This certainly applies to $\delta^{18}O$ in Greenland, which exhibits a 20 per mil seasonality but a maximum long-term change on the order of 8 per mil. The magnitude of this effect can be seen if one compares the mean annual temperature (T_m) at Jakobshavn, Greenland, with the "precipitation-weighted" temperature (Fig. 1A):

$$T_{\text{weighted}} = \int_0^{1\text{ year}} T_t \dot{C}_t dt \Big/ C_{\text{annual}}$$

where T_t and $\dot{C}_t$ are the temperature and accumulation rate, respectively, at time t. Even small changes in precipitation lead to a difference of several degrees Celsius between T_m and T_{weighted}. At Summit, Greenland, $\delta^{18}O$ more closely tracks T_{weighted} than T_m.

A potential problem with attributing $\delta^{18}O$ shifts to changes in moisture source distribution is that the mechanisms required (for example, orographic steering by the Laurentide ice sheet) do not occur as rapidly as some observed $\delta^{18}O$ anomalies. On the other hand, plausible rapid changes in North Atlantic sea surface conditions (such as extent of sea ice) could cause significant changes in the subannual distribution of precipitation events.

Many of the artifacts that would be introduced into the ice core record because of changes in the location of moisture source regions would also result from changes in precipitation seasonality. For example, an increase in deuterium excess values (d), which could be interpreted as indicative of a change in source region sea-surface temperature or humidity, would also result from an increase in the ratio of summer as opposed to winter accumulation, because d exhibits a marked seasonal cycle with a late summer peak.

At present, anomalies in Greenland ice core records should not be interpreted solely in terms of source region variations. On the other hand, the emphasis by Charles *et al.* on the need for a multidimensional perspective in the interpretation of ice cores is important. The combined use of $\delta^{18}O$, δD, and ionic species in the new Summit, Greenland, cores, should make it possible to answer empirically some of the questions raised by GCM experiments as to the interpretation of $\delta^{18}O$ records in terms of temperature.

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Maximum Parasitism Rates and Successful Biological Control

Recently, B. A. Hawkins *et al.* (*1*) tested the refuge hypothesis (*2*) and found that maximum parasitism rates following release of parasitoids in exotic locations (an estimate of the host's refuge) were positively associated with successful control of insect pests. In a reply to criticisms by Myers *et al.* (*3*) and Williams and Hails (*4*), Hawkins *et al.* (*5*) further suggested that according to the hypothesis, maximum parasitism in a host's native region should also be associated with the ability of introduced parasitoids to depress host densities in exotic locations.

We tested this by documenting maximum parasitism rates within the native ranges of 58 species that were pests in exotic locations where they were subjected to biological control by means of parasitoid introductions (*6*). We found that the probability of successful control significantly increases with the maximum parasitism rate within the host's native range (Fig. 1). The substantial scatter around the regression line indicates that the probability of successful control is affected by other factors as well, including climatic and ecological differences between native and exotic locations and idiosyncrasies in the protocols followed for each parasitoid introduction (*2*–*4*). Despite these complications, maximum parasitism rate in native locations still provides a significant measure of the ability of parasitoids to depress host densities below economic injury levels when both hosts and parasitoids are exotic. We also note that there is a threshold for success; no control was achieved for any pest suffering less than 32% maximum parasitism in its native range (Fig. 1). A similar threshold between 33 and 36% was found for maximum parasitism rates in exotic locations (*1*). Consequently, successful biological control can be predicted in part by a relatively simple measure of a host's susceptibility to attack in either native or exotic locations.

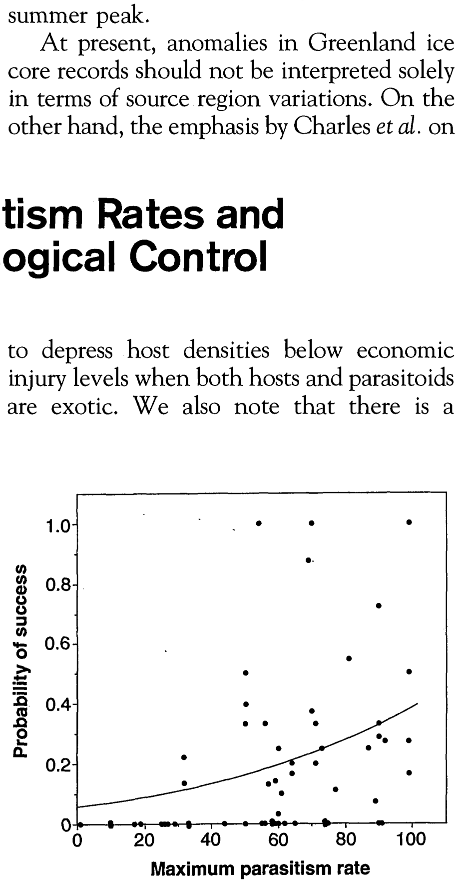

Fig. 1. Relation between maximum percentage parasitism within a host's native range and the probability of success for biological control in exotic locations. Maximum percent parasitism was tested against the number of successes (partial, substantial and complete pooled), weighted by the total number of attempts that have been made against each pest (failures + successes; 787 total introductions against all pest species). Analysis followed the protocols in the GLIM statistical package and was conducted by M. J. Crawley, Silwood Park. The line is described by $\text{logit}(y) = \ln(p/q) = -2.737 + 0.023x$, $\chi^2 = 12.11$, $df = 1$, $P < 0.001$.

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6. Maximum parasitism rates included attack by the entire parasitoid fauna and were obtained from primary literature sources and compilations of biological control projects. Outcomes of parasitoid introductions were obtained from the BIOCAT database, compiled by the CAB International Institute of Biological Control, Silwood Park, United Kingdom. The data and sources are available upon request.

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