To the study of the nesting cycle of yellow wagtail within the Steppe Research Station “Orenburg Tarpania”

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Abstract. Peculiarities of the nesting cycle of Motacilla flava beema Sykes, 1832 (Passeriformes, Motacillidae) within Steppe Research Station “Orenburg Tarpania” are considered in conditions of protected, fallow and pasturable lands in Orenburg region. The role of mutually-useful relations between yellow wagtails and ungulate mammals in steppe communities is underlined. According to preliminary results, we can suppose that the state of the population of model species of yellow wagtail depends on the presence and density of ungulate mammals in the nesting plot. The development of new habitats by M. f. beema is connected with the movement to the south-west of principal vegetation communities and food items of several species of yellow wagtails that, in its turn, are conditioned by climate aridization in the steppe and forest-steppe within Russia and adjacent countries.

1. Introduction

Intensification and changes in technologies and the agriculture approach in the steppe areas during the XX century led to a decrease in biodiversity [1, 2, 3]. Simultaneously, the avifauna biodiversity and the bird’s population inhabiting open and agricultural landscapes sharply reduced [4, 5, 6]. Decrease of the linnet population and common starling in Europe [5], the red-winged blackbird in the USA [7], and others can serve as examples. On the whole, habitats reduction is noticed for 86% of species of birds dwelling on unclaimed agricultural lands [7]. The formation of a low-demanded land fund in the post-Soviet space where restoration of steppe ecosystems happened, on the one hand, promotes to increase biodiversity in the area, and on the other hands, displays low efficiency of the process of ecosystem restoration due to a lack of large plant feeders [8]. To increase the biodiversity of birds in agricultural lands and natural landscapes, a line of authors offers to raise their spatial micro-stations heterogeneity as within separate fields with crops so in agrocenoses in the whole [4]. Natural ecosystems combining plant growing and livestock provide higher density and diversity of local birds than farms practicing only plant growing [9]. An analysis of the influence of the current natural and anthropogenic factors on steppe birds’ avifauna shows that overgrazing in virgin and restoring pastures is favorable for birds inhabiting open spaces. Still, grazing intensity and composition of grazed animals have a considerable significance [10, 11]. Different species of birds demand the various vegetation structures, as the plant structure influences on accessibility and visibility of potential prey and an option of biotopes suitable for nesting.
Homogenous spaces with uniform grassy cover formed due to intensive grazing of one kind of animal may increase the possibility for nests, nestlings, or adult specimens to be found by predators since the masking works less efficiently within the homogenous background. Grazing of different herbivorous animal species causes more heterogeneity in the structure of the vegetation cover that positively affects feed and shelter accessibility for birds inhabiting open spaces, leading to an increase in their number in the area [11].

One of the critical groups of steppe communities mutually-connected with large wild ungulate mammals in the bio-ecological relation is ground-nesting perching birds, including a group of yellow wagtails species (*Motacilla flava* sensulato) (Passeriformes, Motacillidae), among them *Motacilla flava beema* Sykes, 1832, differs from nominative subspecies *Motacilla flava flava* Linnaeus, 1758 white color feathering covering an ear and whiter feathering of ahead. Available data on distribution and settlement density of *Motacilla flava* in dependence on nature management conditions allows using the species as the indicator of steppe communities’ state [12].

The nesting habitat of *M. f. beema* was located within the Eurasian steppe and forest-steppe, from the Volga River to Yenisei River in the XIX century. From the beginning of the XX century and in the XXI century, on the whole, it widened in the north-west direction as the habitats of other species of this group [13, 14]. The development of new habitats by *M. f. beema* and the other species of yellow wagtails is connected with the movement to the north-west of plant associations and feed items of such a group of the birds that, in its turn, is conditioned by climate aridization in steppe and forest-steppe within Russia and adjacent countries. Temperature thresholds of the nesting period of *M. f. beema* connect as with the increase of spring and summer temperatures in the steppe regions of Russia, so in forest-steppe areas that, in its turn, is caused by global warming: each increase of temperature at 1°C moves distribution of plant communities to 100 –160 km to the north [15, 16, 17]. The most southern region of steppes enters into the steppe belt of the East-European region with a specific accent on the province Lower Don and Trans-Volga; the most northern area of steppes is located in the forest-steppe zone in the province of Trans-Volga and extents to the north where the ecotonal milieu of deciduous forest prevails [18, 19]. Species of yellow wagtails in the northern regions of the nesting habitat occupy hydrophilous and mesophilic biotopes; in the southern areas – xerophilous biotopes and agrocenoses [20]. Nesting biotopes in the northern and western regions of the European part of Russia historically changed: here, yellow wagtails often use humid meadows, wetlands, farmlands, and water and wastewater treatment facilities in a large residential place, including in steppe and forest-steppe conditions [20].

