IS THE ANT COLONY A CONSCIOUS ORGANISM?

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ABSTRACT:

The similarity between the interaction pattern of neurons in the human brain and the ant colony makes the latter an object of the hypothesis of being a structure capable of having a consciousness. In this article, Thomas Nagel's definition of consciousness as something that is to be for an organism becomes fundamental for the examination of it as a possible experiential subject. The ant colony, if considered an organism, could be a subject capable of having internal experiences. Therefore, in this article, I developed based on Panpsychism, criteria for colony analysis, presenting which characteristics it must meet in order to be qualified as conscious. I do not argue that the ant colony is a genuine organism, but that, if it is, it will have some kind of conscious experience. In dealing with this question, I examine whether the colony is a biological individual, and then, whether it is possible for the ants' minds to underlie the colony's mind. I conclude that, based on how the parts interact with the whole, there may be more than one resolution to the problem, that is, the colony's consciousness depends on the way how its components are physically and phenomenally integrated.

KEYWORDS: Ant Colony; Consciousness; Panpsychism.

Introduction

In this article, I intend to theoretically examine whether a colony of invertebrate organisms has conscious experience as a unit. In this specific case, an ant colony. To do this, I base myself on the idea of consciousness as "something that is feeling for the organism" (NAGEL, 1979, p. 166)[1]. This concept, if applied to the ant colony, suggests that it is possible for it to manifest subjective aspects of consciousness. However, according to the ontological criteria of experience established by the American philosopher Thomas Nagel (1979, p. 166), the ant colony must first be an organism, and then have a sense of itself as an organism. So, if an ant colony is a genuine organism, it would have a consciousness based on the whole of its conscious parts. This obviously requires an analysis of the concept of the biological individual and its relationship to the subjective experience of a living system. In this case, is the ant colony a genuine organism? Is it therefore an experiential subject? In other words, is there such a thing as being like an ant colony?

My analysis is based on Pampsychism, the thesis that the basic physical constituents of the natural world have mental properties. Specifically, in a version of this argument, known as Combinationist Pampersychism, according to which "the experiential properties of a conscious subject are sometimes mere combinations of the experiential properties of other subjects that compose it" (ROELOFS, 2019, p. 6). Animal consciousness, from this perspective, could be a subjectivity made up of individually conscious components. It is then possible to state that conscious subjects can compose additional conscious subjects.

In this way, an ant colony could be a conscious subject. In other words, the phenomenal experiences of its parts would combine to constitute the phenomenal experience of it as a living entity. Yet, as I've already said, it's important to analyze whether the ant colony is an individual. Next, check whether the ants that make up the colony are conscious subjects. From there, examine how they combine their experiences to ground the experience of the colony.

I'm not stating here in advance that the colony has a consciousness, nor is it my aim to follow a line of thought that leads to that end. What I am addressing is that if the colony is an organism, the pampsychist thesis will apply to it too. This therefore involves problematizing

[1] All quotations in this text have been translated from the original by the author.

the concepts of Material Composition and the concept of Consciousness, this is the connection between the physical form of the living being and subjectivity.

For Pampsychism, as long as the physical parts are properly combined, we have an individual. In line with this reasoning, a conscious organism would be a material system organized in the *right way*, this is, so that the parts are connected enough to constitute a unified whole. However, Composition admits that not every living system would be organized in the *right way* to be a subject of experience. In other words, an organism without a centralized nervous network would not be able to feel the environment internally. But even this idea seems controversial. Is being an organism enough to have a subjective experience? If the answer is yes, then the idea of associating consciousness exclusively with nervous systems may not be accurate. In this sense, would a cell be an experiential subject? Given that, Pampsychism encounters the following obstacle: in order to define what the mind is, we need to understand what the body is. And if there is no precise concept of a biological individual, there will be no concept of consciousness either. In this case, any form of material organization conceived as a living system will be suitable to be seen as conscious to some degree.

The Problem of Composition therefore involves the inconsistency of the concept of organism. Generally speaking, if the notion of the individual is vague, so is the notion of consciousness. Furthermore, Nagel does not present a general organizing principle that clarifies the correct combination of parts to form a subjective entity. Hence, any relationship between part and whole that meets the concept of organism of a given scientific theory can be qualified as a genuine individual. However, this means that it may not be necessary to have a brain to be a conscious subject, but the type of connection between the system and its subsystems would suffice, like an effective communication network. Therefore, a colony of single-celled organisms like the *Portuguese Caravel*, whose body is similar to that of a jellyfish, would have some experience as a unit. Likewise, a colony of social insects. In this case, I'm basing myself on systems that don't have a biological neural network connecting their parts to a central core.

In addition, Pampsychism defends an unrestricted perspective on composition. According to this point of view, the physical components that make up an individual can be recombined to make up another individual. Inspite of that, the notion of part and whole is also vague. The atoms that make up a human person are *part* of that person and, in turn, that person is *part of* a nation or community. Now, if unrestricted composition is true for any part-whole relationship, an individual can be composed of other individuals, as long as there is an

interaction capable of producing a unity. Therefore, Pampsychism seems to accept the idea that one living system can compose another. The important thing is that the components are neatly arranged in the composition of the additional individual (NAGEL, 2004, p. 43-44; ROELOFS, 2019, p. 21). But how do we determine whether an organism is structured in a way that is appropriate for it to have a consciousness? Would a jellyfish, which doesn't have a centralized nervous system but is distributed in its tentacles, have any kind of consciousness? Does the ant, or the bee, even without a superior neural cortex, have subjective experience? Would a colony, whether made up of unicellular or multicellular bodies, have consciousness like an individual?

