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Toni Sims
https://orcid.org/0009-0002-7805-0254
New York University

Jeff Sebo
https://orcid.org/0000-0002-8997-3217
New York University

Ethical Oversight for Insect Research

Этический надзор
за исследованиями насекомых

Абстракт

В данной статье обосновывается необходимость этического надзора за исследованиями насекомых. Поскольку насекомые, вероятно, являются чувствующими существами, мы, как в случае с другими чувствующими животными, обязаны рассмотреть риски для их благополучия при принятии решений, которые могут на них повлиять. В статье также представлены высокоуровневые рекомендации по достижению этой цели. Помимо серьезного отношения к этому вопросу, исследователи могут разрабатывать методы оценки рисков для благополучия насекомых. Кроме того, возможно формирование правил и процедур принятия этически обоснованных решений, касающихся исследований насекомых. При этом, методы, правила и процедуры, применяемые в других видах исследований животных, могут быть адаптированы без необходимости их полного воспроизведения.

Ключевые слова: благополучие насекомых, благополучие животных, надзор за исследованиями

Ethical Oversight
for Insect Research

Abstract

In this article, we present a high-level argument for ethical oversight for insect research. There is a realistic possibility that insects are sentient, and when there is a realistic possibility that an animal is sentient, we have a responsibility to consider welfare risks for them when making decisions that affect them. We also present high-level recommendations for how to achieve this goal. In addition to taking the issue seriously in general, researchers can develop methods for assessing welfare risks for insects, and we can also develop policies and procedures for making ethical decisions about insect research; these methods, policies, and procedures can be adapted from other kinds of animal research without being identical to them.

Keywords: insect welfare, animal welfare, research oversight

Toni Sims, Jeff Sebo

Introduction: Insects Used in Research

Insects are the most common, but least protected, animals used in research. Researchers use billions of insects per year in scientific and medical research.[1] Fruit flies are among the most common insects used in research, but other insects, such as honey bees and beetles, are used as well.[2] Many insects used for research are killed during capture,[3] genetically or surgically modified,[4] exposed to existential threats,[5] or deprived of food, water, and other basic goods.[6] These research methods would, of course, raise clear ethical questions if applied to animals we understand as *sentient*, that is, to animals who we believe can have morally significant feelings like pain, fear, or distress.

However, while many researchers assume that insects are non-sentient, this assumption might not be accurate; any insects have surprisingly sophisticated capacities for perception,[7] learning and memory,[8] communication and

[1] Abraham Rowe, "The Scale of Direct Human Impact on Invertebrates," Rethink Priorities, September 2, 2020, https://rethinkpriorities.org/research-area/the-scale-of-direct-human-impact-on-invertebrates/.

[2] Masamitsu Yamaguchi and Hideki Yoshida, "Drosophila as a Model Organism," in *Drosophila Models for Human Diseases*, edited by Masamitsu Yamaguchi, 1076: 1–10 (Springer, 2018); Zbigniew Adamski et al., "Beetles as Model Organisms in Physiological, Biomedical and Environmental Studies – A Review," *Frontiers in Physiology* 10 (March 28, 2019), https://doi.org/10.3389/fphys.2019.00319.

[3] Ana Montero-Castaño et al., "Pursuing Best Practices for Minimizing Wild Bee Captures to Support Biological Research," *Conservation Science and Practice* 4, no. 7 (July 2022): e12734, https://doi.org/10.1111/csp2.12734.

[4] Nicole Elizabeth Gutzmann, "Making, Testing, and Debating Genetically Modified Insects – ProQuest" (North Carolina State University, 2021), https://www.proquest.com/openview/c4d31997504cfd8ed365abb6ef983466/1?pq-origsite=gscholar&cbl=18750&diss=y.

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[6] S. Rion and T. J. Kawecki, "Evolutionary Biology of Starvation Resistance: What We Have Learned from Drosophila," *Journal of Evolutionary Biology* 20, no. 5 (September 1, 2007): 1655–1664, https://doi.org/10.1111/j.1420-9101.2007.01405.x.

