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## The sociodiversity of biodiversity. Interdisciplinary communication and the example of honeybees

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### ABSTRACT

Environmental issues still tend to be studied and publicly debated from a natural science perspective. However, many ecological problems arise from the direct use of ecosystem resources or less obviously from the indirect consequences of social processes that need to be integrated into socio-ecological research. Using expertise from social and natural sciences in a dialogical way will highlight where shared concepts are necessary and what they could look like. This will emerge from the collaborative research process without the need to come up with a unifying theory in advance. This article promotes the concepts of ‘socioindicators’ and ‘sociodiversity’ – as counterparts to ‘bioindicators’ and ‘biodiversity’ – in order to allow for better communication between the social and natural sciences. The honeybees are a particularly good test case for this socio-ecological communication.

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### Introduction

When the United Nations Environmental Programme published a study about the worldwide threats to honeybees and other pollinators (UNEP 2010), they pointed to a close connection between social and ecological causes: “The study (...) underlines that multiple factors are at work, linked with the way humans are rapidly changing the conditions and the ground rules that support life on Earth” (UNEP 2011). Research on such links could have been expected as a consequence. Cooperation between the natural and social sciences would have explored the ‘multiple factors’, rapid social change and its purported connections to ecological developments. Many studies and even large international networks<sup>1</sup> were in fact initiated after the early news of a mass die-off of honeybees in the years 2006 and 2007 (van Engelsdorp et al. 2007), but the social sciences were not involved.

One of the reasons for this lies in established cultural and institutional patterns in politics, the sciences, and modern societies at large, with the divisions between scientific disciplines playing a particularly important role. The natural sciences have traditionally been concerned with phenomena of the bio-physical environment. They still dominate research about environmental issues ‘beyond’ society, and the majority of social scientists would not object to that. Such one-sidedness has of course been questioned in interdisciplinary or transdisciplinary socio-ecological and sustainability studies. But the above example shows the extent to which the entrenched patterns persist.<sup>2</sup>

Based on natural science diagnoses, public debates about ecological crises often communicate a reductionist conception of society. Typically, humankind in general – with human beings understood as a genus rather than social beings – is called upon to act. Having said that, it should be added that social scientists, for their part, often reproduce an oversimplified image of nature. For instance, they use ‘naturalization’ as a critical term for irrevocably determining social relations, implying that ‘nature’ is immutable<sup>3</sup> although we have known about evolution since Darwin. What’s missing is a better mutual acknowledgement of the diversity and dynamics of nature and society, and, in particular, social science perspectives on ecological issues.

Finding common ground for a shared language among the social and natural sciences is not easy. Below, I will reflect on promising terminological options with reference to the discussion of the honeybee decline. The first step would be a mutual acknowledgment of the complexity of the work carried out by natural and social scientists respectively. Then, I suggest using social science terms as counterparts to established terms in the natural sciences, namely ‘biodiversity’ and ‘bioindicators’. The similar connotations of ‘sociodiversity’ and ‘socioindicators’ can encourage the emergence of broadened perspectives. To make this plausible, the article stresses the social sciences dimension, but the discussion should ultimately promote interdisciplinary communication.

First of all, I discuss how honeybees are a suitable test case for socio-ecological communication because they are simultaneously natural and cultural beings.

They are therefore characterized as nature-culture intermediaries that can open our eyes to natural and sociocultural worlds. Secondly, I refer to theoretical options for communication between natural and social sciences, i.e. specific terminological strategies. However, the debates about a honeybee decline make me inclined to plea for another more pragmatic terminological approach, i.e. the use of ‘sociodiversity’ and ‘socioindicators’. In a similar way that bioindicators make the biodiversity of ecosystems ascertainable, socioindicators open up access to sociodiversity. This option needs to be connected with sustainability research. Also, ‘sociodiversity’ is not a completely new suggestion but has been made in similar ways in literature earlier. The final part of this paper provides more details and plausibility with regard to the honeybee example.

