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transcription, this is not a prerequisite for induction because dipterin is still inducible in *dorsal* mutants. Obviously, there must be some redundancy in the system. Furthermore, dorsal does not bind to the cecropin promoter. But the mammalian Rel proteins are believed to form various homo- or heterodimers with slightly different sequence specificities; so Dif and dorsal may conceivably form similar complexes, with each other or with other factors in the *Drosophila* cells, to form the transcription factors that activate the immune response *in vivo*.

Why a similar (perhaps even the same) system is used for immunity and for the formation of the dorsoventral body axis remains a mystery. Ip *et al.* argue that the induction of innate immune responses is the original function of the Rel proteins. One may speculate that when insects evolved eggshells as an adaptation for a terrestrial lifestyle, the immune system may have been recruited for the com-

munication between the embryo and its immediate surroundings, to ensure that the main axes of the embryo are properly aligned with those of the eggshell.

The discovery of this ancient immune system in *Drosophila* could be of much wider significance. It may give us a key to unravel the mechanisms and evolutionary roots of our own innate immunity. □

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SUPERCONDUCTIVITY

Progress down below

Z. Fisk

THE past month has witnessed a flurry of reports hinting at superconductivity near room temperature (see last week's News and Views by Grant¹). Yet on page 146 of this issue we find Cava and colleagues² reporting the observation of superconductivity in an intermetallic material with $T_c = 23$ K. One might well wonder why anyone bothers to report such a modest T_c . But this concoction, identified here only as part of a polyphase material containing yttrium, palladium, boron and carbon, includes an intermetallic whose superconducting transition temperature essentially ties with the highest T_c found for any other intermetallic compound, that of thin-film Nb₃Ge. This record T_c was achieved in 1974. We now have the first progress in superconducting intermetallics in 20 years.

Among pure elements, the highest T_c is 12 K (ref. 3), in lanthanum under pressure. In binaries, it is possible to double this. Why is it not possible to achieve further increases in ternary or higher intermetallics? It probably is, but nobody, except perhaps Bob Cava's group and a few others, has any clue how to make an efficient search of the enormous ternary and higher phase space for superconductors. The method of the pioneers in this area, Hulm, Matthias and Geballe, was much like Thomas Edison's method of trying everything, occasionally focused by some empirical trend. And indeed, although Cava's group was undertaking a systematic search, this new superconducting composition was one mistakenly made

with the wrong stoichiometry. It is refreshing that a poor idea of where to look is often more useful than a good one in this search for higher T_c s: it is more open to the unexpected.

One thing we do know is that certain intermetallic structures are much more favourable than others for superconductivity. The A15 structure of Nb₃Ge contains a large number of compounds with respectable T_c s. What Cava *et al.* now give us, or so we hope, is a new structure to play with chemically. They do not know what this structure is, or even if it is a ternary or quaternary (although developments to be published next week by the same group^{4,5} suggest the latter). Carbon often stabilizes intermetallic structures, for example the Cu₃Au structure, which has a stoichiometry close to the Y-to-Pd ratio here.

There seems little reason to doubt that Cava *et al.* do have a superconductor. Intermetallics are not fraught with the traps for the unwary found in the oxides. But the superconducting phase could be filamentary: a surprisingly small amount of superconducting material in grain boundaries can give zero resistance and large shielding. Measurements made on a crushed sample, combined with a specific heat measurement through T_c , will go a long way towards addressing this.

In follow-on work, Cava *et al.*⁴ and Siegrist *et al.*⁵ have explored other quaternary borocarbides, and find superconductivity near 17 K in LuNi₂B₂C. The crystal structure is tetragonal and closely related

to that of ThCr₂Si₂, whose family of member compounds reaches biblical proportions. This new borocarbide contains carbon occupying a crystallographic site that is empty in ThCr₂Si₂, one of the useful ways in which to create new derived structures. Another way in which this is done is by partially substituting a different element for one that occupies two crystallographically inequivalent sites in the structure. In fact, this is how the ThCr₂Si₂ structure is derived from the BaAl₄ structure. At the very least, we can now expect extensive attempts to add carbon to the many known and interesting compounds with the ThCr₂Si₂ structure, as well as detailed investigation of the low-temperature magnetic properties of the other rare-earth analogues.

Siegrist *et al.*⁵ observe that their 17 K superconducting borocarbide is part of a homologous series of compounds of general formula (LuC)_m(NiB)_n, where the $m=n=1$ member is not superconducting, and the $m=1$, $n=2$ member is. This series consists of layers and invites comparison to the layering in the cuprates, which also can exist in homologous series. Another interesting similarity to the cuprates is in the temperature dependence of the electrical resistivity: it is common to see so-called electrical resistivity saturation near room temperature in the higher- T_c intermetallics, but neither the cuprates nor LuNi₂B₂C seem to show this, perhaps a reason to think about alternatives to the electron-phonon mechanism here.

Why should we care about this new range of materials? There are at present serious problems in using cuprates for high-current applications. The large structural anisotropies are a metallurgical nightmare for conductor forming, and at present, weak links and/or low flux pinning restrict the useful operating range of cuprates for such purposes to temperatures far below their T_c s. Anisotropy is not likely to be a problem with intermetallics, and although intermetallics tend to be brittle, their precursors are often fairly easily formed into useful shapes. A new class of intermetallic holds the potential for even higher T_c s and higher upper critical fields than are available in the commercial superconducting wires now in use, Nb-Ti and Nb₃Sn. Increases of 50 per cent or more do not seem out of the question, given recent advances in other non-cuprate superconductors such as the fullerenes. We are reminded that the $T_c=11$ K of Art Sleight's perovskite Ba(Pb_{1-x}Bi_x)O₃ was more than doubled⁶ following Mattheiss's suggestion⁷ of sub-

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stituting the barium site partially with potassium, one of the very few cases I am aware of where a superconductivity theorist made a useful prediction for increasing T_c . And such increases would have real application. We may find in the ternary and quaternary materials ways to thwart the structural and other instabilities which so often appear to limit the T_c s achievable in intermetallics, instabilities which rather surprisingly do not seem to limit the T_c s of the cuprates.

