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Editorial

An introduction to the special column on animal social networks

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The use of social network analysis to examine the behavior of social animals has grown rapidly in the past decade. Highly accessible books introducing network analysis techniques to the animal behavior research community (Croft et al., 2008; Whitehead, 2008) provide a gateway to the field. Furthermore, periodical reviews outlining the progress of the field and introducing both new biological questions and new analysis techniques (Krause et al., 2007; Wey et al., 2008; Sih et al., 2009; Croft et al., 2011; Blonder et al., 2012; McDonald and Shizuka, 2013; Pinter-Wollman et al., 2014) fertilize the growth of the use of social network analysis to study animal social behavior.

This special column on animal social networks features papers that present methodological developments as well as new empirical examples of how social network analysis can be used to uncover insights about the organization of animal groups. The papers presented here range both in taxa and biological questions providing a diverse overview of current research on animal social networks. Three main themes that harness network theory to advance our understanding of social behavior emerge in this special column: (1) the first three papers (Dey et al., 2015; Hobson et al., 2015; and Beisner et al., 2015) compare networks over time and across biological situations to understand how social relations in a certain situation or at a particular life stage impact relations in a different situation or time; (2) the next three papers (Inghilesi et al., 2015; Pinter-Wollman, 2015; and Franz et al., 2015) discuss the impact of individual variation in behavior on the function of social groups; and (3) the last paper (Greening et al., 2015) provides a new method for examining the emergence of social processes from interactions among group members.

The ability to compare among networks is fundamental for uncovering the ultimate consequences of social behavior. For example, comparing among social networks of different species can elucidate the environmental pressures that result in various social structures (Sundaresan et al., 2007; Kasper and Voelkl 2009; de Silva and Wittemyer, 2012; Pinter-Wollman et al., 2014). Furthermore, it is often the case that more than one type of network is observed for a particular social group, for example a social group may have a grooming network which is different from an aggression network (Flack et al., 2006). Understanding how interaction networks that represent different situations relate to one another may shed light on emergent properties of the group such as its social stability. However, there is only little theory on how to compare social networks, and methods of data collection can have great implications on the reliability of such comparisons (Castles et al., 2014).

In this special column, three papers use various statistical methods to compare networks that represent different social situations. Dey et al. (2015) examine whether dominance networks of cichlid fish change overtime as groups move through different life history stages. They employ exponential random graph modeling (ERGM) to predict the presence and strength of ties within each network based on various variables such as sex and body size. They then compare these model predictions between networks that represent interactions in non-reproductive periods to those created during periods in which the group is engaged in parental care. Similarly, Hobson et al. (2015) use a multiple regression quadratic assignment procedure (MRQAP) to examine how the ties of weighted networks of monk parakeets can be predicted by continuous variables in both aggressive and affiliative situations. Both these papers produce remarkable visualizations that facilitate the comparison among networks and the examination of how network structure relates to node attributes. Besiener et al. (2015) utilize a newly developed joint modeling approach (Chan et al., 2013) to examine the dependencies between the directed and binary interaction patterns of aggression and status signaling of rhesus macaques, comparing them between socially stable and socially unstable groups. This work combines the comparison between networks describing different social situations with the comparison of networks constructed during different time points.

Animal social networks are produced by individuals that vary in their behavior and in their probability to interact with one another, thus influencing both the structure and function of the social networks (Pinter-Wollman et al., 2011). Inghilesi et al. (2015) harness this individual variation to inform the management of a pest species, the red palm weevil. Traditional methods for irradiating pest insects include the introduction of sterile males into a population. Inghilesi et al. (2015) point out that the specific interactions among individuals may greatly impact the expected population dynamics that are the basis for these irradiation methods. They show that the reproductive network of the pest weevil is highly non-uniform, and that a few are males responsible for most of the matings in the population. Thus, targeting these particular individuals might improve the management of this pest species. These findings raise an important question about whether individual variation in interaction patterns is persistent over time. Pinter-Wollman (2015) addresses the link between persistent individual variation and social network structure. By developing a spatially-explicit agent-based model, inspired by the behavior of harvester ants, Pinter-Wollman (2015) shows that as behavioral persistence increases, the distribution of interactions among individuals in a group becomes less uniform. Finally, behavioral variation among individuals in one context, such as mating networks may influence other types of social networks. To examine potential carry-over across situations, Franz et al. (2015) examine how natural removals of alpha and beta males from a baboon troop influence the structure of female grooming networks.

Although a distinction may be made between processes that shape social networks and processes that flow on existing networks, there are intricate feedbacks between the two types of processes (Sih and Wey, 2014). Social network analysis can elucidate many of these dynamics; however, other analysis methods may further facilitate the examination of these complex processes. In the last paper of this column, Greening et al. (2015) present a modeling framework that is based on simplicial sets, a concept from algebraic topology. This framework provides an exciting new way to both visually and analytically examine the propagation of information in dynamic social groups. One particular advantage of this approach over traditional network analysis is that it can depict simultaneous interactions among more than two individuals, for example as happens when an animal produces an alarm call and many individuals receive the signal simultaneously. Traditional network analysis cannot distinguish between a signal that is simultaneously received by many individuals and many dyadic communication events. The novel use of simplicial sets in the context of information propagation in a social group over time, suggested by Greening et al. (2015), has the potential to transform our understanding of processes that emerge from the interactions among animals that live in social groups.

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