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Standing crop and production estimates of selected Marion Island plant communities

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Standing crop and above-ground standing biomass increases during the growth season are provided for three plant communities on Marion Island (sub-Antarctic). The values support previous observations that low-altitude sub-Antarctic vegetations accumulate large quantities of aboveground plant matter and that they are more productive than most northern hemisphere tundra vegetations.

Introduction

Despite recent efforts inspired by the International Biological Programme, little is known regarding the primary production and standing crops of sub-Antarctic vegetation. Available data to date are confined to Macquarie Island (Jenkin, 1975) and South Georgia Island (Smith & Walton, 1975). Huntley (1972) and Smith (1976, 1977) provide standing crop values of several lowland plant communities on Marion Island. Additional information for three of these communities (fernbrake, *Acaena magellanica* drainage-line and tussock grassland) on the island's eastern coastal plain is presented in this account, and preliminary estimates of their annual production are provided. Comprehensive descriptions of the communities are provided in Smith (1976).

Methods

The standing crop values shown in Table 1 are those at the approximate time of maximum above-ground biomass in the growing season and were derived from the harvested quadrat method described in Smith (1976). Primary production was estimated in two ways: (a) as the difference between peak biomass (living material) and that at the start of the growing season, and (b) the difference between the corresponding standing crop (living and dead material) values.

Results and discussion

Biomass and standing crops

Standing crop and production estimates for the three communities are presented in Table 1; some values for similar communities on other sub-Antarctic islands are also provided. Only general conclusions can be drawn from comparisons between the islands since different methods have been used and these give values which are known to vary, even within the same site (Walton, Greene & Callaghan, 1975). In addition, biomass varies seasonally. As Holdgate (1977) points out, there are two statistical problems in comparing available standing crop and productivity estimates from sub-Antarctic regions, namely the reliability and inter-comparability of the methods, and the relationship of the sample sites to the localities in which they occur. None of these localities has been studied sufficiently well to provide data on the variability in biomass and production within them, and many of the estimates are derived from small atypical areas of sheltered or highly productive vegetation.

Most of the available data, however, indicate that large above-ground biomass values occur in sub-Antarctic vegetation, in contrast to tundra areas of the northern hemisphere with their bitterly cold, continental winters. Large amounts of dead material, predominantly in the form of standing dead, accumulate in sub-Antarctic vegetation and this is reflected in the high standing crop figures in Table 1.

Above-ground biomass and standing crop estimates for 1972 and 1974 from the same communities on Marion Island are very similar but the below-ground values differ between the two dates. This is probably in error, since the 1972 below-ground estimates were based on only 4 samples each.

The 1969 value for the above-ground biomass of fernbrake

Table 1

Standing crop and primary productivity at some sub-Antarctic sites.

Locality	Standing crop (g m^{-2})							Production (g m^{-2} yr^{-1})	
	Above-ground					Below-ground	Total	Above-ground	
	Sampling date	Living		Dead Total	Total S. crop	Total S. crop	Standing Crop	Vascular	Crypto-gram
		Vasc.	Cryp.						
Marion Island									
Closed fernbrake	April 1969[1]	799 ± 32							
	March 1972[2]	568 ± 79	trace	1557 ± 322	2125	3984 ± 684	6109		
	March 1974	567 ± 42	trace	1517 ± 115	2084 ± 137	3602 ± 346	5686	454 (402)	
Acaena drainage-line	Feb. 1972[2]	727 ± 92	224 ± 94	528 ± 107	1479	3607 ± 572	5086		
	Feb. 1974	682 ± 59	482 ± 59	452 ± 42	1616 ± 66	2457 ± 258	4073 ± 280	234 (233)	297
Tussock grassland	April 1969[1]	449 ± 40							
	March 1972[2]	778 ± 134	230 ± 49	1649 ± 225	2657	3988 ± 898	6645		
	March 1974	868 ± 62	382 ± 51	1341 ± 114	2591 ± 140	2483 ± 222	5074 ± 331	352 (385)	113
South Georgia[3]									
Acaena dwarf-shrub		1300	221	521	2042	7536	9578	855	250
Festuca tussock grassland		425	170	1654	2249	1682	3931	340	152
Macquarie Island[4]									
M_1 herbfield		740	15	1587	2342	N.D.			
M_1 grassland		912	6	2693	3611	4800	8411	1890	21
M_2 grassland		328	5	940	1273	N.D.			

Production values in parentheses are calculated by the peak standing crop method.

[1]Huntley (1972), [2]Smith (1976), [3]Smith & Walton (1975), and [4]Jenkin (1975).

vegetation (799 g m^{-2}; Huntley, 1972) is significantly lower than the corresponding 1972 and 1974 estimates (568 and 567 g m^{-2}). The 1969 estimate was based on a fernbrake stand possessing a high (95 per cent) cover of *Blechnum penna-marina*. Although such well-developed stands do occur on slopes offering protection from southerly winds, the average *Blechnum* cover of typical fernbrake areas is generally lower (*ca* 80 per cent in the community studied in 1972 and 1974) and *Azorella selago*, a species exhibiting a low above-ground biomass, is of greater importance in these areas. Above-ground biomasses and standing crops of the Marion Island fernbrake communities are similar to those of a sheltered *Pleurophyllum hookeri* herbfield on Macquarie Island (Jenkin & Ashton, 1970; Jenkin, 1975).

