WEEDS - THE MEDITERRANEAN CONNECTION

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Summary. The five regions of the world sharing a climate like that of the Mediterranean Basin have exchanged, and continue to exchange, weedy plant species. This exchange is seen to be of two forms: an earlier primary invasion of the other four regions by aggressive annual weeds from the Mediterranean Basin, and later secondary invasion by woody species, often between the four regions and from them back to the Mediterranean Basin. Of the woody invaders two interesting groups are the conifers and the succulents. There is also a tertiary invasion within each of the mediterranean regions of native species that have become more invasive as a result of human disturbance.

INTRODUCTION

The five regions of the world sharing the mediterranean-type climate, the Cape region of South Africa, southern Australia, Chile, California and the Mediterranean Basin, are widely spaced on separate continents. To a large extent the biotas of the five regions have evolved from different evolutionary precursors (16). There is however considerable convergence in form and function of the regions' biotas (5, 6, 7, 12).

The Mediterranean Basin has been the source of many invasive organisms that have now become naturalised in the other regions, and subsequently there has been limited but continuing exchange of organisms between all five regions. Some authors have dealt with the Mediterranean Basin as a major source of adventive plants (3, 4, 19, 22). Others have studied one or a subset of the five regions, often compared with the Mediterranean Basin (Israel - California, 15; California - Chile, 5, 16; California, 2; Chile, 18; South Africe - Mediterranean 23; Australia - other regions 10, 11). A recent review has investigated the exchanges of invasive plants between all five mediterranean regions of the world (8).

HISTORY OF INVASIONS

Chile. In the 16th Century the Spaniards began their conquest of South America and first began settling Chile in the late 1530's, establishing Santiago in 1541. The tendency then to introduce crops from one holoclimate to the other was a natural corollary of settlement. Both the crop plants, and the weed seed mixed with them, would have found environmental conditions and the absence of their usual predators, ideal for vigorous growth. The fact that there was early massive invasion by Mediterranean annuals 916) is not surprising. These annuals had already been sieved by more than 10,000 years of association with human activities in the Mediterranean Basin.

South Africa. The second of the mediterranean regions to be explored and settled by Europeans was the Cape Region of South Africa in 1650. However, it was settled by Dutch and other northern Europeans who attempted to implement their practices of agriculture and farming. They did begin growing grapes, and recognised the climatic analogy with the Mediterranean, but the subsequent rate and degree of invasion may have been very different had the Cape been settled by the Spaniards.

California. Whereas California had been discovered in 1542 by the Spaniards, they only began settling the mediterranean region of North America at about the time eastern Australia was discovered by James Cook in 1770. The first of a series of missions was established in San Diego in 1769 and settlement was confined to the mission areas until 1824. The Gold Rush of 1848 saw a rapid increase in population and a concommitant increased demand for food crops (13). Not only was the pattern of invasion by annuals from the Mediterranean Basin repeated there (1), but because of trade and other contact between the two Americas, there was secondarily the exchange of some Chilean and Californian species (16). Raven (16) reports that there are 130 important herbaceous species in common, and the most abundant ones are the 'European' weeds.

An analysis of the Californian weed flora (17) indicates that of 674 introductions, 559 are from the Old World. Of the 115 New World species, most come from temperate North America and tropical America; only 38 species are from South America and some sub-set of those would be Chilean.

Southern Australia. The last of the mediterranean regions to be explored and settled by Europeans was southern Australia in 1828 but, as with South Africa, these settlers came principally from northern Europe. However, not only did Australia receive Mediterranean weeds indirectly from British sources, but the fairly rapid expansion of vines in S.A. and the expansion of wheat and sheep industries promoted contacts with Mediterranean countries. Very soon, by accident (such as with skeleton weed, *Chondrilla juncea*, or design (such as the improvement of pastures with subterranean clover, *Trifolium subterraneum*) (14), many plants of Mediterranean origin were naturalised in southern Australia. Specht (20) has analysed the weed flora (654 species) of S.A. (the settled part of which is mediterranean) and found that 32% came from the Mediterranean Basin, 13% from South Africa, 5% from Chile and 4% from California.

TYPES OF INVASION

Primary Invasions. There are interesting patterns of invasion in each region, but in every case the initial wave of invasions is of annual weeds from the Mediterranean Basin to the other regions. Even in the Baja California which has had less than 100 years of human occupation there is an invasion by the Mediterranean annuals (G. Long, pers. comm., 1986). This might be considered the primary level of biotic invasions.

Secondary Invasions. There is a second level of invasion, that of perennial (woody) weeds and this is apparently stronger between the four other mediterranean regions, and from them back to the Mediterranean Basin. For example, in the Cape region of South Africa there is a serious problem caused by introduced woody plants from Australia.

The Mediterranean Basin is relatively rich in conifers compared to the other mediterranean regions. Conifers are virtually absent from the floras of the three southern regions. Interestingly it is to these three that the Monterey pine, *Pinus radiata*, from California has become a problem. The black pine, *Pinus pinaster*, and the Aleppo pine, *Pinus halepense*, from the Mediterranean Basin, have invaded the Cape Region of South Africa. Monterey cypress, *Cupressus macrocarpa*, from California is also naturalised in the Cape Regions (21).

