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Frequent access to ecosystem services leads to increased understanding of pollination

O acesso frequente aos serviços ecossistêmicos leva a um maior entendimento da polinização

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ABSTRACT

The perception of people on conservation actions affect the efficiency of environmental policies, since it impacts the success of its implementation. We tested whether the perception of people on pollination change among productive and consumption sectors, and if it is influenced by the degree of schooling, using the production-chain of the passion fruit as study model, which demands crossed-pollination provided by large-sized bees. The perception of people along five sectors was evaluated from production to consumption, interviewing 162 people with a questionnaire on passion-fruit pollination. With a correspondence analysis, we correlated each production and consumption sector to the knowledge about pollination presented by them. The understands of each sector was related to the type of education that they received previously (formal/scholar vs. non-scholar, including non-formal education and courses) through a Kruskal-Wallis test. Sellers of inputs and farmers were correlated to perceive bees in a positive way, know more correct concepts about pollination and bee species, and praised large-bees in agriculture, compared to other sectors. Consumers perceived bees in a negative way, know fewer correct concepts on pollination, and associated them with food and not with ecosystem services. However, consumption sectors acknowledged bees as valuable and supported initiatives for pollinator-friendly agriculture. The higher degree of schooling lead to more knowledge on pollination among the sellers, but not in other sectors. In general, familiarity to the subject provided by experience and by non-scholar education increased the understanding about pollination. The insertion of ecosystem services in the daily life of people shall contribute to fixate knowledge and change the negative perceptions about ecosystem services and promote conservation policies.

Keywords: bee, education, scholar, insect, ecosystem services.

RESUMO

A percepção das pessoas sobre ações de conservação afeta a eficiência das políticas ambientais, uma vez que alteram o sucesso da sua implementação. Nós testamos se a percepção das pessoas sobre polinização é alterada ao longo da cadeia produtiva e setores de consumo, e se ela é influenciada pelo grau de escolaridade, usando como modelo de estudo a cadeia produtiva do maracujá, uma espécie que exige polinização cruzada promovida por abelhas de grande porte. Foram considerados cinco setores relacionados ao cultivo e consumo do maracujá, entrevistando 162 pessoas com um questionário estruturado. Comparamos vendedores de insumos, produtores, consumidores primários, secundários e finais, usando uma análise de correspondência para correlacionar os setores com seu respectivo conhecimento sobre polinização.

Por meio de testes de Kruskal-Wallis, verificamos se o conhecimento de cada setor estava relacionado com à educação escolar e/ou não escolar. Os vendedores de insumo e produtores estão correlacionados com maior conhecimento sobre polinização e espécies de abelhas, enaltecem a existência de abelhas de grande porte nas culturas e percebem abelhas de forma positiva, comparados aos setores de consumo. Os setores de consumo sabem menos sobre polinização, perceberam abelhas de forma negativa e associam abelhas à alimentação, não a serviços ecossistêmicos. No entanto, estes setores consideram as abelhas valiosas ao ambiente e apoiam inciativas sustentáveis de produção agrícola. A escolaridade influenciou positivamente o conhecimento no setor dos vendedores de insumo, e não nos outros setores. A familiaridade com o tema promovida pela experiência e educação não-escolar aumentou o conhecimento sobre polinização. O tema de serviços ecossistêmicos pode ser incorporado na vida cotidiana das pessoas de forma a fixar o conhecimento e aumentar o sucesso de políticas de conservação ambiental.
Palavras-chave: abelha, educação, escolar, inseto, serviços ecossistêmicos.

INTRODUCTION

Pollination has a central role in the food production, directly affecting fruit and seed qualities and representing a fundamental ecosystem service to natural and agricultural crops (Klein et al., 2007). Among pollination agents, bees are the most important group, being responsible for 73% of the pollination of agricultural crops in the world (FAO, 2004). Despite their great importance, bees are threatened by land-use change and deforestation (Ramírez et al., 2013), and consequently, a decrease in pollination has been documented since the 1990s (Potts et al., 2010; Goulson et al., 2015).

