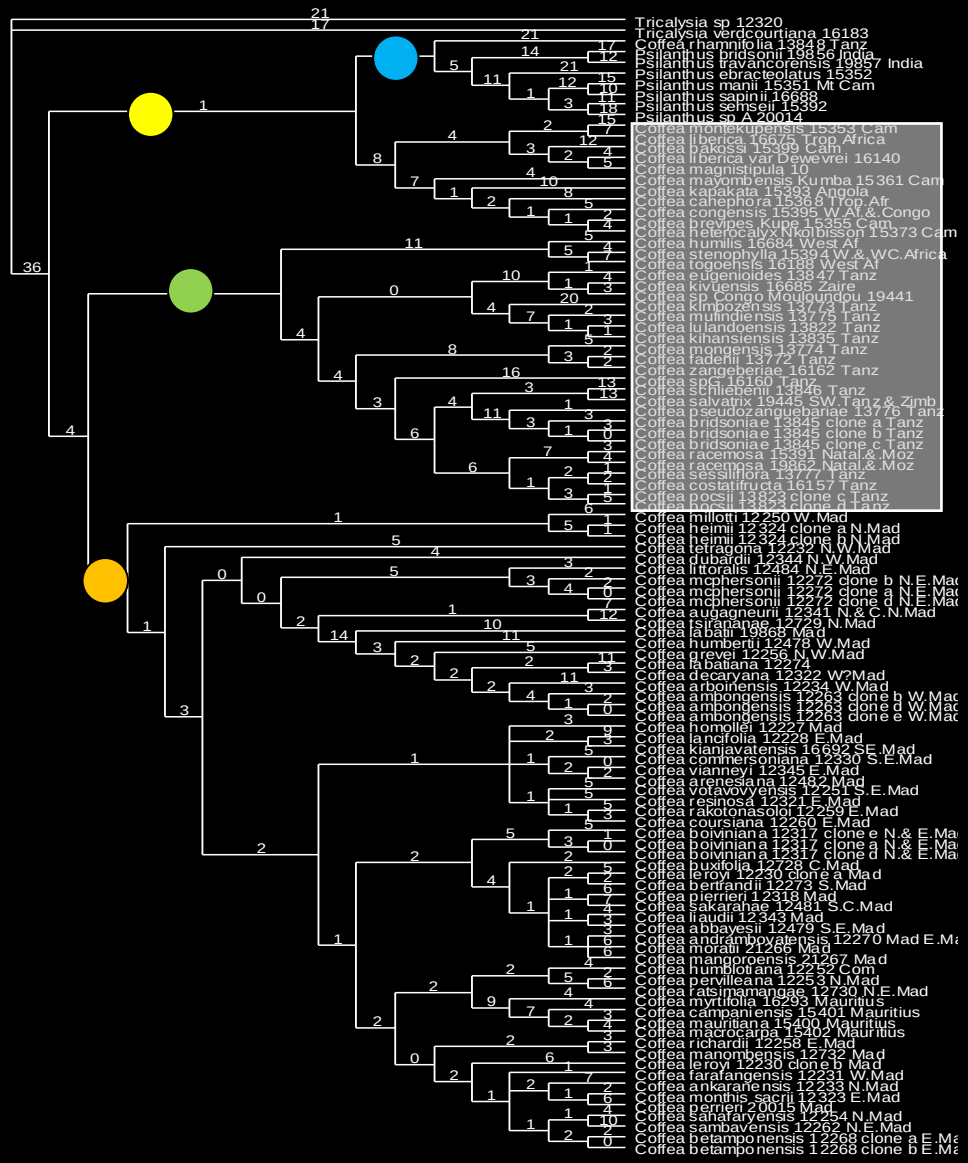
Latest research at Kew
Focusing on coffee species

Coffea arabica (Arabica)

Coffea canephora (robusta)

Phylogeny of coffee (*Coffea*) — 130 species known to science



Former *Psilanthus* [incl. *C. rhamnifolia*]

West Africa [*C. canephora**]

East Africa [*C. eugenioides**]

