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The effect of cropping on diversity and density of springtails (Hexapoda: Collembola) in Khuzestan province, Southwest of Iran

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Abstract

In order to assess the effects of cropping and agriculture on species diversity and Collembolan abundance, two different microhabitats (a wheat field and an abandoned wheat field) were selected in Ramhormoz, Khuzestan province, south west of Iran. Samples were collected monthly from 0 to 15 cm soil depth during 2010 and 2011. A total of 2700 collembolan specimens including 14 species from 11 genus and 7 families were collected from both sites that among them 11 species were collected from the abandoned field while all of them were collected from the crop field. Among the species *Hypogastrura manubrialis* and *Lepidocyrtus sp.* contributed to the high percentage and dominate the total recorded population of Collembola. Analysis of species diversity by Shannon-Wienner index indicated that the diversity index was significantly higher ($p < 0.05$) in the crop field (2.58±0.01) than in the abandoned field (1.61±0.19) and the species densities in the crop field were more homogeneous.

Keywords: Microarthropods, Biodiversity, Fauna, Ramhormoz

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Introduction

Collembola commonly known as springtails, are small wingless soft-bodied hexapods that are usually less than 6 mm in length. This group generally found on or near the surface of the soil and in the litter, under rocks or trees bark. They are free-living and omnivorous organisms, which prefer moist conditions (Paul *et al*., 2011). They contribute to decomposition of organic matter indirectly through the fragmentation of organic matter and the control of soil microbial communities (Bardgett *et al*., 1997). Most Collembola are either microphages, feeding on soil micro flora, and/or detritivores, scavenging on dead organic matter and plant litter (Bardgett *et al*., 1993). Among potential bioindicators collembolans have been considered as a suitable representative because of their integral and beneficial roles in the soil community (Huang *et al*., 2013). Springtails are an important source of prey for polyphagous predators (Hopkin, 1997) and live in close association with the soil microflora and fauna, rendering them better suited for study than larger more mobile invertebrates in small plot agricultural field trials (Cole *et al*., 2001). The soil vegetation covers influence the activities of soil organisms including springtails. This group of microarthropods are ecologically relevant in the soil and sensitive to changes in vegetation, quality of litter materials, habitat structure and human induced disturbances related to land use and management practices, so they can be used as indicators of biodiversity (Muturi *et al*., 2009). Relatively few studies have investigated the effects of cropping on the abundance and biodiversity of Collembola. Among them, Brennan *et al*., (2004) have studied the effects of some agricultural practices on the species richness and abundance of Collembola and Cancela da Fonseca and Sarkar (1998) investigated the effect of agriculture on microarthropods biodiversity. Their results showed that cropping has positive effect on Collembola abundance and biodiversity. Understanding the effect of disturbance as a result of changes in land use practices on abundance and diversity is important to preserve biodiversity of collembolans in human-disturbed land uses (Muturi *et al*., 2009). Although some studies have been done to evaluate the degree of change in collembola diversity patterns related to land use intensification in some parts of the world (Cancela da Fonseca & Sarkar, 1998; Ponge *et al*., 2003; Muturi *et al*., 2009; Paul *et al*., 2011), there isn't any study about collembolan biodiversity in Iran. The high sensitivity of collembolans to microclimatic changes makes them very important bio-indicators of land degradation (Stork, 1995). This group of insects are sampled and identified easily and the study on their biodiversity may be helpful for development of conservation strategies. The aim of this study was to evaluate the effect of cropping on the abundance and diversity of collembolan communities in two different microhabitats in Ramhurmoz, Khuzestan province, south west of Iran.

Materials and Methods

Study area and sampling methods:

The present investigation was carried out in a crop field with two different kinds of plant (wheat in winter and tomato in summer) and an abandoned crop field with about 3 km distance from each other, in Ramhormoz city (31˚15'N, 49˚33'E) in Khuzestan province, south west of Iran. In each sampling occasion, triplicate soil samples from 0 to 15cm soil depth and 10 diameter were taken monthly, during January to December in 2010 and 2011. The soil samples were collected by use of a small shovel and transported to the laboratory at the Ramin agriculture and natural resources university of Khuzestan. The collembolan specimens were extracted using Berlese-Tullgrun funnel and stored in 75% ethanol. Lactophenol and Hoyer’s medium were utilized for bleaching, and then fixing the specimen on the microscopic slides, respectively. The collembolan species were identified according to the keys of Bellinger *et al*. (2014), Potapov (2001) and Thibaud *et al*., (2004).