[7] A. Dafni et al., "Spatial Flower Parameters and Insect Spatial Vision," *Biological Reviews* 72, no. 2 (1997): 239–282, https://doi.org/10.1111/j.1469-185X.1997.tb00014.x; Mandyam V. Srinivasan, "Honey Bees as a Model for Vision, Perception, and Cognition," *Annual Review of Entomology* 55 (2010): 267–284, https://doi.org/10.1146/annurev.ento.010908.164537; Wen Wu et al., "Honeybees Can Discriminate between Monet and Picasso Paintings," *Journal of Comparative Physiology A. Neuroethology, Sensory, Neural, and Behavioral Physiology* 199, no. 1 (January 2013): 45–55, https://doi.org/10.1007/s00359-012-0767-5.

[8] Fabienne Dupuy et al., "Individual Olfactory Learning in *Camponotus* Ants," *Animal Behaviour* 72, no. 5 (November 1, 2006): 1081–1091, https://doi.org/10.1016/j.anbehav.2006.03.011; Martin Giurfa, "Behavioral and Neural Analysis of Associative Learning in the Honeybee: A Taste from the Magic Well," *Journal of Comparative Physiology A. Neuroethology, Sensory, Neural, and Behavioral Physiology* 193, no. 8 (August 2007): 801–824, https://doi.org/10.1007/s00359-007-0235-9.

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sociality,[9] and planning and problem solving.[10] Some also have the capacity to learn from one another and to work together to solve shared problems.[11] Honey bees and bumblebees even indicate awareness of their own cognitive abilities.[12]

In this article, we present a high-level argument for ethical oversight for insect research. There is a realistic possibility that insects are sentient, and when there is a realistic possibility that an animal is sentient, we have a responsibility to consider welfare risks for them when making decisions that affect them. We also present high-level recommendations for how to achieve this goal. In addition to taking the issue seriously in general, researchers can develop methods for assessing welfare risks for insects, and we can also develop policies and procedures for making ethical decisions about insect research; these methods, policies, and procedures can be adapted from other kinds of animal research without being identical to them.

Expanding Animal Research Regulations

In the United States, ethical oversight for the use of animals in research flows from multiple sources. At the federal level, the Animal Welfare Act requires animal research labs to register with the USDA and to establish a review board, known

[9] Reginald B. Cocroft and Rafael L. Rodríguez, "The Behavioral Ecology of Insect Vibrational Communication," *BioScience* 55, no. 4 (2005): 323, https://doi.org/10.1641/0006-3568(2005)055[0323:TBEOIV]2.0.CO;2; Eileen Crist, "Can an Insect Speak?: The Case of the Honeybee Dance Language," *Social Studies of Science* 34, no. 1 (February 2004): 7–43, https://doi.org/10.1177/0306312704040611; Berthold Hedwig, ed., *Insect Hearing and Acoustic Communication*, Vol. 1, Animal Signals and Communication (Berlin, Heidelberg: Springer, 2014), https://doi.org/10.1007/978-3-642-40462-7.

[10] E. Bonabeau et al., "Inspiration for Optimization from Social Insect Behaviour," *Nature* 406, no. 6791 (July 6, 2000): 39–42, https://doi.org/10.1038/35017500; Clint J. Perry et al., "The Frontiers of Insect Cognition," *Current Opinion in Behavioral Sciences* 16 (August 2017): 111–118, https://doi.org/10.1016/j.cobeha.2017.05.011.

[11] Walter M. Farina et al., "Social Learning of Floral Odours inside the Honeybee Hive," *Proceedings of the Royal Society B: Biological Sciences* 272, no. 1575 (September 22, 2005): 1923–1928, https://doi.org/10.1098/rspb.2005.3172; Martin Giurfa, "Social Learning in Insects: A Higher-Order Capacity?," *Frontiers in Behavioral Neuroscience* 6 (September 5, 2012), https://doi.org/10.3389/fnbeh.2012.00057; Ellouise Leadbeater and Lars Chittka, "Social Learning in Insects – From Miniature Brains to Consensus Building," *Current Biology* 17, no. 16 (August 2007): R703–R713, https://doi.org/10.1016/j.cub.2007.06.012; Olli J. Loukola et al., "Bumblebees Show Cognitive Flexibility by Improving on an Observed Complex Behavior," *Science* 355, no. 6327 (February 24, 2017): 833–836, https://doi.org/10.1126/science.aag2360.