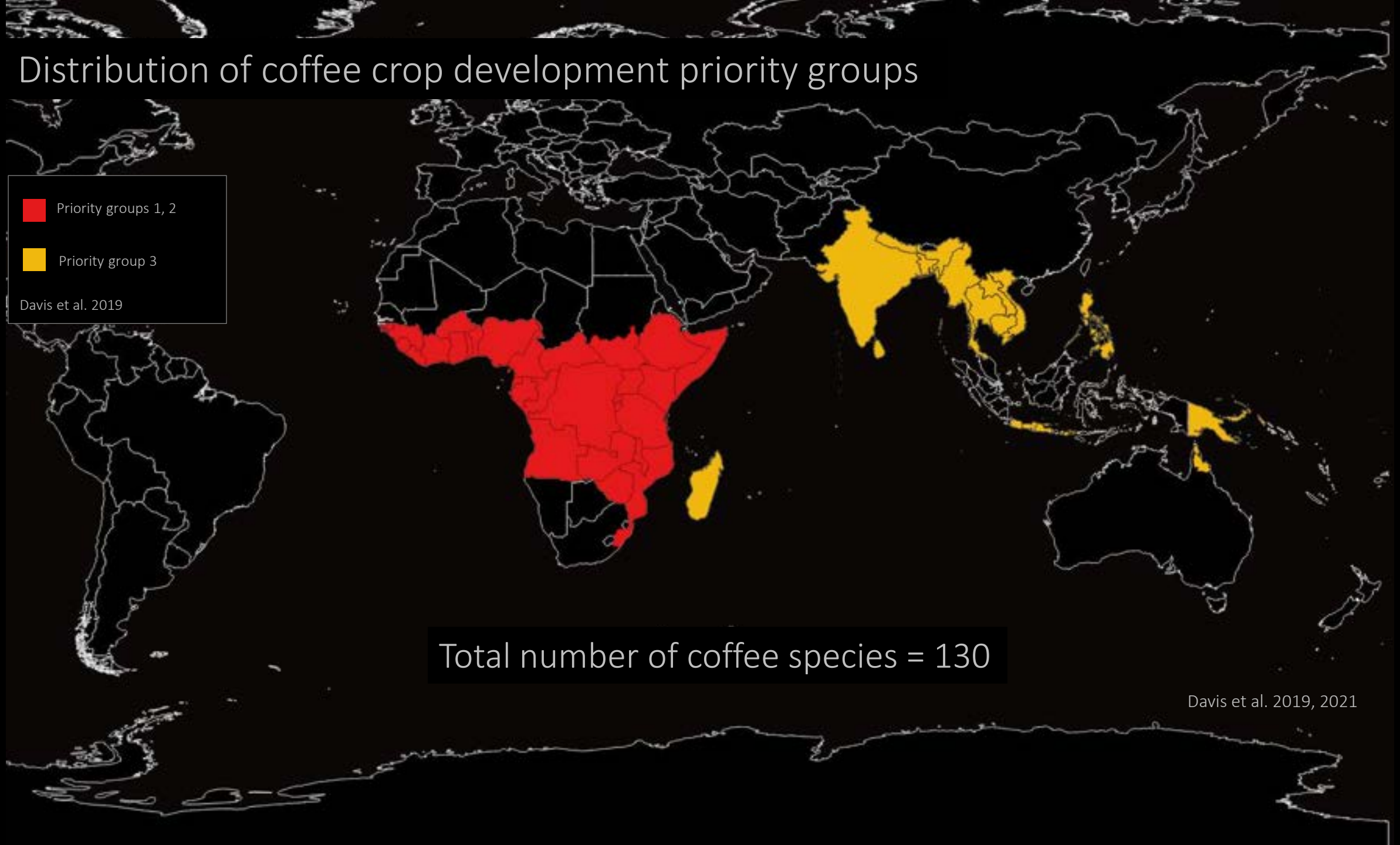
*C. arabica**

Madagascar

Coffee Crop Wild Relative (CWR)
Priority Groups I & II

Maurin et al. (2007)
Davis et al. (2019)

Distribution of coffee crop development priority groups



Total number of coffee species = 130

Davis et al. 2019, 2021

Coffea stenophylla — stenophylla coffee or Sierra Leone coffee

George Don (1834) stated that is was a ‘Native of Sierra Leone, where it is cultivated’… and that ‘The seeds of this species are roasted and used as the common coffee [Arabica], and are even considered superior to it.’

frontiers in Plant Science

ORIGINAL RESEARCH
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Lost and Found: *Coffea stenophylla* and *C. affinis*, the Forgotten Coffee Crop Species of West Africa

Aaron P. Davis[1], Roberta Gargiulo[1], Michael F. Fay[1], Daniel Sarmu[2] and Jeremy Haggar[3]**