The study aims to research peculiarities of the nesting cycle of yellow wagtail *Motacilla flava beema* as an indicator of the steppe community within the Steppe Research Station “Orenburg Tarpania” (SRS “Orenburg Tarpania”) in conditions of steppe ecosystems in Orenburgskaya oblast.

2. Material and Methods
During the field seasons of 2018-2020, a complex examination of the nesting cycle of western yellow wagtail was conducted within the SRS “Orenburg Tarpania”.

In the paper, information on the nesting cycle of *M.f. beema* is considered. Quantitative calculations of birds were conducted in established routes, including all biotopes within the station. Also, point observations for birds were used in the paper. Monitoring for spring and autumn migrations was paid special attention in the study; birds setting on open habitats and their biological peculiarities were studied.

The Russian and Latin terms of birds are given after L. S. Stepanyan [21] and E. A. Koblik [22].

Schematic maps were compiled using software Google Earth Pro 7.3.3.7786, and graphic editors.

3. Study Area
The SRS “Orenburg Tarpania” has not only All-Russian but international significance as within its area, problems concerning acclimatization of ungulate mammals and their impact on native steppe communities continue to be studied the same as in the “Orenburgsky” reserve and others reservations
[23, 24]. The study of steppe communities where species of ungulate animals could inhabit has been paid specific attention. The plots most suitable for these purposes are the Preduralskaya steppe (where the project on Przewalski horses’ introduction has already been realized), regional natural parks. The station is located in the buffer zone of the “Orenburgsky” State reserve (the plot “Preduralskaya steppe”). SRS “Orenburg Tarpania” is placed in 3 km from Sazan village, in the place of former rural buildings and overgrazing. Intensive grazing of livestock happens around at present. The station represents itself as a complex of open-air cages for semi-free animals keeping located along the riverbed of a stream flowing on the Sazan gully; solonetz and alkaline lands are noticed in the station area. The primary type of soil is suppressed southern chernozem. The infrastructure of the station is oriented to acclimatize ungulate mammals that inhabit in open arid landscapes. The total area of the station is 35.0 hectares.

On the SRS “Orenburg Tarpania” area, Bactrian camel *Camelus bactrianus* Linnaeus, 1758, kiang *Equus kiang* Moorcroft, 1841, Przewalski horse *Equus ferus przewalskii* Poliakov, 1881, domestic yak *Bos grunniens* Linnaeus, 1766 occupy the ecological niche of large wild ungulates in model steppe communities. At present, 5 species (29 animal units) of ungulate mammals are kept on the station: 4 Przewalski horses, 4 Bactrian camels, 3 kiangs, 13 domestic yaks, and 5 Orenburg downy she-goats.

Ungulates are kept on open-air cages in combinations that would not provoke conflict situations. Animals are placed in an open-air cage according to their feed preferences and, mainly, held by separate groups. In the spring-summer period, when the central mass of animals is kept in the largest open-air cage having an area of 17.4 ha, species are distributed in the following way: Bactrian camels in the southern part of the open-air cage that is located on the light bank of the stream on overgrazed southern chernozem in the complex with saline soils and wormwood- *Stipa capillata* plant associations (the limiting height of grass stand is 60.0 cm). Przewalski horses prefer the northern part of the sizeable open-air cage placed on the right bank of the stream where more hydrophilous meadow vegetation with the goosefoot family's predominance is developed (the limiting height of grass stand is 70.0 cm). Kiangs are inclined to aggression towards other ungulates; they are kept in separate open-air cages with grass- *Bromus* plant associations' dominance (the limiting height of grass stand does not exceed 40.0 cm).

