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Short Communication

First report of *Halimeda magnicuneata* Verbruggen & Dumilag 2020 from the northern coast of Sri Lanka

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Abstract
The genus *Halimeda* is a group of calcifying green algae that play a crucial role in sediment production and reef stabilisation. During a field survey in November–December in Mathagal, Northern Sri Lanka, the previously unreported species *Halimeda magnicuneata* was identified. This marks the first record of the species in Sri Lankan waters and was confirmed through morphological analysis, segment cross-sections and comparisons with established taxonomic descriptions. The collected specimens had segment widths of 8–21 mm (mean 13.1±4.6 mm), lengths of 9–17 mm (mean 9.9±3.8 mm) and thicknesses of 0.50–1.25 mm (mean 0.75±0.31 mm). The holdfast measured 4–8 mm (mean 6.17±2.02 mm), with an overall algal height of 95–110 mm (mean 102.3±7.51 mm). The branching pattern was dichotomous, a typical characteristic of the genus. The species was found attached to coral rubble in shallow waters (~3 m depth). The microscopic view of segment surface showed hexagonal cells with thick cell walls and cross-section of segment revealed medulla and cortex which consists of layers of primary and inflated secondary utricles. These microscopic characteristics further authenticated the species identification. The present finding contributes to the growing knowledge of the region’s marine biodiversity and highlights the importance of continuous biodiversity assessments. The documentation of *H. magnicuneata* underscores the need for further studies on its ecological interactions, distribution patterns and response to environmental changes.

Keywords: aquatic biodiversity; calcifying green algae; rainy season; sediment production

1 | INTRODUCTION

The calcareous green algae of the genus *Halimeda* J. V. Lamouroux (Bryopsidales, Halimedaceae) are widely distributed in tropical and subtropical seas, particularly in coral reef habitats, pivotal components of tropical marine ecosystems. As major contributors to calcium carbonate sediment production, they play a crucial role in reef consolidation and the global carbon cycle (Verbruggen *et al.* 2005, 2009). Beyond their biogeochemical significance, the complex, segmented thalli of *Halimeda* form structurally complex habitats that support high biodiversity, providing shelter and foraging grounds for a variety of invertebrates and fish (Dumilag *et al.* 2020). A robust understanding of *Halimeda* species diversity, distribution, and ecology is therefore fundamental to comprehending the health and function of tropical coastal systems.

Globally, the genus is well-studied, with current estimates recognising 88 species of *Halimeda* (Guiry and Guiry 2025). However, regional knowledge gaps persist, particularly in the Indian Ocean. Sri Lanka, situated at the confluence of the Bay of Bengal and the Laccadive Sea, hosts a diverse yet underexplored marine flora. Historically, records of *Halimeda* in Sri Lanka have been sporadic and largely confined to the southern and western coasts (Coppejans *et al.* 2009). Coppejans *et al.* (2009) reported three species namely, common and morphologically variable *Halimeda discoidea*, the more delicate, tuft-forming *H. gracilis* and *H. opuntia*. Later, Gunathilaka (2016) expanded this list to five species by adding reef associated *H. macroloba* and *H. tuna*. These species typically inhabit a range of environments from shallow lagoons and reef flats to deeper slopes, yet a comprehensive assessment of their distribution and habitat preferences around the entire island has been lacking.

In the present study, two species of *Halimeda*, *H. opuntia* and *H. magnicuneata*, were recorded in the northern coast of Sri Lanka, especially from Mathagal, Jaffna. Of which *H. opuntia* is already reported from the Jaffna Coast (Premarathna *et al.* 2020). Despite its importance, a systematic study dedicated to the diversity and distribution of *Halimeda* across Sri Lanka, with particular emphasis on integrating the northern province, has not been undertaken. Previous works have either been localized or taxonomic checklists lacking detailed ecological context. This gap hinders a holistic understanding of the genus's ecological contribution to Sri Lanka's coastal ecosystems and its potential vulnerability to environmental change.

