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Short Note

Arthropod Diversity and Distribution; How do the NRCERS Agricultural Procedures Impact?

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Abstract: The National Research Centre's experimental research station (NRCERS) locates in Wadi El Natrun, Egypt 30°29'54.22"N 30°19'10.94"E. The NRCERS has various crop yields (vegetables, fruits, ornamental, and field crops) for different experimental treatments. It followed conventional agricultural procedures in vegetation, fertilisation, irrigation, and plant protection. Such policies have not been evaluated for their impacts on arthropod diversity and distribution. Thus, this study conclusion aims to sufficiently map the arthropod species (pest/predators) distribution, measure the biodiversity indices, to the NRCERS agricultural policies to be modified to support arthropod diversity.

Keywords: Insects; Acari; Araneae; Gastropods; Weeds; Pesticides; Fertilizers; IPM; Arthropod-Plant Interactions; Tri-trophic relationship

Background

Invertebrates are important indicators of soil health and quality, not only for economic crops and trees but also for humans (Stork and Eggleton, 1992; Wall *et al*., 2015; Barreto *et al*., 2021). Arthropods, as an example, are good indicators in both terrestrial (Behan-Pelletier, 1999; Orlofske, 2008; Abdul Maleque *et al*., 2009), and aquatic ecosystems (Sleem and Hassan, 2010; Goldschmidt, 2016). These organisms could measure environmental, biological, and ecological changes, like climate change, which significantly affect public health, agriculture, water supplies, energy production, and land use and development (EPA, 2021). Within soil and/or Agro- ecosystems, the interactions among this enormous group diversified (Wardle, 2006), e.g., arthropod-arthropod (Polis *et al*., 1989; Schausberger, 2003; Wang *et al*., 2019) and arthropod-plant interactions (Dicke and Sabelis, 1988; Cuny *et al*., 2021; Meijer *et al*., 2022). Other invertebrates, as gastropods, that reported to be pests for either field crops and vegetables (Desoky, 2018), or ornamentals and fruits (Eshra, 2013), however, Barker and Efford, (2004) have mentioned the predacious gastropods that are used to control molluscan and other invertebrate pests.

According to the European Commission and the Global Soil Biodiversity Initiative (Orgiazzi *et al*., 2016) Egypt is in the arid/semi-arid climatic zone, which has moderately large annual temperature ranges between 18-28°C, with less than 250 mm of annual rainfall, the soil temperature regimes classified as Hyperthermic; that mean annual soil temperature (MAST) ≥ 22°C and difference between mean summer and winter soil temperatures ≥ 6°C, and Megathermic the mean annual soil temperature is larger than 28°C. These climatic fluctuations have massive significant influences on soil-forming processes, and therefore its biodiversity. As well, Egypt which is vulnerable to water shortage (Omar and Moussa, 2016; Kansara *et al*., 2021), the consequences of water scarcity are hypothesised to eliminate arthropod diversity (Prather *et al*., 2020), and that would be an extra stress for the biogeographic distribution in newly reclaimed areas. Since the mid-50s of the 20th century, the increase in agricultural production through horizontal expansion and reclamation of new lands was a large objective of the Egyptian Government (Wolf, 1993). Because

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of the GERD filling crisis, one of the prospected filling scenarios is the land loss, Heggy *et al*., (2021) have analysed that 5,344,180 feddan would be lost after three years of filling.

The NRCERS

The NRCERS locates in Wadi El Natrun, El Behera Governorate (GCS 30°29'54.22"N 30°19'10.94"E; 23 m BSL), 50 km western Nile (Rasheed branch), 110 km southern Alexandria, and 120 km north of Cairo. The station's total area is about 584,387.18 m² (140 feddan), divided into sections, each for a different kind of experimental crop plantation (Fig. 1).

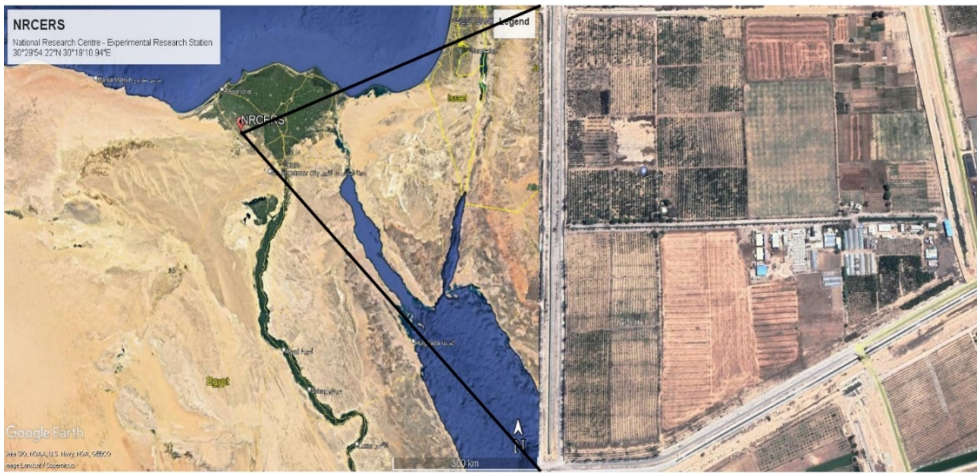

Figure 1. The NRCERS location.

