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TRANSFER OF TECHNOLOGY ON SEAWEED CULTURE

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Experiments on cultivation of economically important seaweeds such as *Gracilaria edulis, Gelidiella acerosa, Sargassum* spp and *Turbinaria* spp have been carried out during the past few years at the Central Marine Fisheries Research Institute. A suitable technique of culture of the agarophyte *Gracilaria edulis* has been developed. Technique for culturing the other seaweeds have not yet been streamlined. The culture technology developed for *G. edulis* comprises of introduction of small fragments of the seaweed into the twists of the coir rope fabricated in the form of nets and tied to the fixed poles in the inshore waters and monitoring their growth. A yield of 3 kg/m^2 was obtained in 60 days from an initial seed material of 1 kg. In the preliminary experiments conducted by using the same technique a yield of 3 kg/m^2 was obtained in 80 days in the case of *G. acerosa*. The regenerative capacity of vegetative fragments in species of *Sargassum* and *Turbinaria* also has been observed in the experimental trials. To transfer the technology of seaweed culture to farmers and entrepreneurs, need-based training programmes have been instituted. The details of the training courses, their content and utility are given below.

Training Programme

The first one is for the farmers, in which the entire farming community of the area where seaweed cultivation is feasible is educated about the significance and the benefits of the seaweed culture programmes in their villages. The families which come forward to take up the seaweed culture should be made to understand the benefits that the technology would bring them and what assistance they can expect from the financing agencies connected with rural development programmes. When technology and financial assistance are made available to them, their contribution should be work and money. The programme of release of seaweed culture technology and demonstrations will be closely linked up with organising appropriate training programmes for the fishermen, marginal agricultural farmers, landless labour and women folk. The training programmes which will be organized in local languages will be of short term duration and will be phased in a manner that they do not interrupt the normal activities of the trainees. The progress of work must be closely monitored in the culture site periodically.

The training part includes an initial orientation training, subsequent training at the appropriate time for the different phases of culture operations, post harvest technology and a final refresher training.

The second programme is for the interested parties and entrepreneurs who can afford to invest money for purchasing the inputs required and for engaging the people to carry out culture operations. For them, the training will be given at the institute itself, so that they can put to practise the technology learnt by them in a

place of their choice that is suitable for seaweed culture.

The transfer of technology programme also includes printing of handouts and pamphlets in regional languages and distribution among the public. The message and methods of science and technology could be spread by conducting farm fairs (Krishi-Melas) inviting fishermen, landless labour and other interested public to witness the various aspects of technology being demonstrated. Mobile exhibition to reach the coastal sector and participation of the concerned scientists in the rural programmes of All India Radio and organizing public lectures in the coastal areas will be helpful for popularising seaweed cultivation in the coastal areas.

Implementation

The Indian Council of Agricultural Research during its Golden Jubiles Year 1979 has started a programme "Lab-to-Land", under which the technologies developed in different Institutes are transferred to the marginal and small farmers and the landless labour. The Central Marine Fisheries Research Institute is involved in transfer of technologies developed on marine prawn and fish culture, open-sea mussel farming, oyster culture and seaweed culture.

The Lab-to-Land programme in seaweed culture was implemented at Mandapam (Tamil Nadu) because the inshore areas of the Gulf of Mannar and Palk Bay are rich in agarophytes. Because of continuous harvest for industrial exploitation the standing crop of agarophytes has depleted. In order to enhance the production to augment the supply, culture of these seaweeds by appropriate technique has to be undertaken. Under the above programme two families from Marakayarpatnam, five form Vedalai and one from Seeniappa Darga were selected after collecting the data of the households on the economic status, occupation, land holding, back ground literacy and leadership qualities for spreading the new technologies to other families. The technology developed for culture of the agarophyte *Gracilaria edulis* was transferred to these fishermen. This includes fabrication of coir nets (5X2 m size), collection of seed material, introduction of the same into the twists of the coir rope and fixing the nets in the coastal waters with the help of palmyra rafters. The seaweed fragments introduced reach harvestable size after 60 days growth. Utilizing 10 kg of seed material for each net, an average yield of 30 kg of seaweed per net can be obtained.

Collection of Feedback Data

Collection of feedback data is considered as the most important aspect of transfer of technology programme. This requires the co-operation of the farmers also for knowing the constraints faced by them. Because of this arrangement, new problems and lacunae in the technology are identified, which enable the scientists to improve the culture technology further.

The seaweed culture has immense potentialities for augmenting the raw material for agar-agar and algin industries, but its significance is greatest as a technology for the economic upliftment of coastal villages. Through this, the fishermen have come in direct contact with the seaweed culture technology for the first time which in course of time may help to supplement the natural seaweed resources available in India.

BIBLIOGRAPHY

AGADI, V. V. AND A. G. UNTAWALE. 1978. Marine algal flora of Goa coast. *Seaweed Res. Util., 3* (1 & 2): 56-70.

AGADI, V. V., N. B. BHOSLE AND A. G. UNTAWALE. 1978. Metal concentration in some seaweeds of Goa (India). *Bot. Mar., 21* (4): 247-250.

AGHARKAR, S. P. 1923. The present position of our knowledge of the aquatic flora of India. *Jour. Indian. bot. Soc., 3*: 252-260.

ANON, 1983. Proven Technology 7. Technology of cultured seaweed production. *Mar. Fish. Infor. Ser.* T & E. *54* : 19-20.

BACKGROUND, A 1976. "Nori" farming in Japan (cultivation of the edible seaweeds of the genus *Porphyra*). In: *Farming marine organisms low in the food chain. Development in Aquaculture and Fisheries Science.* Vol. 1 (Ed. P. Korringa) Elsevier Scientific Publishing Co. Amsterdam. pp 17-48.

BALAKRISHNAN Nair, N., N. SHOBA AND M. ARUNACHALAM. 1982. Algae from southern Kerala coast. *Indian J. Mar Sci., 11* (3): 266-269.

BARDACH, J. E. J., H. RYHTER AND W. O. MCLARNEY. 1972. Seaweed culture. In: *Aquaculture. The Farming and husbandry of Freshwater and Marine organisms.* Wiley-Interscience. A division of John Wiley & Sons, Inc. New York pp 790-840.

BHANDERI, P. P. 1974 a. An estimate of the iodine yielding seaweed *Asparagopsis taxiformis* (Delile) Collins and Harvey from some subtidal reefs of Saurashtra coast. *J. mar. biol. Ass. India., 16* (1):288-289.

BHANDERI, P. P. 1974 b. Culture of the agar yielding seaweeds on ropes from Gujarat. *J. mar. biol. Ass. India, 16* (3):847-849.

BHANDERI, P. P. AND Y. B. RAVAL. 1975. Possibility of seaweed cultivation along the Gujarat coast *Seafood Export Jour., 7* (12):33-36.

BHANDERI, P. P. AND Y. A. TRIVEDI. 1975. Seaweed resources of Hanumandandi reef and Vumani reef near Okha Port. *Indian J. mar. Sci., 4* (1):97-99.

BHANDERI, P. P. AND Y. A. TRIVEDI. 1977. Rope culture of algin yielding seaweed *Hormophysa triquetra* (Linnaeus) Kuetzing. *Bot. Mar. 20* (3):183-185.

BHOSLE, N. B., V. K. DHARGALKAR AND A. G. UNTAWALE. 1975. Effect of seaweed extract on the growth of *Phaseolus vulgaris* L. *Indian J. mar. Sci., 4*:207-210.

BISWAS, K. 1932. Census of Indian algae. Scope of algological studies in India. *Rev. Algol., 6*:197-219.

BISWAS, K. 1934. Progress of algological studies in India. *Curr. Sci., 3*:237-241.

BISWAS, K. 1945. A general review of the marine algae of the western coast of India. *Jour. Bombay nat. Hist. Soc. 45*:515-530.

BLACK, W. A. P. 1954. Constituents of the marine algae. *Ann. Rep. Chem. Soc., 50*:322-335.

BLANCO, G. J. 1973. Status and problems of coastal aquaculture in the Philippines. In: *Coastal Aquaculture in the Indo-Pacific Region* (Ed. T. V. R. Pillay) F. A. O. Fishing News (Books) Ltd., pp. 60-67.

BLUNDEN, G., C. J. BARWELL, K. J. FIDGEN AND K. JEWERS. 1981. A survey of some British marine algae for anti-influenza virus activity. *Bot. Mar., 14* (5): 267-272.

