Bush Jr. was President, was attacked in the USA by extremist media during the budget sequestration in 2013 when Barack Obama was President. As part of regular efforts to highlight projects that are deemed 'wasteful', these media outlets attacked the relevance of my research into waterfowl genitalia, the Obama administration for funding it, as well as my personal character for studying genitalia. This attack quickly turned me into an activist and defender of basic science. I have published several articles on the importance of basic science and given many seminars on why scientists must take an active role in its defense. When this attack took place, I realized that I was unprepared to join the conversation because we do not formally teach this topic to our students or discuss it with our trainees. I believe that we all need to be ready with examples of the unpredictable connection between basic and applied science to highlight that, even when some basic science knowledge never becomes applied science, all applied science requires basic science, and therefore we must cast a wide net. As scientists, we ignore the constant dismissal of basic science at our peril. More and more funding programs are focusing on 'big data', artificial intelligence, and biomedical research, while natural history and fundamental research keep on shrinking.

If you had not made it as a scientist, what would you have become? I was a kickboxing and spinning instructor during most of my PhD, and I think that I would enjoy a career in fitness, dancing, or martial arts. Alternatively, I may have become a baker, so actually perhaps two of these careers would need to go together.

Which aspect of science, your field or in general, do you wish the general public knew more about? I wish people understood that science is self-correcting. People think that science should have all the answers and that, if some answers turn out to be wrong, then none of the answers can be trusted. This misunderstanding has often been exploited to manipulate people, as has become painfully obvious in the time of COVID-19. We make many mistakes in science, but this does not mean that science cannot be trusted. Science can be trusted precisely because it is designed to catch these mistakes and learn from them. I like to say that the sphere of knowledge has fuzzy edges, but the sphere itself always grows and it is solid at its core.

What do you think are the biggest problems science as a whole is facing today? We succeeded beyond our wildest dreams in recruiting more people — specially women — into STEM fields, so we have grown the number of scientists dramatically, and yet the funding to allow all these scientists to practice science never materialized. As a result, we lose many excellent scientists to a lack of job prospects after the PhD or postdoctoral training, and worse they leave science demoralized at what they perceive is a personal failure, when in reality it is the system that is failing. I think that we need to increase science funding dramatically to take advantage of the brain power that we have been growing for the past few decades.

Is there enough left to discover? I decided to pursue a PhD after we reported on the first live sightings of a new species of beaked whale in the Eastern Tropical Pacific that was previously only known by its skull. That we could 'discover' an eight-foot-long animal in 1998 was mind-blowing! Since then there have been four new species of whales added to the list. If we are still discovering whales, there is decidedly enough left to discover! But, herein lies the importance of diversity in scientists. People with different backgrounds, upbringings, and cultures will look at the same problem and ask different questions about it. Maybe some questions have been answered from one perspective, but only by making room for all the diversity will we get more complete answers to our many questions.

What's your favorite organism/cell/molecule? Caffeine! I am Colombian after all.

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Using GPS-enabled decoy turtle eggs to track illegal trade

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The insatiable human appetite for wildlife products drives species to extinction, spreads disease and has negative consequences for the economies of source countries [1,2]. As a major transnational enterprise, illegal wildlife trade is valued between eight and 26.5 billion US dollars annually [3,4]. Because law enforcement is often only reactive, information on trafficking routes is key to disrupting trade and curtailing wildlife crime. In our efforts to uncover trade routes of trafficked sea turtle eggs, we developed and field-tested the InvestEGGator, a 3D-printed decoy turtle egg embedded with a GPS–GSM transmitter (Supplemental Information). Illegally collected clutches of turtle eggs containing a decoy transmitter enabled us to track the movements of traffickers, and thus gain a better understanding of illegal trade routes. The decoys, set to emit a signal once an hour, provided five tracks, the most detailed of which identified an entire trade chain, covering 137 km. Using data provided by the decoys, we identified trafficking routes and on two occasions properties of potential interest to law enforcement. Decoys also yielded anecdotal information, furthering our understanding of trafficking routes.

We deployed one decoy per nest in 101 turtle nests on four beaches in Costa Rica, of which 25% were illegally taken (Supplemental Information). The decoys tracked eggs from five illegally removed clutches (two green turtle, *Chelonia mydas*, three olive ridley, *Lepidochelys olivacea*; Figure 1). Our shortest track emitted its final signal 28 m from a residential property, while another