The decrease in bee-colonies and, therefore, in pollination, has an economic impact and represents a financial turnover of 153 billion euros each year (Gallai et al., 2009). In Brazil, more than 60% of the agricultural crops rely on biotic pollinators, which has a contribution to food production above 10 billion euro (Giannini et al., 2015). There are some human-driven factors decreasing the delivery of the ecosystem service of pollination, such as deforestation, habitat fragmentation, excessive use of pesticides, presence of invasive species, pathogens, and climate change (Le Conte and Navajas, 2008; Neumann and Carreck, 2010; Potts et al., 2010; Goulson et al., 2015; Paudel et al., 2015). Consequently, one promising way to mitigate the causes of the decrease in pollination is to inform people through environmental education, so they promote the conservation policies (Ramadoss and Poyya Moli, 2011; Frantz and Mayer, 2013).

The relationship between humans and nature originates from the how we know, think, perceive, and interact to the environment (Russell et al., 2013). Thus, to mitigate the anthropogenic impacts on pollinators, we need to understand how people perceive their environment and the ecosystem service of pollination. Based on the perceptions of people, we can recommend strategies to increase the awareness of the importance of sustainable actions and biological conservation (De Oliveira and Berkes, 2014). It is also possible to use these perceptions to create educational materials, pollinator-friendly management methods and to suggest research topics on the preservation species.

We analysed the production-chain of the passion fruit (*Passiflora* spp.), a species dependent on biotic pollination. Most fruits produced by this species (~ 95%) are pollinated by a biotic agent (Giannini et al., 2015). Cross-pollination is needed to produce the fruits, and due to the flower morphology, the most important pollinators of this culture are large-sized bees belonging to the genus *Xylocopa* (Corbet and Willmer, 1980). We assumed that each sector related to production and consumption of the passion fruit would have a different perception about large-size bees and their role in pollination. These perceptions could be affected by scholar/formal and/or non-scholar education (Kollmunss and Agyeman, 2002). Non-scholar education would embrace non-formal education and also courses and talks taken spontaneously by the participant. We expected that people closely related to nature should be more interested and therefore know more accurate concepts on ecosystem services (Kasina et al., 2009). Similarly, scholar/formal education might affect the understanding of people, since high degrees of schooling are related to more theoretical knowledge on

ecosystem services (Munyuli, 2011; Hanes et al., 2013; Muhamad et al., 2014).

Our objective with this study was to describe the perception of five sectors related to production and/or consumption of the passion fruit: sellers of agricultural inputs, passion-fruit farmers, and primary, secondary and final consumers. We used an ordination analysis to show whether the knowledge (i.e. the pollination concept, bee species, which pollinator acts in the passion fruit pollination) was related to scholar and non-scholar education.

MATERIAL AND METHODS

We conducted 162 interviews in 30 Brazilian cities in São Paulo state between February and June of 2016, using a structured questionnaire (Box S1, Supplementary Material available online). The application of the questionnaires occurred preferably personally, otherwise by email or finally by mailing material, when the other options were not possible. Respondents were asked to choose one of the alternatives for multiple-choice questions. When the questionnaires were applied personally, the applicators did not answer any question of the interviewee before the end of the application. We applied the interviews to five sectors: (1) sellers of agricultural inputs (n = 32), (2) passion fruit farmers (n = 39), (3) primary consumers (n = 30), (4) secondary consumers (n = 31), and (5) final consumers (n = 30). This categorization was done as it follows:

A) *sellers of agricultural inputs,* consisted in sellers of products, seeds and inputs focused on the passion fruit culture. Here, 34.37% (11) of the questionnaires were applied personally and 65.65% (21) via e-mail; B) *farmers,* comprised organic and conventional passion-fruit farmers of small and medium size properties (maximum 4 ha), some of which have additional financial sources. Most of the farmers (72%) were linked to social organizations or institutes. The questionnaires were applied 30.77% (12) personally, 10.26% (4) by e-mail, and 58.97% (23) by mail; C) *primary consumers,* were those responsible for the direct purchase of passion fruit from the farmer or association. This full sample (30) was taken personally; D) *secondary consumers,* comprised marketers and supermarket managers who purchased the passion fruit from farmers. The questionnaires were applied in the proportions: 80.64% (25) personally, 3.22% (1) by e-mail, 16.12%, (5) by mail; E) *final consumers,* were those who bought the fruits either at fairs or supermarkets. The entire sample (30) was taken personally.