### Honeybees as nature-culture intermediaries

Beekeeping and honey hunting have been human practices for several thousands of years (Crane 1999) and are thus part of the shared cultural history of humans and honeybees. That is why these creatures – as natural beings – are cultural beings as well. But beyond acknowledging them as ‘both’ natural and cultural beings, how can honeybees be addressed in an appropriate way? We lack a specific terminology for these ‘hybrid’ beings. We tend to speak of them as domesticated animals, but this reduces the bees to the status of natural beings under human control (cf. Fenske 2017). The ecological crisis has challenged such notions of control because the manipulation of nature causes reactions that endanger human living conditions, revealing the close connection between biophysical and sociocultural developments. While honeybees can be described as both natural and cultural beings, they are normally referred to as *either* one *or* the other depending on the context. This is also the case in research. The bees are *either* objects of study in the natural sciences *or* their cultural meaning is studied in the humanities. Such a dichotomous division along disciplinary lines indicates that our perception of honeybees is entrenched in modern culture, something that has often been criticized in ecological debates (prominently by Latour 1993).

My own research (Lorenz and Stark 2015; Lorenz 2016) suggests that the perception that bees are not only natural beings is rooted in three things: the practice of beekeeping, bee pollination in agriculture ecosystems, and the role of honeybees in human narratives.

Honeybees may not seem to be as influenced by human manipulation as cattle, chicken or dogs. But beekeeping has had a significant impact throughout history and particularly in recent decades. This is especially clear with respect to breeding. The queen bees are selected in order to promote productive but gentle colonies. Furthermore, the process of tending

and managing honeybees in built hives – choosing the location for the hive, healthcare, hibernation support and honey harvesting – interferes with the bees’ ‘nature’. Yet it would be an exaggeration to speak of a unidirectional instrumentalization since total control is hardly conceivable (Nimmo 2015). To be successful, honeybee management has to be sensitive to the bees’ requirements with regard to living conditions. Harming the honeybees will have an adverse effect on the beekeepers’ earnings. All in all, beekeeping reveals the honeybees to be part of a practical culture.

In contrast to beekeeping, relatively little was known about the role of honeybees in agricultural pollination for a long time. The first biological insights into insect pollination date back to the middle of the eighteenth century, and this knowledge only started to be put to practical use in the pollination of orchards around 1900 (Crane 1999). Although commercial beekeeping has been practiced in many countries for decades, it took the strong decline in insect numbers (Buchmann and Nabhan 1996; Hallmann et al. 2017), and the mass die-offs of honeybees in particular (van Engelsdorp et al. 2007), to remind us that pollination in agriculture cannot be taken for granted. Agriculture depends on insect pollination to a significant degree. In this way, honeybees take part in social processes both directly and indirectly, e.g. in the economy, consumption, science and education. The recent increase in pollination markets with honeybees as the main pollinators is a case in point.<sup>4</sup>

Finally, honeybees populate human stories that let them become cultural beings. Even the bible talks about the land of milk and honey, and honeybees have always featured in cultural history. Humans use bee stories to communicate and reflect on their relationships to each other, their social life, and the world in general. A wealth of honeybee-related symbolism has emerged over several millennia, with certain topoi persisting but also varying over time. These recurring motifs draw on the honeybees themselves, the honey they produce, and the practice of beekeeping.

The social life of the bees is one of the most prevalent topoi. Since ancient times honeybee colonies have often symbolized the monarchist state. Bernard de Mandeville’s famous ‘The Fable of the Bees’ (1714) became a founding document of modern economic ideas. And in the early twentieth century, Ferdinand Gerstung (1919) saw the beehive as an inspiring example for socialism. One hundred years later the swarm behavior of honeybees was seen as a lesson in democracy (Seeley 2010). The industriousness of bees is another abiding motif (what makes it so important for agricultural pollination today), as is the bee sting, i.e. the bees’ defence capability. The latter is often used in fiction, but the concept of ‘killer bees’, i.e. the result of failed cross-breeding (Kastberger 2015), also draws on this narrative. The sweetness and purity of honey is

rich in historical symbolism, with the idea of purity playing a particularly important role in the recent conflicts over GMO in European agriculture (Lezaun 2011).

