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ROBERTA MONIQUE AMÂNCIO DE CARVALHO

ETNOECOLOGIA, BIOFILIA E CONSERVAÇÃO NO CONTEXTO DA CRIAÇÃO DE ABELHAS SEM FERRÃO (APIDAE, MELIPONINI) NA MATA SETENTRIONAL PERNAMBUCANA, BRASIL

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Tese apresentada ao Programa de Pós-Graduação em Etnobiologia e Conservação da Natureza, do Departamento de Biologia da Universidade Federal Rural de Pernambuco, como parte dos requisitos para obtenção de título de Doutora em Etnobiologia e Conservação da Natureza.
Linha de Pesquisa: Sistemas cognitivos e uso dos recursos naturais.

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“Though others might avoid the word, I insist that we talk about ‘love’ in conservation, because we only protect what we love.” (Michael Soulé, entrevista para The Sun Magazine, abril de 2018)

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RESUMO

Fatores afetivos e emocionais constituem um importante aspecto associado ao conhecimento ecológico local e podem exercer grande influência no comportamento humano em direção à conservação da biodiversidade. Ainda assim, a expressão destes fatores depende do contato direto, contínuo e de experiências positivas com a natureza. Nessa perspectiva, investigações sobre atividades que favorecem interações benéficas entre o ser humano e o ambiente, como a criação de abelhas, podem representar casos exemplares para o estudo de valores biofílicos em direção à natureza. Este estudo objetivou investigar os valores afetivos e emocionais associados ao conhecimento ecológico local de criadores de abelhas sem ferrão. A pesquisa foi realizada no Sítio Xixá, uma localidade rural originalmente coberta por Floresta Atlântica, no estado de Pernambuco, Brasil. No primeiro momento, nós consideramos as motivações e preferências dos criadores em direção às abelhas e sua criação. Na segunda etapa, nós analisamos as atitudes e valoração econômica que os agricultores locais (criadores de abelhas e não-criadores) atribuíam a animais de ocorrência local. Valores afetivos e emocionais desempenharam um papel importante sobretudo nas motivações e atitudes dos criadores em direção aos componentes da fauna, fossem eles as abelhas ou outros animais. Questões utilitárias e econômicas influenciaram especialmente a preferência por espécies de abelhas para criar, ainda que estas questões estivessem mais relacionadas a aspectos da economia doméstica e local, envolvendo o uso medicinal do mel, do que a aspectos estritamente financeiros e comerciais. Além disso, os criadores demonstraram atribuir menor importância ao valor econômico dos animais de ocorrência local e estiveram mais dispostos a conservar estes animais por motivos não-materiais, enquanto que os não-criadores estiveram mais dispostos a pagar pela conservação dos animais. Desse modo, nós concluímos que a expressão de valores biofílicos direcionados a animais deve estar, ao menos neste caso, mais relacionada a grupos de pessoas que mantêm atividades que favorecem interações benéficas com o ambiente, como a criação de abelhas. Nesse sentido, nós sugerimos que os valores não-materiais atribuídos aos elementos da natureza pelos grupos humanos devem ser diretamente considerados em políticas de conservação que objetivem o apoio público, como também nos esforços de educação ambiental. Isto é especialmente válido no caso de grupos humanos que residem no entorno de áreas de proteção que estão em processo de implementação do plano de manejo, como é o caso na nossa área de estudo.

Palavras-chave: Conhecimento Ecológico Local, Afetos, Emoções, Meliponicultura, Biologia da Conservação.

ABSTRACT

Emotional and affective factors are an important aspect associated with local ecological knowledge and can exert a great influence on human behavior towards conservation. Nevertheless, the expression of these factors depends on direct, continuous contact and positive experiences with nature. So, researchs on activities that favor beneficial interactions between humans and the environment, such as beekeeping, may represent exemplary cases for the study of biophilic values towards nature. In this study we investigated the emotional and affective values associated with the local ecological knowledge of keepers of stingless bees. The research was carried out in Sítio Xixá, a rural locality originally covered by Atlantic Forest, in the state of Pernambuco, Brazil. Firstly, we considered the motivations and preferences of local keepers towards the bees and beekeeping. In a second step, we analyzed the attitudes and economic valuation that local farmers (beekeepers and non-beekeepers) attributed to locally occurring animals. Emotional and affective values played an important role, especially in relation to the motivations and attitudes of the keepers towards the components of the fauna, be they bees or other animals. Utilitarian and economic issues especially influenced the preference for some bee species to be kept, but these issues were more related to aspects of the domestic and local economy (e. g. domestic usage of honey as medicine) than to strictly financial and commercial aspects. Moreover, beekeepers attributed less importance to the economic value of locally occurring animals and were more willing to conserve these animals for non-material motives, while non-beekeepers were more willing to pay for conservation of these animals. Thus, we concluded that the expression of biophilic values directed to animals must be, at least in this case, more related to groups of people who maintain activities that favor beneficial interactions with the environment, such as beekeeping. Therefore, we suggest that the non-material values attributed to the elements of nature by human groups should be directly considered in conservation policies that aim at public support, as well as in environmental education efforts. This is especially true in the case of human groups living around protected areas that are in the process of implementing the management plan, as is the case in our area of study.

Keywords: Local Ecological Knowledge, Affections, Emotions, Meliponiculture, Conservation Biology.

1. INTRODUÇÃO GERAL

Historicamente, pesquisas etnobiológicas e etnoecológicas têm investigado as interações de populações humanas locais e/ou tradicionais com a natureza, a partir sobretudo da caracterização dos conhecimentos, usos e manejos dos recursos naturais por estas populações. Entretanto, abordagens mais recentes dessas áreas de pesquisa objetivam ampliar a investigação do conhecimento ecológico local por considerar a influência de um conjunto mais amplo de fatores nas interações das populações humanas com a natureza, como fatores emocionais (MARQUES, 2001), simbólicos (TOLEDO e BARRERA-BASSOLS, 2009) e ecológico-evolutivos (ALBUQUERQUE *et al.*, 2015).

Fatores afetivos e emocionais constituem um importante aspecto da relação humano-natureza e podem exercer grande influência no comportamento humano em direção à conservação (SOULÉ, 1988; ANDERSON, 1996; HUNN, 2014). Por exemplo, sentimentos positivos em direção a animais (como "gostar" ou "sentir-se familiar") podem ter influência significativa na disposição para conservar estes mesmos animais (ver MARTÍN-LÓPEZ *et al.*, 2007; ZHANG *et al.*, 2014). Nessa perspectiva, investigações que visem compreender os diferentes fatores (incluindo os afetivos e emocionais) que influenciam a relação humano-natureza contribuem no avanço da Etnobiologia e Etnoecologia, assim como nos estudos de Biologia da Conservação (WOLVERTON *et al.*, 2014).

De acordo com Kellert e Wilson (1993), as interações humanas com a natureza se estendem além de questões de sustento físico e material para envolver também uma necessidade humana por satisfação emocional, estética e cognitiva. Nesse sentido, estes autores elaboraram a Hipótese da Biofilia, por meio da qual sugerem que a tendência humana de se afiliar emocionalmente à natureza deve ser a expressão de uma necessidade biológica que tem sido herdada durante a evolução biocultural e, portanto, essencial ao desenvolvimento mental e físico humano.

Ainda assim, Kellert (2012) destaca que a Biofilia, como outros padrões de comportamento humano complexo, é mediada pelo contexto ecológico e cultural. Desse modo, a predisposição humana de afiliação emocional com o ambiente poderia ser estimulada ou limitada pelas condições ambientais e culturais em que se inserem as populações. O contato direto e contínuo com a natureza e a experiência física e sensorial

através de uma convivência benéfica para todas as espécies diretamente envolvidas seriam, então, fundamentais para que valores biofílicos fossem manifestados e desenvolvidos (NABHAN e ANTOINE, 1993; KELLERT, 2012).

Dessa forma, certas atividades que favorecerem interações benéficas entre o ser humano e o ambiente, como a criação de abelhas, podem representar casos exemplares para o estudo de valores afetivos e emocionais em direção à natureza. A criação de abelhas é caracterizada pelo baixo impacto exploratório dos recursos naturais (JAFFÉ *et al.*, 2015) e por seu potencial para o manejo florestal sustentável (PARK e YOUN, 2012). Através da conservação de insetos polinizadores e do estímulo entre praticantes à manutenção de diversidade vegetal para fornecimento de recursos alimentares às abelhas, esta atividade pode facilitar atitudes favoráveis à conservação da natureza entre praticantes (CHANTHAYOD *et al.*, 2017).

Interações entre populações humanas e as abelhas remontam a milhares de anos e se expressam sobretudo a partir das atividades de caça e coleta do mel e, posteriormente, da criação e manejo de colônias destes insetos (CRANE, 1999). No Brasil, a criação de abelhas nativas vem sendo praticada por séculos entre povos indígenas, quilombolas e outras populações rurais, especialmente nas regiões norte e nordeste (NOGUEIRA-NETO, 1997). As abelhas nativas brasileiras compõem a tribo Meliponini de abelhas neotropicais (Ordem Hymenoptera; família Apidae; subfamília Apinae) e são comumente denominadas de “meliponíneos”, “abelhas sem ferrão” ou “abelhas indígenas”. A atividade de criação destas abelhas é denominada de meliponicultura.

Este estudo objetivou investigar valores afetivos e emocionais relacionados ao conhecimento ecológico local de criadores de meliponíneos. A pesquisa foi realizada na localidade rural Sítio Xixá, situada na Zona da Mata Setentrional do estado de Pernambuco, Brasil. Num primeiro momento, nós consideramos as motivações e preferências dos meliponicultores em direção às abelhas e sua criação. Esta etapa foi guiada pelas seguintes questões: (1) Quais as motivações consideradas por agricultores locais na escolha da meliponicultura como uma das atividades de produção familiar? (2) Quais as espécies de abelhas conhecidas e criadas pelos meliponicultores locais? (3) Quais as espécies de abelhas preferidas pelos meliponicultores e quais critérios influenciam esta preferência? Numa segunda etapa, nós consideramos as atitudes e valoração econômica que os agricultores locais (meliponicultores e não-meliponicultores) atribuíam a animais de ocorrência local na área de estudo. Esta etapa foi guiada pelas seguintes questões: (1) Há diferenças entre os agricultores que criam abelhas e os que não

criam com relação a suas atitudes em direção a animais conhecidos localmente? (2) Há diferenças entre os agricultores que criam abelhas e os que não criam com relação à valoração econômica atribuída a animais conhecidos localmente?

Os resultados da pesquisa foram divididos em dois capítulos escritos em forma de artigo científico. O capítulo 1 “Emoções influenciam as motivações e preferências entre criadores de abelhas sem ferrão?” foi publicado no periódico *Journal of Ethnobiology and Ethnomedicine*. O capítulo 2 “Biofilia e valoração econômica de animais no contexto da criação de abelhas sem ferrão” foi submetido à revista *Biological Conservation*.

2. REVISÃO DE LITERATURA

2.1 ETNOBIOLOGIA E ETNOECOLOGIA

Etnobiologia e Etnoecologia são abordagens científicas interdisciplinares, em que se aplicam teorias e métodos de diferentes disciplinas, com o objetivo de compreender as interações das populações humanas com o ambiente (ALBUQUERQUE e ALVES, 2014). A partir do diálogo entre as ciências naturais, sociais e humanas, cientistas dessas áreas têm investigado os conhecimentos e práticas que populações humanas ditas "locais" ou "tradicionais" apresentam na sua interação com o ambiente (ALVES e SOUTO, 2010).

Os termos "local" e "tradicional" têm sido utilizados em Etnobiologia e Etnoecologia para caracterizar os conhecimentos das populações humanas estudadas diferenciando-os, assim, do conhecimento científico "formal" e "acadêmico" (ALVES e ALBUQUERQUE, 2010). Dessa forma, o objeto de estudo de pesquisas etnobiológicas e etnoecológicas é o "conhecimento ecológico local" ou "conhecimento ecológico tradicional" (BERKES, 1993; BERKES *et al.*, 2000) dos distintos grupos humanos. Vale ressaltar que o termo "conhecimento ecológico local" envolve uma variada gama de contextos socioecológicos em que os grupos humanos podem estar inseridos, desde ambientes florestais (SILVA *et al.*, 2010), costeiros (MOURÃO e NORDI, 2002), agrícolas (ALVES *et al.*, 2005), até localidades urbanas (LADIO e RAPOPORT, 1999) e áreas metropolitanas (ALVES *et al.*, 2008), entre outros.

Historicamente, as investigações em Etnobiologia e Etnoecologia concentram-se sobretudo nas dimensões cognitivas (conhecimentos) e comportamentais (práticas) do conhecimento ecológico local (ALVES e SOUTO, 2010). No entanto, outras abordagens têm ido além do binômio conhecimentos-práticas, de modo a destacar a análise de outros fatores que influenciam a relação humano-natureza, como os emocionais (MARQUES 1995; 2001), simbólicos (TOLEDO e BARRERA-BASSOLS, 2009; FARIAS *et al.*, 2010) e ecológico-evolutivos (ALBUQUERQUE *et al.*, 2015).

Fatores simbólicos e emocionais têm sido discutidos principalmente no âmbito de estudos etnoecológicos, respectivamente o *complexo kosmos-corpus-praxis* como proposto por Toledo e Barrera-Bassols (2009) e a *etnoecologia abrangente* definida por Marques (1995).

De acordo com Hunn (2007), a Etnoecologia teria seu surgimento marcado pela intensificação do enfoque ecológico em estudos etnobiológicos, especialmente a partir de

pesquisas realizadas pelo mexicano Toledo (1992). Além de investigar os conhecimentos sobre elementos não-bióticos dos ecossistemas, como solos, climas e sucessões ecológicas, a Etnoecologia proposta por Toledo também analisa os sistemas de crenças e simbologias (*kosmos*) das populações locais e suas inter-relações com os conhecimentos (*corpus*) e práticas (*praxis*), no que denominou de *complexo kosmos-corpus-praxis* ou *matriz k-c-p* (ver BARRERA-BASSOLS e TOLEDO, 2005).

