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Logging Speeds Little Red Fire Ant Invasion of Africa[1]

[redacted]

ABSTRACT

Here, we document the invasion of equatorial Africa by the little red fire ant (*Wasmannia auropunctata*). Commercial logging and other forms of natural resource extraction have catapulted *W. auropunctata* into the interior of Gabon at a rate 60 times faster than the unassisted rate we measured over 19 years at the Lopé Reserve. We also present photographic evidence suggesting that *W. auropunctata* is negatively affecting the country's exceptionally rich and intact large mammal fauna.

RESUMEN

Nous documentons l'invasion de l'Afrique Équatoriale par la fourmi électrique (*Wasmannia auropunctata*). L'exploitation forestière et les autres formes d'extraction des ressources naturelles ont catapulté *Wasmannia auropunctata* à l'intérieur du Gabon à un rythme 60 fois plus rapide que la progression non assistée que nous avons mesurée sur 19 ans à la Réserve de la Lopé. Nous présentons également des photographies suggérant que *Wasmannia auropunctata* a un impact négatif sur la faune de grands mammifères exceptionnellement riche et intacte du pays.

Key words: equatorial Africa; invasive species; leopard; logging; Wasmannia auropunctata.

Western equatorial Africa (WEA) is a global biodiversity hotspot, holding some of the world's largest blocks of intact tropical forest (Mittermeyer *et al.* 2002). The most pressing threat to the region's biodiversity is mechanized logging, which fragments and destroys habitat (Laurance 1999) and facilitates a booming commercial hunting industry (Wilkie *et al.* 2000). Here, we identify another biodiversity impact of mechanized logging, the spread of a Neotropical invader, the little red fire ant (*Wasmannia auropunctata*). By displacing endemic ants and preying on or outcompeting a variety of other arthropods, *W. auropunctata* has earned a spot as one of the world's top 100 invasive pests (ISSG 2002). Particularly hard-hit have been the Pacific islands, where *W. auropunctata* also affects lizards, tortoises, and domestic dogs (Lubin 1984, Wetterer 1997, Jourdan *et al.* 2001, 2002). Effects on wild mammals have not been widely reported, perhaps because mammals are rare in insular faunas. Here, we present the first material evidence of *W. auropunctata* impact on a large mammal in WEA, which holds one of the richest, most ecologically functional large mammal communities of any tropical forest region in the world (Mack 1993, Oates 1996, Barnes *et al.* 1998).

The first records of *W. auropunctata* infestation in Africa come from 1913 in the Gabonese capital Libreville (Santschi 1914). The next year, Albert Schweitzer noted that a small red stinging ant (probably *W. auropunctata*) was also present ca 145 km up the navigable Ogooué River at Lambaréné (Schweitzer 1931); however, movement overland was relatively slow, requiring another six decades before *W. auropunctata* was detected at the Lopé Reserve, 200 km inland from Lambaréné. *Wasmannia* presence at Lopé was first recorded in 1982, in the garage area of a recently abandoned logging camp, which later become the primary gorilla study area of the Station D'Etude des Gorilles et Chimpanzees (SEGC). Local villagers confirm that *W. auropunctata* was absent until logging roads were cut during the 1970s. Thus, it is likely that the ants that colonized Lopé were stowaways on a logging vehicle.

Between 1982 and 2001, five surveys in the SEGC study area have documented the expansion of *W. auropunctata* (Fig. 1a, b). These surveys suggest a two-phase expansion process in which *W. auropunctata* occasionally makes long-distance movements to colonize new areas, then expands locally around each colonization point. The resulting rate of radial spread at SEGC can be estimated by using the infestation "center of gravity" from the first survey year (1982) as an estimate of the original point of

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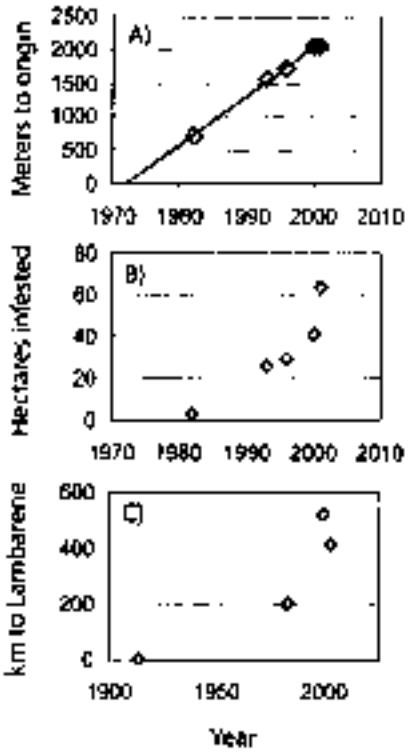

