News & views

DANIEL KRONAUER

Figure 1 | ***Ooceraea biroi* ants.** Snir *et al.*[2] report the discovery that nutritious moulting fluid secreted by pupae (light brown individuals) is ingested by adult ants and larvae (white individuals). The adults place larvae on the pupae, which enables the larvae to feed on these pupal secretions.

Animal behaviour

Ant pupae produce 'milk' that adults feed to larvae

Patrizia d'Ettorre & Kazuki Tsuji

Parental-care behaviours include mammalian lactation to provide milk for offspring. The discovery that adult ants harvest nutritious fluid from pupae and give larvae this fluid reveals social feeding that aids colony success. **See p.488**

Reproduction is costly, and typically entails evolutionary conflicts between parents and offspring, such as in the relative investment of resources[1]. However, cooperation between family members is also common in highly social animals. On page 488, Snir *et al.*[2] report their use of a series of carefully designed experiments that reveal a previously undocumented role for pupae in the social dynamics of ant colonies.

Ants undergo complete metamorphosis during their life cycle. They start from an egg that hatches into a larva, and this larva becomes an adult after passing through an immobile pupal stage during which a profound transformation of the body takes place. Depending on the species, pupae might or might not spin a protective cocoon around themselves. This differs from what happens in other social insects, such as some bee and wasp species, in which larvae go through this transformational stage inside a protective cell built by nest-mate worker insects.

At each major developmental stage in the progression to adulthood, insects moult, shedding the old external cuticle that protects them and producing a new one. A protective moulting fluid is secreted that fills the space between the old and new cuticle. Snir *et al.* show that, just before developing into a fully grown adult, the ant pupa secretes a moulting fluid analogous to 'milk', in that it is used to nourish the young (in this case, larvae), as well as other colony members (adults). The authors used coloured dye to track this fluid transfer from pupae to adults or to larvae, and observed associated behaviours such as adults placing larvae on pupae (Fig. 1).

This fluid is probably a specially generated form of the moulting fluid, and protein analysis suggests that it has high nutritional value, although its exact function needs to be clarified. In other insects, moulting fluid is instead reabsorbed by the pupa itself and recycled for the insect's own use. However, Snir and colleagues reveal that, for ants, the fluid provides shared nutrition, and is distributed to other group members to optimize colony growth, particularly larval development.

The authors report that this fluid enhances colony fitness as assessed by examination of larval growth. But the secretion, like mammalian milk, is costly for the secretor. If the ant fluid is not collected quickly by nest-mate workers, the pupa can become susceptible to fungal infection and die.

A contribution of juveniles to their society is known for many species, including juvenile birds and the sterile workers of naked mole rats[3]. The latter is a representative of what are called eusocial animals. Eusociality (a word with a root that includes the Greek *eu*, meaning good) is characterized by division of labour between reproductive individuals and non-reproductive workers that care for the young; high levels of cooperation; and low levels of conflict among members of the same social unit. The almost 15,000 known species of ant are all eusocial, and ants have evolved one of the most advanced forms of insect social organization and cooperation.

Ant juveniles' contributions to societal requirements have been identified previously. For instance, the larvae of some species secrete silk, which is used to build the nest[4], and eggs and larvae spread the queen's pheromone molecules to colony members[5]. However, pupae, motionless and often enclosed in their cocoon, have been considered comparatively useless. Snir and colleagues' research shatters this assumption and greatly advances our knowledge about the role of the brood (non-adult ants) in ant social dynamics.

It is surprising that, in the history of modern ant science, a century after pioneering studies of ant social behaviour by William Morton Wheeler, ant researchers have observed these societies and yet failed to notice the existence of the phenomenon reported by Snir and colleagues. Wheeler and other scientists of that era focused on mouth-to-mouth or anus-to-mouth nutrition sharing, which is common in, but not restricted to, social insects, and which was termed trophallaxis in 1918 by Wheeler himself[6] (from the Greek *tropho*- and -*allaxis*, meaning exchange of nourishment). Wheeler and his contemporaries thought that the interdependence of nutrition between group members is key to understanding the evolution of social life, and that nutrition circulates through an insect society just as blood circulates in the body and money moves around human societies.

This nutrition theory fell out of favour in the late twentieth century, when explanations of social evolution in ants and other social insects, as provided through the lens of population genetics, grabbed the limelight[7]. However, the nutrition theory is regaining prominence this century, because it might offer a complementary explanation[8]. Advances in modern technologies, such as protein analysis, are helping to clarify the mechanistic function of complex behaviours. We now know that, during trophallaxis, ants exchange not only nutrients, but also a variety of bioactive substances that are related, for instance, to caste differentiation (such as whether an ant becomes a queen or a worker), immune defence and maintenance of gut microorganisms[9]. Trophallaxis also has a key role in the recognition of group identity through the homogenization of colony odour[10].

Snir *et al*. demonstrate that the pupal fluid secreted by motionless pupae of five species, belonging to the five major ant subfamilies, has a social function. When this role evolved is not known. The authors found that honeybees, another highly social lineage, do not show this behaviour. Pupae in honeybee and wasp societies are typically enclosed in individual hard cells, whereas ant pupae are kept in brood piles that are moved around the nest by the workers. This might be a crucial difference, suggesting an idiosyncratic role for the nutritional pupal fluid in the evolutionary trajectory of ant societies, and highlighting the importance of shared nutrition in social evolution. Just as nutrients circulate in ant societies, ideas about the evolution of insect societies can come full circle.

Patrizia d'Ettorre is at the Laboratory of Experimental and Comparative Ethology, UR4443, University Sorbonne Paris Nord, Villetaneuse 93430, France, and at Institut Universitaire de France, Paris. **Kazuki Tsuji** is in the Department of Subtropical Agro-Environmental Sciences, Faculty of Agriculture, University of the Ryukyus, Okinawa 903-0213, Japan, and at the United Graduate School of Agricultural Sciences, Kagoshima University, Japan.
e-mails: d-ettorre@univ-paris13.fr; tsujik@agr.u-ryukyu.ac.jp

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Astronomy

Loops bring news from the Galactic black hole

Anna Ciurlo & Mark R. Morris

Analysis of radio emission from matter near the Milky Way's central black hole sheds light on this previously unobservable region, revealing that the local magnetic field is carried around in complete loops by the matter orbiting the centre.

The Milky Way, like most galaxies, harbours a supermassive black hole at its centre: the formidable Sagittarius A*, which has a mass that is four million times that of the Sun. The activity of central black holes depends on the rate at which they accrete material to fuel them. When this matter approaches the event horizon, the boundary beyond which it can no longer escape the black hole's gravitational pull, the characteristics of the inwards migration can reveal certain properties of the black hole, such as the rate and orientation of its spin. Writing in *Astronomy & Astrophysics*, Wielgus *et al*.[1] report an analysis of emission from Sagittarius A* that they interpret as the signature of a 'hot spot' orbiting the black hole at a radius only five times that of its event horizon — offering the potential for probing the innermost region of the accretion flow.

The matter accreted by Sagittarius A* comes mostly from stellar winds, which are produced by young massive stars in close orbit around the black hole[2–4]. However, less than one-thousandth of the material that these winds feed into the accretion flow actually reaches the event horizon. The rest gets ejected by the tremendous amount of thermal, kinetic and magnetic energy that is generated as matter