[12] Clint J. Perry and Andrew B. Barron, "Honey Bees Selectively Avoid Difficult Choices," *Proceedings of the National Academy of Sciences* 110, no. 47 (November 19, 2013): 19155–19159, https://doi.org/10.1073/pnas.1314571110.

as Institutional Animal Care and Use Committees (IACUCs).[13] Each IACUC then reviews all animal research protocols, determining whether the proposed use of animals is necessary for achieving the proposed scientific result.[14] On a more local level, states and municipalities may also establish their own laws and regulations governing research facilities under their jurisdictions.[15]

Additionally, a nonprofit called AAALAC International administers a voluntary accreditation program for research facilities that comply with the *Guide for the Care and Use of Laboratory Animals* (the *Guide*), which provides suggestions that IACUCs "must," "should," and "may" follow. Over one thousand organizations globally are currently accredited, and to maintain their accreditation they must be reevaluated every three years.[16] The Public Health Service Policy on Humane Care and Use of Laboratory Animals (PHS Policy) provides federal standards to any facility receiving PHS funding as well.[17]

None of the existing laws, policies, and standards protect insects. In fact, most of them fail to protect other animals too, including vertebrates. For example, the Animal Welfare Act does not provide for the protection of many vertebrates, including birds and the most commonly used mammals in labs: rats and mice.[18] IACUCs, the *Guide*, and AAALAC also focus on vertebrates, neglecting insects and other invertebrates like cephalopod mollusks and decapod crustaceans.[19] The PHS Policy also protects all vertebrates used in research, but only if that research is funded by the PHS.[20]

However, there are both practical and moral reasons to establish oversight of insect research. One practical reason is that the public increasingly supports pro-

[13] Andrew D. Cardon et al., "The Animal Welfare Act: From Enactment to Enforcement," *Journal of the American Association for Laboratory Animal Science: JAALAS* 51, no. 3 (May 2012): 301.

[14] Office of Laboratory Animal Welfare, "The Institutional Animal Care and Use Committee," National Institutes of Health, n.d., https://nihodoercomm.az1.qualtrics.com/jfe/form/SV_4NqpUA4fqs9cagZ?Q_CHL=si&Q_CanScreenCapture=1.

[15] Emilio A. Herrera, "Regulation of Animal Research," in *Handbook of Bioethical Decisions. Volume I: Decisions at the Bench*, eds. Erick Valdés and Juan Alberto Lecaros (Cham: Springer International Publishing, 2023), 703–720, https://doi.org/10.1007/978-3-031-29451-8_37.

[16] "What Is AAALAC Accreditation?," AAALAC, n.d., https://www.aaalac.org/accreditation-program/what-is-aaalac-accreditation/.

[17] "PHS Policy on Humane Care and Use of Laboratory Animals," 2015, https://nihodoercomm.az1.qualtrics.com/jfe/form/SV_4NqpUA4fqs9cagZ?Q_CHL=si&Q_CanScreenCapture=1.

[18] For the exclusion of rats and mice, see Cardon et al., 2012. For the common use of rodents in labs, see Grimm, 2021.

[19] Office of Laboratory Animal Welfare, "The Institutional Animal Care and Use Committee," National Institutes of Health, n.d., https://nihodoercomm.az1.qualtrics.com/jfe/form/SV_4NqpUA4fqs9cagZ?Q_CHL=si&Q_CanScreenCapture=1; *Guide for the Care and Use of Laboratory Animals: Eighth Edition* (Washington, DC: National Academies Press, 2010), https://doi.org/10.17226/12910.

