

Ethical Conduct with Invertebrate Animals: Routes for Inclusive, Humanitarian, and Sustainable Education

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Abstract

Perceptions of nature depend on experiences relating to biodiversity, thus this study investigated the representation of invertebrates in different sections of Brazilian society by means of a questionnaire available from March to December 2015 as a resource in terms of the conservation of nature and human health in order to design an ethical values guide for this relationship. This study tested the hypotheses that there are differences in the conception and representation: a) associated with gender, educational level, use of animals in vocational training, tutoring, and housing area; b) according to the role assigned to invertebrates as a resource, including in conservation and health; and c) that the different representations result in different value assignments used to intermediate decisions on how, when, and why to use invertebrates. Thus, through quantitative and cross-sectional research, our objective was to identify the popular representation of invertebrates. The analysis of the results of an online questionnaire with 281 respondents showed definitions and concepts that were predominantly similar to the tested variables, which suggests that the present study provides evidence for the understanding of the ecological importance of the invertebrates, the belief in their sentience, and disagreement with the substitutive use of vertebrates in experimentation. However, the naturalistic and ecological positions regarding nature prevailed, indicating the persistence of utilitarian values. The results cast interpretive clues that the only by cooperation between education and environmental bioethics will possible the confluence of values and interests of animals and human in favor of a critical, ethical, and sustainable society.



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Introduction

Historical Viewpoint and a Brief Chronological Context about Animal Ethics

The interactions between species that are vital for ensuring the continuity of life on Earth can be affected by the disdain shown by humans regarding the natural boundaries of their existence.¹ After millions of years of coevolution and consolidation of the perceptions of nature in the sense of human existence, the implementation of farming has led man to diverge from other animals. The Classical Era then incorporated animals into the scientific context, subsidizing the emergence of medicine and reinforcing the emotional distance between humans and other animals by discrediting their sentience.^{2,3}

Throughout human history, there have been confrontations between the mechanistic view disseminated by Descartes (1592-1650), supported by the conviction that animals are not sentient and thus are exempt from moral status, and the contrary view proclaimed by Voltaire (1694-1778), Jeremy Bentham (1748-1832), and Peter Singer, calling for equal consideration of interests in causing intentional pain and suffering in animals for human benefit.⁴ Academic and popular movements against vivisection and in favor of improving animal welfare have been supported by the Darwinian concepts of the quantitative and qualitative differences between humans and nonhuman animals.⁵ Such movements led to the normalization of animal use in experimentation and animal production. The perspectives of these movements resulted in the legitimization of using animals, for academy and society, to improve techniques and ways of mitigating human diseases and to promote and advance science.⁶ However, ethical and legal guidelines include only vertebrates in their animal terminology, which represent less than 5% of fauna; the exclusion of invertebrates has been justified by the low complexity of their nervous system, leading to their classification as inferior animals.⁷ This comes from experiences conditioned by different ways of thinking, feeling, and acting.^{8,9}

The Multidisciplinary Perspectives of Relationship between Humans and Nature for Inclusive, Humanitarian, and Sustainable Education

The human interactions with nonhuman animals are established based on their social, cultural, and

economic environment and are dependent on how the society and the individual perceive, classify, identify, categorize, and make use of nonhuman animals.¹⁰ As a result, relationships are established based on values, knowledge, and perceptions,¹¹ which influence the ways in which animals will be legitimized and standardized. Fischer *et al.*,¹² identified distinct perceptions of pain, emotions, and affectivity related to the social group. While the community showed less empathy compared to activists and researchers, activists were most concerned with the sensation of pain in animals, whereas scientists gave the least consideration to pain awareness. Although Fischer *et al.*,¹³ showed that rural and urban citizens understood the importance of insects within the food chain, others were unable to list their importance, mainly associating them with disgust in urban areas and fear in rural areas, preferring to keep them away. Fischer *et al.*¹³ (2017a) pointed out that before conservation and education policies are instituted, it is necessary to diagnose popular perceptions in order to select the most appropriate intervention strategy for each context. Consequently, its effects and actions can be efficient and potentiated so that there is synergy between the values attributed to the natural elements and the conservationist demands.

Attitudes toward animals may be influenced by factors such as abundance, diversity, tactile/visual/olfactory/taste sensations, spirituality, asepsis, discomfort, animal resistance or fragility, associated benefits or losses, and knowledge of the species.¹³ Kellert and Berry¹⁴ developed a scale to identify the type of relationship between humans and nature according to their primary views (Frame 1). The values used to guide decisions on why, how, and how much to use certain animals for certain purposes are identified in the ethical conception of the individual (Frame 1).

