

## ON THE LIVES OF SOCIAL INSECTS: SEVEN RESPONSES TO MANUEL ZAPATA

[Translation of: *Cómo viven los insectos sociales? Siete respuestas a Zapata Olivella*; *Tacayá* (Bogotá) (16):4-7, 2009. This popular article was originally submitted to *El Tiempo*, a national daily published in Bogotá. The science editor turned it down as being too technical. One has to wonder what she thinks of her readers if the following counts as "technical".]

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Manuel Zapata Olivella (1920-2004) was a medical doctor, folklorist, defender of human rights, and a distinguished man of letters. I was privileged to meet him in the 1990s, while he was part of the Colombian diplomatic corps in Trinidad & Tobago.

As he explains in his autobiographical *Levantate, Mulato!* -- which is at once a polemic, a celebration of his own and Colombia's tri-racial heritage -- Manuel inherited a materialist viewpoint from this father, Antonio María Zapata V. Throughout his life, his interest in scientific questions was both deep and broad. Upon learning that I am an entomologist with specialization in social insects, he poured forth a host of questions about my beloved little bugs. It was as if these had been accumulating in his curious minds over many years. One day he presented me with a written list of seven questions. I responded verbally on the spot, but some days later I thought his questions merited a more considered response, so I wrote him a long letter.

It occurs to me that this letter might be of some interest to the general public, not just for what it says about social insects but also for what it tells us about the thought of a Colombian cultural icon. The questions are numbered, each followed by my response.

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Manuel Zapata O.  
Embassy of Colombia, Port of Spain  
25 February 2000

Dear Manuel,

Having thought some more about your very interesting questions, I would now like to answer in a somewhat more orderly fashion.

**1. Let us return to your idea about a certain convergence between the behaviour of wasps, ants, termites and bees, on the one hand, and that of humans, on the other hand. Is it conceivable that these social insects have, at some level, a creative or cultural collective consciousness?**

This question arises naturally from some manifestations of collective activity in social insects. Brood care, the protection of the queen, communication about threats and new resources, and above all the often complex, sophisticated architecture of their nests are qualitatively quite different from any phenomenon

seen in solitary insects.

Even so, it has been known for about two centuries that social insects are not a physically distinct group. In particular, their central nervous system is neither more extensive nor more complex than that found in related species with solitary habits. How, then, are we explain their extraordinary organizational and creative capacities?

It is only in recent years that a satisfactory answer -- or, more exactly, the beginning of an answer -- to this question has emerged. The general explanation is that, while individuals do not especially differ from solitary insects in the details of their behaviour, there is a distinct difference in its organization at the level of the colony. In the language of systems theory and computer programming, social insects respond to their environment according to different sets of rules. Some of these rules have been demonstrated experimentally, especially in the process of nest construction. On the whole, the results are in agreement with the older concept of *stigmergy*, which arose out of studies of termites by Pierre-Paul Grassé of France. In this, individual workers respond in a programmed manner to very localized features of the developing nest. Because the programming rules are not the same in all species, the form of the finished nest can be quite species-characteristic.

The key to this concept in its strict form is that each individual reacts exclusively to immediate features according to a uniform set of rules. Nothing like a blueprint or plan exists in the brain of the individual, and by implication stigmergy leaves no room for memory. The Belgian writer Maurice Maeterlinck would have said that the blueprint exists at the level of the colony's "mind", but this idealistic conception has no place in today's experimental, reductionist biology.

Stigmergy gained little acceptance when it was first proposed in the 1950s. It remained a purely theoretical construct for lack of experimental support. With newer methods and an interest in the colony as an information system, it has recently enjoyed renewed attention.

## **2. Is it possible to draw a connection between genes for particular behavioural aptitudes -- such as are seen in *Homo sapiens*, for example -- and social-cultural phenomena in social insects?**

The great irony of the stigmergy concept and its successors is that it can lead to the hypothesis that social insects, despite the impressive, complex phenomena arising from their colonies, are actually less intelligent at the individual level. This means that a social insect normally would have a smaller behavioural repertory -- the sum of kinds of distinct actions that she can perform -- than a comparable solitary insect. One might compare, for example, any of the familiar social wasps of the genus *Polistes* with a solitary mud-nesting wasp.

As far as I am aware, this reasonable hypothesis has never been put to the test, but it flows logically from the theory of stigmergy and recent experimental results in the *superorganism* concept. This latter is an analogy between the organizing principles of a social-insect colony and a complex organism, such as a vertebrate. One sometimes speaks figuratively of the colony's "swarm

intelligence". Even so, I should emphasize that the similarities between swarm intelligence and that of a human being or other complex animal are superficial at best. Fundamentally, they have little in common.

Obviously, having spent the greater part of my life studying social insects, I do not regard colony-level processes as less interesting or in any way "lower" than those of so-called "higher" animals. They are just different.

### **3. Do social insects have any awareness that human beings are their most important natural enemy?**

As a general answer, no. No species of insect, whether solitary or social recognizes humans as its most dangerous enemy, for two reasons. First, *enemy specification* is quite a sophisticated capacity, known from only a very few invertebrates. I am thinking, in particular, of certain social wasps whose alarm communication distinguishes between army ants and other enemies of the colony.

The second reason has to do with how humans can be damaging to social insects. In only a few cases do we attack colonies directly, for example with fire or pesticide spray. Rather, we attack their environment, whether on a large or a small scale. Ants that nest in the forest canopy have no way of recognizing a man with a chain saw, for example, as a threat to their world. It is far outside of their perception. Similarly, the damage that aerosol sprays do to our atmosphere is far removed from direct human consciousness, which is why it has taken so much analysis and publicity to convince us of it.