De acordo com Alves e Souto (2010), o primeiro pesquisador brasileiro a formular uma definição teórica original para a Etnoecologia foi Marques (1995; 2001). Em direção a uma abordagem mais ampla do contexto ecológico nas pesquisas, a *etnoecologia abrangente* proposta por Marques explorou "conexões básicas" através das quais se daria a inserção humana nos ecossistemas: homem-mineral, homem-vegetal, homem-animal, homem-homem e homem-sobrenatural. Além disso, este autor enfatizou o diálogo entre as diferentes disciplinas acadêmicas na realização de estudos etnoecológicos, como também a articulação entre os conhecimentos locais e o conhecimento científico-acadêmico, favorecendo assim o "cruzamento de saberes".

A partir desta abordagem, Marques (2001) definiu a Etnoecologia como um "campo de pesquisa transdisciplinar que estuda os pensamentos (conhecimentos e crenças), sentimentos e comportamentos" das populações humanas com os demais elementos da natureza. Ao considerar os sentimentos humanos nesta definição, este autor amplia a abordagem dos estudos sobre as interações humano-natureza, dando ênfase não somente a temas ecológicos e à inter e transdisciplinaridade, mas também ao aspecto emocional como fator importante na composição do conhecimento ecológico local.

Contribuições recentes que também visam compreender o papel de respostas emocionais na interação humano-natureza têm sido realizadas a partir de abordagens que integram Etnobiologia e Psicologia Evolutiva (ver MOURA *et al.*, 2018). Por esta perspectiva, as respostas emocionais e demais percepções humanas podem ser analisadas a partir da influência tanto da nossa história evolutiva, bem como do contexto ambiental atual e de valores socioculturais mantidos pelas sociedades (FERREIRA-JUNIOR *et al.*, 2014).

2.2 HIPÓTESE DA BIOFILIA

Wilson (1984) definiu Biofilia a "tendência inata de dirigir nossa atenção à vida e aos processos vitais". A partir desta proposição, Kellert e Wilson (1993) elaboraram a

Hipótese da Biofilia sugerindo que uma necessidade biológica humana para se afiliar emocionalmente a outros seres vivos e aos elementos naturais tem sido herdada durante a evolução biocultural. Assim, a Hipótese da Biofilia indica que a afiliação emocional com a natureza teria conferido vantagens adaptativas na nossa interação com o ambiente e, desse modo, seria parte integral do processo de desenvolvimento da espécie humana e essencial à saúde física e mental, bem como à satisfação pessoal e bem-estar (KELLERT, 1993).

Por essa perspectiva, a dependência humana da natureza iria além da busca de alimentos, matérias-primas, solos produtivos e serviços ecossistêmicos, e estaria também relacionada à necessidade humana de pensar, se comunicar, sentir e encontrar realização pessoal (KELLERT, 2012). Dessa forma, a falta de contato ou experiência direta com a natureza provavelmente ocasionaria a diminuição de uma existência satisfatória, não apenas materialmente, mas também cognitiva e afetivamente.

Kellert (1993) expandiu a noção de Biofilia examinando-a através de uma "tipologia de nove aspectos fundamentais", a partir dos quais se expressaria a tendência humana de se afiliar ao mundo natural: humanista, naturalista, estético, ecológico-científico, simbólico, moralista, utilitarista, dominador e negativista. Segundo este autor, cada aspecto representaria um tipo de relação humana básica na dependência com a natureza e indicaria, assim, algum valor adaptativo para a sobrevivência (Quadro 1).

Quadro 1. Tipologia de aspectos biofílicos fundamentais, segundo Kellert (1993).

Aspectos fundamentais	Definição	Valor adaptativo
Humanista	Forte afeição, apego emocional, "amor" pela natureza	União a grupos, partilha, cooperação, companheirismo
Naturalista	Satisfação com contatos e experiências diretas com a natureza	Curiosidade, habilidades ao ar livre, desenvolvimento físico e mental
Estético	Apelo físico e beleza da natureza	Inspiração, harmonia, paz, segurança
Ecológico-científico	Estudo sistemático da estrutura, função e relações na natureza	Conhecimento, entendimento, habilidades observacionais
Simbólico	Uso da natureza para expressões metafóricas, linguagem e pensamento expressivo	Comunicação, desenvolvimento mental
Moralista	Forte afinidade, espiritualidade e preocupação ética com a natureza	Ordem e sentido de vida, laços de parentesco e afiliação
Utilitarista	Exploração prática e material da natureza	Sustento físico e segurança
Dominador	Conquista, controle físico, domínio da natureza	Habilidades mecânicas, proezas físicas, capacidade para subjugar
Negativista	Medo, aversão, alienação da natureza	Segurança, proteção, defesa

Segundo a tipologia de Kellert (1993), a tendência humana para se relacionar com a natureza poderia variar desde atração e afeição (aspectos naturalista e humanista) até aversão e desejo de exploração (aspectos negativista e dominador). Assim, mesmo a predisposição para evitar ou rejeitar determinados elementos da natureza podem ser

entendidos como uma extensão da necessidade humana de se relacionar com o mundo natural, visto que sentimentos de medo e aversão refletiriam experiências emocionais (ainda que negativas) e teriam também sua vantagem adaptativa frente, por exemplo, a ataques ou ameaças de espécies prejudiciais à espécie humana (KELLERT, 1993).

Ulrich (1993) denominou de biofobia a predisposição de manter sentimentos de medo ou reações de fuga a certos estímulos naturais, os quais têm constituído ameaças durante a evolução humana. A partir da análise de pesquisas empíricas e teóricas sobre a associação entre paisagens naturais e a saúde psicológica e fisiológica humana, este autor evidenciou que ambas formas de afiliação, positivas e negativas, com a natureza são complementares e constituem componentes dialéticos do fenômeno biofílico.

Outras análises sistemáticas sobre os variados aspectos de expressão biofílica e suas prováveis funções adaptativas foram realizadas por alguns estudos que examinaram diferentes culturas e suas percepções sobre táxons de seres vivos (ver KELLERT e WILSON, 1993; KELLERT, 2012). Estes estudos reforçam a ideia de que a ocorrência dos tipos de conexões biofílicas é universalmente expressa através das culturas. Todavia, o conteúdo e a intensidade desta expressão parecem ser relativos ao contexto ecológico e cultural no qual se inserem os grupos humanos.

A Biofilia estaria assim diretamente associada à experiência com o ambiente e à aprendizagem cultural para ser desenvolvida e tornar-se completamente funcional (KELLERT, 2012). Wilson (1993) reforça ainda que uma base parcialmente genética para a Biofilia deve ser refletida em um conjunto de regras de aprendizagem biologicamente preparadas ou contra-preparadas, como sugere a psicologia evolutiva (ver SELIGMAN, 1971; MCNALLY, 2016). Ou seja, a tendência humana para se afiliar e dirigir atenção ao mundo natural seria provavelmente mediada por predisposições genéticas que tornariam certas emoções e comportamentos mais prováveis e fáceis de serem adquiridos (aprendizagem preparada), enquanto outros seriam de difícil aprendizagem (contra-preparada).

Dessa forma, o contato sensorial com o ambiente (experiência) e o estímulo da cultura (aprendizagem) teriam um papel fundamental na manifestação e desenvolvimento dos valores biofílicos (NABHAN E ANTOINE, 1993). Kellert (2012) ressalta ainda que o contato direto e contínuo com os elementos naturais, a partir de uma convivência benéfica com a natureza seriam essenciais para a expressão de emoções positivas e valores afetivos na interação humano-ambiente.

2.3 A CRIAÇÃO DE ABELHAS

Por favorecer interações benéficas entre o ser humano e o ambiente, a atividade de criação de abelhas pode proporcionar casos exemplares para o estudo de valores afetivos e emocionais em direção à natureza. Através da conservação de populações de abelhas, esta atividade contribui na manutenção do serviço ecossistêmico de polinização, o qual vai determinar a diversidade genética da flora nativa e a formação de frutos e sementes férteis para os cultivos agrícolas (IMPERATRIZ-FONSECA *et al.*, 2012; WOLOWSKI *et al.*, 2019). Além disso, criadores de abelhas são comumente estimulados a manter e/ou promover a diversidade vegetal, sobretudo no entorno do local de criação, para fornecimento de recursos florais utilizáveis na produção de mel e pólen pelas abelhas (CARVALHO *et al.*, 2003). Dessa forma, a criação de abelhas pode colaborar na manutenção da biodiversidade e na redução da necessidade de desmatamento e exploração de novos habitats, de modo contrário a outras atividades agropecuárias intensivas e/ou convencionais (*e.g.* cultivos de monoculturas e pecuária bovina de corte) (JAFFÉ *et al.*, 2015; POTTS *et al.*, 2016). Resultados de algumas pesquisas empíricas, por exemplo, corroboraram que a criação de abelhas facilitou atitudes favoráveis à conservação da natureza entre praticantes (CHANTHAYOD et al., 2017) e apresentou potencial para o manejo florestal sustentável (PARK E YOUN, 2012).

As interações entre seres humanos e abelhas remontam a milhares de anos e se expressam sobretudo a partir das atividades de caça e coleta do mel e, posteriormente, da criação e manejo de colônias destes insetos (CRANE, 1999). Provavelmente, os egípcios desempenharam as primeiras técnicas de manejo em direção à criação racional de abelhas, colocando-as em potes de barro, enquanto que nas Américas, a civilização pré-colombiana dos Maias foi pioneira no desenvolvimento de técnicas tradicionais de criação de abelhas nativas neotropicais (CAPPAS E SOUZA, 1995; CRANE, 1999).

As abelhas nativas neotropicais produtoras de mel compõem a tribo Meliponini e constituem um grupo de insetos sociais caracterizados pelo ferrão atrofiado ou ausente, utilizado apenas como ovipositor pelas abelhas-rainhas (MICHENER, 2007). Segundo catalogação de Camargo e Pedro (2013), a tribo Meliponini compreende 33 gêneros e apresenta expressiva diversidade e riqueza de espécies sobretudo na América Central e do Sul e África, mas podendo ainda ocorrer com menor expressividade no sudeste asiático e norte da Austrália.

No Brasil, a criação das abelhas nativas (também chamadas de “meliponíneos” ou “abelhas sem ferrão”) é denominada de meliponicultura e vem sendo praticada tradicionalmente entre povos indígenas, quilombolas e outras populações rurais, especialmente nas regiões norte e nordeste (NOGUEIRA-NETO, 1997).

Destaca-se também no Brasil a apicultura, criação de abelhas poliíbridas do gênero *Apis* resultantes do cruzamento entre subespécies introduzidas na época colonial de origem europeia, como *Apis mellifera mellifera*, e a subespécie de origem africana *Apis mellifera scutellata*, introduzida posteriormente na década de 1950 (KERR, 1967). Denominados comumente de “abelhas africanizadas” ou “abelhas com ferrão” os poliíbridos deste gênero se diferenciam das abelhas neotropicais por utilizarem o ferrão como mecanismo de defesa e por produzirem uma maior quantidade de mel por cada ninho.

No Brasil, as atividades de meliponicultura e apicultura se diferenciam especialmente com relação aos objetivos de sua produção. A criação de meliponíneos é comumente praticada por populações locais e/ou tradicionais e o mel é destinado sobretudo ao uso familiar medicinal, enquanto que a apicultura é geralmente praticada com propósitos financeiros mais bem definidos, relacionados ao comércio dos produtos de *A. mellifera* (VILLAS-BÔAS, 2012; JAFFÉ *et al.*, 2015). Ao apresentar um panorama da meliponicultura no contexto mundial, Cortopassi-Laurino *et al.* (2006) também evidenciaram esta tendência que parece haver na criação de abelhas de modo geral, em que a meliponicultura estaria mais associada a técnicas e conhecimentos de populações tradicionais, enquanto que a apicultura seria caracterizada por uma maior integração ao mercado externo para os produtos das abelhas. Apesar destas evidências, pesquisas recentes têm ressaltado a expansão mundial do mercado para os produtos dos meliponíneos e o potencial da meliponicultura para se tornar uma atividade rentável (ALVES, 2013; JAFFÉ *et al.*, 2015).

As interações das populações humanas locais e/ou tradicionais com a criação de meliponíneos têm sido documentadas em estudos etnobiológicos e etnoecológicos, que abordaram principalmente os conhecimentos e práticas locais (POSEY e CAMARGO, 1985; REYES-GONZÁLEZ *et al.*, 2014; CARVALHO *et al.*, 2014), a taxonomia local (COSTA-NETO, 1998; ZAMUDIO e HILGERT, 2012) e os aspectos simbólico-cosmológicos (SANTOS e ANTONINI, 2008; LÉO-NETO e GRUNEWALD, 2014). No Brasil, Posey (1982; 1983a; 1983b) foi pioneiro no registro do conhecimento ecológico indígena acerca das abelhas neotropicais. Através de suas pesquisas com a etnia Kayapó

no estado do Pará, este autor investigou desde os conhecimentos locais sobre a biologia e ecologia dos meliponíneos, as técnicas de criação e manejo, até os aspectos da cosmologia indígena envolvendo representações simbólicas das abelhas. Historicamente, as formas pelas quais essa etnia tem se relacionado com as abelhas representam um componente importante nos argumentos de Posey (1984) em favor do respeito aos povos tradicionais e às suas maneiras de relacionar-se com a natureza.

2.4 CONSERVAÇÃO DA NATUREZA

Estudos etnoecológicos objetivando compreender fatores afetivos e emocionais que influenciam os conhecimentos e comportamentos das populações humanas na sua interação com a natureza podem ampliar o entendimento da relação entre diversidade biológica e cultural e, assim, fornecer conceitos e ferramentas que auxiliem na efetivação dos propósitos de conservação da biodiversidade. Desse modo, estudos deste tipo têm potencial para contribuir tanto no avanço da Etnobiologia e Etnoecologia, como também da Biologia da Conservação.

Segundo Soulé (1985), a Biologia da Conservação é uma ciência multidisciplinar que emergiu da necessidade de fornecer princípios e ferramentas para a proteção da diversidade biológica frente à crise ambiental. Dessa forma, esta ciência se estruturou a partir de abordagens teóricas e práticas com o objetivo de analisar os efeitos das atividades exploratórias humanas sobre as espécies e os ecossistemas, bem como elaborar medidas práticas para prevenção ou mitigação das consequências destas atividades (SOULÉ, 1985).

