Biodivers Conserv (2012) 21:1457–1476
DOI 10.1007/s10531-012-0257-7

ORIGINAL PAPER

Selecting flagships for invertebrate conservation

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Received: 19 July 2011 / Accepted: 14 February 2012 / Published online: 4 March 2012

Abstract Invertebrates have a low public profile and are seriously underrepresented in global conservation efforts. The promotion of flagship species is one way to generate interest in invertebrate conservation. Butterflies are frequently labeled invertebrate flagships, but clear definitions of the conservation actions they are meant to catalyze, and empirical assessments of their popularity amongst non-Western audiences are lacking. To improve the use of invertebrate flagships, we examine how butterflies compare with other taxa in terms of popularity. We then identify characteristics of individual species that are appealing and explore whether these may be used to derive a set of guidelines for selecting invertebrate flagships. We conducted questionnaire-based surveys amongst two target audiences: rural residents ($n = 255$) and tourists ($n = 105$) in northeast India. Invertebrates that were aesthetically appealing, or those that provided material benefits or ecological services were liked. Butterflies were the most popular group for both audiences, followed by dragonflies, honeybees and earthworms. A combination of large size and bright colours led to high popularity of individual species, whilst butterflies with unique

Electronic supplementary material The online version of this article (doi:10.1007/s10531-012-0257-7) contains supplementary material, which is available to authorized users.

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features were liked by tourists but not rural residents. These results provide empirical evidence that butterflies appeal to diverse audiences and have the potential to be deployed as flagships in different contexts. However, prior to promoting invertebrate flagships, their intended uses need to be specified. Here we define an invertebrate flagship as an invertebrate species or group that resonates with a target audience and stimulates awareness, funding, research and policy support for the conservation of invertebrate diversity. In conclusion we outline a set of heuristic guidelines for selecting flagships to raise awareness of invertebrate diversity and conservation.

Keywords Biodiversity · Butterflies · Conservation · Flagship species · Insects · Invertebrates · Public perceptions

Introduction

Invertebrates represent more than 90% of the world's estimated 10 million-plus animal species (Wilson 1992), yet they are underrepresented in global conservation efforts. Invertebrate conservation is fraught with several challenges, especially in the tropics. First, research is disproportionately low compared to the number of invertebrate taxa present (Clark and May 2002). Second, funding and policy directives for invertebrate conservation are limited. For instance, each arthropod species receives 1,000 times less funding for its conservation than each mammal species (Cardoso et al. 2011) and the conservation status of less than 1% of the insect species described has been evaluated (Warren et al. 2007). Third, invertebrates are often considered pests and have low public conservation profiles (Berenbaum 2008). The apathy invertebrates engender impedes the implementation of scientific and policy recommendations, and contributes to the relative lack of interest in invertebrate conservation. Reorienting negative attitudes and generating both professional and public interest in invertebrates is critical if some of these challenges are to be overcome (Kellert 1993; New 1999, 2011).

One way of engaging the public and creating awareness of invertebrate conservation issues is through the promotion of flagships (Guiney and Oberhauser 2008). Flagship species [i.e., "popular charismatic species that serve as symbols and rallying points to stimulate conservation awareness and action" (Heywood 1995)] are meant to perform strategic socio-economic roles within conservation. Flagships have traditionally been large mammals and birds (Clucas et al. 2008; Barua 2011), and are used to catalyze a range of conservation actions, including fundraising, research promotion, and protection of species and their habitats (Caro 2010; Barua et al. 2011). Whilst invertebrate flagships are unlikely to generate the funding or public interest in biodiversity conservation at scales comparable to established vertebrate flagships, they could be effectively used to build public awareness of invertebrates by emphasizing diversity and the vital roles these creatures play in ecosystems (e.g., pollination, seed-dispersal, soil development and decomposition). Invertebrate flagships could catalyze conservation action for other invertebrate groups and promote much-needed research, threat assessments, and policy initiatives. As a hyperdiverse group, conservation interventions for invertebrates are unmanageable at species-level resolutions and, as a result, conservation strategies for invertebrates in the tropics need to rely on surrogates (New 1999; Samways 2007a). Serving as invertebrate flagships, "charismatic microfauna" (Lewis and Basset 2007) could complement the use of ecological surrogates by generating support for management through public outreach and advocacy (New 2011; Veríssimo et al. 2012). In short, invertebrate flagships could be

effectively deployed to overcome some of the public, scientific and policy 'dilemmas' that confront invertebrate conservation today (Cardoso et al. 2011).

However, systematic assessments of which invertebrate groups perform as flagships are lacking. Butterflies are frequently labeled as flagships for invertebrate conservation (New et al. 1995; New 1997, 2009) because they are amongst the few invertebrates that foster public sympathy (Samways 1994), their status and diversity is relatively well-documented (Lewis and Senior 2011), and they engage people through citizen-based monitoring programmes and displays in museums and butterfly houses (Pe'er and Settele 2008). For example, the Monarch butterfly (*Danaus plexippus*) and Queen Alexandra's Birdwing (*Ornithoptera alexandrae*) are two oft-cited examples of invertebrate flagships (Guiney and Oberhauser 2008; Parsons 1992). Unfortunately, there are no heuristic guidelines as to how butterflies might be deployed in novel, non-Western contexts (New 2011). Moreover, empirical evaluation of how well butterflies perform as potential flagships in relation to other invertebrate groups is lacking. For flagships to be effective, they need to resonate with specific, and preferably diverse, target audiences (Barua et al. 2011; Veríssimo et al. 2011). However, appeal is culture-specific and certain taxa, or groups, valued by conservationists or a Western audience may not resonate with communities living close to butterfly habitats. In fact, poorly chosen flagships may backfire and jeopardize well-intended conservation actions (Barua et al. 2010). Hence, the need for evaluating the flagship potential of different invertebrate groups and devising a framework to select effective invertebrate flagships is pressing.