Ethics principles in the relationship that humanity established with nature is embraced by the environmental bioethics agenda,²² since its focus is on identifying and mitigating vulnerabilities resulting from rapid technological development. Bioethics understands as vulnerable actors who do not have decision-making power, therefore subject as decisions of moral agents and dependent on their conscience and responsibility for all moral patients who depend on their choices.²³ Environmental

bioethics as a conflict resolution tool aims to promote debate between different actors, the recognition of their arguments, interests and values and the intermediation of the search for a solution that is good for all. Bioethics as a practical ethics starts and ends, so that the communication process is effective, it is necessary to change paradigms and behaviors that are only achieved with education. Precisely because

it demands a break with traditional standards, there is a need to promote inclusive education, in the sense of considering human and animal interests;⁷ sustainable, to maintain the integrity of adjacent ecological processes;^{13,14} and ethics, in the sense of considering that the values and interests that guide decisions of collective interest must consider the quality of everyone involved.²²

Frame 1: relationship between humans and nature according to their primary views and ethical conceptions used in decisions about use of animal

Relationship between humans and nature according to their primary views ¹⁴	<ul style="list-style-type: none"> a) naturalistic—affectivity with wildlife present in natural habitats; b) ecologist—environment considered as a system for interspecific relations; c) humanistic—empathy only with large animals; d) moralist—defense of animal rights; e) scientific—use of physical and biological attributes to justify interactions with animals; f) esthetics—symbolism and beauty as value; g) utilitarian—nature has a practical and material value; h) domineering—humans have control over nature; i) negativist—belief that nature and animals need removal, intentional or not, owing to contempt, fear, or disinterest.
Ethical conception	<ul style="list-style-type: none"> a) anthropocentric—legitimize the use of nature to satisfy human needs;¹⁵ b) utilitarian—agree to the use of natural resources, disagree with abusive use, and encourage substitution and alternative resources but include animals that are considered sentient;^{16,17} c) welfarist—agree to the use of natural resources but apply the principle of equal consideration of interests based on sentience, respect, welfare, and compassion;¹⁸ d) sentiocentric—only consider animals with the ability to feel as in need protection and care; e) bio-centric—believe in the inherent value of all life forms;¹⁹ f) eco-centric—promulgate as a value the balance of ecosystems and legitimize the death of some individuals for a major benefit;²⁰ g) abolitionist—condemn any use or discrimination of living beings because sentient beings, beyond the interest of not suffering, have interest in living.^{19,21}

Ethical Concerns with Invertebrate Animals

Invertebrates are the most abundant and diverse animals, performing numerous ecological functions such as nutrient cycling, seed dispersal, pollination, biological control, soil fertility, and providing food for countless species.^{1,24} Owing to their ecological importance, they are essential for biodiversity conservation.²⁴ The relationship between humans and invertebrates is conditioned by cultural aspects influenced by the diversity of colors, sizes, shapes, life habits, and most especially by the negative effects of some species, such as the epidemics linked to them.⁸ These result in the

perception of these invertebrates as harmful and disgusting. The availability of shelter and food favors the proliferation of undesirable species, which can act as disease vectors.^{25,26} Many species are used as food and in the production of medical or consumer goods, and a utilitarian value is attributed to them.⁸ According to Fischer *et al.*,²⁷ the zootherapeutic use of animals cannot be neglected by academic and regulatory means due to its amplitude and temporal, cultural, and geographical scope. The authors urged for effective communication between social, environmental, and economic sectors interested in the sustainable use of natural resources and for

the use of common values as mediators of what, how, and when to use animals. The biocentric and anthropocentric values are based on the homology in the sensory, physiological, and genetic systems of vertebrates and invertebrates. Even in the face of evidence of sentience in many species, Naconey⁷ warned that humanitarian care must consider the intrinsic value of every living being and a philosophical reflection on the social consequences of verifying sentience in invertebrates.²⁸ For Fischer *et al.*,¹² although sentience was set as a criterion traditionally used for the segregation of an animal's moral status, this is no longer a valid argument, and it requires the application of the principle of equal-account-of-interests.^{17, 21}

The understanding of the ecological and social role of invertebrate animals is the result of research conducted in different contexts and spaces, inserting into debates and reflections from the interaction with the daily food and medical community^{29,30,31} to the development of conservation programs^{232,33,34,35} and the resulting public policies.³⁶

We depart from understanding popular representation to potentially influence and direct the development of ethical and legal regulations³⁷ and subsidize conservative actions through environmental education and application of the principles of environmental bioethics.¹³ Therefore, we question the perception of invertebrates in a society that considers accessibility to information and knowledge and empathy with animals as plausible variables to influence representation.^{38,39} Assuming that different social actors develop different representations and that the identification of these relations potentiates the direction of intervention actions, our objective was to identify the popular representation of invertebrates, testing the following hypotheses: H1) there are differences in the conception and representation of invertebrates associated with gender, educational level, living with animals on a personal and professional level, and housing area, as attested by other research that analyzed social representation from the perspective of environmental bioethics⁴⁰H2) there are differences in perception according to the role assigned to the invertebrate as a resource, in conservation, and in human health, as suggested by New²⁴ when studying the limitations for invertebrate conservation; and H3) the different representations will result in different value

assignments used to intermediate decisions on how, when, and why to use invertebrates, as hypothesized by Fischer and Santos⁴¹ when studying the promotion of welfare in invertebrates as integrity in research. Therefore, different invertebrate representations are related to the attribution of different values that affect welfare and conservation, which is the fundamental knowledge used to direct the education, sensitization, and awareness strategies subsidizing a inclusive, humanitarian, and sustainable education. The data were analyzed from the perspective of environmental bioethics, which promotes, from a multidisciplinary perspective, the identification and mitigation of vulnerabilities in the relationships established between humans and nature. These relationships are impacted by rapid techno-scientific development and economic interests, which must be permeated by the dialogue between moral agents, guided by universal ethical values that value life and the destitution of suffering on a global, plural, and timeless scale.⁴²

Material and Methods

Participants

Participants were accessed through a general invitation distributed within social media groups such as Facebook and WhatsApp, requiring participants to be over 18 and agree with the research, residents in Brazil, especially region of Curitiba, Paraná. The questionnaire was available from March to December 2015 until the minimum coverage of 100 participants covering each of the following variables was met: gender, education level, formation area, personal or professional interaction with animals, and living area.

