The Butterfly House Industry: Conservation Risks and Education Opportunities

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What is the Butterfly House Industry?
The emergence over the past three decades of live butterfly exhibits as fashionable leisure attractions has created a new global phenomenon: the Butterfly House Industry (BHI). The key innovation was the “butterfly house”: a walk-through vivarium in which curious people and beautiful insects share the same space. Its success has been made possible by means of electronic communication, rapid transportation, and mass production of butterfly livestock.

Unlike traditional invertebrate terrariums included by some zoos, with ants, grasshoppers, spiders and scorpions in glass-fronted cases and occasional hands-on demonstrations of stick-insects and cockroaches, the butterfly house visitor is free to roam the whole space, typically planted and landscaped like a tropical garden, and interact with all the creatures on display. For a child to have a spectacular butterfly flutter just in front of her, or land spontaneously on his head, can be a highly affective experience (see photo pg 24). Butterflies are very popular — for many the only ‘good’ insects — but, until the advent of the butterfly house, there was little opportunity for the average person to see them up close and on demand.

The BHI was established during a period of changing attitudes to conservation in general, and insects in particular. In addressing both the environmental risks and conservation opportunities created by the BHI, we seek answers to three fundamental questions: to what extent is the industry a threat to biodiversity, to what extent is it a benefit to conservation and environmental education, and how can it be managed and regulated to minimize the former and maximize the latter?

INSECT TRADING: PAST AND PRESENT
Insect trading has a long and complex history. Trade in butterflies goes back to post-Renaissance, Enlightenment Europe, when “cabins of curiosity” became fashionable among the rich. Four historical innovations underpin the BHI: development in late 19th century Europe of commercial butterfly ‘farming’ to produce livestock of native and exotic species (largely for amateur entomologists); development in mid-20th century of the concept of butterfly gardening to encourage native species for pleasure and conservation; foundation of the Insect Farming and Trading Agency in Papua New Guinea in 1978, with the express mission to ranch exceptionally desirable and supposedly endangered butterflies (e.g., birdwings) for collectors to promote species and habitat conservation in a sustainable manner through local economic benefits and the emergence from about 1980 of the live butterfly house as a public entertainment, notably Clive Farrell’s London Butterfly House.

Farrell wanted to share his passion for butterflies with the public at large, especially children — to create not only enthusiasm for butterflies and other invertebrates, but also...
contribute to education. The main innovation, first introduced by David Lowe in Guernsey in 1976, was presentation of exotic butterflies within a simulated tropical environment, in the form of a plant-filled, hot and humid ‘walk through’ greenhouse in which young and old were free to explore. Farrell’s successful enterprise also stimulated the next key step: establishment of commercial butterfly farms in the tropics needed to stock the exhibits, such as the large scale facilities created in Costa Rica in 1983 and Malaysia in 1986.

The London Butterfly House became a prototype for the modern temperate-region live tropical butterfly exhibition — a particular type of insect zoo often termed a butterfly zoo, butterfly garden, butterfly center, or butterfly park. However, for consistency we use butterfly house throughout to refer to the London Butterfly House type of exhibition, restricting butterfly garden to open-air developments where only native butterflies are encouraged to visit and, if possible, breed naturally. Butterfly gardens have a different history.

NEW DIMENSIONS: INTERNET COMMUNICATION AND COURIER SHIPPING
Rapid communication and fast, small-volume courier services made ordering and shipping pupas and the display of live butterflies much easier and, together with the pioneer initiatives of the late 1970s, led to the establishment of a booming industry involving several groups of stakeholders: breeders and farmers (producers), suppliers (dealers), and exhibitors along with visitors (the ‘consumers’ in this economic system), all with different interests, knowledge, responsibilities and needs. The basis of the industry is that live butterfly pupas (chrysalids) are mass-produced for the regular re-stocking required due to the relatively short adult lifespan of butterflies.

CURRENT EXTENT AND PHILOSOPHY OF THE BHI

Breeders
Breeders (often called farmers) run the gamut from single people or families to large butterfly farms that can have many employees. Many hundreds of breeders are involved, notably in tropical countries. Being engaged in such a process can have social, economic and environmental benefits: Butterfly farming allows the local community to diversify their income generating activities and to work at home around childcare and domestic duties. It also raises awareness among residents and decision makers of the benefits of conservation.

Suppliers
Suppliers are also diverse, from local businesses handling hundreds of pupas per week to those operating internationally and dealing with thousands. Again, we have little idea of numbers but many people are involved.

Exhibits
Great diversity is characteristic of butterfly houses too, ranging from family enterprises...
It's tough for the average Joe or Jane to see spectacular Indo-Australian Birdwings — in this case a Common Birdwing (Ornithoptera priamus) — in its native habitat. But, one can sometimes see them in the Conservatory at the Lewis Ginter Botanical Garden in Richmond, Virginia. Sept. 13, 2013.

