As a result, p_{CO_2} is projected to reach its annual minimum earlier than in the past (in June, rather than in July and August), and reach its annual maximum in summer, rather than in winter (Fig. 1). The transition from a winter to a summer CO_2 maximum is especially pronounced in shelf seas (those that submerge a portion of a continent), which are crucial harvesting areas for Arctic Indigenous communities.

The occurrence of extreme ocean acidification events associated with high p_{CO_2} during the summer could have big implications for the Arctic ecosystem. Unfortunately, few studies have explored the impacts of large increases in ocean acidification on key Arctic marine species. Fewer still have looked at how combinations of ocean acidification with other stressors, such as high temperatures and changing food availability, will affect species survival[3].

Benthic species (animals that live on the sea floor) that use carbonate ions to build shells and skeletons are expected to struggle as seawater acidifies[4]. Increased acidity might also impair other biological functions – for example, the growth of certain bivalves[5] and the swimming behaviour of polar cod (*Boreogadus saida*)[6]. Such impairments can alter determinants of species' health, such as feeding behaviour, reproductive success and habitat choices. There could also be indirect effects of ocean acidification, arising, for instance, from the competition between species[7]. These direct and indirect effects at different levels of the food web can cause further ripple effects that alter predator–prey relationships and the food web more broadly.

Changes to ecosystem function and food webs would also challenge the food security of Indigenous peoples, with implications for their culture, well-being and economy. (This issue is of particular concern to both of us, because we live and work full time on Indigenous lands, and V.Q.B. is Iñupiaq (Inuit), from Utqiaġvik, Alaska). Many of the marine species that are expected to be adversely affected directly by the combination of increasing summer temperatures and ocean acidification, and indirectly by changes to the food web, are also crucial to Indigenous communities for subsistence hunting, fishing and harvesting.

For example, both subsistence and large-scale fisheries of snow crab (*Chionoecetes* species), prawn and polar cod could be challenged by changes in environmental processes and food-web dynamics. Animals that prey on shell-building creatures might also have to change their feeding habits as food sources diminish, are replaced by new species, or move elsewhere. And even species such as the beluga whale (*Delphinapterus leucas*), narwhal (*Monodon monoceros*) and walrus (*Odobenus rosmarus*) that have varied diets (consisting of benthic species and a variety of fish species[8–10]) could be affected by changes cascading through the Arctic food web. Arctic hunters and fishers already have to deal with the complications of a warming climate, including temporal mismatches in species migration and life-cycle stages, finding ways to procure and prepare foods for safe consumption, and northward shifts in many marine mammals' preferred habitat.

Orr and colleagues' study provides a troubling glimpse of how near-term climate warming and acidification could change the chemical environment at the surface of the Arctic Ocean, but falls short of diving deeper. No organism lives only in the ocean's surface layer, and warming could be much more pronounced in subsurface layers[11]. Future research needs to focus on ocean regions, such as Arctic shelf areas, that are directly relevant to the marine species that Indigenous communities depend on, and on determining the different acidity levels that produce biological effects in these species. A careful consideration of environmental processes and ecosystem functions, as well as the anticipated impacts of ocean acidification on biological, social and cultural dynamics (for example, to determine the effects of ecological disturbance on Indigenous ways of life and food security) will help Arctic communities to plan for consequential change, emerging vulnerabilities and increased risks.

But let's end on a hopeful note. Orr and colleagues' study shows that the reported seasonal changes are unlikely if efforts to mitigate climate change prevent the global temperature from rising by more than 2 °C above pre-industrial values – all the more reason for the world to redouble its commitment to these efforts.

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Scientific community

Narrow hiring practices at US universities

Cassidy R. Sugimoto

An analysis of faculty members employed at academic institutions in the United States reveals that most employees were trained at just a few universities. The finding provides insights into how hiring perpetuates inequalities. **See p.120**

For those hoping to land a coveted academic faculty position in the United States, a doctoral degree from one of just a few institutions can make a big difference. Wapman *et al.*[1] demonstrate on page 120 exactly how important this pedigree is. They examined tenured and tenure-track faculty members who were employed at US PhD-granting institutions between 2011 and 2020, and find that 80% of US-educated faculty members received their doctoral degrees from just 20% of universities. The authors' data set provides sobering insights into how hiring practices perpetuate inequalities throughout academia.

Wapman and colleagues' data – which they obtained from a faculty census compiled by the Academic Analytics Research Center – encompass 295,089 faculty members in 10,612 departments across 368 institutions. The authors categorized these departments into 107 fields and 8 broader domains, to facilitate comparisons between different areas of research spanning all disciplines. The data contain information about each scholar's gender, the institute from which they received their doctorate, and the institution at which they currently work. Following the principles of open science, the authors have made their data free to explore in an interactive tool (see go.nature.com/3dlniup).

Wapman *et al.* ranked institutions in two ways: by production and by prestige. Production rank measures the number of PhD holders from an institution who were employed in faculty positions in the United States. The researchers found that the production of future faculty members was highly concentrated in a few elite institutions – the first quintile of the authors' production rank contained only 8 universities, and the bottom quintile 308 (Fig. 1). In fact, almost 14% of faculty members gained their PhD from just five institutions (University of California, Berkeley; Harvard University; University of Michigan; University of Wisconsin–Madison; and Stanford University).