Statistical analysis

Shannon-Wienner index (H') were calculated for all samples using SDR version 4 software (Species Diversity and Richness, V.4) (Seaby & Henderson, 2006) and one tailed t-test were used to determine the differences between the diversity indices at different sampling sites (Seaby & Henderson, 2006) and the Pielou's evenness index was used to analyze the evenness of each community. The evenness (range 0-1) is a measurement of population-balance in sites, with values ≥ 0.8 indicating optimum population balance (Magurran, 2004).

Results

A total of 2700 collembolan specimens contained fourteen species from eleven genus and seven families were collected from both sites. All fourteen species were collected from the mixed crop field repeatedly but just eleven species from the abandoned field (Figs. 1, 3 and 4). The mean total collembolan density in the crop field (641 individuals/m^2) was higher than in the abandoned field (194 individuals/m^2). The highest and the lowest density was recorded during winter and summer, 380 and 218 individuals/m^2 in crop field and 39 and 4 individuals/m^2 in the abandoned field respectively (fig. 2). The abundance of collembolan species in crop and abandoned fields is shown in figures 2 and 3 respectively. *Hypogatrira manubrialis* Tullberg, *Lepidosyrtus sp*. and *Isotomus palustris* Müller were dominant species in abandoned field and *H. manubrialis, Balistura tuberculata* Stach and *Parisotoma notabilis* Schäffer counted for the highest density in crop field (figs. 2 and 3). The Shannon index of diversity was 1.61±0.19 and 2.57±0.01 and Pielou index of equitability was 0.67±0.06 and 0.97 ±0.004 for the abandoned and crop fields respectively (Table 1). The analysis of difference between the indices of diversity indicated that collembolan diversity in crop field significantly is higher than in the abandoned field at 5% level.

Discussion

As a group, springtails are highly sensitive to desiccation, because of their tegumentary respiration. While springtails contribution to soil respiration is relatively low (Petersen and Luxton, 1982), it is apparent that this group, by their large numbers, have profound impact on soil processes through their influence on the composition and activity of the soil micro flora, and by fragmenting and consuming plant residue (Bardgett *et al*., 1997). The weather condition in this area (Khuzestan province) is hot and dry. Due to irrigation and cropping, the soil in crop field was always wet but in abandoned field was highly dry especially in mid spring till mid-autumn. The overall density and diversity of collembola was higher in the crop field as compared to abandoned field. This may be indicative of soil destruction as a result of desiccation in spring and summer in the abandoned field. In crop field cropping and irrigation alter the soil structure and its chemical nature while in the abandoned field depletion in the soil water and drought making the soil less habitable and conductive for the growth and sustenance of the soil fauna. Higher species diversity and density was recorded during the winter when the soil moisture was on the higher range than summer months. Among the collembolan species *Hypogastrura manubrialis* and *Lepidocyrtus sp.* Contributed to the high percentage to total density in both study sites in late autumn and winter. This implies that these species dominate the total recorded population of collembola and have a wide range of tolerance to soil perturbances. Our results was similar to Cancela da Fonseca and Sarkar (1998). They showed that microarthropod abundances were similar in the rice field and waste land but diversity was higher in the rice field in comparison with the waste land.

Furthermore, the rhizosphere is important for feeding the soil microarthropods. In the abandoned field because of reduced rhizosphere and depletion of organic matter content of soil, temperature is higher and water content is lower than the crop field. These may affect community structure of microarthropods as well as collembolan so the higher number of Collembola found in the crop field as shown by the Garrett *et al.* (2001). Huang *et al.* (2013) assessed collembolan biodiversity at three Gorges area in China and showed that Collembola biodiversity is systematically lost after urbanization and species richness was lowest in highly influenced area organic agricultural methods generally increase biodiversity. This is particularly relevant because modern agriculture has resulted in a loss of diversity in the agricultural landscape and it has been suggested that large scale conservation to organic farming could partly ameliorate this loss (Bengtsson *et al*., 2005).

