МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РОССИЙСКОЙ ФЕДЕРАЦИИ
ТЮМЕНСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ
ИНСТИТУТ ПРОБЛЕМ ОСВОЕНИЯ СЕВЕРА СИБИРСКОГО ОТДЕЛЕНИЯ РАН
ИНСТИТУТ АРХЕОЛОГИИ И ЭТНОГРАФИИ СИБИРСКОГО ОТДЕЛЕНИЯ РАН
ИНСТИТУТ ЭКОЛОГИИ РАСТЕНИЙ И ЖИВОТНЫХ УРАЛЬСКОГО ОТДЕЛЕНИЯ РАН

ЭКОЛОГИЯ ДРЕВНИХ И ТРАДИЦИОННЫХ ОБЩЕСТВ

Материалы V Международной научной конференции

г. Тюмень, 7–11 ноября 2016 г.

ВЫПУСК 5
Часть 1

Тюмень
Издательство
Тюменского государственного университета
2016

УДК 902
ББК Т44
Э400

Э400 **Экология** древних и традиционных обществ : материалы V Международной научной конференции, г. Тюмень, 7–11 ноября 2016 г. / под ред. доктора исторических наук, профессора Н.П. Матвеевой; Министерство образования и науки Российской Федерации, Тюменский государственный университет. — Вып. 5 : в 2 ч. — Ч. 1. — Тюмень : Издательство Тюменского государственного университета, 2016. — 242 с.

ISBN 978-5-400-01320-1 (ч. 1)
ISBN 978-5-400-01313-3

Доклады конференции посвящены методикам междисциплинарного исследования, раскрывающим процессы взаимодействия человека, природы и общества в самых широких хронологических рамках на территории Евразии. Особое внимание уделяется практике преобразования и восприятия ландшафтов у народов в разные эпохи. Представлены материалы изучения природных изменений и катастроф, как глобальных, так и частных, в конкретных регионах. Обсуждаются вариации физической, социальной и культурной адаптации коллективов, в том числе демографические аспекты, палеопатологии, динамика рациона питания. Рассматривается характер антропогенного воздействия на среду обитания. Научные работы объединены в разделы: «Историческая экология человека», «Реконструкция природного окружения древних и средневековых обществ», «Культурные ландшафты», «Жизнеобеспечение древних и средневековых обществ», «Этнология».

Издание осуществлено при поддержке гранта РГНФ 16-01-14030.

УДК 902
ББК Т44

ISBN 978-5-400-01320-1 (ч. 1)
ISBN 978-5-400-01313-3

10. Якимов А.С., Кайдалов А.С., Сечко Е.А., Пустовойтов К.Е., Кузяков Я.В. Почвы раннесредневекового (IV-VI вв. н.э.) городища Среднего Притоболья и их палеогеографическое значение. Археология, этнография и антропология Евразии. 2012. № 4 (52). С. 134-143.
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CLIMATE, VEGETATION AND SINTASHTA ECONOMY IN THE KARAGAILY-AYAT MICROREGION OF THE TRANS-URAL STEPPE

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КЛИМАТ, РАСТИТЕЛЬНОСТЬ И ХОЗЯЙСТВО СИНТАШТИНСКОЙ КУЛЬТУРЫ В КАРАГАЙ-АЯТСКОМ МИКРОРЕГИОНЕ СТЕПИ ЗАУРАЛЬЯ

ABSTRACT: Climate, food security and dietary habits are key issues in human history and up to the present time. Scientific investigations are increasingly focusing on the relationship between climate and subsistence in the past. This paper describes some archaeobotanical results from the Karagaily-Ayat microregion (Chelyabinsk oblast, Kartaly district) in the Transural steppe. There, fortified and systematically planned settlements emerged in the Bronze-Age, representing a completely new settlement model and way of life. In order to reconstruct the related vegetation and climatic conditions in the area as well as economic activities, we combine palynological, sedimentological, and plant macroremains analyses with radiocarbon dating. Cultural layers from archaeological excavations at the fortified Kamennyi Ambar settlement formed the basis to explore plant use among the inhabitants. Pollen data from natural archives were used for statistical comparisons (principal component and cluster analyses) and the subsequent high-resolution reconstruction of palaeoenvironmental conditions. Vegetation mapping with the help of multispectral satellite data in combination with pollen assemblages of surface samples was used to reconstruct past vegetation distribution, estimate steppe productivity, and create a model for livestock management during the Bronze Age. The limitation of the fortified settlements´ distribution (ascribed to the archaeological Sintashta culture) to the Transural region is believed to be the result of the prevailing environmental conditions in this steppe landscape and its perennial rivers. Even if the climate was suitable for agriculture, evidence for crop cultivation is missing from all botanical records. The economic mainstay was animal husbandry (cattle, sheep and some horses). Autonomous activity zones of at least 4 km radius around each Sintashta settlement with grazing resources could easily sustain the estimated population and their livestock.