The four premises of Pampsychism

According to the philosopher Thomas Nagel, in his essay *Panpsychism*, published in the book *Mortal Questions*, Pampsychism[2] is based on four simple premises (NAGEL, 1979, p. 181-182; CLEVE, 1990, p. 215), namely:

1. *Material composition*, or, *Antidualism*, according to which any living organism is a complex material system, consisting of a large number of particles combined in a special way;
2. *Anti-reductionism*, which asserts that mental states are neither physical properties of the organism nor intelligibly derived only from its physical properties;
3. *Realism* or *Anti-eliminativism*, or the view that mental states are genuine properties of the organism and not properties of anything at all;
4. *Antiemergentism*, or the understanding that there are no truly emergent properties of complex systems, but that they are intelligibly derived from the properties of their constituents and their effects on each other when combined.

In this sense, Nagelian Pampsychism (we'll call it that) states that some physical constituents must have non-physical mental properties which, when combined in a correct structure, underlie the emergence of a conscious mind. Subjective experience, however, would not be an emergent property in the strong sense of the term, or rather, as something that arises above the physical structure, but rather, an intrinsic characteristic of basic physical entities.

[2] In general terms, "it is the thesis that some microphysical entities are conscious, that is, there is something that is like being a quark or a photon or a member of some other fundamental physical type". CHALMERS, David. **Panpsychism and Panprotopsychism**. 2013, p. 1.

Nonetheless, when these properties are brought together, the consciousness of the biological entity appears. For this reason, Nagel says that the mind is a biological property, because only the resulting *person* would have a genuine consciousness. There would therefore be no consciousness of the parts and no consciousness of the whole. According to Nagel (2004, p. 48), there is only the consciousness of the organism and nothing else. If only biological entities have conscious mental states, then the realist principle implies the existence of a necessary connection between the neurophysiology of the living system and the appearance of mental states. Regardless, for the link to be necessary, the mental properties must be non-emergent, that is, the mental properties of the living system must be grounded in the micromental properties of the microphysical entities that compose it. Similarly, the mental properties of the Colony as a biological unit would be based on the mental properties of the ants.

So, for the purposes of this study, I consider that the four premises of Pampersychism can be interpreted as conditions for a unit to have conscious experience. In short: a given complex material order can be conscious if the physical entities that make it up are also conscious. However, they need to be arranged in such a way as to constitute an organism. These four premises, if taken as criteria, can be applied to the ant colony. If the colony meets these parameters, it will have some kind of subjective experience. Therefore, it must, according to (o):

a. Material Composition: *Being a structure whose order of parts is sufficient to have a consciousness*. In other words, the ant colony must really be an organism.
b. Anti-reductionism: *An explanation of the Colony Mind based solely on describing the behavior of its parts is not enough*.
c. Realism: *If the Colony is a genuine organism, it follows that it has conscious mental states*.
d. Antiemergence: *The Colony Mind is not an emergent property, but derives directly from the sum of the ants' individual minds*. Therefore, the ants have to be conscious.

In short, the colony, being an organism, will have a consciousness and even if its subjectivity derives directly from the sum of the individual subjectivities, it is not reducible to a solely behaviorist explanation. Even if the emergence of the colony is elucidated from the cooperative behavior of the parts, this is not enough. It is important to add the possibility of the components having subjective states of consciousness. The starting point for the analysis of

this research, based on the pampsychic theory, is that micro-minds can make up macro-minds when combined into an integrated structure.

However, affirming them requires us to assume two principles: that of nesting and that of combination. According to the Principle of Nesting, consciousness contains other conscious systems as part of itself, or can be contained in other conscious systems. According to the Principle of Combination, consciousness is made up of conscious parts brought together in an intelligible way. In this context, the consciousness of an ant colony would be based on the set of individual consciousnesses that make it up.

In line with this reasoning, for the combinationist argument to make any sense, I think it's reasonable that, firstly, the colony is a genuine organism and, secondly, that the ants are experiential subjects. In this way, their minds would be structurally nested. I will then try to examine each of these three points.

Is an ant colony an organism?

To answer this question, I consider Organismicity Theory, defended by David C. Queller and Joan E. Strassman (2009), whose research in evolutionary biology has become crucial for providing an empirical agenda for understanding the reasons for biological individuality, provides the basis for the analysis. Her central idea is that an organism is the product of high cooperation associated with strong control of intra-organismal conflicts (QUELLER & STRASSMAN, 2009, p. 3144; STRASSMAN & QUELLER, 2010, p. 605). In this sense, colonies of social insects or multi-species communities with high cooperation would be integrated enough to constitute genuine organisms.

This theory continues the thinking of the American myrmecologist William Morton Wheeler (1911), who established sociogenesis as an argument for the organismality of the colony, the idea that every organism manifests a strong predilection to seek out other organisms and assimilate or cooperate with them to compose a more comprehensive and efficient biological individual, in order to guarantee its own survival. In Wheeler's view (1911, p. 307-308), the ant colony is a genuine organism.