Given all their connections to nature and culture, honeybees can be characterized as intermediaries. While other animals or entities could also be classified as intermediaries to a greater or lesser degree, e.g. cows (greater) or frogs (lesser) (cf. Hüppauf 2011), countless other creatures do not fall into this category. Thus, the honeybee is one example of a 'hybrid being', but not an arbitrary one. They provide privileged access to the biophysical and social worlds; following<sup>5</sup> the bees allows us to gain insights into both.

### Terminologies – theoretical options, sustainability research and the uses of 'sociodiversity'

Different conceptual strategies have been proposed with a view to developing a shared language for cooperation between the natural and social sciences. One of these strategies advocates the use of the same abstract terms. Cybernetics and system theory developed such a super-theory approach to the biophysical, technological and social worlds and defined terms like 'system' or 'evolution' accordingly. This particular understanding of trans-disciplinarity (Schaller 2004) means that terms that are shared on a general level are specified in distinct fields. Luhmann (1984), for example, categorically differentiates between machine, organic, psychic and social systems, arguing that all of them need theoretical specifications but rely on the general system theory in the first place. While such approaches have had some theoretical success, their functionalist perspective has been criticized by proponents of other social theories as a reductionist understanding of sociality.

The actor-network theory follows another paradigm. It proposes a theoretical language that completely subverts the society/nature – or system/environment – divide and hence also the categorical divide between the social and natural sciences. This approach tries to break new ground by describing 'collectives' of human and non-human beings (Latour 2005) and it has been successful in many areas of the social sciences and humanities. However, it remains to be seen whether it can also make inroads into the established natural sciences.

We will likely have to live with the disciplinary divide for some time to come, but maybe we can make the best of it. The specialization of research has disadvantages but is also justified to a certain extent. Interdisciplinary work can only profit from different perspectives if they are well developed in their own right. A common language is necessary, but it should acknowledge the specific potential and achievements of the different contributors. A pragmatic way of dealing with this problem in my empirical field of research – i.e. honeybee decline,

pollination crisis and the related loss of biodiversity – may be to use terms that have similar connotations but mark differences at the same time. The suggestion here is to introduce the conceptual pairs biodiversity/sociodiversity and bioindicators/socioindicators, which rely on common connotations with respect to 'diversity' and 'indicators' but also differentiate using the prefixes bio-/socio-. They build a communicative bridge across the existing divide. Such a diplomatic approach could promote mutual understanding and greater acknowledgement of the perspectives of different experts. It would open the way for dialogues that might give rise to convergences and agreements without the need for a unifying theory at the outset. Thus, diplomatic dialogue and acknowledging cooperation (cf. Sennett 2012) between natural and social sciences may profit from the terminological intersections while focusing on intermediaries like honeybees.

Before the plausibility of using these terms is further discussed with respect to the honeybees two references need to be added. Firstly, progress in the methods of sustainability research allows relating this terminology to such developments. Bergmann et al. (2012) provide an overview of several options of integrating research strategies and perspectives. Particularly, the 'integration through interdisciplinary conceptual work' (Bergmann et al. 2012, pp. 57–64) that they offer can be regarded as one of the 'integration methods' the suggested terms could be assigned to.<sup>6</sup>