Introduction. The Transurals, situated at the periphery of the Eurasian steppe belt at the northern fringe of Central Asia, are predestined to be a zone of cultural contact, connecting areas east and west of the Ural Mountains ([Бочкарев, 2010; Chernykh, 2008; Епимахов, 2010a, 2010b; Koryakova and Epimakhov, 2007;

Mei, 2003]. At the turn of the 3rd to the 2nd millennium BC, the Sintashta culture with fortified settlements, organized residential areas with rows of buildings, innovations in metallurgical and craft technologies such as spoke-wheeled chariots, as well as new burial rites appear in the Transural. In terms of food supply, cattle bones dominate the osteological material, and one might expect that cereal cultivation was introduced as yet another response to climate change. As the general climatic patterns of the Bronze Age have been controversially discussed in the past, the adaptation of a sedentary lifestyle may either have been triggered by more humid conditions [Gayduchenko, 2002; Лаврушин и Спиридонова, 1999] or by increased aridity, since the latter required animal stabling during winter [Anthony, 2009]. So far, systematic archaeobotanical studies have only been carried out in neighbouring ecological regions [for more references see Stobbe et al., 2016]. Within the scope of the Russian-German research project `Environment, Culture and Society of the Southern Urals in the Bronze Age: A Multidisciplinary Investigation in the Karagaily-Ayat Microregion, Russia` [Krause and Koryakova, 2013; Krause and Korjakova, 2014], the archaeobotanical analyses focus on the interactions between climatic change, human activities and economies in the Transurals.

Methods. Palynological and sedimentological investigations have been focused on the numerous depressions representing parts of the former river system along the Karagaily-Ayat. The age of the sediment sequences was determined by means of radiocarbon dating [Stobbe et al., 2015, 2016]. For statistical comparisons, principal component analyses based on species abundances were used. In order to map and quantify recent land cover patterns in the area of study, Landsat 7, Spot, and ASTER scenes of various recording dates were processed and classified in Erdas Imagine 14 and subsequently mapped in ArcGIS 9 (fig. 1). Sediment samples for plant macro-remain analysis were collected systematically from building features and cultural layers.

