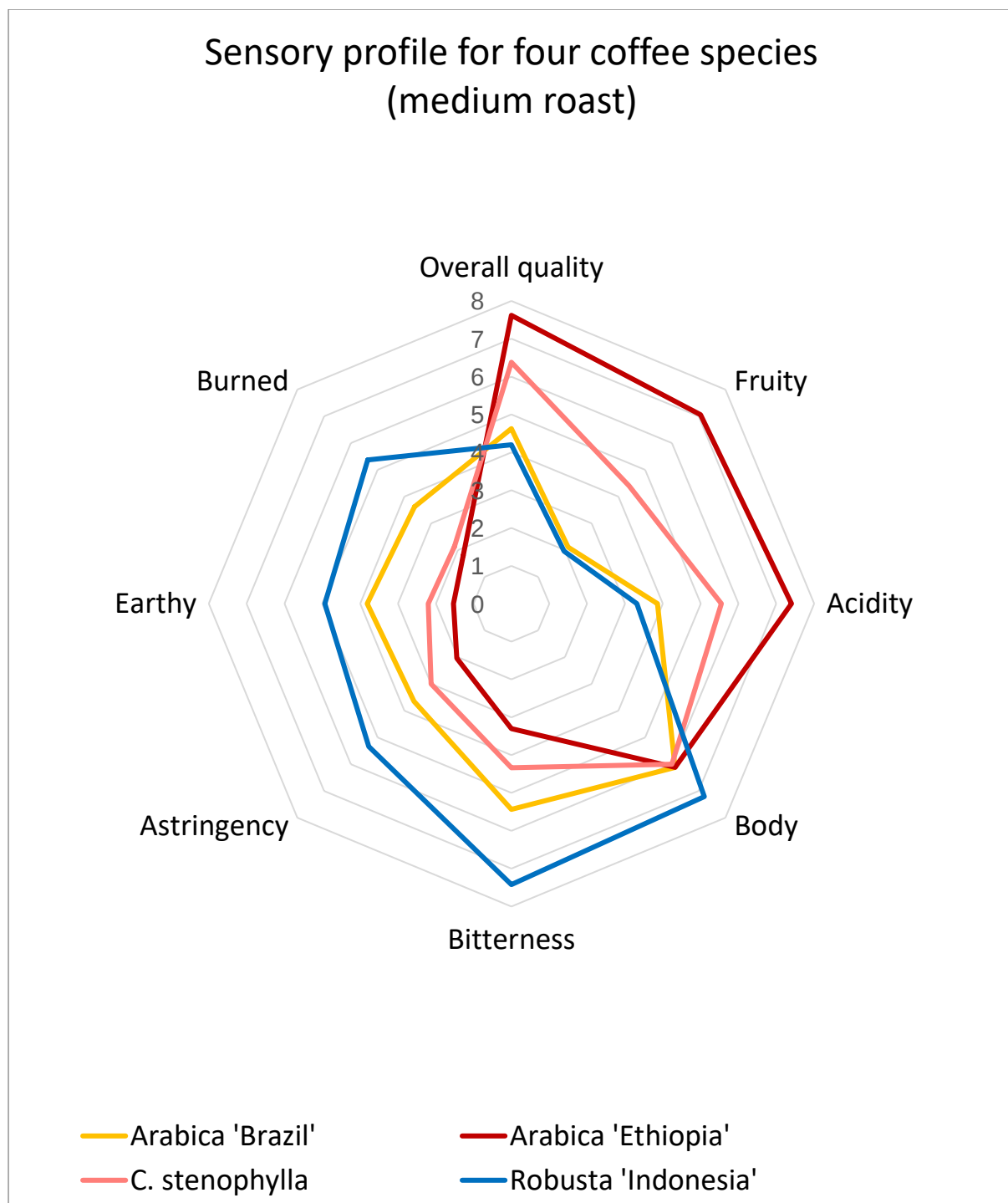

Supplementary information

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

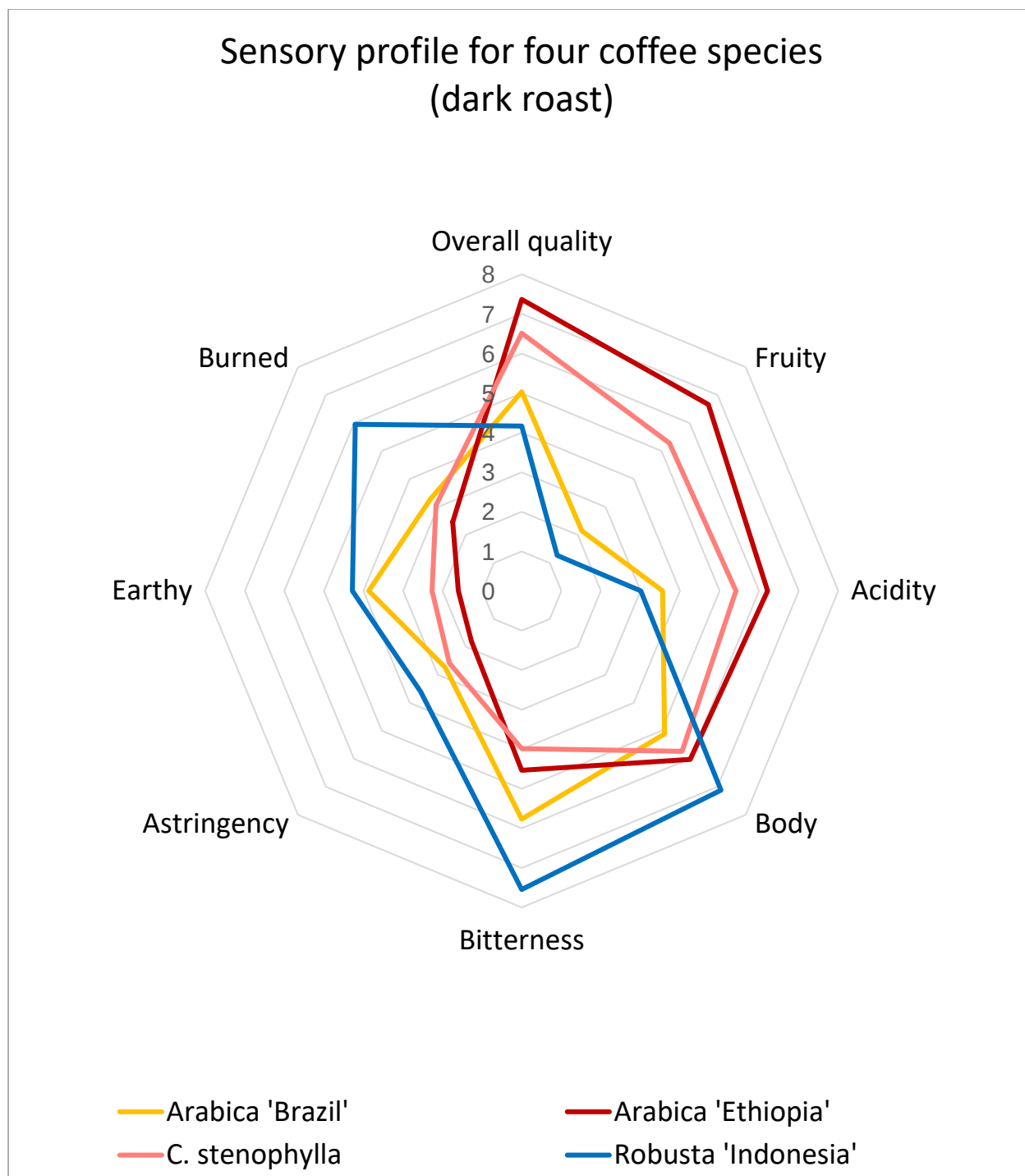
In the format provided by the
authors and unedited

Supplementary Information

Supplementary Figures 1 & 2
Supplementary Text



Supplementary Fig. 1. Radar graph for sensory (flavour) profiles (medium roast), for stenophylla, Arabica and robusta coffee. Graph based on results of CIRAD sensory protocol (see Methods and Supplementary Table 1). The first four criteria (clockwise from the top (overall quality, fruity, acidity and body) are positive for coffee quality, the other four (bitterness, astringency, earthy and burned) are usually negative.



Supplementary Fig. 2. Radar graph for sensory (flavour) profiles (dark roast), for stenophylla, Arabica and robusta coffee. Graph based on results of CIRAD sensory protocol (see Methods and Supplementary Table 1). The first four criteria (clockwise from the top (overall quality, fruity, acidity and body) are positive for coffee quality, the other four (bitterness, astringency, earthy and burned) are usually negative.

