FIRST RECORD OF RED ALGAE *POLYSIPHONIA SUBTILISSIMA* (MONTAGNE, 1840) (FAMILY: RHODOMELACEAE) COLLECTED FROM KARACHI COAST PAKISTAN (NORTHERN ARABIAN SEA).

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ABSTRACT

This study presents a detailed morphology and taxonomic study of *Polysiphonia subtilissima* collected from Abdul Rehman Goth, Karachi coast, Pakistan. *Polysiphonia* is a filamentous heterotrichous red algae, characterized by its branching structures and attachment mechanisms. *P. subtilissima* is notable for its broad salinity tolerance and wide distribution across marine and freshwater ecosystems. This research provides an in-depth examination of the internal and external structures of *P. subtilissima*, contributing to its systematic study and documenting its first recorded occurrence in Pakistani coastal areas, bordering the northern Arabian Sea. The findings enhance the understanding of the species taxonomy and its ecological role in the region.

Keywords: microalgae, *Polysiphonia subtilissima*, red algae, taxonomy, Karachi coast, northern Arabian Sea.

أول سجل للطحالب الحمراء بوليسيفونيا سوبتيليسيما (مونتاني ، 1840) (اللعائلة: رودوميلاسيي) التي تم جمعها من ساحل كراتشي باكستان (شمال بحر العرب).

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المستخلص

تقدم هذه الدراسة مورفولوجيا مفصلة ودراسة تصنيفية لبوليسيفونيا سوبتيليسيما التي تم جمعها من عبد الرحمن القوطي , ساحل كراتشي ,باكستان .بوليسيفونيا هي طحالب حمراء خيطية غير متجانسة ، تتميز بهياكلها المتفرعة وآليات التعلق .تتميز الطبقة الرقيقة بتحملها الواسع للملوحة وتوزيعها الواسع عبر النظم البيئية البحرية والمياه العذبة .يقدم هذا البحث فحصا متعمقا للهياكل الداخلية والخارجية لـ لبوليسيفونيا سوبتيليسيما ,المساهمة في دراستها المنهجية وتوثيق أول ظهور مسجل لها في المناطق الساحلية الباكستانية, على الحدود مع شمال بحر العرب .تعزز النتائج فهم تصنيف الأنواع ودورها البيئي في المنطقة.

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INTRODUCTION

Polysiphonia is a genus of filamentous heterotrichous red algae characterized with filamentous prostrate section and erect series of branches. It attaches to the substratum with unicellular rhizoids. The tips of these rhizoids flatten into haptera, lobed disc structures that help penetrate into host tissues in their parasitic form or secure attachment to surfaces. Their filamentous thalli exhibit a feathery appearance and are highly branched, displaying colors ranging from brownish-red to dark purple (02). They commonly grow on plants as an epiphyte and on rocks as lithophyte in intertidal and sublittoral zones of fresh, marine, and brackish estuaries. This genus is cosmopolitan, distributed worldwide in temperate and tropical waters (11). Currently, the genus *Polysiphonia* includes 721 species reported from various oceanic regions around the globe (09). *Polysiphonia subtilissima* is a marine microalga among a broad tolerance of salinity. consequently, it has been observed transitioning into freshwater ecosystems globally, although only three true freshwater populations have been documented in Florida (22), Jamaica (23), and Spain (15,08). This species' physiological mechanisms enable it to withstand varying salinity levels, as confirmed by molecular studies indicating that freshwater populations are conspecific with marine ones. Notable oligohaline and intertidal populations have been recorded in regions such as Africa (12,03), Asia (27,16), Hawaii (01,25), Australia and New Zealand (19,29), Europe (20,04), Americas (26,14,27,06,17). From Pakistan, research studies on *Polysiphonia* include Farooqui & Begum, (05), identified a new species, *Polysiphonia nizamuddinii*, along the Karachi coast. A detailed study on *Polysiphonia* species was reported by Zahid *et al*., (31). Shameel, (21) have been reported 10 species of *Polysiphonia* from Pakistan. The present study reports first record of *Polysiphonia subtilissima* (18) from Pakistan coast, bordering the northern Arabian Sea. The aim of present study to give a taxonomic account of *P. subtilissima*, sampled from Abdul Rehman Goth of Karachi coast.