For him, the ant colony would be an organism in the sense of a physiological individual, defined by its structural properties - such as having heterogeneous and specialized parts - as well as functional properties - such as the capacity for development, reproduction and self-repair. This means that the colony as a unit is characterized by the definitive separation of the

workers, from the embryonic stage, into sterile ones that will play the same role as somatic cells and reproductive ones, which perform the same function as germ cells in the biological system. From this point of view, Wheeler writes (1911, p. 308):

> An organism is a complex system, absolutely coordinated and therefore individualized, of activities directed mainly at obtaining and assimilating substances from the environment, producing other similar systems, known as offspring, and self-protecting the system and usually also its offspring from disturbances emanating from the environment.

This concept implies that an autonomous entity is characterized by the coordination and integration of its components, which produce this individual detached from the environment. Organismic Theory follows the same line of reasoning as Wheeler, stating that living beings are made up of different levels of social groups that cooperate with each other, emphasizing adaptation as a central aspect of living beings. In other words, high cooperation and controlled or absent conflict between the parties is to say that the organism is the goal of adaptation. Therefore, a living system is a unit of adaptation. It is possible, then, that there are groups with high cooperation and high conflict, thus constituting a society; while groups with low cooperation and low conflict only form simple groups (STRASSMAN & QUELLER, 2010, p. 605-607). But how can we tell which units are true organisms?

Queller and Strassman (2009, p. 3144; 2010, p. 608) state that a proper distinction is based on the characteristics of the parties, whether they are similar or different individuals. As a result, there are two types of organisms: fraternal and egalitarian. Fraternal organisms are those composed of multiple individuals of the same species or clonal individuals, which group together with the aim of transferring the gene *pool* to the next generation. In contrast, egalitarian organisms are those made up of different biological individuals that establish a mutualistic relationship. However, this form of grouping can occur at various levels, this is a biological entity can be a gathering of fraternal and egalitarian individuals, such as man, who is made up of cells and other micro-organisms.

The concept of fraternal organisms takes multicellular organisms such as cats and dogs as its paradigm. In general terms, fraternal paradigm organisms are clonal organisms, in which each part is genetically identical to all the others. In this context, high cooperation is the product of parental closeness. Consequently, we have a physiologically cohesive unit, in which all the cells that make up the unit collaborate to ensure the reproduction of the germ cells. However, in a multicellular organism there are also conflicts, it is possible for mutations in somatic cells to disconnect them from the group, turning them into cancers. Thus, a biological unit is not only

the effect of high cooperation but also of conflict between components, although the conflicts between the parts are either minor or controlled.

An example of a fraternal organism is *D. discoideum*, an amoeba which, depending on the conditions of the environment, can migrate from a solitary life to a social one, by aggregating with others nearby, thus engendering a multicellular organism. Assuming that during the multicellular period there are levels of cooperation as well as latent levels of conflict, but if the conflict is low or sporadic, then it follows that *D. discoideum* is a true organism (QUEELER & STRASSMAN, 2009, p. 3145; 2010, p. 608; 2011, p. 597-607). Depending on the environmental conditions, it can move from a solitary to a gregarious/social way of life.

In addition, colonies of multicellular individuals such as cnidarian siphonophores, specifically *Physalia physalis*, can also be considered organisms, given that low conflict and high cooperation are the result of the clonality of a single unicellular individual. Consequently, the clonal groups specialize functionally and morphologically into four different types of polyps: a) pneumatophore, a vesicle filled with air to ensure buoyancy; b) gastrozooids, which play the role of the colony's digestive system; c) dactylozooids, which function as tentacles; d) and the gonozooids, intended for reproduction. These organisms are dependent on each other, as well as being morphologically associated, so that it is impossible for them to live separately. However, in the traditional view, *P. physalis* is not conceptualized as a biological entity, but rather as an aggregate of polyps. Queller and Strassman's argument (2009, p. 31247; 2010, p. 609), in opposition to this point of view, states that the siphonophore is genuinely an organism, given the high degree of integration of the parts.

On the other hand, non-clonal cooperative groups can exhibit more cooperativeness and conflict control than clonal groups. A colony of social insects, for example, due to the degree of kinship between sisters, can be qualified as an organism or not. Consider the haplodiploidy hypothesis, which supports the idea that in a colony of ants, the coefficient of genetic relatedness between the sisters is 0.75 while that between the sisters and their brothers is 025. This genetic proximity is essential for cooperation between the worker ants (females), since the males do not cooperate much. However, as has been pointed out, not all colonies are organisms. In view of this, Strassman and Queller (2010, p. 609) establish four criteria for analyzing whether a certain system is an organism:

1. When the conflict is strong enough, colonies are not organisms.
2. When the conflict is moderate, they are organisms.
3. When there is zero conflict and zero cooperation, they are not organisms.

4. When conflict is low and cooperation is high, they are organisms.

In this context, if a group of ants becomes antisocial, the colony loses its organism. What matters for organismality is cooperation, or sociability, between the components. If there is conflict, it should be small-scale or local, and if not, at least manageable. Thus, these aspects are the measure for determining which social groupings constitute biological entities.

The concept of egalitarian organisms, in turn, takes as its paradigm the partnership of the eukaryotic cell, made up of the mitochondria and the host cell. Eukaryotic cells are the basis for the variability of living forms. Based on this model, an organism can also be something made up of different species. By this line of reasoning, sexual cooperation between partners of different species is enough to define them as an organism. The most illustrious case is the devilfish (*Caulophryne jordani)*, in which the male (about 1.5 cm long) is a "parasite" of the female (about 18 cm long). When the male attaches itself permanently to the female's body, it atrophies all the organs except the gonads (where the sex cells are produced), thus reaching the "parasitic" stage. Hence, there is a mutualistic relationship: on the one hand, the male feeds on the female's blood; on the other, he provides his gametes for the fertilization of the eggs. This partnership therefore demonstrates that organisms can be produced by the integration of unrelated individuals (STRASSMAN & QUELLER, 2010, p. 610).

