Seaweed resources of Kerala coast and its economic potential

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ABSTRACT

Marine macro algae, popularly known as seaweeds, are one of the most important marine natural resources and used as raw material for the production of phytochemicals, food products and in various industries. More than 20,000 seaweeds are distributed throughout the world, of which only 221 (1.1%) are commercially utilized, which includes 145 species for food and 110 species for phycocolloid production (Sahoo, 2000). In the present work, a comprehensive survey of the Kerala coast have been carried out between 2011–2015 and a total of 147 taxa of seaweeds including 42 economically important species have been enumerated from Kerala coast. The economic prospects of seaweed resources of Kerala are discussed in the present study in order to highlight the potentiality of these resources for future demands.

Keywords: Seaweeds, Kerala coast, Economic, Resources.

INTRODUCTION

India, being one of the megadiverse countries in the world, has a coastline of about 7500 km length and harbours about 865 taxa of seaweeds (Rao and Gupta, 2015). Kerala, located in the south west coast of India, has a coastline of about 580 km length and geographically lies between 8°18’–12°48’ N latitude and 74°52’–77°22’ E longitude. The coastline is remarkably straight and is interrupted by natural rocky landscapes and artificially laid stones, beaches, cliffs, rivers, estuaries and backwaters at many places, which support the luxuriant growth of several sea-weeds. However, there no any comprehensive survey of the coast and only sporadic reports are available in literature (Nair et al. 1982, 1986a, b; Sobha & Nair, 1983; Chennubhotla et al. 1988; Mathew, 1991; Kaliaperumal and Chennubhotla, 1997; Sulekha and Panikkar, 2006). Therefore, we have carried out comprehensive survey of the entire Kerala coast in all the seasons for a period of 4 years between 2011-15 to primarily document the seaweed diversity and to review the prospects of these promising marine resources for its further utilisation for human being.

Methods

The present work is mainly based on the fresh collection of seaweeds from the Kerala coast and a thorough scrutiny of the relevant literature. During the years 2011–2015, 8 field tours were conducted in all the seasons. Totally 149 sites were surveyed and collected 1272 field numbers of seaweeds in duplicate. The original field photographs showing the habits and habitats of seaweeds were taken using the underwater (Olympus) and digital cameras (Nikon COOLPIX L120) and geo locations of the collection sites were recorded using portable GPS (Garmin 12 channels). The seaweed samples were collected randomly from the inter-tidal regions, thoroughly washed and herbarium sheets were prepared for each species and the representative samples were preserved in 4% formalin solution. All the wet and dry specimens were examined carefully under the light and computer attached stereo microscopes (NIKON SMZ1500 and NIKON ECLIPSE 50i) and identified following the standard available literatures (K.S. Srinivasan, 1969, 1973; Desikachary et al., 1990, 1998; Silva et al., 1996; Krishnamurthy, 2000; Jha et al., 2009; Krishnamurthy and Baluswamy, 2010; Kraft, 2007, 2009; Huisman, 2015) and online resources such as Algaebase (www.algaebase.org), WoRMS (www.marinespecies.org), Macroalgal Herbarium Portal (macroalgae.org), International Phycological Society (www.intphycsoc.org/) etc. All the wet and dry herbarium specimens are deposited at Madras Herbarium (MH), Botanical Survey of India, Coimbatore.

RESULTS AND DISCUSSION

A total of 147 taxa (including varieties and forms) of seaweeds were recorded from the Kerala coast, which accounts about 17% of the Indian seaweeds. The enumeration includes 48 taxa of Chlorophyceae, 43 taxa of Phaeophyceae and 56 taxa of Rhodophyceae (Table 1). Among these, the
Table 1. Summary of taxonomic account of seaweed enumerated in Kerala coast.

| Class      | Order | Family | Genus | Species | % value of species |
|------------|-------|--------|-------|---------|--------------------|
| Chlorophyceae | 6     | 9      | 16    | 48      | 33%                |
| Phaeophyceae | 5     | 7      | 17    | 43      | 29%                |
| Rhodophyceae | 10    | 18     | 28    | 56      | 38%                |
| Total      | 21    | 34     | 61    | 147     | 100%               |