BOERGESEN, F. 1930. Some Indian green and brown algae especially from the shores of the Presidency of Bombay. *Jour. Indian bot. Soc., 9*:151-174.

BOERGESEN, F. 1931. Some Indian Rhodophyceae especially from the shores of the Presidency of Bombay—I. *Kew. Bull.,* No. *1*: 1-24.

BOERGESEN, F. 1932a. Some Indian Rhodophyceae especially from the Presidency of Bombay—II. *Kew. Bull.,* No. *3*: 113-134.

BOERGESEN, F. 1932 b. Some Indian green and brown algae especially from the Presidency of Bombay. *Jour. Indian. bot. Soc., 11*: 51-70.

BOERGESEN, F. 1933 a. Some Indian Rhodophyceae especially from the Presidency of Bombay III. *Kew. Bull.,* No. *3*: 113-142.

BOERGESEN, F. 1933 b. Some Indian green and brown algae from the Presidency of Bombay. *Jour. Indian bot. Soc., 12*: 1-16.

BOERGESEN, F. 1934 a. Some Indian Rhodophyceae especially from the Presidency of Bombay-IV. *Kew. Bull.,* No. *4*: 1-30.

BOERGESEN, F. 1934 b. Some marine algae from the northern part of the Arabian Sea with remarks on their geographical distribution. *Kgl. Dansk. Vidensk. Selskab. Biol. Meddel., 11* (6): 1-72.

BOERGESEN, F. 1935. A list of marine algae from Bombay. *Kgl. Dansk. Vidansk. Selskab Biol Meddel., 12* (2): 1-64.

BOERGESEN, F. 1937 a. Contributions to a South Indian Marine Algal flora-1. *Jour. Indian bot. Soc., 16*: 1-56.

BOERGESEN, F. 1937 b. Contributions to a South Indian Marine Algal flora-II. *Jour. Indian bot. Soc., 16*: 311-357.

BOERGESEN, F. 1938. Contributions to a South Indian Marine Algal flora-III. *Jour. Indian bot. Soc., 17*: 205-242.

BOKIL, K. K., V. C. MEHTA AND D. S. DATAR. 1972. Seaweed as manure. III, Field manurial trials on *Pennisetum typhoides* S. H. (Pearl Millet) and *Arachis hypogea* (Groundnut). *Bot. Mar., 15* (3): 148-150.

BOKIL, K. K., V. C. MEHTA AND D. S. DATAR. 1974. Seaweed as manure: II. Pot culture manurial experiments on wheat. *Phykos, 13* (1): 1-5.

BOSE, J. L., KARIMULLAH AND S. SIDDIQUE. 1943. Manufacture of agar in India. *J. Sci. Industr. Res.*, (India) *1*: 98.

BURELLY, P. 1968. Les algues d'eau douce Bou bee et. Cie, Paris. Tomes 1, 2 and 3.

BUKHARI, S. S. AND A. G. UNTAWALE. 1978. Seaweeds as liquid fertilizer and foliar spray. *Seaweed Res. Util., 3* (1&2): 71-78.

CACCAMESE, S., R. AZZOLINA, G. FURNARI, M. CORMACI AND S. GRASSO. 1980. Antimicrobial and antiviral activities of extracts from Mediterranean algae. *Bot Mar, 23* (5): 285-288.

CACCAMESE, S., R. AZZOLINE, G. FURNARI, M. CORMACI AND S. GRASSO. 1981. Antimicrobial and antiviral activities of some marine algae from eastern Sicily. *Bot Ma., 24* (7): 365-367.

CAMERON, M. C., A. G. ROSS AND E. G. V. PERCIVAL. 1948. Methods of the routine estimation of mannitol, alginic acid and combined fucose in seaweeds. *Jour. Soc. Chem. Ind.* London, *67*: 161-164.

CHACKO, P. I. AND C. MALU PILLAI. 1958. Studies on utilisation of the seaweed resources of Madras State. *Contr. Mar. Biol. St. Krusadai Island, 6*: 1-12.

CHACKO, P. I., S. MAHADEVAN AND R. GANESAN, 1955. A guide to the field study of the fauna and flora of Krusadai Island, Gulf of Mannar. *Contr. Mar. Biol. St. Krusadai Island, 3*: 1-16.

CHADEFAUD, M. 1960. Traite de Botanique, Tome 1, Masson et. cie, Paris.

CHAKRABORTY, D. 1945. Agar-agar manufacture from *Gracilaria confervoides. Jour. Proc. Inst. Chem.* (India), *17*: 188.

CHAPMAN, V. J. 1962. *The algae,* London.

CHAPMAN, V. J. AND D. J. CHAPMAN. 1975. *The algae.* English Language Book Society and Macmillan, 497 pp.

CHAPMAN, V. J. AND D. J. CHAPMAN, 1980. *Seaweeds and Their Uses.* Third Edition, Chapman and Hall, London. pp 62-97.

CHATURVEDI, D. K., S. S. VERMA AND S. P. KHARE. 1979. Studies on feeding marine algae (Gracilaria meal) to laying white leghorn birds. *Proc. Int. Symp. Marine Algae of the Indian Ocean Region,* CSMCRI, Bhavnagar, India. p. 51 (Abstract).

CHAUHAN, V. D. 1970. Variation in alginic acid content with growth stages in two species of *Sargassum. Bot. Mar., 13* (1): 57-58.

CHAUHAN, V. D. 1972. Physiological ecology of the early stages of *Sargassum swartzii* (Turner) C. Ag. *Bot. Mar. 15* (1): 49-51.

CHAUHAN, V. D. 1978. Report on the survey of marine algae resources of Maharashtra coast. *Salt. Res. Ind., 14* (1): 1-10.

CHAUHAN, V. D. AND V. KRISHNAMURTHY. 1967. Observations on the output of oospores, their liberation, viability and germination in *Sargassum swartzii* (Turn) C. Ag. *Proc. Semi Sea Salt* and *Plants*, CSMCRI, Bhavnagar, pp. 197-201.

CHAUHAN, V. D. AND V. KRISHNAMURTHY. 1968. An estimate of algin bearing seaweeds in the Gulf of Kutch. *Curr. Sci 37*: 648.

CHAUHAN, V. D. AND O. P. MAIRH. 1978. Report on the survey of marine algae resources of Saurashtra coast, India. *Salt. Res. Ind., 14* (2): 21-41.

CHAUHAN, V. D. AND H. V. JOSHI. 1979. Effect of Indole-3-Acetic acid and Gibberellic acids on the early growth of *Sargassum. Proc. Int. Seaweed Symp. Marine Algae of the Indian Ocean Region.* CSMCRI, Bhavnagar, India. p. 23 (Abstract).

CHEN, T. P. 1976. Culture of *Gracilaria*. In : *Aquaculture practices in Taiwan*. Page Bros. (Norwich) Ltd. pp. 145-149.

CHENNUBHOTLA, V. S. K. 1976. Seaweed Culture. *Indian Science Congress 63rd Session, Waltair (Abstract)*.

CHENNUBHOTLA, V. S. K. 1977. Food from the sea: food from the seaweeds. *Seafood Export Jour., 9* (3): 1-4.

CHENNUBHOTLA, V. S. K., M. NAJMUDDIN AND BIDYADHAR NAYAK. 1977 a. A comparative study of the yield and physical properties of agar-agar from different blends of seaweeds. *Seaweed Res. Util., 2* (2): 87-90.

CHENNUBHOTLA, V. S. K., S. KALIMUTHU, N. KALIAPERUMAL AND J. R. RAMALINGAM. 1977 b. Studies on the growth variation, alginic acid and mannitol contents in *Padina gymnospora* (Kuetzing) Vickers. *Seaweed Res. Util.. 2* (2): 91-94.

CHENNUBHOTLA, V. S. K., S. KALIMUTHU, M. NAJMUDDIN AND M. SELVARAJ. 1977 c. Field culture of *Gelidiella acerosa* in the inshore waters of Gulf of Mannar. Supplement to *Jour. Phycol.* Vol. 13, Abstract No. 454.

CHENNUBHOTLA, V. S. K., N. KALIAPERUMAL AND S. KALIMUTHU. 1978 a. Culture of *Gracilaria edulis* in the inshore waters of Gulf of Mannar (Mandapam). *Indian J. Fish., 25* (1 & 2): 228-229.

