Perceptions and representations of animal diversity: Where did the insects go?

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A B S T R A C T

Insects are everywhere: they represent 73% of the total described fauna, and, being linked to every ecosystem function, they play key roles in biodiversity resilience. However, are we humans aware of this? Through a study conducted on French students in Environmental and Human Sciences, we designed a free-associations test-based game to elucidate whether Insects were a part of animal diversity representations and which Insects were indeed in students' minds. We also looked for perceived values and related knowledge among taxa in order to examine those results with regard to students' socio-demographic characteristics. Besides a known overall negative perception of invertebrates, we found that this perception was correlated to the "human environment" of the person beyond the "exposure to nature" theory: being surrounded by persons actively involved in nature con- servation increases positive perception of Insecta. Moreover, invertebrates were less seen as a part of ecosystems than vertebrates; this implies a lack of a holistic vision of diversity, which might be the key to improving insect understanding and conservation. Departing from the depiction of insects from a specific group of participants, we propose a generic framework to enhance awareness for insect conservation and recommendations to improve education initiatives. These baselines could significantly help future conservation strategies as they address the perception challenge of insects.

1. Introduction

Insects represent 73% of the total described fauna (IUCN, 2014). Their great diversity and numbers give them a key role in ecosystem functioning (Wilson, 1987; Huis, 2014) which enhances the need to conserve these taxa (Leather et al., 2008). Moreover, insects are de- clining worldwide (Dunn, 2005; Hallmann et al., 2017), which alter the ecosystem services they provide for human well-being (Losey and Vaughan, 2006), and this decline does not seem to be halted by the current conservation policy based on the protection of strictly delimited areas (Hallmann et al., 2017). Less charismatic than vertebrates (Kellert, 1993; Lorimer, 2007), poorly known and more difficult to survey (Leather et al., 2008; Cardoso et al., 2011), insects lack pro- tection measures, conservation strategies and, last but not least, peo- ple's concern, valuation and conservation support (Samways, 2015; Donaldson et al., 2016; Leandro et al., 2017).
Hochkirch (2016) calls for action in the face of this "insect crisis we can't ignore". Two main challenges must be faced: the technical chal- lenge and the perception challenge (Samways, 2015). While the former is being addressed, until now the latter has been largely neglected (Simaika and Samways, 2018). Some authors have advocated for the use of flagship species (Guiney and Oberhauser, 2009; Barua et al., 2012), but such approaches might only enforce charismatic single- species conservation approaches (Small, 2011), which might not be the way to efficient insect conservation (Leandro et al., 2017). Never- theless, the principle behind this proposal is to leverage conservation through what is explicitly known and what is liked. That is why the study of the psychological side of insect conservation has grown in concern in the late years (Samways, 2015; Simaika and Samways, 2018). It is important to know which species are recognized and how they are perceived in order to be able to give pertinent solutions for conservation concern, education and action (Bennett, 2016).
Samways (2005) and New (2008) support the use of common names to enhance people's concern for insects and foster their conservation. The idea is to label with understandable names and shape six-legged forms (Duval, 1996; New, 2008). This approach, combined with edu- cational trails, has been used for Odonata species (Suh and Samways, 2001). But dragonflies are relatively poorly diversified and the use of such an approach to richer taxa is questionable (e.g. Coleoptera has 60 times more species than Odonata). Moreover, generic names are poly- semous and can be subjective (Putnam, 1996; Thompson, 2009); fur- thermore, personal experience soundly modifies the perception of *bugs.*

N = 34 / 307 total *ANIMAL* items
NA
A
Cat
Dog
Rabbit
Spider
Fish
Hamster
Tortoise
Mouse
Snake
Ginea pig
N= 105
B
Cat
Rat
Dog
Pigeon
Fly
Mosquito
Squirrel
Cockroach
Birds
Ant
N= 103
C
Cow
Sheep
Horse
Hen
Pig
Goat
Rabbit
Bee
Boar
Snake
N= 115
D
Boar
Fox
Lion
Deer
Wolf
Elephnat
Bear
Giraffe
Snake
Doe
N= 214
Number of citations
N = 14 / 105 total *INSECT* items
E
Ant
Mosquito
Fly
Bee
Buterfly
Wasp
Cockroach
Spider
Ladybug
Firebug
N= 65
F
Butterfly
Ant
Ladybug
Bee
Scarab
Fly
Wasp
Mosquito
Praying mantis
Dragonfly
N= 76
Number of citations
G
***
Vertebrate
Invertebrate (Animals)
Invertebrate (Insects)
N = 2410
N = 628
N = 2882
H
Hymenoptera ***
Diptera ***
Lepidoptera ***
Coleoptera ***
Hemiptera ***
Orthoptera ***
Blattodea ***
Number of citations