The bias towards the production of faculty members from a few institutions was most pronounced in the humanities. This is particularly disconcerting given that the humanities are fields marked by complexity, in which debate and discourse are essential for robust inquiry[2]. Arguably, it is in these fields that a broad range of perspectives is most needed. Because departments often foster particular perspectives[3], this narrow hiring landscape might prevent innovation in teaching and research that could be developed with a broader range of viewpoints.

Wapman and colleagues created a hiring network, which depicts the flow of people between universities, to rank institutes by prestige. The institute that ranked as most prestigious is the one that sends the highest number of its graduates to, and hires the most from, other prestigious universities. The authors' production and prestige rankings differ – for example, Carnegie Mellon University in Pittsburgh, Pennsylvania, does not produce the highest number of future faculty members, but it sends its students to, and hires selectively from, top-producing institutions, thereby increasing its prestige. Despite some circularity in it, the prestige indicator offers a unique perspective on the hierarchical nature of faculty-member hiring in the United States.

Several inequalities were unearthed in the authors' rankings. For example, newly hired faculty members came from a wider array of institutions than did their more-established colleagues, but Wapman and colleagues demonstrated that this was not a sign of positive change. Instead, there were higher rates of attrition among faculty members who graduated from institutions that had a low production ranking. In fact, those trained outside the small number of highly ranked universities were nearly twice as likely to leave academia as were those trained in them. Production inequalities were compounded by inequalities

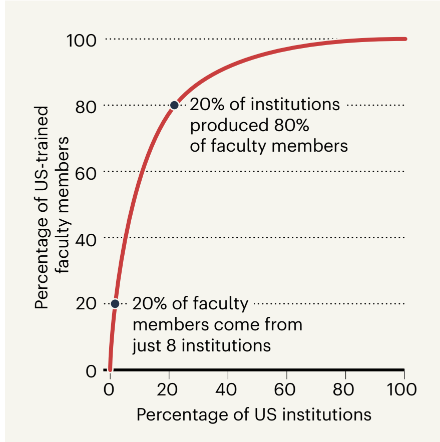

Figure 1 | A few universities produce most US academic faculty members. Wapman *et al.*[1] examined the history of faculty members at 368 US academic institutions to determine where staff obtained their PhDs. They found that the vast majority of faculty members come from only a few institutions. (Figure adapted from Fig. 2a of ref. 1.)

in prestige, with most faculty members being hired at less-prestigious institutions than those in which they were trained. This has implications for mentoring – Wapman *et al.* suggest that the average US-trained faculty member will supervise significantly fewer future faculty members than did their own advisers, further concentrating faculty-member production in the hands of a chosen few.

The authors confirmed the well-known fact that men hold most faculty positions. They showed that men's dominance is slowly waning, but found that this was attributable to men's retirement, rather than to changes in hiring. In fact, the proportion of newly hired women remained static or decreased for all fields between 2011 and 2020 – particularly at institutions of greater prestige. These data indicate that passive policies will not transform the composition of the professoriate. Institutions must adopt more-progressive policies if diversity is to increase.

'Self-hiring' is one way for those at the top to avoid hiring people lower in the hierarchy. The authors showed that the practice is common: 11% of US-trained academics are currently employed at their alma mater, and this situation is particularly likely at prestigious institutions. Rates were especially high in the field of nursing, which might explain why rates of self-hiring were lower for men than for women (who are disproportionately represented in nursing[4]). Self-hiring might not bode well for faculty members – self-hired members left academia at significantly higher rates than did other faculty members.

The United States has a strong reliance on foreign talent[5]. The National Center for Science and Engineering Statistics reports that 45% of PhD holders working in science, technology, engineering and mathematics are foreign-born (see go.nature.com/3f7siqy). But Wapman and colleagues' data suggest that, although the United States relies on foreign talent, it favours those trained in the United States, because only 11% of faculty members held doctoral degrees from foreign institutions. These disparities reinforce the intractable relationship between immigration policies and science policies, underscoring the need for migration policies that facilitate global circulation and support of scholars.

Global policies might serve to further reify inequalities. For instance, the UK government has adopted a High Potential Individual Visa programme for people wanting to work in the country (see go.nature.com/3lduyds). It accepts applicants who have received a degree from one of 37 listed "top global universities". More than half of these institutions are in the United States, with strong overlap with Wapman and colleagues' list of prestigious institutions.

It is likely that intersecting inequalities reinforce Wapman and colleagues' findings. For example, the institutions that have the highest value in terms of endowments (donations that are invested by the university) are also those that have high production and prestige in the current study (see go.nature.com/3r4r5e6). A ranking of institutions by spending on research and development – a proxy for receipt of research funding (see go.nature.com/3dvjolo) – yields the same familiar institutions. Concentration of wealth and human capital go hand in hand.

The open and pressing question left in the wake of Wapman and colleagues' work is: what are the implications of concentration in science? Evidence is mounting for the positive relationship between innovation and diversity – scholars from under-represented groups innovate at higher rates than do those from other groups, but are hired at lower rates[6]. More research is needed to understand how institutions can foster intellectual diversity, and how this intersects with other markers of identity, such as race, ethnicity, gender, disability and social class. Only then can we create responsible policy and avoid institutional reproduction of inequalities.

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