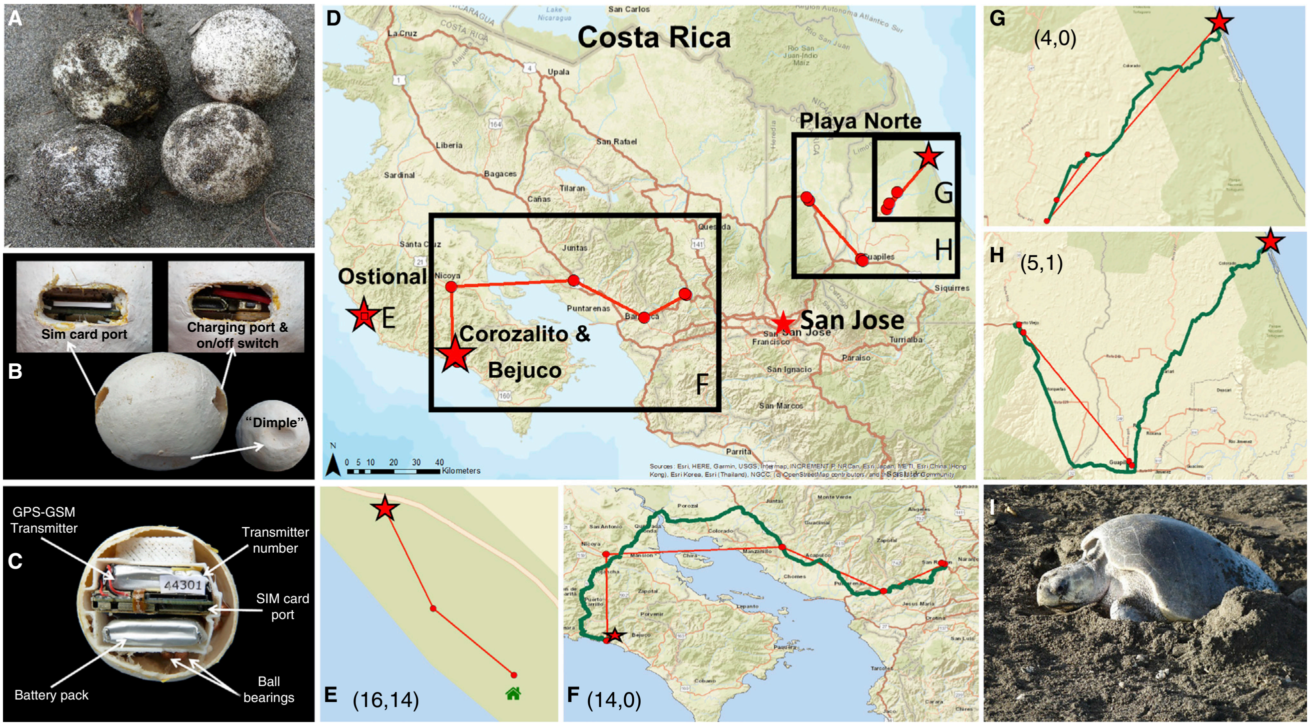

Figure 1. Decoy eggs, data, and estimated routes used by turtle egg traffickers.
(A) Three *Chelonia mydas* eggs and one decoy (bottom left), (B) external (ports are covered prior to deployment) and (C) internal workings of decoy egg, (D) data points provided by four decoy eggs, outlined stars indicate deployment sites, (E) property where decoy signal stopped (green) identified by decoy route (red), (F–H) tracks provided by decoy (red) and likely route taken by traffickers (green) (the fifth track not shown to maintain anonymity of final destination), bracketed numbers represent number of transmissions and repeat transmissions, (I) *Lepidochelys olivacea* during nesting. Map images courtesy of Esri, HERE, Garmin, USGS, Intermap, INCREMENT TR, NR Can, ESRI Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors and the GIS User Community.

travelled 2 km to a bar. Our furthest moving decoy travelled 137 km inland identifying a near-complete trade chain; spending two days in transit from beach to a supermarket loading-bay in the Central Valley, it transmitted a final signal from a residential property the following day (Figure 1F). Given that mobile vendors sell eggs door-to-door in Costa Rica, the supermarket was a likely handover point between trafficker and salesperson.

We also received anecdotal data from reports of discovered decoys. For example, one decoy went off-line in a residential area near Cariari, a town 43 km from the deployment beach (Figure 1G). After eleven days we received photographs, sent from Cariari, of the dissected egg. Accompanying the photographs was information on the place of purchase near Tortuguero and quantities of eggs exchanged. Thus, our system is already yielding intelligence from the local community in addition to track data from the decoys. However, this willingness to share also highlights the lack of sensitivity surrounding this illegal trade.

Planted decoys do not affect the viability of actual turtle eggs. On the Caribbean coast we triangulated all nests and exhumed the contents at the end of the incubation period. There was no significant difference in hatching success ($W = 617$, $P = 0.105$), Stage 1 mortality ($W = 455$, $P = 0.430$), mortality due to microorganisms ($W = 455$, $P = 0.482$) or presence of deformities ($W = 506$, $P = 0.821$) between nests with ($n = 22$) and without ($n = 44$) decoys (Supplemental Information).