Fig. 1. Number of citations of the most cited animal items depending on the environment: A) homes, B) cities, C) agricultural landscapes and D) natural landscapes. Number of citations of the most cited insect items depending on the environments: E) cities, F) natural landscapes. Perception was different between invertebrates and vertebrates (G), but also on the orders cited by the students (H). The bar charts are divided into the proportion of positive perception (green), neutral (grey) or negative (red). The N represents the total number of different cited items by environment (A to F) and the total number of vertebrates or invertebrates cited by participants in each context (G). Icons made by Freepik from www.flaticon.com, CC BY SA license. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Consequently, what people might think when they use the word “In- sect”, or other large-diversity englobing terms, might depend on their rational knowledge, personal experiences and on their feelings and factors such as the environment where they grew up and lived (Lockwood, 2013). Nevertheless, names elicit the memory and activate mental images, which can be shared by people (Pavio, 1977), therefore it is a good entry to study perceptions and representations.

In this study, we investigated the representations, perceptions and knowledge of young adults living in France concerning insects. We specifically focused on students as they form the rising generation, which has to face the Sixth Extinction. Our goals were to get 1) their knowledge, 2) their perception of insects and 3) socio-demographic information that might influence their perceptions and representations. The specificity of their relationship with insects is highlighted by a comparison with their relationship with animals as a whole.

2. Methods

2.1. Definitions

Perception and Representation are results of external and internal factors, related to knowledge, cultural context and personal, or even shared, emotions (Zadra and Clore, 2011; Wan, 2012). Bennett's (2016) definition of Perception, “the way an individual observes, understands, interprets, and evaluates a referent object, action, experience, in- dividual, policy, or outcome”, as it is a synthesis of established defini- tions with a conservation focus focal, was used. We used Bernoussi and Florin (1995) and Oxford Dictionary definitions to state Representation: a description, an image, a model or other depiction of something (a concept) which is encoded in the mental structure of the descriptor, its memory.

As perceptions and representations have key roles in conservation as they shape attitudes towards biodiversity (Kellert, 1993; Bennett, 2016), in this study we assessed “positive”, “neutral” or “negative” valuations and vocabulary related to taxa to go beyond the “good/bad” dichotomy.

2.2. Free association method

We used the free association method as a spontaneous and easy-to- implement way to collect participants' representations while using written words as stimuli. This method allows people to elicit reflexive reactions, towards the given stimulus, which are canalized through free writing of word, expressions and even onomatopoeia. It also allows us to access the semantic context in which the mental image of the given stimulus was formed, thus being pertinent method to reveal collective memory and prototypes (Dany et al., 2015).

2.3. Data collection

Our study targeted environmentally aware young adults but without any special skills in natural history. Thus, we excluded working with students in biology or ecology (Prévot et al., 2016) and we choose to work with first year students from the Human and Environmental Sciences Faculty of Paul-Valéry Montpellier 3 University. These students from geography, history or art history chose to attend an optional and purely theoretical introduction to sustainable development taught by one of us (PJR). Tests were given before class in an amphitheater where all students were gathered.

Data sampling was conducted in three main phases, all three separated by one week during January 2018. During phase I, we asked students to complete a survey and to answer questions about them- selves, such as experiences with nature, persons potentially influential in their relationship with nature, whether they feared any natural elements and socio-demographical information (Supplementary material A1). Then we addressed the question of which animal and entomological diversity is reported by the students and how is it perceived?

To do so, students were asked to complete word association tasks as they are an efficient way to probe subjective conceptions (Joffe and Elsey, 2014). In phase I, they had to write down, on a sheet of paper with four empty boxes, the first 10 animals they know occurring in four types of environments: their home, the city, an agricultural environment and a natural setting they frequent. Afterwards, participants were asked to put a smiley (☺, 😐 or ☹) in front of the items that they cited, representing how they felt about the item. Then we collected all sheets, distributed a new blank one and asked to start again but name Insects instead.