The number of pupas that an exhibit uses per unit display area depends not only on how extensively an exhibition is stocked but also on butterfly welfare; there are enormous differences in butterfly life-spans in different exhibits due to the varied conditions the butterflies experience. A medium-sized exhibit may use about 30,000 pupas per year.

Visitors
Currently, several exhibits in Europe each attract more than one million visitors per year. Globally, we conservatively estimate 40 million visit butterfly houses and butterfly gardens per year — 26 million in the United States alone.

Philosophy
Diversity within the BHI does not just rest in numbers of species, visitors, exhibition sizes, etc. There is also much variation in the underlying motivations and goals pursued in creating and running an exhibit. A personal quest to share a wonder in butterflies and educate people about them is one, others engage in edutainment, and yet others focus on entertainment or are ‘decorations’ in a shopping mall or hotel.

Organization
There is no single governing body or any formal requirement to belong to an association, and many entrepreneurs within the BHI operate largely or even entirely independently of each other. The International Association of Butterfly Exhibitors and Suppliers (IABES) currently represents some 80 BHI stakeholders only, and has a limited Mission Statement: “Advancing the international butterfly exhibition industry through representation, communication, education, and marketing”

CONSEQUENCES OF THE BHI: A NEW ERA OF BUTTERFLY ‘USES’ AND CONSERVATION RISKS
Conservation risks are apparent at four levels and involve breeders through suppliers to exhibits: unsustainable production; potential introduction of aliens through translocation; inter- and intraspecific genetic mixing; and trafficking of diseases.

Risks due to changes in breeding methods
The New Guinea ranching model, based on a conservation ethic, is not suited to the current needs of the BHI. Large-scale commercial breeding of tropical butterflies has shifted from ‘small volume with high unit value’ to ‘large volume with small unit value’. However, although the prime conservation philosophy has largely been dropped, the idea of producing a cash crop beneficial to local people has survived (see below).

Butterfly farming: breeding, ranching or rearing?
Mass production can only be achieved reliably by breeding. Starting with a small number of founder individuals from the wild, butterflies can be bred, generation after generation, in confinement. This requires facilities that provide adequate food, good physical conditions (e.g., temperature, humidity), and protection from antagonists (predators, parasitoids, pathogens), to ensure high survival rates for cropping healthy pupas. Good conditions for mating and egg-laying are also needed.

Assuming the ideal that founder butterflies are obtained locally, to act sustainably a significant number of adults from each cohort should be released to bolster the source population in a semi-natural way. This should be done regularly because after several generations of inbreeding there is risk of genetic deterioration. Simultaneously, to avoid inbreeding depression, fresh local individuals should be added regularly. We consider this a reasonable model for butterfly breeding systems that can be cropped heavily yet remain sustainable without harming local populations.

Ranching, introduced in New Guinea, refers to an open system, where hostplants are increased by horticultural methods within

added to garden centers attracting a few hundred visitors per year, to major, high-profile institutional butterfly houses attracting hundreds of thousands. Some houses operate seasonally while others are open year-round; some offer educational information but others don’t; some have guided tours, and some also have butterfly gardens. Almost all have shops and cafés, and many exhibit other insects and/or other animals as well.

By searching internet sites, it is demonstrable that butterfly houses and gardens have been established in more than 50 countries worldwide, not only in developed but also developing nations — unfortunately, in many cases, not for the benefit of local people but foreign tourists only. The total

number runs to several hundred. Just as there is great variation in the exhibits, the same applies to regulations affecting how and by whom such exhibitions are presented and managed.

Numbers of pupas involved
Worldwide, the number runs to several million per year, with a dollar value to suppliers approximately twice that number. Speculating on a total sale of 5–10 million pupas per annum worldwide, this would represent an annual market value of livestock in the range $10–20 million. The value of deadstock for collectors and production of butterfly artefacts and decorative objects, is likely to be of the same order.
Risks of livestock translocation: alien species

The release of translocated livestock, accidentally or intentionally, is a major threat to biodiversity, risking bastardization of faunas and floras (also called “biopollution”).

The dynamics of most ecosystems can be disturbed by introduced species, generally in unpredictable ways. Care and vigilance should be given to avoid release of any exotic butterfly and its associated organisms, including hostplants, where they have any chance of establishment. It should also be appreciated that translocated species typically first establish at low, seemingly insignificant levels but can undergo explosive increase many years later.

