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COMMUNICATION

CONSERVATION STATUS OF MASCARENE AMARANTH *AERVA CONGESTA* BALF.F. EX BAKER (EUDICOTS: CARYOPHYLLALES: AMARANTHACEAE): A CRITICALLY ENDANGERED ENDEMIC HERB OF THE MASCARENES, INDIAN OCEAN

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Abstract: *Aerva congesta* Balf.f. ex Baker (Amaranthaceae), an endemic of Mascarene Islands (Mauritius and Rodrigues) is assessed for its conservation status. Considering its local extinction in Rodrigues and very small population in Mauritius, in Round Island and at Gris Gris, south of Mauritius its area of occupancy (AOO) is estimated at 8km². Due to its small AOO and threats by increasing native vegetation and alien species, *A. congesta* is evaluated as Critically Endangered following the latest IUCN Red List criteria. The species needs an urgent well-defined restoration program and ecological studies to prevent its extinction.

Keywords: Amaranthaceae, conservation status, extinction, Mauritius, Rodrigues.

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Author Contribution: KBP: participated in botanical survey at Gris Gris where he collected and identified the plant; contributed also in taxonomic and editorial expertise. DHL: contributed taxonomic and editorial expertise. PK: organized and participated in field survey at Gris Gris and contributed in editorial expertise

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INTRODUCTION

The genus *Aerva* Forssk. (Amaranthaceae) consists of 21 species (The Plant List 2013) distributed mostly in the arid or semi-arid regions of the world. Bojer (1837) noted three species of *Aerva* on Mauritius, *A. lanata* (L.) Juss., *A. caudata* Bojer (*nomen nudum*), and *A. chenopodifolia* Bojer (now *Nothosaerva brachiata* (L.) Wight), which are considered as native. Later, Baker (1877) described three species of *Aerva* on Mauritius, two perennials, *A. lanata* and *A. congesta* Balf. f. ex Baker, and one annual, *A. brachiata* Mart. More recently, Townsend (1994) listed three species, the Mascarene endemic *A. congesta*, and two alien species formerly known only from cultivation, *A. lanata* and *A. sanguinolenta* (L.) Blume.

Referring to Townsend (1994) and Sukhorukov (2013), *Aerva congesta* is one of the two known endemic species of the Amaranthaceae in the Mascarene Islands (South West Indian Ocean) (Image 1). It is known from both Mauritius (Image 2) and Rodrigues (Image 3), but is not recorded on Réunion Island. The first specimen was collected by Balfour in 1879 where he indicated that the species grew as a small compact herb present on coralline limestone, in association with *Abrotanella rhynchocarpa* Balf.f. (= *Rhizophogyne rhynchocarpa* S. Moore) and *Oldenlandia sieberi* Baker var. *congesta*. According to Strahm (1989) *A. congesta* has not been

seen or collected on Rodrigues since Balfour, and it is probably extinct there; extensive surveys made on mainland Rodrigues (e.g., Anse Quitor) and some islets (e.g., Ile Gombrani, Ile Chat, Ile Crabe) were unfruitful (Wiehe 1949; Cadet 1972, 1975; Guého 1980; Smith et al. 2004a,b). On Mauritius, Strahm (1989) quoted that there were recent collections from one locality on mainland Mauritius, but only samples from Round Island, an outer islet northern of Mauritius (Image 2), were accessed at The Mauritius Herbarium.

MATERIAL AND METHODS

In June 2013, while carrying out a preliminary population survey of the endemic fern, *Ctenitis maritima* (Pynee & Khurun 2013) at Gris Gris, in the village of Souillac, south coastal region of Mauritius (-20.52526°S and 57.53086°E, 6m elevation) (from Google Earth), the authors (KBP & PK) collected an interesting small prostrate herb, 0.8–3.2 cm tall, on border of the cliffs. Two small patches of *A. congesta* sized 1.8 x 2 cm and 6 x 12.5 cm with a distance of 2.2m between them and consisting of around 10 plants were found. Through closer study and comparison with herbarium specimens and using the 'Flore des Mascareignes' at The Mauritius Herbarium (MAU), the sample collected was identified