The interviews had both multiple-choice and essay questions (Supplementary Material available online). Essay questions were taken by the full transcriptions of the answers, without interruptions. All aspects of the field work that involved humans was conducted according to the ethical approved of the Brazilian Committee on Ethics in Research with Human Beings (CAEE: 46163615.0.0000.5504). The multiple-choice answers were analysed in correspondence analysis to verify the relationship of answers in each sector. We used the general knowledge of the sectors on bees, pollination and pollinators in a correspondence analysis. Also, we ran Kruskal-Wallis test to check whether knowledge was related to the degree of schooling and to the sector each person belonged (Zar, 2010), assuming this represents their non-scholar education. The 'knowledge' was assessed as a sum of the correct answers on what is pollination; whether pollinators are living beings; whether large-sized bees are the pollinators of the passion fruit; how the passion fruit is pollinated (manually or through a biotic agent). All analyses were performed in R (R Core Team, 2017).

RESULTS

We interviewed 162 people, 102 males (63%) and 60 females (37%, Table 1). Most of the sellers of agricultural inputs (72%) had complete or incomplete higher education (university degree), 54% of the farmers and 53% of the consumers reached complete or incomplete fundamental education, and 61% of the secondary purchasers and 47% of the primary buyers had either a full or incomplete high school education (Figure 1). Most of the farmers (72%) received workshops and talks on pollination due to their participation in social association or institutes, which are considered here, together with daily-life and professional experience, as non-scholar education.

The correspondence analysis on each sector's characteristics and on pollination (Figure 2) showed that the sellers of inputs were related to intermediate degree

Table 1. The sum of the people of each gender and its correspondent percentage between brackets, separated by sector from the production chain of the passion fruit, in which we analysed their understanding on pollination. The sectors analysed were: Sellers of inputs, farmers, primary, secondary and final consumers. Full questionnaires presented to each sector is presented in the Box S1 (Supplementary Material available online).

Sector	Males	Females	Total
Sellers	21 (66%)	11 (34%)	32
Farmers	34 (87%)	5 (13%)	39
Primary consumers	17 (57%)	13 (43%)	30
Secondary consumers	29 (74%)	10 (26%)	39
Final consumers	9 (25%)	27 (75%)	36
Total	**110 (62.5%)**	**66 (37.5%)**	**176**