The investigation of the properties of

bulk intermetallic phases has been rather neglected in condensed-matter physics and solid-state chemistry in recent years. This discovery by Cava *et al.* serves to remind us that there is a vast and quite unknown area in intermetallic materials which will hold many surprises. □

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AGRICULTURE

Crops and climate change

John Reilly

WILL global climate change over the next century seriously limit agricultural production and cause widespread famine? Rosenzweig and Parry, writing on page 133 of this issue¹, investigate this possibility and find that although the location of food production may shift, global food prospects do not worsen significantly. There seems to be no 'disaster threshold' for global food production.

This finding is at odds with the language of the Framework Convention on Climate Change, which calls for the world to curb emissions and avoid dangerous greenhouse gas concentrations. The notion of a threshold implies that there is some level of trace gases where the effects are so devastating that we must avoid it at whatever cost, but that we can edge up to this limit as long as we do not exceed it. With the emphasis instead on adjustment and relocation of agricultural production, the debate on climate-change policy shifts to manageable rates of change and to concerns about the responsibility of the world community towards those areas that suffer significant losses.

Impacts

Rosenzweig and Parry's work looks at the agricultural effects to be expected from temperature and precipitation changes associated with a doubling of atmospheric carbon dioxide concentration (or equivalent trace gases), together with the effects of direct 'CO₂ fertilization'. They investigate three different general circulation models (GCMs), each of which gives a change of several degrees in mean global temperature in the next century, and go on to look at crop yields, possible adaptations and a model of world food trade.

Theirs is the first extensive effort to produce a consistent estimate of the impacts of climate change worldwide from specific GCM scenarios. Earlier work tested sensitivities and relied on disparate estimates of the impact on crop yields

with, for many areas of the world, very limited information². The basis of this study is similar, however, in that it relies on detailed crop growth models for specific geographical points. These few points form the basis for extrapolating to states or provinces, nations and regions. The suite of crop response models used by Rosenzweig and Parry was limited to a few (important) grain crops, the results being extended to other crops with reference to the literature. An alternative approach would be to use databases of global geographical information, such as global climate and soils, to estimate crop potential on the basis of the specific climate in each grid and estimates of how that climate will change³.

Adaptation was introduced according to the judgement of local agricultural scientists in each participating country. As such, adaptation response was only as creative and complete as the imagination of the agronomist concerned. Any small group of individuals studying the situation today is unlikely to foresee the full range of possible adaptations — crop breeding, technical advances and more — that might be developed over a hundred years of gradually changing climate. Further, agronomists in the team generally experimented with adaptations at only the most affected site in their country (or region of responsibility). As a simplification, yield losses were halved for the nation if adaptation was partial, and set to zero if it was complete, so that adaptation never outweighed losses. But if adaptation measures could completely or nearly completely offset losses at the most severely affected sites, the same adaptation might well lead to yield increases at the less severely affected sites.

Rosenzweig and Parry's view that farmers will only try to maintain yields against losses but not adapt to increase them is probably over-pessimistic. The Green Revolution and the long-term trend of productivity growth (roughly 2.1

per cent per annum) in US agriculture both testify that farmers will try to increase yields if it pays them to do so. A fuller consideration of adaptation may show that, globally, several of the GCM scenarios could give overall increases in production.

Moreover, the focus on crops that are staples of temperate agriculture may have led to an overestimate of the negative impacts in tropical regions. Thus, their conclusion that developing countries will be more severely affected, although compelling, remains open to further investigation using methods that can consider beans, root crops, sugar cane, and various fruit and vegetable crops better suited to warm climates.

Finally, the economic impact of agricultural changes may strongly depend on whether a country is an agricultural exporter or importer^{4,5}. Agricultural exporting countries fared well during the 1970s when various world commodity prices were high. If climate change leads to high agricultural prices, then developing countries such as Thailand or Argentina, which are major agricultural producers and exporters, could do well, whereas major consuming areas, regardless of the direct impact of climate on agriculture in the region, could suffer. Tempting as it is to simplify the world into 'developed' and 'developing' nations, this may give a misleading picture of the impact on individual countries.

Hunger

A unique contribution of Rosenzweig and Parry's study is the attempt to link the risk of hunger specifically with climate projections. It is generally recognized that current food production capacity is adequate to avoid famine and malnutrition, but famine occurs because available food does not always get to those most in need. Wars and political upheaval are the primary cause of current famines (as in Somalia and Bosnia). In other words, famine and food shortage is a short-term, unexpected (although recurring) phenomenon, whereas climate change is a long-term trend, at least as described by the current generation of GCMs. This trend may, indeed almost certainly will, exacerbate famine potential in some areas. As Rosenzweig and Parry demonstrate, many local production changes may create a global picture of sufficient food, but regional populations continue to be very vulnerable to famine.

This agricultural study contains the core of a debate that will play out in the current Intergovernmental Panel on Climate Change and future negotiations on the Framework Convention. Certainly, it seems callous to balance the human catastrophe of famine, with thousands of deaths and severe malnutrition, against an economic cost of dollars per tonne of