Secondly, 'sociodiversity' has been applied analogous to 'biodiversity' in literature before.<sup>7</sup> Granberg (2010) refers back to Neves (1995) and O'Hara (1995) for explicitly introducing 'sociodiversity'. Several differences need to be noted in comparison with this paper at hand: Granberg investigates agricultural biodiversity and more specifically the diversity of domesticated animals, i.e. the survival of a traditionally bred cattle; as a result, he expects that sociodiversity promotes biodiversity but he also acknowledges 'too restricted (data) for any final conclusions' (Granberg 2010, 191). Actually, Golluscio et al. (2010, p. 1337) find 'some degree of conflict between the preservation of bio- and sociodiversity' in their studies. For the moment, the interrelationships between bio- and sociodiversity should be regarded as a question worth for better exploration rather than an already completed answer. Such an answer is not the focus here and other aspects of Granberg's ideas are much more in line with the intentions of this article. This is particularly true for employing bio- and sociodiversity as a 'conceptual couple' (Granberg 2010, p. 183). In contrast to conceptions which rely on holistic ideas or at least stress the all-entangled web of life and try to conflate the terms in use<sup>8</sup> such a 'couple' insists on differences. Instead of aiming at unification the strategy here is to deal with the heterogeneousness by interdisciplinary cooperation. Therefore, Granberg recommends these terms to improve multi-disciplinary research, i.e. the involvement

of various expertises. Nevertheless, he observes a need for a conceptual connection. While he votes for ‘ecosystem services’ (cf. Bridgewater and Rotherham 2019, p. 297) the option in this article is to follow the honeybees as intermediaries.

### Socioindicators, sociodiversity, and the honeybees

Bioindicators like honeybees – or their products honey, pollen, and beeswax – provide information on the state of ecosystems. Studying these indicators can provide insights into the diversity of ecological interrelationships. But as nature-culture intermediaries, honeybees also flit through different sociocultural contexts. Thus in their interactions with social worlds, honeybees (cf. Lorenz and Stark 2015; Lorenz 2016) become indicators of social conditions and reveal the diversity of social actors, perspectives, practices and dynamics. This diversity can again be illustrated with reference to symbolism and narratives as well as beekeeping practices, pollination and agriculture.

Throughout history, the social life of honeybees has been an indicative metaphor of changing self-conceptions of the human social life. In previous centuries, the honeybee colony was seen as an analogy for the hierarchical order of the monarchy. Nowadays, the swarm has become a metaphor for democratic decision-making. However, recent narratives about honeybees have been dominated by the topos of their massive decline. Their disappearance, i.e. the ‘colony collapse disorder’ phenomenon (van Engelsdorp et al. 2007), has been publicly debated as a major ecological crisis with implications for the survival of humankind, i.e. the honeybees as a barometer of the endangered human-nature relationship. The campaign for a referendum to save the bees (*‘Rettet die Bienen’*) in Bavaria in early 2019 is one example of this.<sup>9</sup> In this case, however, the honeybees were a symbol of more encompassing concerns, including the protection of all pollinating insects, biodiversity in general, and a new direction for agriculture.

While the general discourse about the endangered honeybees and related ecological threats seems to include all people, humankind as a whole cannot be called upon to take action. Instead, the issue can raise awareness of the multitude of social perspectives and dynamics involved. Conflicts in particular highlight this diversity because they force the different actors to assert their positions.<sup>10</sup> The next paragraphs focus on the conflicts surrounding the pollination issue.<sup>11</sup>

- Different actors view the decline of honeybees from different perspectives. For farmers, agricultural administration, and industry, crop pollination is what’s at risk. And since there are substitutes for insect pollination, the safety of specific pollinators is not a major concern. For

beekeepers, their honeybees are endangered. For both farmers and beekeepers, their livelihood is at risk, while for consumers it is the food supply that is threatened. Nature conservation activists and the relevant agencies also see feral bees and other insects endangered in addition to ecosystem pollination.

