Acta Bot. Croat. *31* (1972) 155—164

# GRASSLANDS CONTAINING *CHRYSOPOGON GRYLLUS* IN CONTINENTAL REGIONS OF WEST CROATIA

*LJUDEVIT ILIJANIĆ, VALENTINA GAŽI and JASENKA TOPIĆ*

(Botanical Institute of the University of Zagreb)

Received December 28, 1971.

## Introduction

The species *Chrysopogon gryllus* in Yugoslavia is distributed as a component of the submediterranean and east-continental grassland vegetation particularly. Plant communities of different systematic degrees and position named after it suggest a rather wide ecological amplitude of this plant (comp. Horvatić 1934, 1963; Jovanović-Dunjić, R. 1954, Kojić 1957, 1959; Braun-Blanquet 1961, Csürös and Niedermaier 1966, Aubert and Loisel 1971 and others).

In the north-west and west continental regions of Croatia *Chrysopogon gryllus* is much less frequent and has so far been noted in few localities only: in Podravina at Đurđevački pijesci (Soklić 1943), then more to the east near Vukosavljevica in the environment of Virovitica (Kovačević and Brzac 1960), in the environment of Varaždinske Toplice and Guščerovac (Schlosser i Vukotinović 1869, 1876) and at the foot of the eastern part of Zagrebačka gora (Medvednica) (Kovačević and Brzac 1960).

A few years ago we found this plant in new localities, in the continental regions of west Croatia, to the west of Karlovac where the district of Gorski Kotar begins, where it is distributed as a dominant plant over relatively large areas, especially in grassland vegetation (meadows and pastures) which has not been yet investigated.

We carried out the phytosociological investigations in 1971 in order to establish floristic composition and systematic relationship of this interesting vegetation, which comes as a large oasis in the region distinguished by woods and significant heather vegetation.

## Geographical position and general ecological conditions of the region

The investigated grasslands containing *Chrysopogon gryllus* are distributed in several localities between the rivers of Dobra and Kupa, on the line of the Dobramotel — Zdihovo (fig. 1) at the altitude of about 200—220 m. The largest areas were found at the locality of Vučkovka, about 2—3 km from the Dobramotel towards Rijeka, mostly on the northern side of the road.

This is a borderland of Cretaceous Karst with the characteristic Karst phenomena well marked, especially the abundance of shallower or deeper dolines (ponikve, fig. 2).

Only in some places the rock pieces stick out above the surface of the shallower or deeper soil developed on a carboniferous substratum. The uppermost soil horizon is brown, but at a depth of 10 cm and at deeper profiles at 40 cm the colour becomes red or lightly yellow. The depth of the soil exceeds in some places 70 cm and even more at the bottom of some doline. Parts of the area have been converted into ploughland.

Table 1. Rainfall, temperature, humidity and thermal character of climate
Tab. 1. Količina oborina, temperatura, humiditet i toplinski karakter klime

| Meteorological station (altitude) Stanica (nadmorska visina) | | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | Year God. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zvečaj 190 m | rainfall oborine mm | 80 | 69 | 93 | 91 | 130 | 109 | 98 | 102 | 126 | 158 | 131 | 109 | 1296 |
| Adlešiči-Velika Sela 340m | rainfall oborine | 69 | 68 | 81 | 84 | 136 | 114 | 86 | 101 | 126 | 149 | 122 | 91 | 1227 |
| Adlešiči-Velika Sela | temperature °C temperatura | -1,0 | 0,1 | 5,0 | 10,3 | 14,7 | 18,8 | 21,4 | 20,0 | 16,1 | 10,5 | 6,0 | 0,0 | 10,2 |
| Adlešiči-Velika Sela | rain-factor Kf | — | 68,0 | 16,2 | 8,1 | 9,2 | 6,1 | 4,0 | 5,0 | 7,8 | 14,2 | 20,0 | — | 120,3 |
| Adlešiči-Velika Sela: * climate humidity - humiditet klime | | — | ph | ph | h | h | sh | sa | sa | h | ph | ph | — | h |
| thermal character of climate toplinski karakter klime | | n n | n n | mc uhl | mw ut | w t | w t | h v | w t | w t | mw ut | mc uhl | n n | mw ut |

* Thermal character of climate (after Gračanin)

Toplinski karakter klime (po Gračaninu)

| | | Climate humidity Humiditet klime | | (after Gračanin) (po Gračaninu) |
|---|---|---|---|---|
| | | annual rain factor | monthly rain factor | |
| > 20 °C | hot (h) — vruća (v) | < 40 | < 3,3 | arid (a) |
| 12 — 20 | warm (w) — topla (t) | 40 — 60 | 3,3 — 5,0 | semiarid (sa) |
| 8 — 12 | moderately warm (mw) — umjereno topla (ut) | 60 — 80 | 5,0 — 6,6 | semihumid (sh) |
| 4 — 8 | moderately cold (mc) — umjereno hladna (uhl) | 80 — 160 | 6,6 — 13,3 | humid (h) |
| 0,5 — 4 | cold (c) — hladna (hl) | > 160 | > 13,3 | perhumid (ph) |
| < 0,5 | nival (n) — nivalna (n) | | | |

