In this issue

Why do worker bees work?

It seems as though the theory of natural selection would expect animals to be selfish so as to increase the probabilities of their own survival and reproduction, at the cost of other members of their species. However, there are many instances of altruism in animals. The most striking examples of altruistic behaviour in the animal kingdom are the sterile workers among honey bees and other social insects who spend all or most of their lives labouring for their colony and often die without reproducing. Why do worker bees give up reproduction and work for their colonies? Is this not contrary to the theory of natural selection? To explain this behaviour, W. D. Hamilton developed the concept of *inclusive fitness* and showed that aiding close genetic relatives is analogous to leaving behind one's own offspring!

In the insect order Hymenoptera, which contains most of the social insects (termites, ants, bees and wasps), a peculiar genetic system known as haplodiploidy makes full sisters more closely related to each other that what a female would be to her offspring. In other words, a full sister is genetically equivalent to one and a half offspring! Do hymenopteran females then become workers so often because it is more advantageous to the species to rear siblings than raise one's own offspring? The answer to this question has not been easy to come by. First, hymenopteran females are less related to their brothers than to their offspring so that the advantage in raising full sisters is cancelled out by the disadvantage in rearing brothers. This problem can be overcome in principle if more sisters and fewer brothers are reared. Secondly, not all sisters available to a worker are full sisters because the queens often mate with several males and produce different patrilines of daughters. Whether rearing siblings will be more advantageous than rearing offspring will thus depend on the average relatedness between a worker and her sisters. Such values of genetic relatedness among sisters have now been determined for several species of Hymenoptera.

On **page 374** Raghavendra Gadagkar shows that the observed levels of genetic relatedness among sisters are, in most cases, by themselves insufficient to make the rearing of siblings more advantageous than rearing offspring. Assuming that workers can adjust the ratio of investment between sisters and brothers to a level that is optimal for them, he shows that the value of genetic relatedness among sisters should cross a threshold value of 0.604 for sib-rearing to become advantageous. This means that worker bees do not seem to give up reproduction and work for their colonies merely because rearing siblings is more advantageous than rearing offspring!

Falsifying food fallacies

It is often stated that while food production has increased considerably in our country there has not been much improvement in the nutritional status of the population. Many steps have been taken to introduce amongst the rural population external intervention for medical care and nutrition. According to one view, these measures have not been too successful and have not contributed much either to the health or to the nutritional improvement of the population.

The article on **page 357** discusses the results of some courageous experiments undertaken by the well-known statistician P. V. Sukhatme (with W. E. Edmundson) on two very difficult questions: (1) whether there are approaches other than external intervention and (2) the relationship between food/energy intake and work efficiency amongst undernourished rural population.

Mahatma Gandhi felt that external intervention may not be the best method of tackling the major problems of rural India. It may be much better to educate the people so that they realize the importance of doing things themselves. Following this dictum, the 'Kirkatwadi experiment' tried to bring home to the individual one's responsibility for one's own well-being and that for one's society. If a child is educated, at the right time, on the dangers of eating contaminated food or drinking polluted water, or is taught the evil effects of malnutrition and the methods of overcoming them, half the battle is won.

It is easy to philosophize but extremely difficult to design and perform quantitative experiments even in one village, not to speak of in many; it is much more difficult to interpret the results properly. The problems associated with instructing children in the first principles of health or nutrition, in the prevention of dumping of garbage by the villagers into the school grounds as it was not the property of any particular individual, in the building of lavatories and their proper use, in the capping of wells and chlorination of water; and the difficulties of choosing the parameters that indicate improvements in health and well-being are described. The statistical techniques used to extract some meaning out of the experiments have also been touched upon. According to the authors these experiments have proved that the Gandhian doctrine that education and societal action to change life-style for cleaner and healthier living produces much better results than just impersonal external intervention.

More surprising are the results quoted in the study correlating energy (food) intake and work output in chronically undernourished persons. Edmundson (one of the authors) performed careful studies in Java, trying to correlate food intake and minute-to-minute activity of adult males (using sophisticated techniques like microcalorimetry, analysis of respiratory gases, etc.), and got the unexpected result that average work output per unit energy intake was much higher in individuals with lower energy intake compared to those with higher energy intake. Experiments in community kitchens in India where undernourished women work seem to confirm this result. According to the authors a smaller individual uses much less energy for 'maintenance' and also can produce more work per unit intake (something that is conventionally known by harassed mothers of wiry babies). It is obvious that many more experiments would be necessary before these results are definitely accepted.

After reading about the problems of health care delivery in developing countries, the sophisticated methods used by the computer-based information system called 'Eurodiabeta' to deal with diabetic patients make interesting reading (see **page 342**).

Bamboo boon, or symptom of a bane?

The recent Indian success in consistently inducing bamboo to flower in tissue culture (published in *Nature*) received good notice in the international press. But is it good for science in India if Indian scientists prefer to publish their better work abroad? See editorial (**page 341**) and **pages 346–350** for a comment and some responses.