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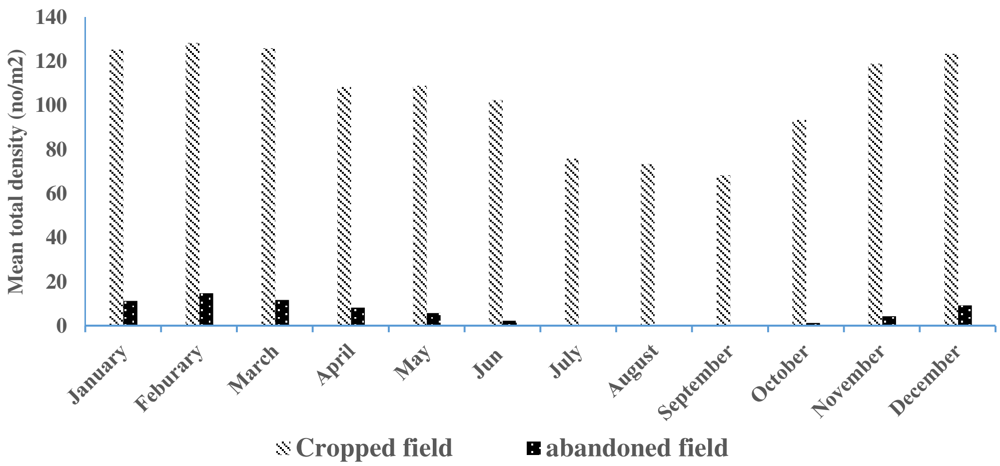

Fig. 1- Mean total density of Collembola in crop and abandoned fields per month during 2010 and 2011

Table 1- Species diversity and Evenness of Collembola in two sampling sites during 2010-2011

Sampling sites	*H'*	*SE*	*J*	*SE*
Crop field	2.57	0.011	0.97	0.004
Abandoned field	1.61	0.197	0.67	0.061

H': Shannon-Wienner index, *J*: Pielou's evenness index.