FIGURE 1. Spread of *Wiesmannia europaemaria* in Gabon. (A) Radial distance of infested patches from assumed origin at SEGC plotted against survey year. (B) Area of infestation at SEGC plotted against survey year. (C) Road distance from river port of Lambaréné vs. year that *W. europaemaria* was first detected.

colonization then, for each survey year, measuring the maximal distance of detected patches of infestations from this origin. For the most recent survey (2001), the patch farthest from the assumed origin was 1361 m farther than the farthest patch in the 1982 survey, implying a spread rate of 1361 m/19 yr or 71.6 m/yr. A linear regression using data on maximal distance from the assumed origin for all five survey years yields a very similar estimated spread rate of 72.9 m/yr (R^2 = 0.99, SE = 3.2 m/yr, P = 0.0002; Fig. 1a). Projecting this spread rate back in time implies an original infestation date of *ca* 1972, which is consistent with the logging history in the area.

Growth in the amount of habitat at SEGC infested by *W. europaemaria* was well described as an exponential process of the form $N_t = N_0 e^{\beta t}$, where N_0 is the surface area infested in 1982 and t is the number of years since 1982. If this equation is rearranged to $\ln(N_t/N_0) = \beta t$, the value of β can be estimated using linear regression (Fig. 1b). This produces an instantaneous growth rate β of 0.168 (R^2 = 0.46, SE = 0.069 m/yr, P = 0.0103), which translates into an annual growth rate of $e^{0.168}$. In other words, the amount of habitat infested by *W. europaemaria* grew 18 percent each year on average. If exponential growth continues at this rate, a zone equivalent to the entire 25 km^2 SEGC gorilla study area will be infested by the year 2025.

Larger-scale observations also implicate logging in the spread of *W. europaemaria* into Gabon. The year 1987 saw the completion of a transnational railroad, built to allow export of timber and manganese from Gabon's interior. Since then, the penetration of *W. europaemaria* into Gabon's interior has greatly accelerated (Fig. 1c). In 1999, *W. europaemaria* was detected 320 km down the train line from Lopé in Franceville. In 2001, *W. europaemaria* was found in Makokou, 215 km by road northeast of Lopé, in a house previously occupied by building contractors and gold prospectors. Despite the shorter distance from Lopé, Makokou may have required longer to colonize because of the lack of rail access, which delayed the arrival of commercial timber exploitation until late 2001. The maximal straight-line distance covered from Lambaréné between 1914 and 2002 was 590 km, indicating that the average annual increase

FIGURE 2. Domestic cats with (A) early and (B) advanced corneal scarring from the sting of *Wasmannia auropunctata*. (C) Automated camera trap photo of a leopard with corneal scarring taken ca 1 km from SEGC. The leopard's home range includes several areas of high *W. auropunctata* infestation.

in the radius of detected infestations in Gabon was 390 km/88 yr or 4.4 km/yr. Thus, logging and other natural resource extraction activities appear to have catapulted *W. auropunctata* into the interior of Gabon at a rate roughly 60 times greater than the local expansion rate observed at SEGC.

Neighboring Republic of Congo is logged independently of Gabon and interviews with researchers and conservationists there suggest that *W. auropunctata* may not yet have invaded Congolese parks. *Wasmannia* has apparently not reached Odzala National Park, which lies in northwest Congo *ca* 185 km east of Makokou (F. Maisels, pers. comm.). *Wasmannia* also has not been observed in Conkouati National Park in southeast Congo (B. Bruet, pers. comm.), even though it is common in the Mayumba region directly across the border in Gabon (G. P. Sounguet, pers. comm.). A cross-border difference in *W. auropunctata* presence also holds on the border with the Central African Republic (CAR), which is also logged independently of Congo. *Wasmannia* is absent from Nouabale-Ndoki National Park in Congo (P. Walsh, pers. obs.) but present directly across the border at Dzanga-Ndoki National Park in CAR (A. Todd and C. Chipolesa, pers. comm.).

It seems unlikely that major *W. auropunctata* infestations in or around Congolese parks would have gone undetected if they were present. In Gabon, *W. auropunctata* tend to aggregate on leaves of the exceptionally thick understory vegetation. It is difficult to walk through a zone of heavy infestation without coming into direct body contact with *W. auropunctata* and, consequently, suffering numerous painful stings. Understory vegetation is equally thick in Congo, particularly in the previously logged areas where a great deal of research and conservation activity and infrastructure are concentrated. Furthermore, local villagers in at least one park in Congo (Nouabale-Ndoki) have no knowledge of *W. auropunctata* while villagers living around *W. auropunctata*-infested Gabonese parks (*i.e.*, Petit Loango and Lope) are acutely aware of its presence and even have a specific local name for *W. auropunctata* (Wetterer *et al.* 1998).