The result also shows that the maximum diversity of seaweeds was recorded during the post-monsoon season whereas 34 species were found throughout the year. During the monsoon and post-monsoon seasons, Chlorophyceae shows the highest diversity (14 species), followed by Rhodophyceae (10 species) and Phaeophyceae (6 species). It is also revealed that out of 147 taxa, 19 taxa were found common, whereas 37 taxa were distributed moderately and 92 taxa were rare or very scanty in distribution (Table 2). Species like Centrocerca clavulatum, Chaetomorpha antennina, Cladophora vagabunda, Enteromorpha compressa, E. flexuosa, E. prolifera, Gelidiopsis variabilis, Gelidium micropterum, Gracilaria corticata, Grateloupia filicina, G. lithophila, Padina tetrastromatica, Hypnea musciformis, Sargassum tenerimum, Ulva fasciata etc. were found widely distributed in Kerala coast. Similarly, species like Acanthophora spicifera, Bryopsis pinnata, B. plumosa, Caulerpa peltata, C. racemosa, C. taxifolia, Chaetomorpha linum, Chondracanthus acicularis, Dictyota dichotoma, Gelidium pusillum etc. were moderately distributed at most of the places. Whereas species like Bostrychia tenella, Champia compressa, Caulerpa scalpelliformis, C. sertularioides, Dictyopteris delicatula, Enteromorpha linza, Gelidiella acerosa, Struvea anastomosans, Ulva reticulata etc. were found very scantily distributed. The rich diversity and luxuriant growth of seaweeds were recorded at Mullurkadalapuram, Vizhinjam, Kovalam, Varkala, Edava, Thangassery, Thirumullavaram, Baypore, Thikkodi, Mahe, Ezhimala, Manjeshwar and Hosabettu coasts.

Table 2. Distributional density of seaweeds of Kerala coast

| Class      | Common | Moderate | Rare | Total number of species |
|------------|--------|----------|------|-------------------------|
| Chlorophyceae | 7      | 12       | 29   | 48                      |
| Phaeophyceae | 4      | 7        | 32   | 43                      |
| Rhodophyceae | 8      | 17       | 31   | 56                      |
| Total      | 19     | 36       | 92   | 147                     |

Economical prospective

Seaweeds are the marine renewable natural resource and have the potential to be utilised in various ways such as food (in the form of recipes, salads, soups, jellies and vinegar), fodder, fertilisers
Table 3. List of the economically important seaweeds of Kerala coast, India