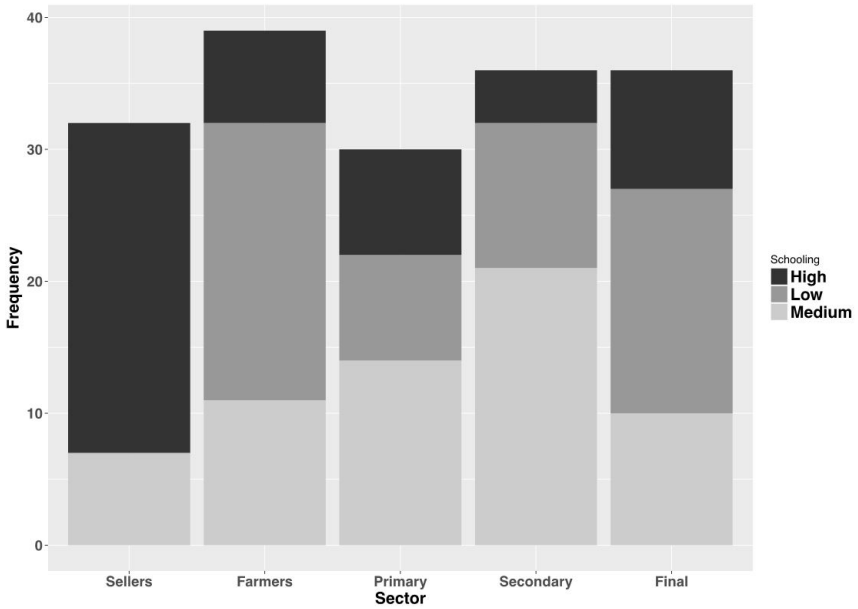

Figure 1. Degree of schooling of each sector interviewed about their perception of pollination in the production chain of the passion fruit. The sector analysed were: Seelers of inputs, farmers, primary, secondary and final consumers. We divided the degree of schooling of people into High: comprising higher education (complete or incomplete); Low: elementary school (complete or incomplete); Medium: secondary school (complete or incomplete).

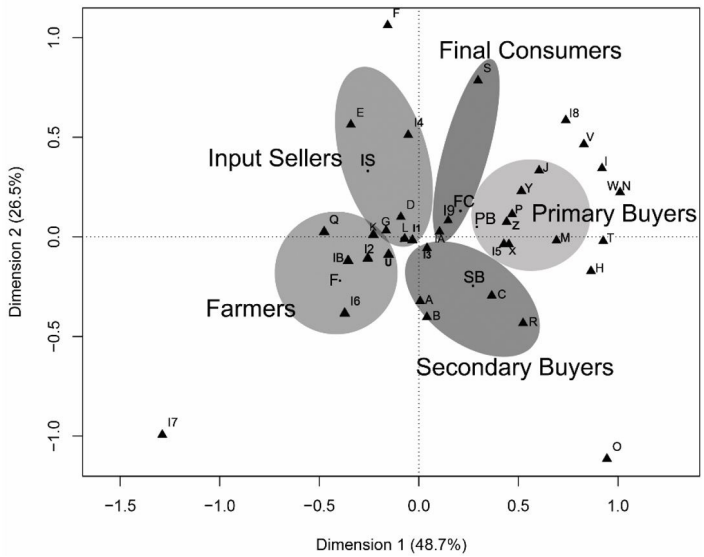

Figure 2. Correspondence analysis of the sectors analysed: Input Sellers (IS), Farmers (F), Primary buyers (PB), Secondary buyers (SB), and Final consumers (FC). The responses given by the interviewees are presented with letters/numbers (see Supplementary Material available online for details on the questionnaires and their answers).

Table 2. Comparison of the 'knowledge' on pollination between sectors: sellers of inputs, farmers, primary consumers (C1), secondary consumers (C2) and final consumers, using a Kruskal-Wallis test followed by Dunn *post hoc* test (p values presented, significant results are shown in **bold**).

	Input sellers	Farmers	C1	C2
Farmers	**< 0.001**			
C1	**< 0.001**	**< 0.001**		
C2	**< 0.001**	**< 0.001**	0.051	
Final	**< 0.001**	**< 0.001**	0.28	0.13

of schooling (college completed (E); college incomplete (F); high school incomplete (D)), to knowledge on pollination (self-proclaimed knowledge on the concept of pollination (G); biotic agents are necessary to pollination (L); know at least three species of bees (I1)), even though they declare that bees are not decreasing in number (I4). Producers were related to high knowledge on pollination (self-proclaimed knowledge on the concept of pollination (K); the size of the bee is important to the pollination of passion-fruit flowers (Q); large-sized bees are essential to the passionflower pollination (U); know more than tree bee species (I2); understand that the use of pesticides affects bees (I6)) even though they do not consider important the existence of a certifying seal (IB).

Among the consumers of the passion fruit, primary consumers were related to low knowledge on pollination (describe that pollination is a method to avoid pests in agriculture (J); do not know the importance of biotic agents to pollination (M); do not know about the importance of the size of the bee for the pollination process (P); know two bee species or less;). However, they acknowledge that destruction of green area affects bees (I5). Secondary consumers were correlated to diverse schooling levels (complete and incomplete fundamental education - A and B; high school C), to small knowledge on pollination of the passion fruit (e.g. beetles are the most effective in pollinating passion fruit flowers - wrong identification of species, R), but they declare that bees are decreasing in number (I3). Final consumers were correlated to not knowing large-sized bees (S); destruction of green area, use of agrochemicals, diseases and global warming affect bees (I9); and consider it important to create a seal to ensure that passion fruit production protects bees and pollinators (IA).

