

# Preface

## **Social Recognition in Invertebrates: An Introduction for the Readers**

Social recognition is regarded as a key element in life of many organisms, where it can play an essential role in the structure and stability of a number of behavioural networks, such as dominance hierarchies, territorial defence, competitive aggression, pair bonds, mate selection, and kin favouritism. The skill for sophisticated and flexible recognition—as for cognitive abilities—has been known for a very long time in vertebrates, particularly in mammals, who are the most closely related to humans and from which there is an expectation to provide some insights for human evolution, being their behaviour easily recognized. However, as evidenced by the growing number of studies and reports, there is an increasing scientific interest in the occurrence and properties of this ability in invertebrates where, however, it may not be so easily and clearly identified. The possible presence of individual recognition as well as the communication media and cues involved in social recognition is the prevalent topic of recent studies, indicating that invertebrates can possess refined recognition systems and that, regardless of their taxonomic status, many animals show sophisticated recognition abilities. The present book offers a compendium of the most recent advances of social recognition in invertebrates, dealing with several behaviours involved in this recognition as cooperative behaviour, parental care, mating and aggressive relationships.

Among invertebrates, eusocial insects (ants, wasps, termites and bees) represent the most fascinating examples of cooperative group living and surely the most studied since 1950s for the evolution of cooperative behaviour and recognition systems. The incredible organization of a social insect colony is based on the ability to recognize and assign individual membership to a particular and relevant class, such as caste, dominance status and gender, and on the discrimination between nestmates from non-nestmates (reviewed in this volume by Bagnères and Hanus; Breed et al.; Cervo et al.). The ontogeny of this nestmate recognition is a still open and fascinating field: according to Signorotti et al. (this volume), wasps and bees

seem to learn the recognition cues required for template formation from their nest/comb odour, while ants learn principally from their nestmates. To avoid errors, the chemical referent template is updated during life, indicating a learning and plastic process, particularly useful for social parasites (Signorotti et al., this volume). Also burying beetles, due to their key features—the extended biparental care and the reproduction on dead vertebrates—evolved sophisticated recognition mechanisms, as recognition of a conspecific sex, the previous mating partner, the breeding partner, including its reproductive state, and the offspring (Steiger, this volume). In insects, social recognition is generally considered to be mediated by chemicals (Breed et al.; Signorotti et al.; Steiger, this volume), and numerous progresses have been achieved in understanding the identity, origin and production of these recognition cues in social hymenoptera. Nevertheless, recent discoveries indicated that visual signals can be relevant in some species of social wasps for several social behaviours (Cervo et al., this volume), and, even in termites, vibration-based signals complement the chemical cues (Bagnères and Hanus, this volume).

Besides, chemical cues are important in social communication of crustaceans, the other most studied taxon among invertebrates for social recognition. Historically, hermit crabs (Hazlett, this volume) and stomatopods (Vetter and Caldwell, this volume) awakened the interest of individual recognition in invertebrates, showing the first evidences of this ability in this group, considered for long time not suitable for this complex phenomenon. In hermit crabs, researchers found a reliable behavioural assay (the explorative behaviour of a test shell in the presence of different odours) that allowed the investigation of this aspect, particularly in dominance interactions (Hazlett, this volume). In stomatopods, the presence of individual recognition was clearly demonstrated both in territorial defence and in reproductive contexts, being mantis shrimps able to recognize also current mates and young, and to avoid previous mates (Vetter and Caldwell, this volume). Individual recognition has been proved in lobsters, but only suggested in crayfish, widely studied for their dominance relationships and mate recognition (Patullo and McMillan, this volume). All forms of social recognition and interspecific communication have been documented in shrimps, including recognition by mate, size, rank, kin and individual (Solomon et al., this volume). On the contrary, in amphipods, despite the great opportunities they have for their social life-style (dense aggregations, cohabitation with mating partners for long time periods, or in family groups), data on their social recognition are still scanty and up-to now limited to mate and female-offspring recognition (Berman et al., this volume). The matter of the multimodal communication in social recognition of crustaceans is emerging as an intriguing research topic: stomatopods have the most advanced vision in Crustacea and can use visual cues and auditory ones (“the click”) in aggressive interactions (Vetter and Caldwell, this volume). Crayfish can couple chemical and visual (and sometimes tactile) cues for the establishment of the hierarchies and the mate selection. However, the message conveyed by the single medium as well as the nature of chemical cues should be still clarified and identified (Patullo and McMillan, this volume).

New invertebrates are eliciting the scientific attention for social recognition, as the annelids, which behavioural interactions are mostly unexplored (Lorenzi et al.,

this volume). Many annelids use chemical and visual cues to locate partners and classify them according to mating status, body size, oocyte ripeness or belonging to same or a different population, but only few pheromones for mate recognition and gamete release have been identified.

