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WHO FIRST INVENTED AGRICULTURE?

—Raghavendra Gadagkar*

Human agriculture, which is believed to have originated some 10,000 years ago, has rightly been considered the most important development in the history of our mankind. Virtually all the plants which we consume today are derived from cultivars that have been bred and modified by humans for thousands of years. There has also been extensive exchange of cultivated crops from one part of the globe to another. While consuming plants and their products, we tend to forget that the cultivation of coffee originated in Ethiopia, that of tobacco around Mexico, tomato and potato in South America, rice in South East Asia and so on. The impact of agriculture on the further development of human societies has been profound - high rates of population growth, urbanization, economic surpluses and providing people with free time - all of which were pre-requisites for the development of modern civilization, including arts, literature and science.

Impressive as all these are, our achievements are surely humbled by the lowly ants which appear to have invented agriculture, and as we shall see below – a fairly sophisticated type of agriculture - almost 50 million years before we did. Three different groups of insects practice the habit of culturing and eating fungi. They are some ants, some termites and some beetles. With a few exceptions, all fungus-growing ants are also leafcutters – they cut pieces of leaves, bring them to the nest and use them as substrata to grow fungi. The ants derive their nutrition only from the fungi so grown and not from the leaves themselves. There are some 200 species of ants which do not know any life style other than fungus farming. Because of their ecological dominance and their insatiable hunger for leaves, leafcutter ants are major pests in some parts of world. These ants can devastate forests and agriculture alike – they may maintain ten or more colonies per hectare and a million or more individuals per colony. Where they occur, the leafcutter ants consume more vegetation than any other group of animals.

As may be imagined, the process of fungus cultivation is a complicated business. In the field, leaves are cut to a size that is most convenient for an ant to carry them back. In the nest the leaf fragments are further cut into pieces 1-2 mm in diameter. Then the ants apply some oral secretions to the leaves and inoculate the fragments by plucking tufts of fungal mycelia from their garden. The ants maintain a pure culture of the fungus of their choice and prevent bacteria and other fungi

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from contaminating their pure cultures. Growing pure cultures of some of these fungi in the laboratory has proved difficult or impossible for scientists. How the ants achieve this remarkable feat remains poorly understood. Not surprisingly, they manure their fungus gardens with their own faeces. When a colony is to be founded, the new queen receives a 'dowry' from her mother's nest - a tuft of mycelia carried in her mandibles. Thus these ants appear to have asexually propagated certain species of fungi for millions of years.

What kind of fungi do these ants cultivate? Do all ants cultivate the same type of fungi? As in the case of human beings, have there been multiple, independent events of cultivating wild species? Like humans, do the ants exchange cultivars among themselves? Until recently it was not easy to answer any of these questions. Today, with the advent of powerful DNA technology, answers to many of these questions can be found. We now know that there have been at least five different independent origins of fungal cultivation by ants, rather than a single event as was supposed previously. Even more interesting, we now have evidence that ants occasionally exchange fungal cultivars among themselves so that different nests of the same species of ants may contain different cultivars. Whether the ants deliberately borrow fungal cultivars from their neighbours or whether the horizontal transfers occur accidentally is however not known. But there is good evidence that new cultivars have been added to the ant fungal gardens from time to time.

An obvious reason for our interest in these relatively recent research findings is because of the striking similarities between human agriculture and ant agriculture. But does ant agriculture suffer from pests like ours does? Yes, of course. The fungus gardens are often infected with a potentially devastating pest which is another kind of fungus called *Escovopsis*. And how do ants deal with the menace of pests? Exactly as we do – they use pesticides. The only difference is that their pesticide is an antibiotic produced by a bacterium. In other words, ant agriculture is more like our organic gardening. But what is even more fascinating is that the antibiotic-producing bacterium grows on the bodies of the ants, deriving its nutrition from the ants themselves. This *close coevolution* of ant, fungus, *Escovopsis* and antibiotic-producing bacterium has persisted for some 50 million years. What effect such agriculture (including perhaps "economic surpluses" thus generated and spare time thus available to the ants) has had on the evolution of the ants themselves? Like in the humans, the advent of agriculture appears to have significantly affected the evolution of leaf-cutter ants. Today the leaf-cutter ants are among the most advanced and sophisticated social insects.

How should we react to the knowledge of such sophisticated achievements by the lowly ants? I would like to believe that this knowledge will generate some amount of modesty about our own achievements and make us more tolerant of other forms of life on earth. I would also like to believe that, as a civilized and cultured species, we will support and encourage some members of our species to devote their lives to the study of the achievements of insects and other lowly creatures.