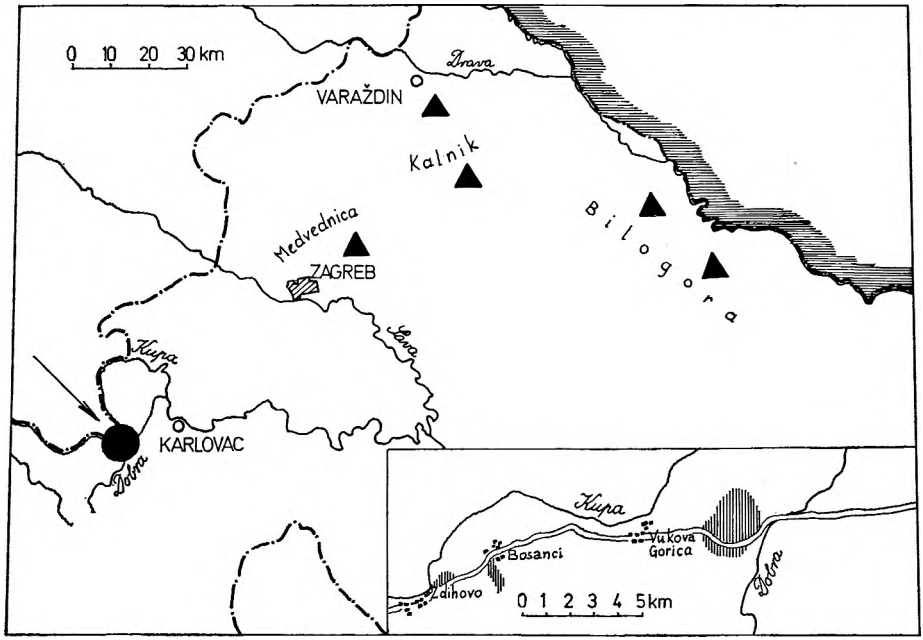


Fig. 1. Distribution of the species *Chrysopogon gryllus* in the continental regions of west and north—west Croatia

▲ recorded localities
● new localities (in the map right, below, marked by hatching).

.Sl. 1. Rasprostranjenost vrste *Chrysopogon gryllus* u kontinentalnom području zapadne i sjeverozapadne Hrvatske

▲ poznata nalazišta
● nova nalazišta (na karti većeg mjerila desno dolje, nova nalazišta označena crtkanjem).

Fig. 2. Landscape.
Sl. 2. Opći izgled krajine.

Fig. 3. *Quercus cerris*, the remainder of natural potential vegetation.
Sl. 3. *Quercus cerris*, ostatak prirodne potencijalne vegetacije.

Fig. 2. — Sl. 2.

Fig. 3. — Sl. 3.

According to Gračanin (1951) this soil belongs to the type of continental red soils turned brown, which transform continuously into podsolised heather red soils (heather podsols).

From meteorological observations of two neighbouring stations we can draw conclusions on the climate of our narrower region: the station of Zvečaj situated about ten kilometers to the south of the investigated area gives the rainfall data only, and the station of Adlešiči—Velika Sela located somewhat to the north, in Slovenia, collects data on temperature and rainfall (Tab. 1).

It can be seen from Table 1 that the annual amount of rainfall is greater than 1200 mm and average annual temperature of the air is about 10 °C. According to Gračanin's classification the climate can be characterized as humid, moderately warm (humidity and thermal character monthly cf. Tab. 1).

With regard to grassland vegetation containing *Chrysopogon gryllus* and several other thermophilous submediterranean plants belonging to the order *Scorzonero-Chrysopogonetalia* H-ić, it may be expected that the climate of this region differs to some extent in the amount of rainfall (probably somewhat reduced) and in the temperature (probably somewhat higher) from the surrounding, especially the western more humid areas.

It would be useful to establish at least two comparative meteorological stations in this region. We believe that our suppositions would be confirmed by exact measurements.

## Floristic composition and systematic position of the investigated vegetation

Floristic composition can be seen in the association table containing 10 vegetation records.* The first eight records originate from the locality of Vučkovka and the last two from the environment of Zdihovo.

Only the vegetation records of the stands containing *Chrysopogon gryllus* have been listed in the association table in order to establish whether it is the characteristic species of one association or has a wider amplitude, as is the case in other parts of its range.

The table proves that some stands differ in their floristic composition in spite of the homogeneous aspect conditioned by *Chrysopogon gryllus* dominancy. The differences in extreme examples are so great, that one cannot speak about different associations or alliances, but rather about different vegetation classes.

This fact becomes obvious by comparing the first vegetation record, containing characteristic species of the communities of the class *Nardo-Callunetea* with the last record in which the former species do not appear at all while the characteristic species of the communities of class *Festuco-Brometea* are abundant. Between these two extremes all transitions and mixtures are existing. Accordingly, Table 2 shows the appearance of a greather number of plants of one class, if viewed from the left to the right, and of the other class if viewed from the opposite direction. All the records, however, contain *Chrysopogon gryllus* in abundance, which is somewhat more abundant in the vegetation records of the class *Festuco-Brometea*.

* We are grateful to Mr. Andrija Ž. Lovrić for determining *Centaurea*-taxons and to Miss Krunica Hruška for *Thymus*-taxons.

Consequently, all the meadows and pastures of the investigated area containing *Chrysopogon gryllus,* with regard to systematic position cannot be joined in the same vegetation unit. In this way we would unite two essentialy different communities. Partially they belong to the class of acidophilous meadows and heather *Nardo-Callunetea,* partially to the class of xerophytic neutrophilous-basiphilous grasslands *Festuco-Brometea* and partially they are transitions and mixtures of both. This must be particularly considered in vegetation mapping in connection with which our investigations have been made.