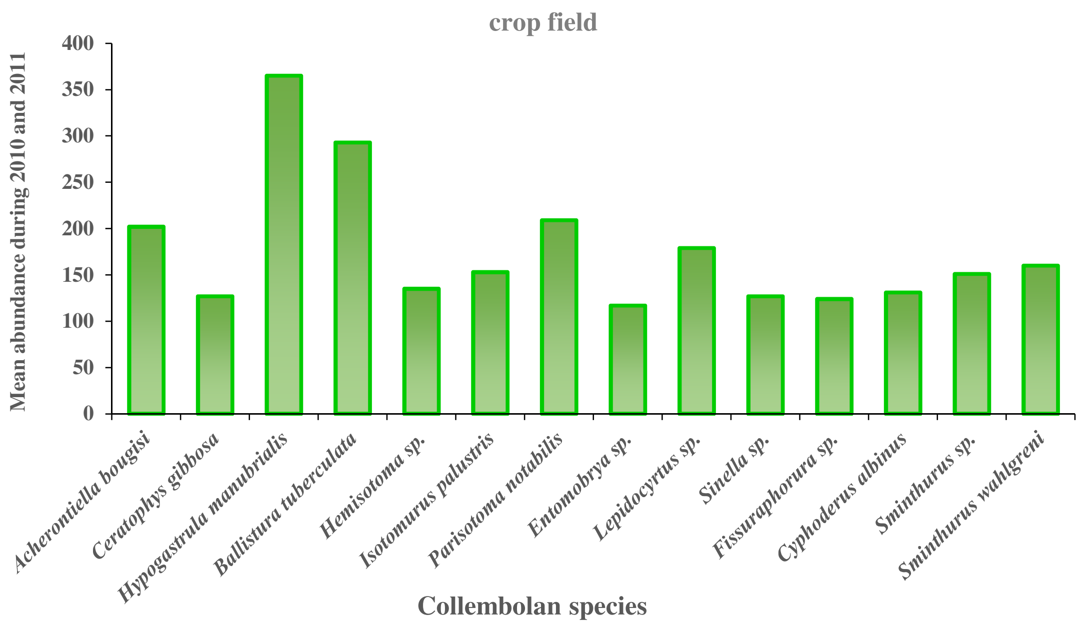

Fig. 2- Mean abundance of collembolan species in crop field during 2010 and 2011

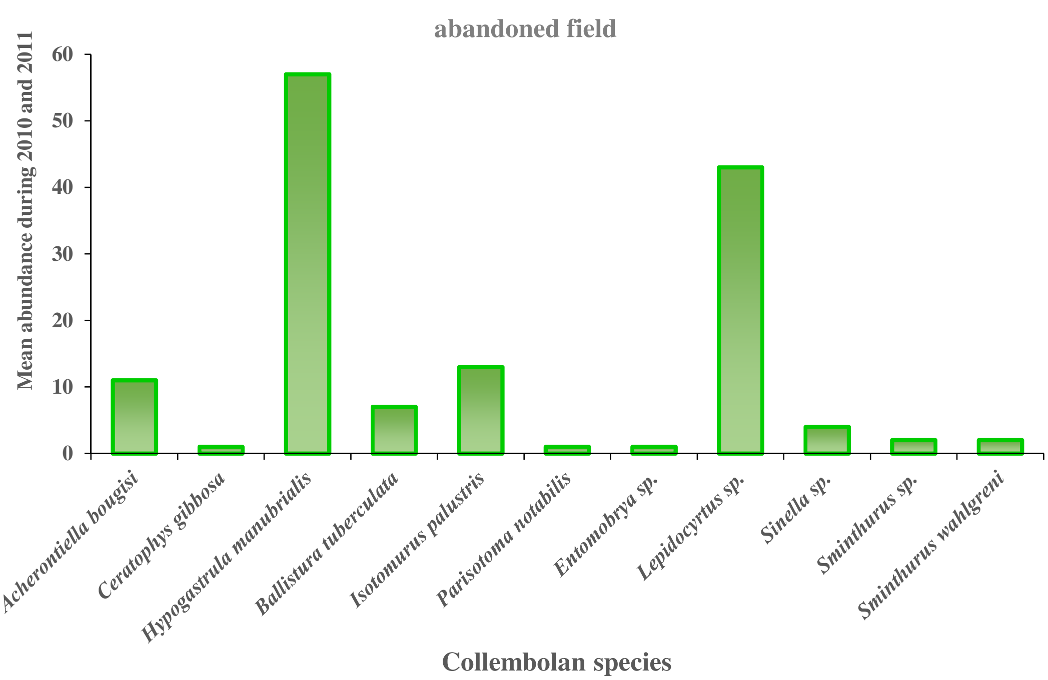

Fig. 3- Mean abundance of collembolan species in abandoned field during 2010 and 2011

References

Bardgett, R. D., Frankland, J. C. and Whittaker, J. B. 1993. The effects of agricultural practices on the soil biota of some upland grasslands. Agriculture, Ecosystem and Environment, 45: 25:45.

Bardgett, R. D., Leemans, D. K., Cook, R. and Hobbs, P. J. 1997. Seasonality of soil biota of grazed and ungrazed hill grasslands. Soil Biology and Biochemistry, 29(8): 1285-1294.

Brennan, A., Fortuneb, T. and Bolger, T. **2004**. Collembola abundances and assemblage structures in conventionally tilled and conservation tillage arable systems. Proceeding of the XIth international colloquium on Apterygota, Rouen, France, 135-145.

Bellinger, P. F., Christiansen, K. A. and Janssens, F. **2014**. Checklist of the Collembola of the World. Retrieved from www.collembola.org.

Bengtsson, J., Ahnstrom, J. and Weibull, A. C. **2005**. The effects of organic agriculture on biodiversity and abundance: a Meta –analysis. Journal of applied Ecology, 42: 261-269.

Cancela da Fonseca, J. P. and Sarkar, S. **1998**. Soil microarthropods in two different managed ecological systems (Tripura, India). Applied Soil Ecology, 9: 105-107.

Cole, L. J., McCracken, D. I., Foster, G. N. and Aitken, M. N. 2001. Using Collembola to assess the risks of applying metal-rich sewage sludge to agricultural land in western Scotland. Agriculture, ecosystems and Environment, 83: 89- 177.

Garrett, C. J., Crossley Jr, D. A., Coleman, D. C., Hendrix, P. F., Kisselle, K. W. and Potter, R. L. 2001. Impact of the rhizosphere on soil microarthropods in agroecosystem on the Georgia piedmont. Applied Soil Ecology, 16: 141-148.