The biological basis of the threat is due to the fact that all butterflies, like the vast majority of organisms, have more or less restricted natural ranges due to the interaction of history and ecology. If released from their historically limited ranges by translocation, they can find suitable climatic conditions and hostplants to become established. For example, 97% of the 4,000 species of butterflies now known from the tropical regions of Africa do not occur naturally elsewhere. However, the South African Geranium Bronze (Cacyreus marshallii), native to South Africa, is now firmly established in Europe, due to species translocations caused by horticultural trade.

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June 27, 2004. Turin, Italy.

The activities of the BHI result in the introduction of exotic plants for horticulture, can provide suitable conditions for subtropical species, including relatives of Monarchs and Lime Swallowtails, frequently used in butterfly houses but a significant citrus pest in its native southeastern Asia, and now established in the Caribbean region of North America.

Introduction of banana-feeding owl-butterflies, native to South America, into butterfly exhibitions in tropical Africa or Asia is fraught with likely economic and ecological danger. Were they to escape, owl-butterflies might easily become a pan-tropical pest of cultivated banana.

The recent establishment of New World Julia Heliconians in Thailand, now spread south to Malaysia, is almost certainly the result of an escape from a butterfly house. The consequences for native heliconians that are likewise specialist feeders on passionflowers are unknown. Plausibly this common butterfly, especially if released from its natural control agents, could extirpate populations of native species by competitive displacement, especially in the increasingly anthropogenic landscapes of southeastern Asia. The list of potential risks includes even the most popular and charismatic morphos, which have a wide hostplant range within the legume family and can easily be reared even in Europe (in summer only); if they were released in Kenya...
or the Malay Archipelago, what might be the result? Translocation risks also affect other steps in the supply chain.

**Spreading of parasitoids and pathogens**

Translocation of butterflies also brings the risk of spreading species of parasitoid flies and wasps as well as diseases associated with butterflies.

Every butterfly species supports its own guild of parasitoids, not all of which will be specific. The presence of parasitoids within a butterfly house is not in itself a problem, but their local escape is a serious conservation risk — in extreme cases possibly comparable to the impact of certain generalist parasitoids released as biocontrol agents. In the U.S., parasitization rates of imported pupas fluctuate greatly but can be as high as 5%. Due to lack of knowledge about the very large number of insect parasitoids that exist (many of which have not even been named), and the great practical difficulties of sampling and identifying such small and highly unapparent insects, introductions of many parasitoids could easily go undetected, with unknown consequences for local faunas.

Concern has been raised about possible risks caused by farmed butterflies associated with wedding releases carrying the OE parasite (*Ophryocystis elektroscirrha*). Although low levels of this parasite have been reported to have relatively minor effects, more recent work has shown impacts on flight speed and endurance and reduced body size and life span. We have little idea how this organism affects healthy butterflies in natural populations. The impact of many pathogens is more acute for insects bred or flown in crowded conditions, or otherwise under
stress. With respect to butterfly pathogens and diseases in general, our knowledge remains rudimentary. We lack reliable knowledge of the natural ranges of even those butterfly pathogens that have been identified, nor do we have any idea of their possible phyllogeographic differentiation. Emergence of the BHI makes the study of butterfly diseases an applied science.

Genetic mixing
In addition to worries about bastardization of faunas by spread of butterfly species and their antagonists, mixing genes within and between species is another key issue.

Almost all Lepidoptera investigated exhibit high levels of genetic diversity. In almost all cases this genetic diversity has a strong geographical component, traditionally and indirectly recognized by division into subspecies. In some of these so-called polytypic species, literally dozens have been named. Although certain subspecies are clearly diagnosable by discrete differences in pattern and color, many are not, being accepted more as a matter of subjective opinion. Almost all named subspecies of butterflies are based on differences in coloration and, although in most cases this will prove to have some genetic basis, these conventional subspecies may or may not correspond to ecologically relevant differences between the populations so defined.

Where geographical intraspecific genetic differences have been demonstrated, either as discontinuous or clinal patterns of variation, these are not always accompanied or marked by changes in visible characters, such as coloration. Such invisible genetic differences can, however, relate to ecologically significant shifts, including hostplant preferences and other variable traits. While there is every reason to believe that such hidden differences are almost universal, their scientific documentation is rare because of intrinsic difficulties in this type of research.

In general, molecular studies reveal that traditional taxonomic divisions frequently underestimate local differentiation. The challenge now is to recognize and address “evolutionary significant units” for conservation, rather than just “species” as conventionally labelled by Linnaean binominals. In most cases we lack information regarding the degree and significance of genetic differentiation between the hundreds of potential source populations being used by the BHI. All we can be reasonably sure of is that, in almost all cases, there will be some degree of genetic differentiation. Of the 50 most common BHI species, all but Painted Lady and Great Eggfly (Hypolimnas bolina) are divided into two or more named subspecies. For example, Mock Swallowtail (Papilio dardanus) from Africa has over 10, Tragic Heliconian, (Heliconius melpomene), from South America has more than 12, and Blue-and-brown Clipper (Parthenos sylvia) as well as Rice-paper Tree- nymph (Ideas leuconoe) (see photos pg. 32 and range map pg. 33) from southeastern Asia over 20. There is an urgent need to study the species used by the Butterfly House Industry in the context of evolutionary significant units.