Ainda que a Biologia da Conservação tenha surgido a partir de uma proposta multidisciplinar, ela esteve inicialmente focada nos aspectos biológicos da conservação, fossem eles teóricos (*e.g.* genética, ecologia e evolução) ou práticos (*e.g.* gestão e monitoramento ambiental) e pouca atenção foi dada aos aspectos humanos e sociais (MEINE *et al.*, 2006). No entanto, pesquisas recentes têm elucidado a importância de abordar a dimensão humana nos estudos de conservação da biodiversidade, tendo em vista a contribuição das ciências sociais na obtenção de resultados e políticas efetivas em direção à conservação da natureza (BENNETT *et al.*, 2017), como também o papel da diversidade cultural na manutenção dos ecossistemas e no manejo das espécies (WOLVERTON *et al.*, 2014).

As atitudes e comportamento humanos em direção à conservação são influenciados por diferentes valores atribuídos à natureza, os quais podem variar entre as culturas ou mesmo entre grupos de indivíduos de uma mesma cultura (TROMBULAK *et al.*, 2004). O valor intrínseco da natureza diz respeito ao valor de existência de determinada espécie ou ecossistema independente de sua utilidade para os seres humanos, enquanto que o valor instrumental ou econômico é baseado nos serviços que determinados componentes da natureza fornecem aos humanos e pode ser medido em termos de valor monetário (VUCETICH *et al.*, 2015; PASCUAL *et al.*, 2010). Já o valor psicológico refere-se ao bem-estar emocional, estético e espiritual que a natureza oferece aos seres humanos a partir de experiências físicas e sensoriais com o ambiente (SOULÉ, 1997; TROMBULAK *et al.*, 2004).

Numa perspectiva de valoração econômica, os tipos de valores atribuídos à biodiversidade e aos serviços ecossistêmicos podem ainda ser divididos em valores de uso e de não-uso (PASCUAL *et al.*, 2010). Os valores de uso estão relacionados ao uso direto de um recurso, a partir de sua exploração ou de sua apreciação, ou ao uso indireto a partir de benefícios derivados de sua função ecossistêmica, enquanto que o valor de não-uso refere-se ao valor intrínseco dos elementos da natureza. Por exemplo, polinizadores como as abelhas podem ser valorados pelos produtos fornecidos para as populações humanas, como mel e cera (valor de uso direto de exploração); pelos aspectos culturais, de lazer e estéticos (valor de uso direto não-exploratório); pela contribuição na reprodução e diversidade genética de plantas nativas e cultivadas (valor de uso indireto) e pelo seu valor de existência (valor de não-uso) (POTTS *et al.*, 2016).

Apesar destes valores não serem necessariamente excludentes entre si, é comum a discordância entre os próprios cientistas da conservação acerca de qual valor deve ser mais representativo do conceito de conservação da natureza e efetivo para os propósitos de proteção da biodiversidade (ver SANDBROOK *et al*., 2011). Acerca disso, Sandbrook (2015) afirma que para o amadurecimento da ciência da conservação seria mais apropriado que seus profissionais reconhecessem a diversidade de conceitos que a conservação pode abarcar e não tentassem criar um consenso rígido, que não representaria a variedade de opiniões.

Por esse ponto de vista, pesquisas em Biologia da Conservação deveriam levar em consideração os diferentes valores e conceitos que podem ser atribuídos à conservação da natureza pelas populações humanas (DÍAZ *et al.*, 2014), para que assim seja possível a

obtenção de resultados mais eficazes visando a proteção da natureza, bem como o bem-estar humano e a manutenção da diversidade biocultural.

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CAPÍTULO 1: EMOÇÕES INFLUENCIAM AS MOTIVAÇÕES E PREFERÊNCIAS ENTRE CRIADORES DE ABELHAS SEM FERRÃO?

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DO EMOTIONS INFLUENCE THE MOTIVATIONS AND PREFERENCES OF KEEPERS OF STINGLESS BEES?

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ABSTRACT

Background

According to the Biophilia Hypothesis, an emotional affiliation with nature has been inherited during human biocultural evolution. Research on beekeeping can contribute to the scientific understanding of the influence of emotions in the human-

nature relationship, since this activity provides concrete experiences of beneficial interaction between the human being and the environment by stimulating conservation-friendly values among practitioners. In this study, we investigated motivations and preferences driving beekeepers' choices. We hypothesized that emotional criteria would be the main motivators in choosing to include beekeeping into small scale farming systems. We also assumed that, once beekeeping has been chosen, the preference among species of bees for raising would also be influenced mainly by emotional criteria.

Methods

Data were collected from free lists and semi-structured interviews with 52 keepers of stingless bees from Sítio Xixá in the state of Pernambuco, Brazil. The content analysis technique was used to analyze data from interviews. The underlying criteria for motivation and preference quoted in the free lists were analyzed with Smith's Salience Index.

Results

Emotional and aesthetic criteria were the most salient motivations for choosing beekeeping as one of the activities in small scale farming systems. On the other hand, honey productivity and bee behavior were the most salient criteria for the preference for certain bee species to be kept.

Conclusions

Emotional criterion had an especially notable influence on the motives for practicing beekeeping, but not on the preference of species to be raised. This demonstrates that the scenario under study represents a panorama of multiple influences in which emotions are

one, but not the only, important component. Finally, our results indicate that the emotional domain should be taken into account in environmental education efforts and in the planning of bee management and nature conservation policies.

Keywords: Ethnoecology, Meliponini, Meliponiculture, Apiculture, Biophilia, Biophobia, Small Scale Farming Systems.

BACKGROUND

Human preferences for particular components of biodiversity, be they species, landscapes or ecosystems, play an important role in attitudes and behaviors directed towards nature conservation, as well as at the implementation of biodiversity management programs [1-3]. Preferred species may concentrate conservation support over less preferred species, given that humans usually protect what they consider important to them [4, 5]. Thus, understanding the underlying criteria that influence preferences may reveal useful information for the development of conservation strategies.

Emotions can exert significant influences in the context of human preferences, motivations and attitudes toward nature [6-8]. The importance of emotions or even the *love* of nature in the predisposition to environmental conservation has been discussed by different authors [9-11]. Wilson [12] denominated Biophilia as the innate tendency for humans to associate with the diversity of life and natural processes. With the Biophilia Hypothesis, Kellert and Wilson [13] suggested that an emotional affiliation with nature has been inherited during human biocultural evolution and, as such, would be linked not only to material exploitation of resources but also to our emotional, aesthetic, spiritual and cognitive development.

Some authors have also studied the influence of emotional orientations on human cognition relative to other animals [14, 15], as well as on the effectiveness of the process of environmental education [16], and emphasized the function of the affective-emotional domain in stimulating human knowledge and learning.

Apparently, the expression of emotional values arising from human-environment interaction depends on direct and continuous contact with nature through beneficial interactions [17, 18]. Therefore, physical and sensorial experience with nature through a beneficial coexistence is fundamental for the cultivation and development of biophilic values.

From this perspective, investigations on activities that provide such experience (*e.g.* beekeeping) can contribute to the scientific understanding of emotional values that guide preferences, motivations and human attitudes towards the conservation of nature.

Beekeeping is recognized for contributing to the conservation of pollinator insect populations [19, 20] and for encouraging practices for the maintenance and/or promotion of plant diversity among practitioners, especially around the place of beekeeping, to provide floral resources used in the production of honey and pollen by bees [21, 22]. In this way, beekeeping has the potential to collaborate in reducing the need for deforestation and exploitation of new habitats and natural resources, unlike other intensive and/or conventional farming activities, that imply a greater dependence on the market (*e.g.* sugar cane monoculture and beef cattle livestock) [23].

Thus, beekeeping may provide concrete experiences of beneficial human-environment interaction by stimulating attitudes of nature conservation among practitioners [24, 25] and potential for sustainable forest management [26].

In Brazil, keeping stingless bees has been a traditional practice among indigenous, afrodescendant communities (generally known in Brazil as "quilombolas") and other rural

populations, especially in the North and Northeast regions [27, 28]. Brazilian bees, called "abelhas sem ferrão" (stingless bees) or "abelhas indígenas" (indigenous bees), compose the Meliponini tribe of Neotropical bees while the activity of raising them is called meliponiculture.

Also noteworthy in Brazil is apiculture, the breeding of poly-hybrids of the genus *Apis* ("honeybees" or "Africanized honeybees") resulting from the cross between introduced subspecies from Europe (*e.g. Apis mellifera mellifera*) and Africa (*e.g. Apis mellifera scutellata*). Among other characteristics, the use of sting as a defense mechanism differentiates these exogenous bees from Brazilian meliponines, which possess an atrophied sting that is only used as an ovipositor by queen bees [29].

In the present study, we aimed to investigate the criteria underlying motivation and preference among beekeepers. The study was guided by the following questions: 1) What are the motivations considered by local agriculturists in choosing to include beekeeping into their local small scale farming systems? 2) What species of bees are known and raised by local farmers? and 3) What species of bees are preferred by local farmers and what are the criteria that influence this preference?

Within the context of small scale farming, where agriculturists commonly use and/or manage a wide range of animal and plant species, we hypothesize that (H1) emotional criteria would be the main motivators in choosing beekeeping as one of the component activities of local small scale farming systems; and (H2) once this activity has been chosen, the preference among species of bees for raising would also be influenced mainly by emotional criteria.

METHODS

Study area

The research was carried out at Sítio Xixá (07°35'5.96" S, 35°24'57.66" W), a rural community in the municipality of Timbaúba, state of Pernambuco, Northeast Brazil. The municipality is located in the Zona da Mata Setentrional Pernambucana (Northern Pernambuco Forest Zone) with an elevation of 101m (**Fig. 1**). The estimated population of the municipality is 53,825 inhabitants, of which 14% live in the rural zone, while the remainder lives in the urban zone [30]. The original vegetation is composed of Seasonal Semideciduous Forest and Seasonal Deciduous Forest, ranging up to Dense Montane Ombrophilous Forest. The climate is tropical with a dry season, mean annual temperature ranging from 22 to 26ºC, and mean annual precipitation of 1073mm [31]. According to Fundação SOS Mata Atlântica [32], the municipality contains approximately 12% of the remaining area of its original Atlantic Forest.

The local economy is based on the sugarcane (*Saccharum officinarum* L.) agroindustry and the production of other crops, such as banana (*Musa* sp.), cassava (*Manihot esculenta* Crantz), beans (*Phaseolus vulgaris* L.) and corn (*Zea mays* L.). Also worth mentioning are livestock raising, footwear and food industries, commercial activities and handicrafts.

Sítio Xixá is situated inside a protected natural area called Refúgio de Vida Silvestre "Matas de Água Azul" ("Matas de Água Azul" Wildlife Refuge), which is an Integral Protection Conservation Unit. The conservation unit encompasses a total area of approximately 38km² and includes portions of three municipalities in the state of Pernambuco: Timbaúba, Vicência and Macaparana (**Fig. 2**). Having been created somewhat recently (Decree nº 40.551 of 2014), the conservation unit is still in the process of being implemented, so it lacks a management council and a management plan [31].

According to data from the Municipal Health Secretary, Sítio Xixá has a total of 367 residents, arranged in 105 families. The main source of family income comes from banana (*Musa* sp.) cultivation, but the maintenance of a variety of agricultural small scale crop fields is a frequent practice for supplementing income or just for self-consumption. Financial aid from government programs also represents an important source of income. Family production is further supplemented by raising animals such as cattle, goats, pigs and bees. Among the younger generations, it is common to hold temporary jobs in the cities.

Data collection

The main reason for choosing Sítio Xixá as a study area was the presence of people who were raising bees in small scale farming systems. Field research was conducted between December 2015 and January 2017. The first contacts with local farmers were intermediated by a technician from the Agriculture Secretary of the municipality. Additional informants were subsequently selected by intentional sampling using the *snowball* technique [33]. Thus, we reached a total of 52 keepers of stingless bees in the study area, which represented approximately half of the local households (45.7%). Among the 52 keepers of stingless bees, only one was also raising Africanized hybrid species of the genus *Apis*.

Among the survey respondents, the majority (88.5%) were men. Age ranged from 27 to 82 years (mean age of 55 years) with 63.5% being older than 50 years. The reported income of the informants was concentrated between one and two times the minimum wage (*i. e.* between US$ 290 and 580, approximately). As for the level of formal

education, 30.8% of the participants were illiterate and, among those having attended school, only two people reported finishing high school.

Prior to data collection, all informants were clarified about the objectives and procedures of the research and only those who confirmed free consent participated. The research project was approved and authorized nationally by the CONEP (National Committee for Research Ethics) through Plataforma Brasil and regionally by CEP-UPE (Research Ethics Committee of the Universidade de Pernambuco) (Protocol CAAE 54357515.7.0000.5207). Authorization to carry out the research was also granted by Agência Estadual de Meio Ambiente (CPRH; State Agency for the Environment), which is responsible officialy for the management of protected natural areas in the state of Pernambuco (Process: n. 002434/2017).

Data collection was done using free lists and semi-structured interviews [34]. The interview questions addressed socioeconomic data (age, gender, formal education level, family income and occupation) and questions related to beekeeping (*e. g.* How did your interest in beekeeping start? Which kinds of bees do you know? Which kinds of bees do you keep? Which kinds of bees do you prefer to keep?). The free-listing method was applied to specifically obtain motivational (Question: What are your motives for raising bees?) and preferential (Question: Why do you prefer this bee?) criteria. In other words, we analyzed two types of decisions among beekeepers in this research: one regarding "motivations" for choosing beekeeping as part of their family farming system; and the other regarding "preferences" in the selection of certain bee species for keeping.

Scientific names of the locally known and kept bee species were determined through the use of entomological collections brought to the field for informant recognition. The collections used belonged to the Laboratoryof of Entomology of the Universidade Federal da Paraíba, João Pessoa, Paraíba State, Northeast Brazil.

Data analysis

The interviews were transcribed verbatim and submitted to content analysis [35], from which the categories for analysis regarding the motivation and preference criteria were defined (**Table 1**). To test the first and second hypotheses was used the Smith's Salience Index. The Index was calculated with the software Anthropac 4.0 [36], determining a salience measure for each criterion, ranging from 0 (minimum) to 1 (maximum). The motivation and preference criteria cited by informants in the free lists were organized into tables using Excel 2013. Each table represented the order of citation of the motivation and preference criteria mentioned by the informants in the free lists. Thus, cultural importance was higher for the criteria that approached the maximum value, *i. e.* those that obtained higher absolute frequency and ranked first in the free lists obtained from the informants [37].

