Letters to the Editor
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Extinction Rates and Butterflies

RATES OF POPULATION EXTINCTONS IN BRITISH invertebrates have now been measured in several different ways ([1]). “Comparative losses of British butterflies, birds, and plants and the global extinction crisis,” J. A. Thomas et al., Reports, 19 March, p. 1879) and may have relevance to estimating global extinction rates (2). We (1) have used the rate of extirpation of species from the whole of the British Isles, measured over the 20th century from the British Red Data Book (RDB), whereas Thomas et al. use distribution changes in the last 20 to 40 years measured in about 3000 map grid cells by 20,000 volunteers. There are notable consistencies and differences in the conclusions of these two approaches.

The extinction of species from the whole of the British Isles is likely to be relatively accurately recorded: Rare species are actively sought, and only one of the 43 species recorded as likely extinct in the RDB has since been rediscovered (with a low and local population). The national extinction rate per century ranges from 0.4% overall for the 14,000 insect species covered in the RDB to 5% for the 60 species of butterflies and 7% for the 40 species of Odonata (the two best-recorded taxa).

Both studies find the rate of loss of selected invertebrate taxa to be roughly the same order of magnitude as the rate of loss of plants and birds. In both studies, butterflies have a notably higher rate of loss than plants or birds, which is not a recording artifact, because these three taxa are well studied.

Given the relatively high local extinction rates of butterflies recorded by these and other studies, we disagree with the conclusion of Thomas et al. that butterflies represent good indicators for losses of other taxa. Rather, Thomas et al.’s study supports our suggestion (2, 3) that butterflies (being mostly warmth-loving and herbivorous) are atypical invertebrates that are relatively sensitive to climatic fluctuations and thus give a potentially misleading guide to extinction rates and human impacts.

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References

Response
HAMBLER AND SPEIGHT SUGGEST THAT butterflies have experienced amplified extinction rates in Britain, and thus their widespread use as indicators of change in insects (1, 2) is inappropriate. We consider this argument to be flawed, because of an artifact of recording.

It is widely accepted that comparisons of the proportion of species believed to have become extinct in different taxonomic groups will be biased if the groups being compared experienced different levels of past recording (1, 3). This occurs because the early species lists for undersampled groups contain a disproportionately high representation of common widespread species (4), and it is the rare and local species in a taxon, which trended not to have been recorded in the first place, that are especially prone to extinction (1, 3). McKinney (3) quantified this artifact in six groups (mammals, birds, molluscs, crustaceans, insects, and marine invertebrates) and obtained a strong correlation between the proportion of species recorded as being globally extinct against the proportion of species that was estimated to have been discovered ($r^2 = 0.82$). We can extend this analysis to different groups of British insects using, like Hambler and Speight, the British RDBs as the main data source (see figure).

The figure, which represents change in 9.2% of all known British insect species plus spiders, shows a similar relationship to McKinney’s, indicating that for groups in which “only” 90% of species had been listed a century ago, recorded national extinction rates were less than half those of groups in which 100% of species had been known. Given the rigor of early butterfly recording, their documented declines were not unusual.

Nor are British butterflies atypically thermophilous, as Hambler and Speight claim. The immature, not adult, stages define climatic constraints on insects (6), and distribution maps show that higher proportions of aculeate Hymenoptera and Orthoptera species than butterflies are restricted to the warmest regions of Britain; moths and dragonflies are similar to butterflies, while staphilinid beetles and woodlice are less confined to warm spots (7). Furthermore, because of climate warming, those butterfly species that are thermophilous experienced population increases in Britain that frequently mitigated the effect of habitat degradation (8). Only four of the ten most rapidly declining butterfly species could be classed as thermodophilous: The majority include alpine species.