When we analysed the most prominent terms used by each sector, using the essay questions, we observed that the sellers of agricultural inputs (IS) were related to terms related to insects (C); farmers were related to terms related to pollination (P) and to positive characteristics of bees (PC), primary consumers were correlated to terms related to nature (N), secondary buyers were correlated to terms related to negative characteristics of bees (NC), and final consumers correlated bees to terms related to food (Al). The Kruskal-Wallis test showed that there was no difference in knowledge on pollination of the passion fruit caused by scholar education among all respondents, irrespective to the sector ($p > 0.05$). Within each sector, producers and consumers did not show any difference in knowledge about pollination following the degree of schooling. Sellers had more correct information on pollination when they show higher degrees of schooling (above complete medium level, $p = 0.007$). Non-scholar education, considered here as daily life, professional experience, participation in workshops and courses, caused differences in the knowledge on pollination, with sellers of inputs and farmers showing more knowledge, even though there were differences between these two sectors (all $p < 0.001$). Consumers did not differ in their knowledge between themselves (all $p > 0.05$), but differed when compared to sellers and farmers (Table 2).

DISCUSSION

Non-scholar education affected the understanding of the ecosystem service of pollination. Sellers of agricultural inputs, who deal commercially with crop pests control, know that bees are insects, for example. However, they do not discriminate which insects provide environmental services, such as pollination or biological control, and which are considered pests in the crops. Therefore, sellers have some proximity to the production of the passion fruit, and therefore, some understanding on pollination, but not as deep as the farmers. The farmers of the passion fruit know the importance of bees as agents of pollination and recognize their positive role, which was also found

in other studies (Gurung, 2003; Kasina et al., 2009) not found in other sectors related to production and consumption of the passion fruit, despite their degree of schooling. Therefore, non-scholar education seems to be the most important factor causing knowledge and positive perception on pollination.

The sectors close to the passion fruit production, i.e. the sellers and the farmers, are related to understanding the pollination concept and consider pollinators essential to the production and quality of the fruit. These sectors also know many bee species and understand that large-sized bees are essential for the passion fruit culture, as it was found also for bees in general (Gurung, 2003; Santos and Costa-Neto, 2012). Other studies also found that farmers and producers know the concept of pollination and the importance of bees as pollinators (Munyuli, 2011; Kasina et al., 2009; López-Del-Toro et al., 2009). In general, these sectors received training on pollination through their social associations or institutes, together with individual experience, which should explain their greater knowledge on the subject (Hanes et al., 2013; López-Del-Toro et al., 2009). Most farmers know the concept of pollination and the importance of bees as pollinators (Munyuli, 2011; Kasina et al., 2009; López-Del-Toro et al., 2009). Thus, training courses or even the follow-up of extension courses may consistently increase the understanding on pollination.

Consumers, who do not deal with the production in their daily lives, know less the concepts analysed and the importance of bees for pollination. Primary consumers associate bees with nature, quote popular names and characteristics of bees; secondary consumers associate bees to negative characteristics, such as stinging, allergy, pain and fear; final consumers associate bees with food, mostly honey (Ulysséa et al., 2010). The association of bees to negative characteristics seems to be common in similar studies, focused in consumers (Modro et al., 2009; Ulysséa et al., 2010). Formal/scholar education within these sectors did not influence the perception on environmental services, contrary to what was found in other studies (e.g. Muhamad et al., 2014). In order to formal/scholar education to be effective, it must be structured with an environmental approach.

In our case, the sectors of sales and consumption of the passion fruit are distant from the areas of production: they live in urban environments. They might not have frequent contact with field production, and the infrequent daily experience with aspects involving pollination and pollinators may affect our results. Consumers, who are in usually in urbanized environments, might have a less effective relationship with pollinators, and therefore, these beings might be less remembered. For these sectors, environmental education might be a component to help to raise awareness and promote ecologically sustainable attitudes (Frantz and Mayer, 2013). Non-scholar education, considering the knowledge promoted by contact with the environment, have a strong influence in this matter.