- There is, furthermore, no consensus on the causes of the decline. Many scientists see *Varroa* mites as the biggest problem for the honeybees (cf. Steinhauer et al. 2018). However, mite-related losses are often due to non-treatment by beekeepers. This has implications for possible solutions. If *Varroa* is the main problem, then better forms of treatments are needed. If, however, non-treatment is the problem, new forms of treatment won’t help. Raising the awareness and qualifications of the beekeepers would make more sense in that case.
- The public debate is more focused on the use of pesticides as a threat to the bees. But for many beekeepers, too, the mites are not a major issue.<sup>12</sup> They claim that they can handle the mites with the available treatments. From their perspective, the bigger problem is pesticide use. The beekeepers depend here on regulations in agriculture and on farmers showing some consideration. Their problem is therefore less the mites and more the lack of opportunities to make decisions independently of farmers and policymakers. The purpose of social science research is not to decide who is right or wrong but to study the conflicts or cooperation resulting from such socially diverse positions. The different perspectives follow their own logic and evaluations of the situation. The entomologists who consider *Varroa* to be the biggest problem continue to look for new treatments. The beekeepers, for their part, try to influence agricultural practice. In the process, they may attempt to collaborate with local farmers and become involved in political protests to increase their influence.

A social science approach explores the social interdependencies of beekeeping practices and the use of pesticides. It looks not only at the farmer who uses pesticides but also at agriculture practices, the dynamics of technological development, patterns of profit-seeking or consumption, as well as the political interests and public debates in society. Many ecological problems arise not from the direct use of ecosystem resources but *from the indirect consequences of social processes* that need to be integrated into socio-ecological research.

### Conclusion

My vote to promote the terms ‘socioindicators’ and ‘sociodiversity’ is presented here for further discussion. This proposal has grown out of empirical

research on honeybee decline and the pollination crisis. However, on this limited basis – and in accordance with the above-mentioned use of ‘sociodiversity’ in literature – it appears to be a reasonable way to connect social science perspectives to research in the natural sciences. Accepting the diversity of social positions, perspectives, and dynamics in ‘the way humans are rapidly changing the conditions and the ground rules that support life on Earth’ (UNEP 2011; see above, [Introduction](#)) is a complex task that calls for collaboration between the natural and social sciences.

While it seeks to encourage collaboration, the proposal does accept the division of the natural and social sciences to some extent with the implication that the division of the empirical phenomenon of the ‘honeybees’ should be acknowledged. For some socio-ecological researchers this may be too high a price to pay. The justification is pragmatic: natural and social science perspectives provide their insights on that established basis. Using expertise from both areas in a dialogical way will highlight where shared concepts are necessary and what they could look like. This will emerge from the collaborative research process without the need to come up with a unifying theory in advance. Dialogue and acknowledging cooperation are necessary in the first place.

## Notes

1. See the activities of COLOSS (Prevention of honey bee COlony LOSSes, <https://coloss.org>), a research consortium that was initially funded by the EU and subsequently developed into an association that continues this work.
2. For other examples, see Bennett et al. (2017) on conservation, Jetzkowitz et al. (2017) on the biodiversity debates, and Overland and Sovacool (2020) on the funding of climate change research.
3. See the polemics on that by Latour (2005, p. 255).
4. In the orchards of the Altes Land (Old Country) near Hamburg, Germany, the price of honeybee colonies for pollination has quadrupled over the last twenty years.
5. In terms of methods, follow strategies are common in ethnography and also recommended in the actor-network theory – in particular, the follow-the-actors strategy (cf. Latour 2005).
6. Although the honeybees cannot really be referred to as ‘objects’ or ‘artifacts’ the ideas of what is called integration through artifacts and boundary objects (Bergmann et al. 2012, p. 105–112) can be helpful for thinking about integration in this field, too.
7. It should be noted that ‘socio-/indicator’ is a common term in the social sciences, and in that way of use (mostly quantitative) it is also applied in sustainability assessments. But this is quite different to the specific application of a parallel term to ‘bioindicator’ for honeybees as it is introduced in more detail in the next section.
8. This is often the case in ‘socio-ecological’ research. For investigating diversity the conception of ‘biocultural

diversity’ may provide an example (cf. Maffi and Dilts 2014; Bridgewater and Rotherham 2019).