Instrument

To evaluate the representation of invertebrates by people, an online instrument (questionnaire) was designed and validated. This questionnaire comprised 22 questions:

- 7 were related to the characterization of the participant (age, gender, education, area of training, residence, living with animals personally or professionally);
- 5 were related to the definition and emotions associated with invertebrates, including 3 open questions ("What do you mean by invertebrate animals?", "List the invertebrates you encounter in your daily life," and "Do you believe that invertebrates can feel?"), 1 semi-structured

question based on previous research 8,12, 33 in which we presented 10 invertebrates (associated with danger, rejection, and/or importance in food and conservation) for correspondence with 9 factors (fear; disgust; indifference; ludic; discomfort, useful and usefulness in food, health, and ecology), and 1 closed question about necessary changes if sentience is proven;

- 1 open question was related to the experimental replacement of vertebrates with invertebrates in scientific research;
- 1 open question and 1 Likert scale addressed the use of invertebrates as a resource;
- 1 open question and 1 Likert scale were about the ecological importance of the invertebrates;
- 1 open question, 2 Likert scales, and 1 closed question addressed human health; and
- 2 Likert scale questions were centered around ethical values and conduct. Each question on a Likert scale was composed of 4 statements in which the respondent scored from 0 to 9 how much he/she agreed with them.

Six panelists analyzed the questionnaires using the Delphi method;⁴⁴ these six panelists were doctors and experts in the areas of biology, law, physics, veterinary medicine, psychology, bioethics, and a representative of the pro-animal movement. The instrument was distributed using the Qualtrics application. The open question corresponding to the definition of invertebrates was categorized into academic (scientific references) or common sense (popular references, citing examples); arguing for the existence of sentience was categorized as technical (scientific arguments) or emotional (references to feelings); and value identification was categorized as anthropocentric (utilitarian value for humanity), biocentric (life as a value, not dependent on the species), or sentiocentric (sentience as a conduct reference).

The questions about the representation of the use of invertebrates were based on the findings of Costa-Neto⁸ who identified avoidance reactions motivated by feelings of disgust, which triggered imaginary damage (fear, disgust, discomfort, disease-causing, and indifference) and approximation reactions motivated by pleasant sensations (admiration; esthetics; use in food, medicine, and rituals; and endowment of ecological and playful values),

which result in multi-interactions. The association of invertebrates as resources was identified through the knowledge of the respondents on the use of invertebrates in the production of medicines or cosmetics. Their knowledge about the conservation of invertebrates was assessed through the importance given to environmental education, and their association with the health of humans was analyzed through their perceived responsibility of the urban pest problem and the forms of control. To access the representation of invertebrates in nature and the ethical values used as guidelines, nine assertions were explained with outcomes based on the positioning with nature proposed in the scale described by Kellert and Berry,¹⁴ as well as the values of the five ethical currents, which were scored from 1 to 9 according to the adherence of the participants.

Statistical and Ethical Procedures

The analysis was conducted on the data of the 281 complete questionnaires out of 408 total participations. For each category of each variable, a sample (of the 281 questionnaires) of the first 50 complete questionnaires was taken considering the following variables: gender (50 male × 50 female), education level (50 basic × 50 high), professional formation involving animals (50 biological/agronomic × 50 non-biological/agronomic), animal tutoring (50 yes × 50 no), and housing area (50 rural × 50 urban). We compared the values of the categories to each other and to the variables within each category. The null hypothesis of the homogeneity of the evaluated parameters was tested on averaged data using ANOVA (test posteriority Tukey) and T-test parametric, after the application of the normality test and adherence to the nonparametric Kruskal–Wallis and Mann–Whitney tests. For the frequency data, we used the chi-square test, using a 95% significance level and 5% error for both tests.

The study was conducted in accordance with the ethical principles promoted by the Helsinki and Tokyo Declarations and resolutions CNS 466/12 and 510/2016, always respecting the integrity and anonymity of the research participants in the treatment, analysis, and preservation of data. The project was granted approval from the CEP/PUCPR (No. 9022-123).

Results

Characterization of Research Participants

Data samples for the present study feature a society profile corresponding to 281 participants (with complete questionnaires) with an average age of 28.3±11.9 years (18–75), of which 73% were female, 72% had higher education, 78% did not use animals in their profession, 82% had pets, and 82% lived in urban areas.

The results for each of the tested hypotheses were presented together, comparing the general representation of the research participants between the different representations of the invertebrates and between the tested variables.