Supplementary Text

Supplementary methods

Sample preparation (harvesting and processing)

The sample of stenophylla (sample (4)), was collected at the *Coffea* Biological Resources Center (BRC *Coffea*, IRD/CIRAD) at Bassin Martin, Reunion Island, on 13 October 2020. The following ten trees/accessions were harvested (name/code) and homogenized into a single sample: FB_59/RM-CF-00271, FB 53/RM-CF-00277, FB 54/RM-CF-00278, FB 55/RM-CF-00279, FB 57/RM-CF-00280, FB 58/RM-CF-00281, FB 60/RM-CF-00283, FB 61/RM-CF-00284, FB 64/RM-CF-00285, FB ?1/RM-CF-00286 (<http://florilege.arcad-project.org/fr/crb/coffee>). The trees were shade grown (under *Grevillea* sp.), at 380 m asl; the field site has an average air temperature of 22.4–23 °C; with an annual precipitation of 1180–1625 mm, with a distinct dry/cool season; the site is supplemented with drip irrigation (every two days). Fresh fruits (cherry) were harvested in the morning by hand, and processed in the afternoon by the washed (wet processing) method. The fermentation process was divided into three successive steps: ‘dry’ fermentation with only mucilage (24 h), maceration by adding water to cover the seeds (15 h) and washing by changing the water three times during mechanical depulping. Air drying of the resulting parchment was undertaken on raised beds over a four week period. Air drying was completed on 12 November 2020, to a moisture level of 11%. The green coffee was screened through a sieve (sizes 14–17) and defective beans were discarded, so as to obtain the final batch for sensory analysis. A total of 4 kg of fresh cherry was harvested, yielding 907 g of parchment coffee and 740 g of clean, green coffee beans, representing a conversion from fresh cherry to clean coffee of 5.4:1 (i.e., equivalent to Arabica coffee).

Stenophylla sample (5) was collected from a natural forest in eastern Sierra Leone, in May 2020. A small sample (c. 70 g) of fresh fruits (cherry) was harvested and de-pulped by hand, dried indoors for two days and sundried for four days (to c. 12% moisture content) in Sierra Leone, and rested (left to mature as parchment coffee) for four months at room temperature (21°C) in the UK, prior to roasting. Removal of parchment resulted in c. 10 g of clean coffee.

Samples (1) Arabica (Sidamo, Ethiopia), (2) Arabica (Sul de Minas, Brazil), and (3) robusta (Flores Island, Indonesia), represent commercial samples, for which we had neither harvesting nor processing information.

Sensory analysis (cupping)

Samples (1)–(4) (Arabica (2 samples), robusta, and stenophylla) were evaluated using a protocol developed by CIRAD, derived from the European standard ISO 6668 and 13299 (hereafter referred to as the CIRAD sensory protocol), by the CIRAD Sensory Analysis Laboratory (Montpellier, France) in December 2020. Three roasts were used (light, medium, and dark), for each of the four samples assessed by this protocol. All samples were roasted simultaneously, for standardization, and left for a minimum of 12 hours before either cupping or vacuum packing (e.g. for the sending of samples for external evaluation), to allow for degassing (mostly CO₂). The samples were ground to a medium/fine powder immediately prior to cupping. For each sample, 15 g of coffee was added to a 500 ml Bodum® French press/cafetière coffee maker, to which 300 ml of boiled water (c. 95°C) was added (water to coffee ratio 20:1). ISO 6668 recommends 7 g of ground coffee per 100 ml of water (water to coffee ratio 14.3:1). The CIRAD sensory protocol uses the higher water to coffee ratio of 20:1 (5 g per 100 ml), to avoid saturation of the taste buds. The hot water was poured directly onto the measured ground coffee, making sure to wet the grounds thoroughly. Shortly afterwards, once the coffee solids have risen to the surface, the mixture was stirred to homogenize the coffee solution and solids. The mixture was left to stand for exactly 5 min., after which time c. 60 ml was poured into each of five cups. Thus, for each of the four samples, there are 60 × 60 ml cups (i.e. four for each of the three roast levels, each with five cups). The four samples were assessed blind, i.e. the species and origin of the samples were unknown to the members of the sensory panel; a code was assigned to each sample. The sensory analysis was undertaken between 50–55°C. Oral evaluation was conducted by aspirating the coffee into the mouth, directly from the sampling cup, to take the vapour and liquid to the tongue and upper palate, and olfactory organs. Each judge had their own set of samples. Three independent sensory panels (Nespresso (Switzerland), Supremo (Belgium), CIRAD (France), plus a group of four companies) undertook the evaluation, to give a total of eight companies/organizations, and 15 judges, including those with Q Arabica Grader™ and Q Robusta Grader™ qualifications (Supplementary Table 5), during December 2020 and early January 2021. The following 15 variables were scored (each out of 10 points) by the judges