The question is: To which of the lower systematic units within these two classes do the stands containing *Chrysopogon gryllus* belong? If we exempt the »typical« mixtures, the stands within the class *Nardo-Callunetea* may be subordinated to the already described association *Genisto-Callunetum* Ht (alliance *Calluno-Festucion capillatae* Ht 1959 prov., order *Calluno-Ulicetalia* Tx 1937) as a distinct sub-association *grylletosum* subass. nov.

This sub-association with dominant *Chrysopogon gryllus* and other much less frequent plants of dry grasslands as differential species, represents a transition from heather communities of the class *Nardo-Callunetea* to grasslands of the class *Festuco-Brometea.* This clearly determines the systematic position of the community.

*Genisto-Callunetum grylletosum* is related to the acidophilous community *Gryllo-Callunetum* Antonietti 1971. prov. from southern Swiss lakes district, but the latter represents heather more than grassland. It belongs to the class *Nardo-Callunetea* and order *Calluno-Ulicetalia* too, but the author interpolates it in the alliance *Sarothamnion* especially because of the abundance of the plants *Sarothamnus scoparius, Pteridium aquilinum* and *Teucrium scorodonia.*

Floristic composition of this community, distributed at the altitude of 200—800 m is heterogeneous, including partially the vegetation of rocks (cf. subass. with *Allium senescens*). It would be more natural to exclude such stands, in spite of *Chrysopogon gryllus* dominancy.

In comparison with *Genisto-Callunetum grylletosum* it is significant, that the community described by Antonietti as *Gryllo-Callunetum* is more influenced by warmer mediterranean climate, which is seen particularly by the presence of some mediterranean plants such as *Cistus salviifolius* and *Erica arborea.*

It seems more difficult, however, to determine the systematic position of the stands belonging to the other class. Doubtlessly they belong to the class *Festuco-Brometea.* Moreover, in our opinion, they can be adjoined to the order *Brometalia* because of the presence of the numerous characteristic plants of the order (i.e. *Hippocrepis comosa, Koeleria pyramidata, Helianthemum nummularium, Prunella laciniata, Globularia elongata* etc.). But it is not certain to which of the alliances it can be adjoined. This grassland shows some floristic relationship with submediterranean grasslands, at least with the association *Danthonio-Scorzoneretum villosae* Ht et H-ič (1956) 1958. This is seen by the presence of numerous common species, particularly of those of a higher degree of presence such as *Chrysopogon gryllus, Danthonia provincialis, Filipendula hexapetala, Plantago media, Trifolium montanum, Dorycnium herbaceum, Prunella laciniata, Scabiosa agrestis, Globularia elongata, Brachypodium pinnatum, Hippocrepis comosa, Lotus hirsutus etc.).* The relationship is not strong enough to unite them into one association, but the question is whether they can be united on a higher systematic level.

Table 2. — Tabela 2.

