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Harvesting of the kelp *Ecklonia maxima* in South Africa affects its three obligate, red algal epiphytes

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Abstract

In South Africa, more than 7000 t (f wt) of kelp (*Ecklonia maxima*) fronds are harvested annually to feed cultured abalone. *Carpoblepharis flaccida*, *Gelidium vittatum* and *Polysiphonia virgata* are conspicuous red algal epiphytes on older kelps and provide habitat and food for numerous animals. Over 4.5 y, we examined the effects of one destructive harvest of *E. maxima* on these 3 epiphytes. Two 20 × 20 m plots of kelp with similar epiphyte loads were demarcated. In one, all *E. maxima* sporophytes with stipes longer than 50 cm were harvested. The other plot served as a control. After 2.5 y the biomass of *E. maxima* in the harvested plot had recovered to control levels, but the epiphyte load (g epiphytes. kg kelp^{-1}) was statistically lower in the harvested plot after 2.5 and 3.5 y, and only recovered after 4.5 y. While most commercial harvesters cut through the "heads" (primary blades) of the kelp, effectively killing them, a new, non-lethal method removes secondary blades 20–30 cm from their bases, leaving the meristems and primary blades intact. At 5 sites studied, *G. vittatum* and *P. virgata* were found almost entirely on stipes and primary blades, and harvesting only distal parts of secondary blades limited losses to about 50% of *C. flaccida* biomass. To protect epiphytes, non-lethal harvesting is recommended and permanent non-harvest zones have been established in addition to limiting kelp yields and disallowing harvesting in Marine Protected Areas.

Introduction

The kelp *Ecklonia maxima* (Osbeck) Papenfuss occurs along the cool-temperate west coast of South Africa, where it dominates the surface canopy of kelp beds between Cape Agulhas and at least Cape Columbine (Figure 1). It has been collected as beach-cast since the 1950's (Anderson et al., 1989) and harvested since the 1970's for the production of a plant-growth stimulant. Since the early 1990's, increasing amounts of *E. maxima* have been harvested as feed for abalone cultured in land-based farms (Anderson et al., 2003). In 2003 more than 7000 t of fresh fronds were harvested from *E. maxima* beds, and demand is increasing as abalone farms expand.

The effects of harvesting on the *Ecklonia* plants and understorey communities have been studied in the past (Levitt et al., 2002) and are being studied now (M. Rothman pers. comm.). However, these studies do not consider effects on the 3 macroalgae that are obligate epiphytes on the stipes and fronds of *Ecklonia*. These 3 rhodophytes, *Gelidium vittatum* (Linnaeus) Kuetzing, *Polysiphonia virgata* (C. Agardh) Sprengel and *Carpoblepharis flaccida*, (C. Agardh) Kuetzing attain significant biomasses (see later) and were shown by Allen and Griffiths (1981) to bear at least 27 species of invertebrates. Furthermore, *C. flaccida* forms a significant part of the diet of the commercially important linefish *Pachymetopon blochii* (Val.) (Pulfrich & Griffiths, 1988). *G. vittatum* was formerly called *Suhria vittata* (Linnaeus) Endlicher (see Tronchin et al., 2002) and has been considered as a potential commercial agarophyte, but because of its epiphytic nature, would be difficult to obtain in sufficient quantities unless it could be

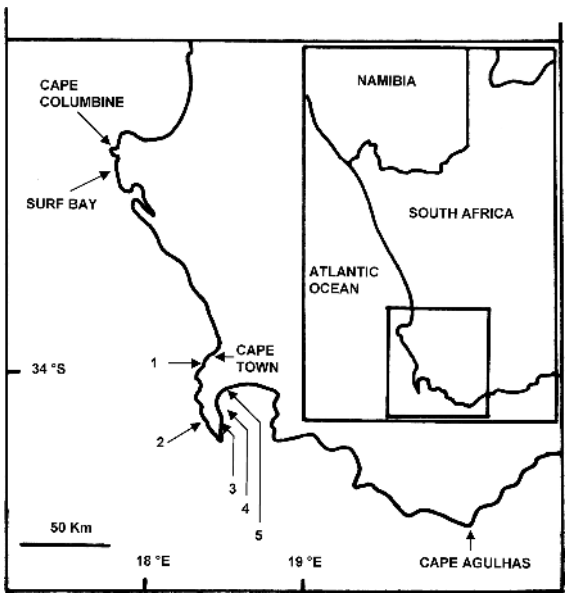

Figure 1. Map showing location of study sites on the South African west coast. Epiphyte survey sites on the Cape Peninsula, are: 1 Oudekraal, 2 Soetwater, 3 Buffelsbaai, 4 Glencairn, 5 Dalebrook.