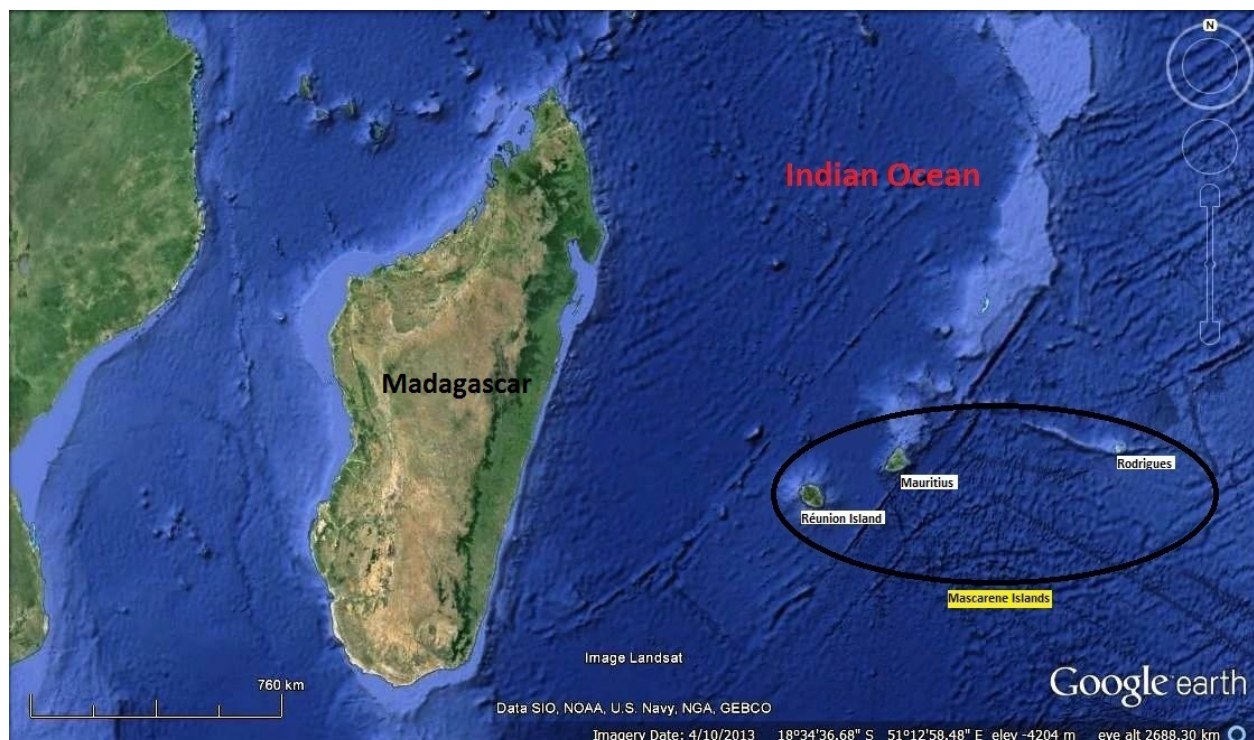


Image 1. Mascarene Islands (encircled) in the Indian Ocean

as *Aerva congesta* Balf.f. ex Baker. The herbarium specimen is deposited at The Mauritius Herbarium, Department of Agricultural Services for the Ministry of Agro Industry and Food Security (Image 4). Significant morphological characters, locality, absolute location, elevation, phenology, other associated species and distribution data were included in the herbarium label.

The actual collection at The Mauritius Herbarium (MAU 0014824) of this small herb is the first sample from mainland Mauritius accessed for this herbarium. The small dimensions of the species, coupled with the steepness of cliffs at Gris Gris (Image 5), are likely to have contributed towards it not being recently collected in this locality.

All MAU available collections before 2014 were from Round Island, with only one voucher (Strahm s.n., MAU 0016304) giving details of its habitat or ecology, showing that the species was restricted to an area near a big gully and below the helipad (-19.85668°S and 57.78629°E; 63m elevation) (from Google Earth), and found occasionally in cracks on bare rocks, similar to where the species was found at Gris Gris.