MATERIALS AND METHODS

The red algae *P. subtilissima* were collected on 22-03-2021 at low tide (0.96 m) from Abdul Rehman Goth (24°51’00’’N 66°49’30’’E) of Karachi coast. Fresh specimens were preserved in 5% formaldehyde with seawater insitu. In laboratory, samples were washed with distilled water and shifted to 70% alcohol for microscopic studies. Measurements were conducted and performed photography under stereo-zoom microscope (model wild, 181300, Switzerland) at 10x50 resolution. Detailed anatomical study and illustrations were made with the aid of upright microscope (Nikon LABOPHOT-2) at 10x4; 10x10 magnifications. Identification of species have been confirmed on morphological and anatomical features (18, 15, 11). The studied specimens were catalogued as MRC&RC-UOK-RHOD-01 and submitted in the museum repository of Marine Reference Collection & Resource Centre, University of Karachi for further studies.

Figure 1. Study area map, Abdul Rehman Goth (24°51’00’’N 66°49’30’’E), Karachi

RESULTS AND DISCUSSION

***Polysiphonia subtilissima* Montagne, 1840**

(Fig. 2 & 3) Material Examined: Abdul Rehman Goth (24°51'00''N 66°49'30''E) Karachi; Dated: 22-3-2021; Catalogued no.: MRC&RC-UOK-RHOD-01.

Habitat: Intertidal, shallow water

Description: Soft, reddish brown, thallus are saxicolous up to the length of 1-4 cm with the width of 1-3 cm (Figure 2C) connected to the pericentral cells in an open manner by strewn rhizoids generally (Figure 2E and 3B), there is one per segment, measuring the diameter of 48-105 µm and 600-1500 µm in length. Discoid heptra is present at the creeping base; long, erect branches, measuring 45-100 µm in diameter, emerge from an indistinct creeping base; lateral branches at intervals of segments 3-5, measuring in length 40-65 µm, in sub-alternate, with a rounded apex measuring in diameter and 40 -50 µm in length (Figure 3A).