In this paper, we examine whether butterflies can act as flagships for raising the public profile of invertebrates in a rural tropical context. Building upon research on public perceptions of invertebrates (Joshi et al. 2000; DeFoliart 1999; Costa-Neto and Magalhães 2007; Jin and Yen 1998; Kellert 1993) we first explore people's attitudes and perceptions of different taxa to determine how butterflies compare to other potential flagship taxa. Second, we examine what physical attributes of butterflies make them appealing to different target audiences, and investigate whether species with unique features are more popular than those that are not distinctive. Identifying characteristics or attributes of butterflies that lead to their popularity may be useful for devising a set of heuristic guidelines to select invertebrate flagships, and would complement literature on flagship selection which is largely vertebrate-centric (Barua et al. 2011; Bowen-Jones and Entwistle 2002; Caro 2010). Finally, we test people's knowledge of invertebrates to identify areas requiring outreach and explore how these can be strengthened through the use of invertebrate flagships. Through this process, we contribute to the literature on developing focused, strategic action tools that promote invertebrate conservation.

Methods

This research focused on Assam, a state in northeast India that falls within the Indo-Burma Biodiversity Conservation Hotspot and has approximately 680 species of butterflies (Evans 1932), and was conducted in rural agricultural villages outside Kaziranga National Park, a world heritage site and international ecotourism destination. People's attitudes toward invertebrates and preferences for different butterfly species were evaluated using structured questionnaires, a method that is effective in assessing the potential of policies prior to implementation (Browne-Nuñez and Jonker 2008). Questionnaires were administered to two distinct audiences: local Assamese community members living in the vicinity of Kaziranga National Park ($n = 255$) and tourists visiting the area from other parts of India

or abroad ($n = 105$). Surveys of local residents were administered in Assamese and involved arbitrarily selecting a house in a village, and thereafter sampling every second house on the left. Tourists were approached in local ecotourism lodges and questionnaires were administered in English.

A pilot questionnaire was used to gauge efficacy of questions and initial structure. Following the pilot, weak items that were poorly worded were revised and the sequence of questions reorganized to improve the flow. The final questionnaire included 20 questions: 5 assessing knowledge and attitudes toward invertebrates, 11 on knowledge and attitudes toward butterflies, and 4 on invertebrate conservation (see online Supplementary Material).

Two sets of photographs were used for the survey. The first set contained local invertebrates and was used as a probe to stimulate discussion (De Leon and Cohen 2005); the species pool was derived from the pilot questionnaire conducted at the outset of the study. Metamorphic stages were tested separately when people clearly distinguished between adults and larval stages. Participants were asked to (1) list invertebrates that they liked and disliked, (2) state reasons for their choices, and (3) rank the top three in both lists. This information was then used to compare how butterflies might perform as flagships in relation to other invertebrate groups. The second set of photographs was of 16 local butterfly species (Fig. 1; Table 1), selected to represent regional variability of: (1) families, (2) sizes, (3) colouration, and (4) shapes/features (e.g., 'tails', camouflage). Butterflies

Fig. 1 A set of butterfly species used to rank popularity and explore potential flagship species. Species include: (1) Common Birdwing (*Troides helena*), (2) White Dragontail (*Lamproptera curius*), (3) Fluffy Tit (*Zeltus etolus*), (4) Redbase Jezabel (*Delias pasithoe*), (5) Common Grass Yellow (*Eurema hecabe*), (6) Indian Cabbage White (*Pieris canidia*), (7) Apefly (*Spalgis epius*), (8) Orange Oakleaf (*Kallima inachus*; underside), (9) Common Crow (*Euploea core*), (10) Orange-striped Awl (*Bibasis jaina*), (11) Rice Swift (*Borbo cinnara*), (12) Orange Oakleaf (*Kallima inachus*;upperside), (13) Fivebar Swordtail (*Graphium antiphates*), (14) Red Helen (*Papilio helenus*), (15) Common Silverline (*Spindasis vulcanus*), (16) Bushbrown (*Mycalesis* spp.)

Table 1 Families and sizes of butterfly species depicted in the survey instrument

Common name	Scientific name	Family	Wingspan (mm)
Common Birdwing	*Troides helena*	Papilionidae	140–170
White Dragontail	*Lamproptera curius*	Papilionidae	40–50
Fivebar Swordtail	*Graphium antiphates*	Papilionidae	80–95
Red Helen	*Papilio helenus*	Papilionidae	115–130
Redbase Jezabel	*Delias pasithoe*	Pieridae	70–85
Common Grass Yellow	*Eurema hecabe*	Pieridae	40–50
Indian Cabbage White	*Pieris canidia*	Pieridae	50–60
Orange Oakleaf	*Kallima inachus*	Nymphalidae	85–110
Common Crow	*Euploea core*	Nymphalidae	85–95
Bushbrown spp.	*Mycalesis* spp.	Nymphalidae	40–50
Apefly	*Spalgis epius*	Lycaenidae	20–30
Common Silverline	*Spindasis vulcanus*	Lycaenidae	26–34
Fluffly Tit	*Zeltus etolus*	Lycaenidae	28–32
Orange-striped Awl	*Bibasis jaina*	Hesperiidae	60–70
Rice Swift	*Borbo cinnara*	Hesperiidae	30–36

were displayed in a fashion such that characteristic features were highlighted. We refrained from selective choice experiments used in other flagship studies (Veríssimo et al. 2009), as initial interviews suggested they would perform poorly amongst local participants not used to questionnaire-based survey instruments. Respondents were asked to select three favourite and three least favourite butterflies from the photographs (Fig. 1), and state reasons for their choice. These responses were then collated to identify attributes of butterflies that appealed to the target audiences.

Major attitude types toward invertebrates were identified through thematic analysis (Ryan and Bernard 2003), and grouped following a typology adapted from Kellert (Kellert 1993), modified according to the study responses. Attitude categories were modified in order to reflect local nuances and to take precautions against a blanket adoption of cultural categories developed in a Western context (Costa-Neto and Magalhães 2007). Invertebrates were ranked using a simple metric: the number of times mentioned over the total number of respondents. Butterfly species were assigned scores by summing the ranks from all individual responses (i.e., 3 for species ranked #1, 2 for #2, 1 for #3) and then divided by the number of respondents for each sample in order to standardize scores into a comparable metric. Species characteristics influencing choice were derived from the reasons for selection that were stated by interviewees. Descriptive statistics were performed using SPSS v.16.

