Antarctic Circumpolar Current (ACC) to transport oceanic anomalies between the three major oceans, Pacific, Atlantic and Indian. Variability in the Antarctic may influence the global climate on longer timescales by changing formation rates of deep and bottom waters, and thus, ultimately, the heat transfer between ocean and atmosphere. By identifying and characterizing an important mode of variability in the Antarctic region, the discovery of the

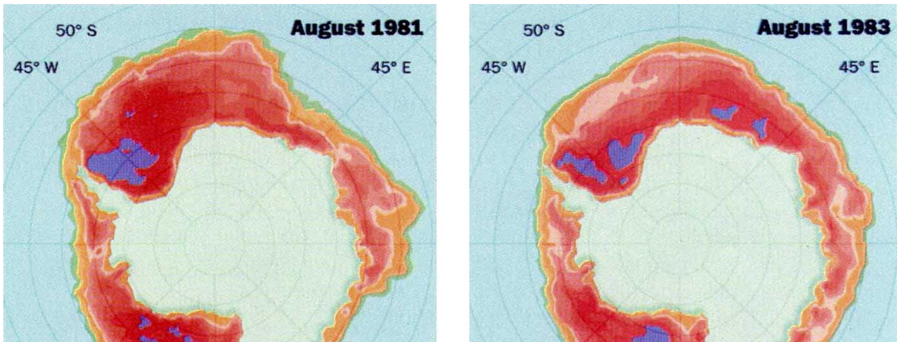

FIG. 1 Mean Antarctic ice concentration, August 1981 (left) and August 1983 (right). The shape of the ice coverage is very different between years, and there are two detectable bulges that move around with the Antarctic Circumpolar Wave. (Taken from images made by the Scanning Multichannel Microwave Radiometer satellite. Image courtesy of NASA.)

IMAGE
UNAVAILABLE
FOR COPYRIGHT
REASONS

Ted Baker

FIG. 2 Half a metre of snow, resting on sea ice that comes just one inch above the water. The picture was taken in the Weddell Sea in May 1992, while new ice was forming in the open water. Local observations of sea ice missed the continent-wide ACW.

ACW opens new directions for research on the interannual variability of the global ocean–atmosphere–cryosphere system.

What causes the interannual variation in the Antarctic region? White and Peterson speculate that it may be ENSO signals propagating to high latitudes through the atmosphere. ENSO, an acronym for El Niño/Southern Oscillation, originates in the equatorial Pacific, and is the best known mode of interannual variation in global climate[2], one which has been shown to have a substantial impact on human affairs[3,4] (causing droughts and floods, forest fires, crop failures and the collapse of fisheries). Numerous studies have associated ENSO events with climate anomalies in middle latitudes as well as the tropics. With this latest addition we can say that ENSO may dominate interannual climate variability even in high latitudes.

Prior studies[5,6] had pointed to ENSO signals in Arctic and Antarctic sea-ice fields. However, the particular Antarctic signal examined (total ice coverage, for example) often did not fully register the ACW sea-ice mode and so underestimated the strength of the connection. Observations of Antarctic sea ice over smaller areas or shorter times[7–9] did reveal some cyclical components in the interannual variability, but their incomplete view of the polar region concealed what we now see to be the passage of a quasi-periodic wave. The ACW framework suggests a way to fit these pieces of information into a coherent pattern, though it remains to be seen just how well they will fit, and how the completed pattern will look.

We note that correlations between anomalies in the Antarctic ice edge and standard indices of ENSO (sea surface temperature in the eastern Pacific and sea-level pressure difference between Tahiti and Darwin — see for example ref. 4) imply that 40 per cent of the variance in the sea-ice anomalies is attributable to ENSO. The Antarctic sea-ice anomalies have even higher correlations with precipitation over tropical land areas (28° N to 28° S, 85.5° W to 152.5° E) and with sea surface temperature in the equatorial Indian Ocean (2.5° N to 12.5° S, 62.5° to 82.5° E). The correlations are not significantly higher than the one with ENSO, however, and both of these measures are themselves strongly related to ENSO. So they raise the possibility that the sea-ice variation may not be entirely determined by an ENSO signal emanating from the Pacific, but do not settle the issue. Regardless, there is strong evidence connecting the ACW to tropical climate variations.

Even with the knowledge that tropical signals propagate to higher latitudes through both ocean and atmosphere, it can hardly be said that the physics of this connection is understood. White and Peterson[1] point out that the propagation speed of the ACW is the same in all three media, which supports the quite plausible idea that the atmosphere, ocean and cryosphere are strongly coupled on interannual timescales. Indeed, that the ACW stands out in the data for all three is prima facie evidence of such interactions. They also note that its speed falls within the range of speeds seen in the ACC, and go on to suggest that advection of sea-surface-temperature anomalies produces the wave, with the time for a complete circumpolar circuit setting the period at 4–5 years. But it is not clear how such a mechanism maintains synchronization with ENSO. Furthermore, the speeds within the ACC are too variable to pick a unique period.

In any event, by discerning such an elegant structure amid the disorder of the climate data, White and Peterson offer us an intriguing puzzle with global climate implications. □

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DAEDALUS

Fuse and lose!

WHY is obesity so common? One theory is that mothers overfeed their babies, to maintain their recommended increase of weight. The fat cells in the infants' bodies multiply rapidly to store all this nutriment. The extra cells persist for the rest of life, eager to seize and store whatever fat comes their way. Only surgery can get rid of them.

Daedalus now has another way: cell fusion. Cells in a culture can easily be induced to fuse together. Specific chemicals, deactivated viruses, or pulses of direct or alternating high voltage can all briefly disrupt the membranes of two cells in contact, causing them to fuse. The resulting joint cell can be perfectly viable. Indeed, fused cells are often found in samples of human tissue, and seem to cause no harm.

But how to work the trick inside the body? Alternating-current fusion probably works by inducing ultrasonic agitation in the cell membrane, which then resonantly captures electrical energy. So Daedalus is combining two well-known medical devices — the diathermy machine, which launches alternating current into a large volume of the body from two contoured electrodes; and the ultrasound scanner, which focuses a beam of ultrasound in a tiny volume of tissue. Cunningly, he will slave them together, to work at exactly the same phase and frequency: 500 kHz or so. The tissue at the ultrasound focus, resonantly excited at that frequency, will then absorb much of the electrical power of the diathermy machine. Most of the cells in that region will fuse. By scanning the ultrasound focus through a whole volume of fatty tissue, most of its cells could be fused. At a stroke, the patient will have half the number of fat cells, each of twice the normal size.

Now a big cell is inefficient; it can't service its large volume through its inadequate surface. The fused fat cells will be forced to shrink, which they will do by flipping into 'discharge' mode, and discarding their excess fat. The patient will lose weight and volume dramatically. When the fused cells have all returned to their previous size he (or she) will be carrying just half the previous burden of fat. If necessary, the process could then be repeated.

Fatties everywhere will rush for the treatment. A reduced fat-cell count will solve their problems permanently. Even better, controlled scanning could remove fat from exactly the regions causing distress, without deflating other more becoming volumes. Forget dieting, ignore exercise and let Daedalus's electro-ultrasonic body sculpture shape the figure of your dreams!

David Jones