Table 1. Categories for analysis obtained from interviews with informants from Sítio Xixá, state of Pernambuco, Brazil.

	Categories for analysis	Terms cited by informants in reference to bees or beekeeping	References
Motivations	Emotional	"like", "pleasure", "joy", "love", "passion"	Kellert (2012)
	Aesthetic	"beautiful", "ornament", "beauty"	Kellert (2012)
	Medicinal use of honey	"remedy", "illness", "cure"	
	Honey trade	"sell", "money"	
	Recreation	"diversion", "relaxation", "hobby", "sport"	Kellert (2012)
	Tradition	"family tradition"	
Preferences	Honey productivity	"a lot of honey", "little honey"	
	Bee behavior	"brave", "aggressive", "bites", "stings", "meek", "calm"	
	Honey quality	"dirty honey", "clean honey", "dirty bee", "clean bee"	
	Medicinal potential of honey	"remedy", "illness", "cure"	
	Honey price	"sell", "money"	

RESULTS

Motivational criteria for choosing beekeeping

The emotional criterion had the highest values for the salience index (0.638) among the motivations for choosing meliponiculture as one of the activities in family farming systems (**Table 2**). With regard to economic activity, honey trade had the fourth highest salience index (0.191), followed by aesthetics (0.322) and medicinal use of honey (0.274). Recreation (0.109) and family tradition of keeping stingless bees (0.053) followed with lower salience index values. These data reinforce our first hypothesis.

Table 2. Salience index of motivational criteria among the informants of Sítio Xixá, state of Pernambuco, Brazil.

Motivational criteria	Frequency (%)	Rank	Salience
Emotional	69.2	1.19	0.638
Aesthetic	48.1	2.00	0.322
Medicinal use of honey	48.1	2.00	0.274
Honey trade	28.8	2.00	0.191
Recreation	17.3	2.22	0.109
Tradition	5.8	1.33	0.053

Known and kept bees

The interviewees cited a total of 19 categories of bees known to them, which corresponded to 15 identified scientific species. According to Camargo and Pedro [38], 13 of these species were previously recorded in the state of Pernambuco, and two (*Frieseomelitta dispar* and *Geotrigona* sp.) had only been recorded in other Brazilian states (**Table 3**).

Table 3. Bees known by the informants of Sítio Xixá, state of Pernambuco, Northeast Brazil.

Species	**Taxonomy (Tribe)**	**Previous occurrence in the state***	**Local name**	**Citation frequency (%)**
Apis mellifera	Apini	Yes	Abelha italiana	100.0
			Abelha africana	88.5
Frieseomelitta doederleini	Meliponini	Yes	Moça-branca	63.5
Frieseomelitta dispar	Meliponini	No	Mané-de-abreu	57.7
Geotrigona sp.	Meliponini	No	Mumbuca ou Munguba	50.0
Melipona scutellaris	Meliponini	Yes	Uruçu boca-de-renda	100.0
			Uruçu boca-de-furo	92.3
Melipona sp.	Meliponini	Yes	Mandaçaia	7.7
Melipona subnitida	Meliponini	Yes	Jandaíra ou Uruçu-mirim	100.0
Partamona sp.	Meliponini	Yes	Cupira	78.8
Plebeia sp.	Meliponini	Yes	Abelha-mosquito verdadeira	100.0
			Abelha-mosquito pequena	90.4
Scaptotrigona sp.	Meliponini	Yes	Abelha-canudo	53.8
Scaptotrigona aff. Tubiba	Meliponini	Yes	Tubiba	75.0
Tetragonisca angustula	Meliponini	Yes	Jati	100.0
Trigona sp.	Meliponini	Yes	Boca-rasa	67.3
Trigona sp.	Meliponini	Yes	Cu-de-vaca	21.1
Trigona spinipes	Meliponini	Yes	Aripuá	96.1
Unidentified			Uruçu-preta	15.4
Total	**15**		**19**	

*Moure's bee Catalog (Camargo and Pedro, 2013)

The species *Apis mellifera*, *Melipona scutellaris*, *Melipona subnitida*, *Plebeia* sp. and *Tetragonisca angustula* were cited by all informants.

At least seven species of bees were kept. Of these, six were Neotropical, belonging to the tribe Meliponini: *Melipona scutellaris*, *Plebeia* sp., *Tetragonisca angustula*, *Scaptotrigona* sp., *Scaptotrigona* aff. *tubiba* and *Melipona subnitida* (**Fig. 3**). Only one local keeper of stingless bees also kept hybrid Africanized *Apis mellifera*.

All the informants raised *M. scutellaris* and 78.8% concentrated only on this species, while the other 21.2% diversified breeding, ranging from two, three or even four different species. Even the breeders who had opted for diversification had colonies of *M. scutellaris*, whose honey was used for medicinal and commercial purposes, and few colonies of the other species, generally grown without medicinal or commercial purposes. The exception was that isolated case previously cited in which *A. mellifera* was raised.

Preference criteria for choice of bee species to keep

All interviewees cited only *M. scutellaris* as the preferred species for beekeeping.

The preference criteria that had the highest salience index (0.716) was honey yield, followed by defensive behavior (0.607) (**Table 4**). Also the criteria of honey quality (0.3) and the medicinal property of the honey (0.25) were cited. The criterion with the lowest salience index was the price of honey (0.117). These data deny our second hypothesis. Emotional criteria were not directly cited by the informants in expressing their preference for a particular bee species for raising.

Table 4. Salience index of preference criteria among the informants of Sítio Xixá, state of Pernambuco, Brazil.

Preferential Criteria	Frequency (%)	Rank	Salience
Honey productivity	84.6	1.48	0.716
Bee behavior	75.0	1.59	0.607
Honey quality	59.6	2.52	0.300
Medicinal potential of honey	53.8	2.79	0.250
Honey price	25.0	2.69	0.117

DISCUSSION

Motivations for keeping bees

Emotional and aesthetics motivation

Beekeeping probably represents an exemplary case in which the manifestation of biophilic values can be favored to the detriment of economic-financial interests.

Similar to our findings, Yap *et al.* [39] reported that, according to traditional apiculturists in Northern Vietnam, the observation and the handling of bees provided them with moments "more relaxed" and "happier". Moore and Kosut [40] noted that watching bees "taking off and returning from their foraging expeditions" was part of the moments of diversion among beekeepers in urban areas. Among the keepers of stingless bees of Sítio Xixá it was also common to receive reports of moments of diversion and relaxation from observing the foraging habits of bees.

Studying beekeeping in the United Kingdom, Maderson and Wynne-Jones [25] discuss "emotional engagement" between beekeepers and bees. According to these authors, regular contact with hives among the most experienced practitioners favored the development of a "multi-sensory sensitivity" toward the natural environment. In that case, the interviewees stated that they had come to feel more intensely certain sounds and scents from the hives and also that the landscapes came to be perceived as habitats and foraging areas for the bees, among other analogous situations. In a similar way, Moore and Kosut [40] reported that beekeepers in some urban areas had an "emotional relationship" with the bees they were keeping.

It seems that beekeeping allows experiences of physical contact and emotional and aesthetic appreciation of the natural world, thus providing beneficial interactions that facilitate the expression of biophilic values in the human-environment relationship.

Symbolic aspects also appear to be important in the relationships between humans and bees. Among the keepers of stingless bees in our study, the existence of symbolic representations about *M. scutellaris* was common, especially the attribution of spiritual qualities, wisdom and capacity of intimate connection between this species and its keepers. Expressions such as "sacred bee", "divine bee" and "science bee" were frequent in reference to this species.

Lawrence [41] analyzed symbolic expressions between bees and their keepers and pointed out that because of the display of an extraordinary social structure and the relevant contributions of their products to human benefit, bees have aroused human interest since antiquity. After investigating the association of these insects with a variety of symbolic representations in different cultures, she stated that bees would represent one of the closest interactions mankind has established with nonhuman animals. Yet according to Lawrence [41], the habit of expressing feelings and desires from the symbolic

representation of certain animals demonstrates a strong inclination for affiliation on the part of human beings, which would reinforce the symbolic dimension of biophilia.

Thus, as in our results, other scientific reports have indicated that emotional and symbolic values permeate the relationship between beekeepers and bees [25, 39, 40, 42-46]. However, most of these studies put little or no emphasis on emotional values, focusing more on cognitive, material, economic and even symbolic issues.

Despite the examples previously discussed, it is necessary to emphasize that interactions with bees do not always provide biophilic expressions. For the genus *Apis*, for example, there are reports of both biophilic [25] and biophobic [47] expressions. According to Ulrich [3], biophobia is a partly genetic predisposition to retain feelings of fear or strong negative/avoidance responses to certain natural stimuli, which have been threats during human evolution.

In the case of the study area, the species *M. scutellaris* facilitated the expression of biophilia and the rearing of these insects was mainly related to emotional and aesthetic motivations. However, the species *A. mellifera* facilitated expressions of biophobia, leading informants to avoid raising them. In the study area, the biophobic manifestations on *A. mellifera* were explicitly directed to stinging, as well as its production of honey with supposedly few hygienic and medicinal qualities as compared to meliponine honey.

In the study by Cho and Lee [47], school students in South Korea expressed biophobic attitudes toward the genus *Apis* exclusively due to the fear of the sting. However, depending on the socio-ecological context in which it is inserted, this genus can also facilitate biophilic expressions, as reported by Maderson and Wynne-Jones [25] for beekeepers in the United Kingdom.

In the case of the American continent, since the introduction of the African bee (*A. mellifera scutellata*) in the state of São Paulo (Brazil) in 1956 [48], Africanized

hybrids have spread to the North and South of the continent, having reached the United States in 1990 [49]. Since then, human attacks by these bees in the Americas have been reported [50, 51]. Thus, due to the defensive use of their sting, these bees are often considered aggressive by keepers of native bees and by the general population on the continent, and are often referred to as “killer bees” [52].

Thus, it is clear that the genus *Apis* can cause biophobic attitudes to emerge due to its defensive behavior of stinging. On the other hand, we did not find reports of biophobic manifestations in the available literature for the Neotropical bees of the tribe Meliponini.

Utilitarian motivation

The criteria for medicinal use and trade honey can be interpreted as utilitarian motivations in beekeeping. Although not as important as emotional and aesthetic motivations, these criteria deserve some consideration.

Similar to the results of other authors [53-55**]**, the medicinal home use of honey in the treatment of various diseases in the study area was a more widespread practice than the selling of honey, which happened on a small scale and only occasionally. Thus, most local honey production was regularly reserved for self-consumption, exchanges and gifts for family and friends.

The medicinal use of honey, usually for personal or family use, reflects aspects of the domestic economy, since the use of this product as an alternative or complement in the local treatment of diseases can probably reduce the expense of conventional medical treatments, thus assuming a role in the household economy.

Among relatives and friends, the regular practice of donating and/or exchanging honey is most often guided by the medicinal value of the product. Similarly, Yap *et al.* [39] reported that, among Vietnamese beekeepers, 5 to 30% of the honey produced was donated to relatives and friends for the purpose of "strengthen relationships" and "increased respect from the community and relatives." In this sense, in some societies the sharing of honey, through exchanges or gifts, seems to be part of a system of local reciprocity in which the maintenance of social bonds does not follow a purely financial perspective. In his classic work, Mauss [56] investigated the relationships of exchanging products in so-called traditional societies and pointed out that the system of giving, receiving and giving back has constituted one of the fundamental principles of local economic organization and rationale, which sometimes differs from the principles of mercantile exchange conventionally practiced in the West.

In our study, then, the economic issues related to the honey of *M. scutellaris* were more linked to a system of exchange and local reciprocity than to market selling and financial interests.

All of the informants, for example, stated that they had no fixed income from the sale of honey. Thus, even though it was an activity undertaken by nearly half the families, meliponiculture was not among the main local sources of income and the motivations for its accomplishment were more related to emotional and aesthetic criteria.

Such cases have also been observed in the relationships of local societies with other biotic components, such as useful plants. After having investigated the main motivations for management practices among the Ixcatec in central Mexico, Rangel-Landa *et al.* [57] pointed that the maintenance of reciprocal relationships, through donation or exchange, was one of the most important sociocultural factors influencing the management of medicinal and ceremonial plants. In addition, the authors examined the

influence of symbolic and aesthetic factors on plant management and suggested that these factors were relevant to understanding species management by local human populations.

Preferred bee species for beekeeping

With regard to bee species preference, the criteria that presented greater salience were related to economic (honey productivity) and ethological (bee behavior) aspects. Preference for bee species for being kept was thus determined by the combination of these two criteria.

Although *A. mellifera* normally has higher honey production than the other locally known bees[1], it was not preferred, since it was considered by keepers of stingless bees as an aggressive bee due to its stinging behavior. The species *M. scutellaris*, on the other hand, represented the best combination of preference criteria from the perspective of the informants, since in addition to high honey productivity (among meliponines) it has a less aggressive behavior (as compared to *Apis* bees), along with better hygienic and medicinal qualities of the honey[2].

In this scenario, two aspects should be highlighted. The first concerns the criterion of honey productivity. Although this criterion was important, it did not necessarily reflect

[1] According to the informants, in the study area *M. scutellaris* has an average honey productivity of 2L/colony/year and *A. mellifera* 20kg/colony/year. Data from the Brazilian Association of Honey Exporters [58] *A. mellifera* has an average of 15kg/colony/year. Villas-Bôas [59] recorded 2.2L/colony/year for *M. scutellaris* in the state of Paraíba, Brazil.

[2]According to the informants, *M. scutellaris* would visit only specific flowers in search of resources for honey production, while *A. mellifera* would supposedly visit various types of materials, such as sugarcane resin (see [60]), dead animals and even animal feces. Thus, honey from *A. mellifera* was considered locally as "dirty" (see [61-63]).

financial aspects, since the criterion of honey price was the least salient. This result seems to reveal an apparent contradiction. In fact, honey productivity offered from each bee species was a material aspect taken into account by the informants, but not as a direct generator of financial resources, since selling was not the main destination of locally produced honey. As discussed previously, the use of honey in the study area reflected aspects related to household and local economy, rather than macroeconomic and financial aspects.