| Name of the community — Ime zajednice | *Genisto-Callunetum gryllotosum* | | | | | | *Globulario-Chrysopogonetum* | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Slope, degrees - - Nagib (°) | 10—12 | — | — | 1—2 | 10—15 | 30 | 10 | 3- -5 | 30 | 2—5 |
| Exposure — Ekspozicija | NNW | — | — | SSW | SW | S | SW | S | SE | S |
| Number of vegetation record — Broj snimke | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| *Chrysopogon gryllus* (Turner) Trin. | 3.2 | 3.2 | 3.3 | 3.2 | 4.3 | 4—5.5 | 3.3 | 4.3 | 4.3 | 4.2 |
| Characteristic species of communities of the class *Nardo-Callunetea* — Karakterističke vrste zajednica razreda *Nardo-Callunetea*: | | | | | | | | | | |
| *Genista sagittalis* L. | 1.2 | 1.2 | 2.2 | 1.3 | + | 1.2 | +.2 | +.2 | +.2 | · |
| *Sieglingia decumbens* (L.) Bernh. | 2.2 | 1.1 | · | 1.1 | + | + | 1.1 | + | 1.1 | · |
| *Calluna vulgaris* (L.) Hull. | 3.2 | 1.2 | 2.2 | 4.2 | 2.2 | 2.3 | +.2 | 1.2 | · | · |
| *Hieracium pilosella* L. | 1.1 | 1.1 | · | 1.1 | 1—2.1 | 1.1 | · | + | + | · |
| *Polygala vulgaris* L. | + | 1.1 | 1.1 | 1.1 | + | + | + | · | · | · |
| *Genista germanica* L. | + | + | + | + | · | +.2 | · | + | + | · |
| *Festuca capillata* Lam. (= *F. tenuif.* Sibth.) | · | 1.2 | 1.2 | 2.2 | · | 1.2 | 1.2 | · | 1.2 | · |
| *Viola canina* L. | + | + | · | 1.1 | 1.1 | + | · | · | · | · |
| *Potentilla erecta* (L.) Hampe. | 2.1 | 1.1 | 1.1 | 1.1 | · | · | · | · | · | · |
| *Nardus stricta* L. | 2.2 | 3.2 | 1.2 | · | · | · | · | · | · | · |
| *Carex pallescens* L. | · | 1.2 | + | · | · | · | · | · | · | · |
| *Antennaria dioica* (L.) Gärtn. | 1.1 | · | · | + | · | · | · | · | · | · |
| *Veronica officinalis* L. | · | · | · | +.2 | · | · | + | · | · | · |
| *Luzula multiflora* (Retz.) Lej. | · | · | + | · | · | · | · | 1.1 | · | · |
| Characteristic species of communities of the class *Festuco-Brometea* — Karakterističke vrste zajednica razreda *Festuco-Brometea*: | | | | | | | | | | |
| **Filipendula vulgaris** Moench. | + | 1.1 | 1.1 | + | 1.1 | 1.2 | 1.2 | 2.2 | 2.1 | 2.2 |
| *Hippocrepis comosa* L. | · | + | + | + | +.2 | + | 1.2 | 1.2 | + | 1.2 |
| *Helianthemum nummularium* (L.) Mill. | + | 1.1 | + | 1.1 | + | 1.1 | 1.2 | 1.1 | · | · |
| *Koeleria pyramidata* (Lam.) PB. | + | · | + | + | · | + | 1.1 | 1.1 | 1.1 | + |
| *Danthonia provincialis* DC. (= *D. calycina*) | · | · | + | + | + | + | + | + | 1.1 | + |
| *Dorycnium herbaceum* Vill. | · | · | +.2 | 1.2 | 1.2 | 2.3 | +.2 | 1.1 | +.2 | (+) |
| *Prunella laciniata* (L.) Nath. | + | · | · | + | 1.1 | · | 1.1 | · | · | + |
| *Globularia elongata* Hegetschw. (= *G. willkom.*) | · | · | + | · | + | · | 1.2 | 1.1 | 1.1 | 1.1 |
| *Brachypodium pinnatum* (L.) PB. | · | · | · | · | · | · | + | 2.2 | · | 1.1 |
| *Trifolium montanum* L. | · | 1.1 | + | + | · | · | · | 1.1 | + | 1.1 |
| *Lotus corniculatus* L. var. *hirsutus* Koch. | · | + | · | · | · | 1.1 | +.2 | · | + | + |
| *Thymus longicaulis* Presl. var. *longicaulis* | · | +.2 | · | · | · | +.2 | +.2 | · | +.2 | 1.1 |
| *Salvia pratensis* L. | · | · | · | · | + | 1.1 | 1.2 | · | + | 1.1 |
| *Scabiosa agrestis* W. K. incl. f. *leiocephala* | · | + | · | · | · | + | · | · | 1.1 | · |
| *Hieracium bauhini* Bess. | · | + | · | · | · | · | 1.1 | + | · | · |
| *Teucrium chamaedrys* L. | · | · | · | · | · | +.2 | +.3 | · | +.2 | 1.2 |
| *Euphorbia cyparissias* L. | · | · | · | · | 1.1 | +.2 | + | 1.1 | · | + |
| *Ranunculus bulbosus* L. | · | + | · | · | · | 1.1 | · | + | · | + |
| *Carex caryophyllea* Ja Tourette | · | + | · | +—1 | + | + | + | + | + | + |
| *Anthericum ramosum* L. | · | + | 1.1 | · | · | · | + | + | · | · |
| *Anthyllis vulneraria* L. | + | · | · | · | · | · | · | + | +.2 | + |
| *Centaurea weldeniana* Reichb. | · | + | · | · | · | · | + | 1.1 | · | · |
| *Euphorbia verrucosa* L. (= *E. brittingeri* Opiz.) | · | + | · | + | · | · | + | · | · | · |
| *Plantago media* L. | · | · | · | · | · | · | + | + | · | 1.1 |
| *Euphrasia stricta* Host. | · | · | · | · | · | + | + | · | 1.1 | · |
| *Knautia purpurea* var. *illyrica* (Beck.) Szabo | · | + | · | · | · | · | · | · | 1.1 | · |
| *Trifolium campestre* Schreb. | · | · | · | · | · | + | · | · | + | + |
| *Sedum sexangulare* L. (= *S. bolonience*) | · | · | · | · | · | +.2 | · | (+.2) | · | · |
| *Potentilla verna* L. | · | · | · | · | · | 1.1 | · | · | + | · |
| *Cirsium acaule* (L.) All. | + | · | + | · | · | · | · | (+) | · | · |
| *Carlina acaulis* L. | · | · | · | · | · | · | · | · | · | + |
| *Centaurea scabiosa* L. subsp. *spinulosa* | · | · | + | · | · | · | · | + | · | · |
| Other species — Ostale vrste: | | | | | | | | | | |
| *Hypochoeris maculata* L. | + | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | · | · |
| *Plantago lanceolata* L. | · | 1.1 | · | · | 1.1 | 1.1 | 1.1 | · | 1.1 | 1.1 |
| *Leucanthemum vulgare* | + | + | + | + | 1.1 | 1.1 | +—1 | + | 1.1 | · |
| *Galium verum* L. | + | · | + | + | + | · | + | + | + | 1.1 |
| *Rhinanthus aristatus* Celak (= *Rh. angustifolius*) | · | 1.1 | 1.1 | 1.1 | 1.1 | + | + | · | 1.1 | 2.1 |
| *Viola hirta* L. | + | · | · | · | + | + | · | + | + | +.2 |
| *Daucus carota* L. | · | · | · | · | + | + | + | · | + | · |
| *Peucedanum oreoselinum* (L.) Moench. | · | +.2 | 1.2 | · | · | · | · | · | 2.2 | · |
| *Briza media* L. | · | · | · | · | · | · | + | · | 1.1 | 1.1 |
| *Hypochoeris radicata* L. | · | · | · | · | · | 1.1 | + | · | + | · |
| *Leontodon hispidus* L. | + | · | · | · | + | · | · | + | · | · |
| *Anthoxanthum odoratum* L. | · | · | · | · | · | 1.1 | · | · | 1.1 | · |
| *Thymus effusus* Host. | · | · | · | 1.2 | 1.2 | · | + | · | · | · |
| *Holcus lanatus* L. | · | · | + | · | 1.1 | 1.1 | · | · | · | · |
| *Lichenes* (col.) | + | · | · | —.2 | · | · | 1.2 | · | · | · |
| *Trifolium pratense* L. | · | · | · | · | + | +.2 | · | · | · | — |
| *Centaurea bracteata* Scop. | · | · | · | + | 1.1 | · | + | · | · | · |
| *Populus tremula* L. | · | · | + | — | · | · | + | · | · | · |
| *Linum angustifolium* Huds. | · | · | · | — | · | · | + | · | · | · |
| *Festuca rubra* L. | · | · | + | — | · | + | · | · | · | · |
| *Carex montana* L. | 1.2 | 1.2 | · | · | · | · | · | · | · | · |
| *Pteridium aquilinum* (L.) Kuhn | · | + | · | (—) | · | · | (+) | · | · | +.3 |
| *Agrostis tenuis* Sibth. | · | · | · | · | · | 1.1 | · | · | + | · |
| *Quercus robur* L. (seedlings — klice) | · | · | + | (—) | · | · | · | · | · | · |
| *Juniperus communis* L. | · | · | + | + | · | · | · | · | · | · |
| *Stenactis annua* L. Ness. | · | + | · | · | · | · | · | · | + | · |
| *Echium vulgare* L. | · | · | · | · | · | · | · | + | · | + |