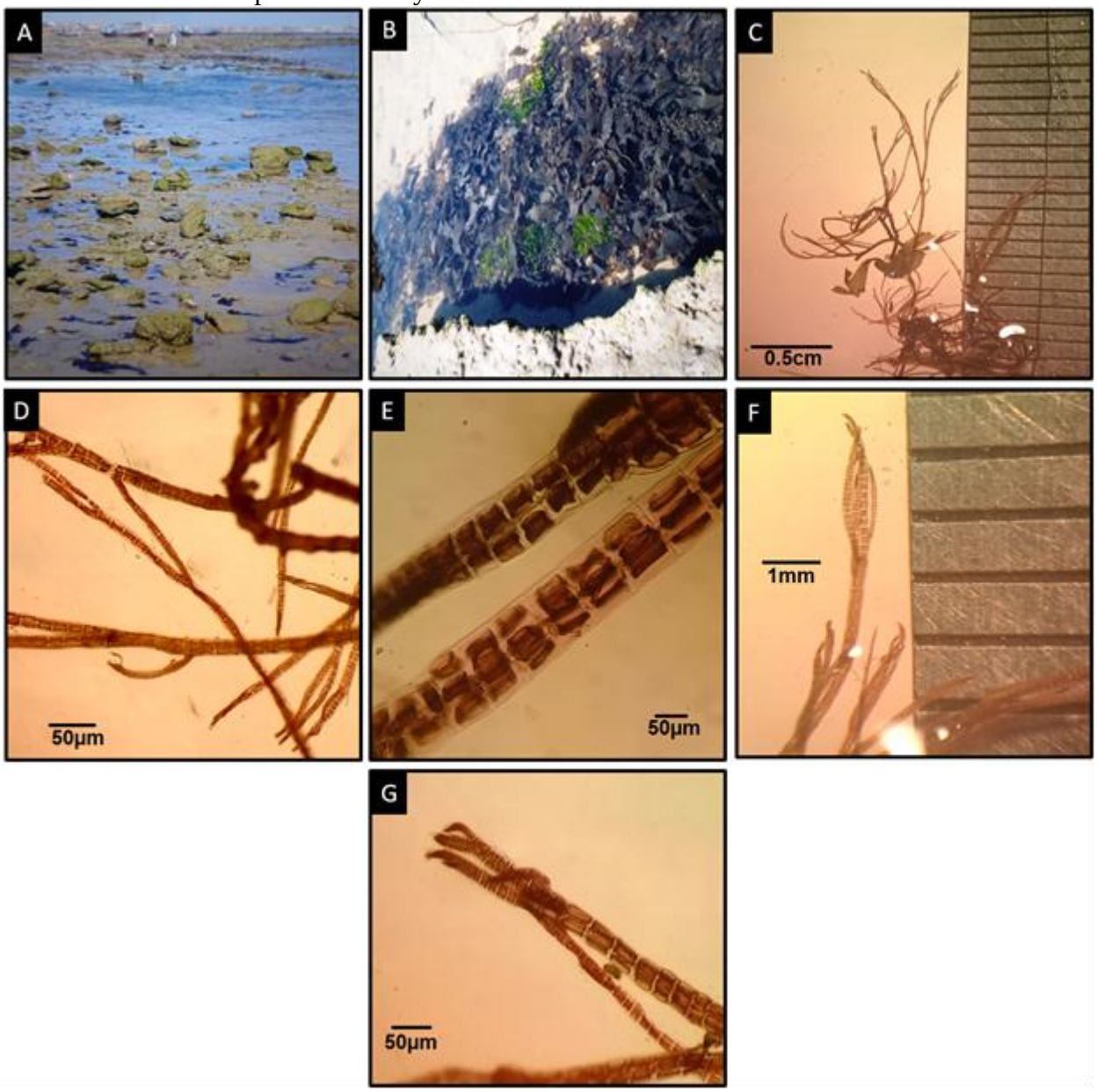

Figure 2. A. Sampling site (Abdul Rehman Goth) at low tide (0.96 m); B. *Polysiphonia subtilissima* samples; C-D. Stalk showing filaments; E. Details of filament showing elongated shaped cells; F-G. Branches arising in axils of trichoblasts

A tiny shoot that emerges from the upright branches and takes the shape of lateral branches tall and broad 1-5 cm, arranged in top branchlets in a long, straight series, and globe-shaped, with a diameter of 50–80 µm. The main axis and lateral branches generate the adventious first cystocarp. The ovoid to globular cystocarps comprises a stalk that is made up of a segment that is 200–240 µm in diameter, an ostiole that is 40–60 µm in

diameter, and carpospores that are 30–50 µm in diameter (Figure 3C). Spermatangial branches are cylindrical, measuring 135-150 µm in length and 25-50 µm in width. (Figure 2G and 3D). They have a subtending trichoblast. From a discoid base, the thallus grows sub dichotomously branching filaments that replace trichoblasts in development. The thallus is deciduous, leaving noticeable scar cells (Figure 2F and 3E).

Distribution: Tropical and subtropical eastern America, Korea, Myanmar, Hawaii, Australia, New Zealand and Europe.

