

ITS1 sequences of type specimens of *Gigartina* and *Sarcothalia* and their significance for the classification of South African Gigartinales (Rhodophyta)

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Uncertainties about the identity of type specimens of red algae have frequently led to taxonomic and nomenclatural confusion. A procedure for extracting PCR-amplifiable DNA from formalin-fixed material and herbarium specimens was used to investigate the taxonomic status of several South African Gigartinales. We compared nucleotide sequences in the internal transcribed spacer 1 (ITS1) region in type specimens and other historically important collections presently referred to *Gigartina bracteata*, *G. radula* and *G. striata*. The following opinions are supported: (1) *Fucus bracteatus* S.G. Gmelin, *Chondrodactylon capense* Kützinger and *Iridaea clathrata* Decaisne represent a single species of South African *Gigartina* (*G. bracteata* (S.G. Gmelin) Setchell & Gardner) in which the disintegration of tetrasporangial sort results in a reticulate thallus. (2) *Mastocarpus polycarpus* Kützinger, *M. incrassatus* Kützinger and *Iridaea lapathifolia* Kützinger represent a single species of South African *Gigartina* (*G. polycarpa* (Kützinger) Setchell & Gardner) that has often, but erroneously, been called *G. radula* (Esper) J. Agardh. (3) *Mastocarpus verrucosus* Kützinger is a later heterotypic synonym of *Iridaea papillosa* Bory (*Sarcothalia papillosa* (Bory) Leister) and was based on material that probably came from southern South America rather than from South Africa, the provenance given by Kützinger. (4) *Fucus striatus* Turner and *Sphaerococcus burmannii* C. Agardh represent a single species of South African *Sarcothalia* (*S. striata* (Turner) Leister).

Key words: DNA, Gigartinales, *Gigartina*, *Sarcothalia*, type material, ITS1, PCR, red algae, South Africa

Introduction

During the brief history of molecular systematics, protocols have been developed for the purpose of extracting and amplifying sequenceable DNA. These protocols vary from one taxonomic group to another, but almost all entail extraction of DNA from fresh tissues or from tissues prepared specifically for DNA extraction by being dried in the air or using silica gel. The need to develop protocols for extracting and amplifying useful DNA from herbarium specimens became apparent in studies of population genetics requiring a large number of samples and in phylogenetic studies for which certain taxa were not otherwise readily available. Pioneering work was done as early as 1985 (Rogers & Bendich, 1985), and now herbarium specimens are routinely used as a source of DNA in phylogenetic studies of flowering plants. Success using herbarium specimens of fungi was reported as early as 1990 (Bruns *et al.*, 1990). Phycologists have generally considered it futile to attempt to extract

useful DNA from herbarium specimens of algae, many of which, prior to being dried, were immersed in formalin for varying lengths of time, a method of preservation shown to be highly destructive of DNA (Pyle & Adams, 1989). Goff & Moon (1993) reported success when using genomic material extracted from a cystocarp taken from a specimen of *Gracilaria* that had been collected 11 years earlier and not fixed in formalin. Those authors obtained sequences from the ribosomal ITS region and the plastid Rubisco spacer region. Brodie *et al.* (1996, 1998) were successful in using herbarium specimens of *Porphyra* collected as early as 1926 but of unstated preservational history. One of the herbarium specimens was an isotype.

In the present paper we give a protocol specifically designed for the extraction and amplification of regions of the chloroplast and nuclear genomes of red algae, using vegetative or reproductive fragments of herbarium specimens without regard for their preservational history. Then, in an attempt to resolve problems entailing certain South African algae that have been assigned to the genus *Gigartina* Stackhouse (Gigartinales), we pursue the sugges-

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