In addition to the species mentioned in the Table the following species have been noted: Rec. 2: *Betula pendula* Roth.; rec. 4: *Centaurea aubia* Sut. subsp. *nigrescens* (Willd.) Hay., *Cytisus nigricans* L.; rec. 6: *Stachys recta* L., *Crataegus monogyna* Jacq., *Quercus cerris* L., *Orchis* sp., *Agrostis alba* L.; rec. 7: *Hypericum montanum* L.; rec. 8: *Andropogon ischaemum* L., *Hypericum perforatum* L.; rec. 9: *Thalictrum minus* L., *Polygala comosa* Schk., *Arenaria serpyllifolia* L., *Cynosurus cristatus* L., *Helleborus* sp., *Poa bulbosa* L., *Viola* sp., *Asparagus tenuifolius* Lam., *Aira capillaris* Host., *Stachys officinalis* (L.) Trev.; rec. 10: *Sanguisorba minor* Scop., *Poa compressa* L., *Achillea collina* Becker, *Linum hologynum* Rchb., *Centaurea dubia* Sut. subsp. *nigrescens* (Willd.) Hay., *Senecio jacobea* L., *Ajuga reptans* L.

In the system of our submediterranean and mediterranean communities (cf. Horvatić 1963) the association *Danthonio-Scorzoneretum villosae* belongs to the submediterranean alliance *Scorzonerion villosae* H-ić, order *Scorzonero-Chrysopogonetalia* H-ić et Ht and class *Brachypodio-Chrysopogonetea* H-ić. If we adhere to our opinion about these stands belonging to the class *Festuco-Brometea* and order *Brometalia,* which seems to be justified, then it is impossible to solve this problem within the order *Scorzonero-Chrysopogonetalia* and class *Brachypodio-Chrysopogonetea.**

Also there is a floristic relationship of grasslands we have investigated with grasslands containig *Chrysopogon gryllus* in eastern continental regions, especially with the association *Agrosti-Chrysopogonetum grylly* Kojić from Serbia, which is as a representative of particular alliance *Chrysopogono--Danthonion calycinae* described by Kojić (1957, 1959). The author emphasizes the similarity of this alliance with the alliance *Bromion,* but he does not subordinate it to the order *Brometalia* but to *Festucetalia vallesiacae,* distributed in regions with less rainfall. The association *Agrosti-Chrysopogonetum grylli* develops as secondary vegetation on habitats of the oak wood association *Quercetum confertae-cerris.* The investigated grasslands are not situated in the zonal area of the woods *Quercetum confertae-cerris* but it is interesting to note that they develop on the habitats where *Quercus cerris* is an important floristic component of the woods (fig. 3, cf. pag. 161). Consequently, certain regularities are discerned in this analogy.

The association *Andropogonetum grylli insubricum* W. Koch 1943 from the environment of Lugano (with basiphilous and acidophilous variant) is analogous to the one describe under the name of *Globulario-Chrysopogonetum.*

Nevertheless, the insubric variant shows a stronger submediterranean influence. The potential, natural vegetation on the habitat of basiphilous variant is the wood of *Quercus pubescens* and *Ostrya carpinifolia* (relationship to illyric submediterranean region). The climate there is very humid too, with appreciable rainfall (even exceeding 2000 mm), but the average annual temperature, especially owing to mild winters, is higher (11—12 °C) and sunny days are numerous (W. Koch 1943 : 579).

If our grassland belongs to the order *Brometalia* which seems justifiable, the question remains whether it is possible to subordinate it to the alliance *Bromion erecti* Br-Bl. (1925) 1936, described by Horvat (1962) as the only alliance of the order *Brometalia* in west Croatian regions, or to adjoin it to another alliance which unites the most closely related communities of our submediterranean regions.