CHENNUBHOTLA, V. S. K., N. KALIAPERUMAL AND S. KALIMUTHU. 1978 b. Seasonal changes in growth, fruiting cycle and oospore output in *Turbinaria conoides* (J. Ag.) Kuetzing. *Bot. Mar., 21* (1): 67-69

CHENNUBHOTLA, V. S. K., KALIMUTHU, M. NAJMUDDIN, R. PANIGRAHY AND M. SELVARAJ. 1979. Seasonal variation in growth, yield of agar-agar and its physical properties in some agarophytes of Tamil Nadu Coast. *Proc. Int. Symp. Marine Algae of the Indian Ocean* Region. CSMCRI, Bhavnagar, India p. 41 (Abstract).

CHENNUBHOTLA, V. S. K., N. KALIAPERUMAL AND S. KALIMUTHU. 1981. Seaweed recipes and other practical uses of seaweeds. *Seafood Export Jour., 13* (10): 9-16.

CHENNUBHOTLA, V. S. K., N. KALIAPERUMAL, S. KALIMUTHU, M. SELVARAJ, J. R. RAMALINGAM AND M. NAJNUDDIN. 1982. Seasonal changes in growth and alginic

acid and mannitol contents in *Sargassum ilicifolium* (Turner) J. Agardh and *S. myriocystum* J. Agardh. *Indian J. Mar. Sci., 11* (2): 195-196.

CHENNUBHOTLA, V. S. K. 1981. *Status of seaweed industry in India.* U N D P Report on the Training Course on *Gracilaria* algae of the South China Sea Fisheries Development and co-ordinating Programme, Manila, Philippines. No SCS/Gen/81/29: 139-145.

CHENNUBHOTLA, V. S. K., N. KALIAPERUMAL, S. KALIMUTHU AND PVR. NAIR. 1983. Biology of the economically important Indian seaweeds. Collected Abstracts of the International Seaweed Symposium, Qingdao, China.

CHENNUBHOTLA, V. S. K , S. KALIMUTHU, M. NAJMUDDIN, R. PANIGRAPHY AND M. SELVARAJ. 1986. Changes in growth and phycocolloid content of *Gelidiella acerosa* and *Gracilaria edulis. Seaweed Res. Utiln. 9* (1 & 2) : 45-48.

CHENNUBHOTLA, V. S. K., N. KALIAPERUMAL, J. R. RAMALINGAM AND S. KALIMUTHU. 1986 Growth, Reproduction and spore output in *Gracilaria foliifera* (Forskkal) Boergesen and *Gracilariopsis sjoestedtii* (Kylin) Dawson around Mandapam. *Indian J. Fish. 33* (1): 76-84.

CHENNUBHOTLA, V. S. K., S. KALIMUTHU AND M. SELVARAJ. 1986. Seaweed culture—its feasibility and industrial utilization *Proc. Symp. Coastal Aquaculture 4*: 1206-1209.

CHENNUBHOTLA, V. S. K., B. S. RAMACHANDRUDU, P. KALADHARAN AND S. K. DHARMARAJ. 1987. Seaweed resources of Kerala coast. Seminar on Fisheries Research and Development in Kerala. Trivandrum (Abstract).

CHENNUBHOVLA, V. S. K., M. NAJMUEDIN, J. R. RAMALINGAM AND N. KALIAPERUMAL. 1987. Biochemical composition of some marine algae of Mandapam cost (South India). Symposium on Research and Development in Marine Fisheries. Mandapam camp.

CHENNUBHOTLA, V. S. K., N. KALIAPERUMAL AND M. S. RAJAGOPALAN. 1987. Seaweed culture in india—An appraisal. Ibid.

CHIDAMBARAM, K. AND M. M. UNNY. 1947. Note on the value of seaweeds as manure. *Madras Agri. Jour.* (July).

CHIDAMBARAM, K. AND M. M. UNNY. 1953. Note on the value of seaweeds as manure. *Ist Int. Seaweed Symp.*, pp. 67-68.

CHRISTENSEN, T. 1962. Alger. In systematisk Botanik (Ed. T. W. Bocher, M. Lange and T. Sorenson) Vol. 2. No. 2. Munkagaard, Copenhagen. 178 pp.

DAVE, H. M., V. SITAKARA RAO AND U. K. TIPNIS. 1969. Iodine content of marine algae from Saurashtra coast. *Phykos*, 8: 68-70.

DAVE, M. J. AND R. G. PAREKH. 1975. Protein content of green seaweeds from Saurashtra coast. *Salt. Res. Indi.*, 11 (2): 41-44.

DEVE, M. J., S. K. GARG AND E. R. R. IYENGAR. 1977. Assessment of the possibility of seaweeds to be utilised as supplementary animal feed. *Salt. Res. Ind.*, 13 (1&2): 33-40.

DAVE, M. J., R. G. PAREKH, S. K. GARG AND D. J. METHA. 1979. Preparation of seaweed meal for the feeding of farm animals. *Salt Res. Ind.*, *15* (2): 34-38.

DAVIDSON, F. E. 1950. The effect of auxin on the growth of marine algae. *Amer Jour. Bot.*, *37:* 502-510.

DAWSON, E. Y. 1966. *Marine Botany: An introduction.* Holt, Rinehart and Winston Inc, New York. 371 pp.

DE JUSSIEU, A. L. 1789. Genera plantarum secundum ordines naturales disposita, Paris. 498 pp.
DESAI, B. N. 1967. Seaweed resources and extraction of alginate and agar. *Proc. Semi Sea Salt* and *Plants*, CSMCRI, Bhavnagar, pp. 343-351.

DEVEAU, L. E. AND J. R. CASTLE. 1979. The industrial development of farmed marine algae. The case history or *Euchenuma* in the Philippines and USA. In: *Advances in Aquaculture* (Ed. T. V. R. Pillay and Wm. A. Dill) F. A. O. Fishing News Books Ltd. England. pp 410-415.

DHANDUKIA, M. M. AND R. SESHADRI. 1969. Arsenic content in marine algae. *Phykosa*, *8*: 108-111.

DHARGALKAR, V. K. 1979. Biochemical studies on *Ulva reticulata* Forsskal. *Proc. Int. Symp. Marine Algae of the Indian Ocean* Region, CSMCRI, Bhavnagar, p. 40 (Abstract)

HARGALKAR, V. K., T. G. JAGTAP AND A. G. UNTAWALE. 1980. Biochemical constituents of seaweeds along the Maharashtra coast. *Indian. J. Mar. Sci.*, *2* (4): 297-299.

DHARGALKAR, V. K., V. V. AGADI AND A. G. UNTAWALE. 1981. Occurrence of *Porphyra vietnamensis* (Bangiales, Rhodophyta) along the Goa coast. *Mahasagar*, *14* (1): 75-77.

DIXIT, S. C. 1964. Species list of Indian marine algae determined by Boergesen. *J. Uni. Bombay*, *32* (2-5): 1-23.

DIXIT, S. C. 1968. Species list of Indian marine algae- II *J. Univ. Bombay*, *36* (3-5): 9-24.

DODGE, J. D. 1969. A review of the fine structure of algal eye spots. *Br. phycol. J. 4* 199-210.

DOSHI, Y. A. AND P SREENIVASA RAO. 1967 a. Stable agar by gamma irradiation *Nature' 216*: 931.

DOSHI, Y. A. AND P. SREENIVASA RAO. 1967 b. Radiation induced enhancement of gel strength in red seaweeds. *Indian Jour Chem.*, *5*: 342-343.

DOSHI, Y. A., P. V. RAJU AND P. SREENIVASA RAO. 1968. A relation between the sulphate content in red seaweeds and the gel strength of agar. *Sci. Cul.*, *34*: 493.

DOUGHERTY, E. G. AND ALLEN, M. B. 1960. In: *Comparative biochemistry of photoreactive systems* (Ed. M. B. Allen). Academic Press, New York and London. pp. 129-143.

DURAIRAJ, S., K. G. JOSEPH AND M. KINGSLEY LAINE. 1978. Preparation of sodium alginate with improved viscosity. *Seaweed Res. Util*, *3* (1&2): 5-8.

