Reprinted with permission from: Proceedings VII International Symposium Biological Control Weeds, 6-11 March 1988, Rome, Italy. Delfosse, E.S. (ed.). 1st Sper. Patol. Veg. (MAF), pp. 417-24 (1989).

The taxonomy of North American leafy spurge

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Abstract

Leafy spurge comprises some 78 Eurasian taxa including 15 hybrids. The six commonest species of the group, and those whose hybrids are well-documented, are *Euphorbia agraria*, *E. cypatissias*, *E. esula*, *E. lucida*, *E. salicifolia* and *E. waldsteinii.* Some of the hybrids found in North America are not necessarily the same as those which occur in Europe, primarily for geographical reasons. Illustrations of 12 taxa including five hybrids, are presented and discussed, and mention is made of six further taxa for which no illustration was available.

Introduction

What has been called leafy spurge comprises an aggregate of some 78 Old World taxa ranging more or less throughout Eurasia. Some fifteen of these are hybrids involving component species of the aggregate. The largest number of species in the aggregate is found in central and eastern Europe, with particular concentrations along the middle and lower reaches of the Danube and eastwards through southeastern Romania into the Ukraine.

The six commonest species, and those best-documented with regard to hybridization, are *Euphorbia waldsteinii* Sojàk (better-known as *E. virgata* Waldst. & Kit.), *E. cyparissias* L., *E. esula* L., *E. salicifolia* Host, *E. lucida* Waldst. & Kit. and *E. agraria* M. Bieb. Croizat (1945) considered these six species, together with some of their allies, which have been variously regarded either as varieties of these six species or as distinct species in their own right, are the chief representatives of the aggregate either to be found or else to be expected to occur as adventives in North America.

According to Moore (1958), the *E. esula* and *E. cyparissias* hybrids which are found in North America may or may not be such as arise in Europe, since members of the leafy spurge aggregate may have opportunities to hybridize in North America which are denied

them in their native locations, since in the former, populations may be brought into juxtaposition which are separated from each other by geographical barriers in the latter. However, from my own investigations, the pattern of hybridization in North America is substantially similar to that which is found in Europe.

Photographic analysis of the aggregate

Photographs of herbarium specimens of members of the aggregate which have been introduced into southern Canada were supplied by the Biosystematics Research Institute, Ottawa (Figs. 1-14).

