

Review Article

A view on the historic and contemporary acridid fauna (Orthoptera: Caelifera: Acrididae) of Iran-A call for conservation efforts

Seyed Hossein Hodjat¹, Alireza Saboori¹ and Martin Husemann^{2*}

1. Jalal Afshar Zoological Museum, Department of Plant Protection, Faculty of Agriculture, University of Tehran, Karaj, Iran.
2. Centrum für Naturkunde, Universität Hamburg, 20146 Hamburg, Germany.

Abstract: The decline of biodiversity, specifically of insects is one of the major topics in conservation biology. In several countries of Europe, recent studies have shown a severe decline in species number and biomass of insects. In most countries of much higher diversity, much less is known about the state of the insect fauna. In this study, we focus on the acridid grasshoppers of Iran as an indicator taxon for diversity decline in a high diversity region. We used data of two surveys to suggest a change in species number between 1963 and after 2000. In the surveys before 1963, the species diversity across multiple localities in Iran was much higher compared to more recent faunistic studies. While this data is not statistically analyzable as the sampling is not completely comparable, the trends show a clear pattern of decline, which likely reflects the reality, conforms well to individual observations of less frequent encounters in the field and matches global patterns of insect decline. However, more standardized quantitative surveys are needed to generate statistically analyzable data. Potential reasons for the observed decline are severe draughts as a result of global climate change, habitat pollution, and destruction for construction and mining and especially overgrazing. Management actions need to be urgently put into place to stop the negative trends. Future studies need to document and test if these are taxon-specific trends or universal patterns in the region.

Keywords: Acrididae, biodiversity hotspot, grasshoppers, nature conservation, Orthoptera

Introduction

Recent studies in Germany and other Western European countries have documented a disastrous decline of flying insect biomass (Hallmann *et al.*, 2017) and species diversity (Fox, 2012). The factors driving this decline are not yet fully explored but are clearly

related to altered land use patterns, intensive use of pesticides and likely climate change. While much is now invested to understand the drivers of insect decline in Europe and to develop action plans preventing further decline much less is known on population trends in other parts of the world, especially in countries with high biodiversity, despite these regions often are specifically threatened. For such regions with high biodiversity and high threat the term biodiversity hotspot has been coined (Myers *et al.*, 2000).

Handling Editor: Ali Asghar Talebi

* **Corresponding author**, e-mail: martin.husemann@uni-hamburg.de
Received: 27 September 2018, Accepted: 15 February 2019
Published online: 21 February 2019

Iran is known to be part of the Irano-Anatolian global biodiversity hotspot (Mittermeier *et al.*, 2011). Its high orographic and climatic diversity with vast deserts and mountain ranges provides large areas of suitable habitat for many species (Noroozi *et al.*, 2008; Gholamifard, 2011; Katouzian *et al.*, 2016; Farashi and Shariati, 2017). This has led to high numbers of endemic taxa (Abivardi, 2001). One group of insects specifically diverse in Iran are the Orthoptera with more than 426 species and subspecies (Cigliano *et al.*, 2018). The short-horned grasshoppers (Caelifera), with 317 species and subspecies (Cigliano *et al.*, 2018; Hodjat *et al.*, 2018), used to be found in high diversity and abundances in Iran. However, at present habitat destruction, overgrazing and construction of roads, as well as the increased heat and decreased water availability due to climate change and erosion (Amiri and Eslamian, 2010; Amiraslani and Dragovic, 2011; Darvish and Rastegar-Pouyani, 2012; Kolahi *et al.*, 2012; Akhani, 2015; Jowkar *et al.*, 2016) are threatening biodiversity in general and the diversity of Caelifera specifically (Dey *et al.*, 2018). Monitoring of sensitive indicator taxa may help to understand the consequences of these destructive forces.