Consequently, both fraternal and egalitarian organisms outline three types of conditions for organismality in social groups (STRASSMAN & QUELLER, 2010, p. 611):

> Firstly, there must be synergistic advantages to cooperation that make it more than a zero-sum game. Secondly, some conditions must broadly align the reproductive interests of the parties. Finally, when potential conflicts remain, they must be suppressed by some mechanism so that organismality is achieved.

These conditions are visible in the colony of social insects since altruism provides the evolutionary benefits for the group. Cooperation is only threatened in situations such as the death of the queen. In such cases, if there are no workers to take the queen's place, the colony will also die. Furthermore, it is possible that the aggregation pheromone released by the queen is a means of reducing conflict and maintaining cooperation.

In short, an organism is a social unit defined by the high degree of cooperation between its parts. This argument can be extended to other colonial animals produced by clonal and non-clonal social groups, as well as to other animals including man. From this perspective, taking into account the level of cooperation and conflict, there would be the possibility of groupings

that approach unity, as well as the existence of groupings that reach unity (STRASSMAN & QUELLER, 2010, p. 614). In this sense, although the ant colony has characteristics that meet the theoretical conditions for being a genuine organism, the fact that the ants are not structurally connected, as is the case with *P. physalis*, in the formation of a multicellular body, but are scattered throughout the environment, favors the view of the colony as being between aggregation and individuality. In this way, the ant colony would be an indeterminate organism.

Are ants conscious?

Assuming, then, that ants are conscious, on what neural substrate is it founded? Where in the brain is processed sensory information integrated into conscious experience? And what is the relationship between the ant's experience and colonial organization? One theoretical approach that defends the existence of consciousness in invertebrate animals is the argument by Colin Klein and Andrew B. Barron (2016), whose importance for the study of the mind lies in presenting a new way of understanding the neurobiological origins of subjective experience. According to these researchers, insect consciousness occurs in a sub-cortical region of the brain, the midbrain. In the midbrain, interoceptive sensory information (stimuli coming from the body) and exteroceptive information (stimuli external to the body) are combined in a neural model of the body moving in the environment (KLEIN & BARRON, 2016, p. 3). Thus, insects would have an integrated neural system capable of supporting conscious experience (MERKER, 2007, p. 70-74).

Two characteristics of the midbrain are fundamental to sustaining subjective experience in insects. Firstly, the integrated processing of spatial information allows the moving animal to eliminate the ambiguity between motor output and sensory input caused by its action in the environment. The various sensory information including position, orientation and body movement (or somatospatial) are unified in a neural model allowing the animal to move in an organized way in space and react to local changes. The second feature is that the integration of information about the animal's physiological needs with the location and availability of resources results in the selection of efficient actions to be carried out by the animal. In short, the midbrain underpins the individual's decision-making and action planning (KLEIN & BARRON, 2016, p. 3-8).

Following this line of reasoning, Klein and Barron (2016, p. 5) argue that the unified and centered representation of the world from the insect's perspective is sufficient for it to have conscious experience. In other words, these animals are sentient, are able to internally sense

(*feel*) their location in space and respond to external stimuli (KLEIN & BARRON, 2016, p. 10-11; SØVIK & PERRY, 2016, p. 2). Furthermore, given that consciousness involves the ability to perceive something, or depends on the existence of external objects, the fact that insects have attention circuits in the proto-brain suggests that they become aware of their surroundings (FEINBERG & MALLATT, 2016, p. 4).

It is possible, from this, to interpret Klein and Barron's (2016) argument about consciousness in insects as being restricted to a rudimentary sense of space. In fact, to make it even clearer, it's not just about moving in space and responding to environmental stimuli, but about combining somatospatial information into an internal representation (SØVIK & PERRY, 2016, p. 2-3). Considering then that consciousness is supported by subcortical structures, the number of neurons, however relevant, wouldn't make much difference without an appropriate functional organization

But Klein and Barron (2016, p. 10-11) do not suggest that insects are capable of monitoring their own cognitive processes, nor that they are self-aware. They wouldn't have the same kind of subjective experience that mammals with a cerebral cortex have. In fact, they would have a primary consciousness, a basic level of experience (SØVIK & PERRY, 2016, p. 4; FEINBERG & MALLATT, 2016, p. 4). The issue surrounding the concept of "level" is the vagueness regarding the number of neurons sufficient to attribute consciousness. Possibly, the occurrence of subjective experience does not depend on the number of nerve cells, but rather on the way the system is organized.

Finally, *if* there is a possibility that ants are able to have a subjective aspect of experience from the integration of chemical, visual and motor sensory information into an internal representation, then consciousness would be an extra explanation not only for decision-making, but also for colonial organization. As a result, conscious experience would provide another insight into ant behavior (KLEIN & BARRON, 2016, p. 7). Now, it remains to be seen how the consciousness of the parts would be integrated to constitute the unified experience of the whole

Is it possible to bring minds together?