The term genetic mixing (sometimes referred to as “genetic pollution”) can be used to describe the situation where genetically (geographically) differentiated populations of a species are brought into contact and hybridize. In crosses between different subspecies, this can be referred to as intra-specific hybridization, but genetic mixing is more general and, applying the precautionary principle, reminds us of the possibility of undesirable consequences from bringing together any geographically differentiated stocks, even when there are no visible differences to alert us. Concern about genetic mixing is not generally expressed because many breeders, suppliers and even exhibitors seem largely unaware of different concepts of species and populations and risks revealed by population genetics. In our experience, butterflies given the same species name tend to be treated as undifferentiated entities in which all individuals are essentially equivalent. In reality this is rarely, if ever, the case.

Concern over genetic mixing is not confined to hybridization at the level of subspecies or evolutionary significant units. It has been documented that about 16% out of a total of 440 European butterfly species hybridize in the wild, and that about half of these hybrids are fertile, with evidence of backcrossing. From this we see that a further risk of genetic mixing can arise in continuous culture facilities from hybridization between species that normally never encounter each other. If such individuals escape or are released and then mate with members of their parental species in the wild, the consequences are unpredictable. With respect to hybridization, rearing closely related butterflies in an artificial, closed environment represents an uncontrolled experiment.

There is considerable risk of genetic mixing among those butterflies bred for ceremonial releases (see below), of which the Monarch is a prime example. Monarchs are also used frequently in butterfly houses. It is not widely appreciated that this species is divisible into several subspecies. Most houses use stock of the North American migratory Monarch. South of Mexico, Monarch populations are not known to exhibit long-distance migratory behavior, and most are considered to belong to various distinct subspecies. Accidental release, for example, of Costa Rican Monarchs supplied to a butterfly house in eastern Canada could have unknown
consequences were they to hybridize with the local migratory population. Recent research has demonstrated that the migratory ability of this butterfly is fine-tuned by a system under direct genetic control.

In Costa Rica, the Pacific and Atlantic coast populations of several species of morphos will almost certainly become mixed, due to butterfly farmers who mass-rear morphos at a rate of many hundreds per week. The threat this represents is unknown, but it seems likely that mixing has already occurred through exchange of breeding stock.

In Asia, butterflies from a breeder’s stock of the Great Mormon (Papilio memnon) produced by intraspecific hybridization (genetic mixing) of two Malaysian subspecies of this highly polytypic butterfly recently escaped in Ambon, Indonesia. This apparently invasive hybrid is now spreading through the Moluccas, and could have a negative impact on specialized native swallowtails that are increasingly dependent on cultivated citrus. It is potentially an acute threat to any of the poorly-known native races of Great Mormons that occur in this region, which could be lost through overwhelming hybridization even before they have been properly documented.

Heliconian species in the genus Heliconius are widely used by the BHI. Laboratory hybrids between Heliconius species are routinely created by researchers investigating evolution and development, and spontaneous species hybrids of Heliconius are known to occur widely in butterfly farms and houses. Were such hybrids to escape almost anywhere in Latin America and interbreed with wild populations, a huge investment of scientific research into the evolution of these butterflies would appear to be at risk. There is growing evidence that a number have already escaped.

**ENVIRONMENTAL AND CONSERVATION OPPORTUNITIES OF THE BHI**

The approximately 40 million visitors per year attending entertainment venues devoted to butterflies represent a huge opportunity for creating ecological, environmental and conservation awareness. Live butterfly exhibits stimulate strong and positive responses among people of all cultures and age groups. Butterflies are flagships for all the small organisms essential to any functional ecosystem. The special ‘hook’ is thus the emotional appeal of butterflies as ambassadors for the invertebrate world. Even though butterfly houses can contribute little to conservation directly (but see below), because of the possibility that they will improve public understanding, the charisma of butterflies offers a starting point for increasing conservation awareness.

**Biological knowledge and conservation awareness**

Any biological principle can be taught with butterflies; they offer ideal subjects to introduce sexual reproduction and life-cycles (with the added ‘spice’ of their remarkable metamorphosis), dependence on critical resources (e.g., specific hostplants), existence of specific antagonists (e.g., parasitoids) as well as general predators (and thus foodwebs), and the need of different food for energy and growth. To understand many conservation issues it is necessary to appreciate that the vast majority of organisms only occur naturally in particular parts of the world, and require specific habitats. Butterflies are ideal subjects for creating such awareness. Given accurate information about the species on display, where they occur, their life cycles and basic habitat requirements, the ground is prepared for the next step in conservation awareness.