Afterwards, the main target was to study specific representations based on the material collected from phase I. Therefore, in phase II, the 20 most frequently cited non-exotic and wild vertebrates (10 items) and invertebrates (10 items) were used as stimuli. Students had one minute to write down any words, descriptions, feelings, stories or phrases that came to mind when they thought of the taxon. In this second phase, stimuli (words) were shown on a screen one by one and they had to fill 20 boxes on blank paper. Vertebrates and Invertebrates were shown alternately. Participants were asked to answer the questions spontaneously.

Finally, in phase III, students had a quiz of 42 true/false questions about biodiversity and insect biology and ecology (Supplementary material A2) as a way to evaluate "actual knowledge about the group" (Kellert, 1993) and complete personal information gathered through the survey from phase I.

Each phase lasted between 30 and 45 min at the beginning of the class. The completion of the survey and the tasks was voluntary and was anonymized by randomly giving each student the name of a scientist, a name that they kept throughout the whole process.

2.4. Taxa characterization

Each "item" cited in the first phase was coded as a Catalogue of Life taxonomical level and based on two proxies of common knowledge: Larousse dictionary descriptions and Wikipedia pages. For instance "dragonfly" is a common name for species belonging to Odonata order; "elephant", as it defines three species from different genus, was coded as the higher common level: Elephantidae family. We also characterized items by their exotic character compared to French fauna (based on the French Wildlife Inventory) and their domestic or wild status.

2.5. Data analyses

To understand the mind-bestiary of students and how cited biodiversity is perceived, first we performed a Chi-squared test to analyze whether there was an association between perceptions and the characteristics of the taxa. Then, we performed Wilcoxon signed-rank, Kruskal-Wallis and Spearman rank correlation tests to examine links between background information from the student and indicator variables of knowledge and perception (i.e. number of different cited taxa, degree of taxonomic level cited, overall perception of animals and in- sects, diversity of the vocabulary employed in phase II and the quiz score from phase III).

Table 1
Most cited vertebrate and invertebrate items used for the second free-association test and their respective assumed taxonomic level, the total number of vocabulary and the mean number of words per participant elicited. We illustrated each item with the dominant perception from phase I, the dominant Kellert's perception value (KVP) and the overall weighted polarity of the vocabulary describing the item based on the rezoJDM French lexical and semantic network database.

Invertebrate item	Assumed taxonomical level	Total number of words	Mean number of words per participant	Dominant perception (phase I)	Dominant KPV	Overall weighted polarity (positive; neutral; negative)	Vertebrate item	Assumed taxonomical level	Total number of vocabulary	Mean number of words per participant	Dominant perception (phase I)	Dominant KPV	Overall ponderated polarity (positive; neutral; negative)
Ant	Family: Formicidae	146	5.6	😐	Scientistic	39; 52; 9	Bear	Family: Ursidae	176	6.6	☺	Scientistic-Ecologistic	38; 40; 22
Bee	Superfamily: Apoidea	148	7	☺	Scientistic-Ecologistic	52; 39; 9	Boar	Species: *Sus scrofa*	155	5.4	☹	Scientistic	33; 38; 29
Butterfly	Order: Lepidoptera	135	5.5	☺	Scientistic	54; 29; 17	Fox	Species: *Vulpes vulpes*	153	5.2	☺	Scientistic	47; 39; 14
Cockroach	Order: Blattodea	132	4.2	☹	Negativistic-Scientistic	13; 30; 57	Hare	Genus: Lepus	112	4.5	☺	Scientistic	47; 37; 16
Fly	Suborder: Brachycera	158	5	☹	Negativistic-Scientistic	22; 32; 46	Hedgehog	Family: Erinaceidae	115	3.9	☺	Scientistic-Ecologistic	27.5; 44; 28.5
Ladybug	Family: Coccinelidae	120	5.5	☺	Scientistic	39; 47; 14	Lizard	Suborder: Autarchoglossa	141	4.7	☺	Scientistic	39.5; 53; 7.5
Mosquito	Family: Culicidae	167	5.9	☹	Negativistic	26; 41; 33	Pigeon	Family: Columbidae	164	4.8	☹	Scientistic	23; 52; 25
Scarab	Family: Scarabaeidae	151	3.9	☺	Scientistic	24; 55; 21	Squirrel	Family: Sciuridae	151	5.8	☺	Scientistic-Ecologistic	48; 45; 7
Spider	Class: Arachnida	136	4.7	☺	Scientistic	24; 55; 21	Stag	Species: *Cervus elaphus*	100	4.6	☺	Scientistic	45; 44; 11
Wasp	Family: Vespidae	115	4.5	☹	Scientistic	25; 46; 29	Wolf	Genus: Canis	175	5.6	☺	Scientistic	33; 33; 34