Scholar education was not related to the understanding of the pollination service, but non-scholar education, which also includes participating in workshops and courses, increased the knowledge on pollination here and in other studies (Hanes et al., 2013; López-Del-Toro et al., 2009). Non-scholar education positively influenced the perception of people on bees and pollination, and the contact with green areas for professional purposes put these sectors into a reality in which knowledge about pollinators becomes a working tool. This professional experience and individual interest influenced the perceptions regarding the importance of the bees in pollination.

Although consumers know less about pollination and pollinators than farmers, they exhibited pro-environmental attitude, being related to the answers “destruction of green areas, use of pesticides, diseases and global warming affect bees” and “consider important to create a seal to ensure that passion fruit production protects bees and pollinators”. They acknowledged bees as valuable and they support initiatives for pollinator-friendly agriculture. Therefore, we show that there is a dichotomy: while consumers have a pro-environmental attitude and believe it is important to protect the bees, they do not know the concepts related to pollinations and do not see bees positively.

Environmental education is a tool that can increase the perception of the importance of pollinators in society (Sodhi et al., 2010). It is important to promote public policies that allow for the creation of green urban areas, which would not only directly favour the survival of pollinator species, but also increase the contact of people

to the ecosystem services provided by pollinator species (Sodhi et al., 2010; Ramadoss and Poyya Moli, 2011). In addition to improving the quality of life of the human population, the presence of green areas can promote contact with living beings to improve the understanding and perceptions of these services (Sodhi et al., 2010; Ramadoss and Poyya Moli, 2011).

CONCLUSIONS

We found different perceptions of the importance of bees along the different sectors related to production and consumption of the passion-fruit mainly due to non-scholar education and, in some cases, due to the degree of scholar education. Farmers and sellers of inputs know more correct concepts about pollination, probably related to their more frequent attendance to training and workshops, besides their daily professional experience.

Sectors related to the passion fruit sales and consumption know less correct concepts about pollination, probably because they live in urbanized sites with less contact with green areas. In general, familiarity to the subject is determinant on peoples' perceptions on pollination and concepts, however this did not turn them pro- environmental seals and regulation.

For the people to be more supportive of conservation policies, especially the protection of bees, it is necessary to invest in awareness-raising activities for sectors that are distant from green areas and of the production itself. The insertion ecosystem services in the daily life may lead to more support of conservation actions. At the same time, it would be necessary to provide options and find collaborative measures to properly assess environmental regulations and seals that would reflect widely accepted along the sectors.

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SUPPLEMENTARY MATERIAL

Supplementary material accompanies this paper.

This material is available as part of the online article from https://drive.google.com/drive/folders/1edTTFVqtV37l3fys35OxFMUqb8vFlWbz?usp=sharing

REFERENCES

CORBET, S.A. & WILLMER, P.G., 1980. Pollination of the yellow passionfruit: nectar, pollen and carpenter bees. *Journal of Agricultural Sciences*, vol. 95, no. 3, pp. 655-666. http://dx.doi.org/10.1017/S0021859600088055.

DE OLIVEIRA, L.E.C. & BERKES, F., 2014. What value São Pedro's procession? Ecosystem services from local people's perceptions. *Ecological Economics*, vol. 107, no. C, pp. 114-121. http://dx.doi.org/10.1016/j.ecolecon.2014.08.008.

FAO, 2004. Conservation and management of pollinators for sustainable agriculture - the international response. In: B.M. FREITAS & J.O.P. PEREIRA, orgs. *Solitary bees conservation, rearing and management for pollination.* Fortaleza: Imprensa Universitária, pp. 19-25.

FRANTZ, C.M. & MAYER, F.S., 2013. The importance of connection to nature in assessing environmental education programs. *Studies in Educational Evaluation*, vol. 41, pp. 85-89. http://dx.doi.org/10.1016/j.stueduc.2013.10.001.

