causes cooling in the North Atlantic and global surface warming to slow or stop will be a key point of debate.

The AMOC is deemed "very likely" to weaken in the coming decades[1]. Indeed, the Atlantic has seen muted rises in surface temperature relative to the global ocean over the past few decades. This relative lack of warming has been interpreted as a fingerprint of AMOC decline, potentially linked to anthropogenic climate change[8]. Whether the AMOC observatories will document the predicted decline remains to be seen, but they have already observed that the AMOC is in a weakened state[9]. Chen and Tung predict that such a weak AMOC will result in a period of rapid global surface warming that could last for more than two decades. ■

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BIODIVERSITY

Speciation far from the madding crowd

New species of marine fishes are found to emerge at a faster rate in high-latitude oceans, which have lower densities of species, than in the species-rich tropics. Are the tropics too crowded for new species to take hold? SEE LETTER P.392

ARNE O. MOOERS & DAN A. GREENBERG

The tropics are, like many cities, hot, busy and crowded. It was previously thought[1] that these conditions in the tropics generate a hotbed for the formation of new species (speciation). Species diversity is remarkably high in the tropics and declines toward the poles. However, newly developed tools to measure speciation rates, coupled with ever-growing global data sets, have enabled the surprising finding that terrestrial speciation rates for the past few million years are similar across different latitudes[2] or increase outside the tropics[3]. On page 392, Rabosky *et al.*[4] document a speciation rate for marine fishes at high latitudes that is twice the speciation rate in tropical seas. This high speciation rate in cold, species-poor waters poses an interesting conundrum for evolutionary biologists and ecologists.

There are two potential drivers of high speciation rates in the tropics. First, the elevated temperatures in the region both speed up metabolism, increasing the number of mutations, and decrease generation times. This is a potentially powerful combination, producing more of the variation necessary for evolution and the possibility of faster evolution. A second possible driver is ecological opportunity. The energy-rich tropics offer abundant resources that can support many different niches. And the tropics are so rich in species that the interactions of members of a single species with its competitors, predators and parasites might differ from place to place, leading to different adaptations and eventual divergence into new niches[1]. Although this narrative makes for a compelling theory, Rabosky and colleagues' discovery suggests a different story, at least for marine fishes.

The authors gathered genetic data for 11,638 species of marine and freshwater fish, along with information on inferred evolutionary relationships based on taxonomic groupings for 19,888 additional fish species for which genetic data were not available. Using these data, and information from 139 dated fossil fishes, the authors generated a large set of plausible phylogenetic trees detailing the evolutionary relationships between all living marine fishes, and, crucially, estimates of when different lineages diverged from one another. These dated trees enable speciation rates to be inferred on the basis of the branching patterns of the tree. Species connected by short branches, and with many close relatives, have high speciation rates, whereas species that are separated by long branches and that have few close relatives have low speciation rates.

Most taxonomic groups are made up of lineages with both low and high speciation rates. The marine fishes in the authors' large phylogenetic trees were no exception, with

50 Years Ago

More than 7,000 people died in traffic accidents last year in Britain and nearly 94,000 were seriously injured … The causes and possible preventative measures were the subject of a recent conference … A police traffic superintendent is reported to have said that the defect which causes nearly every accident lies in "the nut holding the wheel". One contributor pointed out that road engineers should not assume that drivers are omniscient. "If asked to make more than one decision at a time, they will fail; if faced with a situation which can be misinterpreted, someone will eventually find the wrong meaning". The effect of human fallibility is easily apparent in the statistics … during the last three months of 1967 … after the breathalyser test came into operation … driver and passenger casualties fell by 19 per cent, motor cyclist casualties by 16 per cent and pedal cyclists by 14 per cent.
From *Nature* 20 July 1968

100 Years Ago

The utility of forests to a nation is one of the economic factors to its well-being which have been brought to an unforeseen prominence during the world-war: and perhaps to no other European nation has this … development proved so startling, because so totally unsuspected, as to ourselves. Our woods were not grown from the commercial aspect — sport, amenity, and shelter to crops and stock were their main *raison d'ètre*. We did not consider it necessary to grow woods for purely commercial reasons — that is, for the sake of the timber and pit wood and paper pulp, etc … We obtained our requirements in these commodities by importing them from abroad, and relied on the Navy being able to safeguard these imports. We have now discovered our mistake and are paying for it.
From *Nature* 18 July 1918