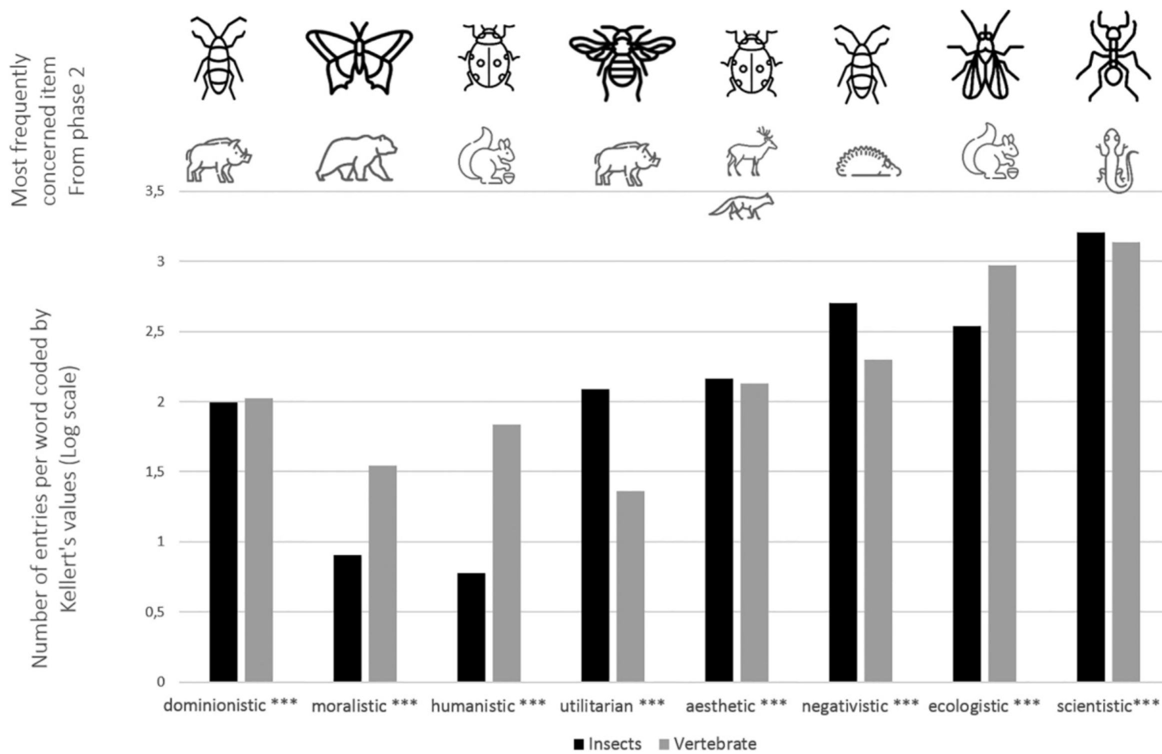

Fig. 2. Number of entries per word coded into Kellert's perception values, in a logarithmic scale. To illustrate each value, we putted an icon representing the items (vertebrates on grey, insects in black) which were the most frequently cited (p-value $< 0.001 =$ ***). Icons made by Freepick from www.flaticon.com, CC BY SA license.

As indicator variables were highly correlated ($R > 0.6$) we kept overall positive perception of insects, hereafter “sympathy for insects”, as the response variable.

Finally, after lemmatizing words and keeping the most frequent words (> 10%), vocabulary related to items from phase II was interpreted through two different prisms. Firstly, Kellert's perception values (KPV) (Kellert, 1993 – Supplementary material A3). KPV were given by three independent coders (CL, PJR and a colleague not involved in this study). Conflicting codes were discussed in order to reach an agreement on the accorded category. Then, values upon items were compared with a Chi-squared test.