[20] "PHS Policy on Humane Care and Use of Laboratory Animals," 2015, https://nihodoercomm.az1.qualtrics.com/jfe/form/SV_4NqpUA4fqs9cagZ?Q_CHL=si&Q_CanScreenCapture=1.

tection for insects and other invertebrates. For example, a 2022 study suggests that the public supports oversight for invertebrate research is at about two-thirds of the level currently provided for vertebrates.[21] And in general, insufficient ethical oversight risks undermining the public's trust in – and support of – scientific research.[22] Drinkwater et al. (2019) provide several historical examples of misalignments between researcher and public values, and such cases can result in outrage, protests, and even violence.

Our focus, however, is on the *moral* reasons to establish oversight of insect research. Insects merit protection for their own sakes, and not just for the sake of research or public trust in science. Our argument for insect welfare protections is based on two primary claims. First, there is a realistic chance that insects are sentient, that is, capable of morally significant feelings like pain, fear, and distress. Second, when there is a realistic chance that animals are sentient, we have a responsibility to consider welfare risks for these animals when making decisions that affect them. Thus, we have a moral responsibility to consider welfare risks for insects when making decisions that affect them, including and especially in research.

Of course, one could argue that there are also practical and moral reasons *not* to establish oversight of insect research. For example, ethical oversight can be onerous; even when the research is ultimately approved, the process of approving it can take a lot of time and energy that could otherwise be spent on research itself. Additionally, ethical oversight can make mistakes, either approving studies that should be rejected or rejecting studies that should be approved. However, we will argue that if there is a realistic possibility that insects are sentient, ethical oversight is warranted despite these costs; at most, these costs should affect *how* ethical oversight is conducted, not *whether* ethical oversight is conducted at all.

There Is a Realistic Chance That Insects Are Sentient

There remains significant uncertainty about the likelihood of sentience in insects. This uncertainty has multiple general sources. Research on insect sentience is currently limited: Scientists have examined only a fraction of insect species for relevant

[21] Michael W. Brunt et al., "Invertebrate Research without Ethical or Regulatory Oversight Reduces Public Confidence and Trust," *Humanities and Social Sciences Communications* 9, no. 1 (August 1, 2022): 1–9, https://doi.org/10.1057/s41599-022-01272-8.

[22] Brunt et al., "Invertebrate Research"; Eleanor Drinkwater et al., "Keeping Invertebrate Research Ethical in a Landscape of Shifting Public Opinion," *Methods in Ecology and Evolution* 10, no. 8 (2019): 1265–1273, https://doi.org/10.1111/2041-210X.13208.

evidence,[23] and they tend to examine insects for evidence of some states, like pain, more than others, like pleasure.[24] Moreover, this research has established mixed results, supporting sentience in some respects but not in others. And of course, there might be other sources of uncertainty as well, including the general difficulty of studying other minds and well-known biases that limit our ability to make objective judgments about nonhuman animals such as insects.

Still, despite the uncertainty, many experts now agree that the current evidence supports at least a *realistic chance* that insects are sentient. For example, the New York Declaration on Animal Consciousness, released in 2024, holds that there is a realistic possibility of consciousness in all vertebrates and many invertebrates, including cephalopod mollusks, decapod crustaceans, and insects. The Declaration has since been signed by nearly 500 experts in science, philosophy, and law and policy from around the world (including both of the authors of the present article, one of whom was a lead organizer of this effort). And while consciousness and sentience are not identical, the evidence for sentience is comparably strong.

Jonathan Birch et al. helpfully provide a framework for evaluating sentience in nonhuman animals by listing eight indicators of sentience in nonhuman animals, four of which are neurobiological and four of which are cognitive behavioral.[25] Since the neurobiology of insects and other invertebrates is very different from the neurobiology of humans and other vertebrates (and since we must allow for the possibility that sentience is "multiply realizable," that is, realizable in different neurobiological structures that play similar cognitive and behavioral roles in the system), we take the four cognitive behavioral indicators to be especially important for assessing insect sentience. They are as follows:

(1) The insect can make motivational trade-offs, namely, they can weigh the risk of a negative experience against competing motivations.