To substantiate the idea of the sum of individual consciousnesses in a joint consciousness, I propose the following thought experiment: Suppose now that the amoeba *D. discoideum* has conscious experience. This unicellular amoeba goes through four stages in its short life: vegetation (unicellular phase), aggregation (constitution of the colony or

multicellular organism), migration (the body transports itself to a region with more available nutrients) and culmination (disintegration)[3]. Knowing this, let's imagine that each stage corresponds to a type of consciousness resulting from the level of physical and experiential integration.

At first, consciousness is still individual, encompassing the experiences of the single-celled organism such as the sensations of detecting nutrients in the environment and the pleasure of feeding on the available micro-organisms. However, when the amount of nutrients becomes scarce, each individual emits a chemical signal summoning the others to aggregate, thus producing a colony. At this early stage, each organism is cooperating with the other at a weak level of physical integration (this is, they are not yet anatomically connected) and phenomenal integration (this is, the shared experience is partial). As a result, you have a kind of collective consciousness characterized by being between the consciousness of the unicellular individual and that of the group. The moment a strong integration between the parts is achieved, a multicellular organism is generated, at the same time as unity consciousness. Here, the experiences of the parts are combined to make up the experience of the multicellular organism. And this lasts until a place is found with a sufficient volume of nutrients for each amoeba, which then causes disintegration.

Assuming that the idea of a mind made from the combination of other minds is true, it requires that the boundary between the experience of the components and the experience of the unity be conceptually well defined. In the example of *D. discoideum*, in which the aggregation of unicellular organisms results in the constitution of a multicellular organism, if it is true that the parts of the colony are conscious, it does not follow that the biological unit has consciousness. It is to be assumed that the colony can be reduced to an aggregation of individuals because it offers selective advantages, without resulting in a unified mind. Each member can have a qualitative character of experience and never share it with the others. There is no way that individual experiences would come together to give rise to the experience of the biological entity.

Here I'm assuming the following idea of constitutive pampsychism: experiential subjects can compose other experiential subjects (not taking into account details such as having a nervous system) (GOFF, 2017, p. 297). In this case, *D. discoideum* brings us to the so-called

[3] Here I have taken as my basis Daniel Schardosim Calovi's doctoral thesis, in which the author presents a careful analysis of the stages of the social life cycle of the amoeba *D. discoideum* simulated computationally. See CALOVI, Daniel Schardosim. *Simulation of the social life cycle of the amoeba Dictyostelium discoideum*. 82 f. Thesis (Doctorate in Science) - Institute of Physics, Federal University of Rio Grande do Sul, Porto Alegre, 2011. Available at: https://lume.ufrgs.br/handle/10183/31612. Accessed on August 20, 2021.

"combination problem". How do micro-consciousnesses combine to form macro-consciousnesses? This problem is about understanding the unity of consciousness in a composite material structure (the brain), how sensory information processed in sets of neurons is unified in the subject's conscious experience.

To illustrate this point, let's look at the *split-brain* experiment. In summary, a patient with epilepsy undergoes a surgery called a callosotomy, which consists of cutting the corpus callosum, whose function is to connect the two right and left cerebral hemispheres, allowing them to communicate with each other. After the surgery we have a subject with the two hemispheres disconnected. The event is curiously interesting, given that the right and left sides of the brain are separated, a single individual emerges with a disunified consciousness (GOFF, 2019, p. 148-154; ROELOFS, 2019, p. 207).

Nagel (1979, p. 159-164), for example, states that the unified experience of consciousness is possibly the result of the integration of two different minds. Based on the split-brain experiment, the philosopher arrives at the idea that the subject's consciousness is the effect of combining the consciousnesses of the physical entities that constitute it. If each cerebral hemisphere has a mind, it seems rational to assume that the mental operations of each side can also be separated to form distinct minds.

The question that arises in Pampsychism, according to Goff (2019, p.148), is: "How does one go from a disunified consciousness (the consciousness of isolated parts) to a neural structure with unified consciousness?" Possibly by the way the basic constituents have been arranged (NAGEL, 2004, p. 48). This suitable form, according to the premise of composition, would be the organism. But the possibility of unicellular organisms, in the hypothesis of having consciousness, when constituting a multicellular organism producing the consciousness of that individual depends on two factors: how close the relationship between the components is and whether the experience of the parts is shareable at a certain level between them and not totally private (ROELOFS, 2019, p. 63-64; GOFF, 2017, p. 292-293; ROELOFS & GOFF, 2020, p. 7). Otherwise, there will be the isolated consciousness of groups of subjects without an additional conscious subject.

In his work *Combining Minds*, philosopher Luke Roelofs (2019, p. 20) defends combinationism, the thesis that "the experiential properties of the whole can, in some cases, be founded on and explained by those of its parts". Human consciousness, from this point of view, could be a subjectivity made up of individually conscious components. If so, would a colony of social hymenopteran insects have its consciousness based on the consciousness of its members? Would the "I" of the colony be the same as that of the parts or something different?

Or is it not a subjective entity? The answer must be based on the following conceptualization of combinationism:

> The experiential properties of a conscious subject are sometimes mere combinations of the experiential properties of other subjects that compose it. A more intuitive way of putting the definition of "combination" is to say that a characteristic of mine is a combination of the characteristics of my parts if those other characteristics, and the way they are connected, both suffice to ground the fact that I am having the characteristic in question and can be appealed to in an explanation of why I have them (ROELOFS, 2019, p. 6).