Critically, it could be pointed out that the northern coastal waters of Sri Lanka have remained a significant blank spot on the map of *Halimeda* research. This region, influenced by distinct oceanic currents and with a different geological history compared to the south, may harbor unique algal assemblages. Therefore, the recent discovery of *H. magnicuneata* populations in northern Sri Lanka presents a novel and ecologically significant finding. Documenting the diversity in this understudied region is essential for establishing a complete national baseline and for understanding the broader biogeographic patterns of marine flora in the Indian Ocean. The ecological significance of this finding is heightened by the role of *Halimeda* as a bio-indicator; shifts in its distribution and abundance can reflect changes in water quality, temperature, and other environmental parameters.

The primary objective of this study was to comprehensively document the species diversity and distribution of the genus *H. magnicuneata* in Jaffna, Sri Lanka, by integrating morphological examination with ecological data. This research aims to provide a foundational dataset that enhances regional phytogeographic knowledge and supports future conservation and monitoring efforts for these ecologically vital calcareous algae.

2 | METHODOLOGY

2.1 Study area

The survey was conducted at four locations along the northern coast of Sri Lanka: Mandaitivu, Mathagal, Kankesanthurai (KKS), and Point Pedro, with three replicate sites sampled at each location. The sampling locations' positions were accurately located using a geographical positioning system (GPS) (Garmin Oregon 750, USA). At Mandaitivu, Site 1 (09.603067°N 079.999170°E), Site 2 (09.603035°N 079.998891°E), and Site 3 (09.603331°N 079.999386°E) were sampled. At Mathagal, Site 1 (09.603336°N 079.999372°E), Site 2 (09.799914°N 079.959926°E) and Site 3 (09.800058°N 079.960654°E) were sampled. At Kankesanthurai, Site 1 (09.799610°N 079.960669°E), Site 2 (09.816769°N 080.045700°E) and Site 3 (09.816479°N 080.046209°E) were sampled. At Point Pedro, Site 1 (09.825647°N 080.251704°E), Site 2 (09.825897°N 080.251441°E) and Site 3 (09.825300°N 080.251944°E) were sampled.

2.2 Sample collection

Regular field visits were conducted monthly from July 2024 to February 2025. During each visit, seaweed samples were collected and identified. At each location, three fixed replicate sites were selected approximately 50 m apart. At each site, a 25 m transect was laid perpendicular to the shoreline, and five quadrats of 0.5 m² were placed at 5 m intervals along the transect. All specimens occurring within each quadrat were carefully handpicked to minimise damage, following the quadrat–transect method and stored in seawater-filled containers for transport to the Laboratory, University of Jaffna, for taxonomic identification (Abirami *et al.* 2024). As the aim was to document diversity, no fixed number of specimens was predetermined; instead, all available individuals within the quadrats were collected. Surprisingly, in November and December, an uncommon *Halimeda* species was collected and identified based on its morphological characteristics.

2.3 Water quality parameters

Water quality parameters, including pH, salinity, water temperature, air temperature, dissolved oxygen (DO), phosphate and turbidity, were measured. Turbidity and phosphate concentrations were determined using the spectrophotometric method. Turbidity was measured at 860 nm, while phosphate concentrations were determined at 660 nm (Strickland and Parsons 1972). All other physico-chemical parameters were measured onsite using a SmarTroll multiparameter (Insitu 458389, USA) handheld equipment (Gobiraj *et al.* 2022) at a depth of 0.5 m. For each sampling event, pH, salinity, and water temperature were measured six times and mean values were computed. The results are presented as mean ± standard deviation (SD).