The vascular above-ground biomass values of the Marion Island tussock grassland community investigated in 1972 and 1974 are higher than the earlier value reported by Huntley (1972). The floristic composition of tussock grasslands on Marion Island varies considerably, although *Poa cookii* always retains its prominence. Huntley's estimate is based upon a virtually pure stand of 30 cm high tussocks of this grass, typical of sea-facing slopes of the shore region and heavily influenced (manuring and trampling) by animals. In these areas the ground between the tussocks is vegetated only by small coprophilous species. In contrast, inland stands of *Poa cookii* tussock grassland are co-dominated by *Acaena magellanica*, which occurs in abundance between the grass tussocks. Several bryophyte species also occur. Although numerous bird burrows undermine these inland areas, damage due to trampling is minimal and no bare ground occurs between the grass tussocks. The greater vegetation cover of these inland communities, added to the fact that the mature tussocks are 40-50 cm high, accounts for the disparity between the aerial biomass values for Marion Island tussock grasslands found by Huntley and in later studies.

The aerial vascular biomasses of tussock grasslands on Marion Island (449-868 g m^{-2}) are in the same range as those previously reported from similar communities on other sub-Antarctic islands, e.g. Macquarie Island M_1 and M_2 grasslands and *Festuca erecta* grassland on South Georgia (328-912 g m^{-2}; Table 1). Much higher values (up to 7525 g m^{-2}) occur in the 2 m tall tussocks of *Poa flabellata* on South Georgia (Smith & Walton, 1975) and the standing crop and production of these tussock areas may be amongst the highest on earth.

The above-ground and below-ground standing crops of wet depressions dominated by *Acaena magellanica* on South Georgia are greater than those of the similar drainage-line communities on Marion Island. This may reflect the lower percentage cover of *Acaena magellanica* in the Marion Island communities. *Blechnum penna-marina*, a species possessing no above-ground perennial tissue, constitutes roughly a quarter of the vegetation cover in these communities, in contrast to the complete vascular dominance of *Acaena magellanica* in the South Georgia community (Walton, 1973).

Primary production

Above-ground vascular primary productions of fernbrake and tussock grassland on Marion Island are similar but are substantially higher than the drainage line community (Table 1). This is surprising in view of the high production measured for the similar *Acaena*-dominated community on South Georgia. The total above-ground production of this community (1105 g m^{-2} yr^{-1}) is twice that of the Marion Island drainage-line community and exceeds that of meadow and dwarf-shrub tundras of the northern hemisphere (Rodin & Bazilevich, 1967).

Aerial production of fernbrake on Marion Island (402-454 g m^{-2} yr^{-1}) is similar to that (464 g m^{-2} yr^{-1}) of the M3 *Pleurophyllum hookeri* herbfield at a sheltered site (245 m above sea level) on Macquarie Island (Jenkin, 1975).

Poa cookii (Marion Island) and *Festuca contracta* (South Georgia) tussock grasslands both produce approximately 500 g m^{-2} above-ground annually. These communities are very much less productive than the 1-1,5 m tall *Poa foliosa* tussocks on Macquarie Island (1900 g m^{-2} yr^{-1}), or the *Poa flabellata* community on South Georgia (*ca* 5 kg m^{-2} yr^{-1}; Smith & Walton, 1975). This latter value may be in error, however, as it was derived from measurements on a single large tussock (Holdgate, 1977).

The values for Marion Island given in Table 1 must be considered to be minimum estimates of annual production, since the peak biomass technique for their determination takes no account of mortality between sampling dates or translocation between above- and below-ground plant organs. The peak standing crop technique overcomes the first limitation, but introduces two further sources of error: (a) no account is taken of decomposition of dead material; (b) standing crop values for the characteristically high quantities of dead material in sub-Antarctic vegetation show large variations within sampling dates which mask the increment due to movement of plant matter from living to standing dead or litter.

It is thought that the Marion Island production values are underestimates for reasons presented in the discussion. Examination of the monthly data for 1973/74 yields more accurate production estimates which exceed those in Table 1 by up to 21 per cent. It is unlikely, however, that even the most luxuriant, pedestalled *Poa cookii* tussock grasslands surrounding penguin and elephant seal colonies on Marion Island are even nearly as productive as the tall, robust tussocks of other *Poa* species on South Georgia and Macquarie Islands.

Conclusion

Vegetation standing crop estimates on Marion Island support previous observations that sub-Antarctic plant communities accumulate substantially higher phytomasses (predominantly in the form of dead matter) in the above-ground sphere than do low-growing shrub tundras of the northern hemisphere. High standing crop values do not necessarily imply high production rates, however, and measured production values for the island are not markedly higher than for wet meadow and dwarf-shrub tundra areas of the northern hemisphere (Rodin & Bazilevich, 1967; Webber, 1974). In contrast, very high productivities have been estimated for some communities at other sub-Antarctic localities.

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