In principle, saying that the experiential properties of a system are grounded in the experiential properties of its constituents means saying that once we have *B*, that's enough for us to have *A*, or rather, the properties of one are grounded in the properties of the other. From this perspective, the consciousness of *A* is linked to the consciousness of *B*, so that without *B* there is no A (ROELOFS, 2019, p. 23).

Secondly, by saying that the properties of the whole are explained by the properties of the parts means that by explaining *B* we have a complete understanding of *A.* In other words, the analysis of the components at a given moment is sufficient to explain the properties of the system at that very moment. In this context, Roelofs (2019, p. 23) argues that "consciousness is a mere combination of the parts if and only if it is both grounded in them and their interrelations and also explained by them and their interrelations".

But what are the experiences of the parts? What is the experience of the whole? Now, to return once again to the mental experiment of *D. discoideum*, the experience of the constituents can be understood as a disunified experience (in the vegetable stage), something that is like being each individual, while the experience of the whole, of course, corresponds to a unified experience (in the aggregation stage), *something that is like being* this entity (NAGEL, 1979, p. 164, 182; 2004, p. 81). Therefore, we have to assume that the organizational pattern instantiated by the cooperation of the parts is the structure in which consciousness appears.

In general, consciousness is analyzed from the point of view of it as a genuine unity, in such a way that it is not possible to see it as a set of parts. However, the argument I'm supporting here, based on pampsychism, is that the organism and consciousness are units made up of relatively integrated constituents. Along these lines, I hold the view of combinationalism, which can be defined in terms of a part-whole relationship, in which the experiential properties of the parts, when combined, underlie and explain the experiential properties of the conscious subject (ROELOFS, 2019, p. 30).

This doctrine is opposed to the Chinese Mind argument proposed by philosopher Ned Block (2002, p. 96-97), who claims that the idea of a composite subjectivity is not coherent. Suppose, then, that the government of China convinces its citizens to simulate a human brain using radio transmitters. Each citizen is given a device to send and receive signals, as well as very specific instructions such as "when you receive signal I, from device S_i, send a signal O to device S_l " (BLOCK, 2002, p. 97). Suppose that the inputs and outputs of the signals occur simultaneously, shared with hundreds of thousands of individuals, in a similar way to the human neural system. Then, an android is connected to the devices in order to be controlled by citizens in the same way as the sensory inputs and motor outputs in the human brain. Consequently, the signals sent by millions of citizens end up producing a machine with intelligent behavior. The question this raises is: are all these citizens conscious as a single individual?

For Block (2002, p. 97), it is counterintuitive to say that they have a conscious group experience. It's absurd. In this case, there is no integration of individual experiences. What there is, is a gap between the consciousness of the parts and the whole. Furthermore, a conscious entity cannot contain another conscious entity as part of it or be contained in it. In this context, consciousness will either exist in the whole, or it will exist in the parts, never in both. According to Roelofs (2019, p. 43), the impossibility of a unified mind emerging is due to the lack of a specific structure that integrates the information produced by the aggregate of the components.

Goff addresses this question, because if unified consciousness is the result of the combination of other consciousnesses, it is rational, then, to think that there exists between the components a kind of *phenomenal bonding*, that is, a relationship between phenomenal fields (or individuated experiences) that give rise to conscious structures from a composite experience. The question of what he calls Phenomenal Composition is defined by the way in which subjects with phenomenality connect to constitute other subjects, requires determining the *appropriate way* in which the composition is carried out, as well as which parts maintain this phenomenal relationship. That said, there are two ways of analyzing phenomenal composition (GOFF, 2017, p. 296):

> a. Restricted composition, the view that only some sets of objects are so organized that they make up other objects, while, on the other hand, there are sets of objects whose form prevents them from making up an object.
> b. Unrestricted composition, the view that any object can be recombined into another object.

For proponents of Unrestricted Phenomenal Composition, *all* the particles that make up a human body are linked to each other by a phenomenal relationship and are therefore capable

of producing another conscious subject (GOFF, 2017, p. 296-297). As for those who defend Restricted Phenomenal Composition, only *some* groups of subjects, but not all, have a phenomenal link between them in such a way as to produce conscious subjects (CLEVE, 1990, p. 216-217). In the Nagelian view, phenomenal composition can be carried out by any subject (NAGEL, 2004, p. 43-44). However, as has already been pointed out, a given system may not be organized in such a way as to produce an experiential subject. Faced with this problem, we have to follow one of two answers, presented by Goff (2017, p. 298), along the lines of Phenomenal Composition: the nihilistic answer, in which subjects never combine to form other experiential subjects; or the universalistic answer, in which subjects always combine to produce another experiential subject. Based on the doctrine of combinationalism, adopted here to examine the ant colony, if the universalist perspective is correct, then we have to assume that subjective experience is shareable, in order to elucidate how phenomenal bonding occurs.

Nagelian Pampsychism affirms that conscious experience is something exclusive to the subject, in other words, it belongs to them and not simultaneously to someone else. The experience of pain, for example, for an individual, would never be felt and understood by someone of the same species. The pain experienced by a wounded animal would be incomparable. Goff and Roelofs (2020) agree in part with this principle of exclusivity, in the sense that certain experiences of a given subject cannot belong at the same time to another, such as the feeling of being "me". In this respect, according to Goff and Roelofs (2020), in subjects who are materially connected, certain experiences would be weakly exclusive. Thus, phenomenal sharing becomes possible. But for this to happen, the weak privacy argument needs to be true. According to this argument, a phenomenal attribute is directly known to a subject and only indirectly known to any discrete subject (GOFF & ROELOFS, 2020, p. 7; ROELOFS, 2019, p. 63).