Grasshoppers, despite often being considered pest organisms, represent sensitive indicators of ecosystem health (Bazelet and Samways, 2011) and have for example been shown to be good models to monitor steppe succession (Fartmann *et al.*, 2012) or the status montane wetlands (Wettstein and Schmid, 2001). Studies of the grasshoppers in Iran have a long tradition and can be largely divided into two periods. In the first period, before 1960, grasshopper species were very abundant. In the second period, after 1960, records indicate a reduction of grasshopper abundance and diversity in various regions of the country, e.g. in Tehran, Khorasan, Azerbaijan, and Kurdistan (Garai, 2010). In the following, we will use survey data from lists of Mirzayans (1959) and Shumakov (1963) and compare

these to more recently published records (i. e. Garai, 2010) to indicate potential trends in the change of abundance of Acrididae in Iran.

Materials and Methods

In this study, we analysed the data of the two largest surveys published by Shumakov (1963) and by Garai (2010). Shumakov himself performed several expeditions to Iran, and also included museum specimens collected before 1963 in his lists. A second general survey of Orthoptera in Iran was published by Garai (2010). Material for this work was collected during various expeditions from 2000 to 2007. Garai's expedition in 2001 included Guilan, Azerbaijan, Mazandaran, North, Razavi and South Khorasan, Isfahan, Hamedan, Zanjan and Tehran Provinces. In 2002, Bushehr, Kerman, Ilam, Lorestan, Fars, Yazd and Hamedan Provinces were visited. From 2003 to 2007 these provinces were repeatedly surveyed.

Results and Discussion

Work on the Orthoptera fauna of Iran has a great tradition with many of the most famous orthopterologists having worked in the country (Uvarov, 1933, 1938; Bey-Bienko, 1948; Chopard, 1959; Shumakov, 1963; Descamps, 1967). Currently, 426 taxa of Orthoptera are listed for Iran; 317 species of Caelifera and 109 for Ensifera (Cigliano *et al.*, 2018). Shumakov (1963) reported a total of 291 Orthoptera taxa in his survey (Fig. 1). Garai (2010) in turn only found 110 species, which suggests a decline of more than 60 % of species. However, it is also clear that the surveys are not comparable and likely much more effort was invested in the first. Hence, it is important that in the future more standardized surveys and collections are performed to gain a better understanding of the actual declines. Nevertheless, the observed trend of decline is likely true as other recent surveys in specific regions of

Iran also show much less taxa than Shumakov's work (Table 1). For Mashhad, for example, Shumakov (1963) reported 30 species, whereas Garai (2010) only found nine species and Jabbari *et al.* (2015) found 19. The results all clearly suggest a decline of species after 1963, which is further supported by observations by the first author of the paper and related scientists in the field (A. Hodjat, pers. obs.).

Interestingly, specific groups of grasshoppers seem to be more vulnerable than others. Several subfamilies were not found in recent surveys any more: Conophymatinae, Hemiaceridinae, Iranellinae, Oxyinae, and Tropidopodinae. These subfamilies only occurred with small numbers of species before, but may have vanished completely. Of the more species-rich groups Acridinae, Tetrigininae, Gomphocerinae, and Pamphaginae seemed to have strongly declined (Fig. 1). Especially, the Pamphaginae seem to have suffered strongly: researchers of the Jalal Afshar Zoological Museum, for example,

organized many trips to northern Karaj districts attempting to recollect *Tropidauchen* and *Saxetania* species, but none were found. Overall the whole family of Pamphagidae appears to have become rare: no member of the family were found in Varamin, Shahr-Rey, Arasbaran, Mashhad, and Khoda-Afrin (Alipoor *et al.*, 2014) or from Arasbaran, Mashhad and south Tehran (Sianaki, 2012; Havaskary *et al.*, 2012; Jabbari *et al.*, 2015). Pamphagidae appear to be a vulnerable taxon in general and have been reported endangered in other regions of the world (Foucart and Lecoq, 1998; Contreras-Diaz *et al.*, 2006). For this family, habitat destruction and loss of their main food plants are the main threatening factors. For other groups, such as the pygmy hoppers (Tetrigidae), the increasing desertification and lack of freshwater sources may be major problems. Along with this goes strong salinization and the related change of vegetation structure and plant communities, which may be detrimental to some grasshopper groups.

