

Phytogeographical analysis of the flora of Belgrade lawns

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Abstract. The cultivated grass-covered lands in Belgrade (in the parks, residential areas, business premises and roadsides) were analysed and 314 different plant species were identified. Their phytogeographical analysis points to the dominance of floral elements of the Holarctic type, with a high presence of cosmopolitan and adventive species. The high degree of compatibility of the chorological structure of Belgrade lawns and the structure of the total ruderal flora in Belgrade indicates, *inter alia*, the tendency of transformation of grasslands into ruderal habitats.

Key words: Belgrade, lawns, phytogeographical analysis

Introduction

Lawns are the component parts of almost all green spaces. In some cases only lawns represent green spaces. Many scientists, landscape architects and horticulturists study and analyse the lawns from different aspects. They all describe them as a substrate or medium which, unlike any other, suits the human feet best, whether for work or for active or passive recreation. Consistently green expanse of the lawns is agreeable to the eye and makes landscape enjoyable to man. In addition to their aesthetical properties, lawns are even more significant with their soil-fixing and erosion-suppressing function, as well as by enabling the further anchoring of soil by trees and shrubs. The erosion-control function of the lawns is significant both in non-urban and urban districts. Lawns also play a very significant reclamation role in the accumulation and purification of waste water, accumulation of heavy metals, reduction of temperature and noise, etc. (Anastasijević 1987; Anastasijević & Vratuša 1999).

As component parts of rural, suburban and urban landscapes, lawns have a special place in landscape architecture and amenity horticulture. The special purpose of grass-covered land determines the function of the lawn, while its functionality depends on the structure of each individual type of lawn. Lawns in Belgrade are maintained with five basic species (*Poa pratensis*, *Lolium perenne*, *Festuca rubra*, *F. pratensis*, *Trifolium repens*). Of course, all cultivated plants that develop spontaneously in the lawns are classified as undesirable, i.e. weed species.

The soil of green spaces in Belgrade is mostly anthropogenised and therefore it is difficult to distinguish a soil type when dealing with urban green spaces. Still, the mechanical properties of the upper soil layers can be characterised as favourable for the growth of grass, while chemical analyses show a relatively low humosity (Stavretović 1996), in contrast to the increased humosity observed on the ruderal sites of Belgrade (Jovanović 1994).

The analysis of lawns in urban spaces indicates clearly that those species, which can stand the culti-

vation and maintenance measures, can survive in the seeded and intensively maintained lawns. Also, the autochthonous plant species at a given site are much more successful in the urban environment in respect to growth, development and survival. The phytogeographical analysis of the lawn flora confirms the above statements (Stavretović & al. 1996).

Material and methods

This study includes the lawns in the narrower territory of Belgrade city. Several categories of grass-covered spaces are analysed: ornamental lawns, park lawns, lawns in the residential quarters, and roadside lawns. Most of the research was performed during the period 1996–2000, while part of the study of park lawns refers to the period 1992–1993 (Stavretović 1996).

Park lawns included in this study were investigated in ten Belgrade parks (76 localities). The lawns of residential green spaces were studied in ten urban settlements (62 localities). The analysed ornamental lawns were situated in front of and around eight business premises and four hotels (23 localities). The lawns studied along roadsides were divided into four types. The lawns of circular roads were investigated at four localities, the lawns of the median strips at seven localities, the lawns along roadsides at 11 localities, and the lawns along the large roadsides at 10 localities.

The identification of flora of Belgrade lawns is based on abundant literature (Hayek 1924–1933; Hegi 1926–1931; Tutin & al. 1964–1980; Jordanov 1963–1979; Josifović 1970–1977; Javorika & Czapody 1975; Velchev 1982–1989; Pignatti 1982; Sarić & Diklić 1986, etc.).

Floristic elements of the investigated ruderal flora are based on the phytogeographical division of the C. European flora proposed by Meusel & al. (1965, 1978, 1992). All adventive and cosmopolitan species are classified also according to their supposed natural range. Classification of floral elements into the basic area types relies on the formation principle of the floristic-vegetation plant-geographical zoning of Serbia (Stevanović 1992).