The second aspect to be emphasized is related to the behavior criterion. Although emotional criterion did not rank high in the preference of informants for bee species, it is important to point out that the behavioral preference criterion was indirectly linked to emotional issues. As pointed out previously, negative emotions, such as fear and aversion, were common toward *A. mellifera* due to its use of sting as a defense behavior. Such negative emotions, therefore, was one of the factors leading local beekeepers to avoid honeybees.

Thus, preference for bee species for being kept in the study area was influenced by the combination of economic (but not necessarily financial) and ethological criteria (which indirectly revealed emotional aspects on the part of the informants).

In other studies, the preference for bee species among beekeepers was also influenced by economic and ethological criteria. Tilahun *et al.* [64] analyzed the criteria chosen by apiculturists in the selection of colonies of honeybees in northern Ethiopia, and found that bee's aggressive behavior was considered, but not among the main selection criteria. In that case, even black species with more aggressive stinging behavior were preferred because of their high levels of honey productivity. Contrary to our results, beekeeping among those Ethiopian informants was directed at financially defined interests.

On the other hand, among keepers of stingless bees in Nocupétaro, Mexico [55], the species with the highest levels of importance were those whose products, such as honey and wax, were preferred by local specialists, especially for food, medicine and, in the case of wax, candle production. Thus, similar to our results, the products derived directly from stingless bees were sporadically commercialized by those Mexican beekeepers.

Our results, and the examples cited above [55, 64], illustrate an apparent trend in beekeeping in which meliponiculture is contextually associated with certain cultural values and characterized by a lesser degree of market dependence, while apiculture tended to be practiced from more financially defined purposes [23, 28, 65]. According to this perspective, the expression of economic-financial criteria in the preference of bee species for beekeeping would be more common among apiculturists than keepers of stingless bees. We wonder if the cultural trend of attributing noticeable value to emotional criteria would be maintained by local keepers of stingless bees in a different context, in which the products of stingless bees were explored in a more market-oriented approach. Further studies could provide answers to this additional question.

CONCLUSIONS

Our results suggest that emotions play an important role in human-bee interactions, especially in relation to the motivations for choosing beekeeping as one of the component activities of local farming systems.

Regarding the preference for particular bee species for beekeeping, emotional criterion did not rank high in the responses of the local keepers of stingless bees, although

the mentioned criterion of bee behavior seemed to indirectly reveal negative emotions on the part of local beekeepers towards the species *A. mellifera*.

In this way, we noticed a notable influence of emotional criterion on the motivations for beekeeping, but not on the preference of bee species to be raised. Thus, the studied scenario represents a panorama of multiple influences, in which emotions are one of the components, but not the only one. Utilitarian and economic issues also influenced the decisions of local keepers of stingless bees.

Thus, we suggest that future research on the human-bee relationship should include the scientific understanding of emotional values that, in all likelihood, influence (directly or indirectly) the relationship between local populations and the natural environment, together with cognitive, practical and symbolic components.

In view of the importance of human motivations and preferences in the development of biodiversity management strategies, our results indicate that the emotional domain involving the human-nature relationship must also be taken into account in environmental education efforts [11, 16, 47] and in the planning of bee management and nature conservation policies.

Utilitarian and economic criteria were especially important in relation to the preference for bee species for beekeeping. Nevertheless, in the meliponiculture practiced in the study area these criteria were more related to aspects of the domestic and local economy than to commercial and financial aspects. Beekeeping, especially meliponiculture, seems to represent an exemplary case in which the manifestation of biophilic values can be favored to the detriment of financial and commercial interests. For further inferences, we suggest that future studies approach biophilic and biophobic expressions in human populations that are related to species of native and exotic bees in different socio-ecological contexts.

DECLARATIONS

Ethics approval and consent to participate

All informants confirmed free and informed consent prior to data collection. The study was approved by the Research Ethics Committee from the Universidade de Pernambuco (Protocolo CAAE 54357515.7.0000.5207). Authorization to carry out the research was also granted by State Agency for the Environment of the state of Pernambuco (Process Nº: 002434/2017).

Consent for publication

Not applicable

Availability of data and material

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare no competing interests.

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Author's contributions

RMAC, AGCA, CFM and RRNA designed the study. RMAC conducted the field work, analyzed the data and drafted the manuscript. All authors contributed to the critical review of the manuscript and approved the final version.

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FIGURES

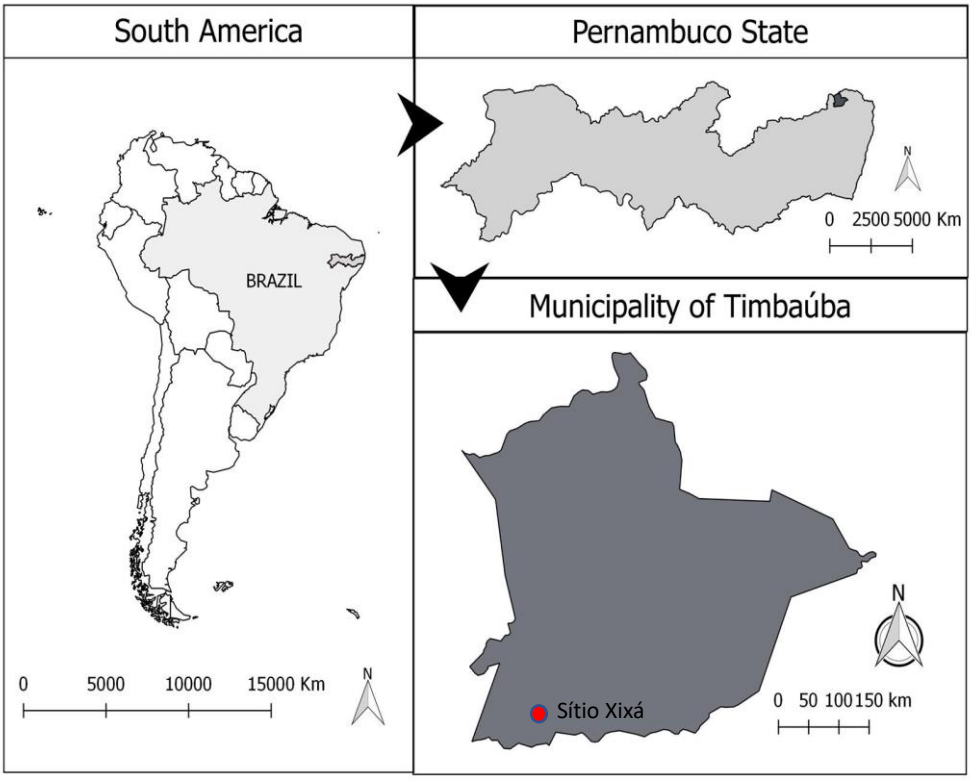

Fig. 1 Geographic location of the study area.

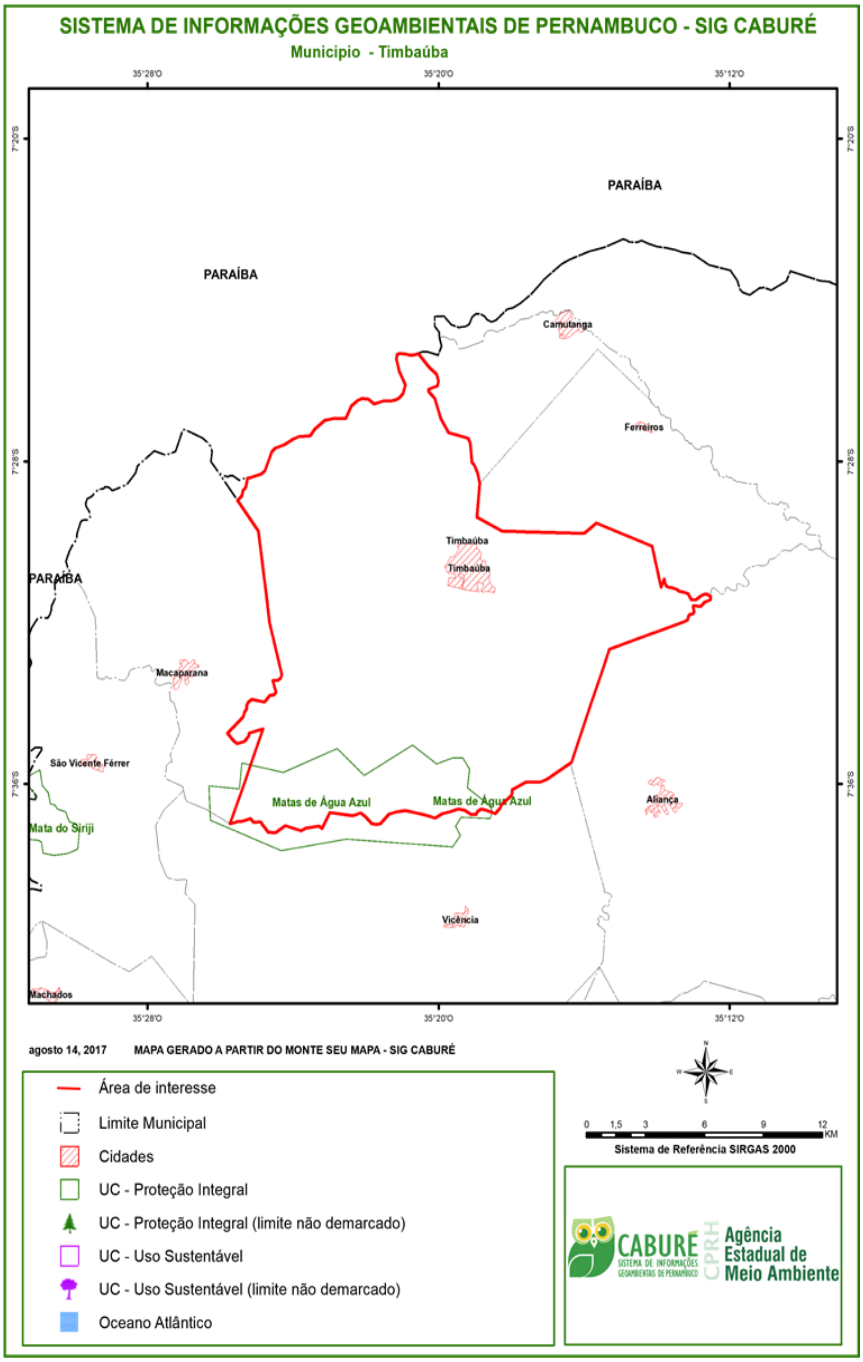

Fig. 2 Geographic location of the Matas de Água Azul Wildlife Refuge (natural protected area) in which the study area was carried out. Source: Agência Estadual de Meio Ambiente do Estado de Pernambuco.

Fig. 3 Stingless beekeeping at Sítio Xixá, state of Pernambuco, Northeast Brazil. **a** *Melipona scutellaris*; **b** *Plebeia* sp.; **c** *Tetragonisca angustula*; **d** *Scaptotrigona* sp.; **e** *Scaptotrigona* aff. *tubiba*; **f** *Melipona subnitida*.

CAPÍTULO 2: BIOFILIA E VALORAÇÃO ECONÔMICA DE ANIMAIS NO CONTEXTO DA CRIAÇÃO DE ABELHAS SEM FERRÃO

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BIOPHILIA AND ECONOMIC VALUATION OF ANIMALS IN THE CONTEXT OF STINGLESS BEEKEEPING

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ABSTRACT

Affective and aesthetic values attributed to nature are primary motivations that can influence human attitudes towards, and economic valuation of, biodiversity. The expression of these values, however, depends on direct contact and positive experiences with nature. In this sense, research on activities that favor beneficial human-nature interactions, such as beekeeping, can contribute to understand the factors (including affective and aesthetic) that influence attitudes towards biodiversity and its economic valuation. Our research was carried out at Sítio Xixá, a rural locality originally covered by Atlantic Forest, in the state of Pernambuco, Brazil. We investigated attitudes towards animals locally known and their economic valuation among two groups of small-scale farmers: keepers and non-keepers of stingless bees. We argued that keepers of stingless bees would cite more affective-aesthetic attitudes towards animals and would be more willing to pay for animal conservation than non-beekeepers. Data were collected using semi-structured interviews. Beekeepers cited more affective-aesthetic attitudes than non-beekeepers. On the other hand, beekeepers were less willing to pay for animal conservation compared to non-beekeepers. It seems that the expression of biophilic values directed to animals tend to be more frequent in groups of people who maintain activities that favor beneficial interactions with the environment, such as beekeepers. However, these values reflect non-material aspects that people attribute to nature, which may not be economically valued by human groups. Therefore, non-material values that human populations attribute to nature, such as those related to affections and aesthetics, should be considered in conservation proposals involving the public.

Keywords: Human Attitudes, Contingent Valuation, Stingless Bees, Meliponini, Emotions, Conservation Biology.

1. INTRODUCTION

The study of human attitudes towards biodiversity has received increasing attention in conservation biology research (Talukdar and Gupta, 2018; Acuna-Marrero et al., 2018). This is due, particularly, to the need to develop effective management strategies, with a view to achieving public support (Dunn et al. 2018; Rodgers and Willcox, 2018).

In pioneering studies, Kellert (1981; 1984; 1985; 1987; 1991; 1993a) investigated different human groups and their attitudes towards a diversity of animals, thus developing a basic typology that would represent the relationship between humans and other animals. This typology is composed of nine attitudes (naturalistic, humanistic, utilitarian, moralistic, ecological-scientific, aesthetic, symbolic, domineering and negativistic) and continues to be used as a reference in conservation and human-nature interaction studies (George et al., 2016; Zajchowski and Brownlee, 2018; Junaedi, 2018).

Since Kellert's studies, empirical research has recognized that affections and emotions are important primary motivations that influence human attitudes toward nature (Martín-López et al., 2007; Ballouard et al., 2012; Zhang et al., 2014; Carvalho et al., 2018). The importance of emotions or even the *love* of nature for the predisposition for environmental conservation has also been discussed theoretically by a variety of authors (Anderson, 1996; Soulé, 1997; Hunn, 2014).

Wilson (1984) defined Biophilia as the "innate tendency to direct our attention to life and vital processes." From the Biophilia Hypothesis, Kellert and Wilson (1993) suggested that human emotional affiliation with nature has been inherited during biocultural evolution and thus our interactions with nature should be associated not only with material exploitation of resources, but also with cognitive, emotional, aesthetic and cultural development.