Results

What are people's perceptions of invertebrates? How do butterflies compare with other potential invertebrate flagship groups?

The two target audiences selected in this study differed on several accounts (Table 2). The average number of years of education was considerably higher amongst tourists than local

Table 2 Characteristics of the two target audiences: residents ($n = 255$) and tourists ($n = 105$)

	Residents	Tourists
Mean age (range)	36.66 (11 to 80)	45.29 (7 to 76)
Mean number of years of education (range)	10.27 (0 to 17)	15.96 (0 to 20)
Mean income per month	US$ 108.57	US$ 1877.23
Membership to environmental organization	10.20%	39.04%

residents, as was average monthly income. Most local respondents (>80%) were involved in farming activities either full- or part-time, while tourists were mainly professionals living in urban or peri-urban localities. Also, more tourists were members of environmental organizations. These factors account for several differences in responses to survey questions, notably on perceptions of invertebrates and knowledge of butterfly conservation and biology.

People's attitudes towards invertebrates were classified into eight broad categories: four positive and four negative (Table 3). These included positive attitudes stemming from the utilitarian role of invertebrates, such as provision of direct material benefits or indirect ecological services. Respondents also had positive attitudes toward invertebrates because of their innate ecological value or the roles they play in maintaining ecosystems, an attitude type defined as ecologistic. A fourth positive category was aesthetic, where people found phenotypic features of invertebrates appealing. In contrast, disliking invertebrates because of disgust or negative appeal was a prevalent negative attitude towards some invertebrates. We found three additional sources of negative attitudes: people disliked invertebrates because of the harm they caused to the human body (corporeal), to their cattle or crops (economic), and in their homes (domestic).

A total of 49 different invertebrate groups were mentioned by respondents, of which 37 were disliked and 26 liked. Butterflies were the most popular group, outscoring all other taxa (rank score = 0.855 for local residents; 0.667 for tourists), followed by dragonflies, honeybees and earthworms (Table 4). Respondents liked butterflies predominantly for their aesthetic appeal (94% of local respondents, 90% tourists), with 78% of local respondents ($n = 198$) and 84% of tourists ($n = 89$) saying they would "feel bad" if there were no butterflies in their locality. Caterpillars, on the other hand, were third on the list of most disliked invertebrates for local residents (rank score = 0.584) and ninth for tourists (rank score = 0.076). Honeybees were liked mainly for their direct utilitarian value (95% of local respondents, 88% tourists), and dragonflies for their aesthetic appeal (81% tourists, 62% local community). Mosquitoes were the least favourite invertebrate, followed by leeches, spiders and wasps (Table 5). These invertebrates were primarily disliked because of the corporeal harm they caused to people, a trend reflected in both the local resident and tourist samples. Respondents said they disliked such insects because they "bite", "suck blood", "sting" or "spread diseases".

The two target audiences differed in terms of their choice of invertebrate groups. For instance, local respondents more frequently mentioned silkworms as a group they liked, as nearly half (49%, $n = 126$) reared silkworms or had done so in the past. Similarly, 25% of local residents liked dragonflies because they provided indirect ecological services by feeding on midges in paddy fields, an observation that was lacking amongst the ecotourist group. Ecologisitic attitudes, on the other hand, were absent from the local community responses. Tourists mentioned the roles butterflies, grasshoppers and dragonflies play in maintaining ecosystems, but such innate values were not attributed to insects by the local respondents. Negative appeal was a feature more frequently stated by tourists as a reason

Table 3 Basic attitudes toward invertebrates adapted from Kellert (1993)

	Attitude		Examples
Positive	Utilitarian (Direct)	Invertebrates liked because of direct material benefit for humans	Silk (silkworms), honey (honeybee), medicinal value (earthworm, snail), edible (snail)
	Utilitarian (Indirect)	Invertebrates liked because of indirect ecological services provided by them	Pollination (butterfly, bee), soil fertilization (earthworm), feed on crop pests (dragonfly, spider)
	Ecologistic	Invertebrates liked for their intrinsic ecological value and roles they play within an ecosystem	"Ecological value" (grasshopper), "Good for ecosystem" (ants)
	Aesthetic	Phenotypic appeal and physical attractiveness of invertebrates	Colour (butterfly, grasshopper), sound (cricket, cicada), glow (firefly)
Negative	Negative (Corporeal)	Invertebrates feared or disliked because of harm caused to the human body	Bite or suck blood (leech, louse), sting (caterpillar, wasp), spread germs and disease (mosquito, housefly)
	Negative (Economic)	Invertebrates feared or disliked because of harm caused to cattle, fields or crops	Suck blood of cattle (tick, mosquito), damage crops (caterpillar, Rice bug)
	Negative (Domestic)	Invertebrates feared or disliked because of harm caused in people's homes	Spoil foodstuff (ants, cockroach), dirties house (spider), ruins wood (termite)
	Unaesthetic	Invertebrates disliked primarily due to lack of phenotypic appeal or disgust triggered by them	Smells (dung beetle), slimy (slug), disgusting (cockroach, slug, snail)

for disliking invertebrates. For example, 32% of tourists said they disliked spiders because they triggered fear or disgust (as opposed to 3% of local respondents), whilst 54% of the local respondents disliked them because they dirtied the house (as opposed to 10% of tourists). A similar pattern was observed for cockroaches.

What traits of butterflies appeal to people? Are species with unique features more popular?

The five most popular butterflies selected by respondents were either large-winged species, had striking colour patterns or a combination of both (Fig. 2). The Common Birdwing (*Troides helena*) was the most popular butterfly amongst local respondents (ranked #1 by 40%) and second most popular species amongst tourists (ranked #1 by 20%) (Mann–Whitney $U = 2710.00$, $p = 0.014$). People said they liked this species because it was "dazzling", "good looking" and "large in size". The Red Helen (*Papilio helenus*), another large-winged species scored relatively lower (ranked #1 by 4% of local respondents, and 2% tourists; Mann–Whitney $U = 621.50$, $p = 0.635$), potentially because it was not as colourful. The upper side of the Orange Oakleaf (*Kallima inachus*) (ranked #1 by 19% of local respondents, 28% tourists; Mann–Whitney $U = 2117.50$, $p = 0.000$) and Redbase Jezabel (*Delias pasithoe*) (ranked #1 by 7% of local respondents, 6% tourists; Mann–Whitney $U = 1032.50$, $p = 0.357$) were appealing as they had bright and varied colours. Respondents said they liked these species as they have "a nice design", "beautiful colours and shape" and are "dazzling".

