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Short communication

Water hyacinth decline across Lake Victoria—Was it caused by climatic perturbation or biological control? A reply

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Abstract

Several authors have identified that a combination of interacting factors involving the El Niño of 1997/1998 and biocontrol by weevils resulted in the rapid reduction of water hyacinth across Lake Victoria [Albright, T.P., Moorhouse, T.G., McNabb, J., 2004. The rise and fall of water hyacinth in Lake Victoria and the Kagera River Basin 1989–2001. J. Aquat. Plant Manage. 42, 73–84; Williams, A.E., Duthie, H.C., Hecky, R.E., 2005. Water hyacinth in Lake Victoria: why did it vanish so quickly and will it return? Aquat. Bot. 81, 300–314; Wilson, J.R.U., Ajuonu, O., Center, T.D., Hill, M.P., Julien, M.H., Katagira, F.F., Neuenschwander, P., Njoka, S.W., Ogwang, J., Reeder, R.H., Van, T., 2007. The decline of water hyacinth on Lake Victoria was due to biological control by *Neochetina* spp. Aquat. Bot. 87, 90–93]. It would appear to us that any disagreement between these papers centres on the order and magnitude of the contributory factors. In this reply we reiterate that whilst weevils almost certainly played their part, the synchronous lake wide reduction of water hyacinth during the second quarter of 1998 was the result of the 1997/1998 El Niño.

Keywords: *Eichhornia crassipes*; El Niño; Lake Victoria; Water hyacinth; Weevils

1. Timing of events and the primary driver

Wilson et al. (2007) conclude that whilst there was a decline in water hyacinth during the first half of 1998, the cover increased in the latter half and not until 1999/2000 did the major reduction occur. As weevils were first introduced in December 1995, 4 years earlier, the collapse was attributable to them.

Lake Victoria is the second largest lake in the world and to condense the system into a single graph is an over simplification of the spatial complexity. Moreover, any synchronicity across such a large waterbody is unlikely to occur at the biological scale unless some overriding metascale process controls it. We thus redrew the satellite data published in Albright et al. (2004) for the three (Uganda, Kenya and Tanzania) main areas of Lake Victoria (Fig. 1). Irrespective of when weevils were introduced, a rapid reduction in water hyacinth occurred synchronously over the lake during the second quarter of 1998. During the latter half of 1997 and first half of 1998, the largest El Niño event recorded this century (McPhaden, 1999; Anyamba et al., 2001) occurred.

Following the El Niño, water hyacinth cover across Lake Victoria varied (Fig. 1). Whilst the majority of Lake Victoria is relatively open the Winam Gulf in Kenya is a confined and sheltered region. The above normal rainfall during the El Niño resulted in flooding across eastern Africa (Birkett et al., 1999; Anyamba et al., 2001) and Lake Victoria rose by 1.70 m (Albright et al., 2004). Stable shoreline water hyacinth stands became dislodged and surrounding rivers and wetlands flooded. Water hyacinth was thus washed into the lake (Fig. 1). Albright et al. (2004) provides evidence for this: "1998 field observations revealed that large floating mats of water hyacinth also included opportunistic native plants such as hippograss and papyrus growing on top of the water hyacinth". These assemblages characterise normally grounded water hyacinth mats from delta and shoreline habitats. Indeed a similar El Niño event in 1962/1963 resulted in the loss of wetlands around Kenya (Gichuki et al., 2001).

In the main lake wave action likely resulted in the majority of this newly introduced material being destroyed (Albright et al., 2004). However, within the sheltered gulf this influence

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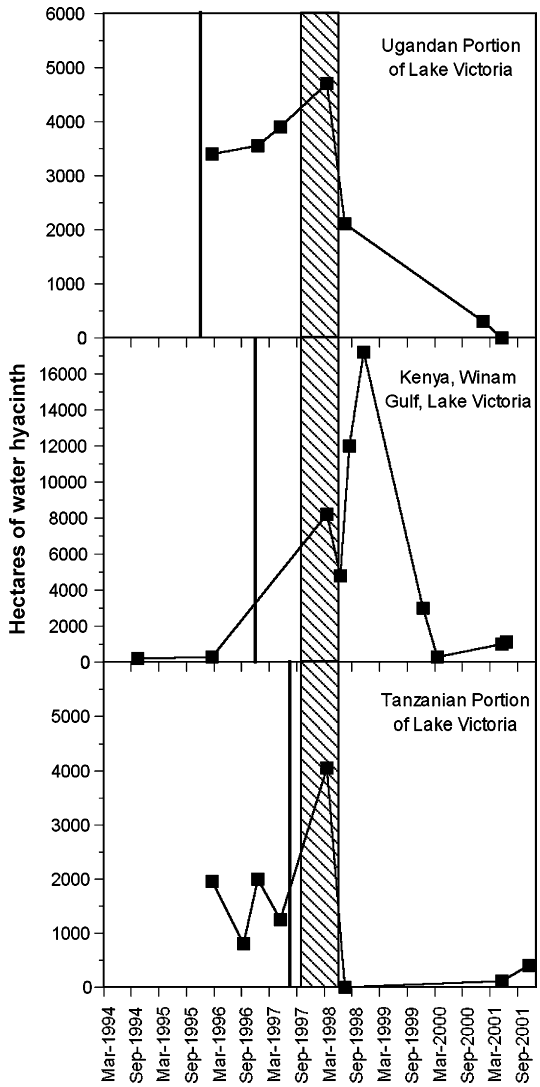

Fig. 1. Hectares of water hyacinth cover across different areas of Lake Victoria over time. The solid line indicates the timing of the introduction of weevils into the area and the hatched section covers the period of the 1997/1998 El Niño (based on Albright et al., 2004).

was likely reduced. Water hyacinth mats may also have been washed into Winam Gulf from the main lake during the El Niño further compounding the observed differences (Albright et al., 2004). Weevils that had been introduced pre El Niño together with those released subsequently (Mailu et al., 1999) were likely responsible for the decline that then occurred in the gulf post El Niño (Fig. 1).