Since we have few vegetation records, we consider it better to leave the question open, the more so because systematic problems of submediterranean and mediterranean grassland communities are being dealth with (cf. not. these page).

For practical purposes (vegetation mapping) it is useful to name the community here described. We suggest a provisory name *Globulario-Chrysopogonetum grylli* prov., without predicting either a definite systematic position or a definite name.

---

* It may be necessary to revise the systematic position of at least part of submediterranean grassland communities whose floristic relationship with analogous eumediterranean communities within the same class is not conspicuous enough.

Since Prof. Horvatić has recently undertaken to consider this problem, we would not discuss it here.

## Ecological conditions

The community named *Globulario-Chrysopogonetum grylli* overgrows slightly inclined to steep areas (2—30°), particularly those exposed to the south (S, SW, SE), on shallower soils highly influenced by carboniferous substratum. This is also seen on soil reaction (Tab. 3) which is alkaline in typical stands and neutral to weakly acid in the transition stands. In addition to the areas among the dolines these stands are developed on the their margins too, but only those south exposed. The stands don't descend deeper in the doline. Evidently, they find their life requirements fulfilled in the sunny and drier habitats with neutral or alkaline soil.

Table 3. Soil reaction — Tab. 3. Reakcija tla

| Depth / Vegetation record — Dubina / Snimka | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 0 – 5 cm | 5,40 | 5,15 | 5,50 | 5,23 | 5,00 | 5,87 | 5,50 | 6,16 | 6,16 | 7,74 |
| in | 10 –15 | 5,46 | 5,50 | 5,60 | 5,60 | 5,55 | 5,39 | 5,95 | 6,05 | 5,60 | 7,88 |
| $H_2O$ | 30 –35 | 5,65 | 5,60 | 5,57 | 5,80 | 5,64 | 5,72 | 5,91 | 6,21 | 5,75 | — |
| | 50 –55 | 6,02 | 5,97 | 7,37 | 5,93 | 5,85 | 5,80 | 6,32 | — | 6,22 | — |
| pH | 0 – 5 | 4,10 | 4,18 | 4,23 | 3,87 | 3,98 | 4,50 | 4,15 | 4,82 | 5,05 | 7,23 |
| in | 10 –15 | 4,12 | 4,08 | 4,12 | 4,20 | 4,22 | 4,10 | 4,30 | 4,83 | 4,25 | 7,50 |
| n KCl | 30 –35 | 4,16 | 4,10 | 4,20 | 4,18 | 4,11 | 4,38 | 4,20 | 4,33 | 4,26 | — |
| | 50 –55 | 4,20 | 4,10 | 6,40 | 4,28 | 4,05 | 4,30 | 4,23 | — | 4,22 | — |

The second type of grassland named *Calluno-Genistetum grylletosum* develops under the same anthropogenous influence (mowing and pasture), but on a deeper rather wet and cold soil, on plateaus between dolines or north exposed margins of dolines. Neither does this association descend to the bottom of the doline in its complete floristic composition because *Chrysopogon gryllus* and the other thermophilous species disappear and the species of the communities of *Nardo-Callunetea* (i. e. *Nardus stricta, Potentilla erecta, Antennaria dioica, Genista sagittalis, Sieglingia decumbens* etc.) develop more abundantly. In descending to the bottom of the doline different species (i. e. *Holcus lanatus, Cynosurus cristatus, Trifolium pratense, Prunella vulgaris* etc.) belonging to the class of wet lowland meadows *Molinio-Arrhenatheretea* and order *Arrhenatheretalia,* are adjoined and substituted successively to the above mentioned species. This type of grassland has not yet been investigated in this region.

It would be necessary to carry out more comprehensive ecological especially microclimatological investigations of this interesting vegetation, because the microclimate is due to specific relief forms (dolines) one of the most dominant factor in the development of the soil and vegetation.

## Syndinamic relations

The communities described here represent secondary vegetation, developed after degradation of the primary forest vegetation. The question is what kind of woods have been there.

Although we cannot answer with certainty, we can conclude about the original woods from the retained fragmentarily developed small stands or groups of shrub and trees, which appear on this area. The main difficulty is the mosaic distribution of smaller areas of different habitats, and consequently, it is not possible to conclude on the vegetation of larger areas on basis of individual trees or smaller stands. Even the woods are mosaicly distributed just as is the pasture and heather vegetation.

Relatively, the best preserved is the vegetation in steep dolines not convenient for ploughing or mowing. In this vegetation many species are present *(Carpinus betulus, Quercus robur, Corylus avellana, Epimedium alpinum, Festuca heterophylla, Tilia cordata, Ligustrum, vulgare, Crataegus monogyna, Primula vulgaris, Galium vernum, Sanicula europaea),* which indicates the habitat of natural woods, floristically the most closely related to the association *Querco-Carpinetum croaticum* Ht *(Carpinion betuli, Fagetalia, Querco-Fagetea).*

This is true for the habitat with secondary developed grasslands of the class *Molinio-Arrhenatheretea* and order *Arrhenatheretalia.* On the habitats containing grasslands (and heather) *Genisto-Callunetum grylletosum,* however, the species *Betula pendula, Quercus robur, Populus tremula, Rhamnus frangula, Lathyrus montanus* are found more frequently, which leads us to conclude that it is the habitat of natural woods of the alliance *Quercion robori-petraeae (Quercetalia robori-petraeae, Quercetea robori-petraeae).* It is difficult to say, what association it belongs to *(Querco-Betuletum?).*

On the habitat of the association *Globulario-Chrysopogonetum grylli* the oak *(Quercus cerris,* fig. 3) is a very important woody species, and the shrubs such as *Cornus mas, Rhamnus cathartica,* and herbaceous plants *Melittis melissophyllum, Viola hirta, Lathyrus niger* have been found.