Reports that *W. auropunctata* may be affecting wild mammals first came from the Petit Loango Reserve on the southwest coast, where forest elephants (*Loxodonta cyclotis*) and red river hogs (*Potamo-*

thera pardus) in zones of heavy *W. auropunctata* infestation behaved in a way suggesting unusually poor vision (Wetterer *et al.* 1999, S. Lahm, pers. obs.). Blindness is a useful indicator of *W. auropunctata* impact because vertebrate eyes are particularly vulnerable to *W. auropunctata* stings. For example, *W. auropunctata* stings are a common cause of blindness among domestic dogs in the Solomon Islands (Wetterer 1997) and cause blindness in reptiles on other Pacific islands (Lubin 1984; Jourdan *et al.* 2001, 2002). A study conducted in 2002 in the SEGC study area at Lopé suggested that leopards may also suffer from the sting of *W. auropunctata*. A leopard, photographed in the act of biting an automated camera trap, had milky corneas (Fig. 2c). Three other photographic "recaptures" of the same leopard showed that its home range contained several areas heavily infested with *W. auropunctata*. The leopard photograph was taken only a kilometer from the SEGC, where over the last decade a series of domestic cats have developed an eye ailment strikingly similar to that of the leopard (Fig. 2a, b). The building in which the cats lived is heavily infested by *W. auropunctata*, with a stream of ants perpetually eating from the cats' food dish and ants regularly crawling on the cats' fur. Domestic cats in Franceville and Makokou developed a similar ailment within two and six months after discovery of *W. auropunctata* in their respective houses.

Evidence of impact on large mammals in WEA is still anecdotal. We do not yet have quantitative data on the incidence of *W. auropunctata*-induced blindness in wild mammals or even on the background level of similar symptoms that may be induced by causes other than *W. auropunctata* stings. Data on the impact of *W. auropunctata* on other fauna are also lacking. But, given the pervasive effects of *W. auropunctata* in other regions, the implications of *W. auropunctata* infestation are chilling. This tiny ant may eventually threaten WEA's biological riches to an extent equal to the more tangible threats posed by commercial hunting and habitat destruction. Research on the impact of *W. auropunctata* on the fauna of WEA and potential management options is urgently needed.

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Peter D. Walsh

Department of Ecology and Evolutionary Biology,
Princeton University,
Princeton, New Jersey 08540, U.S.A.

Phillipp Henschel

Wildlife Conservation Society,
Bronx, New York 10460-1099, U.S.A.

Kate A. Abernethy

Department of Biological and Molecular Sciences,

University of Stirling,
Stirling FK9 4LA Scotland

Caroline E. G. Tutin

Department of Biological and Molecular Sciences,
University of Stirling,
Stirling FK9 4LA, Scotland

Paul Teller

New York University,
Dept. of Anthropology,
25 Waverly Place,
New York, New York 10003 U.S.A.

and

Sally A. Lahm

Institut de Recherche en Ecologie Tropicale,
BP 13354, Libreville, Gabon

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The *Azteca–Cecropia* Association: Are Ants Always Necessary for Their Host Plants?[1]

ABSTRACT

We assessed the effects of *Azteca alfari* presence on herbivory and growth of saplings for two Amazonian *Cecropia* species. For both species, rates of herbivory were low and did not differ between ant-removed and ant-maintained plants. Plant growth, measured over six months, was also similar among treatments. This is the first experiment to show that in its native mainland habitat, *Cecropia* may suffer low incidence of attack by insect herbivores in the absence of associated ants.

RESUMO

Nós testamos os efeitos da presença de *Azteca alfari* sobre a herbivoria e crescimento em arvoretas de duas espécies de *Cecropia*, na Amazônia. Para ambas espécies, as taxas de herbivoria foram baixas e não diferiram entre plantas que tiveram as formigas removidas ou mantidas. O crescimento das plantas, medido após seis meses, também foi similar entre os tratamentos. Este é o primeiro experimento que mostra que em seu hábitat natural, *Cecropia* pode sofrer baixa incidência de ataque por herbívoros na ausência das formigas associadas.

Key words: ants; ant–plant interactions; herbivory; mutualism; myrmecophyte.

One of the most conspicuous ant–plant associations in the Neotropics is that between *Azteca* and *Cecropia*. Most members of the plant genus *Cecropia* are myrmecophytic and display obvious adaptations to house ants, including large hollow internodes, thin spots in the internode wall via which ants gain access, and a modified petiole base (trichilium) from which food bodies are continuously produced and harvested by associated ants (Bailey 1922, Wheeler 1942, Rickson 1971, Berg 1978). *Cecropia* trees, in turn, may benefit from their *Azteca* in several ways. *Azteca* often chews and kills the shoot tips and tendrils of vines that attempt to climb *Cecropia* trunks, thus acting as an allelopathic agent of the plant (Janzen 1969, Schupp 1986). In addition, these ants may provide supplemental nutrients to *Cecropia* trees (Sagers *et al.* 2000, *cf.* Putz & Holbrook 1988). There has been a lack of consensus, however, on

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