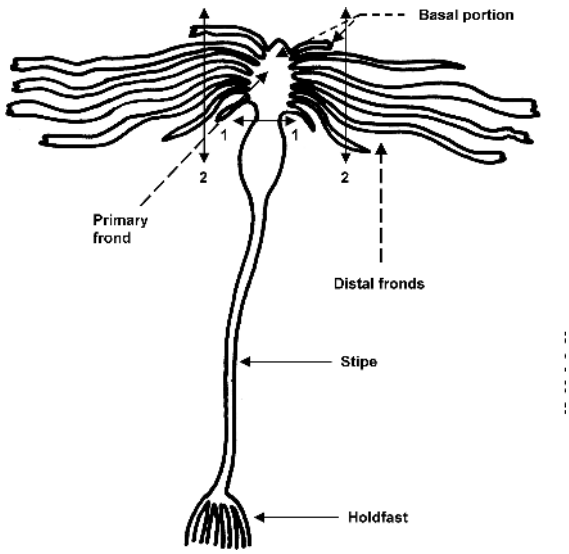

Figure 2. Diagram of *Ecklonia maxima* sporophyte to show parts referred to in text.

cultivated (Anderson & Bolton, 1985; Anderson et al., 1989; Anderson, 1994).

How harvesting affects epiphytes depends on the harvesting methods and the position of the epiphytes on the kelp. If whole kelps are removed, all attached organisms will be lost. In Norway, after harvesting of *Laminaria hyperborea* (Gunn.) Foslie by trawling, young kelps grew up rapidly to replace the mature sporophytes, but epiphytes and holdfast fauna populations took significantly longer to recover (Christie et al., 1998). Because epiphyte populations take time to become established, they are more abundant on older kelp plants (Whittick, 1983; Christie at al., 1998). Epiphytic macroalgae are often an important habitat for small invertebrates that may be ecologically important in the kelp–bed system (Christie et al., 1998; Allen & Griffiths, 1981). Furthermore, it is reasonable to assume that the abundance of such invertebrates will increase with the biomass of the epiphytes, as shown in Norway (Christie, 1995).

The 3 epiphytes in this study were known to have somewhat different distributions on the sporophytes, but these have never been quantitatively established. *Gelidium vittatum* is found on stipes or on the limpet *Cymbula compressa* that in turn grows only on these stipes. *Polysiphonia virgata* grows on the stipes. While *Carpoblepharis flaccida* was known to grow on fronds, it was not clear where on the primary or secondary fronds it is concentrated.

It is important to know where the epiphytes occur on the kelp sporophytes, because there are basically 3 harvesting methods used in South Africa. Kelp harvested for the extraction of a plant-growth stimulant is cut at the base of the stipe, and stipes and fronds used. The holdfast subsequently dies and rots off the substratum. Kelp for abalone feed is harvested in one of two ways. In the first method, the whole "head" (primary frond and attached secondary fronds – see Figure 2) is cut off, and either the stipe and holdfast die and rot off, or the stipes are cut off by divers a few days later and collected and sold for alginate extraction. In the second method, only the distal parts of the secondary fronds are cut off. This method does not kill the sporophyte: the remaining basal parts of the secondary fronds continue to grow, and all other parts are unharmed. The main advantage of this "non-lethal" method is that a substantially higher yield of kelp fronds can be obtained from a given area of kelp bed, because the replacement of biomass does not involve going through the whole life-history of the kelp: the secondary fronds continue to grow from their basal meristems (Levitt et al., 2002).

Most of the commercial harvesters supplying abalone feed prefer to cut the whole head off the *Ecklonia* sporophyte because it is easier and yields a high return per effort during each boat trip. However, on some areas of the coast, the demand for kelp fronds is now threatening to exceed the limits set by management,