2.4 Morphological analysis

In the laboratory, specimens were rinsed with fresh water to remove epiphytes and debris. Morphological features, such as shape and size of the segments, the nature of the node, the calcification patterns and branching pattern, were analysed by visual examination. To show the specific characteristics of the species surface view and cross section of the segments were examined. For light microscopy, specimens were preserved in 4% formalin and decalcified using 20% HCl. Dried herbarium materials were rehydrated by immersion in 50% glycerol for 24 hours before processing. Cross sections of the thalli were prepared using a microtome blade, and the sections were mounted in 50% glycerol solution for observation (Bandeira-Pedrosa *et al.* 2004). Surface view and mounted sections were observed under a trinocular microscope (Euromex iScope: i51153 - EPL) with magnification of X100. Photographs were taken through the EuroMex VC-3034 camera fitted with a trinocular microscope observed in an attached computer installed with Image Focus 4 software at the Advanced Fisheries Science Laboratory, University of Jaffna, Sri Lanka. Taxonomic identification followed by the standard keys provided by Hillis-Colinvaux (1980), Verbruggen and Kooistra (2004a, 2004b) and Coppejans *et al.* (2009).

2.5 Herbarium preparation

A healthy and well-developed specimen was selected for preservation. The specimen was cleaned of sand, shells, mud, epiphytes and mounted on herbarium sheets under water to minimise overlapping. Excess water was drained and specimens were arranged using forceps. The sheets were blotted dry with blotting paper, covered with cotton cloth and pressed between wooden boards at room temperature. Blotting papers were replaced daily until the specimens were completely dry. The dried specimen was attached to the sheets using gum and tape. The herbarium sheet was properly labeled with collection number, species name, locality, date and ecological details (Dhargalkar and Kavlekar 2004). The prepared herbarium voucher (Voucher number- IANKSK001) was deposited in the Department of Fisheries, University of Jaffna, where it is available for future reference and verification.

3 | RESULTS

3.1 Sample collection and distribution

Collected samples were categorised, identification confirmed into species level and the occurrence of the new species *H. macrocuneata* was observed only among the samples collected from Mathagal region, Northern Sri Lanka and not from other locations. That too these species were collected only during November and December months. It was observed that the *H. macrocuneata* thalli anchored to rocky surfaces using a holdfast, a disc made of much thickened rhizoidal filaments.

3.2 Morphological characteristics

After thorough visual examination and microscopic analysis the newly discovered seaweed species was characterised with the below described main morphological characteristics. The collected specimen exhibited distinct morphological traits, including large, cuneate (wedge-shaped) segments. The morphological measurements of specimens collected during the study are as follows: bifurcated stipes originate from the holdfast in most thalli. The segment originates from the stipe are smaller and thicker than the other segments, heavily calcified, cylindrical to narrow wedge-shaped. The other segments are entirely flattened, their width ranged from 8 to 21 mm with a 13.1 ± 4.6 mm (n = 15) mean value, while the segment length varied between 9 and 17 mm with a 9.9 ± 3.8 mm mean value (n = 15). The majority of large, flattened segments are broader than the length, those are broadest above their middle. These large segments are wedge-shaped to almost round and lightly calcified. The segment thickness was recorded between 0.5 and 1.25 mm with a 0.75 ± 0.31 mm (n = 6) mean value. The holdfast measured between 4 and 8 mm with a mean of 6.17 ± 2.02 mm (n = 6), and the overall height of the algae ranged from 95 to 110 mm with a mean of 102.3 ± 7.51 mm (n = 6). All measurements were performed with six replicate thalli, values followed by the mean denotes standard deviation of the mean values. The segments are with bright green coloration when fresh, fading to pale green upon drying. The branching pattern was dichotomous, typical characteristics of the genus. The species was found attached to coral rubble in shallow waters (~3 m depth). The substrate was dominated by fine sand interspersed with dead coral fragments. Based on these characteristic features, the collected species was identified as *Halimeda magnicuneata* (Dumilag *et al.* 2020; Figure 1a, 1b).

3.3 Anatomical characteristics

The surface microscopic view of a segment of *H. magnicuneata* showed a hexagonal outline with a thick cell wall (Figure 2a). The filaments within segments showed a definite pattern of organisation, the exterior cortex and the central axis, medulla. Exterior to utricles inter filamental spaces were there, where calcification begins. Cross walls were absent throughout, which makes this plant a coenocyte. The microscopic view of the cross-section of *H. magnicuneata* revealed layers of primary and secondary utricles in the cortex region. Each inflated secondary utricle enclosed several primary utricles within it (Figure 2b). Peripheral utricles were 51 – 60 µm in diameter and 66 – 96 µm in length. The secondary utricles were distinctly swollen, with diameters ranging from 90 – 200 µm and heights from 115 – 193 µm. The medullary siphons were 890 to 1690 µm long. These characteristics further authenticate the species identification as *H. magnicuneata*.