Auguste Forel first discussed the relevance for motivational trade-offs for sentience with respect to ants.[26] He observed that ants can weigh the motivation to forage for

[23] One exception is that bumble bees appear to enjoy the activity of rolling balls even when no appetitive reward is ever associated with them (Galpayage Dona et al. 2022; for full references, see the bibliography). Such play-like behavior was also recently discovered in fruit flies (Triphan and Hueteroth, 2023), and appears to be linked to a positive affective state.

[24] Most insect research focuses on social insects like ants and honeybees, though there are likely millions of insect species on Earth. See Nigel E. Stork, "How Many Species of Insects and Other Terrestrial Arthropods Are There on Earth?," *Annual Review of Entomology* 63 (January 7, 2018): 31–45. https://doi.org/10.1146/annurev-ento-020117-043348.

[25] Jonathan Birch et al., "Review of the Evidence of Sentience in Cephalopod Molluscs and Decapod Crustaceans," *LSE Consulting. LSE Enterprise Ltd. The London School of Economics and Political Science* (January 1, 2021), https://www.wellbeingintlstudiesrepository.org/af_gen/2.

[26] Auguste Forel, *The Social Life of Ants*, 1902.

an out-of-sight food against the need to battle for colony defense. Such trade-offs indicate the capacity for sentience because they depend on *mental representations* of stimuli, rather than simply the stimuli themselves.

(2) The insect shows flexible self-protecting behavior, like wound-tending or grooming.

While few, if any, studies investigate self-protecting behavior in insects, insect researchers have reported anecdotally that some insects appear to tend their wounds during unrelated studies.[27] This behavior suggests that the insect is aware of the location where they experience pain and not merely reacting reflexively.[28]

(3) The insect learns to associate a noxious stimulus with a more neutral one.

For example, honey bees seem to associate previous attacks from spiders with their locations. A honey bee who has been recently attacked at a foraging site will head-butt another bee if the other bee signals that the site of the attack is an attractive feeding location.[29] This seems to indicate an awareness of danger even after the initial negative experience has passed.

(4) The insect seeks or shows a preference for analgesics or anesthetics when injured.

An insect can demonstrate such a preference for an analgesic in several ways. They can learn to self-administer the drug. The insect can spend more time in locations where they have received the drug. Or, they can choose to receive the drug over other benefits, like food. Thus far, very few studies investigate whether injured insects show a preference for anesthesia.

Matilda Gibbons et al. recently evaluated six orders of insects on all eight of Birch et al.'s indicators.[30] They found that Blattodea (e.g. cockroaches and termites) and flies display six of the eight indicators. Fly larvae and Hymenoptera (e.g. wasps, bees, and ants) display four. Lepidoptera (e.g. butterflies and moths), Orthoptera (e.g. grasshoppers and crickets, Blattodea larvae, fly larvae, and Lepidoptera larvae) display three. The rest of the insects evaluated display one or two. However, this

[27] Matilda Gibbons et al., "Chapter Three – Can Insects Feel Pain?" A Review of the Neural and Behavioural Evidence," in *Advances in Insect Physiology*, ed. Russell Jurenka, vol. 63 (Academic Press, 2022), 155–229, https://doi.org/10.1016/bs.aiip.2022.10.001.

[28] Robert W. Elwood, "Pain and Suffering in Invertebrates?," *ILAR Journal* 52, no. 2 (2011): 175–184, https://doi.org/10.1093/ilar.52.2.175.

[29] James C. Nieh, "A Negative Feedback Signal That Is Triggered by Peril Curbs Honey Bee Recruitment," *Current Biology* 20, no. 4 (February 23, 2010): 310–315, https://doi.org/10.1016/j.cub.2009.12.060.