EICHLER, A. W. 1886. Syllabus der Vorlesunqen uber speciella and Medicinisch-pharmaceutische Botanik, 4th Ed. Berlin

ENDLICHER, S. 1836. Genera plantarum secundum ordines naturales disposita. Vindbonae

FELDMANN, G. 1963. In Precis de Botanique. (Ed. M. Chadefaud and M. Emberger) Masson et. Cie, Paris. pp 83-249.

FOTT, B. 1959. Algenkunde, Gustav Fisher, Jena.

FRITSCH, F. E. 1935. *The structure and reproduction of algae*, Vol. I. University Press, Cambridge. pp. 1-791.

FURUKAWA, A. 1973. Present status of Japanese marine aquaculture. In: *Coastal Aquaculture in Indo-Pacific Region* (Ed. T. V. R. Pillay). F. A. O Fishing News (Books) Ltd., pp. 29-47.

GARBER, P., J. D. DUTCHER, E. G. ADAMS AND J. R. SHERMAN. 1958. Protective effects of seaweed extracts for chicken embryos infected with influenza B or mumps virus. *Proc. Soc. Exp. Biol. Med*, *99*. 590-593.

GOLDSTEIN, M. E. 1973. Regeneration and vegetative propagation of the agarophyte *Gracilaria debilis* (Forsrkal) Boergesen. (Rhodophyceae) *Bot. Mar.*, *26* (4): 226-228.

GOPALAKRISHNAN, P. 1969. Some marine algae from the Gulf of Kutch. *Phykos, 8*: 61-67.

GOPALAKRISHNAN, P. 1970. Some observation on the shore ecology of the Okha coast. *J. mar. biol. Ass. India*. *12* (1 & 2): 15-34.

GUIST, G. G., C. J. DAWES AND J. R. CASTLE. 1982. Mariculture of the red seaweed, *Hypnea musciformis*. *Aquaculture*, *28* (3, 4): 375-384.

HARVEY, W. H. 1836. Algae. In Flora Hibernica, Mackay, J. T. Dublin.

HENRIQUEZ, P., A. CANDIA, R. NORAMBUENA, M. SILVA AND R. ZEMELMAN. 1979. Antibiotic properties of marine algae. II. Screening of Chilean marine algae for antimicrobial activity. *Bot. Mar.*, *22* (7): 461-463.

HORNELL, J. 1918. *Report on the further development of fishery resources of Baroda State.*

HUMM, H. J. 1951. The red algae of economic importance. Agar and related phycocolloids. In: *Marine Products of Commerce* (Ed. Tressler, D K.). New York.

IYENGAR, M. O. P. 1957. Algology in progress of science in India. Sn. VI. Botany. *Natn. Inst. Sci. India*. New Delhi: 229-251.

JAGANNATHAN, V. AND R. VENKATAKRISHNAN, 1979. Nutritional investigations of seaweeds in chick ration. *Proc. Int. Symp on Marine Algae of the Indian Ocean Region* CSMCRI, Bhavnagar, India pp. 49-51 (Abstract).

JAMES, P. S. B. R., V. S. K. CHENNUBHOTLA AND RODRIGO. 1980. Studies on the fauna associated with the cultured seaweed *Gracilaria edulis*. *Proc Symp. Coastal Aquaculture*, M. B. A. I., Cochin, India, p. 111 (Abstract)

JOSEPH, I. AND S. MAHADEVAN, 1948. Production of agar-agar. *Dept. Res. Univ. Travancore, Rep. for Septen.*, pp. 55-60.

JOSEPH, I., K. GANAPATHY AND S RAMAMURTHY. 1948. Recoverable iodine from Indian *Sargassum*. *Dept. Res. Univ. Travancore, Rep. for Septen.*, pp. 60-61.

JOSHI, A. C. 1949. Indian Botany; present position and prospects. Presidential Address. *Four. Indian bot. Soc., 28*: 1-15.

JOSHI, H. V. AND V. KRISHNAMURTHY. 1971. The species of *Enteromorpha* from India *Bot. J. Linn. Soc., 65* (1): 119-128.

KALE, S. R. AND KRISHNAMURTHY. 1967. Effect of different media on the germlings of *Ulva lactuca* var. *rigida*. *Phykos, 6* (1 & 2): 32-35.

KALIAPERUMAL, N. AND M. UMAMAHESWARA RAO. 1975. Growth, fruiting cycle and oospore output in *Turbinaria decurrens* Bory. *Indian J. Fish.*, 22 (1 & 2): 225-230.

KALIAPERUMAL, N. AND S. KALIMUTHU. 1976. Changes in growth, reproduction, alginic acid and mannitol contents in *Turbinaria decurrens* Bory. *Bot. Mar., 19*: 157-159.

KALIAPERUMAL, N. AND M. UMAMAHESWARA RAO. 1981. Studies on the standing crop and phycocolloid of *Gelidium pusillum* and *Pterocladia heteroplatos Indian J. Bot., 4* (2): 91-95.

KALIAPERUMAL, N. AND M. UMAMAHESWARA RAO. 1982. Seasonal growth and reproduction of *Gelidiopiss variabilis* (Greville) Schmitz *J. Exp. Mar. Biol. Ecol., 61*: 265-270.

KALIAPERUMAL, N., V. S. K. CHENNUBHOTLA AND S. KALIMUTHU. 1977. Growth, reproduction and liberation of oospores in *Turbinaria ornata* (Turner) J. Agardh. *Indian. J. Mar. Sci., 6.* (2): 178-179.

KALIMUTHU, S. 1980. Variations in growth and mannitol and alginic acid contents of *Sargassum myriocystum* J. Agardh *Indian J. Fish*, *27* (1 & 2): 265-266.

KALIMUTHU, S., V. S. K. CHENNUBHOTLA, M. SELVARAJ, M. NAJMUDDIN AND PANIGRAHY, 1980. Alginic acid and mannitol contents in relation to growth in *Stoechospermum* marginatum (C. Agardh) Kuetzing. *Indian Fish, 27* (1 & 2): 267-269.

KANNAN, L. AND K. KRISHNAMURTHY. 1978. A survey of the algae of the Porto-Novo region (Coromandel Coast. Bay of Bengal). *Seaweed. Res. Util. 3* (1 & 2): 1-4.

KAPPANNA, A. N. AND V. SITAKARA RAO. 1932. Iodine content of marine algae from Gujarat coast. *Jour. Sci. Indust. Res.* (India), *21*: 559-560.

KAPPANNA, A. N. AND A. VISWESWARA RAO. 1963. Preparation and properties of agar-agar from Indian seaweeds. *Indian Jour. Tech. 1*: 224.

KAPPANNA, A. N., A. VISWESWARA RAO AND I. C. MODY. 1962. Alginic acid content of some of the brown seaweeds of Sourashtra coast. *Curr. Sci., 31*: 463-464.

KARUNAKAR, P. D., M. S. RAJU AND S. VARADARAJAN. 1948. Manufacture of agar-agar from seaweed, *Gracilaria lichenoides*. *Indian Vet. J., 24*: 274.

KOSHY, T. K. AND C. C. JOHN. 1948. Survey of *Gracilaria* resources of Travancore coast. *Dept. Res Unia. Travancore. Rep. for Septen.*, pp 53-55.

KOW, T. A., Y. S. LING AND T. W. HIN. 1973. Experiments in coastal aquculture in Singapore. In: *Coastal Aquaculture in the Indo-Pacific Regions* (Ed. V. V. R. Pillay) F. A. O. Fishing News (Books) Ltd., England pp. 375-383.

KRISHNAMURTHY, V. 1967. Marine algal cultivation—necessity, principles and problems. *Proc, Semi. Sea Salt* and *Plants* CSMCRI, Bhavnagar. pp. 327-333.

KRISHNAMURTHY, V. 1980. The marine algae of Tiruchendur, South India. *Seaweed Res. Util., 4* (1): 49-58.

KRISHNAMURTHY, V. AND H. V. JOSHI. 1969. The species of *Ulva* Indian waters. *Bot J. Linn. Soc. 62*: 123-130.

KRISHNAMURTHY, V. AND H. V. Joshi. 1970. A Check-list of Indian Marine Algae, CSMCRI, Bhavnagar. pp. 1-36.

KRISHNAMURTHY, V. R. VENUGOPAL, J. G. THIAGARAJ AND H. N. SHAH. 1967. Estimating drift seaweeds on the Indian coasts. *Proc. Semi. Sea Salt* and *Plants*, CSMCRI, Bhavnagar, pp. 315-320.