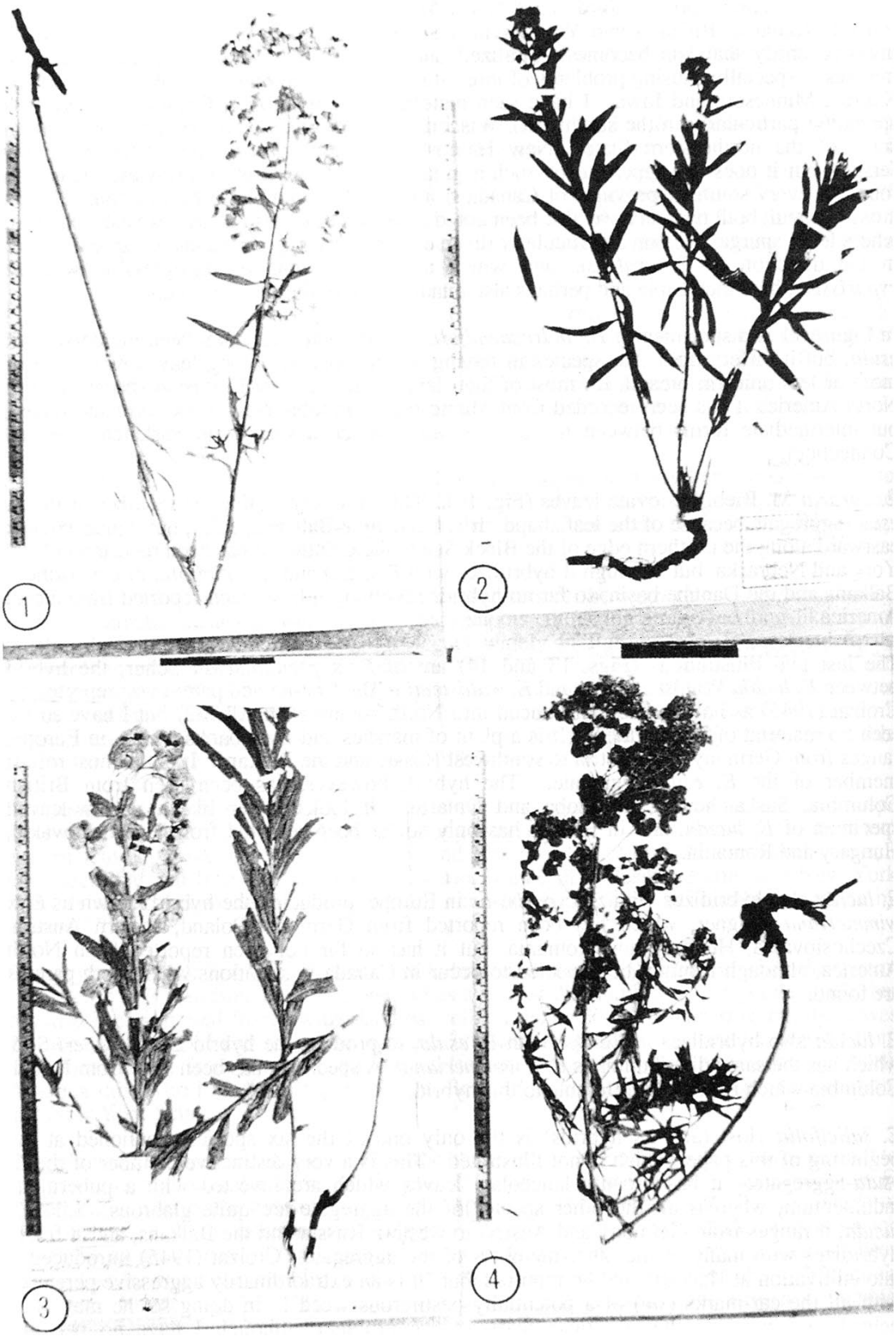
Figure 1 is a specimen which conforms well to the type of *E. waldsteinii.* Material of this has been seen from right across southern Canada from British Columbia to Ontario, as well as from the USA from Oregon, Montana, Wyoming and Connecticut. It differs from its widespread hybrid with *E. esula* chiefly in having somewhat broader cauline leaves that are broadest below the middle and more or less rounded at the base. Although widespread, it does not appear to be as serious a pest as the hybrid. Specimens from Manitoba and South Dakota show signs of introgression with *E. esula*, but possibly some generations back. In Saskatchewan, intermediates between *E. waldsteinii* and *E. boissieriana* (Woron.) Prokh. are found, and in Manitoba between *E. waldsteinii* and *E. uralensis* Fisch. ex Link. *E. waldsteinii* is native to central and southeastern Europe, the northern Caucasus and western Siberia.

At the top right (Fig. 2) is a specimen which I have determined as *E. boissieriana* (Woron.) Prokh. This species, which was first of all described as a variety (var. *orientalis*) of *waldsteinii* by Boissier (De Candolle 1862), is native to southwestern Asia, and was first recorded in North America by Croizat (1945) on the basis of specimens from Connecticut. It has subsequently turned up in Washington, Oregon, British Columbia and Saskatchewan, and is possibly also in Ontario. It is more robust than *E. waldsteinii*, and has broader leaves of a different outline.

Figures 3 and 4 are of specimens which I have determined as a hybrid between *E. boissieriana* and *E. esula,* a hybrid which, as far as is known, has not been reported for Eurasia, but which has been recognized amongst material from British Columbia, Saskatchewan, Ontario and Iowa, and it possibly also occurs in Manitoba and North Dakota. It is somewhat reminiscent of *E.* x *pseudovirgata*, the hybrid between *E. waldsteinii* and *E. esula*, but with generally broader leaves.

