Genesis of secondary vegetable communities of post agrogenic plakor landscapes (Meshchovskoe Opolye)

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Abstract. The article shows the dependence of the composition of synanthropic plant communities of postagrogenic landscapes in the agroclimatic conditions of the Central regions of the Nonchernozem zone of the Russian Federation (Meshchovskoe opolye) on agroclimatic conditions, the composition of the segetal complex of agrophytocenoses and agricultural technologies used for cultivation, the influence of anemochoric inspection and episodic pyrogenic disasters. Tap-root and rhizome species of segetal plants are predominantly involved in the development of fallows; the highest density of formations and accumulation of the phytomass of communities is observed in May – June, which is influenced by the frequency of occurrence, productivity, and specific area of dominant plant species. It has been established that the floristic core includes 214 species of higher herbaceous plants that determine the productivity and potential food value of secondary meadow communities, including invasive species that have an adaptive potential to zonal ecological and soil conditions. The placement of agrophytocenoses of oats during the development of middle-aged cereal-legume meadow phytocenoses with a share of legumes in the structure of up to 35% contributes to an increase in the yield of grain fodder by an average of 9.3% and an increase in the collection of metabolic energy by 11.1%.

1. Introduction
Meshchovskoe opolye is the largest erosional plain of the Bryansk-Zhizdrinsky woodlands. The daytime surface is represented by developed on cover and loess loams, gray forest, sod-slightly podzolic soils. At present, more than 33% of the arable lands of its territory, for one reason or another, are classified as fallow. Secondary meadow phytocenoses are formed, including species with different invasive status: Lupinus polyphyllus Lindl. and Solidago gigantea Ait., Erigeron canadensis L., possessing an adaptive potential to zonal ecological and soil conditions [1-2]. In this regard, the analysis of secondary phytocenoses is of current scientific and practical importance.

2. Materials and methods
The study of synanthropic plant communities was carried out in a long-term field experience at the site of monitoring of secondary phytocenoses and the development of technologies for accelerated development of fallow lands. Kaluga Research Institute of Agriculture - a branch of the Federal State Budgetary Scientific Institution “Federal Research Center of Potatoes named after A.G. Lorkha” in the Przemysl district of the Kaluga region in 1999-2020. The monitoring site (100.0 hectares) is located on the southeastern above-floodplain terrace of the river Vysa, refers to the girder-field type of agricultural landscape. Evaluation of the productivity and quality of biomass of phytocenoses was
carried out on permanent registration plots (2500 m$^2$) in 30 repetitions, laid down in a typical way. The floristic composition was studied by the route method. The analysis of the coenoflora of fallow lands and the assessment of the potential fodder value of plants on dry lands of various moisture levels in the Meshchovsky opolye (Peremyshl, Sukhinichsky, Babyninsky districts of the Kaluga region) were carried out using conventional methods on characteristic areas of landscapes with an area of 5-15 hectares (using mapping by an unmanned aerial vehicle (UAV) – DJI Phantom 3 Professional, stock camera 4KF / 2.8, 94$^\circ$ FOV) [3-4].

3. Results and discussion

The formation of phytocenoses on fallow lands is determined by the following complex: agroclimatic conditions - landscape - edaphic conditions - previous agrophytocenosis - agrotechnology - the composition of the segetal complex. Phytocenotic relationships, anemochornic inspermations determine the composition of synanthropic communities and the duration of the restoration stages to typical vegetation [5-6].

In crop rotations with varying degrees of saturation of the structure with leguminous crops and perennial legumes (from 30 to 60%), the segetal complex was formed by species presented in decreasing order of their projective abundances:

- **Numerosae** (moderately) – *Achillea millefolium* L., *Capsella-bursa pastoris* (L.) Medik, *Centaurea cyanus* L., *Chenopodium album* L., *Cirsium arvense* L., *Convolvulus arvensis* L., *Echinochloa crusgalli* (L.) Beauv., *Elytrigia repens* (L.) Nevski, *Equisetum arvense* L., *Galium aparine* L., *Matricaria chamomilla* L., *Polygonum aviculare* L. s. L., *P. bistorta* L., *P. convolvulus* L., *Rumex acetosella* L., *Stelaria media* L., *Taraxacum officinalis* Wigg., *Thlaspi arvense* L., *Trifolium arvense* L.;

- **Pauces** (little) - *Agrostis tenuis* Sibth., *Cirsium setosum* (Willd.) Bess., *Consolida regalis* S.P. Gray, *Galeopsis speciosa* Mill., *Linaria vulgaris* Mill., *Menta arvensis* L., *Polygonum persicaria* L., *Rhap ontus raphanistrum* L., *Spergula arvensis* L.;

- **Rarae** (rare) - *Barbarea vulgaris* R. Br., *Bunias orientalis* L., *Euphorbia helioscopia* L., *Fumaria officinalis* L., *Stachys palustris* L.

Communities of one- and two-year-old fallows were initiated by the species belonging to tap-root (up to 44-52% in the biomass structure) and rhizome (23-31%) groups of segetal plants. The greatest accumulation of biomass was observed in May – June (113.9 c / ha), the smallest - in August – September (56.3 c / ha). The productivity of communities in the summer period varied from 0.3 to 1.9 kg / m$^2$. The density of the price elements of segetal-ruderal formations was 240-300 pcs / m$^2$. The formation of phytomass depended on the productivity of dominant species ($r = 79.54 \pm 0.21$), on their specific area ($r = 91.21 \pm 0.18$) and on the frequency of occurrence ($r = 87.47 \pm 0.19$).