RESULTS

Aerva congesta in the Mascarenes is extant only on

Mauritius and is believed to be extinct in Rodrigues. This halophyte species grows in open areas and bare rocks, within the salt-sprayed region (Strahm 1986; Bullock et al. 2002; Lavergne 2007; Khadun et al. 2008). On Round Island it grows with native species of grasses, forming the only native dominated community in this islet (Johansson 2003) and includes a subpopulation of around 19 individuals (*A. Gungadurdoss*, pers. comm. 21 June 2016). At Gris Gris, the species shows a similar ecology; it is found rooted in rock crevices of exposed cliffs in association with the native grasses and sedges, including (*Zoysia matrella* (L.) Menill, *Stenotaphrum dimidiatum* (L.) Brongn. and *Fimbristylis cymosa* R.Br.), as well as other native species (*Dichondra repens* J.R. Forst. & G. Forst., *Ctenitis maritima* (Cordem.) Tardieu and *Selaginella obtusa* Spring). In Gris Gris, the fire prone alien invasive grass *Heteropogon contortus* (L.) P.Beauv. ex Roem. & Schult. is also present.

Evaluation of current conservation status (IUCN 2001)

The whole population of the species is considered under '2 locations' comprising two subpopulations. The extent of occurrence (EOO) of the species cannot be calculated from two localities and is deemed to be small. Taking the topographic limitations throughout its geographic range, the Area of Occupancy (AOO) was measured as 8.0km² (800ha) and the number of mature



Image 2. Distribution (red dots) of *Aerva congesta* on Mauritius (including Round Island)

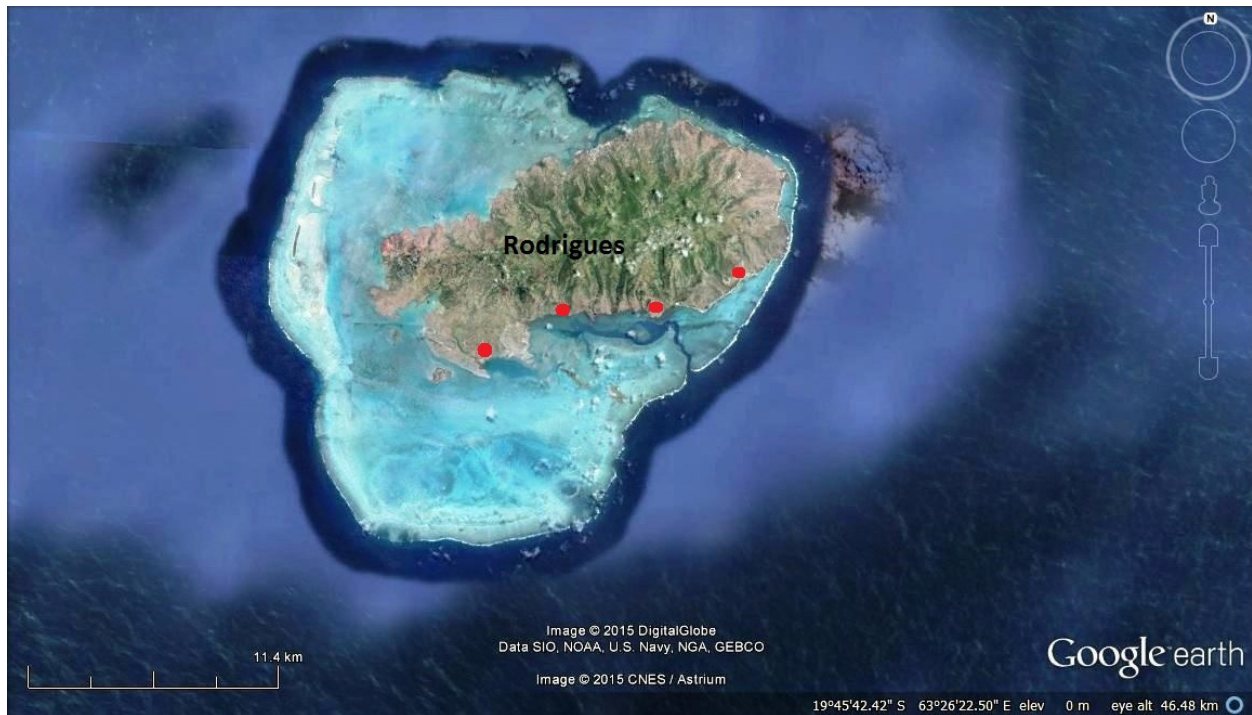


Image 3. Historic distribution (red dots) of *Aerva congesta* in Rodrigues

individuals was 29.