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Coffea arabica (Arabica) and *C. canephora* (robusta) almost entirely dominate global coffee production. Various challenges at the production (farm) level, including the increasing prevalence and severity of disease and pests and climate change, indicate that the coffee crop portfolio needs to be substantially diversified in order to ensure resilience and sustainability. In this study, we use a multidisciplinary approach (herbarium and literature review, fieldwork and DNA sequencing) to elucidate the identity, whereabouts, and potential attributes, of two poorly known coffee crop species: *C. affinis* and *C. stenophylla*. We show that despite widespread (albeit small-scale) use as a coffee crop species across Upper West Africa and further afield more than 100 years ago, these species are now extremely rare in the wild and are not being farmed. Fieldwork enabled us to rediscover *C. stenophylla* in Sierra Leone, which previously had not been recorded in the wild there since 1954. We confirm that *C. stenophylla* is an indigenous species in Guinea, Sierra Leone, and Ivory Coast. *Coffea affinis* was discovered in the wild in Sierra Leone for the first time, having previously been found only in Guinea and Ivory Coast. Prior to our rediscovery, *C. affinis* was last seen in the wild in 1941, although sampling of an unidentified herbarium specimen reveals that it was collected in Guinea-Conakry in 2015. DNA sequencing using plastid and ITS markers was used to: (1) confirm the identity of museum and field collected samples of *C. stenophylla*; (2) identify new accessions of *C. affinis*; (3) refute hybrid status for *C. affinis*; (4) identify accessions confused with *C. affinis*; (5) show that *C. affinis* and *C. stenophylla* are closely related, and possibly a single species; (6) substantiate the hybrid *C. stenophylla* × *C. liberica*; (7) demonstrate the use of plastid and nuclear markers as a simple means of identifying F1 and early-generation interspecific hybrids in Coffea; (8) infer that *C. liberica* is not monophyletic; and (9) show that hybridization is possible across all the major groups of key Africa *Coffea* species (Coffee Crop Wild Relative Priority Groups I and II). *Coffea affinis* and *C. stenophylla* may possess useful traits for coffee crop plant development, including taste differentiation, disease resistance, and climate resilience. These attributes would be best accessed via breeding programs, although the species may have niche-market potential via minimal domestication.

Keywords: agronomy, climate change, coffee, West Africa, crop wild relatives (CWRs), DNA, Sierra Leone, speciality coffee

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Preliminary cupping of stenophylla (SCA score of 80.25)

Images: Union Hand-roasted coffee

A detailed sensory evaluation in Montpelier, France

nature plants

LETTERS

https://doi.org/10.1038/s41477-021-00891-4

Check for updates

Arabica-like flavour in a heat-tolerant wild coffee species

Aaron P. Davis[1]✉, Delphine Mieulet[2,3], Justin Moat[1], Daniel Sarmu[4] and Jeremy Haggar[5]

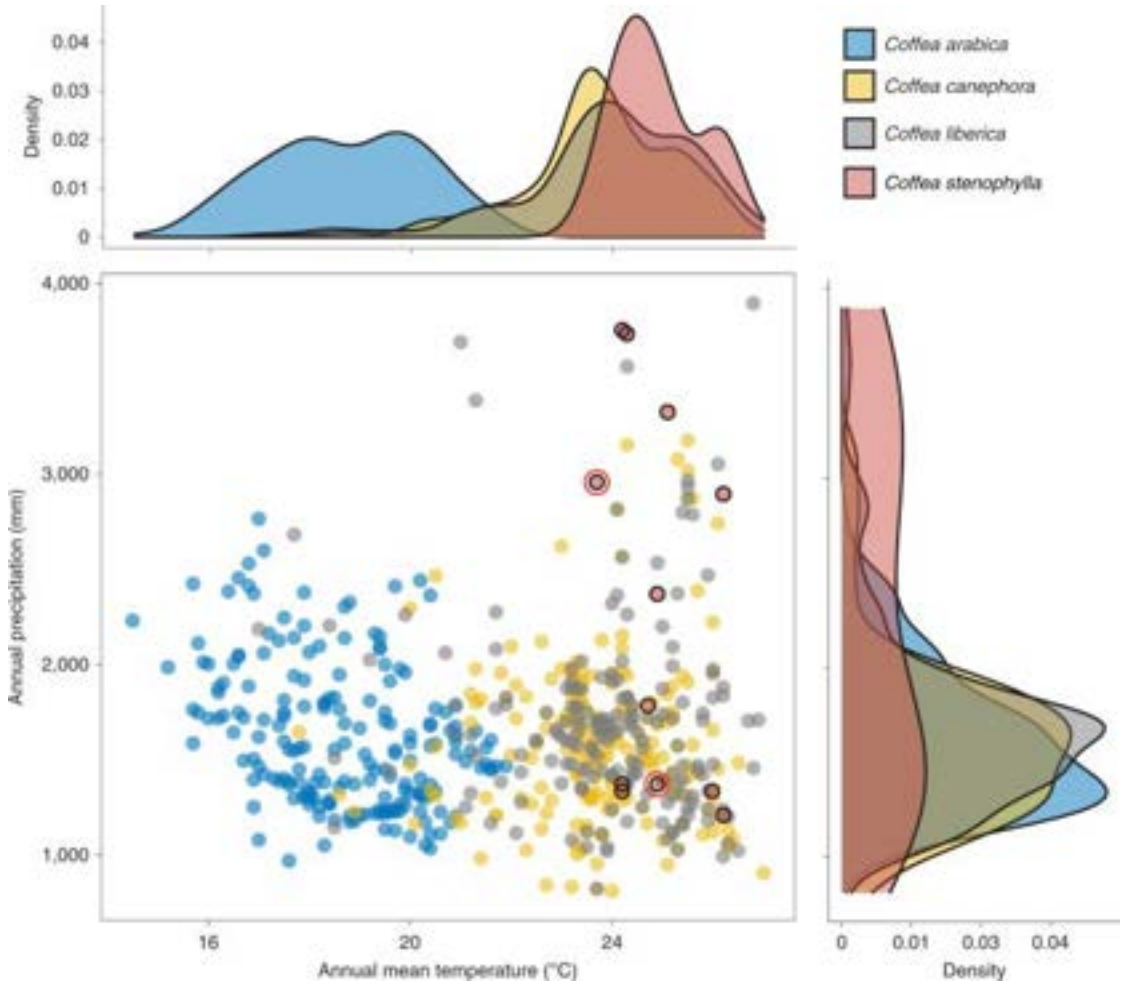
There are numerous factors to consider when developing climate-resilient coffee crops, including the ability to tolerate altered climatic conditions, meet agronomic and value chain criteria, and satisfy consumer preferences for flavour (aroma and taste). We evaluated the sensory characteristics and key environmental requirements for the enigmatic narrow-leaved coffee (*Coffea stenophylla*), a wild species from Upper West Africa[1]. We confirm historical reports of a superior flavour[2,3] and uniquely, and remarkably, reveal a sensory profile analogous to high-quality Arabica coffee. We demonstrate that this species grows and crops under the same range of key climatic conditions as (sensorially inferior) robusta and Liberica coffee[4–9] and at a mean annual temperature 6.2–6.8 °C higher than Arabica coffee, even under equivalent rainfall conditions. This species substantially broadens the climate envelope for high-quality coffee and could provide an important resource for the development of climate-resilient coffee crop plants.