The need for habitat conservation can be directly connected to butterfly exhibits by awareness that the butterflies on display only occur naturally in particular geographical areas where they are dependent on specific resources, and that many of these places are threatened by human activity. But there is also opportunity to highlight conservation needs in areas local to the butterfly house, or where the majority of visitors come from. An exhibit can link to local as well as global conservation concerns and initiatives, in part focused on butterflies and plants, but also addressing the need to promote ecosystem conservation.

**Ecological and environmental literacy**

Combining basic biological knowledge with the need for conservation provides an opportunity to introduce an understanding about ecosystems and how they work: energy flows, nutrient cycles, foodwebs, nested systems, feedback loops, self-organization and so on. These ideas underpin the need for sustainability, including food security. Butterfly houses have two special opportunities to get this message across: they can demonstrate how the butterflies on display have been bred in a sustainable way, and the butterfly house itself can provide an example of a sustainable enterprise by practising, for example, efficient energy use by employing only renewable or durable materials, offering organic food, and adopting and promoting fair trade principles.

Live butterfly exhibits thus have an enormous potential to educate visitors about nature, ecology, ecosystems, conservation, the environment, and even social responsibility—a far greater educational potential than anticipated when the industry began. They can take advantage of the emotional response to butterflies to get visitors’ attention, and then convey not only facts about butterflies, but also a more rational understanding of insects and their ecological roles, including many benefits to humans. There must be explicit attention to the goals of a better understanding of nature, increased engagement with invertebrates, and with ecological, conservation and environmental issues, and appreciation of the need for environmental policies and actions. We do not suggest that these educational opportunities outweigh the environmental risks. Instead, we propose cooperation between stakeholders (see below) to minimize the risks while maximizing the education.

**SOME NOVEL SOCIAL AND ETHICAL CONSIDERATIONS**

In addition to the ethical issue of risks to biodiversity, the industry also gives rise to novel ethical concerns about human socio-economics, and of animal care.

The BHI has suddenly propelled butterfly pupas into the global economy, as a cash crop. The need for continuous supplies from tropical and subtropical countries provides an opportunity for a steady income to breeders and farm workers. As users of potentially sustainable non-timber forest products, the BHI can directly contribute to economic welfare of people in developing countries, at the same time indirectly fostering habitat conservation. However, for this to be sustainable, not only with respect to the butterflies and their habitats but also the producers, it is economically as well as ethically essential that fair trade principles are rigorously applied. Any desire of suppliers and end-users (exhibitors and visitors) to drive down prices for pupas through market practices needs to be moderated in light of this; price competition with respect to the primary product on which the whole industry depends is potentially destructive. Healthy competition within the industry needs to focus on quality of value-added components delivered at the point of use (e.g., butterfly houses renowned for their good presentation, educational offer, and restaurant facilities).

The availability of spectacular live butterflies has also created demand for their use where fun or momentary amusement is the only rationale. Release of butterflies during a private party, or as part of a night club event, is unacceptable. That this happens in countries where mistreating a dog or cat can be a punishable offense is partly a measure of our collective distaste for insects in general. It also reflects the distance to go in extending ethical concern, first to all humans and then, slowly, to a wider and wider circle of sentient creatures. Respect for the lives of insects has yet to be widely accepted, but it is an ethical issue nonetheless. Closely linked
is the problem of seeing wildlife, including butterflies, as merely material objects that can be used without regard to their intrinsic value, as mere commodities. This is not the place to enter the huge debate that surrounds this issue, but the existence of the BHI requires that, ultimately, it is addressed: in what circumstances is it ethically acceptable to confine butterflies within an artificial space for our entertainment? Similar issues affect some public opinions regarding commercial aquaria. The existence of souvenir and decorative industries based on dead butterflies raises further issues in relation to the BHI.

**ACTIONS NEEDED TO REDUCE RISKS AND INCREASE OPPORTUNITIES**

**Managing the conservation risks**

Three key requirements are identified to combat conservation risks: sustainable breeding as the sole means of mass production for livestock; preventing introduction (accidental or intentional) of alien species of butterflies, their hostplants, parasitoids, and pathogens; and avoiding genetic mixing both at breeding facilities or through short- or long-range translocations. These can be translated into a fourth, overarching action: educating all industry stakeholders to understand why it is important to avoid these risks — and why they should voluntarily engage in reciprocal monitoring and control to ensure a high degree of compliance. Only by managing the risks and ensuring that staff are aware can the BHI demonstrate environmental and ethical responsibility.