| Name of the taxa | Uses | References |
|------------------|------|------------|
| **CHLOROPHYCEAE** |      |            |
| Enteromorpha compressa (L.) Nees | Edible, Fodder, Medicinal | Kaliaperumal et al., 1995; Shynu et al., 2014 |
| Ulva fasciata Delile | Edible, Fodder, Medicinal | Sobha et al., 2008; Shynu et al., 2014 |
| Ulva lactuca L. | Edible, Fodder, Medicinal, Manure | Shynu et al., 2014 |
| Ulva reticulata Forssk. | Edible | Sobha et al., 2008; Kaliaperumal et al., 1995 |
| Ulva rigida C.Agardh | Edible | Kaliaperumal et al., 1995; Shynu et al., 2014 |
| Ulva quillonensis Sindhuv&Panikkar | Edible, Fodder, Medicinal | Kaliaperumal et al., 1995; Shynu et al., 2014 |
| Acrosiphonia orientalis(J. Agardh) P.C. Silva | Medicinal | Manilal et al., 2012. |
| Cladophora prolifera(Roth) Kutz. | Edible, Fodder | Shynu et al., 2014 |
| Cladophora fascicularis (G. Mertens ex C.Agardh) Kutz. | Edible, Fodder | Kaliaperumal et al., 1995; Shynu et al., 2014 |
| Bryopsis plumosa(Huds.) C. Agardh | Edible, Fodder, Manure | Shynu et al., 2014 |
| Caulerpa peltata J.V. Lamour. | Edible, Fodder, Manure | Shynu et al., 2014 |
| Caulerpa racemosa (Forssk.) J. Agardh | Edible | Kaliaperumal et al., 1995; Sobha et al., 2008 |
| Caulerpa serrulatoides (S.G. Gmel.) M. Howe | Edible, Fodder, Manure | Kaliaperumal et al., 1995; Shynu et al., 2014 |
| Caulerpa taxifolia (Wahi) C. Agardh | Edible, Fodder, Manure | Shynu et al., 2014 |
| Dicryopteris bartayresiana J.V. Lamour. | Edible, Fodder, Medicinal, Manure | Shynu et al., 2014 |
| Lobophora variegata (J.V. Lamour.) Womersley ex E.C. Oliveira | Industrial | Shynu et al., 2014 |
| Padina gymnospora (Kutz.) Sond. | Edible, Fodder, Industrial, Manure | Shynu et al., 2014 |
| Padina tetrastrumastica Hauck | Edible, Fodder, Industrial, Manure | Sobha et al., 2008; Shynu et al., 2014 |
| Sargassum myrioctystum J. Agardh | Edible, Manure, Industrial (Agar) | Kaliaperumal et al., 1995; Shynu et al., 2014 |
| Sargassum tenerimum J. Agardh | Edible, Manure, Industrial (Agaroid) | Kaliaperumal et al., 1995; Shynu et al., 2014 |
| Sargassum wightii | Edible, Manure, Industrial (Agar) | Kaliaperumal et al., 1995; Sobha et al., 2008; Shynu et al., 2014 |
| Turbinaria conoides (J. Agardh) Kutz. | Industrial (Agar) | Kaliaperumal et al., 1995 |
| Turbinaria ornata (Turner) J. Agardh | Edible, Industrial (Agaroid) | Kaliaperumal et al., 1995; Shynu et al., 2014 |
| Porphyra indica V. Krishnam. & Baluswani | Edible | Kaliaperumal et al., 1995 |
| Porphyra kanyakumariensis V. Krishnam. & Baluswani | Edible | Shynu et al., 2014 |
| Gelidiolum micropterum Kutz. | Edible, Industrial (Agar) | Kaliaperumal et al., 1995; Shynu et al., 2014 |
| Gelidium pusillum (Stackhouse) Le Jolis | Industrial (Agar) | Kaliaperumal et al., 1995 |
| Gelidella acerosa (Forssk.) J. Feldmann & G. Hamel | Industrial (Agar) | Kaliaperumal et al., 1995 |
| Gracilaria corticata (J. Agardh) J. Agardh var. cylindrica M.U. Rao | Industrial (Agar) | Kaliaperumal et al., 1995; Sobha et al., 2008; Shynu et al., 2014 |
| Gracilaria corticata (J. Agardh) J. Agardh | Industrial (Agar) | Kaliaperumal et al., 1995; Shynu et al., 2014 |
| Gracilaria edulis (S.G. Gmel.) P.C. Silva | Edible, Industrial (Agar) | Kaliaperumal et al., 1995; Shynu et al., 2014 |
| Gracilaria foliifera (Forssk.) Borgesen | Industrial | Shynu et al., 2014 |
| Gracilaria verrucosa (Huds.) Papenf. | Manure, Industrial (Agar) | Kaliaperumal et al., 1995; Shynu et al., 2014 |
| Asparagopsis taxiformis (Delle) Trevis. | Edible, Industrial (Antifouling agent) | Kaliaperumal et al., 1995; Manilal et al., 2010 |
| Grateloupia filicina (J.V. Lamour.) C.Agardh | Edible, Industrial (Carageenan) | Shynu et al., 2014; Sahu and Kumar, 2014 |
| Corallina elongata J. Ellis & Sol. | Medicinal | Shynu et al., 2014 |
| Jania adhrens J.V.Lamour. | Industrial | Shynu et al., 2014 |
| Hypnea muscosiformis (Wulf.) J.V. Lamour. | Edible, Medicinal, Industrial (Carageenan) | Kaliaperumal et al., 1995; Pramitha and Lipton, 2013; Shynu et al., 2014 |
| Hypnea valentiae (Turner) Mont. | Edible, Medicinal, Industrial (Carageenan) | Kaliaperumal et al., 1995; Pramitha and Lipton, 2013; Shynu et al., 2014 |
| Gelidopsis intricata (C. Agardh) Vickers | Industrial | Shynu et al., 2014 |
| Sphyrillops hypnoides (Bory) Papenf. | Industrial (Agaroid) | Chennubhotla et al., 1987; Kumar and Bai, 2008. |
| Acanthophora spicifera (Vahl.) Borgesen | Edible, Industrial (Agaroid) | Chennubhotla et al., 1987; Shynu et al., 2014 |
(SLF), Biofuels, and in various industries. Since ancient times, they are used as food in various forms, especially in South East Asian countries (Japan, China, Korea, Indonesia) and Pacific (Hawaii). Presently, there are 42 countries in the worldwide with reports of commercial exploitation of seaweeds. Among them, China holds first, followed by North Korea, South Korea, Japan, Philippines, Chile, Norway, Indonesia, USA and India. These top 10 countries of the world contribute up to 95 % of the world’s commercial seaweed utilization (Khan and Satam, 2003). According to Braune & Guiry (2011), seaweeds like Porphyra for Nori, Laminaria for Kombu, Undaria for Wakame are cultivated on large scale and annually harvested a quantity of about 400,000 tons.

The utilization of seaweed resources plays an important role in supporting the economy in many parts of the world. However, in India, the attention in this regard is drawn only in the recent years (Chennubhotla et al., 2013 a and b). Only experimental scale cultivation of commercially important seaweed such as Gelidiella acerosa, Gracilaria edulis, Hypnea musciformis, Acanthophora spicifera and Sargassum for Kombu, Undaria for Wakame is reported. Seaweeds are one of the most important marine natural resources, contrary to its name as ‘weed’. First of all, awareness should be created among the coastal villagers regarding the direct uses of seaweeds as food (in the form of salad, soup, jellied etc.), industries (pharmaceuticals, textile, cosmetics, painting, manures, fertilizers etc.) and for cattle feed. For continuous supply of raw materials, large scale cultivation should be promoted which will improve the financial status of the local people by providing employment. The economically important seaweed cultivations boom to the fishery villagers.

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