[30] Gibbons et al., "Chapter Three – Can Insects Feel Pain?"

study found no strong evidence that any insect *fails* to display an indicator. In other words, those insects who display few indicators of sentience are not necessarily *non-sentient*; we simply lack sufficient evidence.[31]

A Realistic Chance of Sentience Is Enough for Ethical Oversight

While there is substantial disagreement about animal ethics, there is now general agreement that when an animal has the capacity for *welfare* – that is, when they have interests and, relatedly, the ability to be benefited or harmed – they merit moral consideration for their own sake in decisions that affect them. There is also general agreement that when an animal is sentient, they have the capacity for welfare in the relevant sense.[32] It follows that sentience is, if not necessary, then at least sufficient for moral consideration. For example, the *Guide* expresses a desire to "enhance animal well-being and minimize or eliminate pain and distress" for animals whose use in research has not yet been replaced.[33]

Recently, experts have started to take seriously the idea that we have moral responsibilities to animals in cases involving substantial uncertainty about sentience as well. For example, the New York Declaration on Animal Consciousness includes not only a scientific commitment but also a moral commitment. As noted above, the scientific commitment is that there is a realistic possibility of consciousness in all vertebrates and many invertebrates, including insects. And the moral commitment is that when there is a realistic possibility of consciousness in an animal, we have a responsibility to consider welfare risks for that animal when making decisions that affect them.[34]

This shifting understanding in the research community reflects a shifting understanding in law and policy. For example, Birch et al. released a report in 2021 applying this method to cephalopod mollusks and decapod crustaceans. The report

[31] Gibbons et al., "Chapter Three – Can Insects Feel Pain?"

[32] This is perhaps because pleasure and pain – which all and only sentient individuals experience – is increasingly considered a key component of welfare (Browning and Birch, 2022; for full references, see the bibliography). In recent decades, many expert opinions have shifted from understanding sentience as one necessary condition for welfare to the necessary and sufficient condition (Duncan, 2006). In particular, philosophers Singer (1979), DeGrazia (1996), and Varner (2012) have argued that sentience is necessary and sufficient for welfare.

[33] *Guide for the Care and Use of Laboratory Animals.*

[34] Kristin Andrews et al., "Background to the New York Declaration on Animal Consciousness," 2024, http://nydeclaration.com.

concluded that there is a realistic possibility that these animals are sentient, and it recommended that "cephalopod molluscs and decapod crustaceans be regarded as sentient animals for the purposes of UK animal welfare law."[35] To its credit, the UK government then expanded its animal welfare law accordingly, though it remains to be seen whether this expansion will lead to real policy change.[36]

Why do experts increasingly agree that we have moral responsibilities to animals in cases of uncertainty about sentience? The answer is that we have a responsibility to consider morally significant risks. For instance, if there is a realistic possibility that a research protocol will harm thousands of sentient animals, then researchers have a responsibility to consider this risk when deciding whether to proceed. And this kind of risk can arise in at least two ways: The researchers know that the animals are sentient but not whether the protocol will harm them, or the researchers know that the protocol will "damage" the animals but not whether the animals are sentient. Either way the result is the same: a morally significant welfare risk.

To be clear, to say that we have duties to insects is not to say that we have the same duties to them that we have to humans or other animals. Instead, it is only to say that we should take reasonable, proportionate steps to mitigate welfare risks for insects when making decisions that affect them. And assessments of which steps count as reasonable and proportionate can consider many factors, including: How likely are particular insects to be sentient? If they *are* sentient, how likely is a particular protocol to harm them, and how much would it do so? And: What are the expected benefits and harms for humans and other animals too, and do the expected benefits of the protocol outweigh, or otherwise justify, the expected harms overall?

When we consider these and other relevant factors, we might reasonably conclude that our duties to individual insects are relatively minimal. For example, we might think that we have fewer duties to individual insects than to individual humans, in part because they have fewer interests. We might also think that we have weaker duties to individual insects than to individual humans, in part because they have weaker interests. But even if so, that might not mean that we should simply "rubber stamp" harmful insect research. We still owe insects moral consideration, and we might at least sometimes find that particular protocols harm them more than they benefit humans or other animals in expectation, particularly in the aggregate.