Coffee is a ubiquitous beverage that drives a multibillion dollar global coffee industry[10], supports the economy of several tropical countries and provides livelihoods for >100 million coffee farmers[11]. Despite its global success, the coffee supply chain is beset with challenges, including cyclic price volatility, extreme weather events, increases in the prevalence and severity of pests and diseases and even modern-day slavery. In addition to these constraints and issues, and compounding them, are the negative influences of accelerated climate change[12]. Successful coffee farming occurs within a relatively narrow climatic envelope and is susceptible to weather perturbations throughout its growth and life cycle, rendering it sensitive to climate change. Future-proofing the supply chain under climate change is seen as a major objective for the coffee sector but so far there has been limited progress. There are three main resiliency pathways for coffee: (1) the relocation of coffee farming to areas with suitable climates, especially to higher elevations; (2) adapting coffee farming practices (for example, the use of irrigation, shade or improved shade and cover mulching); and (3) the development of either adapted coffee crop cultivars (via plant breeding) or the use of new coffee crop species. Relocation of coffee farming to higher elevations offers considerable long-term potential for high-elevation coffee-producing countries, such as Ethiopia, but there are disadvantages, including competing land use and loss of livelihoods for lower elevation farming communities[6]. Irrigation is effective against low rainfall and other farm adaptation interventions may offer some potential; both imply additional costs. Progress on breeding climate-resilient coffee crop plants is at an early stage, with attention focused on the two main coffee crop species, Arabica (*Coffea arabica*)[13] and robusta (*C. canephora*)[14].

In 2019/20, Arabica coffee contributed ~56% of global production, robusta 43% and Liberica coffee (*C. liberica*) <1% (ref. [10]). Within the context of long-term climate change, it has been argued that Arabica alone does not have the potential to attain the level of climate resiliency required for adaptation[11] under existing climate change projections[12]. Arabica is a cool-tropical plant, originating from the highlands (1,000–2,200 m) of Ethiopia and South Sudan[15]; in the wild and in cultivation it has an optimum mean (annual) temperature range of 18–22 °C (refs. [5,6]). For Arabica, there appears to be no evidence of climate partitioning or useful (physical or physiological) climate resilience attributes, over its indigenous range or in cultivation[6,7]. Robusta coffee is a predominately low-elevation species (50–1,500 m), occurring naturally across much of wet-tropical Africa[17] and is adapted to higher mean (annual) temperatures of 24–26 °C (ref. [8]) or perhaps even higher to 30 °C (ref. [9]). It is also resistant to the prevalent strains of coffee leaf rust (*Hemileia vastatrix* Berk. & Broome), a serious constraint for Arabica farming in Central and South America. For these reasons, robusta is often mooted as the replacement species for Arabica under a scenario of increasing temperatures and declining and increasingly erratic rainfall. However, robusta may require as much or more rainfall (soil moisture) as Arabica, relative to other climate variables (for example, air temperatures) and could be more temperature sensitive than previously supposed (≤16.2–24.1 °C under a revised estimate of optimal range[9]). There is a well-defined price difference between the two species, with Arabica achieving higher prices[10] due to its superior taste. Robusta and Liberica are excluded from the higher value specialty coffee sector, which is currently the sole preserve of Arabica. *Coffea eugenioides*, a very minor crop species, has an excellent flavour and has started to gain attention as a niche-market, high-end coffee but its seeds (coffee beans) are small (less than half the size of Arabica seeds) and yields are low[16].