Secondly, each vocabulary related to items was characterized by its polarity (positive, neutral, negative) based on the French lexical and semantic network database rezoJDM (Lafourcade, 2007; Joubert et al., 2018). This database collects, since 2007, words perceptions' from on- line contributors (at least 1000 regular participants since the creation of the website of rezoJDM in 2007). As every descriptive word was on the database and had > 30 polarity attributions, we assigned to each item an overall weighted polarity reflecting the frequency of the vocabulary. Analyses were carried out using R software 3.4.1 (R Core Team, 2017). All answers were transcribed into an Excel database. Out of the 195 enlisted students in the course, only 101 completed all three phases of the experiment. Therefore, our analyses are based on the responses of those 101 participants.

3. Results

3.1. Insect perception

From the 369 different cited items, all taxonomic levels combined, none was given in its Latin name. Ten items had to be withdrawn be- cause either the item was not an Animal (Bacteria, Plant, Mushroom or Unknown).

When asked which animals they knew in different types of environments, students reported firstly mammals (50.3%) and birds (15.5%). Vertebrate constituted 80.6% of cited taxa. This vertebrate diversity was characterized by 231 different items whose systemic level was particularly precise: in 55.9% of the cases it was at the genus, species or subspecies level. Taxa belonging to the Insecta class were mentioned in third place (12.4%): 41 different insect items, corresponding at 88.7% to a high-level taxonomic category (the order or the family).

Insects represented 86% of the diversity mentioned when Insects only had to be cited, the rest being other invertebrates, mainly spiders (8.2%) or earthworms (1.7%). At this time, 105 different items were cited, mostly taxa between order and family level (87.2%).

Within Animals and Insects, there was a difference of appreciation based on the environment in which the item might be present (home, cities, rural and natural environments) (Fig. 1A–F) or the different nature of the items ((in)vertebrate, order) (Fig. 1G–H). Vertebrates were significantly seen more positively than invertebrates; Lepidoptera and Coleoptera items were also seen more positively than other Insecta orders.

Items from “natural landscapes” were also more appreciated than those from the urban sphere, particularly for non-domestic and in- vertebrate items. Indeed, “exotic” or “domestic” characteristics were related to positive appreciations. This result echoed literature on preferences of exotic fauna (Ballouard et al., 2011), dislike of wilderness in ‘Human spaces’ such as homes and cities (Cegarra, 1999; Rupprecht, 2017) and highlighted the importance of the context where the animal is represented by its perception.

In addition, we noticed that for Animals, natural environments elicited the highest number of different items (2 times more than for the others); from cities to natural environments the evenness among the most cited species significantly increased (Fig. 1A–D) which might enforce the Human and the Non-Human spaces idea. Nevertheless, for Insects, the number of items was constant through environments (Fig. 1E–F).

Fig. 3. Word cloud representation: the most frequently cited vocabulary (> 10%) for four invertebrate items from phase II: the bee, the cockroach, the mosquito and the ladybug. The length of the font is proportional to the frequency of the word. The color of words represent the overall polarity (positive, negative or neutral) extracted from the rezoJDM French lexical and semantic network database. Icons made by Freepick from www.flaticon.com, CC BY SA licence. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 2
Participants' major characteristics: as some answers were correlated, we chose to show those who were explored for statistical tests. Participants' personal background was confronted to their overall positive perception of insects (Sympathy). Sympathy was calculated based on the mean number of "happy smileys" putted in front of invertebrate items during phase I by each participant.

Characteristics	Summarized answers	~Sympathy	
Average age	21 ± 4 years old (range 17–50 years)	$R = 0.15$	p-Value = 0.16
Gender	58.4% women; 38.6% men; 1.9% "other"	U = 825.5	p-Value = 0.5
Parents with environmental related professions	9% yes; 91% no	U = 384.5	p-Value = 0.72
Presence of a rich sensitive social environment	83.3% yes [divides into 11 levels[a]]; 26.7% no	$R = 0.25$	p-Value = 0.031
Environment where they grew up	49% rural; 35% urban; 16% both	$\chi^2 = 122,4$	p-Value = 5.24e-29
Outdoor activities practice (athletic, artistic, camping…)	92% yes [divided into 4 classes[b]]; 8% no	$R = 0.07$	p-Value = 0.95
Nature related fear	66.6% yes (36.6% being invertebrates); 33.3% no	U = 543.5	p-Value = 0.31

[a] Levels were estimated depending on the number and the nature of the persons evoked (Collado et al., 2017).
[b] Levels were estimated depending on the number and frequency of mentioned activities.