On the other hand, various approaches in the area of conservation biology have emphasized the importance of estimating the economic benefit of biodiversity and ecosystem services to assist in political decision-making processes towards conservation (Costanza et al., 1997; Pascual et al., 2010). In this sense, research that uses techniques of economic valuation of biodiversity to provide information to support conservation programs has received prominence (Schutgens et al., 2018).

The Contingent Valuation method (Mitchell and Carson, 1989) stands out among the most used economic valuation techniques. The method involves questioning individuals about their willingness to pay a sum of money for the conservation of a given species or environmental service. Research using this method has revealed that human motivations to pay for conservation are sometimes based on non-material valuation of nature, such as affective and aesthetic values (Martin-López et al., 2007; Sattout et al., 2007; Marre et al., 2015).

The expression of affective and aesthetic values deriving from human-environment interactions should depend strongly on direct and continuous contact with nature (Nabhan and Antoine, 1993). According to Kellert (2012), physical and sensorial experiences with nature through a beneficial coexistence for the directly involved species would be fundamental for biophilic values to be manifested and developed.

Thus, research on activities that favor beneficial human-nature interactions, such as beekeeping, can contribute to the empirical analysis of the various factors (including affective and aesthetic) that influence the attitudes towards biodiversity and its economic

valuation. Beekeeping provides concrete experiences of positive human-environmental interaction through the conservation of native pollinators (Maderson and Wynne-Jones, 2016) and encourages the maintenance and promotion of plant diversity in order to provide food resources to bees (Chanthayod et al., 2017). Thus, this activity is commonly recognized for its potential contribution to sustainable forest management (Park and Youn, 2012).

In Brazil, keeping native honeybees has traditionally been practiced in the North and Northeast regions. Native Brazilian bees, called "stingless bees" or "indigenous bees", make up the tribe Meliponini of Neotropical bees, while the activity of keeping them is termed meliponiculture (Nogueira-Neto, 1997).

We aimed to investigate attitudes toward animal species and their economic valuation among small-scale farmers, with particular interest in comparing two particular groups: those that kept stingless bees and those that did not. For this, we considered the following questions: 1) Do farmers that keep stingless bees and those who do not differ in the kinds of attitudes they have towards locally known animals? 2) Do the two groups of farmers differ in their economic valuation of locally known animals?

Firstly, we argue that farmers who keep stingless bees would cite more affective-aesthetic attitudes toward locally known animals than farmers who did not. Additionally, we argue that the meliponiculturists would be more willing to pay for the conservation of locally known animals than those who did not practice meliponiculture.

2. MATERIAL AND METHODS

2.1 Study area

The research was carried out at a rural locality called Sítio Xixá (07°35'5.96" S, 35°24'57.66" W), located in the municipality of Timbaúba in the state of Pernambuco, Brazil (Fig. 1). The municipality covers an area of 292,984 km² and is located in the Mata Norte region. The estimated population of the municipality is 53,825 inhabitants, of which 14% live in the rural zone while the others live in the urban zone (IBGE, 2010). The native vegetation is composed of Semideciduous and Deciduous Seasonal Forest varying to Dense Montane Ombrophilous. The climate is tropical with a dry season; the mean annual temperature varies from 22 to 26ºC and the mean annual rainfall is 1073 mm. According to Fundação SOS Mata Atlântica (2017), the municipality has approximately 12% of its original Atlantic Forest remaining.

The rural activities in the region are main based in the sugarcane (*Saccharum officinarum* L.) agroindustry along with the production of other crops, such as banana (*Musa* spp.), manioc (*Manihot esculenta* Crantz), beans (*Phaseolus vulgaris* L.) and corn (*Zea mays* L.). Livestock is also noteworthy.

Part of Sítio Xixá is located within the wildlife refuge "Matas de Água Azul", which is an officially protected area, belonging to category IV (Habitat/species management area) in IUCN (Dudley, 2008). This conservation unit has a total area of approximately 38 km². Having been recently created (Decree nº40.551 of the year 2014), the refuge is still being implemented so it lacks a management plan (Pernambuco, 2014).

According to Secretaria de Saúde Municipal, Sítio Xixá has 367 residents and 105 families. The main source of family income is the cultivation of bananas. It is also common, although to a lesser extent, to keep a variety of agriculture crops to supplement

income or for own consumption. Financial aid from government programs also represents an important source of family income. Family production is further increased by raising animals such as cattle, goat, pigs and bees. Among the young residents, salaried work is also common in cutting sugarcane, along with temporary work in cities.

2.2 Data collection

Sítio Xixá was chosen as the study area due to the presence of families of small-scale farmers, 47.6% of which keeped stingless bees. Field research was conducted between January and September 2018. Initial contacts with local farmers were intermediated by a technician from the municipality. Beekeepers were subsequently selected by intentional sampling using the snowball technique (Bailey, 1994), which resulted in a total of 54 beekeepers. Non-beekeepers were then selected with the goal of reaching the total of the families of the study area. The final sample consisted of 43 non-beekeepers and 54 beekeepers, who together (n = 97) represented 88.6% of the families of Sítio Xixá. Families whose heads of household were not at home or who did not feel comfortable responding to the interview were not included in the sample.

From the socioeconomic point of view, the studied farmers (beekeepers and non-beekeepers) represented a relatively homogeneous group. Beekeeping was an important differential between the groups of farmers under study. The majority (88.9%) of beekeepers were men, and ages ranged from 27 to 82 years. The reported income of the informants was concentrated between one and two times the minimum wage (between US$ 264 and US$ 503, approximately). As for the level of formal education, 42.6% were illiterate and only three individuals had completed high school. Among non-beekeepers, the majority (83.7%) were men, with ages ranging from 22 to 81 years. The reported income was also concentrated between one and two times the minimum wage. As for the level of formal education, 51.2% were illiterate and only three non-beekeepers had completed high school.

The objectives and procedures of the research were clearly explained to all informants prior to data collection, and only those who confirmed free consent participated. The research was approved and authorized by Comissão Nacional de Ética em Pesquisa (CONEP) through Plataforma Brasil and Comitê de Ética em Pesquisa of the Universidade de Pernambuco (CEP-UPE) (Protocol CAAE 54357515.7.0000.5207). Authorization to carry out the research was also granted by Agência Estadual de Meio Ambiente (CPRH), the agency responsible for managing protected areas in the state of Pernambuco (Process Nº: 002434/2017).

Data collection was accomplished by performing semi-structured interviews (Albuquerque, 2014). Interviews aimed at determining the attitudes and economic valuation that each informant attributed to 18 species of locally occurring animals. The animals to be studied were selected by means of a pre-test in which 11 informants (six beekeepers and five non-beekeepers) were asked about the local animals they liked best (biophilic) and the ones they liked least (biophobic). After that, 18 species of animals with the highest frequency of citation were selected and photographs of these animals were taken to the field for the informant's recognition and subsequent scientific identification. These 18 animal species included six with biophilic tendency, six with biophobic tendency and six of ambiguous character (Table 1). Bees were not considered for analysis due to biases that could cause to the group of beekeepers.

To determine attitudes, each informant was questioned about the 18 selected species of animals. The interview included the photograph of each species followed by the question “Do you like this animal? Yes or no? Why?”. All reasons cited by the informants were taken into consideration for analysis, and thus each informant could express more than one attitude for each animal.

The respondents was then asked about their willingness to pay for the conservation of the same species of animals according to method of contingent valuation (Mitchell and Carson, 1989). This method proposes a hypothetical market in which the individuals reveals their willingness to pay for the conservation of given species. In the case of this research, we asked the following question: “Let’s imagine that this species is in danger of extinction. Some government institutions would, then, create a conservation plan for the species. If this plan included voluntary contributions to raise funds to help with the conservation projects for the species, would you contribute? How much between R$ 0 and R$ 50.00?”.

2.3 Data analysis

2.3.1 Attitudes

Responses were categorized after Kellert’s basic typology (1993b; 2012). The nine basic attitudes suggested by this typology were grouped into six categories of analysis for the purposes of this study: affective-aesthetic, negativistic, materialistic, moralistic, ecological-scientific and symbolic (Table 2).

The number of citations for each category was used to compare attitudes between the two groups of farmers, considering all the animals. Normality of the data was tested using the Shapiro-Wilk test. The Mann-Whitney U test was used to assess the significance of differences in the number of individual citations for each attitude between the two groups of farmers. This test was performed using Statistica software version 13.3 (Statistica, 2017) and a significance level of 5% ($p < 0.05$) was used.

2.3.2 Economic valuation

To determine which of the two groups of farmers would pay the highest total value for the conservation of all animals, the total, average and median sum of the amounts willing to be paid by each informant for all species were calculated.

To differentiate the two groups of farmers according to who would pay the highest and lowest amounts, the values cited by the informants were categorized into four ranges: zero (R$ 0.00); ten (R$ 1 – 10.00); thirty (R$ 11 – 30.00) and fifty (R$ 31– 50.00).

The number of citations for each range was used to compare the economic valuation of the two groups of farmers, considering all the animals. The normality of the data was tested using the Shapiro-Wilk test. The Mann-Whitney U test was used to assess the significance of the differences in the number of individual citations of each range between the two groups of farmers. This test was performed using Statistica software version 13.3 (Statistica, 2017) and a significance level of 5% ($p < 0.05$) was used.

2.3.3 Attitudes and economic valuation considering groups of animals

Simple Correspondence Analysis (SCA) was used to assess the relationship between the attitudes and economic valuation mentioned by the farmers considering the three selected groups of animals: biophilics, biophobics and ambiguous. SCA was then applied to the two groups of farmers (beekeepers and non-beekeepers) separately. Statistical Analysis System software version 8 (SAS, 1999) was used to perform this analysis.

3. RESULTS

3.1 Attitudes

Beekeepers cited significantly (U=872.5, p=0.03) more affective-aesthetic attitudes towards the animals chosen for this study than non-beekeepers (Table 3). This result confirmed our first assumption.

The two groups of farmers also differed significantly with regards to moralistic (U=715.5, p=0.001), ecological-scientific (U=804.5, p=0.009) and symbolic (U=867.5, p=0.03) attitudes, which were all cited more by the meliponiculturists than by the other farmers studied (Table 3).

No significant differences were found between the two groups of farmers regarding negativistic (U=1140.0, p=0.88) and materialistic (U=1037.5, p=0.37) attitudes (Table 3).

Both groups of farmers had a high frequency of affective-aesthetic and negativistic citations, while ecological-scientific and symbolic attitudes were the least mentioned by both groups (Table 3).

3.2 Economic valuation

The group of non-beekeepers had the highest total value for disposition to pay for the conservation of the animals, as well as higher mean and median values (Table 4).

The two groups of farmers differed among the valuation ranges. Beekeepers differed significantly (U=801.0, p=0.009) from the non-beekeepers in the ‘zero’ range, which was more frequent among the former (Table 5). In other words, the group of meliponiculturists had the largest number of refusals to pay for the conservation of the given species of animals. The reasons given among the meliponiculturists for not being willing to pay were: (1) would not pay, but the animal deserves to be conserved (69.3%) and (2) the animal does not deserve to be conserved (30.7%). The reasons given by the non-beekeepers were: (1) the animal does not deserve to be conserved (47.4%); (2) would not pay, but the animal does deserve to be conserved (45.2%); and (3) indifferent (7.4%). The denials to pay for conservation by both groups of farmers were addressed to animals that tended to trigger biophobic reactions.

No significant differences were found between the two groups of farmers for the valuation ranges of ‘ten’ (U=1159.0, p=0.99), ‘thirty’ (U=991.0, p=0.21) and ‘fifty’ (U=1147.5, p=0.92) (Table 5).

The results of this analysis contradicted our second assumption. Beekeepers had lower average disposition to pay for species conservation than non-beekeepers and had the largest number of refusals to pay for the conservation of the animals.

Both groups of farmers had a high frequency of citation for the ‘ten’ valuation range (Table 5). In other words, most of the informants of both groups were willing to pay the lowest amounts (between R$ 1.00 and R$10.00) towards conservation of the animals.

3.3 Attitudes and economic valuation considering groups of animals

Each SCA identified two dimensions that were projected onto two-dimensional plots. For both groups of farmers (beekeepers and non-beekeepers), the two dimensions together explained 100% of the total variance of the data (Fig. 2a and 2b, respectively). These high percentages indicate the adequacy of the analysis to explain the variation of the data in two linear combinations.

In both groups of farmers, the animals with biophilic tendency were associated with affective-aesthetic and materialistic attitudes and with the highest valuation ranges, ‘thirty’ and ‘fifty’ (yellow circles in fig. 2a and 2b). The animals with biophobic tendency were associated with negativistic attitudes and with the ‘zero’ valuation range, again in both groups of farmers (black circles in fig. 2a and 2b). Among beekeepers, the animals with ambiguous tendency were close to ‘ten’ valuation range (purple circle in fig. 2a), while among non-beekeepers these same animals were close to ‘thirty’ valuation range (purple circle in fig. 2b).

In the group of beekeepers, moralistic and ecological-scientific attitudes were close to animals with biophobic tendency (dashed circle in fig. 2a), while in the group of non-beekeepers these same attitudes were close to center of the graphic axis (dashed circle in fig. 2b).

Symbolic attitudes were excluded from this analysis due to the low frequency of citation of this attitude in both groups of farmers.

The results of this analysis demonstrated similar patterns between the two groups of farmers regarding their attitudes and economic valuation directed to the groups of animals studied. Nevertheless, some differences were found. The willingness to pay for conservation of animals with ambiguous tendency was higher among non-beekeepers. Among beekeepers, moralistic and ecological-scientific attitudes were closer to the animals with biophobic tendency.

4. DISCUSSION

4.1 Attitudes

4.1.1 Affective-aesthetic attitudes

Beekeepers cited more affective-aesthetic attitudes than non-beekeepers (Table 3). This finding suggests that the expression of biophilic values towards animals tends to be more frequent in groups of people who maintain activities that provide beneficial interactions with nature than those who do no such activities.