**Sustainable breeding.** The need to adopt sustainable breeding throughout, rather than employ rearing, is fundamental. However, this is not a simple issue and it has consequences. A key implication is that farmers should invest in breeding only a small range of industry-suitable, common species native to their own area of operation, with appropriate technical expertise. They should resist the temptation (normally satisfied we believe by rearing) to make rarer species available to the supply chain on an opportunistic basis. Rare species are not necessary for education, and they are rarely, if ever, more valued than common butterflies by the vast majority of visitors.

In our view, the industry should not continue to extend its species range by including rarer butterflies as ‘specials’ — on the contrary, less common species already on the market should be omitted. Common species that can be supplied with low risk to agreed countries worldwide (see below) provide sufficient diversity to satisfy all the needs of butterfly houses and their public.

**Discouraged translocations.** Not only is it undesirable to trade species from one region to another where they could establish (tropical to tropical location; or temperate to temperate region, north to south, or vice versa), but it is also quite unnecessary, as all regions offer a wide range of suitable local species for display. ‘Local’ recipients of numerous exotics very unlikely to become established were they to escape: Sensible self-regulation of these matters by house-managers could be turned to advantage with respect to local conservation and sustainability issues. A general rule should be that exhibits in the tropics only use local species.

**Parasitoids and diseases.** With respect to parasitoids and diseases, it is in the breeders’ own economic interests to have healthy livestock. Consequently, one might expect that the export of infected pupas would be rare. However, if breeders and suppliers depend on or include pupas accumulated from opportunistic rearers, then infestation is likely to be higher. In addition, although breeders and suppliers will be well aware of egg and caterpillar parasitoids, they are likely far less aware of parasitoids that only emerge from pupas as by that stage most of their stock has normally been sold. Good communication between exhibitors and producers is necessary to alert breeders that they are sending out unhealthy stock. The presence of such parasitoids within a butterfly house is rarely a problem for exhibitors, since they are not rearing all life stages—but it can be for the environment if they escape! Containment of small flies and wasps is far more difficult than butterflies and there is little direct reward for preventing their release.

In general, the precautionary principle suggests that breeders and suppliers need to be more aware of the risks, undertake better management of diseases in their breeding facilities, and take as many precautions as practical to avoid passing on parasitized or ‘sick’ pupas. This is no more than good animal husbandry, of the sort now widely practised by modern zoos. To achieve this, however, there is a need for new research, and this could only be undertaken by willing cooperation between BHI stakeholders and the scientific community.

Even without further research, thorough education and effective monitoring of breeding facilities should be undertaken seriously. In general, larger, well-organized and well-equipped breeding facilities seem preferable to small or individual production enterprises. The development of well-managed cooperatives might overcome this potentially unfortunate socio-economic limitation.

**Genetic mixing.** It is unwise and unnecessary to use alien stock of any species that occurs locally or even regionally in the area where a butterfly house is located. The same principle applies to breeding — farmers should not mix stock, nor should they source stock from elsewhere of species that occur naturally in their area of operation. If hybrids become established in a breeding facility, they should be terminated immediately. These problems can largely be avoided if breeders resist the temptation to exchange livestock, even within the same country. Dependence on nearby source populations will also encourage breeders to be more forthright about local conservation issues.

Responsibility for combating these risks lies at all stages in the supply chain. This includes the need to develop effective livestock screening procedures (for short-lived creatures quarantine procedures are not practical). Further, it is not only a matter of individual butterflies accidentally escaping or hitchhiking on visitors—members of the public quite often steal live butterflies, for fun, as a joke, or in some misplaced ‘act of mercy’ to give the insects their freedom. Without inadvertently encouraging the idea, exhibitors need to make their public aware that such actions carry a real risk of ecological damage and that, moreover, it is rarely ‘merciful’ for the butterflies to be released into what is, for them, an alien environment.

**Conservation opportunities**

Although some believe the industry can make a direct input to conservation, unlike modern zoo programs for threatened vertebrates, butterfly houses should not endeavour to breed and display endangered butterflies. The survival of myriad endangered invertebrates is almost entirely dependent on habitat conservation, coupled with mitigation of impacts such as pollution and climate change.

The industry can make a direct contribution to conservation when and if the economic return from breeding facilities is sufficient to persuade people to protect specific natural or semi-natural habitats for biodiversity. Examples include the Kenyan Kipepeo Project, intended to conserve the Arabuko-Sokoke Forest, and similar projects in Tanzania, Malaysia, Peru, Guyana and elsewhere. Some farms are using their profit to buy land for biodiversity conservation. The International Tropical Conservation Foundation, in part funded by a Swiss butterfly house, owns and manages Shipstern Nature Reserve in Belize.