Criterion B: B1: The EOO of the species cannot be computed from two localities and is deemed to be very limited. Of the three conditions to be fulfilled under B1, the species is found to qualify for two: (a) severely fragmented and (b) continuing decline observed under the sub criteria: (iii) area, extent and or quality of habitat and (v) number of mature individuals. B2: The AOO is 8.0km² and since this estimate is less than 10km², and fulfils two of the three conditions: (a) severely fragmented, and (b) continuing decline observed under the sub criteria: (iii) area, extent and or quality of habitat, and (v) number of mature individuals; the species qualifies under 'Critically Endangered' category.

Criterion C: C2: Based on observed, estimated, projected and inferred continuing decline, the species is 'Critically Endangered' as it qualifies under C2, fulfilling one of the two conditions: (a) (i) number of mature individuals in each subpopulation comprises less than 50 mature individuals.

Criterion D: Since the estimated population comprises less than 50 mature individuals it qualifies under 'Critically Endangered' category.

Final assessment: CR B1ab(iii,v) & B2ab(iii,v); C2a(i); D (Appendix 1).

DISCUSSION

The species has been closely monitored on Round Island for nearly four decades and has always occurred in low density (Strahm 1986; Bullock et al. 2002; Khadun et al. 2008), with an estimated population of less than 100 individuals (Page 1995). From 1975 to 1996 the density and distribution remained unchanged (Bullock et al. 2002) even after eradication of invasive alien goats and rabbits, indicating that grazing by alien species seemed not to have been a threat. This could be related to the fact that the species might be adapted to grazing as both Mauritius and Rodrigues had two species of giant tortoises each. On the other hand, the species has declined by 50–60 % in more recent times and it was mentioned that increasing native vegetation cover could be the main threat on Round Island (Khadun et al. 2008). Indeed, it is known that grazing can promote species co-existence by reducing interspecific competition between plants and thereby reducing likelihood of competitive exclusion of one plant by another (Begon et al. 2006). In 2007, an analogue species of extinct tortoises of Mauritius, the Giant Aldabra *Aldabrachelys gigantea* and the Madagascan Radiated Tortoise *Astrochelys radiata*, were introduced to Round Island to help restore ecological function such as grazing and seed dissemination (Griffiths et



Image 4. (A) Steep cliffs where *Aerva congesta* grows at Gris Gris; (B) *Aerva congesta* with bare roots. (© Kersley Pynee).

al. 2013). The number of individuals of the species on Round Island after introduction of these tortoises has, however, decreased from an estimated population of less than 100 individuals (Page 1995; Bullock et al. 2002) to a subpopulation of 16 individuals (A. Gungadurdoss, pers. comm. 21 June 2016).

As a safeguard conservation action, the species is successfully propagated at the nursery of the Nature Reserve of Ile aux Aigrettes since over a decade. The propagated plants were used for both augmenting the population of Round Island (Khadun et al. 2008), and also trying to establish a new population on Ile aux Aigrettes. Of the 50 individuals planted on Ile aux Aigrettes in 2013, however, none survived the first year (M. Goder, pers. comm. 24 July 2014).

The discovery of a new population at Gris Gris reduces the species' chances of extinction. However, the newly discovered population in Gris Gris is very small. Furthermore, there are signs of natural erosion of the cliff around where the species is growing, decreasing the number of suitable sites. The presence of alien invasive weeds, as well as fast-growing native species, like *Stenotaphrum dimidiatum* has potentially negative impacts on *A. congesta* at Gris Gris through interspecific interactions detrimental to native plant populations as shown elsewhere on the island (Baider & Florens 2011). To conserve the recently located population, we suggest setting up ex situ propagation by the institutions concerned like the National Parks & Conservation Service and the Forestry Service; avoiding mixing the plants from the two populations to preserve their eventual genetic distinctiveness. A minor weeding would minimize the negative effect posed by alien species as well as the fast growing grasses like *Z. matrella* and *S.*

dimidiatum; however, this needs to be well planned to minimize soil erosion. A restoration program should also be implemented to increase native cover of the site that contains other threatened native species like the fern *Ctenitis maritima* and the endemic liana *Cissus anulata* Desc., which is known only from this region of the island; taking into account not to create too much shade over the plant which requires substantial exposure to thrive.