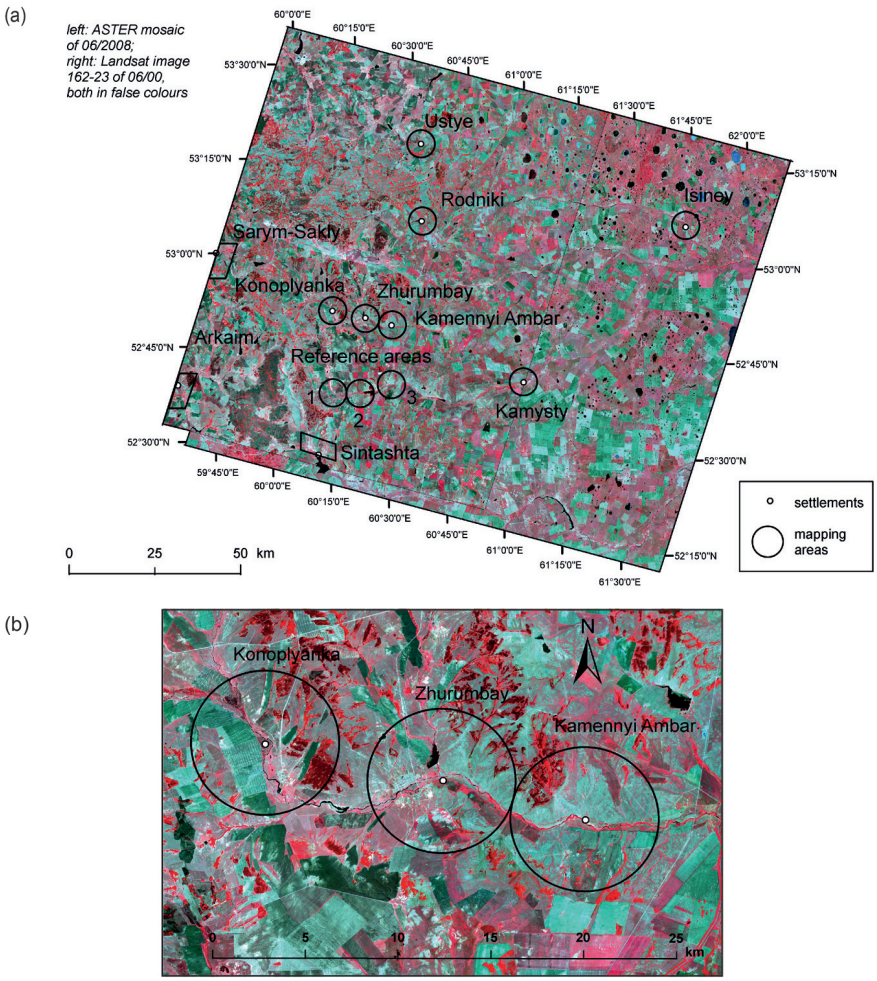

Fig. 1 (a) Overview of selected fortified settlements for vegetation mapping and (b) Karagaily-Ayat micro-region with the autonomous economic activity zones of 4 km radius around Konoplyanka, Zhurumbay and Kamennyi Ambar (subset of Figure 1a; all imagery in false colours)

Study area. The area of investigation extends from 50º to 54º N and 59º to 62º E on the Transural peneplain, located east of the southern Ural mountains and gently dipping towards the western Siberian lowlands. The undulating plain reaches altitudes between 200 and 300 m a. s. l. Chernozems are the dominant soil type, but as a result of secondary salinization, solonetz also occur [Чернянский, 1999; Плеханова и др., 2007]. The study area lies in the steppe zone and its natural vegetation is a herbaceous feather-grass and fescue/feather-grass steppe with small groves of birch (‘*kolki’*) and pine (‘*bory’*). In the floodplain of the perennial Karagaily-Ayat, species-rich meadow steppes have formed.

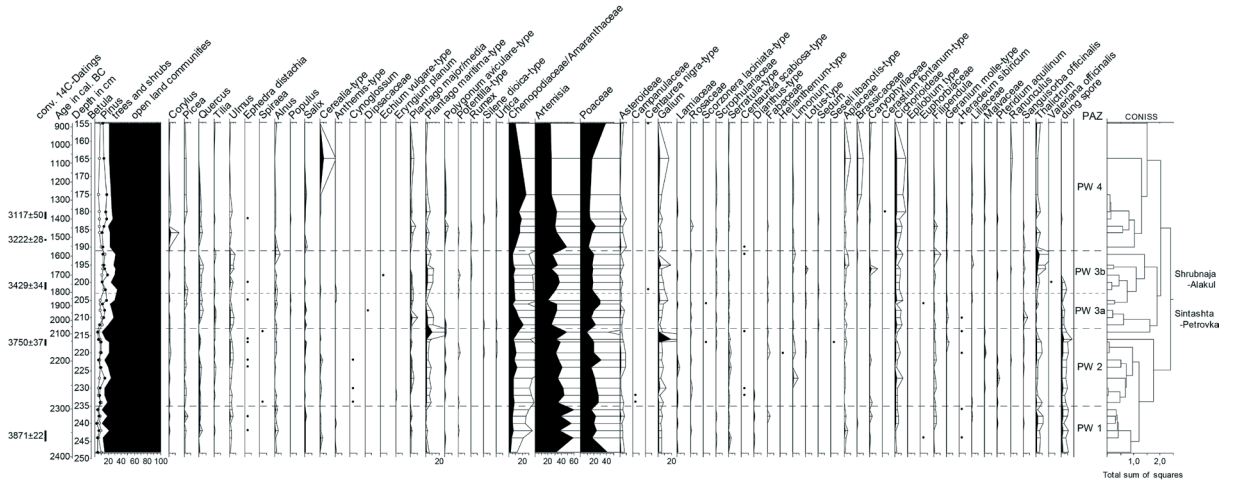

Fig. 2. Regional pollen diagram of depression PW. Percentages based on total terrestrial pollen counts (TTP), plotted on time and depth scale