9. Other examples are the novels by Coupland (2009) and Lunde (2017).
10. This is also a methodological approach recommended by Latour (2005).
11. On the interplay of actors in the urban beekeeping boom, see Lorenz and Stark (2015).
12. For similar findings and debates in the US, see Suryanarayanan and Kleinman (2013).

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## References

- Bennett NJ, Roth R, Klain SC, Chan KMA, Clark DA, Cullman G, Epstein G, Nelson MP, Stedman R, Teel TL, et al. 2017. Mainstreaming the social sciences in conservation. *Conserv Biol.* 31(1):56–66. doi:10.1111/cobi.12788.
- Bergmann M, Jahn T, Knobloch T, Krohn W, Pohl C, Schramm E. 2012. Methods for transdisciplinary research: a primer for practice. Frankfurt a.M: Campus.
- Bridgewater P, Rotherham ID. 2019. A critical perspective on the concept of biocultural diversity and its emerging role in nature and heritage conservation. *People Nat.* 1:291–304. doi:10.1002/pan3.10040.
- Buchmann SL, Nabhan GP. 1996. The forgotten pollinators. Washington D.C: Island Press.
- Coupland D. 2009. *Generation A*. Toronto: Random House Canada.
- Crane E. 1999. *The world history of beekeeping and honey hunting*. London: Routledge.
- de Mandeville B. 1714. *The fable of the bees: or, private vices, publick benefits*. Roberts: London.
- Fenske M. 2017. Narrating the swarm. *Changing metanarratives in times of crisis. Narrative Cult.* 4(2):130–152.
- Gerstung F. 1919. *Der Sozialismus im Bienenstaat*. Berlin: Pfenningstorf.
- Golluscio RA, Román ME, Cesa A, Rodano D, Bottaro H, Nieto MI, Betelú A, Golluscio LA. 2010. Aboriginal settlements of arid Patagonia: preserving bio- or socio-diversity? The case of the Mapuche pastoral Cushamen Reserve. *J Arid Environ.* 74:1329–1339. doi:10.1016/j.jaridenv.2010.05.012.
- Granberg L. 2010. The interrelationship of sociodiversity and biodiversity: experiences from a post-Soviet Siberian village. In: Stammler F, Takakura H, editors. *Good to eat, good to live with: nomads and animals in Northern Eurasia and Africa*. Sendai: Center for Northeast Asian Studies, Tohoku University; p. 179–193. (Northeast Asian study series 11).