As a primary conclusion, animal diversity in young adult minds appeared to be biased towards positively perceived mammals which can be considered as charismatic and belonging to the 'Human sphere', and domestic animals, which are useful and historically familiar to Humans (Cegarra, 1999; Shapiro et al., 2017).
Secondly, we encounter a relatively poor invertebrate diversity in students' representations of animals, despite the fact that such diversity doubled when only insects were asked. Items cited within 'Insect' revealed the fuzziness of the concept. This was confirmed with some questions from the quiz from III[rd] phase: earthworms and centipedes were labelled as 'insects' in 46% and 72% of the cases, respectively. Apparently, in students' minds, Insects are firstly an archetype of non- vertebrate animal, which is more negatively seen than vertebrates. This poor knowledge about insects echoes a similar study carried out with young adults in the United-States (Shipley and Bixler, 2017).

3.2. Values on taxa

From phase I, we acknowledged the 20 most frequent items and inputted them into the second free-association test (Table 1). Phase II vocabulary was composed of 1475 different words (all species combined).
Concerning values to the most frequently cited items, we saw significant differences between taxa and (in)vertebrate qualification (Fig. 2). Vertebrates were more prone to ecologistic, humanistic and moralistic KPV than insects, while the latter had higher scientistic and negativistic values. Indeed, Insects were more prone to anatomical or behavioral descriptions (scientistic sensu KPV) rather than ecological information (interactions with other species, habitats), which was greater for vertebrates (ecologistic sensu KPV). This result might reflect that, for participants, insects are less linked to the ecosystem than vertebrates, making it difficult to see them as essential to ecosystem functioning and Human development. In fact, only "bees" had vocabulary related to utilitarian values and dominant ecologistic vocabulary. Thus, utilitarian values might not be a first good leverage to insect conservation (Simaika and Samways, 2018). Furthermore, the description of species by striking anatomical features is typical in child- hood (Tunnicliffe and Reiss, 1999) which highlight the weakness of student knowledge concerning insects (Matthews et al., 1997).
Negativistic vocabulary such as "unpleasant", "disgusting", "harmful", "unclean" and "ugly" was inherent to all invertebrates, except the butterfly, while "dangerous" and "spiky" were the only negative vocabulary related to vertebrates ("wolf", "bear", "boar" and "hedgehog"). Only the ladybug and butterfly were described as "beautiful" and a representation of "nature"; this confirms previous studies (Knight, 2008; Batt, 2009). This disgust driven negativistic values upon invertebrates is well known in occidental culture (Nash, 2004; Lockwood, 2013).
Most frequently, taxa prone to negativistic vocabulary (fly, mosquito, cockroach) were also seen as organisms that we have to control (dominionistic values sensu KPV). Historically, the first scientific approach to insects was pest control (Chansigaud, 2001) and, with the sanitization of urban spaces in the 20th century, some anthropophilous taxa such as ants and cockroaches, were no longer welcomed and 'needed' to be controlled (Blanc, 2009; Frioux, 2009).
Nevertheless, dominionistic value did not appear in Kellert's (1993)survey. In our context, students were predominantly city-dwellers: maybe the wish to control the wildlife may be greater among city dwellers (Clayton and Myers, 2015; Rupprecht, 2017). This logically follows phase I results which showed a more positive perception on fauna from "natural landscapes" (Fig. 3).
Moreover, even if it was not possible to compare it statistically because of the small number of words (N = 75/10,485), vertebrate species elicited words or sentences referring to conservation concern, especially wild carnivores such as the

Bear and the Wolf, while in- vertebrates did not.

Some differences can be pointed out between participants' perceptions and polarity form the rezoJDM database (Table 1). Indeed, rezoJDM vocabulary tended to be more neutral for Ladybug and Mosquito, items that are supposed to be strongly positive and negative respectively in students' representations. This might come from the rezoJDM database itself, which gathers personal contributions without any semantic or environmental context. Nonetheless, in most of the cases it was concordant with participants' responses, echoing with a larger panel of persons and therefore confirming the validity of our public to probe general insect perception.