Surprisingly, little experimental data exist on social (and individual) recognition among octopuses (not present in this volume), despite their unusual cognitive abilities due to the refined neuronal organization and vertebrate-like behavioural machinery they have. Based on the available knowledge, Boal (2006) concludes that there is no robust experimental evidence for assuming the capability of recognition of species, offspring or kin in cephalopods. However, some examples may provide insights for future studies. Among octopuses, individuals of *Octopus bimaculoides* are reported to be able to distinguish same- from opposite-sex on the odour as suggested by measures of changes in ventilation rate (Boal 2006). On the other hand, males of *Hapalochlaena lunulata* approach and attempt to mate either female or male conspecifics (Cheng and Caldwell 2000). Several species are known to use body patterning as defence systems (e.g. camouflage) but also as an intra-specific means of communication, mostly in the contexts of fight and mating (reviewed in Tricarico et al. 2014). Recently, Tricarico et al. (2011) showed that *Octopus vulgaris* can recognize conspecifics and can discriminate (and remember) familiar from unfamiliar individuals. This means that this species is able of, at least, class-level or binary individual recognition (Tibbetts and Dale 2007), an ability never found in other cephalopod species. The ability to recognize and remember ‘opponents’ and conspecifics may have an adaptive value for *O. vulgaris*, being the likely proximate mechanism regulating the “dear enemy phenomenon” and possibly explaining the scarcity of interactions between octopuses, as observed in the field. Despite the needs of more in depth studies needed to clarify whether *O. vulgaris* is able of true individual recognition, the study by Tricarico et al. (2011) is to the best of our knowledge the sole reporting conspecific social recognition in cephalopods (see Boal 2006 for a review). Finally, it is noteworthy to report that Anderson et al. (2010) noted that octopuses are also capable to recognize the caretakers in the laboratory. Recognition of humans among animals is a peculiar capability reported in a few species that, if confirmed in octopus, may further provide evidence of the peculiarity of these animals among other invertebrates. Concerning other molluscs, we have scanty information: the presence of species recognition was found in the slug *Limax grossui* (an individual follows the mucus trails of conspecifics: Cook 1977), while in *Aplysia fasciata* the ink seems to be used as a social cue during intraspecific interactions (Fiorito and Gherardi 1990).

## The Way Ahead

This volume shows that several studies have now been conducted on a wide range of invertebrates to investigate the different behaviours and aspects of their social recognition, leading to new discoveries and advances. Insects and crustaceans as

crayfish, hermit crabs, shrimps and stomatopods have proven themselves to be excellent model studies for this topic. Anellids and amphipods are emerging as promising taxa for future studies, while molluscs, particularly cephalopods, could reveal great surprises when coming out from the “grey area”. However, the number of considered invertebrates is still low, despite this group comprises the majority of animal species on the earth. The adopted experimental procedures appear to be sometimes limited for several reasons (no reliable behavioural assay or lack of certainty on observed behaviours and/or used communication media and signals), and should be thus improved. Today, individual recognition, ontogeny of nestmate recognition and social multimodal communication are the great expectations of social recognition in invertebrates. As stated by Gherardi and colleagues in 2012 “The way ahead may be long, but the promises of disclosing unexpected cognitive abilities in this extremely vast and diversified assemblage of animals make it worth being followed.”

Laura Aquiloni  
Elena Tricarico

## References

- Anderson RC, Mather JA, Monette MQ, Zimsen SRM (2010) Octopuses (*Enteroctopus dofleini*) recognize individual humans. *J Appl Anim Welfare Sci* 13:261–272
- Boal JG (2006) Social recognition: a top down view of Cephalopod behaviour. *Vie et Milieu* 56:69–79
- Cheng MW, Caldwell RL (2000) Sex identification and mating in the blue-ringed octopus, *Hapalochlaena lunulata*. *Anim Behav* 60(1):27–33
- Cook A (1977) Mucus trail following by the slug *Limax grossus* L. *Anim Behav* 25:744–781
- Fiorito G, Gherardi F (1990) Behavioural changes induced by ink in *Aplysia fasciata* (Mollusca: Gastropoda): evidence for a social signal role of inking. *Mar Behav Physiol* 17:129–135
- Gherardi F, Aquiloni L, Tricarico E (2012) Revisiting social recognition systems in invertebrates. *Anim Cogn* 15:745–762
- Tibbetts E, Dale J (2007) Individual recognition: it is good to be different. *Trends Ecol Evol* 22:529–537
- Tricarico E, Borrelli L, Gherardi F, Fiorito G (2011) I know my neighbour: individual recognition in *Octopus vulgaris*. *PlosOne* 6(4):e18710
- Tricarico E, Amodio P, Ponte G, Fiorito G (2014) Cognition and recognition in the cephalopod mollusc *Octopus vulgaris*: coordinating interaction with environment and conspecifics. In: Witzany G (ed) *Biocommunication of animals*. Springer, Berlin, pp 337–349

Social Recognition in Invertebrates

The Knowns and the Unknowns

Aquiloni, L.; Tricarico, E. (Eds.)

2015, XVI, 266 p. 34 illus., Hardcover

ISBN: 978-3-319-17598-0