Results and discussion. Environment. The pollen spectra of two deposits from the Karagaily-Ayat valley show that a steppe vegetation has existed for the last 9000 years. Artemisia, Chenopodiaceae, and Poaceae dominate all the pollen spectra and tree pollen reach maximum levels of 30–35%. Minor variations of tree pollen percentages, changes of the *Artemisia*/Chenopodiaceae ratio and the composition of herbs do indicate, however, that the steppe vegetation during the Bronze Age was subject to variations [Kalis and Stobbe, 2012; Stobbe, 2013; Stobbe et al., 2015, 2016]. According to palynological data (Fig. 2), *Artemisia* was dominant around 2400 cal. BC, pointing at the existence of an undisturbed feather-grass steppe. The percentages of deciduous trees (Ulmus, Quercus, Tilia and Alnus*)* reach their highest values during this phase and thus imply that the climate was relatively humid. Parallel to the founding of the settlement Kamennyi Ambar around 2100 cal. BC, Artemisia values drop while Chenopodiaceae values increase. At the same time, tree pollen increase as well, (which testifies the continued existence of a humid feather-grass steppe with a slightly higher share of forest, while the rise of Chenopodiaceae hints at the degradation of the steppe as a result of anthropogenic impact. The small lakes around the settlement were probably used as watering holes for domestic animals, thus strongly affecting the local vegetation. Around 1900 cal. BC, the pollen composition accounts for a reduced human and animal interference. The pollen curve of Chenopodiaceae drops, that of Poaceae rises, and the riparian vegetation appears to be less disturbed. These developments can be correlated with the end of the Sintashta–Petrovka settlement phase. In the period that followed, and during the subsequent Srubnaya-Alakul phase, the pollen spectra provide evidence for human impact on a minor scale. It can possibly be related with a less intensive, rather seasonal occupation in contrast to the Sintashta period. Around 1700 cal. BC, dung spores are no longer present, and Plantago major*,* which, together with Chenopodiaceae, serves as an indicator for anthropogenic influence, is not attested, either. This development can be correlated with the abandonment of the settlement Kamennyi Ambar. Approximately 150 years after evidence for arid conditions is found.

Results of principal component analysis (PCA) reveal that zones equivalent to the Bronze Age cluster together with samples from the last 400 years and recent surface samples [Stobbe et al. 2015; 2016]. These similar vegetation patterns may result from comparable climatic conditions. With respect

to the micro-region along the Karagaily-Ayat River, a relatively humid climate predominated between approximately 2400 and 1600 cal. BC, and during the last 400 years. We therefore have to assume that the introduction of new settlement forms and economic systems related to sedentism were not developed in response to aridity in the Bronze Age [Stobbe, 2013; Stobbe et al., 2015; 2016]. The results indicate that, despite the occurrence of periodic droughts, farming was theoretically possible in the Sintashta environment [Stobbe et al., 2015]. However, the analyses of the macrobotanical remains at Kamennyi Ambar and Konoplyanka [Rühl et al., 2015] did not reveal evidence of agriculture for the Sintashta period. Residues of cultivated plants were not found. All plant macro-remains belong to wild herbaceous plants and trees from the steppe area. Some ruderal plants (Polygonum and Chenopodium species and some Asteraceae) are the only indicators of a (slight) degradation of the steppe which may have caused by zoo-anthropogenic influences as well as the abundance of salt in local soils and long-lasting dry spells. The Bronze Age economy was mainly based on animal husbandry, supplemented by fishing and gathering of wild plants [Rühl et al., 2015; Stobbe et al., 2013].

Capacity model for the Karagaily-Ayat microregion. Along a 20 km segment of the Karagaily-Ayat River, the Konoplyanka, Zhurumbay, and Kamennyi Ambar sites are located relatively close to each other in contrast to the average distance of about 23 km between Sintashta sites. Provided that these three settlements were inhabited contemporaneously, the minimum radius of independently managed economic zones in the immediate surroundings was 4 km and the sustainable management of ecological resources must have been possible within the available space (Fig. 1). To test this hypothesis, we calculated the biomass production and grazing capacity of the given rangeland and determined the number of animals which can be sustainably managed within the 4 km radius throughout the year. The model is based on the recent vegetation distribution and respective area sizes derived from the vegetation mapping. Our results show that the autonomous economic zone around Kamennyi Ambar could support 0.47 livestock units per ha (1 livestock unit = 1 cow = 1 horse = 10 sheep). Taking into account estimated population figures of selected Sintashta settlements (41-42 buildings with 5-10 individuals per household) the assumed animal numbers per capita for the Bronze Age [2.4 animals as estimated by Косарев, 1991 for the late Bronze Age] as well as the herd composition (50% cows, 40% sheep and 6% horses [Rassadnikov et al., 2013]), the natural environment of the considered areas was suited to support a sedentary society of livestock herders without any danger of overgrazing — even if we assume a household size of 10 persons with a total of 1000 animals [Stobbe et al., 2016].

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