3.3. Knowledge, personal construction and perception

Sympathy for six-legged creatures, an overall positive perception of Insects from phase I, varied depending on the participant's sensitive social environment and place where participants declared growing up. While the “growing up environment” related to sympathy result echoed with KPV results from phase II and thus place dependent perception's from phase I, the influence of a rich and close sensitive to nature social environment was new in the context of insects' perceptions and re- presentations. Nevertheless, there was no significant difference be- tween gender, actual knowledge (quiz from phase III, diversity of items) nor practice of outdoor activities or parents' environmental related profession in relationship to “sympathy for insects” (Table 2).

Sympathy for insects thus might be a construction from a specific moment with a specific person, independently from formal knowledge (Chawla, 2017; Shipley and Bixler, 2017).

4. Discussion

4.1. Getting a picture of Insecta

Insect conservation is a complex problem that cannot be easily ad- dressed without an interdisciplinary approach. Our workflow enabled us to go from a perceived animal diversity panel to a specific panel of perceived “insects” before narrow known into particular representations. Now, what can we offer to address the “perception challenge” in our context?

Phase I showed us that, even if invertebrates were less frequently cited than vertebrates and were more negatively perceived or de- scribed, they were not completely absent. This result allows us to see the base upon which we can build a strategy for insect conservation through perception change. Indeed, a positive or a negative perception is a first leverage: it means engagement rather than disinterest (Clayton and Myers, 2015).

“Butterfly”, “bee” and “ladybug”, with overall positive perceptions and previously mentioned as charismatic (Snaddon and Turner, 2007; Small, 2011; Barua et al., 2012), came in the top ten of mentioned taxa but only when asking ‘Insects only’. Thereby, first six-legged to pop-up in participants' minds while we call for Animals are “problematic” and “harmful” items. Concordantly, when thinking about Insects only, problematic species appear first, but then useful and charismatic in- vertebrates are also mentioned. Which means that, whatever the con- text, ‘Insect’ elicits first a negative image. Indeed, first-mentioned invertebrates are neither “beneficial” nor “charismatic”, but can be related to diseases (mosquito, fly) or fears (spider) (Merckelbach et al., 1987; Batt, 2009; Lockwood, 2013); indeed, the most common animal phobias are entomophobia and arachnophobia (Lelord and André, 2001) and indeed in our study 21% of participants spontaneously mentioned a fear related to invertebrates.

General literature (Raffles, 2010; Lockwood, 2013) and scientific studies (Kellert, 1993; Costa-Neto, 2003) argue that insects are associated with fear, disease and damage in different cultures, which puts them in the “no” box of conservation. Actually, in a parallel study conducted with 180 psychology students, participants were less willing to engage in conservation for insects than for mammals and birds, and, if they were, it would be for their utility rather than their aesthetic or intrinsic values (CL, unpublished). Nash (2004) paraphrased this in his paper title: “Desperately Seeking Charisma: Improving the Status of Invertebrates”.

Although charisma plays a major role at present in obtaining social and financial support for conservation (Mace et al., 2007), this quality is mostly the privilege of species taxonomically nearer to Humans (Stokes, 2007; Batt, 2009). If empathy, which is a response to the emotional and cognitive connection made by perceptions and re- presentations, is a predictor of pro-environmental behavior (Chawla, 2009; Kals and Müller, 2012), insect conservation is seriously dis- advantaged (Lorimer, 2007; Lockwood, 2013) and desperately seeking charisma in insects may be not the way forward into unbiased (insect) conservation. Maybe the way is ahead an acceptation of this primary negative attitude.

While perceptions cannot be easily changed, particularly for in- vertebrates in the point of view of disgust/fear-evolutionary response (Batt, 2009; Lockwood, 2013), they can be demystified to get in- vertebrate tolerance if not sympathy in a first stage (Lockwood, 2013; Schonfelder and Bogner, 2017). Based on vocabulary used in phase II we can already work with participants to explain that bees ‘sting’ and spiders bite as a defense, they do not ‘aggress’; not all cockroaches are pests; ants, cockroaches and scarabs are not ‘unclean’, they are ‘cleaners’; Mosquitos are not ‘useless’, they are a part of a greater food web and play a part in ecosystem functioning, etc. Empathy could come though halo effect when comparing to “good”, “non harmful” and useful species when demystified.