From this fact we may conclude that the conditions in those habitats are favourable for development of more thermophilous types of woods of the order *Quercetalia pubescentis.* One cannot say for certain what association is in question *(Quercetum cerris?).*

Consequently, natural potential vegetation may be devided into three types of woods: slightly acidophilous to neutrophilous woods of the alliance *Carpinion betuli,* acidophilous woods of the alliance *Quercion robori-petraeae* and neutrophilous to basiphilous and thermophilous woods of the order *Quercetalia pubescentis* (alliance?).

Although it is not easy and simple to determine in field work either the boundaries of the mentioned three types of woods or the secondary types of vegetation because of mosaicly distributed, poorly preserved original vegetation, we consider that the chief relations are well pronounced.

## Conclusions

The most important results of the present investigations are:

1. Southeuropean-southwestasiatic species *Chrysopogon gryllus* has been found in new localities in continental regions of west Croatia (fig. 1), as an important component of grassland vegetation. This has contributed to the knowledge of its distribution in this area.

2. From the floristic and phytogeographical viewpoint it is interesting to note the presence of taxons, such as *Danthonia provincialis, Centaurea weldeniana, C. bracteata, C. spinulosa, Linum angustifolium, Asparagus tenuifolius,* which should be emphasized.

3. The investigated grassland vegetation with dominant *Chrysopogon gryllus* is heterogeneous and belongs even to different classes. The community *Genisto-Callunetum grylletosum* belongs to the class *Nardo-Callunetea, Globulario-Chrysopogonetum grylli* to the class *Festuco-Brometea.* This latter association is of a more thermophilous character and shows closer relations with analogous submediterranean vegetation.

4. Because of thermophilous, submediterranean character of this grasslands it may be supposed that the climate here is also somewhat warmer than in the surrounding areas with the vegetation of a more expressively middleeuropean and subatlantic character.

5. As the species *Chrysopogon gryllus* has a wide phytosociological amplitude in this area too, it cannot be the basis of systematic division of the grassland vegetation. This must be taken into consideration in vegetation mapping.

## References — Literatura


*Antonietti, A.,* 1970: Su un'associazione di brughiera del piede meridionale delle Alpi. Ber. Geobot. Inst. ETH (Zürich) *40,* 9—27.

*Aubert, G.* et *R. Loisel,* 1971: Contribution à l'étude des groupements des *Isoeto-Nanojuncetea* et des *Helianthemetea annua* dans le sud-est méditerranéen français. Ann. Univ. Provence *45,* 203—241.

*Braun-Blanquet, J.,* 1961: Die inneralpine Trockenvegetation. Gustav Fischer Verlag. Stuttgart.

*Csürös, St.* et *K. Niedermaier,* 1966: Phytozönologische Untersuchungen über die *Chrysopogon* - Gesellschaften des Tirnavahochlandes (R. S. Rumenien). Vegetatio *13,* 6, 302—318.

*Gračanin, M.,* 1950: Mjesečni kišni faktori i njihovo značenje u pedološkim istraživanjima. Poljopriv. znanstv. smotra (Zagreb) *12,* 51—67.

*Gračanin, M.,* 1951: Pedologija III. dio. Sistematika tala. Školska knjiga, Zagreb.

*Horvat, I.,* 1931: Brdske livade i vrištine u Hrvatskoj. Acta bot. (Zagreb) *6,* 76—90.

*Horvat, I.,* 1962: Vegetacija planina zapadne Hrvatske. Prirodoslov. Istraž. (Zagreb), *30,* Acta biol. 2.

*Horvatić, S.,* 1934: Flora i vegetacija otoka Paga. Prirodoslov. Istraž. (Zagreb) *19,* 116—372.

*Horvatić, S.,* 1963: Vegetacijska karta otoka Paga s općim pregledom vegetacijskih jedinica Hrvatskog primorja. Prirodoslov. Istraž. (Zagreb) *33,* Acta biol. 4.

*Jovanović-Dunjić, R.*, 1954: O fitocenozi đipovine (*Chrysopogon gryllus*) u istočnoj Srbiji. Zborn. rad. Inst. za ekol. i biogeogr. (Beograd) 5, 5, 1—18.

*Koch, W.*, 1943: Das *Andropogenetum grylli insubricum*, eine Trockenwiesen-Assoziation des Südtessin. Ber. schweiz. bot. Ges. *53* A, 579—594.

*Kojić, M.*, 1957: *Chrysopogono-Danthonion calycinae* nova sveza iz reda *Festucetalia vallesiacae* Br.-Bl. et Tx. Zborn. rad. Poljopriv. fak. Zemun *5*, 2, 51—55.

*Kojić, M.*, 1959: Zastupljenost, uloga i značaj đipovine (*Chrysopogon gryllus* Trin.) u livadskim fitocenozama Zapadne Srbije. Arhiv za poljopriv. nauke (Beograd) *12*, 37, 3—46.

*Kovačević, J.* u. *Brzac, T.*, 1960: Zwei neue Standorte *Chrysopogon gryllus* Trin. in Nordwest-Kroatien. Fragm. balcan. Musei maced. Skopje *3*, 14/73, 113—115.