Figure 5 is *E. uralensis* Fish. ex Link. This species ranges from southern Russia across to western Siberia and central Asia, and it is characterized by its very narrow, elongate and sharply acute cauline leaves. Specimens of this have been seen from Idaho, Wyoming, Colorado and Kansas, as well as from Ontario.

Perhaps one of the most readily-recognizable members of the aggregate, *E. cyparissias* L., with its characteristically densely leafy axillary shoots conferring a pine-seedling-like aspect on the plant, is shown in Figure 6. It occurs widely in Europe from France and Spain eastwards to south European Russia and the Balkans. It has been introduced into northern Europe, and in the New World is more of a problem in Canada than in the USA, especially in



Figures 1-4. *Euphorbia* spp. from herbarium specimens provided by the Biosystematics Research Institute, Ottawa.

eastern Canada. Moore and Pritchard (1960) and others showed that two forms occurred: a fertile tetraploid and a male-sterile diploid. These are morphologically indistinguishable except for differences in the size of the leaf-epidermal cells.

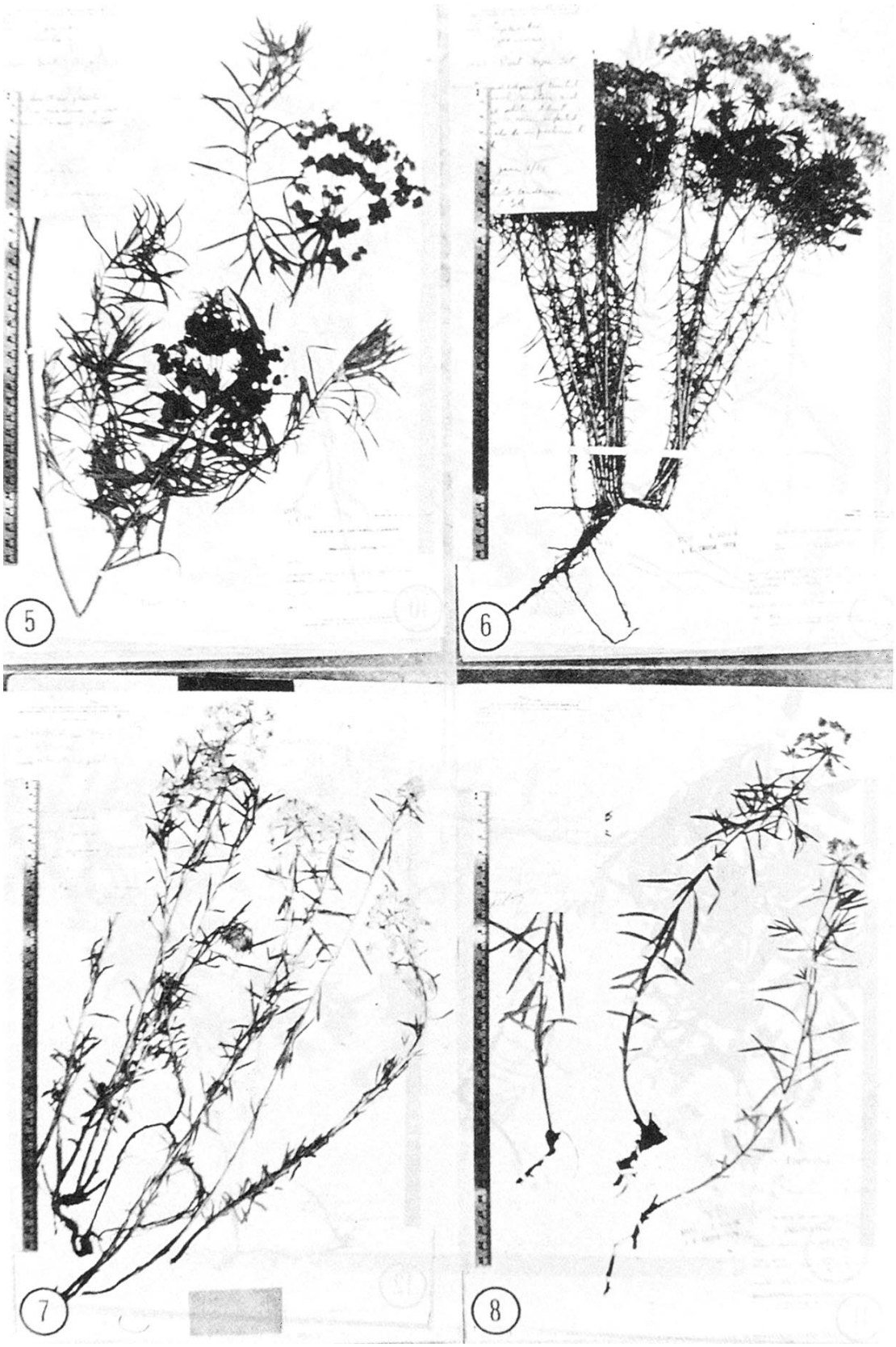
E. x *pseudoesula* Schur (Fig. 7), is a hybrid between *E. cyparissias* and *E. esula.* In Europe this hybrid has been reported as occurring along waterways in eastern Germany, northern and eastern Austria, Czechoslovakia, Hungary and Romania. In North America collections, I have seen material from Saskatchewan, Ontario, Minnesota, Massachusettes and New York State. It is also known as *E.* x *figerti* Dörfl., and has been raised artificially in Canada by Moore (1958).