The expression of emotions in human-animal interactions has been widely studied due to the proximity and regularity of these interactions, either as direct contact with an occasional animal or as more frequent and continuous direct contact. For example, Ballouard et al. (2012) examined the influence of a snake handling experience in the field on the attitudes of children and found that positive emotions and willingness to protect these animals increased considerably among the studied children after the experience of direct contact with snakes. Similarly, Prokop and Fancovicova (2016) analyzed the effect of a school activity involving the handling of gastropods on student's attitudes towards these animals and other animals that usually cause aversion in humans (e.g. snake and bat). They demonstrated that students who have had experiences of direct contact with gastropods have reduced negative emotions towards these animals as well as towards other animals considered to be biophobic.

Prokop and Tunnicliffe (2010) analyzed the influence of direct and continuous contact with pets by comparing the attitudes of children who kept pets at home with those who did not own pets. Children who maintained continuous contact with pets had more positive attitudes towards animals that are considered biophilic (e.g. rabbit and squirrel) as well as those considered biophobic (e.g. rat and wolf).

The examples discussed so far in this item show the effect that direct and/or regular contact with animals has on the manifestation of positive emotions directed towards certain components of fauna, whether they are considered biophilic or biophobic. More broadly, other authors have studied the effects of the degree of contact with nature in general (and not only with certain animals) on the expression of biophilic values directed towards animals. For example, Zhang et al. (2014) analyzed the emotional attitudes directed towards wild animals by children by comparing students from rural and urban schools in China. The degree of contact with nature was measured by student involvement in outdoor activities that were maintained in their daily lives. The students of rural schools had, in this situation, greater contact with nature, which was positively related to the biophilic attitudes and negatively related to the biophobic attitudes towards animals.

In the case of the farmers of Sítio Xixá, both of the studied groups (beekeepers and non-beekeepers) commonly have, in general, direct and continuous contact with animals and nature because both occupy rural locations due to agriculture being the main source of income. However, it is important to consider that beekeepers maintain beneficial interactions with the environment through the activities of meliponiculture, which differs from other local agricultural activities, which usually involve the use of pesticides (e.g. banana cultivation) and the slaughter of animals (e.g. raising cattle and pigs). Thus, this human-bee interaction can favor affective and aesthetic attitudes toward bees (Carvalho et al., 2018), and influence attitudes toward other locally occurring animals, as evidenced by the present study.

The relationship between biophilia and bees has also motivated studies regarding potential educational implications. Cho and Lee (2017) analyzed the biophilic values of students in South Korea through an environmental education program with bees, which involved expository classes and lectures on aspects of the biology and ecological importance of these insects, as well as observations and direct contact with honey, wax and the bees themselves. After the implementation of the environmental program there

was increased affinity and biophilia towards bees, as well as a feeling of connection with nature, among the students. The authors of this study discussed the importance of environmental education programs using partner insects, especially bees, which appear to be good mediators to stimulate biophilic values toward nature.

It seems that the expression of biophilic values is not just associated with direct and regular contact with animals and other elements of nature, but is especially associated with those contacts that involve the maintenance of activities with potential beneficial coexistence with nature, as is the case with beekeeping, among other activities. From a similar perspective associated with human-bird interactions, Silva-Andrade et al. (2016) analyzed the perceptions and attitudes towards birds of two groups of farmers; one who maintained conventional production techniques (e.g. monocultures and mechanized agriculture) and one who maintaining unconventional techniques (e.g. minimization of external inputs and diversification in production). The unconventional farmers identified more bird species and had more favorable attitudes towards their conservation than the conventional farmers. The unconventional farmers also demonstrated greater "sensitivity" towards nature, as evidenced by a greater citation frequency for "beauty" of vocalization and plumage and the pleasure of contemplating these animals. The authors concluded that the adoption of certain types of agricultural practices has important implications for the local ecological knowledge of farmers and their attitudes towards conservation. This trend is similar to what we observed in Sítio Xixá, where farmers who performed different agricultural practices demonstrated different attitudes (including affective-aesthetic) towards certain components of the fauna and their conservation.

4.1.2 Other attitudes

Our analysis revealed that moralistic, ecological-scientific and symbolic attitudes were more often cited by beekeepers than by non-beekeepers (Table 3). These attitudes were mainly related to positive aspects of the human-animal relationship, such as concerns of animal ethics (generally based on Christian values), the ecological importance of the species and their use in symbolic representations, respectively. This result seems to reinforce the tendency for more frequent expression of positive attitudes towards animals by groups of people who maintain direct, continuous and beneficial contact with nature.

Similarly, Kellert and Westervelt (1983) and Bjerke et al. (1998) investigated the attitudes towards animals of two groups of adolescents that differed in degree of regular contact with pets. The results of both surveys revealed that teenagers who cared for pets had more moralistic, ecological-scientific and humanistic attitudes towards animals in general, while those without pets were more associated with utilitarian and negativistic attitudes.

The present study found no significant differences between beekeepers and non-beekeepers for materialistic and negativistic attitudes.

4.2 Economic valuation

Beekeepers were less willing to pay for animal conservation than non-beekeepers (Tables 4 and 5). Nevertheless, the main reason presented by the meliponiculturists for

the refusal to pay for the conservation of certain animals did not necessarily imply a lack of interest in their conservation (see section 3.2 Economic valuation). Although the meliponiculturists attributed less economic value to the local fauna, most of them recognized the importance of its conservation. This apparent contradiction may indicate that they attribute other types of values that motivate their concern for conservation.

The contingent valuation method was also used by Streever et al. (1998) to examine the economic value attributed to the conservation of different categories of wetlands in Australia. Similar to our results, these authors found divergences between motivations and willingness to pay for conservation on the part of the interviewees. In that case, the main motivations for conservation were related to non-material aspects, such as the intrinsic value of wetlands and their benefit for future generations. However, the wetland categories related to these main motivations received the lowest economic values by the interviewees. This finding led the authors to emphasize the importance of non-material aspects of nature in human motivations to conserve, even though these aspects were not economically valued in the results of the contingent valuation.

Other research using the contingent valuation method has also emphasized the influence of non-material values, such as intrinsic (Schutgens et al., 2018) and aesthetic (Sattout et al., 2007) value, on the responses of disposition to pay for conservation. From this perspective, Kotchen and Reiling (2000) discussed the possibility that this method could be biased against individuals who presented conservation-friendly attitudes based on non-material aspects, because these aspects are difficult to economically value. However, other research has shown that, in many cases, the disposition to pay for biodiversity conservation can be influenced precisely by non-economic reasons, such as affective and ethical aspects (Martin-López et al., 2007; Spash, 2009).

Thus, in order to control the potential biases inherent in contingent valuation and to improve the interpretation of responses about the willingness to pay for conservation, many studies have recommend that approaches to economic valuation of nature incorporate the analysis of human attitudes towards biodiversity and the environments studied so that the underlying factors that influence the disposition to pay for conservation can be identified (Kotchen and Reiling, 2000; Martin-Lopéz et al., 2008; Choi and Fielding, 2013).

In the present study, although the beekeepers were not willing to pay for conserving some animals considered biophobic, they cited more positive moralistic and ecological-scientific attitudes towards the same animals, when compared to non-beekeepers (Fig 2a and 2b). Such positions were reflected in phrases such as “I don’t give money for the hawk because it eats chicks, but every animal is a piece of nature and can’t be ended” or “For this one here (snake) I pay nothing, but it has a function in nature, feeding on insects, so it deserves to live”.

It seems that non-material values of nature (which include affective, aesthetic, moralistic and ecological aspects) were the main motivators of the conservation-friendly attitudes beekeepers exhibited towards animals. On the other hand, non-beekeepers were more influenced by economic values attributed to nature, given their greater willingness to pay for the conservation of animals and their tendency to express non-material aspects less.

5. CONCLUSIONS

The two groups of farmers studied — beekeepers and non-beekeepers — differed with regard to their attitudes and the economic value they attributed to the components of fauna considered in this study. Beekeepers had more affective-aesthetic attitudes towards these animals than non-beekeepers, although those were less willing to pay for animal conservation.

In this scenario, the expression of biophilic values towards animals seems to be related more to groups of people who maintain activities that favor beneficial interactions with the environment, such as beekeeping. However, these values reflect non-material aspects attributed to nature, which, in some cases, are not economically valued by human groups, as seems to have happened with the beekeepers in our study. Thus, according to our results, beekeepers were more associated with the expression of non-material values towards nature, whereas non-beekeepers were more associated with the expression of economic values.

In fact, conservation-friendly attitudes and behaviors towards the fauna can be driven by non-material values (Stokes, 2007; Slagle et al., 2012; Zhang et al., 2014; Acuna-Marrero et al., 2018). Therefore, we suggest that non-material values attributed to the elements of nature by human groups should be considered in conservation policies aiming at public support. Nevertheless, economic values of nature play an important role, especially if we consider subsidies for conserving endangered species and their habitats (Schogren et al., 1999). Thus, the values attributed to nature, be they economic or not, must be considered in order involve the public in conservation proposals. This is especially true when it comes to human groups living around areas that became officially protected only a few years ago, such as our study area.

The theoretical and methodological link between biophilia and economic valuation of biodiversity is clearly applicable to studies of human-animal interactions and its associated emotions (and other non-material aspects) in the conservation of nature. This seems to be a promising approach, especially for investigating activities with beneficial interactions with nature, such as stingless beekeeping.

Our data revealed, in part, the complexity of human-animal relationships, and evidenced an opportune situation for the use of interdisciplinary approaches in which economic, ecological and emotional aspects, among others, are considered.

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TABLES AND FIGURES

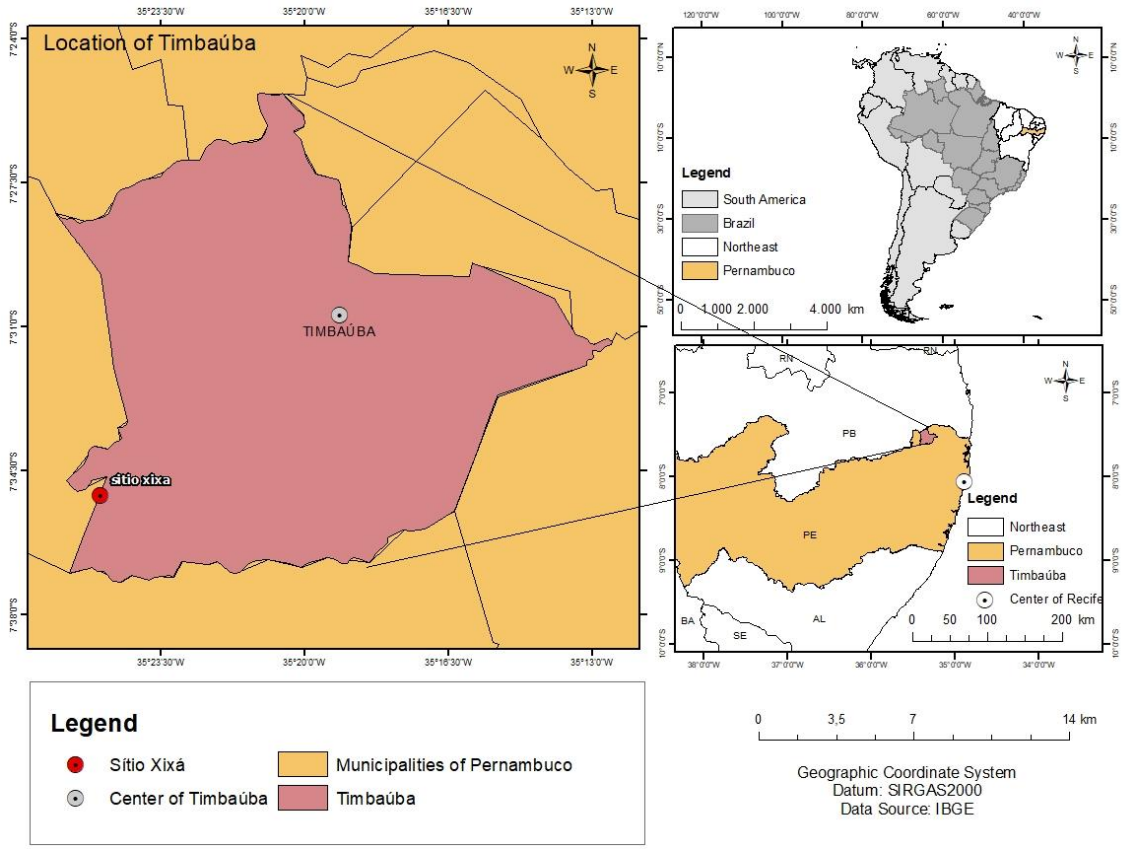

Figure 4. Geographic location of the study area.