35 Birch et al., "Review of the Evidence of Sentience."

36 Department for Environment, Food & Rural Affairs, The Rt Hon Lord Benyon, and Lord Goldsmith, "Lobsters, Octopus and Crabs Recognised as Sentient Beings" (gov.uk, 2021), https://www.gov.uk/government/news/lobsters-octopus-and-crabs-recognised-as-sentient-beings.

Recommendations

It will take a while to determine what appropriate ethical oversight for insect research requires. This section briefly suggests two steps that can be taken towards this goal, in addition to taking the issue seriously in general. First, researchers can develop methods for assessing welfare risks for insects, and second, researchers can develop policies and procedures for making ethical decisions about insect research. In both cases, researchers can adapt frameworks that we already use for other animals. However, they should keep in mind that these frameworks have limitations even in the context of traditional animal research, and they should also keep in mind that insect research differs from traditional animal research in important respects.

Regarding methods of assessment that researchers use for ethical oversight, it can help to start by adapting methods that we currently use for nonhuman mammals, which typically follow the "three Rs": We start by asking whether we can *replace* the use of animals in a proposed study without compromising its scientific or medical value. If the answer is no, we then ask whether we can *reduce* the use of animals without compromising these forms of value. Finally, if the answer is no, we ask whether we can *refine* the use of animals without compromising these forms of value. We then replace, reduce, or refine the use of animals where possible, and we proceed with this use where necessary.[37]

However, many researchers argue that the three Rs, even if ideally implemented, are insufficient for ensuring the welfare of nonhuman research subjects.[38] For example, ethical oversight of human subjects research includes a commitment to treat research subjects with respect, compassion, and justice, and it allows harms for research subjects to trump benefits for society in many cases, even when the harms

[37] W. M. S. Russell and R. L. Burch, *The Principles of Humane Experimental Technique* (London: Methuen and Co., Ltd., 1959); Jeff Sebo, "Integrating Human and Nonhuman Research Ethics," in *Handbook of Bioethical Decisions. Volume I*, eds. Erick Valdés and Juan Alberto Lecaros, Collaborative Bioethics, vol. 2 (Cham: Springer International Publishing, 2023), 685–701, https://doi.org/10.1007/978-3-031-29451-8_36.

[38] Jarrod Bailey, "It's Time to Review the Three Rs, to Make Them More Fit for Purpose in the 21st Century," *Alternatives to Laboratory Animals* 52, no. 3 (May 1, 2024): 155–165, https://doi.org/10.1177/02611929241241187; David DeGrazia and Tom L. Beauchamp, "Beyond the 3 Rs to a More Comprehensive Framework of Principles for Animal Research Ethics," *ILAR Journal* 60, no. 3 (December 31, 2019): 308–317, https://doi.org/10.1093/ilar/ilz011; Darian M. Ibrahim, "Reduce, Refine, Replace: The Failure of the Three R's and the Future of Animal Experimentation," *University of Chicago Legal Forum* (2006): 195–230; Sebo, "Integrating Human," 685–701; J. M. G. Vorstenbosch, "The Ethics of the Three Rs Principle: A Reconsideration," *Animal Welfare* 14, no. 4 (November 2005): 339–345, https://doi.org/10.1017/S0962728600029675.

are necessary to achieve the benefits. When adapting the three Rs for new animal populations, we should consider the possibility that animals deserve similar forms of consideration, albeit in species-appropriate ways.

Regarding the policies and procedures that researchers use for ethical oversight, it can likewise help to start by adapting policies and procedures that we currently use for nonhuman mammals. As noted above, these policies and procedures typically take the form of institutional animal care and use committees (IACUCs). Like Institutional Review Boards (IRBs) used for human-subjects research, IACUCs often include scientists, ethicists, and community members to ensure representation of diverse perspectives. They also periodically inspect research facilities to assess whether the animals are being treated well over the course of the study. Such policies and procedures can be considered for insect research oversight as well.