3.4 Taxonomical hierarchy of *Halmeda magnicuneata*

Empire Eukaryota; Kingdom Plantae; Subkingdom Viridiplantae; Phylum Chlorophyta; Subphylum Chlorophytina; Class Ulvophyceae; Order Bryopsidales; Suborder Halimedineae; Family Halimedaceae; Tribe Halimedeae; Genus *Halimeda*; Species: *Halimeda magnicuneata* (Guiry and Guiry, 2025).

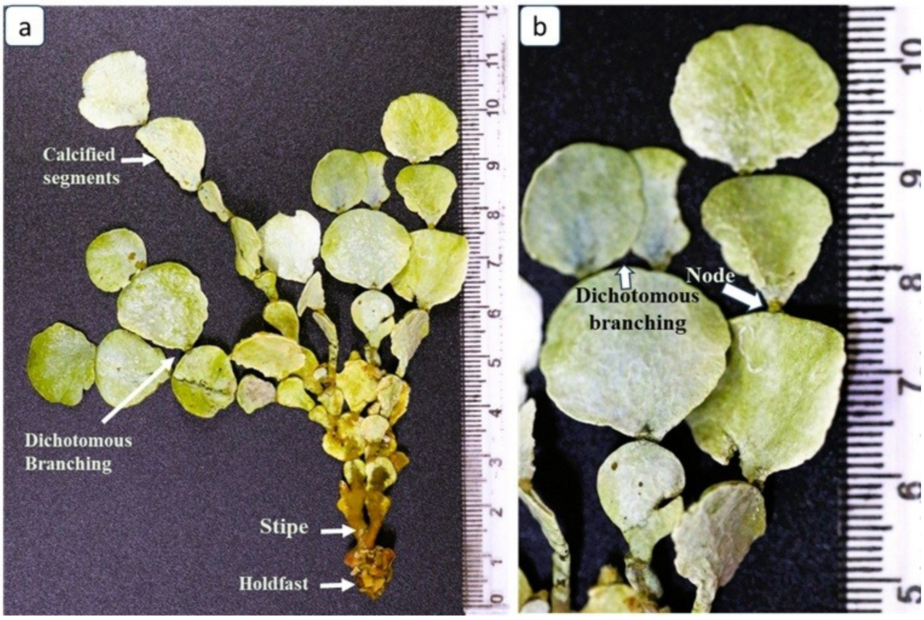

FIGURE 1 a) Whole thallus of *Halimeda magnicuneata* collected from Mathagal, Northern Sri Lanka (20 November and 13 December, 2024). The image shows the basic morphological characteristics of the species, including its large, wedge-shaped, calcified segments; **b)** Close-up of dichotomous branching in *H. magnicuneata* and node shown by an arrow; calcification is not uniform; It tends to be denser along the outer cortex and less in the medullary region, due to this the margin and surface of the segment look thickened and rough.

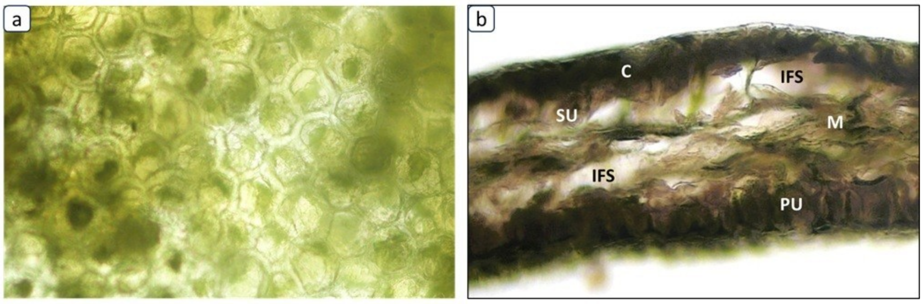

FIGURE 2 Light microscopic views of segment of *Halimeda magnicuneata*; **a)** Surface view x 100; **b)** Cross section of segment x 100, M-Medulla, C-cortex, IFS-Inter Filamental Space where calcification begins, PU-Primary utricle, SU-Secondary utricle.