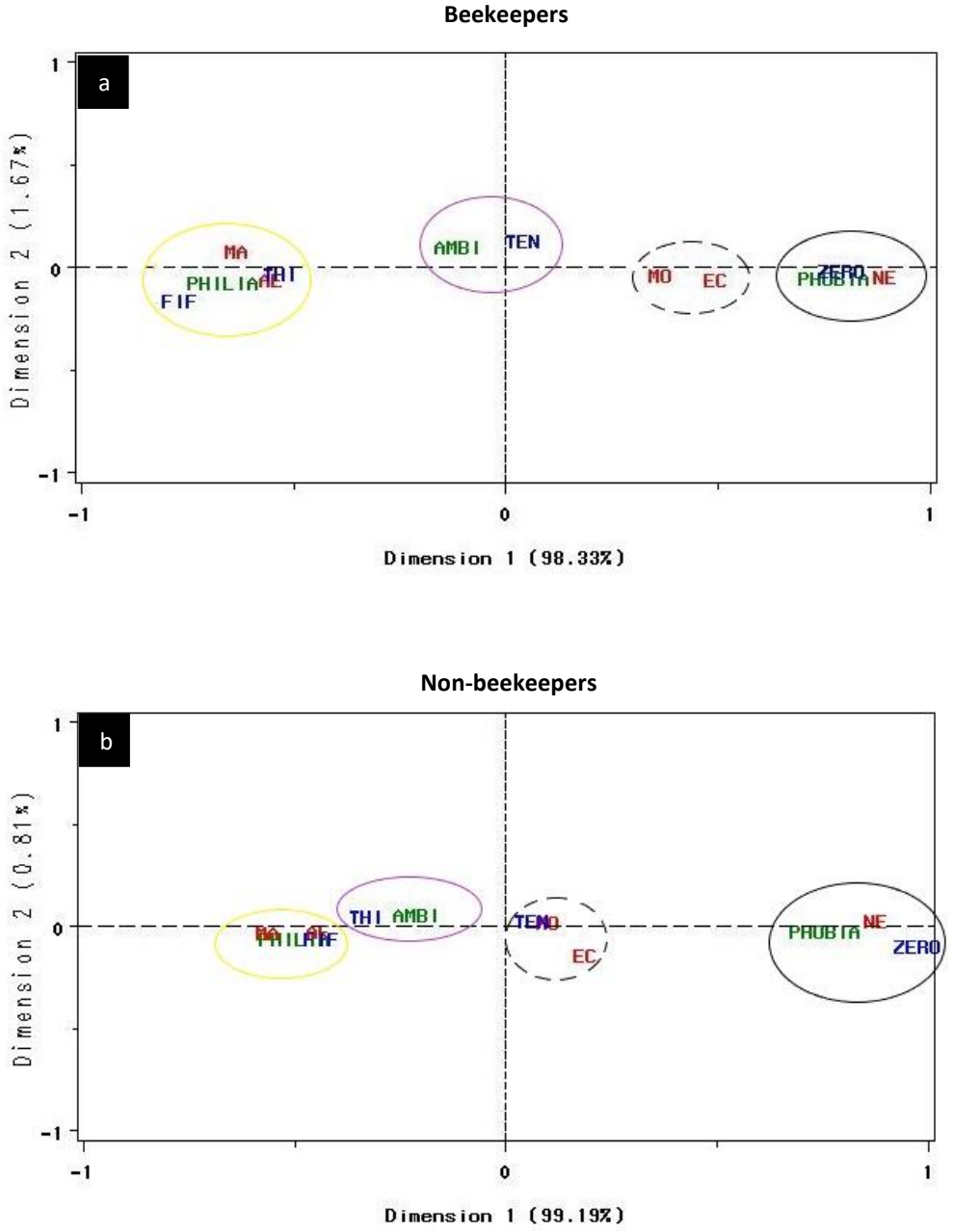

Figure 2. Two-dimensional plots generated by SCA for the attitudes and economic valuation cited by the beekeepers (a) and non-beekeepers (b) toward group of animals locally known.

Attitudes in red: AE = affective-aesthetic; NE = negativistic; MA = materialistic; MO = moralistic; EC = ecological-scientific. **Groups of animals in green:** PHILIA = animals with biophilic tendency; PHOBIA = animals with biophobic tendency; AMBI = animals with ambiguous tendency. **Economic valuation in blue:** ZERO = R$ 0.00; TEN = R$ 1.00-10.00; THI = R$ 11.00-30.00; FIF = R$ 31.00-50.00.

Yellow circles = attitudes and economic valuation to animals with biophilic tendency; **black circles** = attitudes and economic valuation to animals with biophobic tendency; **purple circles** = economic valuation to animals with ambiguous tendency; **dashed circles** = moralistic and ecological-scientific attitudes.

Tabela 1. Species of locally known animals selected for study.

Species of animals	Local name	Local tendency	Conservation status (IUCN, 2019)	Native/exotic; Domestic/Wild
Canis lupus familiaris	Cachorro	Biophilic	NE	Exotic; Domestic
Equus caballus	Cavalo	Biophilic	NE	Exotic; Domestic
Bos taurus	Boi	Biophilic	NE	Exotic; Domestic
Dasypus novemcinctus	Tatu verdadeiro	Biophilic	LC	Native; Wild
Saltator coerulescens	Sabiá-gonga	Biophilic	LC	Native; Wild
Ramphastos vitellinus	Tucano	Biophilic	VU	Native; Wild
Spilotes pullatus	Caninana	Biophobic	LC	Native; Wild
Rupornis magnirostris	Gavião	Biophobic	LC	Native; Wild
Cerdocyon thous	Raposa	Biophobic	LC	Native; Wild
Rhinella marina	Sapo	Biophobic	LC	Native; Wild
Atta sp.	Saúva	Biophobic	NE	Native; Wild
Mesoclemmys tuberculate	Cágado	Biophobic	LC	Native; Wild
Felis catus	Gato	Ambiguous	NE	Exotic; Domestic
Gallus gallus domesticus	Galinha	Ambiguous	NE	Exotic; Domestic
Sus scrofa domesticus	Porco	Ambiguous	NE	Exotic; Domestic
Eira barbara	Papa-mel	Ambiguous	LC	Native; Wild
Sapajus libidinosus	Macaco-prego	Ambiguous	LC	Native; Wild
Athene cunicularia	Coruja buraqueira	Ambiguous	LC	Native; Wild

Table 2. Categories for analyzing attitudes towards local animals formulated from the responses of the informants during semi-structured interviews.

Responses of informants	Basic attitude	Reference Kellert (1993b; 2012)	Categories for analysis in this study
"Pet", "It is good to have around", "I like to see it"	Naturalistic	Satisfaction in direct contact with nature	Affective-aesthetic
"I have affection for it", "I love it", "I adore it"	Humanistic	Emotional attachment, love of nature	Affective-aesthetic
"It is pretty", "It is a beautiful animal"	Aesthetic	Physical appeal and beauty of nature	Affective-aesthetic
"I am afraid of it!", "Disgust", "Kills my animals", "Eats the chickens and chicks"	Negativistic	Fear, aversion, alienation from nature	Negativistic
"It serves a purpose", "Provides me money", "Generates income for the family"	Utilitarian	Practical exploitation and material of nature	Materialistic
"I want to keep it in my home"	Dominionistic	Conquest, physical control, mastery of nature	Materialistic
"Left by God", "It's a piece of nature and so must be liked", "An animal that does not harm anyone"	Moralistic	Spirituality and ethical concern with nature	Moralistic
"It has a function in nature", "It is important because it eats pests"	Ecological-scientific	Systematic study of function and relationships in nature	Ecological-scientific
"Its song calls the rain", "Its song announces death"	Symbolic	Use of nature for metaphorical expressions	Symbolic

Table 3. Number of citations, and medians, referring to attitudes toward animals by the two groups of farmers.

Attitudes	B (n=54)		NB (n=43)		p-value
	N(%)	Med.	N(%)	Med.	
Affective-aesthetic	483 (32.4)	9	316 (31.3)	7	0.03*
Negativistic	299 (20.0)	6	244 (24.1)	5	0.88
Materialistic	272 (18.2)	5	229 (22.7)	5	0.37
Moralistic	284 (19.0)	5	149 (14.7)	3	0.001*
Ecological-scientific	126 (8.4)	2	67 (6.6)	1	0.009*
Symbolic	28 (1.9)	0	5 (0.5)	0	0.03*

B = beekeepers; NB = non-beekeepers; N = absolute frequency; % = relative frequency; Med. = median
* Significant differences at the level of 5%

Table 4. Total, mean and median values relative to the disposition to pay for the conservation of animals by the two groups of farmers.

	Total value	Mean	Median	Min.	Max.
B (n=54)	13,210.00	244.60	217.50	25.00	650.00
NB (n=43)	13,495.40	313.80	235.00	0.00	900.00

Values in Brazilian reais (R$)
B = beekeeper; NB = non-beekeeper

Table 5. Number of citations, and medians, for valuation ranges regarding the disposition to pay for the conservation of animals by the two groups of farmers.

Ranges of economic valuation	B (n=54)		NB (n=43)		p-value
	N(%)	Med.	N(%)	Med.	
Zero	257 (26.4)	5	135 (17.4)	2	0.009*
Ten	365 (37.5)	5	309 (39.9)	6	0.99
Thirty	212 (21.8)	4	165 (21.3)	2	0.21
Fifty	138 (14.2)	1	165 (21.3)	1	0.92

B = beekeepers; NB = non-beekeepers; N = absolute frequency; % = relative frequency; Med. = median
* Significant differences at the level of 5%

CONSIDERAÇÕES FINAIS

A criação de abelhas sem ferrão por populações locais e/ou tradicionais representa um caso exemplar para o estudo da expressão de afetos e emoções em direção à natureza. Ao que tudo indica, as interações humano-abelhas estabelecidas no âmbito da meliponicultura favorecem a manifestação de valores biofílicos direcionados à natureza em detrimento de interesses comerciais e monetários.

Nossos resultados indicaram que fatores emocionais foram a principal motivação considerada pelos agricultores locais para escolher a criação de abelhas sem ferrão como uma das atividades componentes dos sistemas locais de produção familiar. Além disso, os meliponicultores apresentaram mais atitudes afetivo-estéticas em direção a animais de ocorrência local do que os não-meliponicultores. Dessa forma, nós evidenciamos que o componente emocional e afetivo desempenha um papel importante nas interações humano-abelhas, especialmente com relação às motivações e atitudes humanas direcionadas aos componentes da natureza, sejam eles as abelhas ou outros animais.

Ainda assim, questões utilitárias e econômicas também influenciaram as decisões dos meliponicultores, sobretudo em relação a preferência por espécies de abelhas para criar. Todavia, estas questões estiveram mais relacionadas ao uso medicinal do mel e seu papel na economia doméstica e local do que a aspectos financeiros e comerciais na criação de abelhas. Além disso, os criadores de abelhas demonstraram menor importância ao valor econômico dos animais de ocorrência local utilizados neste estudo e estiveram mais dispostos a conservar estes animais por motivos não-materiais (*e.g.* valores morais e de função ecológica da espécie), enquanto que os não-criadores estiveram mais dispostos a pagar pela conservação dos animais.

Desse modo, nós concluímos que a expressão de valores biofílicos direcionados a animais deve estar mais relacionada a grupos de pessoas que mantêm atividades que favorecem interações benéficas com o ambiente, como a criação de abelhas sem ferrão. Nesse sentido, nós sugerimos que os valores não-materiais atribuídos aos elementos da natureza pelos grupos humanos (*e.g.* emocionais, afetivos, morais, entre outros) devem ser diretamente considerados em políticas de conservação que objetivem o apoio público, como também nos esforços de educação ambiental (ver APÊNDICE A). Isto é especialmente válido no caso de grupos humanos que residem no entorno de áreas de proteção que estão em processo de implementação do plano de manejo, como é o caso na nossa área de estudo.

Por fim, nós ressaltamos a aplicabilidade de abordagens interdisciplinares na investigação de interações humano-animais e suas emoções associadas (entre outros valores não-materiais), em conexão com as bases teóricas e metodológicas da etnoecologia e da biologia da conservação visando, assim, alcançar os propósitos de conservação da diversidade biológica e do patrimônio cultural associado.

APÊNDICE A

Imagens da oficina “Compartilhando saberes sobre as abelhas e seus criadores”, realizada em junho de 2018 pelo Grupo de Estudos em Etnoecologia (UFRPE), na Escola Municipal Elvira de Albuquerque Maranhão (Timbaúba, PE, Brasil). Na oficina foram compartilhados resultados parciais da tese com professoras do ensino fundamental que atendem a crianças residentes no Sítio Xixá. Objetivou-se problematizar pedagogicamente o contexto da meliponicultura local e auxiliar na construção de um conhecimento escolar mais adequado à realidade agrícola e ambiental em que vivem as crianças e suas famílias.

ANEXO A

Normas para publicação na revista Biological Conservation.

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Please use correct, continuous line numbering and page numbering throughout the document.

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There are no strict requirements on reference formatting at submission. References can be in any style or format as long as the style is consistent. Where applicable, author(s) name(s), journal title/book title, chapter title/article title, year of publication, volume number/book chapter and the article number or pagination must be present. Use of DOI is highly encouraged. The reference style used by the journal will be applied to the accepted article by Elsevier at the proof stage. Note that missing
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Divide the article into clearly defined sections.

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Please place legends above Tables and below Figures. They should follow the
References at the end
of the manuscript.

Article structure

Subdivision - numbered sections

Divide your article into clearly def ined and numbered sections. Subsections should be numbered 1.1 (then 1.1.1, 1.1.2, ...), 1.2, etc. (the abstract is not included in section numbering). Use this numbering also for internal cross-referencing: do not just refer to 'the text'. Any subsection may be given a brief heading. Each heading should appear on its own separate line.

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State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Material and methods

Provide sufficient details to allow the work to be reproduced by an independent researcher. Methods that are already published should be summarized, and indicated by a reference. If quoting directly from a previously published method, use quotation marks and also cite the source. Any modifications to existing methods should also be described.

Theory/calculation

A Theory section should extend, not repeat, the background to the article already dealt with in the Introduction and lay the foundation for further work. In contrast, a Calculation section represents a practical development from a theoretical basis.

Results

Results should be clear and concise.

Discussion

This should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

Conclusions

The main conclusions of the study may be presented in a short Conclusions section, which may stand
alone or form a subsection of a Discussion or Results and Discussion section.

Glossary

Please supply, as a separate list, the definitions of field-specific terms used in your article.

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If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly for tables and figures: Table A.1; Fig. A.1, etc.

Essential title page information

• ***Title.*** Concise and informative, yet not overly general. If appropriate, include the species or ecosystem that was the subject of the study, or the location where the study was done. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible

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A concise and factual abstract is required (maximum length of 250 words). The abstract should state briefly the purpose of the research, the methods used, the principal results and major conclusions. Please try to keep each sentence as specific as possible, and avoid such general statements as "The management implications of the results are discussed". An abstract is often presented separately from the article, so it must be able to stand alone. For this reason, References should be avoided, but if essential, they must be cited in full, without reference to the reference list. Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

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Although a graphical abstract is optional, its use is encouraged as it draws more attention to the online article. The graphical abstract should summarize the contents of the article in a concise, pictorial form designed to capture the attention of a wide readership. Graphical abstracts should be submitted as a separate file in the online submission system. Image size: Please provide an image with a minimum of 531 × 1328 pixels (h × w) or proportionally more. The image should be readable at a size of 5 × 13 cm using a regular screen resolution of 96 dpi. Preferred file types: TIFF, EPS, PDF or MS Office files. You can view Example Graphical Abstracts on our information site. Authors can make use of Elsevier's Illustration Services to ensure the best presentation of their images and in accordance with all technical requirements.

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Strunk Jr., W., White, E.B., 2000. The Elements of Style, fourth ed. Longman, New York.

Reference to a chapter in an edited book:

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