The impact of *Neochetina* spp. weevils on water hyacinth is widely published and they have been used successfully throughout the world (Julien et al., 1999). We do not dispute this or claim that the El Niño was solely responsible for the reduction in water hyacinth. What we maintain is that ‘‘the introduction of weevils into Lake Victoria has had an impact on water hyacinth populations but the wet and cloudy weather of 1997/1998 almost certainly played a major part by accelerating the decline through direct effects’’ (Williams et al., 2005).

2. Light climate, combining factors and experimental design

Wilson et al. (2007) believe it is highly unlikely that cloudy weather could explain the massive reduction in water hyacinth and that there is no substantive link between low light levels and plant mortality.

We do not suggest that a reduced light climate alone was responsible for the reduction but rather reduced incident light reduced the growth rate of a photosynthesising plant and that ‘‘light . . . can limit maximum growth throughout the entire lake’’ (Williams et al., 2005). In other words, a lack of light or rather low light levels does not cause instant mortality but rather prolonged sub-optimal light will reduce growth and reproduction rates and relatively increase the effect of other debilitating influences such as other weather related factors, e.g. water level, wave action, water quality, temperature and humidity as well as weevil herbivory and phytopathogenic attack (Albright et al., 2004; Williams et al., 2005; Wilson et al., 2007).

As suggested by Wilson et al. (2007), we did undertake experiments on water hyacinth growth *in situ* within floating enclosures. One of our aims, however, was to develop a rapid method for comparing relative growth potential of plants from different stands and so identify future problem areas around the lake. We maintain that the single plant approach was ‘fit for purpose’ as seen in Fig. 3 of Williams et al. (2005).

3. Weevil stability and water hyacinth resurgence

Wilson et al. (2007) believe that our concern over potential resurgence is unfounded largely because biocontrol is sustainable through population regulation.

The eventual level of control can only be understood by knowing how the control agents’ populations are regulated (Dent, 2000). Changes in plant quality can affect the efficiency of weevils and a rapid deterioration of plants can lead to an early decline in weevil populations. Indeed, severe leaf damage can kill eggs and young larvae and can have a disproportionate effect on subsequent control such that plants can recover (Center et al., 1999). This usually occurs in the sub-tropics where water hyacinth growth is seasonal rather than continuous as it is in Lake Victoria. However, the sudden ‘crash’ in 1998 would have been similar to that seen in seasonally controlled environments with the sinking plants taking with them weevil eggs, larvae and pupae (Ogwang, 2001; Wilson et al., 2007). Thus, in accordance with the basic tenants of biocontrol (Huffaker and Messenger, 1976), unstable host populations may well lead to unstable controlling herbivore populations.

Following the synchronous collapse of the water hyacinth community, the few remaining weevil populations would not have been in a natural state of flux (Ogwang, 2001). Moreover, the potential for augmentation was limited at that time because many of the rearing pools around Lake Victoria were neglected with almost no weevils present (A.E. Williams, personal observation). As a result, a small increase in water hyacinth cover was seen during 2000/2001 (Ogwang, 2001; Albright et al., 2004; Ogwang and Molo, 2004). This was attributed to the germination of the old seed bank. However, we do not suggest that control could not be exerted by weevils. Indeed, the remaining low levels of water hyacinth are likely as a result of them although it should be noted that weevil densities were still low up to at least 2002 (Ogwang and Molo, 2004; Albright et al., 2004). Moreover, recent resurgence reports from the River Kagera (EAS, 2005) are of concern because weevils have never become established within the river systems around Lake Victoria (Ogwang and Molo, 2004) and as such incoming material must be infested with weevils from within the lake before biocontrol can take affect.

Overall biocontrol should not be taken for granted and regular monitoring should be undertaken. We concur with Wilson et al. (2001) that ‘‘understanding the conditions under which weevils are not successful is a key area of research’’ especially with respect to Lake Victoria because, as they suggest, the efficiency of weevils may be less effective in very large waterbodies than smaller ones.

4. Conclusion

We agree that further work is required to monitor water hyacinth and weevil populations within Lake Victoria. We agree that biological control should be an integral part of the future management of Lake Victoria. We agree that without weevils the reduction in water hyacinth may not have been as dramatic is it was. However, we have clearly demonstrated that the synchronous, lake wide reduction of water hyacinth in 1998 was unequivocally a result of the El Niño which affected vegetation in numerous ways across the whole of eastern Africa (Anyamba et al., 2001). As such the El Niño associated weather pattern has not ‘‘confused the issue’’ but rather nature is complex, it is only humans who are confused.

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