Dull colouration and small body size contributed to low ranking. Species that had a combination of these attributes were amongst the least popular butterflies. For instance, the

Table 4 Ten most liked invertebrates for (a) local residents and (b) tourists

	Invertebrate	Class	Order	No of responses	Rank	Reason for choice (% of respondents mentioning cause)			
						Utilitarian (direct)	Utilitarian (indirect)	Ecologistic	Aesthetic
Local Community	Butterfly	Insecta	Lepidoptera	218	0.855	1.38	5.05	0.00	93.58
	Honeybee	Insecta	Hymenoptera	172	0.675	**94.77**	4.07	0.00	2.91
	Dragonfly	Insecta	Odonata	151	0.592	0.66	24.50	0.00	**62.25**
	Earthworm	Annelida*		116	0.455	6.03	**91.38**	0.00	0.86
	Grasshopper	Insecta	Orthoptera	110	0.431	10.00	7.27	0.00	**81.82**
	Silkworm	Insecta	Lepidoptera	96	0.376	**93.75**	1.04	0.00	0.00
	Firefly	Insecta	Coleoptera	67	0.263	2.99	0.00	0.00	**91.04**
	Snail	Mollusca*		49	0.192	**59.18**	6.12	0.00	16.33
	Spider	Arachnida	Araneae	43	0.169	2.33	**62.79**	0.00	13.95
	Ant	Insecta	Hymenoptera	18	0.071	16.67	27.78	0.00	**50.00**
Tourists	Butterfly	Insecta	Lepidoptera	70	0.667	0.00	1.43	2.86	**90.00**
	Honeybee	Insecta	Hymenoptera	43	0.410	**88.37**	9.30	0.00	2.33
	Earthworm	Annelida*		21	0.200	4.76	**85.71**	0.00	0.00
	Dragonfly	Insecta	Odonata	21	0.200	0.00	4.76	4.76	**80.95**
	Grasshopper	Insecta	Orthoptera	18	0.171	0.00	0.00	11.11	**83.33**
	Dung Beetle	Insecta	Coleoptera	12	0.114	0.00	0.00	0.00	**83.33**
	Ant	Insecta	Hymenoptera	10	0.095	0.00	40.00	0.00	30.00
	Firefly	Insecta	Coleoptera	8	0.076	0.00	0.00	0.00	**100.00**
	Spider	Arachnida	Araneae	7	0.067	0.00	42.86	0.00	42.86
	Silkworm	Insecta	Lepidoptera	6	0.057	**66.67**	16.67	0.00	0.00

Numbers in bold indicate most frequent response

* Indicates phylum; all other categories in this column belong to phylum Arthropoda

Table 5 Ten most disliked invertebrates for (a) local residents and (b) tourists

	Invertebrate	Class	Order	No of responses	Rank (proportion)	Reason for choice (% of respondents mentioning cause)			
						Negative (corporeal)	Negative (economic)	Negative (domestic)	Unaesthetic
Local Community	Mosquito	Insecta	Diptera	191	0.749	**97.38**	0.52	0.00	0.52
	Leech	Annelida*		187	0.733	**93.58**	1.07	0.00	5.88
	Caterpillar	Insecta	Lepidoptera	149	0.584	**87.25**	9.40	0.00	1.34
	Spider	Arachnida	Araneae	78	0.306	15.38	1.28	**53.85**	2.56
	Wasp	Insecta	Hymenoptera	77	0.302	**93.51**	3.90	0.00	1.30
	Cockroach	Insecta	Blattodea	71	0.278	35.21	0.00	**49.30**	9.86
	Louse	Insecta	Phthiraptera	50	0.196	**72.00**	2.00	0.00	0.00
	Tick	Insecta	Ixodida	44	0.173	**77.27**	15.91	0.00	2.27
	Midge	Insecta	Diptera	43	0.169	**97.67**	0.00	0.00	0.00
	Gnat	Insecta	Diptera	42	0.165	**97.62**	0.00	0.00	0.00
Tourists	Mosquito	Insecta	Diptera	70	0.667	**91.43**	0.00	0.00	0.00
	Spider	Arachnida	Araneae	31	0.295	**41.94**	0.00	9.68	32.26
	Wasp	Insecta	Hymenoptera	30	0.286	**80.00**	0.00	0.00	6.67
	Leech	Annelida*		25	0.238	**84.00**	0.00	0.00	8.00
	Cockroach	Insecta	Blattodea	18	0.171	16.67	0.00	33.33	50.00
	Fly	Insecta	Diptera	13	0.124	**76.92**	0.00	0.00	7.69
	Louse	Insecta	Phthiraptera	12	0.114	**58.33**	0.00	0.00	8.33
	Ant	Insecta	Hymenoptera	12	0.114	**58.33**	0.00	16.67	8.33
	Caterpillar	Insecta	Lepidoptera	8	0.076	**62.50**	25.00	0.00	12.50
	Hornet	Insecta	Hymenoptera	3	0.029	**100.00**	0.00	0.00	0.00

Numbers in bold indicate most frequent response

* Indicates phylum; all other categories in this column belong to phylum Arthropoda