Results and discussion

Chorological analysis of the total flora of Belgrade lawns includes 314 recorded species. The species are

classified into seven basic groups and 18 subgroups according to the type of area range (Table 1). Holarctic area type is represented by 158 species (50.32 %) of the total flora of Belgrade lawns (Table 1, Fig. 1). Species of European-W. Asian type of distribution have been most abundant among them. These species form a nucleus of maintained lawn flora, as well as the entire ruderal flora of Belgrade (Jovanović 1994).

Table 1. Survey and percentage of the basic floristic area types and area groups in the study of Belgrade lawns

Distribution type (group)	(%)	n
Adventive	13,38	42
Cosmopolitan	15,29	48
Holarctic	50,32	158
European-West Asian subtype	27,39	86
Central European-Mediterranean-oriental-Pontic-South Siberian-Turanian-Central Asian	10,51	33
Central European-Mediterranean-Pontic-South Siberian	13,69	43
Central European-Pontic-South Siberian-Turanian	2,87	9
Central European-Mediterranean-oriental-Turanian	0,32	1
Eurasian	15,29	48
Eurasian-North American	4,46	14
Paleoholarctic-paleotropical	3,18	10
Mediterranean-Continental	12,1	38
Mediterranean-Pontic-South Siberian	3,82	12
Mediterranean-Pontic-South Siberian-oriental-Turanian	6,05	19
Mediterranean-oriental-Turanian	1,27	4
Mediterranean-Submediterranean	0,95	3
Central European-Mediterranean	5,09	16
Central European-Mediterranean-Submediterranean	3,18	10
Central European-Submediterranean	1,91	6
Central European	3,18	10
Central European	2,55	8
Atlantic-Central European	0,32	1
Central European-European Boreal-West Siberian	0,32	1
Pontic-South Siberian	0,64	2
Total:	100	314

The analysed lawns in Belgrade include 14 species (4.96 %) which, in addition to the Eurasian Continent, also inhabit the North American Continent. The most significant species of the circum-Holarctic area group is *Festuca rubra*, a highly ornamental species, usable and desirable in all types of lawns. Mention also deserves the species *Prunella vulgaris*, which is a good ground cover in shady and moister localities.

Another group of abundant species belong to the cosmopolitan (15.29 %) and adventive (13.38 %) elements of the flora of Belgrade, which indicates best the high anthropogenic effect, the degree of ruderal-

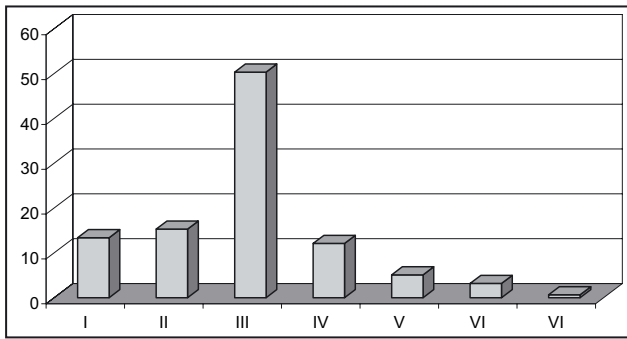


Fig. 1. Area spectrum of the total flora of Belgrade lawns: I – Adventitive; II – Cosmopolitan; III – Holarctic; IV – Mediterranean-Continental; V – Central European-Mediterranean; VI – Central European; VII – Pontic-South Siberian.

isation, and also the magnitude of ecological value of the representatives of these specific area types.

The Mediterranean-Continental area type holds the fourth position, with 38 species (12.1%). A somewhat lower percentage of Mediterranean-Continental plants, predominantly of thermo-xerophilous character, can be related to the maintenance measures and watering of the Belgrade lawns.

The Central European-Mediterranean area type is represented by six species (5.09%), while only 10 (3.18%) Central European species were recorded. The lowest number of representatives (only two species: 0.64%) belongs to the Pontic-South Siberian area type.

The structure of the dominant Holarctic area type comprises seven different area groups, among which the European-West Asian (27.39%) and Eurasian (30.38%) species predominate, forming together the basic chorological nucleus of the flora of Belgrade lawns. The European-West Asian subtype includes four groups of floral elements (Fig. 2, I-IV). The first group of floral elements within the above subtype is the Central European – Mediterranean – Oriental – Pontic – South Siberian – Turanian – Central Asian, which consists of 33 species (20.88%) of the total number of plants of the Holarctic area type. The significant species of this group are: *Ballota nigra*, *Hordeum murinum*, *Bromus sterilis*, *Poa bulbosa*, *Dactylis glomerata*, etc.

