and join the still sparsely populated roots of modern clades.

As emphasized by Giles *et al.* and others[16], the early Carboniferous is increasingly being recognized as a key episode in the history of modern vertebrate diversity. Alongside the origin of modern tetrapods, the root of the actinopterygian crown group probably lies somewhere in this interval, as does the first ascent of the ray-finned fishes towards ecological prominence. But polypterids as we now understand them emerge as a Mesozoic phenomenon, with their earlier ancestry perhaps barely distinguishable from that of other early members of the ray-finned clade. Polypterid shape looks increasingly specialized, including those remarkable — and now apparently deceptively primitive — pectoral fins[2,3]. ■

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MATERIALS SCIENCE

Nanomagnets boost thermoelectric output

The direct conversion of heat into electricity — a reversible process known as the thermoelectric effect — can be greatly enhanced in some materials by embedding them with a small number of magnetic nanoparticles. SEE LETTER P.247

STEPHEN R. BOONA

Thermoelectric materials can convert waste heat into electrical energy, and have applications in both power generation and cooling. The efficiency with which the conversion occurs is quantified in part by the thermoelectric figure of merit *ZT*. On page 247, Zhao *et al.*[1] report a remarkable advance in the search for high-efficiency thermoelectric materials. The authors use a material based on the semiconductor cobalt antimonide ($CoSb_3$) to show that the addition of a small number of cobalt nanoparticles — equivalent to just 0.2% of the material's total mass — substantially increases the material's *ZT*. The technique could potentially improve the efficiency of a wide range of thermoelectric materials.

The quantity *ZT* parameterizes several properties that relate to how heat and electricity flow through materials. Because these properties are intrinsic to the materials, the efficiencies of thermoelectric coolers and generators are independent of their size — unlike, for example, refrigerators driven by vapour compression, or internal combustion engines. In principle, this means that thermoelectric devices offer superior performance over mechanical heat engines in situations requiring less than about 100 watts of power[2].

In practice, however, the inefficiency and impracticality of current thermoelectric technologies largely relegates them to niche applications in which their other advantages over conventional systems — such as reliability, scalability and lack of vibrations — outweigh their inefficiency. For example, they can be used to cool detectors in electron microscopes and to power space probes as they drift between planets[3].

Because thermoelectric coolers represent one of only a few practical tools for cooling matter, an improvement in thermoelectric technology is potentially valuable for both power-generation and temperature-control applications. Accomplishing this goal will require us to identify materials or physical mechanisms that boost *ZT*. Zhao and colleagues take an important step in this direction by showing that the *ZT* of certain materials can be enhanced by exploiting magnetic nanoparticles (nanomagnets). As a demonstration, they consider $CoSb_3$-based materials embedded with cobalt nanoparticles.

50 Years Ago

In this paper we describe the synthesis from hydrogen cyanide of yet a further class of compounds — polymers that are readily converted by water to peptide like solids … In the reducing atmosphere of primeval times direct synthesis of polypeptides would have been highly favoured as hydrogen cyanide was certainly a major component of the atmosphere. We suggest that after polymerization and modification in the presence of other reactive molecules such as hydrogen sulphide and acetylene, the prototypes of today's proteins were formed after the macromolecules settled into the cold oceans. As the process of molecular evolution continued, this protein-dominated material gave rise to protein-directed life.
From *Nature* 16 September 1967

100 Years Ago

During the year under review four new entomological field laboratories have been erected in several parts of Canada … In a country like Canada, the administration of the Destructive Insect and Pest Act naturally involves a good deal of routine work. More than 2¼ millions of imported trees and plants were examined in 1914–15. This work had special reference to gipsy moth and brown-tail moths and other foreign insect pests … It appears that the intensity of the infestation of these two moths in Nova Scotia and New Brunswick has decreased, though the area over which they have spread has become extended. An excellent feature is the co-operation which has taken place with the U.S. Government in suppressing these pests, and in introducing into Canada certain of their more important insect enemies.
From *Nature* 13 September 1917