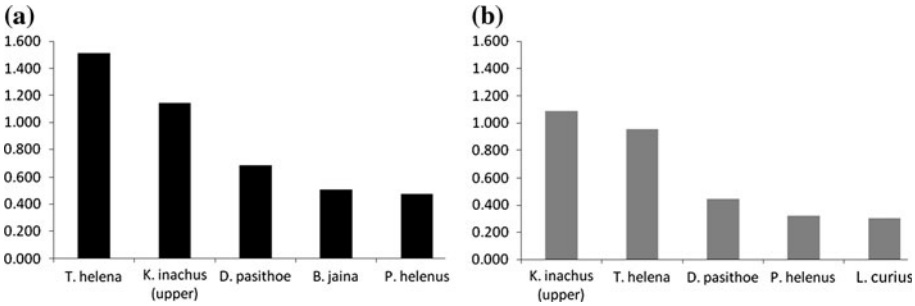

Fig. 2 Five most popular butterflies: **a** local residents and **b** tourists

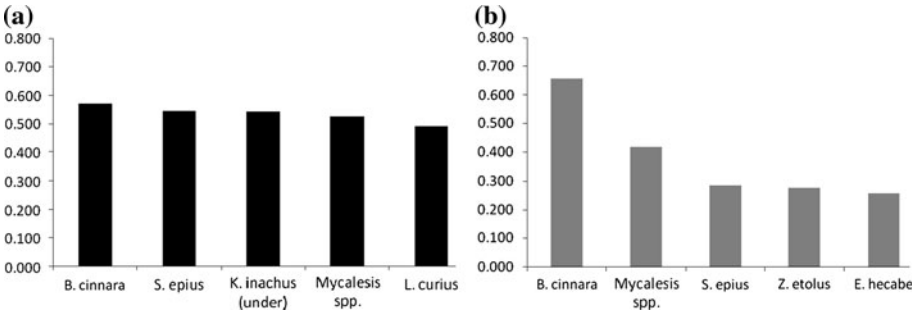

Fig. 3 Five least popular butterflies: **a** local residents and **b** tourists

Rice Swift (*Borbo cinnara*) ranked least favourite by 8% of local respondents and 11% of tourists (Mann–Whitney $U = 1051.00$, $p = 0.515$), and the Bushbrown spp. (*Mycalesis* spp.) was ranked least favourite by 10% of local respondents and 20% of tourists (Mann–Whitney $U = 650.50$, $p = 0.453$) (Fig. 3). Local respondents thought that *B. cinnara* was "moth-like", "harmful" and "small", whilst several tourists said it was "dull", "ugly" and "looks like a wasp". Similarly, comments about the *Mycalesis* spp. included "not bright", "small", and "not easy to recognize" (local respondents); and "no beauty", "common" (tourists). Other small-bodied and less colourful species such as the Apefly (*Spalgis epius*) also scored low for both respondent groups.

A major contrast in the choices of the local community and tourists was that of the White Dragontail (*Lamproptera curius*). This species was amongst the tourist favourites (ranked in top 3 by 18%), but among the least favourites for the local respondents (ranked in bottom 3 by 21%) (Fig. 3). Tourists said the species was "unusual", "has an interesting shape" and a "cool tail", whilst members of the local community thought it "may be harmful", "looks poisonous", is "frightening" and "scary". Few local participants liked butterflies that were phenotypically distinct. For instance, the underside of the *K. inachus* was amongst the least favourite butterflies for local respondents, but this species did not rank as low for tourists.

What is people's knowledge of invertebrate diversity and conservation?

Fifty-six percent of the local respondents ($n = 143$) and 20% ($n = 21$) of tourists said that the number of invertebrate species in Assam was under a thousand. Moreover, 60% ($n = 154$) of the residents and 63% ($n = 66$) tourists said they could recognize or name at

most 30 different types of invertebrates. Only 2% ($n = 6$) of the local respondents guessed the number of butterfly species present in Assam (estimated butterfly diversity: 600–800), and a third (35%; $n = 88$) said it was fewer than 200. Fourteen percent ($n = 15$) of the tourists said the number of butterfly species in Assam was fewer than 200; none were able to guess the estimated range.

When asked whether butterflies brought benefits to humans, 63% ($n = 160$) of residents and 94% ($n = 99$) tourists said yes ($\chi^2_{[1]} = 83.01$, $p = 0.000$). Benefits mentioned by local residents include: aesthetic (e.g., "increases environmental beauty") (5.88%; $n = 15$), "controls environmental pollution" (2.75%; $n = 7$), pollination (33.73%; $n = 86$), "feeds on harmful insects" (1.57%; $n = 4$), and silk production (3.92%; $n = 10$). Reasons mentioned by tourists were limited to aesthetic benefits (7.6%; $n = 8$) and pollination (63%; $n = 66$). Twenty-four percent ($n = 62$) of local residents and less than 1% ($n = 1$) of tourists said butterflies caused harm to people ($\chi^2_{[1]} = 117.61$, $p = 0.000$). Reasons mentioned by local residents include: "caterpillars damage crops" (3.92%; $n = 10$), "butterflies cause body itches" (3.14%; $n = 8$), "produce moths" (0.78%; $n = 2$) and "carry germs" (0.78%; $n = 2$).

Knowledge of butterfly biology was relatively better, with 88% ($n = 224$) of residents and 74% ($n = 78$) tourists saying that adult butterflies fed on nectar. However, 10% ($n = 26$) of residents said that they also fed on small insects. Seventy-two percent ($n = 183$) of residents and 94% ($n = 99$) tourists said butterflies helped in pollination. Not many local respondents directly associated caterpillars with butterflies. When asked what caterpillars were, frequent responses were "invertebrate" or "flying insect" (93%; $n = 238$); only three individuals (1.17%) said they were the larval stages of butterflies. On the other hand, 78% ($n = 81$) of tourists said caterpillars were a "larval stage of butterflies" and only 7% ($n = 7$) used the general category "insect". However, when specifically asked whether caterpillars formed part of the butterfly life-cycle, 72% ($n = 184$) of local respondents said yes.

When asked what was the most appropriate habitat for the sustenance of butterflies, people's gardens emerged as the most popular choice for local residents (71%; $n = 182$), followed by protected areas (36%; $n = 93$), village woodlots (31%; $n = 80$) and tea estates (10%; $n = 26$) (Cochran's $Q = 2.034$, $df = 3$, $p = 0.000$). In contrast, protected areas were the most popular choice amongst tourists (64%; $n = 67$), followed by gardens (22%; $n = 23$), tea estates (5.7%; $n = 6$) and village woodlots (2.85%; $n = 3$) (Cochran's $Q = 1.134$, $df = 3$, $p = 0.000$).