Amongst the other 120 coffee species[15] there are numerous species able to grow in warmer and drier environments relative to Arabica, robusta and Liberica and some markedly so[17]. So far, however, none of these species has demonstrated the required flavour and agronomic attributes for wide-scale commercial success.

In this respect, *C. stenophylla* (hereafter stenophylla), a species endemic to Guinea, Sierra Leone and Ivory Coast (Fig. 1), is of considerable interest[1]. Several historical references (1834–1929) indicate that this species has an excellent taste[1], as good as 'best mocha'[2] and possibly superior to all other coffees, including Arabica[3]. However, given their age and context, these claims have been heavily caveated[1] and sensory praise for this species has not been universal[18]. In its native habitat, stenophylla is a species of low-elevation (~400 m), hot-tropical environments (Fig. 2). It is also reported to be drought tolerant and have partial resistance to coffee leaf rust,



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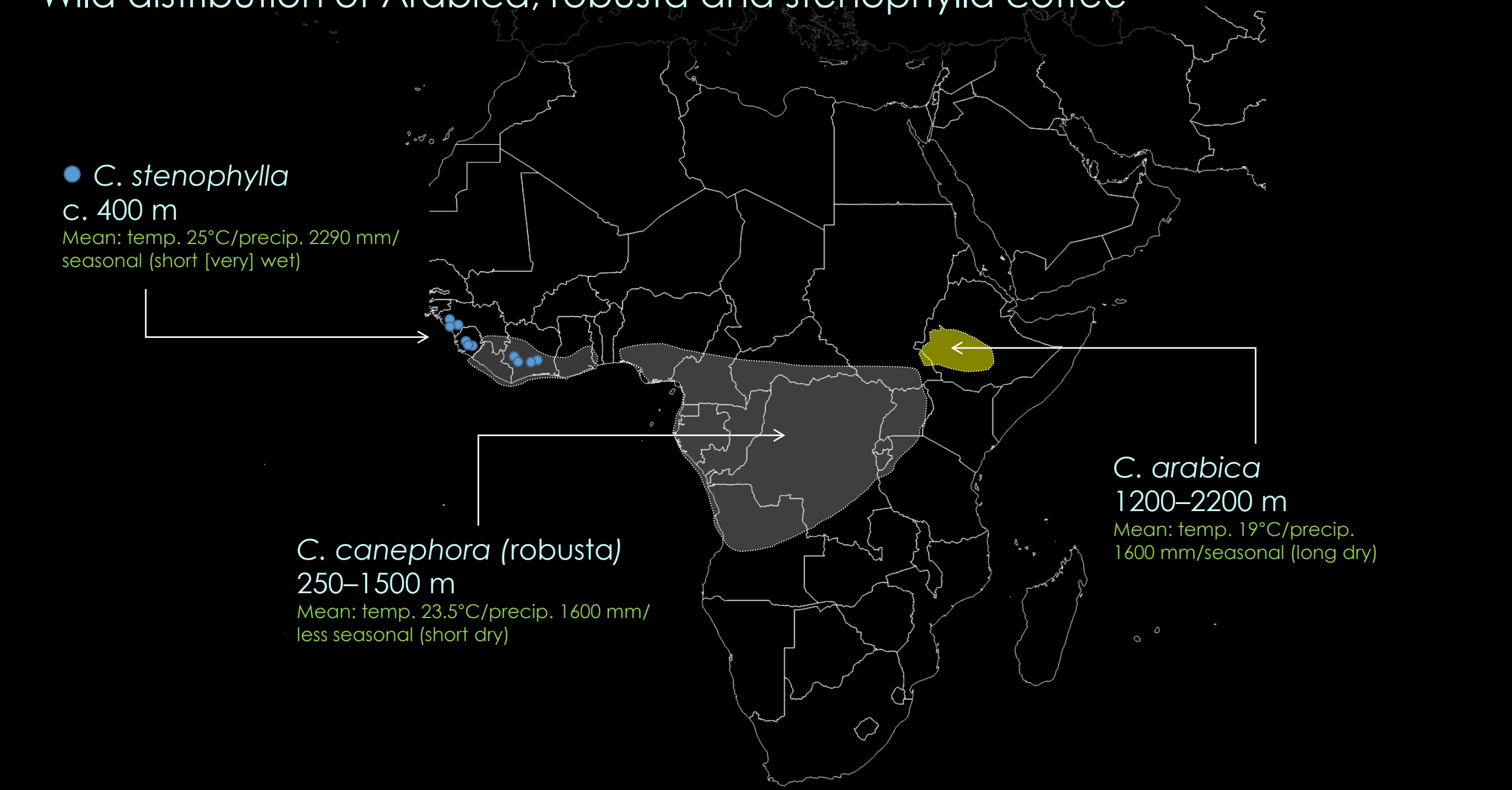
Wild distribution of Arabica, robusta and stenophylla coffee



Liberica coffee

West Africa to Sri Lanka — 1870s

Liberica coffee (*Coffea liberica*)