### **4. Human beings despoil honey bees of their food stores. Is there reason to believe that the bees' response to this has shaped their responses to other natural enemies?**

I can think of just one probable example of the awareness to which you referred in question 3. It has to do with this very problem, raids by humans on the products of the hive. In this hemisphere there is much discussion of why africanized honey bees -- the so-called "killer bees -- are so ready to sting. As William Ramírez B. of Costa Rica emphasizes, they should not be regarded as aggressive but defensive. That is, they act in response to a perceived threat to the colony. Even so, we can readily admit that they attack and sting with much less provocation than do European honey bees of the same species. How is this difference in their behaviour to be explained?

According to the American entomologist Justin O. Schmidt, this has evolved over thousands of years, during which the main agent of natural selection has been human beings. This exploitation continues when we domesticate honey bees and protect them from their other enemies, such as the mites that attack larvae and worker bees. This does not mean that the bees gain no advantage -- in terms of the reproduction of their genes -- from being domesticated. Still, there is a contradiction in the relationship, as probably exists in any domestication of one species by another. Humans and honey bees have some interests in common, but we also have opposed interests. The defensive behaviour of every race of *Apis mellifera* -- not just africanized bees, although theirs is most conspicuous -- is a manifestation of this permanent contradiction.

And the greater defensiveness of some bees to the human threat has undoubtedly given rise to a greater defensiveness in the face of such other enemies as honey badgers and bears.

**5. Do these insects appear to possess what we might call a talent for architectural "civilization"? I am thinking of their coöperative habits, such as in nest building, accumulation of food and other materials, organization of collective labour, division of large prey in the field, use of leaves and branches as bridges, and so on. I wonder if we might do well to call the main caste "artisans", rather than "workers".**

This suggestion has the advantage of emphasizing that the behaviour of social insects represents processes under the individual's control. In everyday speech, "worker" can imply the use of brute force under another's orders, while an artisan acts by her own volition and knows what she is doing.

Since the time of Aristotle in the western tradition, and probably even earlier in Egypt and China, people written admiringly of honey-bee nests. In the Middle Ages and later, writings on the honey bee emphasized (often in quite a rhapsodic way) not just the order and harmony of their societies but also the physical perfection of their combs. Mathematicians went so far as to formulate proofs of the combs' optimal dimensions. Charles Darwin dedicated several pages of *The Origin of Species* to explaining how this optimal form could have evolved through a series of very gradual steps under the influence of natural selection. Darwin was quite right to think that the nests of this and some other social insects presented a difficulty for his theory, as they seem more in accord with the creationist argument from design.

Today we have little difficulty accounting for these very admirable nests by means of evolutionary mechanisms. Even so, they are among the most striking features of social insects, so that there is much to be said for your term "artisan insects".

**6. Do ants practise cannibalism?**

I believe you refer to the consumption of dead individuals by their nestmates. Except in strictly herbivorous species, this has been noted in many ants. The habit is observed more often in some social wasps, in which larvae and sometimes pupae are eaten under circumstances of scarcity or the breakdown of the colony. E.P. Deleurance of France described an "abortive brood" phase as a regular part of the colony cycle, in which the adults remove from their cells those larvae that are not yet ready to turn into pupae.

Cannibalism seems to be a more integral part of the social life of termites. We should note that these insects mostly feed on dead wood and other plant matter, consisting mainly of carbohydrates and with only a very low protein content. They cannot afford to waste any utilizable protein source, so that they do not discard the bodies of dead nestmates -- as honey bees are well known to do -- but eat them. This habit extends to eating wounded individuals, even if they are still alive and kicking. This might seem cruel to us, but it makes good sense in terms of the overall colony economy, as a wounded individual will likely

die of infection. It is far better to eat them now than to let them rot.

**7. I would like to know more about the physiological ability of termites to regurgitate cellulose from plants in the form of a sort of cement for nest building and to store water in the abdomen against periods of drought.**

Some termites, including some conspicuous arboreal species, utilize semi-digested plant matter as nest-construction material. This is a sort of excrement, although not fully digested, which can be mixed with mud and/or undigested plant matter. As far as I know, it has not been analyzed an engineering point of view.

One question of interest is the variety of materials utilized by different species in the same habitat. For example, *Microcerotermes arboreus* and *Nasutitermes corniger* are common species here in Trinidad (as well as in Colombia). They live practically side by side in the same habitats, apparently with access to the same resources. Nonetheless, the first makes its nest mostly of mud, with very little plant matter, while the second utilizes little or no mud. This contrast, which can be observed in any walk in the forest, has never been explained.

The use of certain colony members to store water and other fluid is known from some termites and many ants. In this respect, the Swiss psychiatrist and entomologist Auguste Forel spoke of the colony's "social stomach". Most social insects do not have individuals specialized to store fluids, but we can speak of a social stomach in all species. Any droplet that remains in an individual's crop -- i.e. that has not reached the stomach, in the strict sense, and so remains undigested -- belongs to the colony as a whole and can be requested by any other hungry/thirsty individual. This phenomenon has been demonstrated experimentally in social wasps by means of radioactive honey. This is presented to just a few individuals, yet within just a few hours it is found throughout the colony. That is, all nestmates have become radioactive.

Cordially,  
Chris