Where appropriate and economically feasible, butterfly houses can also help raise awareness and promote habitat conservation projects for particular endangered taxa. Such initiatives should never disguise lack of attention to basic biological education and local conservation. House managers should ensure that sustainable practices and habitat conservation are promoted by all their...
Exhibitors should provide educational material and, wherever possible, other opportunities (e.g., films, guided tours, talks, demonstrations, bookshops, further reading suggestions, web sites, etc.) for visitors to learn about the biology of butterflies and their place in nature. This must include information about the natural systems in which they occur, and transmit the idea that habitat conservation is essential for long-term survival. This understanding should, if possible, reach the level of basic systems thinking, to appreciate the other organisms that are part of the living communities on which butterflies depend, and of which they are a part.

Although there are rare examples of good educational practice, the educational offerings of most butterfly houses are insufficient, misleading, incorrect, or even lacking altogether, particularly in private for-profit exhibits. At present most visitors seem happy just to experience (and photograph) free-flying butterflies, and make little demand for educational information — other than to inquire about the names of butterflies on display. But people cannot demand what they do not know about, and there is thus little or no pressure on exhibitors to provide a good educational experience as well as a “butterfly experience.” Such investments need to be made. However, because exhibitors sense little demand and start-up costs are likely to be considerable, few butterfly houses seem willing to sustain suitable educational programs.

We suggest that another reason for lack of appropriate and accurate biological and conservation messages is a lack of profound knowledge about butterflies and natural systems on the part of the three groups of primary stakeholders. These stakeholders also need to recognize that they will do better in all respects if they cooperate rather than compete. Cooperation will be essential for successful self-regulation if they are to avoid increasing legal restriction.

Many people engaged in the BHI are involved because they have a love of nature. We suggest that, in addition to what E.O. Wilson termed biophilia, many have “butterfly-philia”, and by adding a more rational understanding of butterflies and their ecological requirements to this emotional enthusiasm will allow them to run a knowledge-based operation. In a similar way, the majority of butterfly house visitors have an emotional affection for butterflies. While nurturing and encouraging this, they must also be helped to understand the place of butterflies in the natural world, and get a better idea of how our world works. Only in this way can visitors add rational understanding to emotion to get full value from their butterfly house experience. This will only be possible if those running the industry have that knowledge themselves, and thereby become confident, able and keen to communicate it.

Although the needs and opportunities for effective education at different venues are very varied, even the best-run houses have considerable room for improvement, at least with respect to the wider issues of environmental awareness and sustainability. For most exhibitors the immediate challenge must be to increase their educational offerings considerably. Given the generally low standard, rapid improvement to some minimum level should be a realistic target, assuming the industry can get assistance from competent educators and scientists to help prepare suitable pedagogical material.

The ethical imperative
Managing the conservation risks and ensuring staff are aware of the issues involved are ethical responsibilities of the BHI. Public education and good animal husbandry are equally important ethical imperatives if the industry is to survive increased scrutiny and future regulation.

With respect to good husbandry, it is essential that suitable temperature, light and humidity conditions are maintained within exhibitions, and that particular attention is paid to access to water and suitable food. The sight of a dehydrated zoo animal without access to water is likely to invoke public outrage. How
long before the public become aware that dehydrated butterflies are equally unacceptable (and unnecessary), or that morphos and owl-butterflies denied access to suitable fruit are also being badly treated?

Good husbandry has practical benefits for the exhibitor: healthy butterflies provided with appropriate resources will behave in more interesting ways. This also raises an apparent conflict of interest between stakeholders, breeders and suppliers on one side, and exhibitors on the other. Good husbandry by exhibitors is likely to reduce their need for pupas, as the butterflies will live longer. Short term this will be an economic advantage to exhibitors, at least offsetting the increased costs of good husbandry, but an economic loss to the breeders and suppliers. However, we believe this apparent conflict is illusory: the normal dynamics of supply and demand will rapidly come into play. Moreover, security of the entire rights chain is predicated on the success of the exhibitors and, crucially, their public patronage. Just as modern zoos can no longer afford to display emaciated and disturbed animals in tiny cages, an increasingly sophisticated public will begin to demand that butterflies in a butterfly house are demonstrably well cared for. With respect to buyers who purchase pupas simply as material for fun events with no educational potential, such indoor releases are ethically unacceptable, send a poor message, and have the potential to bring the entire BHI into disrepute — suppliers should restrict their sales to serious exhibitors.