Egypt's agricultural total cropland area (feddan) was increased by 16.55% since 2000. The total fertilizers usage (tonnes) increased for N (16%), P2O5 (44.83%), K2O (285%), and the fertilizers use per area (kg/ha) indication had significant changes of N which decreased by 0.5% while increasing reported in case of P2O5 (24.26%), and K2O (230.20%) during these 20 years. Organic manure that applied to soil (kg) was highly increased; for chickens (92.23%) and cattle (30.33%) manures. The total pesticides usage (tonnes) was increased; insecticides (72.72%) and herbicides (268%), also the indication of pesticides usage (kg/ha) was positively enlarged by 129%. These indications led to a climate change that affected the Egyptian temperature (°C), which had increasingly raised by 1263% (FAOSTAT, 2021). A proposed timeline maps from 1985 till 2022 generated using Google Earth (Pro 7.3.4.8248 Beta, https://www.google.com/earth/index.html) have showed significant differences in location structure, due to climatic and human activities changes (Figs. 2-6).

Figure 2. The NRCERS location, 1985.

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Figure 3. The NRCERS location, 2004.

Figure 4. The NRCERS location, 2012.

Figure 5. The NRCERS location, 2017.

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Figure 6. The NRCERS location, 2022.

Prather *et al*., (2020) reported that arthropod diversity and abundance have been significantly affected due to drought and other abiotic stress factors, as well as biotic factors (Orlofske, 2008). Theoretically, such factors shift the Agro-ecosystem into desert-ecosystem over time, thus, alternative agriculture policies must take place instead of conventional agriculture (Omar and Moussa, 2016).

Historically, the first published biogeographical map has described the botanical distribution of France, in the 3rd edition of the "*Flore française*" by Lamarck and Candolle in 1805 (Ebach and Goujet, 2006). Little is known about the biogeographical distribution of invertebrates, however, a lot of published data about Egyptian phytogeographical diversity and distribution in oases, deserts, and newly reclaimed areas since the beginnings of the 20th century (Hassanein Bey, 1925; Boulos, 2000; Abd El-Ghani and El-Sawaf, 2004; Abd El-Ghani *et al*., 2008, 2013, 2017; Kaky and Gilbert, 2017; Abdelaal *et al*., 2020). Most of the cited literature on land reclamation concerned macro-scale consequences of cultivation and the complications of ensuring either adequate and sustainable water supply (Wolf, 1993; Adriansen, 2009; Tawfik *et al*., 2012), or other agricultural procedures (e.g., fertilizing) (Zeidan, 2007; Bakry *et al*., 2011, 2012).

Arthropod species diversity and distribution data in the NRCERS and/or Wadi El Natrun, were not rich enough to figure out the different trophic relationships in this new region. However, some studies at El Behera governorate have revealed the abundance, survey, taxonomy, and even control applications for mite (Abou-Awad *et al*., 2006, 2016, 2017; Nasr, 2016; El-Laithy *et al*., 2021) insect (Haggag *et al*., 2014; Adss and Tabikha, 2016; Salama *et al*., 2016; Alfazairy *et al*., 2020), and true spider (El-Naggar and Sallam, 2000; El-Erksousy *et al*., 2018) phytophagous and predatory species, as well as some molluscan plant pests (Eshra, 2013). Besides, no published biogeographic data of these organisms' distribution.

Weeds are being distributed withing the NRCERS all over the year. Different species of weed taxa, which required to be controlled (NRCERS administration personal communications). The weeds do need to multiple usage of herbicides exclusively (Fig. 7-10). However, these weeds could interact as alternative shelters for predatory species that possibly existed. Weeds are acting essential role in similar ecosystems in Algeria (Deghiche-Diab *et al*., 2016, 2020), and they must be managed not to be eliminated.

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Fig. 7. The associated biodiversity in weed ecosystem, that being a shelter for lepidoprous insects (Photo credits: Dr. Zidan I.M., Oct 2021)

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Figure 8. Weeds been parasitizing on flax plot (Photo credits: Dr. Zidan I.M., Dec 2021).

Figure 9. Massive weed clusters in citrus orchard (photo credits: Dr. Zidan I.M., Nov 2021).

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Fig. 10. Weeds of boarders and pavements, hypothesized an alternative ecosystem for both herbivores and predatory species (Photo credits: Dr. Zidan, I.M, Oct 2021).

Conclusion

FAO (2021) stated that the extreme use of mineral fertilizations and chemical compounds (e.g., fertilizers, pesticides) could led to nutrient imbalance. That would be reflects on the invertebrate diversity as; reduces soil microorganisms growth rates, decreases the nutrient flow, negatively impacts on the agro-ecosystem's food webs, changes the outcome products (e.g., vegetables, fruits, cereals) nutritional content. Thus, this article aiming sufficient biogeographic studies to be carried out, in order to introduce a map of arthropod species (pest/predators) distribution, projects to measure the biodiversity indices of these organisms, and to the NRCERS agricultural policies to change, on order to support arthropod diversity.

Abbreviations

NRCERS: National Research Centre experimental research station, **IPM**: Integrated Pest Management, **TSSM**: Two-spotted spider mite, **GCS**: Geographic coordination system, **BSL**: Below sea-level, **GERD**: Grand Ethiopian Renaissance Dam,

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