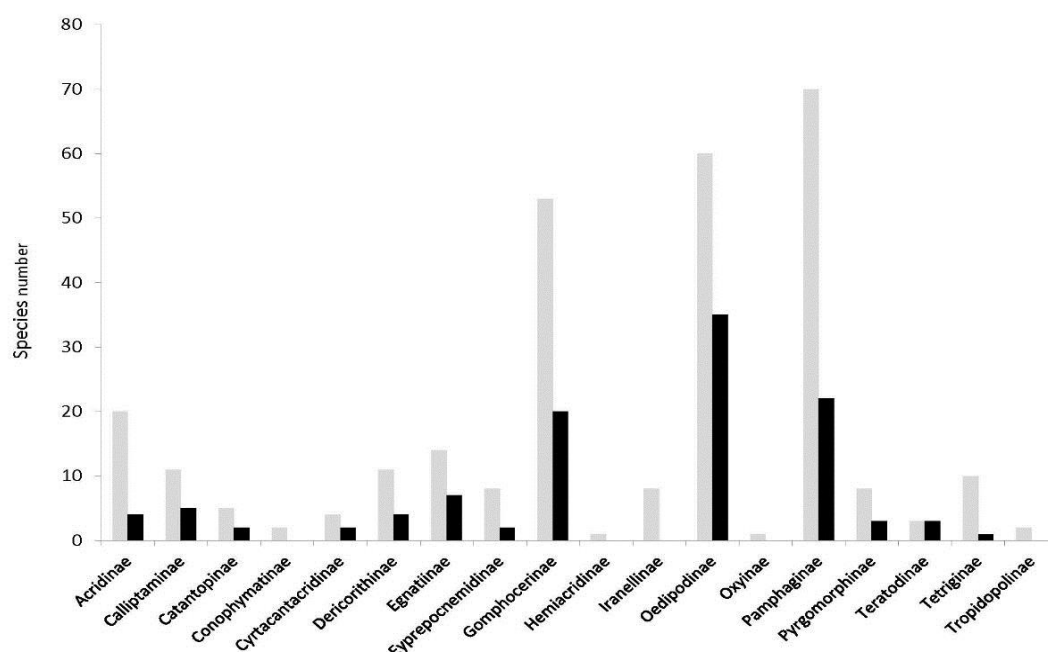


Figure 1 Number of species recorded in 18 subfamilies of Acridoidea recorded by Shumakov (1963, grey) compared to Garai (2010, black).

Reasons for the decline of Orthoptera in Iran are diverse, but four factors may be the strongest drivers: desertification, pollution, habitat destruction for mining and roads, and overgrazing (Fig. 2). Desertification in Iran was first recognized in the 1930s. Overgrazing of rangelands, increasing global temperature, and decreasing rainfall are factors that further enforced rapid desertification. Desert areas in Iran have strongly increased in the last decades and threaten major parts of the country, except parts of Kurdistan, and the areas around the Caspian Sea. Seventeen regions already have

vast deserts: Bushehr, Fars, Hormozgan, Ilam, Isfahan, Kerman, South Khorasan, Razavi Khorasan, North Khorasan, Khuzestan, Central deserts (Markazi), Qazvin, Qom, Semnan, Sistan and Baluchistan, Tehran and Yazd (Amiraslani and Dragovich, 2011). The gradual reduction of rainfall in Iran from 1935 and particularly after 1963 is well documented and has changed the fauna significantly within the last 50 years (Khaliq *et al.*, 2014); a pattern also observed in other regions, e.g. by Low *et al.* (2013) and Footit and Alder (2009) for Kazakhstan and Turkmenistan.

Table 1 Comparison of Acrididae records by Shumakov (1963) and later surveys at four localities of Iran. The number of species recorded in 1963 could not be recovered in any of the more recent surveys.

Locality	Sistan-Baluchistan	Central deserts (Markazi)	Mashhad	South Khorasan
Shumakov (1963)	28	30	30	36
Garai (2010)	5	19	9	5
Havaskary <i>et al.</i> (2012)	-	26	-	-
Jabbari <i>et al.</i> (2015)	-	-	19	-
Hosseini and Mofidi-Neyestanak (2014)	-	-	-	25



Figure 2 Main reasons for Orthoptera decline in Iran: a) habitat destruction for construction, b) desertification, c) overgrazing, and d) pollution.