The natural conditions of the SRS “Orenburg Tarpania” correspond to ecological peculiarities of the milieu condition of the historical steppe communities and are suitable for the habitation of species of yellow wagtails and keeping and acclimatization of ungulate mammals. Species of yellow wagtails for the nesting prefer soil fertile enough with high organic composition pollution-free of high-density metals and loose (sandy loam or light loam) that would be easily trampled down in the course of preparation of the nesting pit and afterward building of a nest. Similar data was received before for Ulyanovsk region (the Middle Volga region) [25].

In the biotope of western yellow wagtail suitable for the nesting, 09.13.2018, we noticed steppe salvia *Salvia tesquicola* Klokov et Pobed., 1954, dandelion late *Taraxacum serotinum* (Waldst. &Kit.) Poir, *Crinitaria villosa* (L.), eurotia grey *Ceratoides papposa* Botsch. etkonn., brackish aster *Aster tripolium*, European grasswort *Salicornia europaea* L., goosefoot *Chenopodium* sp. L., and others; 04.17.2020 within the station areas and neighboring territories, we noticed mass blooming of Scythian tulip *Tulipa scythica* Klokov et Zoz and gagea *Gagea* sp., painting the steppe brightly yellow color attracting yellow wagtails.

4. Results
As a result of the conducted studies, the nesting cycle of yellow wagtail was revealed as an indicator of steppe communities in biotopes suitable for nesting under the influence of large ungulate mammals. 04.10.2020 we observed spring migration and the arrival of 8 pairs of yellow wagtails. 04.15–17.2020 there was a struggle for the nesting plots between males of yellow wagtails, fights between males for females, mating competitions, the formation of nesting pairs.
In the central part of the sizeable open-air cage with reed tangle around the stream where at present yaks and Przewalski horses are placed, we noticed 8 specimens of yellow wagtails. Simultaneously, females were sitting on tall stems of reeds nearby males: they took a seat next to females. Some birds stand close to ungulates, pick feed—insects which they flush. Yellow wagtails gather meal on old excrements of yaks that are resting in the grass. Two specimens of yellow wagtails were noticed in the open-air cage with kiangs. On the whole, in the station area, 8 pairs of western yellow wagtails were seen.

05.15.2020 in the station area, we recorded the nesting of western yellow wagtail *M. f. beema*. 08.9–14.2020 we noticed after-nesting before departure accumulation of western yellow wagtails in the open-air cage with yaks, where birds were picking insects together with common starlings before seasonal migration.

Yellow wagtail prefers to nest on plots occupied by cereals-Bromus plant associations, likes vegetation with the definite height of the stem—no more than 30-40 cm. It prefers the open-air cage field with yaks for feeding. For visiting of the open-air cage plots with other species of ungulate animals in the station, western yellow wagtails' preference increases in a row: Bactrian camel-Przewalski horse-domestic yak. Thus, western yellow wagtail choices a plot with kiangs to nesting, plots with other species of ungulate mammals it uses as additional feeding biotopes. The principal feeding biotope of yellow wagtail occupies the waterside zone of the stream and dams, shallow water, riverside tangle, and halophyte small meadows around them, a cage plot with yaks (figure 1).

![Map of SRS “Orenburg Tarpania” objects](image)

*Figure 1.* Map of SRS “Orenburg Tarpania” objects: 1 - administrative buildings; 2 – household area; 3 – open-air cages for joint keeping of *Equus ferus przewalskii* u *Bos grunniens*; 4 – open-air cage for joint keeping of *Equus kiang* u *Camelus bactrianus*; 5 – *Equus kiang*’s open-air cage; 6 – *Equus ferus przewalskii*’s open-air cage; 7 - location of *M. f. beema* nesting; 8 – State Reserve “Orenburgsky”. Background Google Earth Pro.