Liberica coffee (*Coffea liberica*) Uganda 2016

The development and mainstreaming of wild-type excelsa coffee

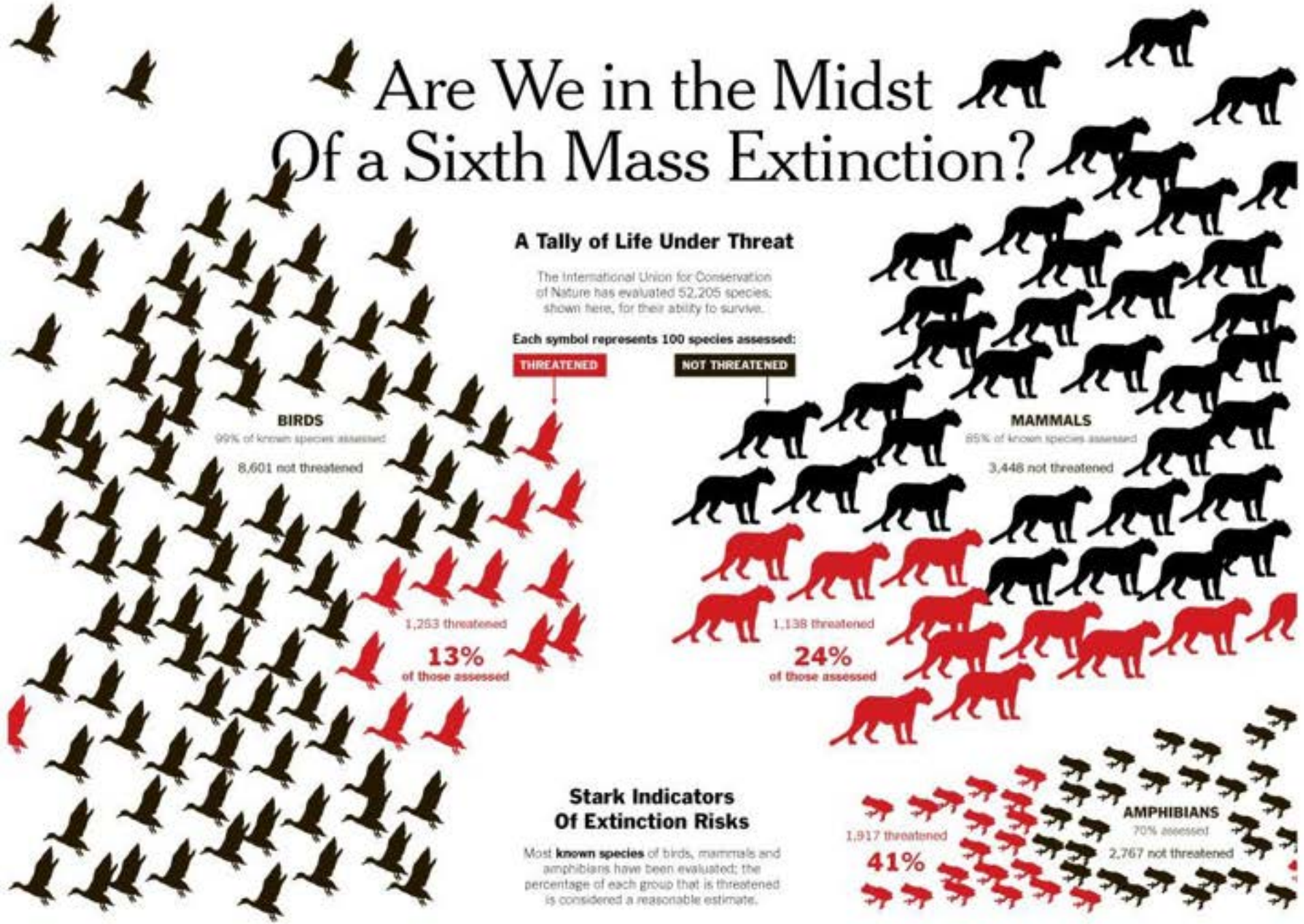
Northern Mozambique 2019

Northern Mozambique 2019

Northern Mozambique 2019

Northern Mozambique 2019

Are We in the Midst Of a Sixth Mass Extinction?



RESEARCH ARTICLE | APPLIED ECOLOGY

High extinction risk for wild coffee species and implications for coffee sector sustainability

Aaron P. Davis[1,*], Helen Chadburn[1], Justin Moat[1,2], Robert O'Sullivan[1,3], Serene Hargreaves[1] and Eimear Nic Lughadha[1]
+ See all authors and affiliations

Science Advances 16 Jan 2019:
Vol. 5, no. 1, eaav3473
DOI: 10.1126/sciadv.aav3473

Abstract

Wild coffee species are critical for coffee crop development and, thus, for sustainability of global coffee production. Despite this fact, the extinction risk and conservation priority status of the world's coffee species are poorly known. Applying IUCN Red List of Threatened Species criteria to all (124) wild coffee species, we undertook a gap analysis for germplasm collections and protected areas and devised a crop wild relative (CWR) priority system. We found that at least 60% of all coffee species are threatened with extinction, 45% are not held in any germplasm collection, and 28% are not known to occur in any protected area. Existing conservation measures, including those for key coffee CWRs, are inadequate. We propose that wild coffee species are extinction sensitive, especially in an era of accelerated climatic change.

