

LETTERS

Edited by Jennifer Sills

Exoskeleton progress yields slippery slope

W. CORNWALL'S FASCINATING News Feature on the growing use of exoskeletons in the military—i.e., robotically augmented ambulatory systems—documented a number of technical hurdles yet to be overcome in this emerging technology (“In pursuit of the perfect power suit,” 16 October, p. 270). In addition to their military potential, exoskeletons will aid many civilians suffering from restricted mobility. However, despite their possibilities, exoskeletons pose substantial ethical, legal, and social concerns that will quickly become all the more relevant with the rapid growth of both the military and civilian industries.

The ability to augment otherwise healthy individuals with military-grade exoskeletons starts us down the slippery slope of human enhancement, a challenging area with broad repercussions in conventional society ranging in applications from medicine to sports. Additionally, in transforming soldiers into quasi-machines, we risk further dehumanizing warfare and its human actors, raising the potential for abuse not only by the enemy, but by commanding officers. This capacity for exploitation can also affect civilian workers who will use exoskeletons in heavy industries.

Even corrective uses associated with restoring abilities to the disabled raise social justice concerns relating to the availability of, and accessibility to, this life-altering technology. Therapeutic implementations may also compel us to redefine nontrivial concepts of disability and ableness in light of the growing capacity to technologically supplement human frailties; additionally, current legal and regulatory structures may be unable to appropriately fit newly abled individuals within current disability conventions.

Not only will exoskeletons likely raise novel legal issues relating to product liability, but the potential to implant brain machine interfaces (BMIs) within the posterior parietal cortex, resulting in preconscious control over the exoskeleton, may challenge longstanding near-universal tenets of criminal law. In most jurisdictions, an individual cannot be guilty of a crime if they lack the threshold *mens rea* and *actus reus* (i.e., a guilty mind resulting in a guilty action). BMIs, particularly those supplemented with artificial intelligence,



A soldier tests a system built to augment walking performance. The ethical, legal, and social implications of exoskeletons such as this one have yet to be explored.

could result in arguably involuntary actions that confound criminal culpability and conceivably put into question even more fundamental issues of free will. In anticipating, promptly acknowledging, and perhaps even tackling these and other concerns, we can preempt and preclude potentially hampering legislation and regulation that might inhibit innovation.

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Torture's inefficiency long established

IN THE 16 October issue, R. J. McNally reviews a book by Shane O'Mara, *Why Torture Doesn't Work* (“Cruel and unuseful punishment,” Books *et al.*, p. 284). I applaud the efforts of the reviewer and the author to publicize this issue, and I would like to remind readers that the inefficiency of torture has long been established, in modern times first and foremost by the Central Intelligence Agency (CIA) itself—the organization at the heart of the current torture dilemma.

McNally claims that “few scholars have

scrutinized” the question of whether “abusive questioning reliably causes people to reveal truthful information that they would otherwise refuse to disclose,” but this is only true in a qualified sense. In the 1950s and 1960s, the CIA managed a series of front organizations, such as the Human Ecology Fund, to issue grants for empirical studies of human stress responses. The CIA enlisted numerous behavioral science researchers who did not know that their research was contributing to a torture manual (1, 2).

Although using neuroscience may be a new way to demonstrate that physical distress induces “neurocognitive deficits,” the CIA had well determined by 1963 that “psychologists and others who write about physical or psychological duress frequently object that under sufficient pressure subjects usually yield but that their ability to recall and communicate information accurately is as impaired as the will to resist” (3). The CIA's Counterintelligence Interrogation (KUBARK) manual also observed that “in general, direct physical brutality creates only resentment, hostility, and further defiance” rather than useful information (4).

The purpose of torture is not to produce useful information; rather, “all coercive techniques are designed to induce regression” (3)—that is, specifically, to erase the individual will by exploiting the psychological and physical dependence of captives on their captors. Ending the practice of torture would seem to involve more than a new, convincing demonstration of its inutility as a means of obtaining information. In this light, then, perhaps the more important assumption to reexamine relates to the disturbing notion that torture has any purpose beyond the exacting of pain, control, and domination.