BRITISH ANTARCTIC SURVEY/SPL

Figure 1 | Remarkable fish diversification in remarkably cold waters. Rabosky *et al.*[4] analysed global patterns of where new species of marine fishes arise. The authors find that marine fishes that live near Earth's poles, such as Antarctic icefishes (for example, the black-fin icefish, *Chaenocephalus aceratus*, shown here), give rise to new species much faster than do fishes in warmer and more species-rich tropical seas.

speciation rates varying by more than 50-fold between lineages. The authors combined these values with global maps of where these species live, revealing a clear geographical structure to the speciation rates. Because small biases integrated over large amounts of data could produce misleading inferences in these sorts of studies[5], the authors considered several ways to estimate speciation rates and to map species' location. But whether the authors considered the patterns looking species by species, place by place or ecoregion by ecoregion, there was always a pattern of the average speciation rate increasing from the tropics towards the poles.

Rabosky and colleagues consider only a few potential mechanisms that might affect the rate at which marine fishes produce new species at high latitudes. At higher latitudes, marine fishes tend to have longer generation times and slower metabolisms[6] than have fishes in the tropics, suggesting that such extended generation times and lower mutational input do not limit speciation rate in these cold-adapted lineages. The authors also tested and discounted the interesting possibility that high-latitude species are the descendants of tropical lineages that exhibited adaptations for cold-water living and also happened to have high speciation rates. This negative result suggests that a high-latitude marine environment, rather than the species that colonizes it, drives high speciation rates.

The correlation of high speciation rates with low diversity is consistent with the idea that there are unfilled ecological opportunities near the poles. However, ecological opportunity is something that is inferred rather than witnessed[1]. The shape of a phylogenetic tree can indicate slowing speciation as species numbers rise — a pattern that is consistent with diminishing ecological opportunity[7]. If closely related species in such clades occupy different niches, as might be the case for the high-latitude Antarctic icefishes[8] (Fig. 1), this would be consistent with ecological opportunity having a key role in driving their diversification. Such analyses are needed to determine whether high-latitude groups have reached the ecological limits of their ecosystems or whether high-latitude fish diversity might be expected to continue increasing.

Continued diversification at higher latitudes might seem reasonable, given that Earth's cooling over the past 30 million years or so[9] has given rise to the present, relatively young temperate and polar realms. However, the rate of speciation at high latitudes reported by Rabosky (roughly 0.2 new species per species per million years) is high. If this rate had been sustained over the whole of the past 30 million years, high latitudes would have tropical levels of species diversity by now. Given that the accumulation of diversity depends on both speciation and extinction rates, one explanation that reconciles a high speciation rate and low current diversity is if both speciation and extinction are elevated outside the tropics[10]. This could result in a pattern in which an increase in the number of species is limited by high extinction rates, and poleward realms would have few, but relatively young, species. Measuring extinction rates is almost as difficult as trying to assess ecological opportunity, but new approaches that combine information on extinct species represented in the fossil record with information from their living relatives[11] might offer a way to investigate whether extinction rates are greater at higher latitudes.

The view of high-latitude oceans as 'sleepy' backwaters remote from the exciting evolutionary bustle of the tropics will need to change if it turns out that both speciation and extinction of marine fishes occur at a faster pace beyond the tropics. Such a pattern would imply that living cheek by jowl, or rather gill by jaw, in the tropics is a condition that is more constraining than productive, such that the real biodiversity action is taking place where there is less, rather than more, biodiversity. Far from the madding crowd, as it were. ■

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CORRECTION

The News & Views article 'Intestinal-niche conundrum solved' (*Nature* **558**, 380–381; 2018) indicated that two papers (M. Shoshkes-Carmel *et al. Nature* **557**, 242–246; 2018, and B. Degirmenci *et al. Nature* **558**, 449–253; 2018) solved an outstanding debate — the identify of a stromal-cell population that sends Wnt signals to intestinal stem cells. However, a paper published earlier this year (G. Greicius *et al. Proc. Natl Acad. Sci. USA* **115**, E3173–E3181; 2018) also identified a stromal-cell source for Wnt signals.