INTRODUCTION

Coffee as a crop and wild species

Coffee (*Coffea* L.) is one of the world's most widely consumed beverages, supporting a multibillion-dollar sector (*1*) spanning a lengthy value chain from farmer to consumer. As coffee production is largely in the hands of smallholder farmers, the livelihood value is immense, with an estimated 100 million coffee farmers worldwide (*2*). Global coffee trade relies on two species: Arabica (*Coffea arabica*) comprising c. 60% of traded coffee, and robusta (*Coffea canephora*), the remaining 40% (*1*). Liberica coffee (*Coffea liberica*), a third beverage species, is cultivated worldwide (and used as a grafting rootstock for Arabica and robusta) but is insignificant in terms of global trade (*1*). *C. arabica*, a product of the ancient hybridization of *C. canephora* and *Coffea eugenioides* (*3*, *4*), occurs naturally in Ethiopia and South Sudan (*5*); *C. liberica* and *C. canephora* occur wild across much of wet tropical Africa (*6*).

Arabica coffee has been farmed for at least several hundred years and may have been wild harvested for millennia, first as a food and then later as a beverage (*7*). Farming of robusta was first recorded in Africa in the early to mid-1800s (*8*) but probably predates records by hundreds of years. Liberica coffee cultivation was first documented in the early 1870s, but despite great hopes, its cup qualities failed to meet the taste requirements of the consumer, and thus the aspirations of

Global Change Biology

PRIMARY RESEARCH ARTICLE | Open Access

Least concern to endangered: Applying climate change projections profoundly influences the extinction risk assessment for wild Arabica coffee

Justin Moat, Tadesse W. Gole, Aaron P. Davis

First published: 16 January 2019 | https://doi.org/10.1111/gcb.14341 | Cited by: 2

Abstract

Arabica coffee (*Coffea arabica*) is a key crop in many tropical countries and globally provides an export value of over US$13 billion per year. Wild Arabica coffee is of fundamental importance for the global coffee sector and of direct importance within Ethiopia, as a source of harvestable income and planting stock. Published studies show that climate change is projected to have a substantial negative influence on the current suitable growing areas for indigenous Arabica in Ethiopia and South Sudan. Here we use all available future projections for the species based on multiple general circulation models (GCMs), emission scenarios, and migration scenarios, to predict changes in Extent of Occurrence (EOO), Area of Occupancy (AOO), and population numbers for wild Arabica coffee. Under climate change our results show that population numbers could reduce by 50% or more (with a few models showing over 80%) by 2088. EOO and AOO are projected to decline by around 30% in many cases. Furthermore, present-day models compared to the near future (2038), show a reduction for EOO of over 40% (with a few cases over 50%), although EOO should be treated with caution due to its sensitivity to outlying occurrences. When applying these metrics to extinction risk, we show that the determination of generation length is critical. When applying the International Union for Conservation of Nature's Red list of Threatened Species (IUCN Red List) criteria, even with a very conservative generation length of 21 years, wild Arabica coffee is assessed as Threatened with extinction (placed in the Endangered category) under a broad range of climate change projections, if no interventions are made. Importantly, if we do not include climate change in our assessment, Arabica coffee is assessed as Least Concern (not threatened) when applying the IUCN Red List criteria.

1 INTRODUCTION

For the 2015/2016 coffee harvest period, c. 4.2 million tonnes (71.92 million 60 kg bags) of

Science

Holy crappuccino. There's a latte trouble brewing... Bio-boffins reckon 60%+ of coffee species may be doomed

Climate change is going to make Monday mornings much, much, much more of a grind

By Katyanna Quach 21 Jan 2019 at 06:02 135 SHARE ▼

Coffee plants, the source of the warm brown elixir powering millions of people worldwide using the magic of caffeine, are, it is claimed, at risk of extinction.

A study led by researchers at the UK's Royal Botanical Gardens indicates at least a whopping 60 per cent of all 124 coffee species are under threat of annihilation by climate change and deforestation. Their findings were published this month in Science Advances and Global Change Biology.