Tertiary Invasions. The third level of biological invasions are those occurring within each mediterranean region e.g. within the Mediterranean Basin

there is considerable movement from east to west, and less from north to south; from northern Mexico into California and within California; there are also some examples of east-west invasions within mediterranean Australia; and local movements in South Africa.

Some representative examples of the invasions are illustrated in Fig. 1.

FUTURE INVASIONS

The prognosis for the future of invasions in the mediterranean regions is for an increase in "community" weeds, plants finding unexploited resources in disturbed communities (9). These are more insidious and are often "woody" weeds of the secondary invasion. These cannot be managed with herbicides, they require modification of management practices such as the use of fire -- especially in areas where the maintenance of a natural community is highly desirable.

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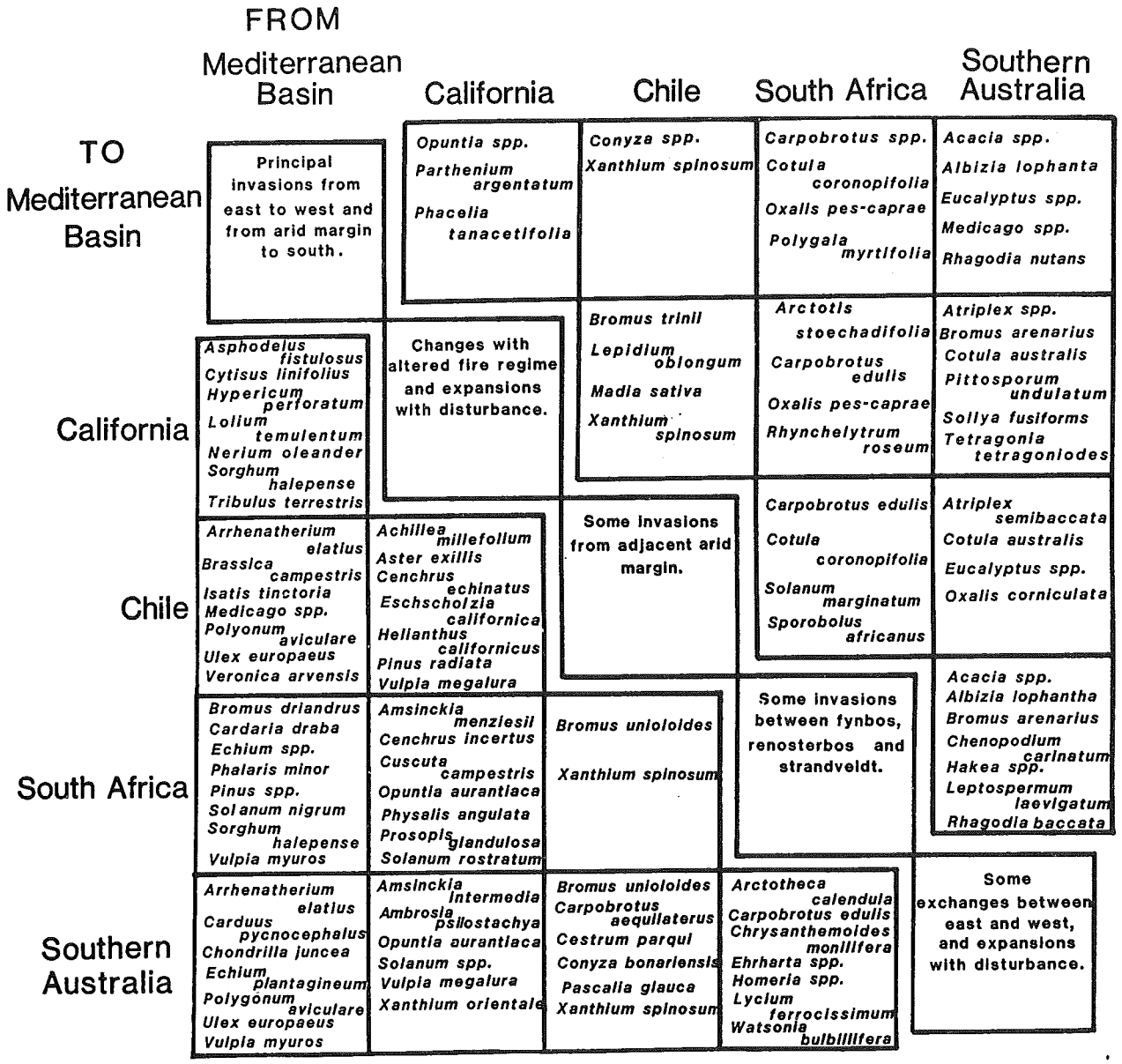

Figure 1. Representative examples of invasive species from each of the five Mediterranean regions to the others. The diagonal entries refer to tertiary invasions within each region.

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