KRISHNAMURTHY, V., P. V. RAJU AND R. VENUGOPAL. 1969. An aberrant life history in *Gracilaria edulis* (Gmel.) Silva and *Gracilaria corticata* J. Ag. *Curr. Sci., 38* (14): 343-344.

KRISHNAMURTHY, V., P.V. RAJU AND P. C. THOMAS. 1975. On augmenting seaweed resources of India. *J mar. biol. Ass. India., 17.* (2): 181-185.

KUROGI, M. 1963. Recent laver cultivation in Japan. *Fishing News Intl., 2* (3): 269-274.

LANGALIA, J. K., K. SESHADRI AND D. S. DATAR. 1967. The alkali contents of the marine algae. *Proc. Semi Sea. Salt* and *Plants*, CSMCRI, Bhavnagar pp. 289-295.

LEVRING, T., H. A. HOPPE AND O. J. SCHMID. 1969. *Marine Algae. A survey of Research and Utilization.* Gram, be Gruyter & Co., Hamburg, pp. 1-421.

LEWIS, E. J. 1962 a. Studies on the proteins, peptides, and free aminoacid contents in some species of *Padina* from south-eastern coast of India. *Curr Sci., 31.* 90-92.

LEWIS, E. J 1962 b. Studies on the proteins peptides and free aminoacid contents in some species of brown algae from south-eastern coast of India. *Rev , Algol., 6*: 209-216.

LEWIS, E. J. 1963 a. Studies on the proteins, peptides and free aminoacid contents in some species of marine algae from south-eastern coast of India. *Rev., Algol.*, 7: 15-25.

LEWIS, E. J. 1963 b. The proteins, peptides and free aminoacid composition in species of *Acanthophora* from south east coast of India *Rev., Algol.*, 7: 237-241.

LEWIS, E. J. 1963 c. Studies on the proteins, peptides and free aminoacid contents in some species of red algae from south-eastern coast of India. *Proc. natn. Inst. Sci. India*, 29: 137-145.

LEWIS, E. J. 1963 d. Studies on fortnightly analysis of the proteins, peptides and free aminoacids in some marine algae from Bombay. *Proc. natn. Inst. Sci. India, 29*: 363-286.

LEWIS, E. J. 1967. A review of protein, peptide, and free aminoacid contents of Indian Marine Algae. *Proc. Semi. Sea Salt* and *Plants*, CSMCRI, Bhavnagar, pp. 296-308.

LEWIS, E. J. AND E. A. GONZALVES. 1959 a. Studies on the free aminoacid contents of some marine algae from Bombay. *Jour. Univ. Bombay, 28:* 1-5.

LEWIS, E. J. AND E. A. GONZALVES. 1959 b. Aminoacid contents of the erect and creeping fronds of species of *Caulerpa* from Bombay. *Jour. mar. biol. Ass. India, 1:* 54-56.

LEWIS, E. J. AND E. A. GONZALVES. 1959 c. Studies on the free aminoacid contents of species of *Caulerpa* from Bombay. *Jour. mar biol Ass. India, 1:* 203-205.

LEWIS, E J. AND E. A. GONZALVES. 1960. Aminoacid contents of some marine algae from Bombay. *New Phytol , 59:* 109-115.

LEWIS, E. J. AND E. A. GONZALVES 1962 a. Studies on the protein, peptide and free aminoacids in cystocarpic and tetrasporic plants of *Agardhiella roubusta* from Bombay. *New Phytol., 61:* 288-290.

LEWIS, E. J. AND E. A. GONZALVES. 1962 b. The protein, peptide and aminoacid contents of some species of marine algae from Bombay. *Ann. Bot. N. S., 26.* 301-316.

LEWIS, E. J. AND E. A. GONZALVES. 1962 c: Periodic studies of the proteins, peptides and free aminoacid in *Enteromorpha prolifera,* f. *capillaris* and *Ulva lactuca* var. *rigida. Ann. Bot. N. S., 26:* 317-327.

LING, S. W. 1973. A review of the status and problems of coastal aquaculture in the Indo-Pacific Region. In: *Coastal Aquaculture in the Indo-Pacific Region.* (Ed. T. V. R. Pillay) F. A. O. Fishing News (Books) Ltd., pp. 2-25.

LINNAEUS, C. 1754. Genera plantarum. Holmiae. 500 pp.

MAHONTY, C. B. 1956. Fishery byproducts industry in India—Seaweeds. in : *Progress of Fisheries Development in India*-Cuttack.

MAIRH, O. P. 1982. Seasonal variation in alginic acid and viscosity of sodium alginate from a brown alga *Cystoseira indica* (Thivy et Doshi) Mairh, from Port Okha *Seaweed Res Util.,* 2 (1) : 43-46.

MAIRH, O. P. AND V. KRISHNAMURTHY. 1968. Observations on the germination of spores and growth of germlings in a *Cystoseira. Jour. Indian bot. Soc. 47 :* 256-263.

MAIRH, O. P. AND P. SREENIVASS RAO. 1978. Culture studies on *Gelidium pusillum* (Stack). Le Jolis. *Bot. Mar., 21* (3) : 169-174.

MAIRH, O. P., P. C. THOMAS, B. K. RAMAVAT AND P. SREENIVASA RAO. 1979. Fertilizer pellets and their application in the field cultivation of *Gelidiella acerosa* (Forssk.) Feld et Hamel. *Proc. Int. Symp. Marine Algae of Indian Ocean Region,* CSMCRI, Bhavnagar, India. Abstract No. 12.

MATHIESON, A. C. 1969. The promise of seaweed. *Oceanology Intl.*, Jan/Eeb. 1969. pp. 37-39.

MEHTA, B. R. AND R. G. PAREKH. 1978. Mannitol content in brown algae of the coast of Sourashtra. *Bot. Mar , 21* (4) : 251-252.

MEHTA, V. C., B. S. TRIVEDI, K. K. BOKIL AND M. R. NARAYANA. 1967. Seaweeds as manure: I- Studies on nitrification. *Proc. Semi. Sea Salt* and *Plants,* CSMCRI, Bhavnagar pp. 357-365.

MICHANEK, G. 1975. Seaweed resources of the Ocean, F. A. O. *Fish. Tech. Rep.* No. 138. pp 1-126.

MISRA, J. N. 1966. *Phaeophyceae in India.* I. C. A. R. New Delhi, pp. 1-203.

MITRA, G. 1946. *Development of Chilka Lake,* Cuttack

MIURA, A. 1975. *Porphyra* cultivation in Japan. In : *Advance of phycology in Japan.* (Ed. J. Tokida AND H. Hirose) Dr. W. Jung b. v. Publishers, The Hague. pp. 273-304.

MOHAN JOSEPH, M. AND V. KRISHNAMURTHY. 1977. Studies on the shedding of carpospores in *Gracilaria corticata* J. Ag. *Seaweeds Res Util., 2* (1) : 1-8.

MURTHY, M. S. AND P. RADIA. 1978. Eco-biochemical studies on some economically important intertidal algae from Port Okha (India). *Bot. Mar., 21* (7) : 417-422.

NAQVI, S. W. A.,MITTAL, S. Y. KAMAT, SOLIMABI AND C V. G REDDY. 1979. Bromine content in some seaweeds of Goa (central west coast of India). *Bot. Mar., 22* (7) : 455-457.

NAQVI, S. W. A., SOLIMABI, S. Y. KAMAT, L FERNANDES AND C. V. G. REDDY. 1981. Screening of some marine plants from the Indian coast for biological activity. *Bot. Mar., 24* (1) : 51-55.

NEELA, M. V. 1956. Analysis of seaweeds. *Home. Sci. Bull. Women's Christian Coll.,* Madras.

NEISH, I. C. 1979. Developments in the culture of algae and seaweeds and the future of the industry. In : *Advances in Aquaculture* (Ed. T. V. R. Pillay and Wm. A. Dill) FAO Fishing News (Books) Ltd. England pp. 395-402.

OZA, R. M. 1971. Effect of IAA on the growth of fragment of *Gracilaria corticata,* J. Ag. *Seaweed Res. Util., 1 :* 48-49.

OZA, R. M. 1978. Studies on Indian *Gracilaria.* V. Seasonal variation in agar and gel strength of *Gracilaria corticata.* J. Ag. occurring on the coast of Veraval. *Bot. Mar., 21* (3) : 165-167.