And finally…
Something about enjoying coffee


Peets
Peets
Peets
Peets
Peets
Peets
DUNKIN' DONUTS
Sale!
5.99

Unroasted beans of robusta and Arabica

Ethiopia – harvest by hand in forest conditions


Washed coffee — Ethiopia


Drying washed coffee

Roasting profiles

Speciality coffee


SIMONELLI

SCAA

Coffee Taster's Flavor Wheel

SPECIALTY COFFEE ASSOCIATION OF AMERICA

WORLD COFFEE RESEARCH

COFFEE TASTER'S FLAVOR WHEEL CREATED USING THE SENSORY LEXICON DEVELOPED BY WORLD COFFEE RESEARCH

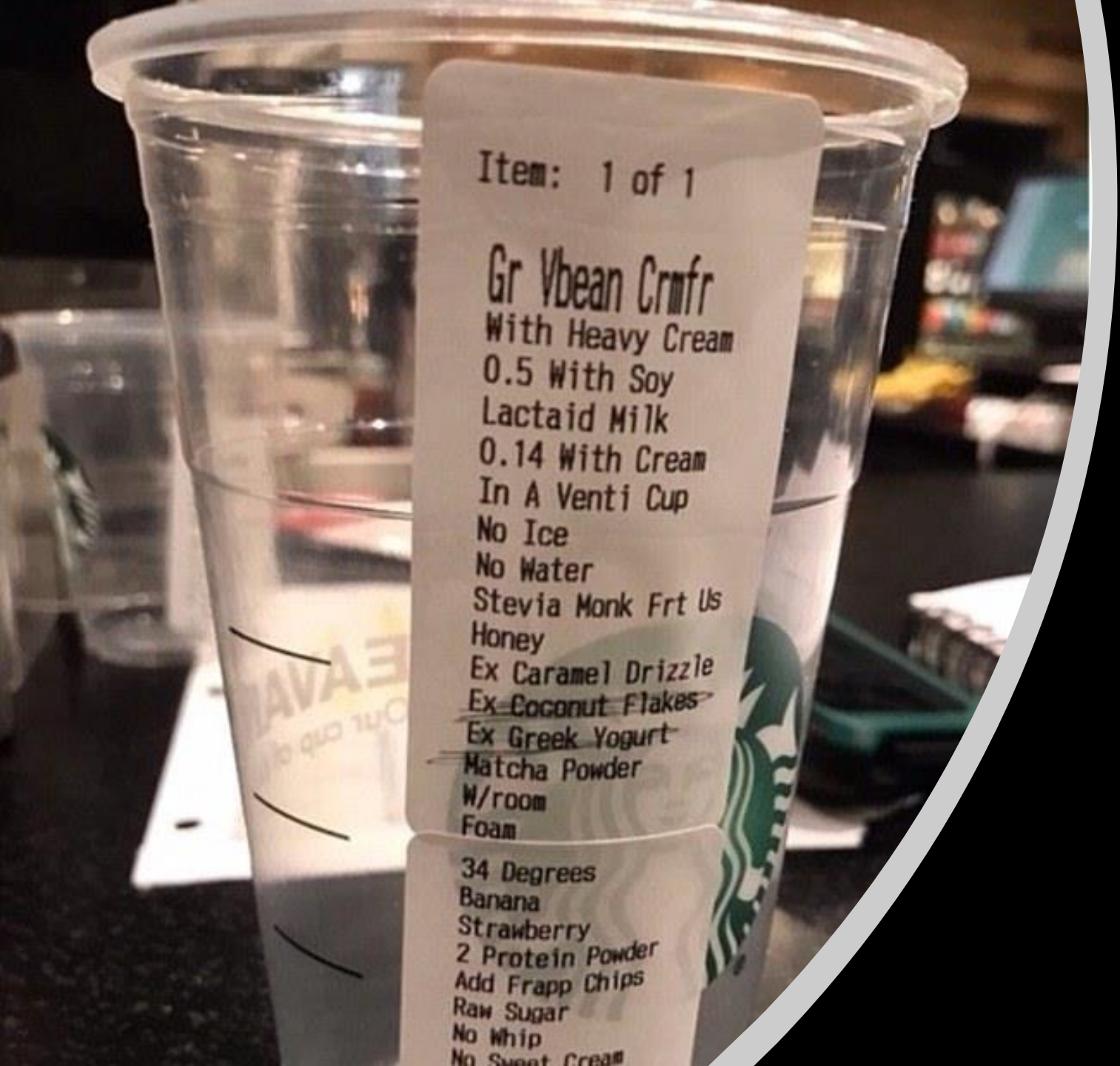
V.1

SPECIALTY COFFEE ASSOCIATION OF AMERICA

WORLD COFFEE RESEARCH

COFFEE TASTER'S FLAVOR WHEEL CREATED USING THE SENSORY LEXICON DEVELOPED BY WORLD COFFEE RESEARCH


A single shot espresso for $25 (Australia 2017)


Item: 1 of 1
Gr Vbean Crmfr
With Heavy Cream
0.5 With Soy
Lactaid Milk
0.14 With Cream
In A Venti Cup
No Ice
No Water
Stevia Monk Frt Us
Honey
Ex Caramel Drizzle
Ex Coconut Flakes
Ex Greek Yogurt
Matcha Powder
W/room
Foam
34 Degrees
Banana
Strawberry
2 Protein Powder
Add Frapp Chips
Raw Sugar
No Whip

The $32 latte

Thank you for listening

Royal Botanic Gardens | Kew | UK