E. x *gayeri Boros* & Soó (Fig. 8) is another hybrid involving *E. cyparissias.* The other parent in this case is *E. waldsteinii.* In Europe, it has a similar distribution to *E.* x *pseudoesula,* but has also been reported from Switzerland as well. It resembles *E. cyparissias*, but the leaves are not parallel-sided and they taper towards and acuminate apex, a character derived from the other parent, from which latter they differ in being somewhat narrower. In North America this hybrid has been reported from British Columbia, Manitoba, Ontario, Vermont and New York State.

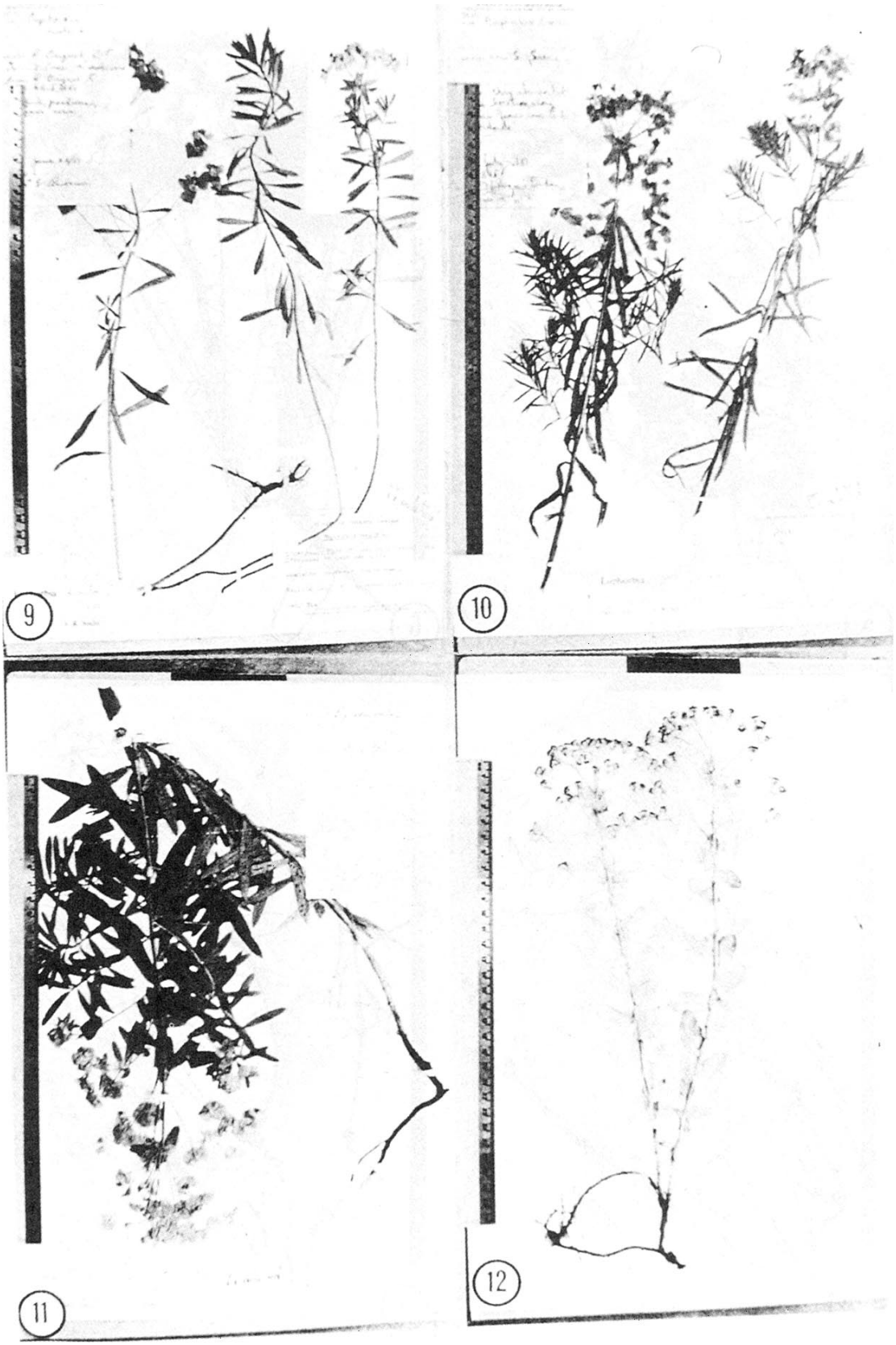
E. esula itself is portrayed in Fig. 9. Note the characteristically oblanceolate leaves tapered to the base and obtuse at the apex. In Europe, *E. esula* has much the same distribution as *E. cyparissias.* This name has sometimes been applied in the literature to cover the whole of leafy spurge in North America, but as Croizat (1945) and others have shown, this is far too simplistic an assessment of the situation. In the restricted sense, however, *E. esula* has been verified as having been introduced into Alberta, Saskatchewan, Ontario, Idaho, Wyoming, Colorado, Minnesota, New York and New Jersey, but records from British Columbia, Manitoba, Quebec and Nova Scotia undoubtedly refer to the hybrid with *E. waldsteinii.* I have seen material of *E. esula* from Manitoba, Nova Scotia and Ontario showing signs of introgression with *E. waldsteinii.*

The hybrid with *E. waldsteinii* is shown in Fig. 10. This is *E.* x *pseudovirgata* (Schur) Soó, and it is widespread both in Europe and North America. In Europe it occurs from Britain to Poland, Romania, Bulgaria and Yugoslavia, whilst in North America it is the aggressively invasive entity that has become naturalized and has spread so rapidly in the American midwest, especially causing problems of infestation in Montana, both the Dakotas, Nebraska, Kansas, Minnesota and Iowa. I have seen material from Wyoming, Colorado (where it is spreading particularly in the southwest), Wisconsin and Michigan. It has also turned up in some of the northeastern States (New Hampshire, Massachusetts, New York and New Jersey), but it does not appear to be such a great pest there as it is further west. It is also found in every southern province of Canada from British Columbia to Nova Scotia. Backcrossings with both parents have also been noted from some of these areas. In Saskatchewan, where leafy spurge takes on a particularly diverse set of guises, populations occur which veer in the direction of *E. uralensis* and which also show signs of introgression with *E. cyparissias*; here then triple and perhaps also quadruple hybrids seem to occur.