OZA, R. M. AND V. KRISHNAMURTHY. 1968. Studies on carposporic rhythm of *Gracilaria verrucosa* (Huds.) Papenf. *Bot. Mar., 11* (1-4) : 118-121.

OZA, R. M. AND P. SREENIVASA RAO. 1977. Effect of different culture media on growth and sporulation of laboratory raised germlings of *Ulva fasciata Bot. Mar., 20* (7): 427-431.

PAPENFUSS, G. F. 1955. Classification of the algae. In: *A Century of Progress in the Natural Sciences,* 1853-1953. *Calif. Acad. Sci. San Francisco.* pp. 115-224.

PAREKH, R. G. AND VISWESWARA RAO. 1964. Extraction of bulk proteins from the green seaweed, *Ulva rigida. Indian Jour. Tech., 2*: 387.

PAREKH, R. G., L. V. MARU AND M. J. DAVE. 1977. Chemical composition of green seaweeds of Saurashtra Coast. *Bot. Mar. 20* (6): 359-362.

PARIJA, P AND B. PARIJA. 1946. Algal succession on a rocky island named Charai Guha in the Chilka Lake. *Jour. Indian bot. Soc.* (M. O. P. Iyengar Commemo. Vol.) pp. 375-379.

PARKER, H. S. 1974. The culture of red algal genus *Eucheuma* in the Philippines *Aquaculture, 3* (4): 425-439.

PASCHER, A. 1914. *Ber. dtsch. bot. Ges.* 32, 136.

PATEL, B. A. AND G. V. JOSHI. 1967. Seasonl variations in chemical composition in *Ulva lactuca* and seawater. *Indian. Jour. exp. Biol., 5*: 236-238.

PATEL, J. B., B. V. GOPAL, V. R. NAGULAN, K. SUBBARAMAIAH AND P. C. THOMAS. 1979. Experimental field cultivation of *Gelidiella acerosa* at Ervadi, India. *Proc. Int Symp. Marine Algae of the Indian Ocean Region,* CSMCRI, Bhavnagar, India. pp. 24-25 (Abstract).

PATEL, J. B., B. V. GOPAL, V. R. NAGULAN, K. SUBBARAMAIAH AND P. C. THOMAS, 1980. Experimental field cultivation of *Gelidiella acerosa* at Ervadi, India. *Symp. Coastal Aquaculture,* Marine Biological Association of India, Cochin p. 189 (Abstract).

PERCIVAL, E. 1968. Marine algal carbohydrates. *Oceanogr. Mar. biol. Ann. Rev., 6*: 137-161.

PILLAI, V. K. 1955 a. Observations on the ionic composition of bluegreen algae growing in saline lagoons. *Proc. natn. Inst. Sci. India, 21*: 90-102.

PILLAI, V. K., 1955 b. Utilization of natural byproducts for the cultivation of blue-green algae. *Curr. Sci., 24*: 21.

PILLAI, V. K. 1955 c. Water soluble constituents of *Gracilaria lichenoides*. *Jour. Sci. Indust. Res.* (India), *14 B*. 473 477.

PILLAI, V. K 1956. Chemical studies on Indian seaweeds. I: Mineral constituents. *Proc. Indian* Acad. Sci., B. *44*: 3-29.

PILLAI, V. K. 1957 a. Chemical studies on Indian seaweads. II: Partition of Nitrogen. *Proc. Indian Acad. Sci.*, B *45*: 43-63.

PILLAI, V. K. 1957 b. Chemical studies on Indian seaweeds. III: Partition of Sulphur. *Proc. Indian Acad. Sci.*, B 45: 101-121.

PILLAI, V. K. 1957 c. Alginic acid from *Sargassum* seaweeds. *Res. Ind. 2*: 70-71.

PILLAI, V. K. 1964. Studies on the use of alginates in frozen fishery products. *Fishery*. Tech. *1*: 176-179.

PRESCOTT, G. W. 1968. *The algae: A review.* Haughton Mifflin Co., Boston 436 pp.

PROVASOLI, L. 1957. Effect of plant hormones on *Ulva, Biol. Bull., 114*: 375-384.

QASIM, S. Z. AND M. V. M. WAFAR. 1979. Occurrence of living corals at several places along the west coast of India. *Mahasagar. 12* (1): 53-58.

RAGOTHAMAN, G. 1979. Littoral algal survey of south Gujarat coast (Devka, Golvad and Daman). *Proc. Int. Symp. Marine Algae of the Indian Ocean Region* CSMCRI, Bhavnagar, India. p. 6 (Abstract).

RAJU, P. V. 1971. The effect of in situ application of growth hormones and fertilizers on photosynthetic c^{14} incorporation in some marine algae. *Bot. Mar. 14* (2): 129-131.

RAJU, P. V. AND P. C. THOMAS. 1971. Experimental field cultivation of *Gracilaria edulis* (Gmel). Silva. *Bot Mar., 14* (2): 71-75.

RAJU, P. V. AND R. VENUGOPAL. 1971. Appearance and growth of *Sargassum plagiophyllum* (Mart.) C. Ag. on a fresh substratum. *Bot. Mar. 14* (1): 36-38.

RAMA RAO, K. 1970. Studies on growth cycle and phycocolloid content in *Hypnea musciformis* (Wulf.) Lamour. *Bot. Mar.,* 13 (2): 163-165.

RAMA RAO, K. 1979. Studies on Indian Hypneaceae—V. Spores and natural propagules in the selected species of *Hypnea*, the potential Indian Carrageenophyte, for its field cultivation. *Proc. Int Symp. Marine Algae of the Indian Ocean Region.* CSMCRI, Bhavnagar. India. pp 30-31 (Abstract).

RAMA RAO, K AND V. KRISHNAMURTHY. 1968. Study of the preparation and properties of phycocolloid from *Hypnea musciformis* (Wulf.) Lamour. from Veraval, Gujarat coast, *Bot. Mar., 11*: 129-133.

RAMA RAO, K. AND P. C. THOMAS. 1974. Shedding of carpospores in *Gracilaria edulis* (Gmel.) Silva. *Phykos,* 13 (1) : 54-59.

RAMA RAO, K. AND V. KRISHNAMURTHY. 1978. Studies on Indian Hypneaceae. I. Seasonal variation in phycocolloid content in two species of *Hypnea* (Gigartinales, Rhodophyceae). *Bot. Mar., 21* (4) : 257-259.

RAMA RAO, K. AND K. SUBBARAMAIAH. 1980. A technique for the field cultivation of *Hypnea musciformis* (Wulf.) Lamour., a carrageenophyte. *Symp. Coastal Aquaculture.* M. B. A. I., Cochin, India. p. 189 (Abstract).

RANDHAWA, M. S. 1930. Historical review. Address; in: *Proc. Symp. Algology,* ICAR, New Delhi, pp. 4-24.

ROUND, F. E. 1973. *The Biology of the Algae,* Edward Arnold, London-278 pp.

RYTHER, J. H. 1968 a. *Porphyra* (Nori) culture in Japan. The status and potential of aquaculture particularly invertebrate and algae culture. Part II. Invertebrate and algae culture. (Reproduced by National Technical Service, Springfield. Va. 22151). pp. 228-241.

RYTHER, J. H. 1968 b. *Undaria* culture in Japan. The status and potential of aquaculture; particularly invertebrate and algae culture. Part II. Invertebrate and algae culture (Reproduced by National Technical Information Service, Springfield. Va. 22151). pp. 242-248.

SADASIVAN PILLAI, K. 1961. Alginic acid from *Sargassum* seaweeds of Indian coasts—Its extraction on a cottage industry basis. *Chemical age of India, 12* : 425-430.

SADASIVAN PILLAI, K. AND N. S. VARIER. 1952. Studies on the structure of alginic acid from the *Sargassum* seaweeds of Cape Comorin. *Jour. Proc. Inst. Chem.,* (India), *24* : 205.

SAITO, Y. 1975. *Undaria.* In : *Advance of Phycology in Japan* (Ed. J. Tokida and H. Hirose) Dr. W. Jung b. v. Publishers, The Hague. pp. 304-320.