(H1) Invertebrate Representation: Definition, Examples, and Sensations

The term invertebrate was predominantly linked to the academic description rather than common-sense knowledge, primarily in males with higher education who were from the biological/agronomic area, animal tutors, and urban citizens (Figure 1). The scientific definition (as “animals that have no spine or vertebrae”) predominated over common sense (as “earthworms and snakes” or “insects”). For the sentience definition, the technical argument (as “reactions of discomfort and behavioral changes that they show after manipulation”) was more commonly selected than the emotional option (as “animals are good to say, they feel pain, etc.”).

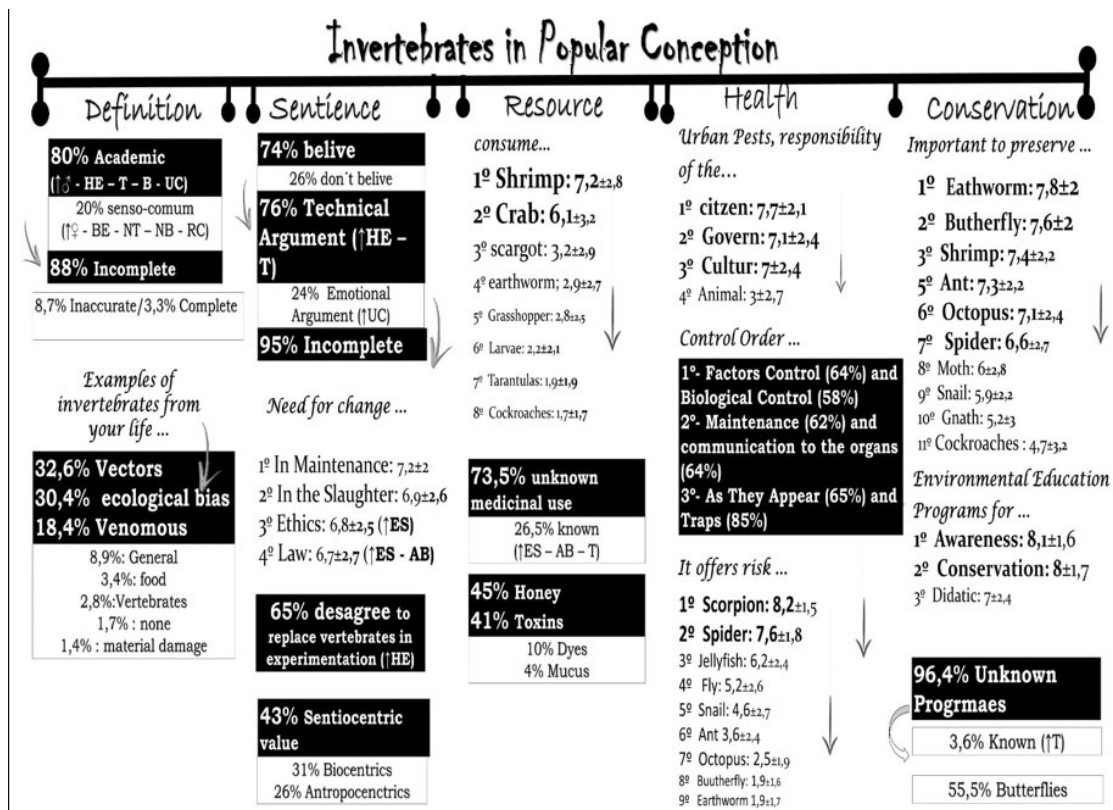


Fig.1: Flowchart of results of popular representation of invertebrates considering definition, existence of sentience, use as a resource, conservation context, and health

The frequencies of the responses were compared in each category and between the variables (♀ = female, ♂ = male; HE = high education, BE = basic education; T = tutor, NT = non tutor; B = biologic area, NB = non biologic area; UC = Urban Citizen, and RC = rural citizen), using the chi-square test for frequency values and ANOVA for mean values, with the most frequent being represented prominently in the black box or accompanied by the symbol ↑.

The citations of invertebrates corresponded to 676 records grouped in 69 taxonomic groups with the predominance of arachnids (15%), oligochaetes (14%), lepidopterans (11%), and insects in general (9%), with 3% citing vertebrates such as snakes, frogs, and geckos, 1.8% citing no examples, and generalizations such as "oh all that creeps, flies, and disrupts life in the summer." The grouping of citations according to the functional group of the animals

resulted in the majority inserted in the context of vectors, with ecological or venomous bias (Figure 1).

The feelings associated with invertebrates were represented without a clear pattern among the variables tested, highlighting the disgust and fear of animals such as cockroaches and spiders, use of snails and octopus as food, and conservation of butterflies (Figure 2).