In Figure 11 is a specimen of *E. androsaemifolia* Willd. This has often been included in *E. esula*, but it differs from that species in having much broader, oblong leaves which are of more or less uniform breadth for most of their length. It is a west European species, and in North America it has been recorded from Minnesota, Manitoba, New York and New Jersey,



Figures 5-8. *Euphorbia* spp. from herbarium specimens provided by the Biosystematics Research Institute, Ottawa.



Figures 9-12. *Euphorbia* spp. from herbarium specimens provided by the Biosystematics Research Institute, Ottawa.

Figures 13-14. ***Euphorbia*** **spp. from herbarium specimens provided by the Biosystematics Research Institute, Ottawa.**

but intermediate forms between it and *E. esula* have been seen from Saskatchewan and Connecticut.

E. agraria M. Bieb. has ovate leaves (Fig. 12). This is a very distinctive member of the *E. esula*-aggregate because of the leaf shape. It is basically a Balkan species, but it also extends eastward along the northern edge of the Black Sea to the Crimea. It has been reported in New York and Nebraska, but although it hybridizes with *E. esula* and *E. salicifolia* in the northern Balkans and the Danube basin, so far no hybrids involving it have been reported from North America.

The last two illustrations (Figs. 13 and 14) are of *E.* x *pseudolucida* Schur, the hybrid between *E. lucida* Waldst., & Kit. and *E. waldsteinii.* The first-named parent was reported by Croizat (1945) as having been introduced into North America (in Alberta) but I have so far seen no material of it from there. It is a plant of marshes and river banks which, in Europe, ranges from Germany and Austria to southwest Russia and the Balkans. It is the most robust member of the *E. esula*-aggregate. The hybrid, however, has been seen from British Columbia, Saskatchewan, Manitoba and Ontario. It looks rather like a narrow-leaved specimen of *E. lucida,* and in Europe has only so far been reported from Czechoslovakia, Hungary and Romania.

E. lucida also hybridizes with *E. cyparissias* in Europe, producing the hybrid known as E. x *wimmeriana* Wagner, which has been reported from Germany, Poland, eastern Austria, Czechoslovakia, Hungary and Romania, but it has so far not been reported from North America, although it might be expected to occur in Canada in situations where both parents are found.

E. lucida also hybridizes in Europe with *E. esula*, to produce the hybrid *E. x wagneri* Soó, which has the same distribution as *E.* x *wimmeriana.* A specimen has been seen from British Columbia which is possibly referable to this hybrid.

E. salicifolia Host (and its hybrids) is the only one of the six species mentioned at the beginning of this paper which is not illustrated. This is a very distinctive member of the *E. esula*-aggregate: it has broadly lanceolate leaves which are invested with a puberulous indumentum, whereas all the other species of the aggregate are quite glabrous. Like *E. lucida*, it ranges from Germany and Austria to western Russia and the Balkans, and it freely hybridizes with many of the other members of the aggregate. Croizat (1945) introduced it into cultivation at Harvard, and he reported that "it is an extraordinarily aggressive perennial with all the ear-marks (*sic*) of a potentially pestiferous weed"! In doing so, he may have helped to compound the American leafy spurge problem, although I have no personal knowledge of the subsequent history of that introduction, if any.

The hybrid between *E. salicifolia* and *E. waldsteinii* is *E.* x *angustata* (Roch.) Soó, which has been reported from Hungary and Romania; between *E. salicifolia* and *E. cyparissias* is *E.* x *peisonis* Rech. f., reported from Austria, Hungary and Romania; and between *E. salicifolia* and *E. esula* is *E. x paradoxa* (Schur) Podp., from Austria, Czechoslovakia, Hungary and Romania. Of all the members of the *E. esula*-aggregate, only this latter hybrid is, apart from *E. cyparissias*, considered to have any horticultural merit, but so far, I have not seen any specimen indicative of its having been introduced into North America.

Conclusion

In conclusion, the leafy spurge problem is a complex one, and so this involved taxonomic situation must be borne in mind when it comes to testing possible agents for biological control programmes.

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