We did not receive track data from every clutch that was taken. We recovered six decoys on the beach near nests, presumably discovered and discarded by collectors. At three beaches, these discoveries occurred before we received data from subsequent deployments, suggesting multiple egg collectors may be in operation, or that foreign objects in the nest are not perceived as a threat.

We know that some decoys malfunctioned. We estimated the malfunction rate by examining the outcome of 38 nests containing a decoy (13 illegally removed, 25 recovered). Of the 25 recovered decoys, 17 were functional and eight failed, giving an estimated failure rate of 32%. Applying this 32% failure rate to the 13 removed decoys suggests that five (4.16) would be expected to fail. Of the eleven that did not yield data, we predict that six were functional, but stayed in an area without signal (Supplemental Information). We speculate the most likely reason for malfunction was exposure of the transmitter to moisture that had penetrated the port seals.

In Costa Rica, desecrating a *C. mydas* nest carries a penalty of US $530, and authorities value *L. olivacea* eggs at 600 Costa Rica colóns (₡; US $1.20) each [5,6]. When we consider the additional clutches taken at our study sites on the nights our decoys moved, prosecutions resulting from our study could generate sanctions of US $1,558 to US $2,222. However, prosecutors also consider loss of offspring, ecological and protection costs of nests and recommend fines that reflect this. In 2017, a judge awarded a fine of ₡4,197,428 (US $7,370) for illegally removing 224 *L. olivacea* eggs [6]. This case is now used for recommending penalties.

We have demonstrated it is possible to place a GPS transmitter into a turtle nest and follow a trafficking event from beach to end consumer. A limitation on the Caribbean coast was the low signal reception, but this will improve as infrastructure develops. More importantly, in Costa Rica as in many turtle range countries, it remains extremely difficult to secure convictions for illegal take of wildlife, due to the limited resources available to target traffickers. InvestEGGator eggs therefore have a vital role in documenting trafficking patterns for law enforcement, gather high quality evidence and ultimately disrupt the illegal trade. Decoys are also applicable to other egg-laying reptiles that are under pressure from human egg collectors, such as crocodiles [7,8], and are broadly applicable to other trafficked species, such as birds endangered by egg collectors. Deployment of affordable decoy wildlife products shows great promise as a tool to help curb illegal wildlife trade.

SUPPLEMENTAL INFORMATION

Supplemental Information includes one figure, one table and experimental procedures and can be found with this article online at https://doi.org/10.1016/j.cub.2020.08.065.

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AUTHOR CONTRIBUTIONS

Conceptualization: K.W.-G.; Methodology: K.W.-G. and H.P.; Software: K.W.-G.; Validation: K.W.-G.; Formal Analysis: H.P. and R.A.G.; Investigation: H.P.; Resources: K.W.-G., D.R.-C. and C.M.-B.; Data Curation: H.P.; Writing Original Draft: H.P., D.L.R., D.R.-C. and C.M.-B.; Writing – Review and Editing: H.P., D.L.R., R.A.G. and K.W.-G.; Visualisation: H.P.; Supervision: D.L.R., R.A.G. and K.W.-G.; Project Administration: H.P.; Funding Acquisition: H.P. and K.W.-G.

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Crocodile-like sensory scales in a Late Jurassic theropod dinosaur

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Early in amniote evolution, epidermal scales evolved in stem reptiles as an efficient barrier against water loss and ultraviolet radiation, making them a key development in the transition to a fully terrestrial existence [1]. Accordingly, epidermal scales are not simple inert structures but highly-evolved organs suited to perform a broad suite of functions. Here, we provide new data on the epidermal complexity of a non-avian theropod, *Juravenator starki*, from the Torleite Formation (upper Kimmeridgian), Bavaria, Germany [2]. Although epidermal scales have been noted previously on the tail of *Juravenator*, we report a unique scale type with distinctive circular nodes that we identify as integumentary sense organs, analogous to those in modern crocodylians. The surprising presence of such structures suggests the tail had a sensory function, which is nevertheless congruent with the inferred ecology of *Juravenator* and the evolution of integumentary sense organs among archosaurs.

The tail of *Juravenator* preserves remarkable integumentary details between the 8th and 22nd caudal vertebrae, which were visualised under a combination of white and UV light. Ornamented polygonal (pentagonal or hexagonal) scales, observed here for the first time, form a discrete longitudinal band up to six scales deep (dorsoventrally) ventral to caudal vertebrae 10–14. Individual scales are anteroposteriorly elongate (~1.0 x 0.7 mm) and ornamented by several fine longitudinal ridges. Within the posterior half of each scale is a circular structure consisting of a disc (~0.15 mm in diameter) circumscribed by a narrow, raised ring. The maximum diameter of the entire ringed structure is ~0.3 mm (Figure 1A–C).

The ornamented scales in *Juravenator* have no parallel among avian or non-avian dinosaurs but share distinct