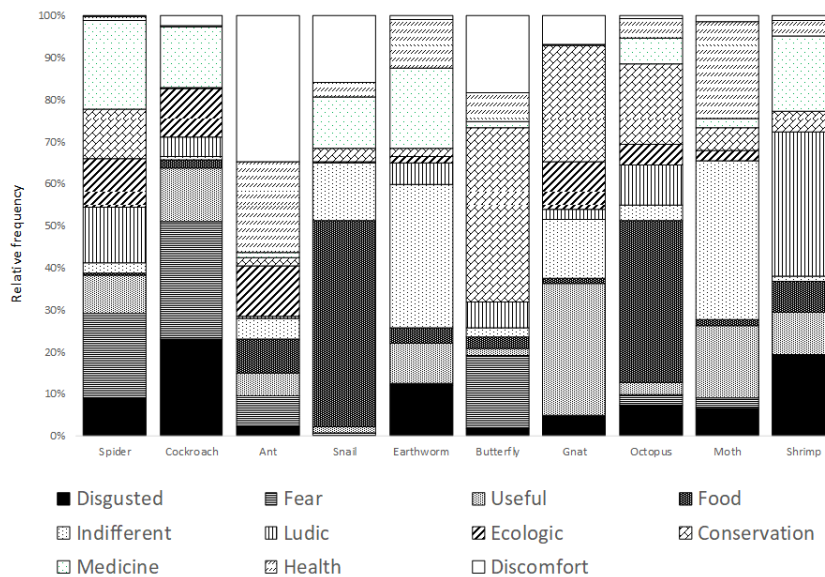


Fig.2: Relative frequency of sensation assignment for each invertebrate group

The existence of sentience in invertebrates was indicated by 74% of the respondents who used technical arguments to justify it (especially pronounced in participants with higher education and those who were tutors), whereas emotional arguments were used by urban citizens. The lower frequencies of disbelief in the existence of sentience in animals occurred in the participants with basic education, non-tutors, and rural inhabitants. Most arguments were categorized as incomplete (Figure 1). The position regarding the importance of behavioral changes during invertebrate treatments as evidence of their sentience was relatively homogeneous, with a high value for all options. Highlighting ethical and legal aspects by higher education respondents (Figure 1), most disagreed with the use of these animals for vertebrate replacement in experiments. The justification for this position was based on arguments centered mainly on sentient values, whereas to justify agreement

with the substitution, 53% of the respondents used sentient values and 46.5% used anthropocentric values.

(H2) Invertebrates as a Resource

The ability to feed on products obtained from invertebrates resulted in higher scores for crab shells and shrimp dumplings, whereas the lowest scores were for dried cockroaches and larvae products (Figure 1). Most respondents were unaware of the medicinal or cosmetic uses of invertebrates, with the highest frequencies being related to respondents from higher education (18%), from biological areas (22%), and animal tutors (21%). The participants cited honey, propolis, venom, snail mucus, cochineal and silkworm-based dyes, snakes, and horses.

Invertebrates Associated with Human Health

Responsibility for urban pests generated high scores on all variables for the citizen, government, and

culture, with the lowest attributions to the animals themselves (Figure 1). Respondents uniformly ranked the pest elimination sequence, with “factor control” and “biological control” being the most common first choice, followed by “maintenance” and “communication to the responsible organ.” Deletions “as the animals appear” and “through traps” were ranked as the last options (Figure 1). The danger posed by some invertebrates was homogeneous; however, the higher scores were attributed to spiders and scorpions and the lowest to earthworms and butterflies (Figure 1).

Invertebrates Involved in Conservation

The importance of preserving invertebrates was linked to high scores for earthworms and butterflies and low scores for cockroaches and mosquitoes. Respondents related invertebrates to

conservation and awareness programs rather than as a didactic resource. Most reported not knowing about conservation programs for invertebrates (Figure 1). Positive responses, mainly from tutors, included the following: butterfly garden of Foz do Iguaçu, Reserve Serelepe, Natural History Museum of Curitiba and Paranaguá Aquarium.

(H3) Ethical Representation of Invertebrates

The attitudes toward nature resulted in no difference between the groups; naturalists and environmentalists had higher scores, whereas the dominating and oppositional achieved the lowest scores (Figure 3). The predominant adherence with ethical outcome statements from sentiocentric, utilitarian, and welfarist respondents also showed no differences among the groups (Figure 3).

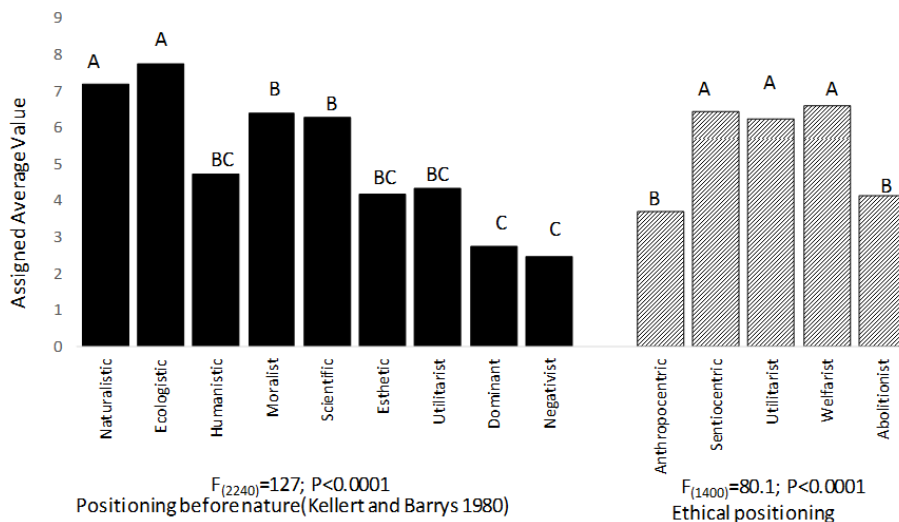


Fig.3: Average values assigned to outcomes related assertions to the second position on the nature and scale of Kellert–Berry and in accordance with ethical positions. Means were compared using ANOVA, and significantly different values (P < 0.05) accompanied by different letters

Discussion

The results of this study indicate that invertebrates are beginning to drive ethical questions and that motives regarding invertebrates include the awareness or need for species conservation and the control of pests and vectors. However, the uniform representation of invertebrates by different segments of society is favorable for education programs because it makes it possible to identify the same assumptions.