Discussion

In a seminal essay on public attitudes toward invertebrates, Kellert (1993) concluded that in order to engender greater public appreciation of invertebrates, a better understanding of the basis for unfavourable attitudes towards invertebrates, especially arthropods, was critical. Our study suggests that negative attitudes are influenced by four distinct factors. First, invertebrates are feared because of the harm they might cause to the human body. In fact, taxa that caused corporeal harm (e.g., mosquitoes) were the most disliked by both the rural community and the tourist group. Corporeal aversion is likely to be a context-transcendent factor, triggering negative attitudes toward invertebrates across cultures or communities (Davey et al. 1998). Second, invertebrates are viewed unfavourably because of the economic losses they induce. Economic loss, and the invertebrates that caused it, were more frequently mentioned by residents than tourists. This difference may arise from

the fact that residents were largely agricultural farmers and had first-hand encounters with such taxa, as opposed to tourists who were mainly professionals from an urban background. Hence, certain attitudes toward invertebrates are influenced by the culture, occupation and places inhabited by a respondent. Third, taxa are disliked if they cause harm in people's homes. For example, ants are disliked because they spoil food and termites as they ruin woodwork. Lastly, the phenotypic characteristics of certain invertebrates trigger disgust or are conceived to be strongly unaesthetic. Disgust may be induced by the smell, bodily appearance, or touch (e.g., "slimy", "crawly") of invertebrates, an attribute sometimes described as a "yuck-factor" (Lorimer 2007). Besides the phenotypic attributes of a taxon, individual dispositions and cultural background also influence why an invertebrate may appear unaesthetic. For instance, most tourists disliked spiders because they were "ugly", "creepy" or "frightening", but local residents did not view them in the same way. Residents' main reason for disliking spiders was because they dirtied their homes with webs.

Invertebrates that were both harmless and aesthetically appealing, e.g., butterflies, dragonflies and fireflies, were liked by both respondent groups. These taxa have potential for being promoted as flagship species. Local residents particularly favoured invertebrates that provided direct material benefits (e.g., honeybee, silkworm) or indirect ecological services (e.g., earthworm, dragonfly). Almost half the local respondents said they reared silkworms or had done so in the past, confirming observations that cultural and economic practices play a role in influencing people's attitudes toward invertebrates (Jin and Yen 1998). Such utilitarian attitudes were less prevalent amongst tourists. Similarly, several local respondents mentioned indirect ecological benefits from dragonflies (i.e., "feeds on midges in paddyfields"), but not tourists who did not interact with dragonflies in the same way or context. These findings illustrate the importance of local cultural knowledge, and the role it may play in shaping the way people view invertebrates. On the other hand, ecologistic attitudes, such as appreciating invertebrates for their intrinsic ecological value and roles in maintaining ecosystems, were limited to tourists. This might be partly explained by the fact that the tourists had higher number of years of formal schooling and many were members of environmental organizations, both important avenues through which science-based ecological knowledge are disseminated.

Attitudes to certain invertebrates were ambivalent. For instance, spiders scored high on both liked and disliked responses. Certain people disliked spiders because they dirtied homes with their webs, were scary, or caught 'beneficial' insects, whilst others liked the beauty of their webs and said they caught 'harmful' insects. Similarly, some individuals disliked snails because they damaged crops, were "yucky", "slimy" and "disgusting", whilst others liked them because they were edible, had "medicinal value" and were "beautiful". These examples illustrate some of the difficulties in promoting invertebrates as flagship species, as affinity and affection towards invertebrates can be differentially motivated (Schlegel and Rupf 2010). Attitudes toward invertebrates arise from a complex interplay of factors, which could involve species' biological and phenotypic attributes, dispositions and tendencies of particular individuals, and the cultural knowledge and educational background of a person. These complexities urge us to exercise caution when selecting invertebrate flagships. Empirical assessments of how the target audience relates to the taxon are vital prior to floating a flagship species (Veríssimo et al. 2012; Barua et al. 2011).

Butterflies were the most popular invertebrate group amongst both audiences, lending further support to observations about their widespread popularity (Guiney and Oberhauser 2008; Caro 2010; New 2009). As the results above elucidate, the popularity of butterflies arose from their aesthetic appeal, and, to a lesser extent, for the indirect ecological services

they provide in the form of pollination. Whilst there might be some social desirability bias in these responses as our study was focused on butterflies (King and Bruner 2000), it does not rule out the fact that people viewed butterflies favourably. However, a major caveat with promoting butterflies as flagships is that people generally did not view caterpillars favourably, as they caused corporeal harm and induced economic damage. Negative attitudes toward caterpillars were more pronounced amongst the local resident sample, ranking amongst their least favourite invertebrates. Conservation initiatives promoting butterflies as flagships would benefit from being cognizant of this finding, as a simultaneous like for butterflies and dislike for caterpillars may also prevail across other tropical country contexts. Some negative attitudes toward caterpillars could be mediated through outreach and education programmes, but this may be difficult to achieve if larval stages of Lepidoptera cause considerable damage in a locality. It may even lead to a 'flagship mutiny' if larval stages are associated with major pest outbreaks (Barua et al. 2010). In such circumstances, choosing alternate invertebrate groups such as dragonflies might be a better strategy.

Our findings confirm observations that phenotypic attributes may be important when promoting invertebrates amongst the public (Van Hook 1997). Our survey responses from both the local residents and tourist samples showed a few general trends that might serve as heuristic guidelines for identifying an initial pool of butterfly flagships. First, species with large wingspans were preferred to those with smaller wingspans. Second, bright and colourful species were more appealing than drab and cryptic ones. The high popularity of the Common Birdwing (*T. helena*) was due to a combination of its large size and bright colour, whereas colourful species with smaller wingspans (e.g., Common Silverline (*Spindasis vulcanus*)) were less popular. The inverse of this combination, i.e., small size and drab colours, led to butterflies being unpopular. The Rice Swift (*B. cinnara*) and Bushbrown (*Mycalesis* spp.) are two species that exemplify these attributes.