While desertification is a major problem not only for grasshoppers, but also humans, grasshoppers and other arthropods are under a more direct threat-sheep. Overgrazing is a very imminent problem in Iran and concerns most of the country and even protected areas. While tackling the negative impacts of climate change is an almost impossible task, overgrazing, pollution, and mining can be more easily addressed. In order to preserve at least parts of the fauna still present in the country, conservation management plans are urgently needed. In order to make informed and wise decisions, the biodiversity of Iran needs to be studied in much more detail with standardized surveys to identify areas of specifically high biodiversity and hence conservation concern.

Acknowledgements

We thank Dr. Adrienne Garai, Dr. Axel Hochkirch and two anonymous reviewers for comments on previous versions of the manuscript.

References

- Abivardi, C. 2001. Iranian Entomology-An Introduction. Vol. 1: Faunal Studies. Springer-Verlag, Berlin-Heidelberg, Germany.
- Akhani, H. 2015. Iran's environment under siege. *Science*, 350: 392.
- Alipoor, M., Irani, S., Kazemi, M.S., Ghanbalani, G. N. and Mofidi-Neyestanak, M. 2014. Orthoptera identification in Khoda-Afarin region of east Azerbaijan and dominant species. *Entomology Journal of Agricultural Crops*, 4: 37-47.
- Amiraslani, F. and Dragovich, D. 2011. Combating desertification in Iran over the last 50 years. An overview of changing approaches. *Journal of Environmental Management*, 92: 1-13.
- Amiri, M. J. and Eslamian, S. S. 2010. Investigation of climate change in Iran. *Journal of Environmental Science and Technology*, 3: 208-216.
- Bazelet, C. A. and Samways, M. J. 2011. Identifying grasshopper bioindicators for habitat quality assessment of ecological networks. *Ecological Indicators*, 11: 1259-1269.
- Bey-Bienko, G. Y. 1948. New species and subspecies of acridids (Orthoptera: Acrididae) from Baluchistan [in Russian]. *Comptes Rendus de l'Académie des Sciences de l'URSS (C. R. Acad. Sci. URSS) (N. S.)*, 60: 498.
- Chopard, L. 1959. Gryllides d'Iran. [Ergebnisse der entomologischen Reisen Willi Richter, Stuttgart, im Iran 1954 und 1956 Nr. 22.]. *Stuttgarter Beiträge zur Naturkunde, Serie A (Biologie) (Stuttg. Beitr. Naturk. Ser. A)*, 24: 4.
- Cigliano, M. M., H. Braun, D. C. Eades and Otte, D. 2018. *Orthoptera Species File*. Version 5.0/5.0. [26.09.2018]. <http://orthopteraspeciesfile.org>.
- Contreras-Diaz, H. G., Lopez, H., Oromi, P. and Juan, C. 2006. Microsatellite loci development in endangered pamphagid grasshoppers endemic to the Canary Islands (Orthoptera). *Conservation Genetics*, 7: 767-771.
- Darvish, J. and Rastegar-Pouyani, E. 2012. Biodiversity conservation of reptiles and mammals in the Khorasan Provinces, Northeast of Iran. *Progress in Biological Sciences*, 2: 95-109.
- Descamps, M. 1967. Revue et diagnose preliminaire de quelques Pamphagidae et Acrididae d'Iran (Orth. Acridoidea). *Entomologie Systematique*, 72: 27-37.
- Dey, L.-S., Saboori, A., Hodjat S. H., Tork, M. and Husemann, M. 2018. A faunistic review of the Iranian species of *Sphingonotus* (Orthoptera, Oedipodinae) with a key to the species. *Zootaxa*, 4379: 151-176.
- Farashi, A. and Shariati, M. 2017. Biodiversity hotspots and conservation gaps in Iran. *Journal for Nature Conservation*, 39: 37-57.
- Fartmann, T., Krämer, B., Stelzner, F. and Poniowski, D. 2012. Orthoptera as ecological indicators for succession in steppe grassland. *Ecological Indicators*, 20: 337-344.