4.2. A roadmap from perception to conservation

The shift of perception and the durability of this change need scientific evidence of the interrelationship between species, original features on which we can reflect or engage and even demystify (Schultz and Kaiser, 2012). Knowledge and understanding of the natural world can arise from outdoor direct experiences and/or (in)formal education (Chawla, 2009; Prévot et al., 2016). Difficult as it seems, perception shift is not impossible, as it has operated for Birds in the late years of the 20th century (Chansigaud, 2012), Primates and the wolf (Almedia et al., 2017) in the United States and, in recent years, Hymenoptera pollinators (Williams and Osborne, 2009; Sing et al., 2016). However, they need to pass through the right catalyzer, which can influence re- presentations' construction journey.

Is it the use of common names? We need to consider that the significance and images behind the names. Moreover, values they elicit and the representations they might reflect should be understood in the socio-cultural context (Bang et al., 2007; Wan, 2012). Here, ant was a symbol of collective “work” and “intelligence” and scarab of “Egypt”. Costa-Neto (1998) showed that in northern Brazil “Abeia” label (“Bee”) was used for 23 different taxonomic terms from Apidae and Vespidae families, while in our context it is restricted to the honeybee. This is consistent with the result obtained by Schonfelder and Bogner (2017) with German students ranging from primary school to university. Thus, “bee” is not a catalyzer of “wild bees” representation.

Our study shows that the perception of insects by Humans is com- plex and taxa dependent. Furthermore, our results underline that a relative “sympathy” for insects is more likely to be related to a sensitive regard (accompanied observation and valuation, i.e. joint attention) and an exposure to nature during childhood, which has been largely studied in conservation education and psychology (Chawla, 2007; Myers, 2012). Contrary to people questioned by Kellert (1993), students from the early 21st century did not associate insects with an outdoor experience (naturalistic values); moreover, ‘practice of outdoor activities’ did not influence their “sympathy” for the six legged, letting us think that the environment alone is not enough to get a representation of insects.

A study by Tunnicliffe and Reiss (1999) showed that children learned names and attributes of animal taxa essentially from home and, secondly, by joint direct observation. Chawla (1999) showed that 77% of people who followed a pro-environmental life path evoked family, particularly parents, as triggers of this choice. A high quality sensitive social entourage -key socializers (Chawla, 2009; Collado et al., 2017)- can direct attention to the value of invertebrates and engage for “insect sympathy”.

Based on such observations, and knowing that the Human-Insect relationship is conditioned by an evolutionary and cultural heritage (Lockwood, 2013), we encourage to build holistic instruction of bio- logical diversity and importance accompanied by highly influential persons (school teachers and parents) to diminish the perception challenge from insect conservation effort.

Parents and teachers should be able to follow training programs by NGOs and entomologists in order to sensitize to insects and connectedness of such diversity to other species and ecosystems, and thus improve the likelihood to sensitize others (Matthews et al., 1997; Wagler and Wagler, 2012). The classroom is a great moment in which there is a teacher-students joint attention; involving parents in such moments should increase the sensitizing effect on insect perceptions and lead to positive attitudes. Examples of demystification, linkage to ecological challenges (i.e. reduction of pesticides, biodiversity interactions sustainability) and the use of non-charismatic taxa during class are the “Mosquitoes in the Classroom” (Matthews et al., 1997) and Cowles' (1984) “cockroaches”.

5. Conclusion

We must encourage ecologists, teachers and NGOs to rethink the way they educate the public to effectively reach comprehension through the right words and actions. The success of protection and conservation plans largely depends upon the public's understanding and implication. Our study underlined the importance of bias in the public's representation of insects. An analogous situation may appear for all different sociodemographic categories (farmers, pest managers, politicians…). This awareness is imperative and a prerequisite to enable general every citizen to engage in dialogue, develop a common vision of insects and contribute together to establish effective and timely biodiversity preservation.

Furthermore, stablish a roadmap to conservation based on public's conservation psychology should go beyond insects: it is imperative to acknowledge the diversity of biodiversity. Shifting from species to ecosystems should be the future of environmental education to reach an inclusive conservation approach (Simaika and Samways, 2018).
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Appendix A. Supplementary data

Supplementary data to this article can be found online at https:// doi.org/10.1016/j.biocon.2019.07.031.

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