Considering the failed augmentation on Round Island since 2004 and the failed introduction on Ile aux Aigrettes in 2013, we suggest setting up systematic research to better understand the ecological requirements of the species. Finally, it is advisable to survey similar habitats in Mauritius, Rodrigues and Réunion to try to locate eventual new populations.

Specimens examined: Mauritius: Round Island, 22.vii.1968, Michel, s.n. (MAU 0015990); August 1975, Bullock et al., s.n. (MAU 0015991); August 1978 Gardner et al. s.n. (MAU 0016305); 2.viii.1986, Strahm s.n. (MAU 0016304); Gris Gris, 23.vii.2013, -20.525277S; 57.530555E, 9m elevation, Pynee et al. s.n. (MAU 0014824); Ile aux Aigrettes, 24.vii.2014, -20.420833S; 57.730833E, 8m elevation, Pynee s.n. (MAU 0016024; cultivated).

Rodrigues: no loc., August–December 1874, *Balfour* s.n. (holotype K 000243711; isotype M).

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Appendix 1. Assessment

RED LIST ASSESSMENT (IUCN 2001): *Aerva congesta*

Kingdom: Plantae
Phylum: Tracheophyta
Class: Magnoliopsida
Order: Caryophyllales
Family: Amaranthaceae
Subfamily: Amaranthoideae
Genus: *Aerva*
Species: *congesta*
Authority: Isaac Bayley Balfour, 1877.

Common name: Mascarene Amaranth

Taxonomic notes: The species was described first by Isaac Bayley Balfour (1877) with distribution in Rodrigues, where its presence was observed as frequent on the island. Type specimen is from Rodrigues: Balf.f. s.n., 1874 (holo. K, 1 sheet; isotyp. M, 1). The species is considered valid and *Aerva congesta* is an accepted name as per version 1.1 of The Plant List (2013).

ASSESSMENT INFORMATION

Red List Category and Criteria (Version 3.1): Critically Endangered CR B1ab(iii,v) & B2ab(iii,v); C2a(i); D.

Justification: The whole population of the species is restricted to two severely fragmented locations comprising two sub-populations. The area of occupancy is estimated as 8km² and the number of mature individuals is 29. Major threats such as erosion, fire, and alien species keep this species as Critically Endangered due to the continuing decline observed in the area/quality of habitat and number of mature individuals.

GEOGRAPHIC RANGE / DISTRIBUTION INFORMATION

Range description: The species is endemic to Mauritius and is found at an elevation range of 3–90 m.

Countries of occurrence: Endemic to Mauritius and presumed extinct in Rodrigues

Extent of Occurrence (EOO): Not estimated, but is very small.

Area of Occupancy (AOO): AOO is estimated to be 8km².

Number of locations: The species is currently found in two severely fragmented locations

Range map: See Image 2.

POPULATION INFORMATION

Population: The species is estimated to have about 29 mature individuals, of which 10 are estimated to be found at Gris Gris and the remaining 19 on Round Island.

Population trend: The population is declining. Over the last 10 years the population has declined by 50–60 %, mainly on Round Island due to various threats primarily due to competition with fast growing native and alien grasses and soil erosion.

HABITAT AND ECOLOGICAL INFORMATION

Habitat and ecology: This halophyte species is a small prostrate herb, 0.8–3.2 cm tall, grows in open areas, in cracks and bare rocks, within the salt-sprayed region on border of the cliffs and in rock crevices of exposed cliffs at an

elevation between 3-90 m. The species is mostly restricted to cliffs and predominantly brown soils. In association with the following native species of grasses and sedges (*Zoysia matrella* (L.) Menill, *Stenotaphrum dimidiatum* (L.) Brongn. and *Fimbristylis cymosa* R.Br.) as well as other native species (*Dichondra repens* J.R. Forst. & G. Forst., *Ctenitis maritima* (Cordem.) Tardieu and *Selaginella obtusa* Spring). In Gris Gris, the fire prone alien invasive grass *Heteropogon contortus* (L.) P.Beauv. ex Roem. & Schult. is also present. Key threats to the species observed in the study area are competition with fast growing native and alien grasses; sometimes competing for resources like light, water and nutrients and leading to poor plant growth.

System: Small prostrate perennial herb.