- Footitt, R. G. and Adler, P. H. 2009. Insect Biodiversity, Science and Society. Wiley-Blackwell, Hoboken, NJ, USA.
- Foucart, A. and Lecoq, M. 1998. Major threats to a protected grasshopper, *Prionotropis hystrix rhodanica* (Orthoptera, Pamphagidae, Akicerinae), endemic to southern France. *Journal of Insect Conservation*, 2: 187-193.
- Fox, R. 2012. The decline of moths in Great Britain: a review of possible causes. *Insect Conservation and Diversity*, 6: 5-19.
- Garai, G. A. 2010. Contribution to the knowledge of the Iranian orthopteroid insects. *Esperiana*, 15: 393-417.
- Gholamifard, A. 2011. Endemism in the reptile fauna of Iran. *Iranian Journal of Animal Biosystematics*, 7: 13-29.
- Hallmann, C. A., Sorg, M., Jongehans, E., Siepel, H., Hofland, N., Schwan, H., Stenmans, W., Müller, A., Sumser, H., Hören, T., Goulson, D. and de Kroon, H. 2017. More than 75 percent decline over 27 years in total flying insect biomass in protected areas. *PLoS ONE*, 12: e0185809.
- Havaskary, M., Farshbaf, P. A., Kazemi, R., Satar, M. H. and Rafeii, A. 2012. A contribution to the short horned grasshopper (Orthoptera, Acrididae) from Arasbaran and vicinity, N W Iran. *Munis Entomology and Zoology*, 7: 970-977.
- Hodjat, S.H., Tork, M., Seiedy, M. and Defaut, B. 2018. A taxonomic review of recorded species of Caelifera (Orthoptera) in Iran. *Materiaux Orthopteriques et Entomologiques*, 23: 35-75.
- Hosseini, S. A. and Mofidi-Neyestanak, M. 2014. An investigation of fauna and taxonomy of Orthoptera (Hexapoda) in Kordestan province, Iran. *Entomology Journal of Agricultural Crops*, 1: 9-26.
- Jabbari, A., Modarres Awal, M., Fekrat, L., Karimi, J. and Rashki, M. 2015. On the short-horned Grasshoppers (Orthoptera-Caelifera) fauna of northeastern Iran with some information on sweep sampling capture rates. *Iranian Journal of Animal Biosystematics*, 2: 33-42.
- Jowkar, H., Ostrowski, S., Tahbaz, M. and Zahler, P. 2016. The conservation of biodiversity in Iran: threats, challenges and hopes. *Iranian Studies*, 49: 1065-1077.
- Katouzian, A. R., Sari, A., Macher, J. N., Weiss, M., Saboori, A., Leese, F. and Weigand, A. M. 2017. Drastic underestimation of amphipod biodiversity in the endangered Irano-Anatolian and Caucasus biodiversity hotspots. *Scientific Reports*, 6: 22507.
- Khaliq, A., M. Javed, M. Sohail, and Sagher, M. 2014. Environmental effects on insects and their population dynamics. *Journal of Entomology and Zoology Studies*, 2: 1-7.
- Kolahi, M., Sakai, T., Moriya, K. and Makhdoum, M. F. 2012. Challenges to the future development of Iran's protected areas system. *Environmental Management*, 50: 750-765.
- Low, F., Navratil, P., Kotte, K., Scholer, H. F. and Bubenzer, O. 2013. Remote-sensing based analysis of landscape change in the desiccated seabed of the Aral sea-a potential tool for assessing the hazard degree of dust and salt storms. *Environmental Monitoring and Assessment*, 185: 8303-8319.
- Mirzayans, H. 1959. Liste des Orthopteres et leurs distribution en Iran. *Entomologie et Phytopathologie Appliqués*, 18: 10-28.
- Mittermeier, R. A., Turner, W. R., Larsen, F. W., Brooks, T. M. and Gascon C. 2011. Global biodiversity conservation: the critical role of hotspots. In: Zachos, F. E. and Habel, J. C. (Eds.), *Biodiversity Hotspots*. Springer, Berlin, Germany, pp: 3-22.
- Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B. and Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature*, 403: 853-858.
- Noroozi, J., Akhiani, H. and Breckle, A. W. 2008. Biodiversity and phytogeography of the alpine flora of Iran. *Biodiversity and Conservation*, 17: 493-521.
- Shumakov, E. M. 1963. Les acridiens et les autres orthoptères de l'Afghanistan et de l'Iran [in Russian]. *Trudy Vsesoyeznogo Entomologicheskogo Obschestva*,

