COMMENTARY

by Bernard Dixon

BIOTECHNOLOGY AND THE POPULATION PROBLEM

The most misleading salesmanship ever practiced in the name of biotechnology centered on the idea that mountains of single cell protein could save mankind from starvation. According to this scenario, the Third World hungry were expected to feed themselves and their livestock on biomass produced in abundance from the assorted wastes and effluents of civilization.

The argument was never really credible. Whatever the real merits of microbial food, few enthusiasts today believe it could ever fill more than a tiny percentage of the planet's empty stomachs. Even the specter of over-population itself seems to have receded—obscured, perhaps, by the immediate nuclear threat and by more remote though equally frightening prospects such as climatic catastrophe.

But the specter has *not* gone away. And that is why John Postgate, addressing an historic meeting of Britain's Society for General Microbiology recently, was right to focus his talk about "Microbes and the Future of Man" not on gene splicing, novel vaccines or germ warfare, but on the population explosion. Even if all international plans for fertility control were successful, Postgate reminded his audience, the present terrestrial stock of 4×10^9 humans would reach a figure of between 7.5×10^9 and 8×10^9 by the early decades of the next millennium. The children due to mate and produce those extra mouths are already here, and will reproduce at a rate greater than that at which their parents die.

"Today about a third of the world's population is alive and fed, albeit sometimes inadequately, by courtesy of the Haber process," Postgate pointed out. "For the fertilizer industry provides, from atmospheric nitrogen, the fixed nitrogen which underpins over 30 per cent of the world's agricultural productivity." Nutritional support for an almost doubled quota of *Homo sapiens* would require both industrial and microbial nitrogen inputs to expand by nearly two-fold. Moreover, while chemical manufacturers and eco-freaks might dispute the relative merits of artificial fertilizers and microbes as answers, none denied that the problem existed and was serious.

There was an understandable hint of irritation in Postgate's talk over those biologists and politicians who *do* seem to be neglecting these grim facts. Not least for applied microbiologists, whose predecessors helped create our dilemma by their triumphs in conquering infectious disease, the need to boost food production ought to have overwhelming priority. What, indeed, could pose a greater threat to civilization than simultaneous, inexorable increases in world population, in the legitimate expectations of its members, and in the energy inputs required to support each individual and satisfy those expectations?

Another English microbiologist who certainly is preoccupied by these issues, but does not proffer single cell protein as a simplistic panacea, is James Lynch from the Glasshouse Crops Research Institute at Littlehampton. His *Soil Biotechnology* (published recently by Blackwell Scientific) is an admirably argued book listing a host of opportunities for improving conventional crop husbandry through unconventional microbiology. As a guide to ways in which we might manipulate microbial activity to enhance agricultural and horticultural productivity, it is a timely and unique review of possibilities overshadowed during the past decade by more immediately glamorous aspects of biotechnology.

As Lynch observes, the cause of heightened soil fertility may also have suffered through the charlatanry of "snake-oil salesmen", selling farmers miracle potions containing organisms that are supposed to increase crop yields dramatically. While agreeing that dependable products of this type may be feasible one day, Lynch is sceptical about much of the evidence to date, and concerned by the very wide variations achieved in field trials.

Far more significant, he suggests, are preparations now being developed on a genuine scientific basis. One group contains soil inoculants such as *Pseudomonas fluorescens*. This produces an antibiotic (pyoluteorin) that is effective against *Pythium ultimum,* an all-too-common scourge of cereals. Another group embraces the plant-growth-promoting rhizobacteria (PGPR). Certain strains of the *Ps. fluorescens-putida* group, for example, colonize roots of sugar beets, potatoes, and radishes very quickly, boosting yields by as much as 144 per cent. They restrict the supply of iron, making it less available to certain members of the natural microflora, especially pathogens.

One series of *in vitro* experiments showed that PGPR worked by producing a siderophore, pseudobactin, that inhibited growth of *Erwinia carotovora,* the bacterium responsible for soft-rot of potatoes. With ferric chloride added to the medium, no such effect occurred. But when pseudobactin was included in the water supply for *in vivo* greenhouse tests, potato plants more than doubled in weight. The explanation was a 74 per cent decrease in the number of pathogenic fungi on and around the roots.

Further trials indicated that the bacteria colonized the entire rhizosphere of treated potatoes—including developing daughter tubers and the apical roots of adjacent, untreated plants. Moreover, while different species of plants are thought to have their own characteristic rhizospheres, there is evidence that some bacteria may benefit several different crops. At least one pseudomonad and its associated siderophore, for example, can prevent infections in barley as well as potatoes.

Here, then, is an area where wider researches are urgently needed. As James Lynch concludes: "Such relatively low-cost studies in soil biotechnology should show a good return on investment, and help to increase our food productivity even if our net energy resources decline." That is precisely the approach we require if John Postgate's horrendous challenge is to be adequately met.

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