In this way, the authors defend a weak phenomenal sharing, that is, a single experience that can belong to multiple subjects. Phenomenal sharing would only occur when these subjects are overlapping - one containing the other as its own part, or both sharing a single part of themselves, such as Siamese twins with brains connected by a neural bridge[4]; or insects, such as ants, through multimodal communication; or bees, through dance, informing the location of

[4] I'm referring to the famous case of the Siamese sisters Tatiana and Krista Hogan who share a thalamic bridge between their brains. The neural bridge seemed to allow the two to share not only sensory signals but, perhaps, conscious thoughts. See DOMINUS, Susan. *Could Conjoined Twins Share a Mind?* The New York Times Magazine, 2011. Available at: https://www.nytimes.com/2011/05/29/magazine/could-conjoined-twins-share-a-mind.html?pagewanted=all. Accessed February 2, 2021.

food. In such situations, a particular experience would be shared, generating a group consciousness.

Taking into account the combinationalist argument, the phenomenal connection, Goff suggests (2016, p. 181-182), could be identical to the spatial relationship; in this way, a group of physical components, being spatially connected, could form a conscious subject. Now, if we imagine different ways in which objects relate spatially, we will have different types of consciousness. Assuming that social insects are these objects, the phenomenal connection between the members of a colony will depend on how they are spatially connected. In the latter case, ants are generally dispersed in the environment, they don't have a spatially close relationship like somatic cells, or an anatomical connection as occurs with *D. discoideum* in the constitution of a multicellular body. The integration between the ants is basically chemical. If they were closely connected in physical space, we would have a strong phenomenal unity; if, on the other hand, they were loosely connected, the phenomenal unity would be weak. Consequently, if we take into account the type of arrangement of the physical constituents and the phenomenal unity, then it is natural to suppose that there are different forms of experience.

Having attested that, Goff, starting from the premise of Material Composition, proposes that if the basic constituents are arranged in the form of an organism, then we have a subjective entity. However, as he himself admits (2017, p. 298), there is an implicit difficulty in the argument of composition, the boundary between the organic and the non-organic, between what is truly an organism and what is not. This difficulty lies in the imprecision of the proper arrangement of physical entities at the right moment to produce an organism. At any given point in time, Goff writes, it can be said that there is a limit situation, in which we don't know how to determine the beginning and end of an organism, a precise interval in which we have a zygote and previously only sperm and egg. As a result, if there is no principle of organization, we have to accept the hypothesis of borderline cases in material composition (2017, p. 298).

In this context, if the ant colony, according to the theory of organismality, is a genuine organism, given that it has high cooperation between members (QUELLER & STRASSMAN, 2009, p. 3147-3148), from the perspective of the theory of autopoiesis, in turn, it does not constitute an organism due to the absence of a semi-permeable membrane (THOMPSON, 2013, p. 130). Therefore, it seems reasonable to say that it is on the borderline of organismality. Here, considering conscious experience in living entities, the colony would be between being a conscious and non-conscious organism. But this depends, of course, on the type of coupling between the parts (VARELA, 2000, p. 67-68). Assuming that the insect colony forms something close to an organism, from the point of view of Phenomenal Composition, it could

be in an intermediate zone. Regarding this problem, Goff (2017, p. 298) writes: "If the existence of an organism is necessary and sufficient for the existence of a conscious subject, and if it is sometimes vague whether or not we have an organism, it follows that it is sometimes vague whether or not we have a conscious subject."

Answers?

We are therefore faced with the so-called *Boundary* Problem or *Nesting Problem* (ROSENBERG, 2004, p. 81-90; FEKETE *et. al.*, 2016, p. 1-16; SCHWITZGEBEL, 2014, p. 1-21; ROELOFS, 2019, p. 59), which deals with the limit between the experience of the individuated parts and the experience of the individuated whole. In other words, whether or not the mind of the component subject disappears into the mind of the whole. The Boundary Problem leads to the assertion that the experiences of the subject shared with each of its components may or may not produce a genuine combination. This means that the component subjects can either have the same entire set of experiences as the additional subject, or there can be a gap between the experience of the parts and that of the whole (ROELOFS, 2019, p. 59-60).

We therefore don't know from this perspective whether a given complex system has an integrated experience. The answer depends more on how this organization is understood. Hence the boundary problem, the imprecision in determining whether or not the experience of the component subjects disappears in the experience of being the whole, and also whether they are continuous or discontinuous with each other. As Goff (2017, p. 298) rightly pointed out, it is possible to imagine intermediate biological structures, which in turn correspond to an indeterminate consciousness. Following this line of reasoning, we developed the answer to the title question of this work, based on an epistemic reading of the part-whole relationship. In other words, it needs to be properly composed and we don't know if it really is in such a way as to produce a phenomenal unity. So, assuming that it is, in fact, an organism, we have the following answers based on the boundary problem (ROSENBERG, 2004, p. 84-85):

> ***R .1*** *Each ant is an experiential subject, but the colony is not*. This possibility is true if the phenomenal sharing between the ants does not contain information with sophisticated representation or if the structure resulting from the cooperation between the elements is not capable of phenomenal unification.