Further, shape and upper/lower-wing symmetry also influenced people's choice. Hesperiids (excluding the colourful Orange-striped Awl (*Bibasis jaina*)) were unpopular amongst respondents because of their angular wings and bulbous eyes—features that lend to them being labeled "moth-like" and "ugly". Preferences for butterflies with distinct features varied with the target audience. For instance, the White Dragontail (*L. curius*), a butterfly with elongated hindwings and transparent fore-wings, was amongst the five most popular butterflies for tourists, who liked its unique features. In fact, this species was the favourite butterfly of all members of the research team. However, the dragontail was one of the least popular butterflies amongst the local residents, who said it looked scary and that it might be harmful. Similarly, the cryptic, leaf-like underside of the Orange Oakleaf (*K. inachus*) was unpopular amongst the local target audience. Together, these findings have two important implications for the selection of invertebrate flagship species. First, the choice experiments used in this study shows that particular attributes that resonate with target audiences can be identified and should be the starting point of any invertebrate flagship selection procedure.[1] These attributes can subsequently be mapped on to a broader species pool exhibiting similar characteristics, increasing the choice of potential flagships for a conservation campaign. Second, the differences between the two sample groups suggest that target audiences matter when selecting invertebrate flagships. One size is not likely to fit all, and flagships need to be tailored to the target audience in mind.

A critical issue with flagship species is their intended use: what conservation actions will the species help catalyze? Vertebrate flagships have been used to promote a range of

[1] We are grateful to Diogo Veríssimo for this observation.

Table 6 Impediments to invertebrate conservation that can be overcome through the strategic deployment of invertebrate flagships (adapted from Cardoso et al. 2011)

Impediment		Possible solutions	Role of flagship species
Public dilemma	People throughout the world do not recognize invertebrates or their roles in the ecosystem. In consequence, there is a public disregard for invertebrate species in need for conservation	(a) Better information (b) Better marketing	Promote awareness of ecological roles and diversity of invertebrates; mitigate public apathy toward invertebrates through marketing and dissemination
Political dilemma	Policy makers and stakeholders view invertebrates as species that are indirectly protected by umbrella vertebrate species. Invertebrate-specific protection measures and funding are limited	(a) Red-listing (b) Legal priority listing (c) Inclusion in environmental impact assessment studies	Promote policy, protection measures and funding for invertebrates by catalyzing public awareness and action
Scientific dilemma	Discovery and description of new species, and collection of spatial and temporal data on known species are regarded as dated science. Taxonomy and classical ecology are underfunded	(a) Parataxonomy (b) Citizen science programmes (c) Biodiversity informatics	Generate public interest in invertebrates, leading to greater participation in citizen science programmes

actions including conservation awareness, fundraising, ecotourism, community-based conservation, promotion of funded research, protection of species and habitats (flagship umbrella species), and influencing policy (Caro 2010; Barua et al. 2011). However, the popular use of flagships frequently gravitate towards mammals (Clucas et al. 2008; Barua 2011), and seldom profile invertebrate conservation issues. We believe that the central role of invertebrate flagships, such as butterflies, should be streamlined into one that raises the public and policy profile of invertebrates and catalyzes invertebrate-specific conservation actions. In a recent paper, Cardoso et al. (2011) identify three 'dilemmas' that impede current invertebrate conservation (Table 6). Our study findings reflect how some of these dilemmas play out in local contexts. For instance, people's knowledge of invertebrate and butterfly diversity was quite poor overall, with more than half of the local residents, and a fifth of the tourists stating that the number of invertebrate species in Assam was under a thousand. Based on the number of Lepidoptera, Coleoptera and Odonata alone, Assam is home to at least 3,000 species, a figure that would be significantly larger if all invertebrate groups are considered. Similarly, a third of the local respondents said there were under 200 species of butterflies in Assam, a figure significantly lower than the c.680 species found in the state (Evans 1932). Further, local respondents believed that people's gardens were the best habitats for butterflies, whereas tourists mostly mentioned protected areas. Our studies in the region suggest that protected areas have the highest diversity and support several endemics. Small village woodlots, although not as diverse as protected areas, support greater butterfly diversity than many home gardens.

These observations point to areas for future conservation outreach that might be enabled through the deployment of invertebrate flagships. Flagship invertebrates could be deployed to draw attention to the high diversity of invertebrate life and highlight the crucial ecological roles such as pollination, seed dispersal and soil fertilization they play in ecosystems. This could lead to support and appreciation for invertebrates, organisms E.O. Wilson

describes as "the little things that run the world" (Wilson 1987). Further, invertebrate flagships could help stimulate invertebrate-related ecotourism and recreation. Butterflies and dragonflies are two groups that are known to generate such interest and connect people with nature (Lemelin 2007; Samways 2007b). Flagships can provide a 'hook' that often leads to more sustained interest, resulting in the development of naturalists and amateur lepidopterists who are keen participants in conservation and research programmes (New 2011). Moreover, firsthand experience of these creatures could also help build public constituencies that appreciate invertebrates and who, as stakeholders, can play an important role in lobbying with policy-makers. In this context, we suggest that an invertebrate flagship should be defined as, *an invertebrate species or group that resonates with a target audience and stimulates awareness, funding, research and policy support for the conservation of invertebrate diversity.* This would help streamline the role of invertebrate flagships, enabling conservationists to channelize scarce resources and manpower to develop arenas for action not adequately met by existing (vertebrate) flagships.