SOME OTHER CONSEQUENCES OF ELECTRONIC COMMUNICATION AND RAPID COURIER SERVICES FOR TRADE IN BUTTERFLIES

The principal risks exemplified for the BHI also apply to national and international exchange of insect livestock by “amateur” entomologists, hobbyists and insect lovers, and the new fashion for outdoor ceremonial butterfly releases. As these uses for live butterflies offer no opportunities for public education about environmental and conservation issues, we mention them only briefly here.

Livestock ‘trading’ for and by amateurs

In the past, amateur exchanges of livestock and commercial butterfly trading were rather small scale activities, largely carried out by relatively well-informed enthusiasts and a few, mostly well-known traders. Even so, in 1991 it was estimated that the global market for dead butterflies ran into tens of millions of dollars. Nowadays, traditional print media offering livestock are substituted by internet-based interactive platforms. The world-wide web and courier services now make shipping of livestock an activity in which anyone can join and which in effect has no limits. Many different kinds of live insects (not just butterflies) are sold and exchanged worldwide within days or even hours. What recipients do with their livestock is uncontrolled. As with the BHI, legislation is missing — but even if it existed it is very doubtful it could be enforced. Thus, only good environmental education can address these risks. Most amateurs are even more biophilic than stakeholders in the BHI and, even if they have limited general biological understanding, many are real specialists and often extremely knowledgeable about the particular species in which they are interested. However, there are potentially high translocation and genetic risks attached to amateur livestock trading and exchange, and this remains largely unrecognized.

Ceremonial butterfly releases

The spiritual issues associated with butterflies makes one wonder why they have been so little used in ceremonial activities until recently. Modern means of communication and transport in combination with the new ability to mass-produce butterflies has now given rise to the phenomenon of ‘ceremonial releases’, typically involving flights of Monarchs and several other species released at weddings, funerals, birthdays and comparable occasions. In 2010 it was reported that 11 million individual butterflies were released in North America alone. In contrast to live exhibits, such acts rarely have education value but raise similar conservation issues as the BHI. The release industry is largely served by a different set of entrepreneurs well organized through the International Butterfly Breeders Association, currently with 150 members — many more than IABES. Notably, they are breeders and suppliers at the same time. A considerable controversy concerning the conservation risks and ethical issues has developed (see American Butterflies Spring 1998, available online at http://www.naba.org/releases.html).

School kits

Another development has seen major growth in the supply of school “butterfly kits,” with caterpillars or fertilized eggs and artificial diet to feed the caterpillars. Once children have witnessed the fascination of metamorphosis, the temptation to give the lovely butterflies their freedom is often irresistible. While this schoolroom use of live butterflies undeniably has educational potential, it is beyond the scope of this paper. However, a treatment of butterfly kits similar to this discussion on the BHI is certainly warranted.

PERSPECTIVES

We anticipate that the intentional movement of insects for the purposes of entertainment will continue to increase, a scenario in which the BHI will play a leading role. Moreover, this activity will become even more global, with insects being moved not only from the tropics to temperate regions, but also from country to country within the tropics. The issues discussed in this paper will thus become ever more relevant and even more pressing than now.

We have referred to the bastardization of fauna and flora with the more or less tacit assumption that this is a bad thing. There are biological reasons to expect that increasing homogenization will lead to numerous extinctions. In reality, however, with respect to plants at least, the genie is well and truly out of the bottle. Ever since humans adopted agriculture and ceased to be hunter-gatherers, intentional hybridization, genetic mixing (now including GMOs), and translocation of plants has followed at an ever accelerating rate. Not only plants for food, but also those we grow in our back yards simply for pleasure, come from all over the world and are thrown together with little reason or thought. Although plant translocation creates numerous environmental problems, little is done to stop it.

If so, what does it matter if a few of the world’s most beautiful butterflies become feral on other continents, or have their genomes muddled up — after all, they evolved in natural systems that almost everywhere are now more or less disrupted by human activity, including the presence of numerous non-indigenous plants. In the great scheme of things, do butterflies matter? Why should we worry about them? All we can say in response is that, in agreement with E.O. Wilson and numerous other commentators, we believe that all species and natural ecosystems are valuable, and we should do all that we reasonably can to protect them. Moreover, we do not intend to ‘defend’ this belief by resorting to economic or other utilitarian arguments — not least because it will always be possible to make a case that more money, or some other supposed good, can be realized by transforming any given component of the natural system without regard for its relationship to the whole.

The BHI presents a wonderful opportunity for spreading environmental awareness. However, the extent to which this promise can be made real will depend very much on the industry rising to the challenge to engage effectively in education, research and conservation, and self-regulate to minimize the environmental risks involved.

This article has been slightly altered from one that first appeared, with references and notes, in the journal Conservation and Society in 2012. All illustrations, except the map on pg 33, are new.