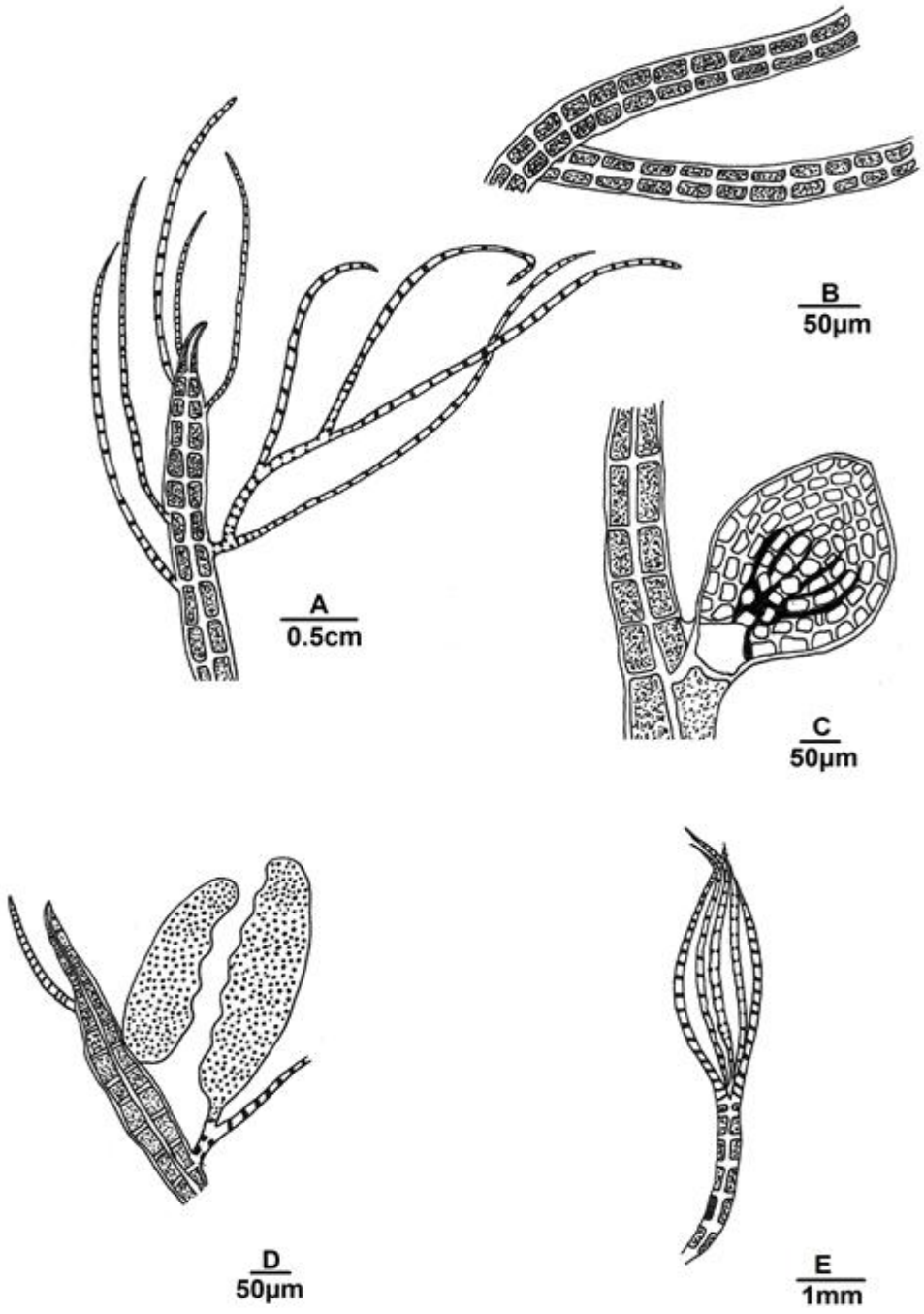

Figure 3. *Polysiphonia subtilissima*. A. Apex of a branch with rounded apical cells; B. Surface view of branch, showing elongated shaped cells; C. Mature cystocarp; D. Spermatangia; E. Branch arising in axils of trichoblasts