The Central European – Mediterranean – Pontic – South Siberian group is the most numerous group in the European-West Asian subtype, with 43 plant species (27.22%). The significant species of this group are: *Trifolium pratense*, *T. hybridum*, *Medicago falcata*, *Lamium purpureum*, including the good-quality grasses *Agrostis vulgaris*, *Festuca pratensis* and *Cynosurus*

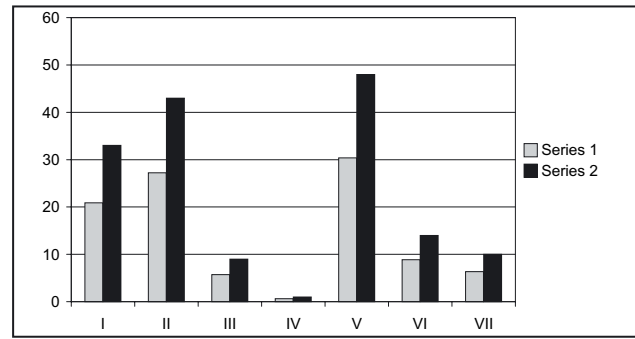


Fig. 2. Chorological spectrum of the Holarctic area type in the flora of Belgrade lawns:

I – Central European-Mediterranean-Oriental-Pontic-South Siberian-Turanian-Central Asian; II – Central European-Mediterranean-Pontic-South Siberian; III – Central European-Pontic-South Siberian-Turanian; IV – Central European-Mediterranean-Oriental-Turanian; V – Eurasian; VI – Eurasian-North American; VII – Paleoholarctic-Paleotropical.

Series 1 – percentage of plant species; Series 2 – numerical values.

cristatus, as well as the very efficient ground covers *Viola odorata*, *Erodium ciconium*, *Lysimachia nummularia*, *Geranium pusillum*, etc.

A significantly lower number of species belongs to the Central European – Pontic – South Siberian – Turanian group (9.7%). A noteworthy weed species in this group is *Geum urbanum*, while the other species are represented to a much lesser extent. The species *Thymus serpyllum*, with its characteristic low creeping growth, sticky flowers, and pleasant smell could be used for ground cover. The Central European – Mediterranean – Oriental – Turanian area group is represented only by the seedlings of *Acer campestre* observed under and near the crowns of the mother tree.

The Eurasian area group is represented by 48 species (15.29%), which cover different ranges of the geographical climatic zones. Among them, the best represented species belong to temperate to sub-meridional, i.e. meridional belts. This area group has only one good-quality grass (*Festuca ovina*) and a considerable number of useful ground covers (*Achillea millefolium*, *Ranunculus repens*, *Viola canina*, *V. tricolor*, *Fragaria vesca*, *Plantago lanceolata*). The majority of species in this area group belong to the category of weeds, which are absolutely undesirable in the lawns (*Rubus caesius*, *Inula britannica*, *Chenopodium glaucum*).

A detailed analysis of the structure of provenance of the cosmopolitan species, which have 48 representatives (15.29%) in Belgrade lawns, shows dominance of the species of Eurasian and Mediterranean origin (Fig. 3).

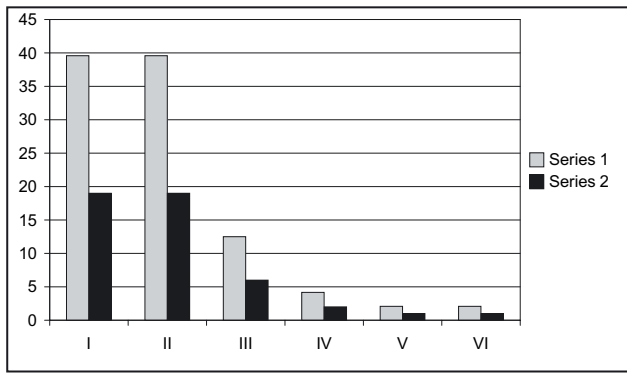


Fig. 3. Chorological spectrum of the cosmopolitan area types in the flora of Belgrade lawns:

I – Euroasian; II – Mediterranean; III – circum-Holarctic; IV – Tropical; V – European; VI – Paleoholarctic-Paleotropical. Series 1- percentage of plant species; Series 2- numerical values.