SAITO, Y. 1979. Seaweed aquaculture in the North West Pacific. In : *Advance in Aquaculture* (Ed. T. V. R. Pilly and Wm. A. Dill). F. A. O. Fishing News (Books) Ltd. England. pp. 402-410.

SARMA, Y. S. R. K. AND M. KHAN. 1980. Algal taxonomy in India. Botanical records and monographs-2. Today and Tomorrow's Printers and Publishers, New Delhi. pp. 1-153.

SHAH, H. N. AND A. V. RAO. 1969. Recovery of mannitol from Indian brown seaweeds. *Res. Ind., 14* (3) : 117-119.

SHAH, H. N., I. A. Mody and A. VISWESWARA RAO. 1967. Seasonal variation of viscosity of sodium alginate from *Sargassum* species and the preparation of high viscosity alginates, *Indian Jour. Tech., 5* : 269-270.

SITAKARA RAO, V. AND U. K. TIPNIS. 1964. Protein content of marine algae from Gujarat coast. *Curr. Sci., 33 :* 16-17.

SITAKARA RAO, V. AND U. K. TIPNIS 1967. Chemical composition of marine algae from Gujarat coast. *Proc. Semi. Sea Salt and Plants,* CSMCRI, Bhavnagar, pp. 277-288.

SMITH, G. A. 1955. *Cryptogamic Botany;* Vol. I. Mc Graw Hill Book Co., New York. 546 pp.

SOLIMABI AND S. W. A, NAQVI. 1975. Alginic acid content of some brown seaweeds of Goa *Mahasagar 8* (1 & 2) : 97-99.

SOLIMABI AND B. DAS. 1977. Distribution of iodine in marine algae of Goa region. *Indian J. mar. Sci., 6* (2) : 180-181.

SOLIMABI, B. DAS, S. Y. KAMAT, L. FERNANDES AND C. V. G. REDDY. 1980. Seasonal changes in carrageenan and other biochemical constituents of *Hypnea musciformis. Indian. J. mar. Sci., 9* (2): 134-136.

SOLIMABI, B. DAS, P. K. MITTAL AND S. Y. KAMAT, 1981. Bromine and iodine contents in sponges and algae of the Andaman Sea. *Indian J. mar.* Sci., *10* (3): 301-302.

SREENIVASA RAO, P. 1967. Laver cultivation in Japan. *Salt Res. Ind., 4* (4): 141-144.

SREENIVASA RAO, P. 1969. Systematics, ecology and life history of Indian Gelidiales with special reference to agarophyte *Gelidiella acerosa* (Forsskal) Feldman et Hamel. *Salt Res. Ind., 6*: 46-47.

SREENIVASA RAO, P. 1970. Systematics of Indian Gelidiales. *Phykos. 9*: 63-78.

SREENIVASA RAO, P. AND S. R. KALE. 1969 Marine algae from a little known place of Gujarat coast I. Algae from Gopnath. *Phykos, 8*: 71-82.

SREENIVASA RAO, P. AND Y. A. Shelat. 1979. Antifungal activity of Indian seaweed extracts. *Proc. Int. Symp. Marine Algae of the Indian Ocean Region.* CSMCRI, Bhavnagar, India. p. 47 (Abstract).

SREENIVASA RAO, P. AND K. S. PAREKH. 1981. Antibacterial activity of Indian seaweed extracts. *Bot Mar., 14* (11): 577-582.

SREENIVASA RAO, P., E. R. R. IYENGAR AND F. THIVY. 1964. Survey of algin bearing seaweeds at Adatra reef, Okha. *Curr. Sci 33*: 464-465.

SREENIVASA RAO, P., H. H. PAREKH, B. K. RAMAVAT AND S. B. BHATT. 1979 a. Preparation and properties of liquid seaweed fertilizer. *Proc. Int. Symp. Marine Algae of the Indian Ocean region.* CSMCRI, Bhavnagar, India p. 57 (Abstract).

SREENIVASA RAO, P., S. J. TARWADE, K. S. R. SARMA, K. ANJANEYULU AND H. M. MODY, 1979 b. Seaweed as a source of energy: Production of fuel gas from seaweed, *Sargassum. Proc. Int Symp. Marine Algae of the Indian Ocean Region,* CSMCRI, Bhavnagar, India. *p.* 56 (Abstract).

SREENIVASA RAO, P., K. S. PAREKH AND H. H. PAREKH. 1979 c. Antibacterial activity of different fractions of seaweed extracts. *Proc. Int. Symp. Marine Algae of the Indian Ocean Region,* CSMCRI, Bhavnagar, India. p. 47 (Abstract).

SREENIVASA RAO, P , K. S. PAREKH, H. H. PAREKH, S. B. TRIVEDI AND B. A. DAVE. 1979 d. Effect of seaweed extracts on *Mycobacterium tuberculosis. Proc. Int. Symp. Marine Algae of the Indian Ocean Region,* CSMCRI, Bhavnagar, India. p. 47 (Abstract).

SRINIVASAN, K. S. 1946. Ecology and seasonal succession of the marine algae at Mahabalipuram (Seven Pagodas) near Madras. *Jour. Indian. bot. Soc.,* (M. O. P. Iyengar commemo. Vol.) pp. 267-278.

SRINIVASAN, K. S. 1950. Distribution patterns of marine algae in Indian seas *Proc. Symp. Algology,* ICAR, New Delhi. pp. 219-242.

SRINIVASAN, K. S. 1965. Indian botany in retrospect with particular reference to algal systematics. *Jour. Asiatic Soc., Bengal, 7*: 49-78.

SRINIVASAN, K. S. 1966. Conspectus of *Sargassum* species from Indian territorial waters. *phykos, 5*: 127-129.

SRINIVASAN, R. AND T. SANTHANARAJA. 1967. Studies on the extraction and properties of agar-agar from the seaweed *Gracilaria* species in Madras State. *Madras Jour. Fish., 3*: 146-151.

STANFORD, E. C. C. 1883. *Chem. News., 47*: 254-257, 262-269.

STANIER, R. Y. AND VAN NIEL, C. B. 1962. *Bact. Rev., 42*, 17.

SUBBARAMAIAH, K. 1937. Ascorbic acid content and growth in *Ulva fasciata* Delile, *Phykos, 6*: 115-117.

SUBBARAMAIAH, K. 1970. Growth and reproduction of *Ulva fasciata* Delile in nature and in culture. *Bot. Mar., 13* (1): 25-27.

SUBBARAMAIAH, K., AND V. KRISHNAMURTHY. 1967. Laboratory culture of seaweeds. *Proc. Semi. Sea Salt* and *Plants,* CSMCRI, Bhavnagar pp. 321-326.

SUBBARAMAIAH, K., S. R. KALE AND V. KRISHNAMURTHY. 1967. Gametes and germlings of *Ulva fasciata* Delile. *Curr. Sci., 36*: 128-129.

SUBBARAMAIAH, K., K. RAMA RAO, P. C. THOMAS, M. R. P. NAIR, B. V. GOPAL AND V. R. NAGULAN. 1975. Cultivation of *Gelidiella acerosa. Salt Res. Ind., 11* (1): 33-36.

SUBBARAMAIAH, K., K. RAMA RAO, M. R. P. NAIR, C. V. S. KRISHNAMURTHY AND M. PARAMASIVAM 1979 a. Marine algal resources of Tamil Nadu. *Proc. Int. Symp. Marine Algae of the* indian Ocean Region, CSMCRI, Bhavanagar, India. p. 14 (Abstract.)

SUBBARAMAIAH, K., K. RAMA RAO AND M. R. P. Nair. 1979 b. Marine algal resources of Lakshadweep. *Proc. Int. Symp. Marine Algae of the Indian ocean Region.*, CSMCRI, Bhavnagar, India. pp. 6-7 (Abstract).

SUBBA RAO, G. N. 1965. Use of seaweeds directly as human food. *Indo-Pacific Fish. Coun. Reg. Studies. No. 2*: 1-32.

SUBBA RAO, P. V., K. RAMA RAO AND K. SUBBARAMAIAH. 1977. Screening of certain red seaweeds for phycocolloids. *Seaweed Res. Util*, *2* (2): 82-86

SUBRAHMANYAN, R. 1967. Methods of assessing seaweed resources and problems. *Proc. Semi. Sea Salt* and *Plants*, CSMCRI, Bhavnagar. pp. 311-314.