3.5 Water quality parameters

Common water quality parameters, recorded during the study period, are presented in Table 1.

TABLE 1 Water quality parameters in Mathagal, northern Sri Lanka during November and December 2024 (*n* = 6).

Parameters	November	December
Water temperature (°C)	28.2 ± 0.2	27.1 ± 0.1
Salinity (ppt)	27 ± 0	29 ± 0
pH	7.91 ± 0.02	7.25 ± 0.02
Turbidity (FAU)	5	3
P (mg L^{-1})	1.4	0.15
PO_4^{-3} (mg L^{-1})	4.4	0.45
P_2O_5 (mg/L)	3.3	0.33
Dissolved oxygen (ppm)	5.31	6.12

3.6 Temporal occurrence

The species *H. magnicuneata* was observed only during November and December 2024, while it was absent in all other sampling months. In addition to *H. magnicuneata* other macroalgal taxa are also documented during the study period. A few of them are *Halimeda opuntia*, *Acanthophora specifera*, *Gracilaria corticata*, *Caulerpa racemosa*, *Caulerpa serrulata*, *Hypnea spinella* and *Hypnea pannosa*. In November, *H. magnicuneata* comprised 23.8% of the total individuals and contributed 8.3% of the wet biomass. In December, although the total seaweed abundance decreased, *H. magnicuneata* accounted for 41.7% of the total individuals and 11.0% of the wet biomass.

3.7 Diversity indices

In November, the Simpson diversity index was 0.335 based on counts and 0.393 based on biomass, while the Shannon index values were 1.094 (count) and 1.006 (biomass). Evenness was high during this month, with 0.996 for count-based data and 0.916 for biomass. In December, diversity indices showed slight variation, with Simpson values of 0.312 (count) and 0.369 (biomass), and Shannon indices of 1.254 (count) and 1.148 (biomass). Evenness during December was slightly lower than in November, with values of 0.905 (count) and 0.828 (biomass).

4 | DISCUSSION

Halimeda magnicuneata was described as a new species by Dumilag *et al.* (2020). The type specimen was collected from a reef environment in Bulusan, Sorsogon, Philippines, at depths of 5 – 10 meters. This habitat includes sheltered vertical walls and overhangs exposed to moderate wave action. The species grows on rocky substrates and is associated with coral reef ecosystems (Dumilag *et al.* 2020).

The present investigation is the first documentation of *H. magnicuneata* in Sri Lanka, expanding the known distribution of the species to the Indian Ocean. Morphologically, *H. magnicuneata* is distinguishable from other local *Halimeda* species, such as *H. opuntia* and *H. discoidea*, by its larger, cuneate segments and distinct calcification patterns. A notable distinction between *H. magnicuneata* and *H. macroloba* is the shape and segmentation of the thallus. *Halimeda magnicuneata* has more distinct, robust segments, *H. macroloba* is characterised by a more flattened, fan-shaped thallus with broader segments. The morphological characteristics of *H. magnicuneata* observed in this study align with its previously described features, including its relatively large, thick segments with partially fused basal segments (Dumilag *et al.* 2020). Nevertheless, dimensions and numbers can vary in different studies due to differences in both nutrients and environmental conditions. Apart from the morphological dimensions, misidentification of *H. magnicuneata* from *H. cuneata* could be resolved by the presence of cushion segments (1.5 mm long and 5.5 mm broad) which supports the typical segments, a stalk region of uncorticated medullary filaments and by the general trichotomous branching pattern of the segments in *H. cuneata* (Hillis-Colinvaux 1980). The anatomical features observed in the present specimens closely correspond with the description provided by Dumilag *et al.* (2020). The presence of inflated secondary utricles enclosing several primary utricles supports for its identification. Though these support the morphological and anatomical identification of *H. magnicuneata*, leaves room for future molecular analysis for species assemblages.