The cosmopolitan species of Eurasian origin include some especially good-quality lawn species, such as *Poa trivialis* and *Agrostis alba*. However, the number of undesirable weed species is much higher (*Agropyron repens*, *Taraxacum officinale*, *Cichorium intybus*, *Setaria glauca*, *Bilderdykia convolvulus*, etc.).

Among the cosmopolitan plants of Mediterranean origin is the chamomile (*Matricaria chamomilla*) applied in the layout of pharmaceutical lawns, while *Cynodon dactylon* is potential material for the protection of slopes, parts of roads, sandy terrains and the like. The other cosmopolitan species of Mediterranean origin on grass-covered terrains are classified as weeds, i.e. conditional weeds (*Bromus mollis*, *Lolium multiflorum*, etc.).

The cosmopolitan plants of circum-Holarctic origin are represented on the Belgrade lawns by six species, predominantly of ruderal-segetal character (*Poa annua*, *Setaria viridis*, *Plantago major*, etc.). Only two representatives of the cosmopolitan area types are of tropical origin, of which *Polygonum aviculare* is an especially significant and well-represented species. It can stand the most extreme contamination, treading, drought, and poor quality of soil in the urban environment.

A detailed analysis of the primary area of adventive species shows dominance of plants of the North American origin (Fig. 4). Of 14 representatives of North American origin altogether, Belgrade lawns comprise (mostly as seedlings or juvenile plants) the following introduced woody species: *Acer negundo*, *Acer saccharinum*, *Robinia pseudoacacia*, *Celtis occidentalis*, and a shrub species *Mahonia aquifolium*. There are also three ornamental species used in town landscaping and also in flower gardens (*Aster lanceolatus*, *A. novi-belgii*,

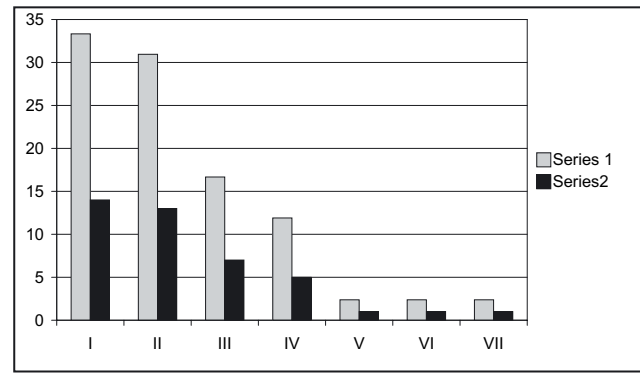


Fig. 4. Chorological spectrum of the adventive area types in the flora of Belgrade lawns:

I – North American; II – Asiatic; III – Mediterranean; IV – Pan-tropical; V – European; VI – Unknown descent; VII – Balkan. Series 1- percentage of plant species; Series 2- numerical values.

Tradescantia virginiana). The remaining species of the adventive North American origin are weeds that also invade the grass-covered areas (*Amaranthus retroflexus*, *Stenactis annua*, *Ambrosia artemisiifolia*, etc.).

A great number of adventive species is of Asian origin. Among them are also the seedlings and juvenile plants of a high number of introduced species of the phanerophyte life form, used in town landscaping (*Cotoneaster zabelii*, *Malus prunifolia*, *Buddleja davidii*, *Koeleruteria paniculata*, *Berberis thunbergii*, *Sophora japonica*, *Ailanthus altissima*). The majority of plants of Asian origin are cultivated plants. Along with the above-mentioned phanerophytes, there is also lucerne (*Medicago sativa*). Still, of all the adventive species of Asian origin, *Duchesnea indica* increasingly occupies the lawns and can be potentially applied as a good ground cover.

All the identified adventive species of Mediterranean origin are cultivated plants used in agriculture (*Triticum turgidum*, *T. aestivum*, *Onobrichys sativa*), fruit farming (*Prunus cerasus*), or in landscaping (*Cercis siliquastrum*, *Vinca major*, *Calendula officinalis*). Adventive plants of the pan-tropical origin are represented by five species, of which two are ornamental species used in town landscaping (*Symphoricarpos orbiculatus*, *S. albus*). The adventive species of European (*Vinca minor*), Balkan (*Aesculus hippocastanum*) and unknown origin (*Althaea rosea*) are also introduced ornamental plants.