During the monitoring for the movement of a male *M.f. beema*, we managed to discover a localization of the nest of such subspecies close to kiang’s cage in a small plot of the grassland.

In the course of route observation, a male of yellow wagtail flew into the nest, stayed there for 60 seconds, then set on its favorite sentry roost site (a fence of the cage). Simultaneously, he kept in his claws fecal capsules of chicks remaining in the nest. Having made sure that nothing threatened the
nestling, the male left the post of the observation – the root site on the kiang's cage – and flew out its nestling plot area to throw fecal capsules of the chicks.

Large ungulate mammals create a biotope suitable for nesting for yellow wagtails and maintain it in the optimal state. Kiang and other large ungulates trample with the hooves and loosen soil, making holes in the ground that is fit for the nest building, biting off the grass, creating and maintaining a grass stand state at a certain height (from 20 to 40 cm). In holes from hooves, sometimes even under the piece of dry excrement, yellow wagtail builds a nest protecting it from wind and prying eyes (larks act similarly under a lack of the thick grass stand). Moreover, fresh and old excrements of ungulates are a specific “large dining room” for yellow wagtails. There are larvae of many insects-carphophagous, different kinds of bugs and butterflies, Hymenoptera, dipteran insects that form a staple in the diet of birds.

5. Discussion
The conducted studies showed that in conditions of protected and adjacent fallow and pasture lands in Orenburg region (on the example of the SRS “Orenburg Tarpania”), ecological niches of yellow wagtail and ungulate mammals spatially are adjusted to each other, have the area of collaboration on the level of biocological relations of the partnership. Wagtails nest and feed under the protection of large ungulate mammals (kiangs, yaks) – it is a model of mutually beneficial ties of Passeriformes nesting on the grounds and ungulate mammals in the steppe communities.

Yellow wagtails play a significant role in the life of ungulate mammals. A herd of grazing ungulates, as a rule, is accompanied by flocks of yellow wagtails (folk name – “dairy maids”), gathering insects flushed from grass stand and animals. In the nest-building period, yellow wagtails use horsehair (from kiang and Przewalski horse) to lining a tray in the nest and pluck old hair from the back and sides of grazing animals (yaks) for warmth-keeping of the lining in the nest. In the approach of predators or a human, yellow wagtails gather in noisy flocks and loudly cry, notifying the heard of ungulates about the danger. Thus, herd hoofed mammals function as creators of the biotope suitable for nesting, and ground-nesting perching birds support a function of convoy and service of ungulates.

Western yellow wagtail, the same as the other species of such a group of birds, is an indicator of steppe and halophyte meadow-steppe communities confined to steppe water bodies (in this case, they act the same as larks indicating at steppe communities) [26].

Yellow wagtails can be considered birds of pastures and agricultural lands due to close links with ungulate mammals. Eurasian steppes (including secondary, anthropogenic-transformed, restoring) can be regarded as a typical place of such a group of birds habitat under even small water bodies and halophyte little meadows connected with it, that is, the food reserve of birds where they can build stable nesting settlements. Thus, the received data should help us understand birds' critical role in the steppe communities and habitats in protected and anthropogenically transformed areas and farmlands in other regions with similar conditions.

6. Conclusion
The distribution of yellow wagtail on protected and fallow lands in Orenburg region probably depends on two principal gradients: a time of existence of native steppe and secondary communities and the number of ungulate mammals.

The state of the population of the model species of yellow wagtail depends on the presence and density of ungulate mammals (kiang, Przewalski horse, and others) on the nesting plot that, in the whole, affects on a state of the population of the studied species of birds.

The modeling of steppe communities that correspond to the biotope of yellow wagtails and ungulate animals in SRS “Orenburg Tarpania” shows mutually beneficial relations between such groups of animals. On a vast area of protected steppe and fallow, pasturable lands in Orenburg region, in the whole, old fallows prevail, and a total number of wild and domestic hoofed decreases. The introduction of wild hoofed in the steppe ecosystems as the place of their original habitat will increase
the biodiversity of perching birds. The studies of interconnections of biota components in steppe ecosystems based on the SRS “Orenburg Tarpania” should be continued.

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