> ***R .2*** *Each ant is an experiential subject, as is the colony*. This possibility is true if constitutive pampsychism is true. In this context, the experience of the whole would be founded on and explained by the experience of its parts combined in a special form. Precisely, the colony would be organized in such a way as to support a consciousness.
>
> ***R .3*** *The colony would be an experiential subject, but none of the ants would be*. This possibility implies that the component minds would be annulled by the mind of the whole, or that the components are not experiential subjects, but from the relationship between them emerges a system capable of having phenomenality.

The position to which combinationalism seems to be committed is R2, since it aligns with the argument for unrestricted phenomenal composition. However, if we think about how ants are related in space, we get a different explanation. For example, in a *split-brain* we have a disunified consciousness (NAGEL, 1979, p. 151-159); in two brains connected by a single cortical thalamus we have two individuated minds that, through a channel, share some experiences, without resulting in a phenomenal unity (LANGLAND-HASSAN, 2013, p. 1737-1759; ROELO, 2013, p. 1737-1759). 1737-1756; ROELOFS, 2019, p. 11); whereas in the hypothesis of a brain fusion, the individuated minds in the fusion process would gradually lose their independence until they are annulled and replaced by the supermind (FEKETE *et al.*, 2016, p. 14; ROELOFS, 2019, p. 277-288).

Now, compared to the amoeba *D. discoideum* and the siphonophore *P. physalis*, ants are not physically connected to the point of generating a multicellular body. In fact, they are dispersed in the environment. Even if we claim that the emergent pattern is capable of sustaining a collective subjectivity, the lack of a close connection may imply the experiential character of the unit. This detail seems relevant, as it calls into question whether or not it is a genuine unit, or if it is close to achieving unity. In the latter case, the ant colony would be at the limit of organicity. By analyzing the concepts of spatial order of physical entities and phenomenal unity (GOFF, 2017, p. 300), I can imagine a fourth answer to the problem:

> ***R4*** *The colony would be an experiential subject, but its experience is relative to the spatial arrangement of the components*. This possibility implies

> that the colony, even if capable of sustaining a consciousness, would be weakly integrated, finding itself in an intermediate degree, or in a gray zone.

We have no idea what it's like to be a consciousness in a gray zone because this is a study in its early stages, but if we consider that the colony doesn't have a material border (THOMPSON, 2013, p. 130-131; VARELA, 2000, p. 222) and its elements are scattered, even if the way they interact is enough for a phenomenal unity, it's possible that it's weak. Not only for this reason, but also because we are not sure whether the shared informational content is rich. In comparison, a multicellular organism composed of *D. discoideum* could have a greater phenomenal unity, due to the spatial proximity of the parts.

As a result, according to Roelofs (2019, p. 282), to say that phenomenal unity is vague is to say that "there is a midpoint at which it is neither determinately true nor determinately false that the experience of the components is phenomenally unified, because their relations are neither differentially rich enough nor differentially not". It is in this sense that I argue that it is inaccurate to say that the ant colony has a consciousness. It resembles the jellyfish in that it doesn't have a central brain that connects sensory information into an internal representation. In other words, it is because it functions as a distributed neural network that the ant colony would be on the borderline of a genuinely conscious system.

Therefore, whether a colony of social hymenopteran insects is conscious will depend on the characteristics of its composition. The answer, in order to determine whether a society-like system is fit to be an experiential subject, requires solving the problem of combination, which remains, so far, insoluble. Nevertheless, the way in which the parts are connected is epistemically debatable. In short, a "yes" or "no" answer is uncertain for the time being.

Conclusion

During the course of this work, I examined the hypothesis that the ant colony was a conscious subject. I considered, based on the concept of composition, that if it were a genuine organism, it could have some kind of consciousness. In view of this, I analyzed the ant colony from the point of view of material and phenomenal composition. In other words, I argued that the ants, being experiential subjects, could gather their experiences into a unified whole. The colony's consciousness, in this case, would be continuous with its micro-conscious parts. However, given that experiential unity depends on how the parts of the individual are spatially related - whether close together or scattered; there would therefore be a limit to the composition

of a consciousness. This means that genuine organisms, or those close to becoming organisms, would have different types of phenomenal consciousness.

In the case of the ant colony, the way the ants are distributed in space would imply the level of phenomenal unification. Of course, there are objections, such as claiming that only the integration of information, by means of chemical signals, for example, would be enough, regardless of whether the members are close together or spread out. However, the way the parts are arranged in the constitution of the body reflects on the subject's level of consciousness. Thus, he concludes that the ant colony would have a weak integration of individual experiences. The colony's consciousness would be in an intermediate region. Now, taking into account that the colony may be on a dividing line of organicity, it would also be in a gray zone of phenomenality.

That said, I suppose that the uncertainty about the strongly unified experience in an ant colony seems coherent. The other three answers based on the part-whole relationship are also valid. Both continuity and discontinuity are possible between the experience of the parts and that of the whole. However, I think the fourth answer, which states that the ant colony is a case of borderline consciousness, is more appropriate. This answer takes into account the two sides of the composition: the physical and the phenomenal. Both are imprecise concepts in the pampsychist theory. Therefore, the colony having an imprecise consciousness doesn't seem absurd. I think, on this basis, that consciousness can be an indeterminate property of the organization.

Finally, it is possible to say that R_1, R_2, R_3 and R_4 can serve as a paradigm for examining other forms of organismal colonies, considering interaction, communication and the arrangement of the parts. It is not possible to guarantee that all of them are in a context analogous to that of the ant colony, but, in comparison, to affirm that some have a greater degree of consciousness, while others are absent.

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