The social representation of invertebrates conditioned by the social group

The social groups represented in this research demonstrated a similar perception of invertebrates, contrary to the initial hypothesis (H1). The definition of invertebrates was the parameter that generated the most discrepancies, with women, participants with a basic education, participants coming from a non-biological/agrarian formation area, non-tutors, and residents of the rural area most commonly

appropriating definitions based on common sense, which can be decisive in guiding decisions. Still, scientific definitions in participants with high education suggest the importance of scientific information in the formation of representations for the determination of legal and technical positions from the acceptance and understanding of the invertebrate sensibility. This evidence supports the perspectives of Feijó *et al.*⁴⁵ and Herzog and Golden,³⁷ which stated that education influences the concern that is attributed to animals and indicated that it impacts morality.

In the present study, it was not possible to identify patterns of relationships with the invertebrates and the social groups evaluated. Disgust was associated with not only cockroaches, worms, and shrimp but also with spiders, mosquitos, and moths. However, fear, beyond that expected for spiders and cockroaches, was also associated with butterflies. The mosquito was associated with utility and conservation, but shrimp, aside from being related to food, were considered playful and medicinal, along with spiders, cockroaches, snails, and worms. These results can be explained using the references of Costa-Neto and Pacheco⁴⁶ that indicated that affective dimensions and biopsychosocial aspects determine the form of perception and relationships with animals. This perspective can trigger feelings of disgust, which stimulate the avoidance response and determine imaginary damage or pleasant sensations, stimulating approach and multiple interpolations. As per Costa-Neto and Pacheco⁴⁶, this information is essential to the success of interventions that should use sensory factors to modify emotions and the way the object is perceived. Thus, assistance is required to change negative perceptions, especially in children, by associating animals with appropriate sensory stimuli, attractive colors, and interesting lifestyles, promoting future conservation and sustainable management.

This study confirmed the link between invertebrates and negative aspects. Generalized associations of invertebrates led respondents to include animals such as snakes, geckos, and frogs as examples. Similar results were obtained by Fischer *et al.*,¹³ in which¹⁵ groups were exemplified as insects and¹⁰ corresponded to other taxa. Costa-Neto and Resende⁴⁶ suggest that this result was due to a range of entomophobic emotions arising from established

relationships with cultural attributions and affective aspects,^{8, 47, 48} and they are referred to by Costa-Neto⁸(2003a) as entomoprojective ambivalence. In this, emotions of disgust, contempt, repudiation, dislike, and fear of different animals are associated with the insect category. For New,²⁴ these bad feelings delayed the implementation of conservation programs, which are influenced by popular segments to academics. The author warned of the danger of invertebrate demonization due to the discrepancy between the number of species that could potentially do some damage and those that bring essential benefits for maintaining ecosystems.

The attribution of sentience to invertebrates was also primarily associated with access to information inherent to higher education, indicating a legitimate trend in the inclusion of sentience in ethical and moral arguments. This aspect was elucidated by Oliveira and Goldim,⁴⁹ who stressed the importance of strengthening knowledge about sentience; however, as long as this confirmation does not consolidate, it is necessary to take care, respect, and responsibility in conducting research with invertebrates. This expectation was envisioned in the disagreement with the use of the invertebrate as a replacement for vertebrates in scientific research. Higher education respondents used technical arguments based on sentient values and called for changes in ethics and legislation, suggesting the incorporation of the 3R principle⁵⁰ inherent in this segment. Urban citizens also spoke out against substitution, expressing doubt that the trials using invertebrates could yield results that could be applied to humans. However, they also used emotional arguments influenced by common sense, which may be linked to politically correct stances that did not hold during the research, which reveal utilitarian values.¹³

The Social Representation of Invertebrates Conditioned by the Role of the Animal In Society

The results of this research support the hypothesis H2 that the difficulty of including invertebrates in ethical debates comes from the diversity of representations associated with the complex relationships established with different species. Additionally, the results suggest that these associations could render invertebrate species vulnerable by promoting reckless commercial exploitation when they are understood to be a

resource or indiscriminate extermination when they are understood to be dangerous.

The understanding of respondents regarding the use of invertebrates as resources has been linked to the cultural context. There is a selective acceptance of invertebrates as a source of proteins, highlighting crustaceans, whose unsustainable exploitation results in the depletion of fish stocks, causing critical environmental and social consequences.²⁴ According to Costa-Neto,^{8,42} this result is illogical in the view of the similarities in nutritional fruit-fish with other invertebrates and even vertebrates. According to the author, entomophagy is an emerging alternative to overcome the concerning protein deficiency in the world population, validated culturally in more than 100 countries. More than 1500 species are gathered for this purpose, predominantly terrestrial and cosmopolitan insects. However, in Brazil, despite the faunal diversity, entomophagy is just beginning to be associated with diseases. Although Fischer and Santos⁴¹ warned that despite the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Food and Agriculture Agency (ONU) encouraging the consumption of insects as a renewable natural protein alternative that is beneficial for humans, environmental health, and the economy,⁵¹ the increased confinement of invertebrates could potentially increase the vulnerability of animals that may have their welfare compromised in the absence of maintenance and slaughter protocols that consider their biological needs. Costa-Neto⁴² also emphasized the importance of the development of management and production techniques in the confinement system, aimed at reducing the impact of collection pressure and maximizing production. Consequently, we envision the insertion of this theme in teaching and research in biological and agrarian areas.

