Detection of aggregative behaviour in binary choice experiments (Détection des comportements agrégatifs dans les dispositifs à choix binaire)

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In agronomy, the ethological study of invertebrates is of primary interest for both pest and auxiliary species, as a step in the research of methods for either controlling or favouring them. Social behaviour is one of the first aspect studied in this context, because it leads to very different strategies for the management of the species. Social patterns can be characterized as neutral, aggregative or territorial. Aggregative behaviour is defined as a natural tendency for individuals to cluster in space into groups of varying sizes, as opposed to territorial behaviour which leads to maximal dispersion of individuals, the neutral pattern corresponding to a completely random spatial distribution, without any inter individual interaction.

Social pattern can be detected in "binary choice experiments". In such experiments, individuals are introduced in a closed area containing two identical target zones, which are in some way attractive for the studied species, surrounded by a neutral area. After a pre established delay, the number of individuals having reached each target zone is counted and the whole process is repeated, each time with different individuals. The number of individuals in each target zone can then be modelled to test hypothesis about the type of social behaviour showed by the species in the context of the experiment.

If the social behaviour is neutral, the individual choices are independent and the number of individuals in one target zone can be modelled by a binomial distribution, given the assumption that the individual probability of the choices remains constant during the experiment. Any lack of fit of the observed numbers on this theoretical distribution can be interpreted as the results of either a territorial or an aggregative behaviour, depending the alternative pattern shown. With a territorial behaviour, individuals tend to choose the least crowded target zone, leading to a more uniform pattern than random, while individuals of an aggregative species will follow the group, resulting in very unbalanced distributions between the targets.

Analysis of these experiments to detect the type of social behaviour can be conducted through a goodness-of-fit test of the observed counts in the target zones on a binomial theoretical distribution. But observed data present specific characteristics that make the traditional adjustment tests (e.g. Chi-square GOF test) fail. Even if the total number of individuals introduced in the experimental area remains constant between replicates, the number of individuals reaching both target zones varies, as some individuals can be in the neutral area at the time of the observation. Each replicate has its own reference distribution, as the number of trials of the theoretical binomial distributions differs. The real null hypothesis is that the number

of individuals in one target zone follows a family of binomial distribution of parameters (n_i, p), n_i being the sum of the counts in both target zones for replicate *i*.

We show that the use of generalized linear models (GLMs) can circumvent these pitfalls and deliver a reliable diagnosis on the social behaviour of the studied invertebrates. The strength of this behaviour can then be evaluated through the use of common correlation models.

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