The present research provides a thorough analysis of the morphological and taxonomic identification of the species *P. subtilissima* collected from Abdul Rehman Goth, Karachi coast, Pakistan bordering northern Arabian Sea. The research provides fine aspects of their

internal and external structures, allowing a better comprehensive study of their systematic study. *P. subtilissima* reported globally from every continent of coastlines except Antarctica (15). This species has a widely phytogeographical distribution in steamy and moderate coasts of the Atlantic Ocean, Indian Ocean, and Pacific Ocean Regions (11).10 species of *Polysiphonia* including: *P. abscissa*, *P. codiicola*, *P. crassicollis*, *P. urceolata f. lepadicola*, *P. variegata* (now accepted as *P. denudate*), *P. elongata*, *P. nizamuddinii*, *P. kampsaxii*, *P. platycarpa*, *P. ferulacea* have been reported from Pakistan by Zahid *et al*., (31) and Shameel, (21). *P. subtilissima* is a first record and new addition to the diversity of red algae from Pakistan. *Polysiphonia subtilissima* are reported typically from marine and mangrove habitats and estuarine lakes (09). This is originally a marine microalgal taxon which is sole species of the genus that has lately been documented in genuine habitats of freshwater (22, 23, 15, 08) with adaptations in physiological contraption that further strengthen its acceptance with changeable salinity (28). *P. subtilissima* usually propose temperature over 20 ℃ (07), salinity concerning , *P. subtilissima* has a broad ecological niche attainment its most favorable at 8‰ and showed to be more thermophilic and was capable to endure elevated turbidity (13). Additionally, molecular studies have established that the freshwater inhabitants are the same species as the marine assemblage of *P. subtilissima* (15). Species within the genus *Polysiphonia* have been delineated based on key taxonomic characteristics, including 1) the count of pericentral cells, 2) the presence or absence of cortical cells, and 3) the connection of rhizoids to the pericentral cells (10,30). Species contained by the genus *Polysiphonia* was identified on morphological characteristics, including the plant's habit and height, color and texture, branching patterns and holdfast structure, occurrence or non-occurrence of axial cortication, nos. of crosswise divided pericentral cells, size and shape of apical cells, segment intervals and heptat type, as well as whether the laterals are poly- or monosiphonous. *P. subtilissima* here is found similar to the description and illustrations presented by Jar-San & Soe-Htun in (11). The specimen examined in the present study exhibited a soft texture and fragile structure, as characterized by Jar-San & Soe-Htun, (11). The coloration of the specimen is reddish brown, consistent with the description by Montagne (18). The thallus is undersides are typically prostrate; however growing species typically curl concavity-wise towards the substratum. A large number of the lateral branches emerge in longitudinal rows and have restricted expansion as like (15). *P. subtilissima* tetra sporangial branches in the upper branchlets are globe-shaped and can be seen in long, straight series. The stalk of a cystocarp is 210–248 µm in diameter, with segments of 40–50 µm in diameter for the ostiole and 38–50 µm for the carpospores, which include numerous clavate carpospores, and 185–200 µm long gonimoblast filament surrounding them. The cystocarps are ovoid to globular in shape just like (11). In conclusion, this study significantly contributes in the understanding of morpho-taxonomic features of *P. subtilissima*, recorded from the Abdul Rehman Goth, Karachi coast, Pakistan. By providing detailed insights into the internal and external structures of this species, the research enhances the systematic study of *P. subtilissima* and expands the known diversity of red algae in Pakistan. The species' broad distribution across tropical and temperate regions, along with its presence in both marine and freshwater habitats, underscores its ecological versatility. The morphological consistency of the Karachi specimen with global descriptions reaffirms its identification. This comprehensive analysis not only enriches the taxonomic framework but also sets a foundation for future studies on the ecological and physiological adaptations of *P. subtilissima* to varying environmental conditions.

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