Hopkin, S. **P. 1997**. Biology of the springtails. Oxford, 340pp.

Huang, C., Wang, T., Luo, Y., Chen, S. and Kim, K. C. 2013. Assessing Collembola biodiversity under human influence at three Gorges area China. Environmental of Entomology, 2(2): 214-222.

Magurran, A. E. 2004. Measuring Ecological Diversity. Blackwell publishing, Oxford, pp: 256.

Muturi, J. J., Mbugi, J. P., Mueke, J. M., Lagerlóf, J., Mungatu, J. K., Nyamasyo, G. and Gikungu, M. 2009. Collembola density and diversity along a gradient of land-use types in Embu district, eastern Kenya. Tropical and Subtropical Agro ecosystems, 11(2): 361-369.

Paul, D., Nongmaithem, A. and Jha, L. K. **2011**. Collembolan density and diversity in a forest and agro ecosystem. Open Journal of Soil Science, 1: 54-60.

Petersen, H. and Luxton, M. 1982. A Comparative Analysis of Soil Fauna Populations and Their Role in Decomposition Processes. Oikos, 39(3): 288-388.

Ponge, J. F., Gillet, S., Dubs, F., Fedoroff, E., Haese, L., Sousa, P. J and Lavelle, P. 2003. Collembola communities as bio indicators of land use intensification. Soil Biology Biochemistry, 35: 813-826.

Potapov, M. 2001. Synopses on Palearctic Collembola, volume 3. Isotomidae. Abhandlungen und Berichte des Naturkundemuseums Görlitz, 73: 1–603.

Seaby, R. M. and Henderson, P. A. 2006. Species Diversity and Richness Version 4. Pisces Conservation Ltd., Limington, England.

Stork, N. E., 1995. Measuring and monitoring arthropod diversity in temperate and tropical forests. In: Boyle, T. J. B., Boontawee, B. (Eds.), Measuring and Monitoring Biodiversity in Tropical and Temperate Forests. Center for International Forestry Research, Bogor, 257–270.

Thibaud, J. M., Schulz, H. J. and da Gama Assalino, M. M. **2004**. Synopses on Palaearctic Collembola, volume 4. Hypogasturidae. Abhandlungen und Berichte des Naturk undemuseums Görlitz, 75: 1–287.

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اثر کشاورزی بر تنوع و تراکم پادمان (Hexapoda: Collembola) در استان خوزستان، جنوب غرب ایران

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چکیده

به‌منظور ارزیابی اثرات کشاورزی بر تنوع گونه‌ای و فراوانی پادمان، دو خرد زیستگاه متفاوت (یک مزرعه گندم و یک مزرعه قدیمی متروکه) در شهرستان رامهرمز در استان خوزستان واقع در جنوب غرب ایران انتخاب گردید و نمونه‌برداری‌هایی به‌صورت مرتب هر ماه یک‌بار از عمق ۰ تا ۱۵ سانتی‌متری خاک طی سال‌های ۱۳۸۹ تا ۱۳۹۱صورت گرفت. در مجموع ۲۷۰۰ نمونه پادم جمع‌آوری گردید که شامل ۱۴ گونه از ۱۱ جنس و ۷ خانواده بودند. از میان گونه‌های جمع‌آوری شده، ۱۱ گونه از مزرعه متروکه جمع‌آوری گردید درحالی‌که تمام گونه‌های شناسایی شده از مزرعه گندم جمع‌آوری شدند. گونه‌های *Hypogastrura manubrialis* Tullberg و *Lepidocyrtus sp* با داشتن بالاترین درصد فراوانی به‌عنوان گونه‌های غالب شناسایی شدند. نتایج آنالیز تنوع گونه‌ای با استفاده از شاخص شانون وینر نشان داد که این شاخص در مزرعه گندم (۲/۵۸±۰/۰۱) به‌صورت معنی‌داری ($p < 0.05$) بالاتر از مزرعه رهاشده (۱/۶۱±۰/۱۹) بود. همچنین فراوانی گونه‌ها از یکنواختی بالاتری در مزرعه گندم نسبت به مزرعه متروکه برخوردار بودند.

واژه‌های کلیدی: بندپایان کوچک، تنوع زیستی، فون، رامهرمز

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