*Schlosser, J.* et *Vukotinović, Lj.*, 1869: Flora Croatica, Zagrabiae.

*Schlosser, J.* et *Vukotinović, Lj.*, 1876: Bilinar. Flora excursoria. Zagreb.

*Soklić, I.*, 1943: Biljni sviet podravskih piesaka. Hrv. šum. list *67*, 3—33.

SADRŽAJ



*Ljudevit Ilijanić, Valentina Gaži i Jasenka Topić*
(Institut za botaniku Sveučilišta u Zagrebu)

Južnoevropsko-jugozapadnoazijska vrsta *Chryspogon gryllus* rasprostranjena je u našoj zemlji kao značajni elemenat travnjačke vegetacije prvenstveno u submediteranskim i istočnokontinentalnim područjima. U ostalim zapadnijim dijelovima Jugoslavije znatno je rijeđa.

Posljednjih godina našli smo je na novim nalazištima veoma obilno u sastavu zanimljive travnjačke vegetacije između rijeke Kupe i Dobre (sl. 1), pa se time upotpunjuje slika o rasprostranjenju rdobrade u kopnenim područjima Hrvatske.

Novi lokaliteti nalaze se u graničnom području kontinentalnoga Krša na pragu Gorskoga kotara. Fenomeni krša izraženi su tamo naročito u pojavi velikoga broja manjih ponikava (sl. 2).

Klima šireg područja je umjereno topla, humidna, prosječno s više od 1200 mm oborina godišnje (tab. 1). Karbonatna podloga kredne starosti samo mjestimice viri na površini u obliku manjih ili većih kamenih blokova, dok je najvećim dijelom pokrivena plićim — neutralnim do bazičnim — ili dubljim — slabo do umjereno kiselim — tlima. Ta tla pripadaju u smislu Gračaninove klasifikacije kontinentalnim posmeđenim crvenicama i podzoliranim vrištinskim crvenicama.

*Chrysopogon gryllus* dominira u travnjačkoj vegetaciji koja je fitocenološki veoma heterogena, te u sistematskom pogledu pripada čak različitim vegetacijskim razredima (tab. 2).

Zajednica *Genisto-Callunetum grylletosum* subas. nov. pripada razredu acidofilnih travnjaka i vriština *Nardo-Callunetea* Prsng. 1949 (odn. svezi *Calluno-Festucion capillatae* Ht 1959 prov. i redu *Calluno-Ulicetalia* Tx. 1937), a zajednica *Globulario-Chrysopogonetum grylli* prov. razredu *Festuco-Brometea*. Između jednih i drugih su mješavine, odnosno prijelazi.

Zajednica *Globulario-Chrysopogonetum grylli* podređena je redu *Brometalia*, ali je pitanje pripadnosti svezi ostalo otvoreno, dok se potpunije objasne odnosi tih travnjaka prema svezi *Bromion* s jedne strane, te svezi *Scorzonerion villosae* i drugim srodnim submediteranskim zajednicama, s druge strane.

Istaknute su i sličnosti s analognim zajednicama istočnokontinentalnih područja naše zemlje te s nekim zajednicama iz područja južne Švicarske.

Pojava termofilnih travnjaka poput submediteranske oaze okružene područjem mezofilnih listopadnih šuma i vriština srednjeevropskog i subatlanskog karaktera dopušta pretpostavku da i primarna (šumska) vegetacija na takvu staništu ima termofilniji karakter.

To se zaista dade i naslutiti, iako je primarna vegetacija uglavnom uništena. Osim cera *(Quercus cerris)*, koji se tu i tamo sačuvao (sl. 3) kao svjedok, potvrđuje to i nazočnost drugih termofilnijih vrsta reda *Quercetalia pubescentis* (npr. *Cornus mas, Melittis melissophyllum, Lathyrus niger).*

Na osnovi toga moguće je zaključiti da je i klima nešto toplija nego u susjednom području koje okružuje ovu oazu, pa bi bilo veoma korisno osnivanje dviju komparativnih meteoroloških stanica u trajanju od barem nekoliko godina. Uvjereni smo da bi rezultati egzaktnih mjerenja potvrdili navedenu pretpostavku.

Značajno je međutim da su ekološke prilike zbog nejednolikog mezorelijefa i mikrorelijefa veoma promjenljive na malim udaljenostima (brojne ponikve) pa bi bilo potrebno izvršiti i podrobnija ekološka, napose mikroklimatološka istraživanja. Posljedica tako promjenljivih ekoloških prilika je naime i vrlo promjenljiva i mozaički raspoređena vegetacija.

O tome valja prilikom kartiranja vegetacije posebno voditi računa, to više što prividna (fizionomska) homogenost vegetacije uvjetovana dominantnošću jedne vrste sakriva bitne florističke razlike u biljnom pokrovu. U našem slučaju to je naročito vrsta *Chrysopogon gryllus*, koja, kao što se i ovdje pokazalo, ima veoma široku fitocenološku amplitudu te ne može poslužiti kao osnova za podrobnije raščlanjenje travnjačke vegetacije.

Prof. dr. Ljudevit Ilijanić i
Jasenka Topić
Institut za botaniku
Sveučilišta u Zagrebu
Maruličev trg 20/II
41000 Zagreb (Jugoslavija)

Prof. dr. Valentina Gaži
Zavod za poljoprivrednu botaniku
Poljoprivrednog fakulteta
Šimunska 25
41000 Zagreb (Jugoslavija)