Correlates of water colour in streams rising in Southern Cape catchments vegetated by fynbos and/or forest

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Abstract

Both so-called "white" and "black" streams occur in the Southern Cape. We investigated 33 streams in the Southern Cape to determine which factors (catchment vegetation, altitude, geology/soil-type, slope and aspect) may be correlated with water colour. Most black streams rise in high elevations on steep south slopes, with catchments vegetated by fynbos and with pale-coloured soils. Exceptions such as permanently white fynbos streams and black indigenous forest rivers do occur. When black water was filtered through horizons of different soils in most cases, and especially in red/yellow soils, the water was decolored. Streams from catchments with red/yellow soils did not become darker during stormflow. The main correlate with dark stream colour is the paleness of catchment soil colour.

Introduction

Streams with both clear ("white") and stained ("black") waters occur in areas of the Cape with nutrient-poor soils. This co-existence of both types of streams continues to be puzzling (Van Wyk, 1988). Rivers that are acid, black and foamy due to the presence of certain dissolved organic carbon (DOC) compounds (e.g. phenols, tannins, humic/fulvic acids and saponins) largely produced by plants, are well known to be typical of many areas of the world with nutrient-poor, sandy, bleached and podzolised soils and are usually associated with sclerophyllous evergreen vegetation (Janzen, 1974). They are also common in peaty areas (Mitchell, 1990). Biologically these DOC compounds are considered to deter herbivores (Janzen, 1974). These DOC are a dynamic group of humic compounds (Chesworth and Macias-Vasquez, 1985), once leached out of plant material they usually form organo-metal (iron/aluminium) complexes and are responsible for staining of the water (Moore, 1988; Mitchell, 1990). The formation and mobilisation of organo-metal complexes in the soil initiates podzolisation. Podzolisation is a complex soil process which eventually leads to bleached sandy upper horizons and the formation of impenetrable organo-metal hardpans further down the profile (Duchafour, 1982). Black waters are the active eluviating agents in the podzolisation process (Reeve and Fergus, 1982).

Very little work has been published on the aspects of the chemistry of Cape plants related to their defense from herbivores and which may also play a role in staining streams. Glyphis and Puttick (1988) recorded a mean phenol level of 7,55 % in 23 species in a Cape strandveld community. This value is close to the high level of 7,57 % recorded in a nutrient-poor African rain forest (McKey et al., 1978). Another study showed that phenolic compounds were widespread in all species from the Cape Proteaceae genera *Leucadendron* and *Leucospermum* (Perold, 1984). Despite the general lack of information on this aspect of the phytochemistry of Cape plants, they can be expected according to Janzen (1974), to be heavily chemically defended against herbivory. This is because the dominant mesic vegetation types of the Cape, both the shrublands ("fynbos") and forest, are sclerophyllous and evergreen because the soils are typically sandy and nutrient-poor (Kruger, 1979). Therefore all the rivers rising in catchments with these nutrient-poor soils should be stained, as are rivers in other similar areas. The question thus becomes: why are some of the rivers of this area of the Cape actually white?

River water colour may possibly relate to the fynbos/forest dichotomy. For example, Schloms et al. (1983) suggested that black streams rising on areas of the S. Cape plateau are black due to the presence of fynbos, rather than indigenous forest, in their catchments. To date there are no data to show whether the indigenous forest can, or does, give rise to black rivers.

Another possible factor is the effect of different soil types and horizons, within a nutrient-poor environment, on river colour. Reeve and Fergus (1982) investigated the occurrence of occasional white water streams in an area with predominantly black-water streams in S.E: Australia. In their situation white springs occurred where black water had passed through yellow-brown podzol C horizons before it formed a spring downslope. In the yellow-brown horizon the organic compounds are sorbed onto active clay minerals and thus removed from the system. Thus the adsorbtion of DOC by podzol horizons appears to be largely responsible for regulating its concentration in streams (McDowell and Wood 1984). Reeve and Fergus (1982) argued that white waters were "the residual liquid phase of the podzolisation process".

In the S. Cape, as a result of varied geology and topography, a wide variety of soil forms occurs. Although the soils vary in physical nature they are generally acid and podzolised. According to Schloms et al. (1983) and Schafer (1992) the dominant soils (using the system of MacVicar et al., 1977) are: Lamotte (dunes), Estcourt and Glenrosa (coastal plateau), Oakleaf, Clovelly, Kroonstad and Lamotte (mountain foothills), Houwhoek, Mispah, Cartref and Champagne (mountains). For the fynbos biome as a whole, Campbell (1983) noted that Mispah, Cartref, Glenrosa and Champagne accounted for more than 65% of the soil profiles. True podzols (Houwhoek, Lamotte), are neither common nor well developed (i.e. with impenetratable horizons) in the Cape (Campbell, 1983; Schloms et al., 1983). The lack of strongly developed podzols suggests that sorption sites for soluble organic compounds produced by the plants should still be present on clay minerals in most soil profiles. Thus most of the Cape rivers should apparently be white.

A further confounding factor is the common observation that many rivers become darker during winter. Van der Zel et al.

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