In communities, there is a manifestation of anisotropy of the grass stand in the vertical and horizontal planes. Stratigraphic division made it possible to establish the predominant accumulation of phytomass (up to ½ part) at a height of 30-60 cm from the soil level and to distribute it relative to the dominant spot, for example, the *Artemisia absinthium* L. formation. + *Matricaria discoidea* D.C. + *Dactylis glomerata* L. + *Apera spica-venti* (L.) Beauv. + *Erodium cicularium* (L.) L` Her (figure 1).

The pioneer stage communities are classified as syntaxa of the class *Stellarietea mediae* Tx. et al. Exvon Rochow 1951, later formations to the class *Artemisietea vulgaris* Lohmeyeretal. Exvon Rochow 1951. The passage of the syngenetic series was often limited by episodic pyrogenic influences in the spring and autumn periods, which contributed to the development of derivative formations within the community syntaxa: *Polygono arenastri – Poetae annuae* Rivas-Mart. 1975 – *Epilobietea angustifolii* R. Tx. et Prsg 1950. Phytocenoses assumed contagious-aggregated features and tendency to frequent fluctuation changes [6-8]. The projective cover varied from 36.9-78.2% for pioneer communities (2-3 years old) and up to 83.3-96.7% for middle-aged deposits (9-12 years old). The vegetation of long-term fallows (12 and more years) on dry lands occupied a relatively small
The composition of meadow communities above the floodplain terraces on podzolized and poorer soils in humus content was less diverse and represented by formations of grasses – *Agrostis tenuis* Sibth., *Anthoxanthum odoratum* L., *A. spica-venti*, *Bromopsis inermis* (Leyss.) Holub, *Calamagrostis epigeios* (L.) Roth., *Cynosurus cristatus* L., *D. glomerata*, *Festuca rubra* L., *Ph. phleoides*, *Nardus stricta* L., *Setaria pumila* (Poir.) Roem. et Schult. In the composition of lowland meadows, because soils accumulate a greater amount of moisture, plants that are potentially valuable in terms of forage have appeared, associations with a different proportion of the participation of *Leguminosae* species in the structure have been formed. The core of the cenoflora of the Meshchovsky opolye consisted of 214 species of higher herbaceous plants from 29 families (196 native and 18 adventive species, flora of the Kaluga region, among which species of the families *Compositae*, *Gramineae*, and *Leguminosae* were most common (table 1).

| Family                      | Total number of species | including species that have no potential food value and are poisonous |
|-----------------------------|-------------------------|-----------------------------------------------------------------------|
| Plant communities in general | 214/100*                | 179/78.7                                                             |
| Main families, including:   |                         |                                                                       |
| *Gramineae* Juss.           | 148/86.9                | 114/66.7                                                             |
| *Cruciferae* Juss.          | 26/20.1                 | 10/12.2                                                              |
| *Rosaceae* Juss.            | 13/7.1                  | 12/5.8                                                               |
| *Leguminosae* Juss.         | 10/4.4                  | 9/3.3                                                                |
| *Umbelliferae* Moris.       | 24/17.3                 | 11/11.1                                                              |
| *Lamiaceae* Lindl.          | 9/6.8                   | 8/5.7                                                                |
| *Scrophulariaceae* Juss.    | 16/8.0                  | 16/8.0                                                               |
| *Compositae* Giseke         | 14/6.2                  | 14/6.2                                                               |
|                             | 36/17.0                 | 34/14.4                                                              |

Note: * - above the line is the number of species in the floristic (economic) structure, below the line - their mass fraction in the composition of the biomass yield of communities.

Derivatives of phytocenoses had a common floristic core and consisted of a group of forbs (share in the structure of biomass – 40-56%) and grasses (up to 24-36%), the group of legumes participated in their formation insignificantly (up to 6-11%). In synanthropic communities of upland lands that underwent invasive transformation, associations of invasive species (*E. canadensis*, *L. polyphyllus*, and *S. gigantea*) were more productive than native ones, which may indicate their high adaptive ability to zonal soil-ecological conditions [2; 5; 7; 9-10]. In the communities of *L. polyphyllus* and *S. gigantea*, a comparatively greater accumulation of root residues in the 0-30 cm layer of soil was noted.
During the development of middle-aged deposits, it was found that the distribution of agrophytocenoses of *A. sativa* after the rise of the grass-legume meadow phytocenosis sod with the predominant participation of the invasion *L. polyphyllus* (the share in the biomass structure is up to 15-35%) and native species – *Lathyrus pratensis L.*, *Lotus corniculatus L.*, *Medicago spp.*, *T. hybridum*, *T. pratense*, *V. cracca* (total share up to 7-15%) contributed to an increase in the yield of grain forage by 8.0-10.5% (up to 52.6 c / ha) and an increase in the collection of metabolic energy by 11.1%. Forb-cereal and cereal-forb phytocenoses, depending on the share of participation in the structure of cereals, had insignificant differences (42.3-49.4 c / ha) *C. epigeios*, *E. repens*, *Poa trivalis* L.) – the grain fodder yield was 72.6% (34.7 c / ha) of the productivity in the control – 47.6 c / ha (vetch-oat mixture).

4. Conclusion
The initiation and floristic composition of synanthropic plant communities is determined by the segetal complex of preceding agrophytocenoses, anemochoral inspermations, and pyrogenic disasters. In the ecological and soil conditions of the Meshchovsky opolya, the floristic core of phytocenoses of fallow lands includes 214 species of higher herbaceous plants that determine productivity and their potential food value, postagrogenic transformation of the properties of gray forest soils. The productivity and energy-protein nutritional value of oat agrophytocenoses grain forage after the sod rise of secondary meadow vegetation was determined by the share of participation of *Leguminosae* Juss. species in their phytocenotic structure.

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