The Mediterranean-Continental area type is represented by 38 species (12.10%) in the Belgrade lawn flora. It is differentiated into four area groups of floral elements claiming a major part of their range in the Mediterranean region, and extending more or less

deep into the continental (meridional-submeridional) regions of Europe and Asia (Jovanović 1997).

The best represented group is the Mediterranean – Pontic – South Siberian – Oriental – Turanian group with 19 species, or 50 % of the total number of species of this area type (Fig. 5). All representatives of this group are weeds or conditional weeds. The Mediterranean – Pontic – South Siberian group consists of 12 plant species, including some woody species, but also two species which could be used in the establishment of some types of lawns, for example, along the larger roads (*Myosotis arvensis*, *Salvia pratensis*). Only four species of the Mediterranean – Oriental – Turanian group are recorded. Among them, *Medicago arabica* is the most abundant, producing the most important lawn cover at several localities. The species *Trifolium patens* also has good properties and is one of the three representatives of the Mediterranean-Submediterranean group of this area type.

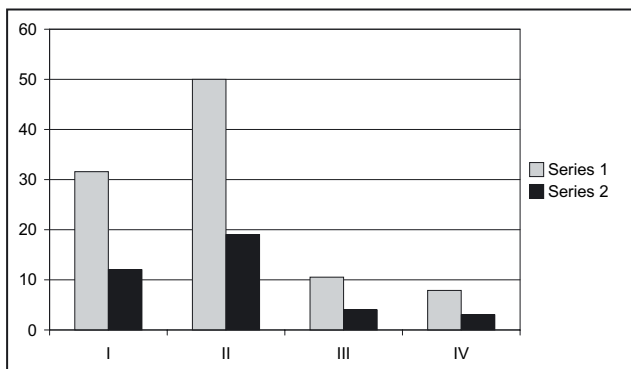


Fig. 5. Chorological spectrum of the Mediterranean-Continental area type in the flora of Belgrade lawns: I – Mediterranean-Pontic-South Siberian; II – Mediterranean-Pontic-South Siberian-Oriental-Turanian; III – Mediterranean-Oriental-Turanian; IV – Mediterranean-Submediterranean. Series 1 – percentage of plant species; Series 2 – numerical values.

The Central European-Mediterranean floral elements are represented by 16 species, or 5.09 % (Fig. 6). These species are predominantly distributed in the temperate climatic zone of the Central European region, with a pronounced tendency of spreading towards the more favourable mesophilous sites of the Submediterranean or Mediterranean. This group contains some very good and frequently applied ground covers (*Hedera helix*, *Ajuga reptans*, *Bellis perennis*), and also some potential ones (*Geranium molle*). It should be noted that in Serbia no spaces under ground covers, such as *Ajuga reptans* and *Bellis perennis*, are used or established. This group includes *Lolium per-*

enne, the most frequently used species for all types of lawns, as well as a species of artificial grassland, *Arrhenatherum elatius*, useful for roadside lawns.

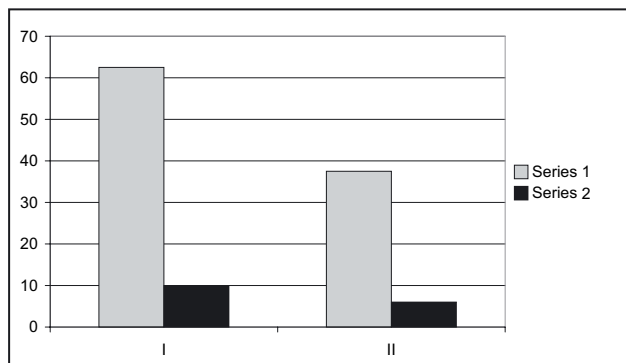


Fig. 6. Chorological spectrum of the Central European-Mediterranean area type in the flora of Belgrade lawns: I – Central European-Mediterranean-Submediterranean; II – Central European-Submediterranean. Series 1 – percentage of plant species; Series 2 – numerical values.