GALLAI, N., SALLES, J.M., SETTELE, J. & VAISSIÈRE, B.E., 2009. Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics*, vol. 68, no. 3, pp. 810-821. http://dx.doi.org/10.1016/j.ecolecon.2008.06.014.

GIANNINI, T.C., CORDEIRO, G.D., FREITAS, B.M., SARAIVA, A.M. & IMPERATRIZ-FONSECA, V.L., 2015. The dependence of crops for pollinators and the economic value of pollination in Brazil. *Journal of Economic Entomology*, vol. 108, no. 3, pp. 849-857. http://dx.doi.org/10.1093/jee/tov093.

GOULSON, D., NICOLLS, E., BOTÍAS, C. & ROTHERAY, E.L., 2015. Bee declines driven by combined stress from parasites, pesticides, and lack of flowers. *Science*, vol. 347, no. 6229, pp. 1-16. http://dx.doi.org/10.1126/science.1255957.

GURUNG, A.B., 2003. Insects–a mistake in God's creation? Tharu farmers' perception and knowledge of insects: a case study of Gobardiha Village Development Committee, Dang-Deukhuri, Nepal. *Agriculture and Human Values*, vol. 20, no. 4, pp. 337-370. http://dx.doi.org/10.1023/B:AHUM.0000005149.30242.7f.

HANES, S.P., COLLUM, K.K., HOSHIDE, A.K. & ASARE, E., 2013. Grower perceptions of native pollinators and pollination strategies in the lowbush blueberry industry. *Renewable Agriculture and Food Systems*, vol. 30, no. 2, pp. 124-131. http://dx.doi.org/10.1017/S1742170513000331.

KASINA, M., KRAEMER, M., MARTIUS, C. & WITTMANN, D., 2009. Farmers' knowledge of bees and their natural history in Kakamega district, Kenya. *Journal of Apicultural Research*, vol. 48, no. 2, pp. 126-133. http://dx.doi.org/10.3896/IBRA.1.48.2.07.

KLEIN, A.M., VAISSIÈRE, B.E., CANE, J.H., DEWENTER, I.S., CUNNIGHAM, S.A., KREMEN, C. & TSCHARNTKE, T., 2007. Importance of pollinators in changing landscapes for world crops. *Proceedings. Biological Sciences*, vol. 274, no. 1608, pp. 303-313. http://dx.doi.org/10.1098/rspb.2006.3721.

KOLLMUNSS, A. & AGYEMAN, J., 2002. Mind the gap: why do people act environmentally and what are barriers to pro-environmental behaviors? *Environmental Education Research*, vol. 8, no. 3, pp. 239-260. http://dx.doi.org/10.1080/13504620220145401.

LE CONTE, Y. & NAVAJAS, M., 2008. Climate change: impact on honey bee populations and diseases. *Revue Scientifique et Technique (International Office of Epizootics)*, vol. 27, no. 2, pp. 485-497. http://dx.doi.org/10.20506/rst.27.2.1819.

LÓPEZ-DEL-TORO, P., ANDERSEN, E., BARRAZA, L. & ESTRADA, A., 2009. Attitudes and knowledge of shade-coffee farmers towards vertebrates and their ecological functions. *Tropical Conservation Science*, vol. 2, no. 3, pp. 299-318. http://dx.doi.org/10.1177/194008290900200303.

MODRO, A.F.H., COSTAS, M.S., MAIA, E. & ABURAYA, F.H., 2009. Percepção entomológica por docentes e discentes do município de Santa Cruz do Xingu, Mato Grosso, Brasil. *Biotemas*, vol. 22, no. 2, pp. 153-159. https://doi.org/10.5007/2175-7925.2009v22n2p153.

MUHAMAD, D., OKUBO, S., HARASHINA, K., PARIKESIT, GUNAWAN, B. & TAKEUCHI, K., 2014. Living close to forests enhances people ' s perception of ecosystem services in a forest–agricultural landscape of West Java, Indonesia. *Ecosystem Services*, vol. 8, pp. 197-206. https://doi.org/10.1016/j.ecoser.2014.04.003.