across four categories: (1) Odour (olfactory intensity); (2) Taste (acidity, bitterness); (3) Impression (astringency, body, sourness); and (4) Aroma (fruity, harsh, green, earthy, metallic, phenol, rotten, burnt, smelly) (Supplementary Table 1). The panel members were also asked to provide additional commentary (e.g. flavour detail (tasting notes), sweetness, and faults); and specify an overall quality score out of 10 (Supplementary Table 1). For the CIRAD sensory protocol aroma is defined as: the sensory attribute perceptible by the olfactory organ via the back of the nose when tasting. Four questions were added to the protocol (i.e. outside the regular CIRAD sensory protocol: (1) Is this Arabica coffee (yes/no)? (2) Is this robusta coffee (yes/no)? (3) Could this coffee be commercialized (yes/no)? (4) Is this coffee new (yes/no)? Yes/no responses (0/1) for the four questions were totalled to provide a percentage score (Fig. 4; Supplementary Table 4).

Stenophylla sample (5) was evaluated using the Specialty Coffee Association (SCA) protocol (<https://sca.coffee/research/protocols-best-practices>), with modifications due to small sample size (see below), by Union Hand-Roasted Coffee (London, UK) in August 2020. The sample was roasted to a light/medium profile using an Ikawa Pro™ (Ikawa, London) sample roaster, for 7:21 min. at a start temperature of 130°C and an end temperature of 205°C. The roasted sample was left to de-gas (mainly CO₂) for c. 12 hours and then assessed ('cupped') by a panel of three professional coffee evaluators, comprising a Q Arabica Grader™ (the highest accreditation for the sensory evaluation of coffee), acting as panel leader, and two international specialty coffee judges. Oral evaluation was conducted by aspirating the coffee into the mouth, via a broad-bowled spoon (a 'cupping spoon'). Sample (5) was evaluated against four other coffee samples, from four species: Arabica (hybrid), Liberica, both commercial samples, and *C. brevipes* and *C. montekupensis*, both cultivated in Cameroon from wild stock. The samples were evaluated semi-blind, i.e. samples were given codes or Latin names but no further context. The recommendation from the SCA protocol is a minimum of five cups for each sample evaluation, i.e. 16.5 g ground coffee per 300 ml water, a water to coffee ratio of 18:1. Stenophylla sample (5) comprised c. 10 g of ground coffee, meaning that only three 60 ml cups could be evaluated, rather than five. A SCA specialty coffee cupping score was attributed to the three samples by the cupping panel, using the criteria of the Specialty Coffee Association (SCA) (<https://sca.coffee/research/protocols-best-practices>). Tasting notes and other observations were recorded, as per the SCA specialty coffee protocol (<https://sca.coffee/research/protocols-best-practices>). Detailed cupping results are reported only for stenophylla (sample (5)). According to the SCA protocol, the following final scoring has proven to be a meaningful way to describe the range of coffee quality: 90–

100 = Outstanding (Specialty); 85–99.99 = Excellent (Specialty); 80–84.99 = Very good (Specialty); < 80.0 = Below specialty quality (not Specialty). The lack of five cups, as required by the SCA protocol, did not enable a detailed score to be given. Instead a consensus score was awarded by the panel leader, for agreement or otherwise by the other two judges.

Supplementary results

Additional sensory information for sample (5)

The sensory (cupping) report of the SCA panel judges, i.e. stenophylla sample (5) returned a consensus score of 80.25, i.e. very good (Specialty coffee); the other samples did not receive a score but were all deemed to be below 80. The following summary was provided for stenophylla (sample (5)): “Fragrance [i.e. the smell of the dry, ground coffee] reminiscent of washed African Arabica, close to Rwanda profile. Notes of citrus and red berries, hints of floral. On the wet aroma [i.e. after hot water has been added] some fermentation, a little funky [i.e. slightly fermented, probably as a result of suboptimal drying and sorting]. In the cup [taste] very sweet, stone fruits, honey, some herbaceous notes, some tea quality, light black tea. Good body and sweetness. Considering the small amount of coffee and the fact [that] it could not be cleaned from physical defects, [the] coffee had a very good clarity. Flavours are identifiable and I feel with better processing and sorting this coffee can be improved. The cups did not show any negative, undesirable qualities, looking at it from specialty Arabica point of view. It had positive attributes, as associated with quality Arabica coffee, such as sweetness and fruit driven acidity.” (E. Chodarcevic, Union Hand-Roasted Coffee, pers. comm.). The final score only marginally placed stenophylla sample (5) from Sierra Leone in the specialty coffee category. However, it should be noted that further improvements would be expected, given the size of the sample, crudeness of processing, and lack of domestication or pre-farm selection (i.e. it was a wild plant selected at random, with minimal attention to processing).