The perception of spiders and scorpions as having high risk potential attests to the emotional and cultural connection of disgust sensations and avoidance reactions. According to Costa-Neto,⁸ these are the result of an evolutionary process wherein the specificity of distinction ability becomes widespread. Further, it automatically promotes protection against few animals, though potentially against those capable of transmitting disease, inoculating toxins, or causing material damage.⁴⁹ This culminates in the

“insecticide culture”,²⁴ where just over 10 species of potentially dangerous arachnids in a world of more than 40,000 species can lead to an exaggerated extermination, enhanced by the pest control market, compromising the conservation of species important to the ecosystem.^{24,41} This is a delicate issue according to Fischer *et al.*¹³ because people should be oriented towards prevention and control; however, they should also promote sustainable actions for conservation. For example, Fischer and Gang⁵² identified clear vulnerabilities, both in animals and in people, resulting from the control of the giant African snail. They called for more caring and sympathetic interventions with nature and provided the population with full information and training based on common values, investing in prevention through education.

The high-education participants showed an understanding that the impacts of urban pests were not associated with animals but rather with those who understood the cultural influence and the responsibility of citizens and public managers, again elucidating the importance of access to knowledge. The need to equip citizens was reported by Fischer and Tamioso,⁵³ whose accessible, correct, and complete information promotes the autonomy and protagonism of co-responsibility in the maintenance of environmental health. It is favorable that respondents supported the containment initiative of urban pest management through the promoting factors of infestation, benefiting biological control at the expense of the destruction of the animals. This indicates that the population, at least that outlined in this study, is open to ethical and sustainable control interventions.

The representation of invertebrates within the context of conservation was linked to the ecological function of earthworms, the esthetics of butterflies, and the importance of some invertebrates, such as shellfish, as a food resource. This position indicates an anthropocentric/utilitarian bias and associates care as a means of providing benefits to humans. Therefore, even the intrinsic ecological value can incur impacts. For example, butterflies, conventionally linked with symbols associated with environmental preservation, favor popular adherence to environmental education programs.⁵⁴ However, New²⁴ countered this view, concatenating the processes of ecological imbalance triggered

by excessive collection. Limited knowledge of environmental education programs that use invertebrates reflects their limited use in this sector, compromising the educational process. According to Fischer *et al.*,¹³ the ethics value is not something that imposes itself, but it must be incorporated by the population through its insertion in the management of natural resources.

The Representation of Invertebrates and the Ethical Implications with Support of Disruptive, Inclusive, Humanitarian, and Sustainable Education

The concordances with the ethical assertions indicated the existence of a pattern among the analyzed group, with discrepancies in the perceptions previously indicated in the Hypothesis H3. Different representations will result in different value assignments used in making decisions on how, when, and why to use invertebrates. The assignment of different values that are comparable among the groups may be favorable for educational interventions. The predominance of positive relationships with invertebrates, considering the scale of Kellert and Berry,¹⁴ reflects an identification with naturalistic and ecological views, primary interest in wildlife and the environment as a place of inter-relations and corroborating the concept of deep ecology, and that humans are just another member of the complex interrelationships on the planet.⁵⁵ However, this position did not correspond with the answers given in the other questions and indicated a contrast to the findings of New,²⁴ Oliveira and Goldim,⁴⁹ and Magalhães-Sant'ana.⁴⁷ They associated the distancing of invertebrates with the limitations of changing the status of their inferiority and conservation. The respondents probably identified with politically correct answers, suggesting the inclusion of invertebrates in ethical debates and demands for environmental education and the implementation of eco-centric values, such as conscious responsibility and sustainability,⁴¹ which becomes more viable in the face of the receptivity of the public.

Respondents also equaled the identification with the ethical concept regarding the use of invertebrates as resources, corroborating data from Fischer and Tamioso.⁵³ The high scores for assertions with sentientist, utilitarian, and welfarist justifications demonstrate the establishment of parameters and

arguments for animal use, typical of the academic environment and corresponding to the research approach. It is important to note that the legal documents that regulate animal experimentation include only vertebrates⁵⁶ (CONCEA 2016), using sentience as a criterion and depriving legal protection to approximately 95% of fauna.

The utilitarian and welfarist conceptions showed dissonance with the ecologist and naturalist positions previously indicated, validating the use of animals with idoneous justification for the mitigation of other vulnerabilities, such as with vertebrate use in experiments, however, dependent to interventions with morally and legally accepted justifications and with care to avoid causing pain and suffering.⁴¹ The academy, however, relies on sentient evidence to direct its conduct; therefore, more information about the conditions of handling and management conditioned to the habits of the animals is needed.⁴¹ Naconecy,⁷ Magalhães-Sant'Ana,⁴⁸ Oliveira and Goldim,⁴⁹ Fischer *et al.*,^{12,27} Fischer and Santos⁴¹ and Fischer and Gang⁵² reaffirmed the indispensability of including invertebrates in ethical debates, encouraging care and their inclusion in the legal norms of animal protection, transposing the utility values and inducing news specialists, innovating methodology, and disruptive social insertion.