We are also surprised that Hambler and Speight consider phytophagous insects to be unduly sensitive to environmental change. This contradicts their earlier statements (9), with which we agree (6), that specialists, such as taxa inhabiting rotting trees, are more threatened; moreover, the well-recorded taxa with the highest reported extinction rates in Britain have different lifestyles: carnivorous aquatic (dragonflies) and social terrestrial (bumblebees). In theory, parasitic species are the most vulnerable of all to change (10). Parasitoids are too poorly described to assess critically, but social parasites of ants have a disproportionately high representation in RDBs (6).

In conclusion, we do not claim that butterflies are ideal indicators of other insect changes, but they appear to be suffi-
ciently representative to be employed usefully, due to their comprehensive recording levels, as the only invertebrate taxon for which it is possible to estimate rates of decline in many parts of the world (1, 2).

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**References and Notes**


11. We thank A. Stubbs, M. G. Morris, and J. Davy-Bowker for data included in the figure.

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**Networks by Design: A Revolution in Ecology**

**Environmental Change and Anthropogenic Activities Threaten Biodiversity and Compromise Essential Ecosystem Services**

Environmental change and anthropogenic activities threaten biodiversity and compromise essential ecosystem services at local to global scales (1, 2). Despite this, current ecological understanding derives mainly from site-specific research and measurements at scales of ≤10 m² and at durations of ≤5 years (2–4). Several new [e.g., Conservation International’s TEAM, the National Park Service Vital Signs, and SAEON (South African Environmental Observatory Network) (5–7)] or proposed [e.g., the U.S. National Science Foundation’s NEON and ORION (8, 9)] initiatives for continental and global-scale research and monitoring networks represent unprecedented new funding in support of ecological research. These programs promise to expand scales of ecological understanding and transform ecology into a more mechanistic and predictive science.

Some assume that such networks should be assembled by locating a single site in each of a number of ecoregions, biomes, or biodiversity hotspots [e.g., (10)], or that by developing large networks employing standard methods, many questions will be answered by brute force. However, the high degree of variability inherent in large-scale systems makes it difficult to disentangle exogenous and endogenous sources of change and may compromise the efficacy of network designs. Designing an effective, large-scale ecological network is remarkably complex. In particular, ensuring appropriate levels of integrated sampling to achieve adequate statistical power at multiple spatial and temporal scales is extremely demanding. Previous efforts, often involving substantial expense (11–15), have been limited by several recurring problems: absence of clear questions underlying the design, sampling inadequacy and bias, inadequate statistical power, heterogeneity of measurement, incomplete and unstructured metadata, lack of tools for integration and analysis of heterogeneous data, and cultural or institutional impediments to data sharing.

By tradition, ecology has been a grassroots discipline in which individual investigators drive the scientific enterprise in an

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**Noguchi’s Contributions to Science**

**The Random Samples Item "On the Money"** (4 June, p. 1443) states that Hideyo Noguchi discovered the syphilis-causing microbe *Treponema pallidum* and that he was trying to develop a vaccine for yellow fever. Both of these statements are incorrect.

Noguchi proved that the neurological disease called tabes dorsalis was due to late stage syphilis infection. He demonstrated the presence of *Treponema pallidum* in some sections from the spinal cord of a patient with tabes dorsalis.

He became interested in yellow fever, and because of his experience with *Treponema*, he thought that this disease was also caused by some spirocheta-like organisms. He went to Merida, Mexico, to study yellow fever. A local physician introduced him to a patient who had Weil disease, which also produced jaundice but was caused by *Leptospira icterohemorrhagiae*, a spirocheta-like organism. Noguchi discovered this organism and published it as the cause of yellow fever. Many competent microbiologists failed to repeat his findings, and his statement was considered a mistake. He went to Ghana to study yellow fever once more, and he died there from the disease. He never realized that this disease was caused by a virus, which was eventually discovered by Walter Reed.

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uncoordinated and serendipitous fashion. Transforming this paradigm to one that will advance large-scale, mechanistic understanding across multiple spatial and temporal scales that reflect critical environmental gradients will require a revolutionary change in approach and in the culture of the discipline.

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References and Notes
5. See www.teaminitiative.org.
6. See http://science.nature.nps.gov/im/monitor.
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