However, many researchers argue that the policies and procedures associated with IACUCs are imperfect as well. Not only are the three Rs insufficient even if ideally implemented, but standard implementation is far from ideal. Nonhuman subjects research is a fundamentally fraught enterprise, since everyone assessing this research is, of course, human, and humans have a clear tendency to favor our own species, as well as a clear tendency to favor the status quo, particularly when we stand to benefit. These biases will likely be even stronger with research on insect populations, since we relate to insects much less than we relate to other primates, mammals, and vertebrates (which is already not always enough).

Of course, we must be realistic. The establishment of ethical oversight for insect research is likely not the time to significantly improve our tools for ethical oversight of nonhuman subjects research, since this effort will already be challenging enough even if all we do is extend current tools to insects in watered-down form. Still, as researchers start to take seriously ethical oversight for insect research, it helps to keep in mind that this step, while a significant improvement on a status quo that involves total institutional neglect, may not be enough for ethical treatment of insects. Further research will be required to determine how best to treat this extremely large and potentially vulnerable population of research subjects.

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Toni Sims has worked as a researcher, writer, and editor for a variety of academic and nonprofit institutions. In addition to her work with the NYU Center for Mind, Ethics, and Policy, Wild Animal Welfare Program, and Center for Environmental and Animal Protection, she conducts independent and contract research. Previously, she worked as an editor at the Center for AI Safety, a research fellow at Longview Philanthropy, and the managing editor of *Social Theory and Practice*. She also worked as the director of research for Animal Charity Evaluators, where she led charity evaluations and managed two grant programs. Toni studied philosophy at NYU and received an MA in philosophy from Georgia State University.

Toni Sims pracowała jako badaczka, autorka i redaktorka dla różnych instytucji akademickich i non profit. Oprócz pracy w NYU Center for Mind, Ethics, and Policy, Wild Animal Welfare Program i Center for Environmental and Animal Protection prowadzi badania niezależne i zlecone. Wcześniej pracowała jako redaktorka w Center for AI Safety, była pracownikiem naukowym w Longview Philanthropy oraz redaktorką naczelną czasopisma *Social Theory and Practice*. Pracowała również jako dyrektor ds. badań w Animal Charity Evaluators, gdzie kierowała procesami ewaluacji organizacji charytatywnych i zarządzała dwoma programami grantowymi. Studiowała filozofię na Uniwersytecie Nowojorskim i uzyskała tytuł magistra filozofii na Uniwersytecie Stanowym Georgii.

Jeff Sebo is Associate Professor of Environmental Studies, Affiliated Professor of Bioethics, Medical Ethics, Philosophy, and Law, Director of the Center for Environmental and Animal Protection, Director of the Center for Mind, Ethics, and Policy, and Co-Director of the Wild Animal Welfare Program at NYU. Jeff is author of *The Moral Circle* (2025) and *Saving Animals, Saving Ourselves* (2022) and co-author of *Chimpanzee Rights* (2018) and *Food, Animals, and the Environment* (2018). He is also a faculty fellow at the Guarini Center on Environmental, Energy & Land Use Law at the NYU School of Law, a board member at Minding Animals International, a senior research fellow at Law AI, and a mentor at Sentient.

Jeff Sebo jest profesorem uczelni w dziedzinie nauk o środowisku, profesorem afiliowanym w dziedzinie bioetyki, etyki medycznej, filozofii i prawa, dyrektorem Center for Environmental and Animal Protection, dyrektorem Center for Mind, Ethics, and Policy oraz współdyrektorem Wild Animal Welfare Program na Uniwersytecie Nowojorskim. Jest autorem książek *The Moral Circle* (2025) i *Saving Animals, Saving Ourselves* (2022) oraz współautorem *Chimpanzee Rights* (2018) i *Food, Animals, and the Environment* (2018), a także współpracownikiem Guarini Center on Environmental, Energy and Land Use Law przy Wydziale Prawa Uniwersytetu Nowojorskiego, członkiem zarządu Minding Animals International, starszym pracownikiem naukowym w Law AI oraz mentorem w Sentient.