SUMITRA VIJAYARAGHAVAN, M. D. RAJAGOPAL AND M. V. M. Wafar. 1980. Seasonal variations in biochemical composition of seaweeds from Goa coast. *Indian J. mar. Sci. 9* (1): 61-63.

TAMIYA, H. 1960. Role of algae as food *Proc. Symp Algology*, ICAR, New Delhi, pp. 379-389

TAYLOR, W. R. 1964. The genus *Turbinaria* in eastern seas. *Jour. Linn. Soc. London* (Botany), *58*: 475-490.

TEWARI A. 1975. The effect of a morphactin on the vegetative growth of *Gelidiella acerosa Phykos 14* (1 & 2) : 125-128.

TEWARI, A., M. PRASADA RAO AND V. KRISHNAMURTHY. 1968. Chemical composition of a species of *Porphyra* from Visakhapatnam. S. India. *Curr. Sci., 37*: 138.

THIVY, F. 1952. Investigations of seaweed products in India with a note on properties of various Indian agars. *Proc. Indo-Paci. Fish. Council*, Sec. *2* : 173-175.

THIVY, F. 1958. Economic seaweeds. In *Fisheries of West Coast of India*, Bangalore. pp. 74-80.

THIVY, F. 1960. Seaweed utilization in India. *Proc. Symp. Algology*, ICAR, New Delhi, pp. 345-365.

THIVY F. 1964. Marine algal cultivation. *Salt Res Ind., 1* (1) . 23-28.

THOMAS, P. C 1977. Seasonal variation in the yield and physical properties of agar-agar from *Gracilaria verrucosa* (Hudson) Papenfuss. *Seaweed Res. Util., 2* (2) : 78-81.

THOMAS, P. C. AND V. KRISHNAMURTHY. 1976. Agar from cultured *Gracilaria edulis* (Gmel.) Silva. *Bot. Mar., 19* : 115-117.

THOMAS, P. C., K. RAMA RAO AND K. SUBBARAMAIAH 1975. Periodicity in growth and production of agar of *Gelidiella acerosa* (Forssk.) Feldman et Hamel. *Indian J. Mar. Sci., 4* (2) : 210-212.

UMAMAHESWARA RAO, M. 1969 a Catalague of marine algae in the reference collection of the Central Marine Fisheries Research Institute. *Bull. cent. mar. Fish. Res. Inst., 9* : 37-48.

UMAMAHESWARA RAO, M 1969 b. Agar and algin yielding seaweeds of India. *Proc. 6th Int. Seaweed Symp.*, pp. 715-721.

UMAMAHESWARA RAO, M. 1969 c. Seasonal variations in growth, alginic acid and mannitol contents of *Sargassum wightii* and *Turbinaria conoides* from the Gulf of Mannar, India. *Proc. 6th Int Seaweed Symp.* pp. 579-584.

UMAMAHESWARA RAO, M. 1970. The economic seaweeds of India. *Bull. cent. mar. Fish. Res. Inst.* No. *20* : pp. 1-68.

UMAMAHESWARA RAO, M. 1972 a. Coralreef flora of Gulf of Mannar and Palk Bay. *Proc. Symp. Corals* and *Coral Reefs* (1969). pp. 217-230.

UMAMAHESWARA RAO, M. 1972 b. On the Gracilariaceae of the seas around India. *Jour. mar biol. Ass. India, 14* (2) : 671-696.

UMAMAHESWARA RAO, M. 1972 c. Ecological observations an some intertidal algae of Mandapam coast. *Proc. Indian natl. Sci. Acad., 38* B (3 & 4) : 298-307.

UMAMAHESWARA RAO, M. 1973. The seaweed potential of the seas around India. *Proc. Symp on Living Resources of the Seas Around India* (1968). pp. 687-692.

UMAMAHESWARA RAO, M. 1974. a On the cultivation of *Gracilaria edulis* in the nearshore areas around Mandapam. *Curr. Sci., 43* (20) : 660-661.

UMAMAHESWARA RAO, M. 1974 b. Observations on fruiting cycle, spore output and germination of tetraspores of *Gelidiella acerosa* in the Gulf of Mannar. *Bot Mar., 17* (4) : 204-207.

UMAMAHESWARA RAO, M. 1976. Spore liberation in *Gracilaria corticata* J. Agardh growing at Mandapam. *J. exp. Mar. Biol. Ecol., 21* : 91—98.

UMAMAHESWARA RAO, M. 1978. Seaweed resources of Andhra Pradesh. *Seaweed Res. Util, 3* (1 & 2) : 51-55.

UMAMAHESWARA RAO, M. AND T. SREERAMULU. 1963. Vertical zonation and seasonal and variation in the growth of *Porphyra* on Visakhapatnam coast. *Curr Sci, 32* : 173-174.

UMAMAHESWARA RAO, M. AND T. SREERAMULU. 1970. An annotated list of the marine algae of Visakhapatnam (India). *Bot. Jour. Linn. Soc., 63* : 23-45.

UMAMAHESWARA RAO, M. AND S. KALIMUTHU. 1972. Changes in mannitol and alginic acid contents of *Turbinaria ornata* (Turner) J. Agardh in relation to growth and fruiting. *Bot Mar., 15 :* 57-59.

UMAMAHESWARA RAO, M. AND N. KALIAPERUMAL. 1976. Some observations on the liberation and viability of oospores in *Sargassum wightii* (Greville) J. Ag. *Indian J. Fish., 23* (1 & 2), 232-235.

UNNI, C. K. 1967. Natural radioactivity of marine algae. *Proc. Semi. Sea Salt* and *Plants,* CSMCRI: Bhavnagar. pp. 265-273.

UNTAWALE, A G. AND V. K. DHARGALKAR. 1975. *Report on the seaweed resources of the Goa coast.* N. I. O , Dona Paula, Goa. pp. 1-10.

UNTAWALE, A. G., N. B. BHOSLE AND V. K. DHARGALKAR. 1977. Properties of phycocolloid extraction from seaweeds of Goa. *Indian J. mar. Sci., 6* (2) : 181-183.

UNTAWALE, A. G., V. K. DHARGALKAR, V. V. AGADI AND T. G. JAGTAP. 1979. Marine algal resources of the Maharastra coast. *Tech. Report.* Natl. Inst. of Oceanography, Goa. 48 pp.

UNTAWALE, A. G, V K DHARGALKAR AND V. V. AGADI. 1983. *List of marine algae from India* N. I. O , Dona Paula, Goa. pp. 1-42.

VALSON, A. P. 1955. Alginic acid content of some of the common seaweeds of the Gulf of Mannar area. *Curr. Sci., 24*: 343-345.

VARIER, N. S AND K. SADASIVAN PILLAI. 1952. Mannitol from *Sargassum* seaweeds. II. Optimum conditions for extraction of alginic acid from *Sargassum* seaweeds of Cape Comorin. *Bull. cent. Res. Inst., 2*: 39.

VARMA, R. P. 1960. Flora of the pearl beds off Tuticorin. *Jour. mar. biol. Ass. India, 2*: 221-225

VARMA, R. P. AND K. KRISHNA RAO. 1962. Algal. resources of Pamban area. *Indian J. Fish. 9*: 205-211.

VILHELM, J 1931. Archaeophyta and Algophyta. Prague.

VINOGRADOV, A. P. 1953. The elementary chemical composition of marine organisms. *Sears, Foundation for Marine Res.*, No 11.

VISWESWARA RAO, A. 1964. Protein from *Ulva. Salt Res. Ind., 1*: 37.

VISWESWARA RAO, A. AND I. C. MODY. 1964. Extraction of alginic acid and alginates from brown seaweeds. *Indian Jour. Tech., 3* (8): 261-262.

VISWESWARA RAO, A. K. N. PATEL AND H. N. SHAH. 1965. Manufacture of agar-agar from red seaweeds. *Res. Ind., 10*: 131-133.

WHITTAKAR, R. H. 1969. Science, N. Y., 163, 150.

YAPHE, W. 1959. The determination of kappa carrageenan as a factor in the classification of Rhodophyceae. *Canad. Jour. Bot., 37*: 751-757.

ZINGDE, M. D., S. Y. S. SINGBAL, C. P. MORAES AND C. V. G. REDDY. 1976. Arsenic, Copper Zinc and Manganese in the marine flora and fauna of coastal and estuarine waters around Goa. *Indian J. mar. Sci., 5*: 212-217.