MUNYULI, T., 2011. Farmers' perceptions of pollinators' importance in coffee production in Uganda. *Agricultural Sciences*, vol. 2, no. 3, pp. 318-333. http://dx.doi.org/10.4236/as.2011.23043.

NEUMANN, P. & CARRECK, N.L., 2010. Honey bee colony losses. *Journal of Apicultural Research*, vol. 49, pp. 1-6. http://dx.doi.org/10.3896/IBRA.1.49.1.01.

PAUDEL, Y.P., MACKERETH, R., HANLEY, R. & QIN, R., 2015. Honey Bees (*Apis mellifera* L.) and pollination issues: current status, impacts, and potential drivers of decline. *The Journal of Agricultural Science*, vol. 7, no. 6, pp. 93-109. http://dx.doi.org/10.5539/jas.v7n6p93.

POTTS, S.G., BIESMEIJER, J.C., KREMEN, C., NEUMANN, P., SCHWEIGER, P. & KUNIN, W.E., 2010. Global pollinator declines: trends, impacts and drivers. *Trends in Ecology & Evolution*, vol. 25, no. 6, pp. 345-353. http://dx.doi.org/10.1016/j.tree.2010.01.007.

R CORE TEAM, 2017 [viewed 21 November 2018]. *R: A language and environment for statistical computing* [online]. Vienna, Austria: R Foundation for Statistical Computing. Available from: https://www.R-project.org/

RAMADOSS, A. & POYYA MOLI, G., 2011. Biodiversity conservation through environmental education for sustainable development-a case study from puducherry, India. *International Electronic Journal of Environmental Education*, vol. 1, no. 2, pp. 97-111.

RAMÍREZ, V.M., CALVILLO, L.M. & KEVAN, P.G., 2013. Effects of human disturbance and habitat fragmentation on stingless bees. In: P. VIT, S.R.M. PEDRO & D.W. ROUBIK, orgs. *PotHoney: a legacy of stingless bees*. New York: Springer, pp. 269-282.

RUSSELL, R., GUERRY, A.D., BALVANERA, P., GOULD, R.K., BASURTO, X., CHAN, K.M.A., KLAIN, S., LEVINE, J. & TAM, J., 2013. Humans and nature: how knowing and experiencing nature affect well-being. *Annual Review of Environment and Resources*, vol. 38, no. 1, pp. 473-502. http://dx.doi.org/10.1146/annurev-environ-012312-110838.

SANTOS, M.R. & COSTA-NETO, E.M., 2012. O mangangá (Xylocopa spp., Apidae) como polinizador do maracujá-amarelo (Passiflora edulis Sims f. flavicarpa Deneger, Passifloraceae) na percepção dos moradores de Gameleira do Dida, Campo Formoso, Bahia, Brasil. *Interfaces Científicas-Saúde e Ambiente*, vol. 1, no. 1, pp. 19-29. http://dx.doi.org/10.17564/2316-3798.2012v1n1p19-29.

SODHI, N.S., LEE, T.M., SEKERCIOGLU, C.H., WEBB, E.L., PRAWIRADILADA, D.M., LOHMAN, D.J., PIERCE, N.E., DIESMOS, A.C., RAO, M. & EHRLICH, P.R., 2010. Local people value environmental services provided by forested parks. *Biodiversity and Conservation*, vol. 19, no. 4, pp. 1175-1188. http://dx.doi.org/10.1007/s10531-009-9745-9.

ULYSSÉA, M.A., HANAZAKI, N. & LOPES, B.C., 2010. Percepção e uso dos insetos pelos moradores da comunidade do Ribeirão da Ilha, Santa Catarina, Brasil. *Biotemas*, vol. 23, no. 3, pp. 191-202. https://doi.org/10.5007/2175-7925.2010v23n3p191.

ZAR, J.H., 2010. *Biostatistical analysis*. Upper Saddle River: Pearson Prentice Hall. 944 p.