The Central European area type is represented by 10 species (3.18 %) (Fig. 7). Among them, the most significant species are *Festuca arundinacea* and *F. heterophylla*, whose application in the establishment of grass-covered spaces is increasing, thanks to the efforts of selectioners who have created numerous varieties resistant to different environmental conditions (shade, slope, dry substrate, etc.).

The Pontic – South Siberian area type is represented by two species whose application is possible in the lawns along larger roads. The species *Thymus marschallianus* is a plant that can be applied in the establishment of the so-called pharmaceutical lawns, Mauretanian-flowering lawns along the roads in the parks and in the residential areas, on spaces which are not subject to treading.

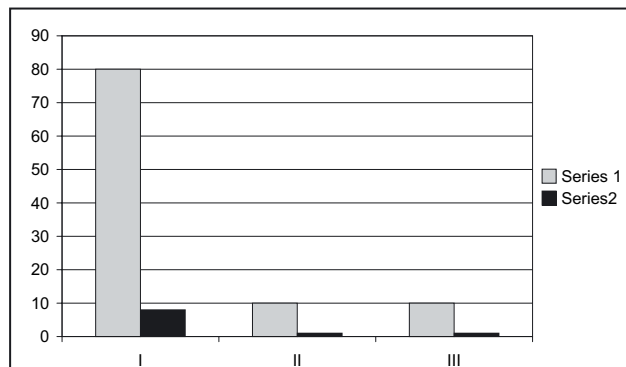


Fig. 7. Chorological spectrum of the Central European area type in the flora of Belgrade lawns: I – Central European; II – Atlantic-Central European; III – Central European-European Boreal-West Siberian. Series 1 – percentage of plant species; Series 2 – numerical values.

A comparison of the range spectrums of the study areas shows seven basic range types in all types of lawns, except in lawns of the business facilities, where no presence of species in the Pontic-South Siberian range (Fig. 8) has been identified. In all lawn types the best represented type is the Holarctic range type. The cosmopolitan and adventive species are also highly represented, while the number of species of other range types decreases almost consistently from the Mediterranean-Continental, via Central European-Mediterranean and Central European, to the Pontic-South Siberian species.

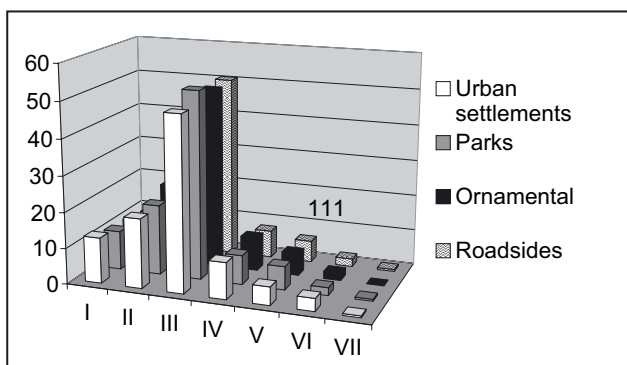


Fig. 8. Diagram survey of the range type representation of the analysed lawns in Belgrade: I – Adventive; II – Cosmopolitan; III – Holarctic; IV – Mediterranean-Continental; V – Central European-Mediterranean; VI – Central European; VII – Pontic-South Siberian.

Conclusions

The paper presents the results of the chorological analysis of 314 different plant species recorded in the maintained grass-covered areas in Belgrade (in the parks, residential areas, around business premises and roadsides).

The most numerous group of 158 species altogether is the Holarctic area type (50.32%), which ranges throughout more or less wide regions of the Northern Hemisphere. The most numerous species within the Holarctic area type belong to different groups of the European – West Asian subtypes and to the Eurasian group of floral elements, which also form the basic chorological nucleus of the total flora of the maintained lawns in the region of Belgrade.

The flora of the analysed Belgrade lawns contains a high number of cosmopolitan (15.29%) as well as of adventive species (13.38%), which indicates best the high anthropogenic effect, the degree of ruderalisa-

tion, and also the magnitude of the ecological value of the representatives of these specific area types.

The species that belong to different floral elements and area groups of the Mediterranean – Continental, Central European – Mediterranean, Central European and Pontic – South Siberian area types are present in considerably lower numbers.

The high degree of compatibility of the chorological structure of Belgrade lawns and the structure of the total ruderal flora in Belgrade indicates, *inter alia*, a tendency of ruderalisation of the grass-covered lands and the need of their more intensive maintenance.

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