Steps toward selecting invertebrate flagships

Criteria for selecting flagship species have generally been devised from the deployment of vertebrate flagships (Home et al. 2009; Barua et al. 2011; Caro 2010; Bowen-Jones and Entwistle 2002). Whilst these are not strict criteria that pre-determine which species would become a flagship, they could serve as a set of heuristic guidelines for what attributes and features to use when designing choice experiments to identify a pool of species that may resonate with a target audience. However, the relevance of these guidelines for invertebrates is contingent on the intended uses of invertebrate flagships. When promotion of awareness of invertebrate conservation and diversity is the primary goal, the conservation status of an invertebrate is important (Table 7). Several threatened invertebrate species are known to evoke research interest and policy directives (New 2009; Steencamp and Stein 1999), and threatened invertebrates may be better suited than those that are not. In addition, species that typify some of the key roles invertebrates play in ecosystems could be effective tools for public communication. For instance, the Richmond Birdwing (*Ornithoptera richmondia*) butterfly has been used to highlight aspects of insect ecology to youth and community groups in Australia (Sands et al. 1997). For invertebrate flagships to be able to promote awareness through direct encounters or ecotourism, they should belong to a group that is diverse, not cryptic and easily identified by non-experts. Butterfly and dragonfly-watching are two emerging invertebrate ecotourism activities (Lemelin 2007), and part of their popularity arises from a combination of these features. The focal flagship taxon should have physical attributes that make them aesthetically appealing to the target audience. Large body size and bright colours are important, and these are features shared by established invertebrate flagships such as the Queen Alexandra's Birdwing and the Homerus Swallowtail (*Papilio homerus*) (New 2009). An important, but often overlooked criterion is whether the taxon has an attractive common name. The rediscovery of *Dryococelus australis* would not have earned the attention it received if it lacked the common name Lord Howe Island stick insect or the "land lobster" (Berenbaum 2008). Finally, when targeting local communities, selecting species or groups that have cultural significance or generate direct economic value may be effective in building a positive image of invertebrates. Species that are labeled 'National Butterflies' or those which appear on postage stamps are known to attract public attention (New 2011).

Together with dragonflies, butterflies are amongst the few invertebrate groups that are able to meet most of these criteria. However, when selecting novel invertebrate flagships, it

Table 7 Relevant guidelines for selecting flagship species to stimulate conservation awareness and their applicability in the context of invertebrates

Guideline[a]	Recommendation	Applicability for invertebrate flagships	Performance of invertebrate group			
			Butterflies	Dragonflies	Honeybees	Earthworms
Geographical location and range	Taxon should ideally be in a region of high conservation priority	Low	***	***	***	***
Conservation status and population size	Threatened species more likely to draw conservation action	High; threatened invertebrates may be useful for raising awareness, fostering research and influencing policy	***	***	?	?
Represents other species	Should represent ecology, habitats or threats of co-occurring species	High; should be able to represent vital ecological roles invertebrates play	***	**	***	**
Recognizable and easily observed	Should be easily recognized by target audience	High; taxonomy should be relatively well worked out, group should be diverse to reflect invertebrate diversity; should not be cryptic	***	***	**	*
Physical appearance and special characteristics	Distinctive features and unique life-history traits may enhance the appeal of flagship species	High; species should be aesthetically appealing to the target audience	***	***	*	*
Cultural significance and positive associations	Important when targeting local communities; should have cultural resonance and no negative associations	High; invertebrate should not cause significant damage	***; caveat is caterpillars	***	**	**
Traditional knowledge and common names	Important when targeting local communities; common names should be appealing	High; common names important for building public profile of invertebrates	***	***	*	*

Table 7 continued

Guideline[a]	Recommendation	Applicability for invertebrate flagships	Performance of invertebrate group			
			Butterflies	Dragonflies	Honeybees	Earthworms
Economic value	Important when targeting local communities	High; species that provide direct utilitarian benefits may help build a positive profile of invertebrates	**	*	***	***
Charisma	Should be considered charismatic amongst the target audience	High; should be able to resonate with the target audience	***	**	*	*
Existing usage	Could be species already in use; should not conflict with other uses	Medium; existing usage within conservation may enable better channeling of funds and scarce resources for invertebrate conservation	***	**	*	*

The performance of four most popular invertebrate groups identified in this study is discussed against each criterion. *** High, ** Intermediate, * Low, ? Unknown

[a] Guidelines derived from relevant academic literature (Barua et al. 2011; Bowen-Jones and Entwistle 2002; Caro 2010; Home et al. 2009)

is essential that target audiences are identified and their intended uses clearly defined. The public, policy and scientific shortfalls outlined above could provide a useful starting point for thinking about what actions an invertebrate flagship could help catalyze. Next, potential taxa should be matched with target audiences. The guidelines for attributes that need to be taken into consideration provide important cues for initial selection. In our case, large and brightly coloured butterflies such as the Common Birdwing (*T. helena*) are potential candidates, favoured by both tourists and the local community. The species represents vital roles that invertebrates play (e.g., pollination), and may be used to highlight the high diversity and economic benefits of Lepidoptera (e.g., silk). As a flagship, it needs to be actively promoted through marketing and awareness campaigns targeted at ecotourists, local schools and photography clubs that are becoming increasingly popular in India. Further, this species is easily recognizable, and occurs in forests, village woodlots and occasionally people's gardens. It has a high potential for generating interest and encouraging people to find it in their locality. In fact, it could be deployed as a 'hook' to engage people in butterfly-watching and photography, hobbies that are gaining momentum within India, with amateur lepidopterists making important contributions to documenting species diversity and distributions (e.g., The Indian Foundation for Butterflies; http://ifoundbutterflies.org/). Moreover, the common name Birdwing allows for parallels to be drawn with Queen Alexandra's Birdwing—the world's largest butterfly—potentially adding to brand creation and marketability. Once such candidate species are identified and promoted as flagships, empirical evaluations of the extent to which they deliver intended conservation goals need to be conducted. Such systematic selection of flagships could help address several shortfalls that face invertebrate conservation today.

Acknowledgments We extend our gratitude to the Flagship Species Fund Small Grants Programme of Flora and Fauna International and the Sigma Xi Grants-in-Aid of Research (GIAR) program which provided funding for this project. We would like to thank all members of Butterfly Northeast who were instrumental in project preparation, planning, and implementation, including: Bipul Das, Santanu Dey, Sanjay Talukdar, and Rajib Rudra Tariang. Meredith Root-Bernstein and Dr Owen Lewis commented on earlier drafts of this paper. Nekib Ali, Polash Bora, Phalgun Chetia, Diganta Gogoi, Tarun Gogoi, Biju Hazarika, and Pradip Saikia extended invaluable assistance during fieldwork, and the staff and management of Wild Grass, Kaziranga hosted our team. MB's work was enabled by the University of Oxford Clarendon Fund, Felix and Wingate Scholarships. Finally, we are grateful to all the individuals who took the time to speak with us and answer our questionnaires.

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