The integration of humans and nature was also emphasized in the rejection of anthropocentric precepts, which suggests changes to current paradigms, with the dismissal of the legitimacy of the human domain. For Fischer *et al.*,¹² it is necessary to overcome the human/nature dualism to promote harmonious coexistence. Still, poor adherence to the abolitionist thought was expected, as even abolitionist exponents, such as Francione,²¹ do not include invertebrates in their considerations. This raises the question of the association with the dependence on animals for many purposes widely accepted by society. Naconecy⁷ refers to this as the "Ethics for Vertebrates," referring to an intrinsic speciesism even in radical animal liberation movements. The predominance of the 3R principle is emphasized over the need to incorporate ethical values of care, equal consideration of interests, and the benefit of doubt. Given that all animals must be respected in society, it is necessary to justify the application of the benefit of the doubt regarding the sentience of invertebrates, as the

absence of evidence is not evidence of the absence of sentience.⁴¹

Considering the various relationships established with invertebrates and the homogeneity across social groups according to this research design and sample, it is necessary to stimulate a debate on the access to information and education. It is urgent and fundamental for invertebrates that the agenda of environmental education interventions is followed, as this is a powerful tool for instigating changes in behavior and consciousness with the intention of improving the interrelations with nature.²⁰ Therefore, the use of a tool that promotes the integration of actors, legitimizing the ecological importance and inherent value of all animals, is required. Thus, Fischer and Santos,⁴¹ in confluence with Fischer *et al.*,^{13,27} suggested the establishment of multidisciplinary environmental bioethics committees as a means of promoting debate on how, why, and how much to use invertebrates for scientific activities, ecotourism, and food and how to promote healthy living with species that make up the ecosystem. Fischer and Santos⁴¹ emphasized the role of environmental bioethics in promoting consistent science based on the arguments of researchers, editors, sponsors, and society. These arguments should be supported by the principles of responsibility, honesty, and impartiality, and they should promote technical and legal instruments for thorough research that can be promoted by educational institutions associated with ethical animal use. Fischer and Santos⁴¹ found that the assimilation of ethical promotion in research involving invertebrates in academia is not proportional. This fact may potentially delay or prevent the inclusion of the group in ethical and legal norms that value professional competence aimed at integrity in research striving for the reproducibility, veracity, and applicability of research.

Social representations use the diversity of invertebrates and legislation to justify the difficulty of drafting identifying tools and protocols for capture and collection, transportation, maintenance, and experimentation. However, Fischer and Santos⁴¹ identified agreement in ecological, utilitarian, or abolitionist discourses over the need to improve communication and education, such that the limits of scientific knowledge are pushed beyond the academic world, bringing regulatory bodies and

society closer together. According to Mather,⁵⁷ the intrinsic value of an animal and the concern for their care increases as more scientific information becomes accessible to society. Fischer and Santos⁴¹ believe the academy should direct its performance with invertebrates based on biocentric and eco-centric values and research integrity considering its scientific and social responsibility, because these studies are justified in the benefit they bring to society.

Final Considerations

The results of this study are indicative of possible interpretation routes for cultural influences and access to information, pointing to an ethical concern about the insertion of invertebrate animals in the moral community. Therefore, the training of citizens is necessary to be able to choose critically and to act protagonistically. The ongoing change in the relationship with vertebrates is promoting a concept that animals should not be mistreated or subjected to unnecessary suffering. This is a gain for the cause of animal protection. However, ethics that segregate animals based on their taxonomic group is illogical. Such ethics that favor only those animals considered superior legitimize the criteria-free exploitation of animals that have been considered inferior. Therefore, it is necessary to promote the inclusion of invertebrates under animal protection.

Popular perceptions of invertebrates, analyzed from the perspective of environmental bioethics, promulgate the identification and mitigation of invertebrate vulnerabilities from their relationships with humans. The mitigation of vulnerabilities must be permeated by the dialogue between moral agents, marked by common ethical values and the destitution of suffering on a global, plural, and timeless scale. These perspectives, in cooperation with the educational and inclusive function of the deliberative space of the ethics committees present in the public, private, non-governmental, and academic sectors that contemplate all levels of disruptive education, can be a tool that promotes this desired change. Consequently, there is a way to achieve long-term responses, concepts of change, social behavior, and public policy, means that are attributed to students, future citizens, and the role of moral agents. The awareness of the ecological relevance of invertebrates is necessary

for emphasizing their value for biodiversity beyond the ecological bias reaching the ethical sphere and fighting the speciesism that contaminates the present ethics. From this perspective, environmental bioethics emerge as the mediator for the dialogue between the needs and interests of humans, who decide how, when, and how many invertebrates to use, the cultural constraints attached to these animals, and the inherent, urgent, and essential need for the care and protection of these animals.

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Conflict of Interest

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