- Hallmann CA, Sorg M, Jongejans E, Siepel H, Hofland N, Schwan H, Stenmans W, Müller A, Sumser H, Hörren T. 2017. More than 75 percent decline over 27 years in total flying insect biomass in protected areas. *PLoS ONE*. 12 (10):e0185809. doi:10.1371/journal.pone.0185809.
- Hüppauf B. 2011. Vom Frosch. Eine Kulturgeschichte zwischen Tierphilosophie und Ökologie. Bielefeld: Transcript.
- Jetzkowitz J, van Koppen C, Lidskog R, Ott K, Voget-Kleschin L, Wong CML. 2017. The significance of meaning in and the meaning of biodiversity research: why IPBES needs the social sciences and humanities. *Innovation*. 31(sup1):38–60. doi:10.1080/13511610.2017.1348933.
- Kastberger G. 2015. Die Afrikanisierte Honigbiene. In: Lorenz S, Stark K, editors. *Menschen und Bienen. Ein nachhaltiges Miteinander in Gefahr*. Munich: Oekom; p. 105–116.
- Latour B. 1993. *We have never been modern*. New York: Harvester Wheatsheaf.
- Latour B. 2005. *Reassembling the social. An introduction to actor-network-theory*. Oxford: Oxford University Press.
- Lezaun J. 2011. Bees, beekeepers, and bureaucrats: parasitism and the politics of transgenic life. *Environ Plann D*. 29:738–756. doi:10.1068/d0510.
- Lorenz S. 2016. The endangerment of bees and new developments in beekeeping: A social science perspective using the example of Germany. *Int J Environ Stud*. 73 (6):988–1005. doi:10.1080/00207233.2016.1220703.
- Lorenz S, Stark K. 2015. Saving the honeybees in Berlin? A case study of the urban beekeeping boom. *Environ Sociol*. 1 (2):116–126. doi:10.1080/23251042.2015.1008383.
- Luhmann N. 1984. *Soziale Systeme. Grundriß einer allgemeinen Theorie*. Frankfurt M.: Suhrkamp.
- Lunde M. 2017. *The history of bees. A novel*. New York: Touchstone.
- Maffi L, Dilts O, editors. 2014. *An introduction to biocultural diversity. Biocultural Diversity Toolkit 1-5*. [accessed 2020 Oct 5]. <https://terralingua.org/shop/biocultural-diversity-toolkit>.
- Neves W. 1995. Sociodiversity and biodiversity, two sides of the same equation. In: Clüsener-Godt M, Sachs I, editors. *Brazilian perspectives on sustainable development of the Amazon Region*. Vol. 15. Paris: UNESCO; p. 91–103. (Man and the Biosphere Series).
- Nimmo R. 2015. The bio-politics of bees: industrial farming and colony collapse disorder *Humanimalia. J Human/Animal Interface Stud*. 6(2):1–20.
- O'Hara SU. 1995. Valuing sociodiversity. *Int J Soc Econ*. 22 (5):31–49. doi:10.1108/03068299510147915.
- Overland I, Sovacool BK. 2020. The misallocation of climate research funding. *Energy Res Soc Sci*. 62:1–13, 101349. doi:10.1016/j.erss.2019.101349.
- Schaller F. 2004. Erkundungen zum Transdisziplinaritätsbegriff. In: Brand F, Schaller F, Völker H, editors. *Transdisziplinarität. Bestandsaufnahme und Perspektiven*. Göttingen: Uni-Verlag Göttingen; p. 33–45.
- Seeley TD. 2010. *Honeybee democracy*. Princeton (Oxford): Princeton University Press.
- Sennett R. 2012. *Together. The rituals, pleasures and politics of cooperation*. London: Allen Lane.
- Steinhauer N, Kulhanek K, Antúnez K, Human H, Chantawannakul P, Chauzat M-P, vanEngelsdorp D. 2018. Drivers of colony losses. *Curr Opin Insect Sci*. 26:142–148. doi:10.1016/j.cois.2018.02.004.
- Suryanarayanan S, Kleinman DL. 2013. Be(e)coming experts: the controversy over insecticides in the honey bee colony collapse disorder. *Soc Stud Sci*. 43 (2):215–240. doi:10.1177/0306312712466186.
- UNEP. 2010. *Global honey bee colony disorder and other threats to insect pollinators*. [accessed 2019 Aug 5]. [www.unenvironment.org/resources/report/unep-emerging-issues-global-honey-bee-colony-disorder-and-other-threats-insect](http://www.unenvironment.org/resources/report/unep-emerging-issues-global-honey-bee-colony-disorder-and-other-threats-insect).
- UNEP. 2011. *Bees under bombardment. Report shows multiple factors behind pollinator losses*. [accessed 2019 Aug 5]. [www.mondialisations.org/php/public/art.php?id=34314&lan=EN](http://www.mondialisations.org/php/public/art.php?id=34314&lan=EN).
- van Engelsdorp D, Underwood R, Caron D, Hayes J. 2007. An estimate of managed colony losses in the winter of 2006–2007: A report commissioned by the apiary inspectors of America. *Am Bee J*. 147:599–603.