- Moskva [= Horae Societatis Entomologicae Unionis Sovieticae] (Trudy Vses. Entomol. Obshch. [= Horae Soc. Entomol. Union. Sov.]), 49: 149.
- Sianaki, S. 2012. Biodiversity of short horned grasshopper in Varamin and Rey. Thesis. Faculty of Agriculture. Azad University, Jahrom, Iran.
- Uvarov, B. P. 1933. Studies in the Iranian Orthoptera, II. Some new of less known Acrididae. Trudy Zoologitscheskogo Instituta, Akademiia Nauk SSSR, Leningrad, Russia.
- Uvarov, B. P. 1938. Studies in Iranian Orthoptera. III. Annals and Magazine of Natural History, London, 11: 375.
- Wettstein, W. and Schmid, B. 2001. Conservation of arthropod diversity in montane wetlands: effect of altitude, habitat quality and habitat fragmentation on butterflies and grasshoppers. Journal of Applied Ecology, 36: 363-373.

مروری بر فون تاریخی و معاصر راست‌بالان (Orthoptera: Caelifera: Acrididae) ایران-هشدار مبتنی بر حفظ محیط‌زیست

سیدحسین حجت^۱، علیرضا صبوری^۱ و مارتین هوسمن^{۲*}

۱- موزه جانورشناسی استاد جلال افشار، گروه گیاه‌پزشکی، پردیس کشاورزی و منابع طبیعی، دانشگاه تهران، کرج، ایران.

۲- مرکز تاریخ طبیعی، دانشگاه هامبورگ، هامبورگ ۲۰۱۴۶، آلمان.

پست الکترونیکی نویسنده مسئول مکاتبه: martin.husemann@uni-hamburg.de

دریافت: ۵ مهر ۱۳۹۷؛ پذیرش: ۲۶ بهمن ۱۳۹۷

چکیده: کم شدن تنوع زیستی به‌ویژه در حشرات یکی از عنوان‌های اصلی حفاظت طبیعی در زیست-شناسی است. مطالعات جدید در چندین کشور اروپایی شاهد کم شدن شدید گونه‌های حشرات و توده زیستی آنها است. در بیش‌تر کشورهایی که تنوع زیستی زیادی دارند از وضعیت تعداد گونه‌های حشرات اطلاع کمی در دست است. این مطالعه مربوط به تعداد گونه‌های ملخ‌های ایران است که در گذشته از تنوع زیادی برخوردار بوده است. تعداد گونه‌های ملخ‌ها از دو دسته آمار پیش از سال ۱۳۴۲ و پس از سال ۱۳۸۰ با استفاده از بررسی‌های منتشر شده برای مناطق مختلف جمع‌آوری شد. تعداد گونه‌ها پیش از سال ۱۳۴۲ در مقایسه با آمار اخیر خیلی بیش‌تر است. این داده‌ها قابل مقایسه آماری نبودند. در هر حال روند تغییر آنها الگوی روشنی را از کم شدن تعداد گونه‌های ملخ‌ها در تمام مناطق ایران نشان می‌داد. روند کم شدن گونه‌های ملخ با مشاهده‌ها و مقایسه‌های ما مطابقت داشت و با نتایج انتشار یافته در جهان مشابه بود. به‌رحال به بررسی‌های آماری بیش‌تری نیاز است تا برای مناطق مختلف ایران به نتایج قاطع‌تری رسید. دلایل پنهانی کم شدن گونه‌های ملخ‌های ایران می‌تواند مربوط به خشکسالی و تغییرات آب و هوایی جهانی باشد. آلودگی شدید محیط‌زیست و تخریب با جاده‌سازی یا تهیه معادن به‌ویژه چرای بی‌رویه دام‌ها تأثیر بیش‌تری بر ادامه زندگی ملخ‌ها می‌گذارند. لازم است با به‌کارگیری مدیریت صحیح محیط‌زیست از بروز آثار منفی کم شدن تنوع زیستی در کشور کاست.

واژگان کلیدی: تنوع زیستی، ملخ‌ها، حفاظت طبیعی، راست‌بالان