November and December are the peak of the heavy rainy season in northern Sri Lanka, primarily due to the northeast monsoon. The increased rainfall during these months could have influenced the presence of *H. magnicuneata*. Higher freshwater input may have temporarily altered water quality parameters such as salinity, nutrient availability and turbidity, potentially creating favourable conditions for this species. In contrast, *H. opuntia* was found in all other months, suggesting that it may have a broader tolerance to environmental fluctuations. Water quality parameters observed during November and December showed slight variations within a relatively narrow range. Further long-term studies are needed to determine whether this seasonal occurrence is directly linked to monsoonal changes or other ecological factors.

Hillis-Colinvaux (1980) showed that *Halimeda* species exhibit optimal growth within a temperature range of approximately 25 – 29°C, with 27 – 29°C considered most favourable. The water temperatures recorded in the present study fall within this range, with 28.2 ± 0.2°C in November and 27.1 ± 0.1°C in December. These values are consistent with reported optimal conditions and may explain the occurrence of *H. magnicuneata* during these months.

Vogel *et al.* (2015) demonstrated that *Halimeda* species are able to persist in environments with pH values as low as 7.7, and in some cases under more extreme conditions (pH < 7.0) at volcanic CO_2 seep sites in Papua New Guinea. These findings indicate a relatively broad tolerance to reduced pH, which is consistent with the conditions observed in the present study (7.91 ± 0.2 in November and 7.25 ± 0.2 in December), supporting the occurrence of *H. magnicuneata* during these months. While *Halimeda* is typically associated with oceanic salinities around 34 – 36 ppt (Hillis-Colinvaux 1980), it has been observed to persist in environments with reduced salinity. In the present study, values of 27 – 29 ppt were recorded during November and December, indicating that *H. magnicuneata* can tolerate sub-oceanic salinities, possibly reflecting local freshwater inputs.

Halimeda magnicuneata was observed during months when water clarity was high, with turbidity values of 5 FAU in November and 3 FAU in December. Low turbidity ensures adequate light penetration for photosynthesis and calcification, consistent with previous reports that *Halimeda* prefers well-lit reef environments (Hillis-Colinvaux 1980; Vogel *et al.* 2015). Taken together, these environmental conditions likely contributed to the successful occurrence of *H. magnicuneata* in these months, reflecting its ecological flexibility and tolerance to a range of water quality parameters. In November, the seaweed community showed moderate diversity with a fairly even distribution of species. By December, some species became more abundant while others declined, leading to a slight decrease in evenness. Despite these changes, *H. magnicuneata* maintained a consistent presence relative to other species.

The presence of *H. magnicuneata* in Mathagal highlights the ecological significance of shallow coral reef habitats in the said region of northern Sri Lanka and ensures habitat preference of the species. As a calcifying alga, *Halimeda* contributes to reef-building processes and carbonate sediment production, emphasising its role in maintaining reef ecosystem health. No previous records are found for the occurrence of *H. magnicuneata* in Sri Lankan coastal waters and therefore this contribution adds novel findings to the macroalgal biodiversity of northern Sri Lanka and enhances the current understanding of its marine flora.

5 | CONCLUSIONS

The identification of *H. magnicuneata* in Mathagal is a notable addition to the marine biodiversity of Sri Lanka. This finding underscores the need for continued exploration of the country's marine flora, particularly in understudied northern regions. Future studies focusing on the species' ecological interactions and potential applications are recommended.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

AUTHORS' CONTRIBUTION

Ishara Anjalie: Writing – original draft, fieldwork, laboratory analysis, data recording, identification, visualization. K. Nahmagal: Writing - review and editing, identification, investigation, validation. K. Sivashanthini: Writing - conceptualisation, methodology, review and editing, visualization.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available within the article and/or its supplementary materials.

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