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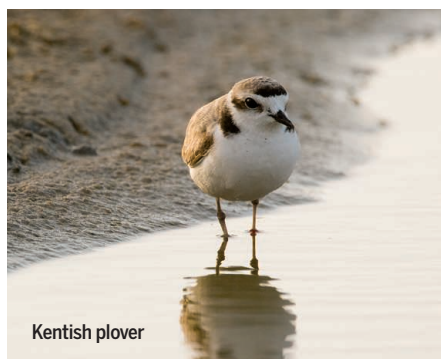
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Pollution threatens migratory shorebirds

IN ADDITION TO the destruction and loss of coastal wetlands along migration routes (“Hostile shores,” C. Larson, News Features, 9 October, p. 150), contamination in the Yellow Sea poses a critical threat to migratory shorebirds.

China's coastal wetlands have suffered from serious pollution, and Bohai Bay in the northwestern Yellow Sea has been particularly affected. Annual fluxes of mercury, cadmium, lead, and arsenic from 13 coastal cities in this area are estimated to be 30, 400, 1400, and 2000 tons per year, respectively, into Bohai Bay (1). The pollution of inorganic nitrogen and phosphorous, oil, and heavy metals has led to a sharp decline of fishery resources (2), greatly decreasing the food supply available to migratory shorebirds.

Pollutants in water, mud, and organisms from the area can cause substantial harm to bird health. For example, cadmium, arsenic, and lead in fish and shellfish from Yantai exceeded the limits in China's food safety standard (3), and the DDT levels in shellfish exceeded the wildlife quality criteria at most sampling sites in Bohai Bay (4). Some metals and persistent organic pollutants can accumulate in shorebirds, by means of biomagnifications along the food chains. Many chemicals can cause changes



Kentish plover

to the avian thyroid gland and/or disruptions in the reproductive system, although acute mortality has rarely been reported. For example, exposure of Kentish plovers to the Prestige oil spill adversely affected their reproductive performance by changing egg quality (5). Moreover, the Yellow Sea region has been contaminated heavily with plastic debris (6), which can result in health disorders and even death (7).

Some emerging anthropogenic pollutions may result in unexpected negative impacts on bird behaviors. Offshore wind energy applications are increasing in the region, including in Rudong and the Bohai Bay, the two most critical sites in the whole flyway. Electromagnetic radiation generated from wind farms is likely an emerging threat to bird orientation (8). In addition, artificial lights in the coastal zones could have negative and deadly effects, especially on fledglings (9).

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TECHNICAL COMMENT ABSTRACTS

Comment on "Worldwide evidence of a unimodal relationship between productivity and plant species richness"

Lauri Laanisto and Michael J. Hutchings

Fraser *et al.* (Reports, 17 July 2015, p. 302) report that a hump-backed model describes the worldwide relationship between productivity and plant species richness in grassland communities. We reanalyze their data from a larger-scale perspective, using a local species pool. This influences richness far more strongly than productivity, and, when this is taken into account, the hump-backed richness-productivity relationship disappears.

Full text at <http://dx.doi.org/10.1126/science.aad4836>

Response to Comment on "Worldwide evidence of a unimodal relationship between productivity and plant species richness"

Lauchlan H. Fraser, Meelis Pärtel, Jason Pither, Anke Jentsch, Marcelo Sternberg, Martin Zobel

Laanisto and Hutchings claim that the local species pool is a more important predictor of local plant species richness than biomass and that when the species pool is considered there is no hump-backed relationship between biomass and richness. However, we show that by calculating a more appropriate measure of species pool, community completeness, both regional and local processes shape local richness.

Full text at <http://dx.doi.org/10.1126/science.aad4874>



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