INFORMATION ON THREATS

Major Threats: The main threats to the two species population are:

- Direct competition for resources such as water, light, nutrients with exotic grasses and other herbaceous weeds.
- Increasing erosion, mainly during the dry season where there is less ground cover due to die off of exotic grasses like *Heteropogon contortus* and where the ground is more vulnerable to erosion.

Additional threats: Drought; fire; cyclones; diseases; pest attack; littering (at Gris Gris) burrowing by Shearwater birds (on Round Island) and thus leading to damage of plants are other possible threats.

USE AND TRADE INFORMATION

Use: Not known.

Livelihoods and sustenance: Not reported.

Trend in off take from the wild: Not reported.

Trend in off take from cultivation: Not reported.

INFORMATION ON CONSERVATION ACTIONS

Conservation actions:

- The Mauritian Wildlife Foundation is propagating the species through seeds and cuttings for augmentation on Round Island and introduction on Ile aux Aigrettes. Forms part of the Round Island Plant Restoration Plan
- Weeding and planting in localized patches

Research in place:

- Optimising choice of sites for the augmentation, re-introduction and introduction programmes to ensure that the correct conditions for the species, including microclimatic requirements are fulfilled.
- Investigating the translocation of *Aerva congesta* to other offshore islets and Rodrigues.
- Investigating the fate of native herbaceous community on Round Island and carrying out weed management in localized patches.

Research needed:

- Setting up systematic research to better understand the ecological requirements of the species.
- Determining the success of different planting techniques regimes on plant survivorship.

Monitoring in place:

- Protecting planted areas against Shearwater burrowing
- Sowing seeds into restoration areas
- Treating restoration planting and seed sowing as field trials in order to gain valuable information to aid future restoration work on Round Island and elsewhere.

Education in place: Not known

Education needed: Awareness and sensitization campaign

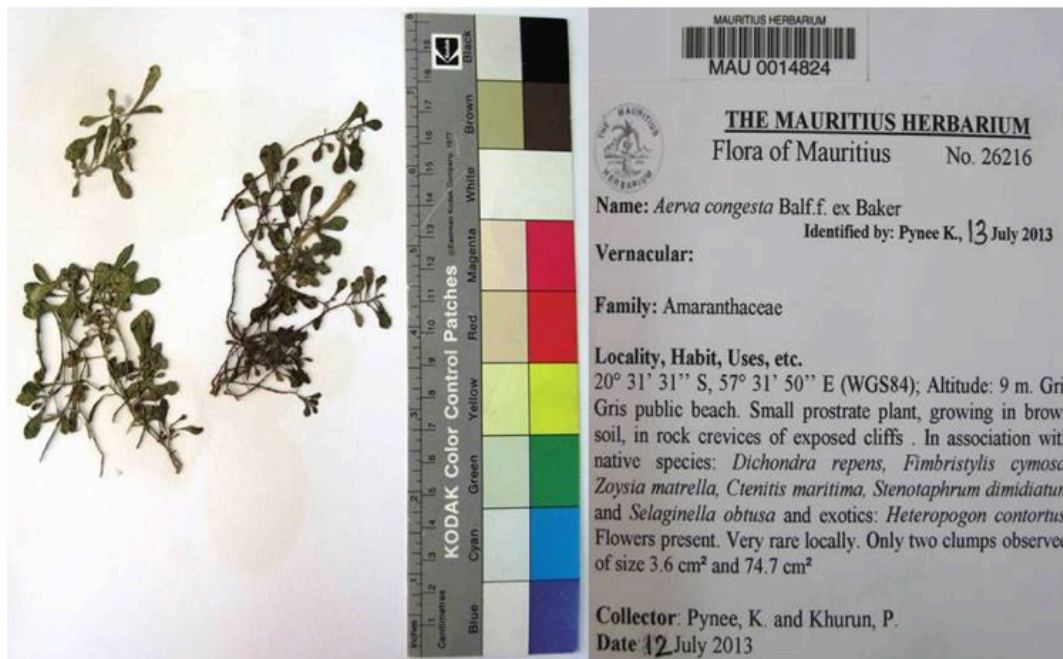


Image 5. Herbarium sample of *Aerva congesta*, MAU 0014824 (© Kersley Pynee).

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Miscellaneous

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