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POPULATION DYNAMICS OF SOIL MITES INHABITING UNDER WHEAT AT SHARKIA GOVERNORATE, EGYPT

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ABSTRACT:

Population dynamics of soil mites, Nesoribatula pacifica Aoki (Oribatulidae), Pediculaster geotrupi Mahunka (Pygmephoridae) and Arctoseius bilinear Nasr (Ascidae) under wheat was carried out in two districts, Diarb-Nigm and Zagazig, Sharkia Governorate, Egypt during two growing seasons 2020/2021-2021/2022. The population of N. pacifica increased forming two peaks; the first peak was recorded on December 20th, reaching to (24&9 individual) in both seasons, while the second peak was recorded on (January 19th & February 3rd), reaching to (30 &11 individual) in the two seasons in Zagazig, respectively. while, in Diarb-Nigm, (3 & 4 peak) were recorded in both seasons, as follow: during (January 4th, February 3rd & March 20th), reaching to (15,26 & 28 individual) in the 1st season, respectively and during (December 5th, January 19th, February 18th & March 20th), reaching to (12, 7, 15 & 17 individual) in the 2nd season, respectively. The mite, P. geotrupi recorded three peaks during both seasons on (December 5th, January 4th & February 3rd) and (January 4th, February 3rd & March 5th), was reaching to (15, 12 & 20 and 20, 27 & 23 individual) in Zagazig, respectively. While, in Diarb-Nigm, (2 & 3 peak) were recorded in the 1st and 2nd seasons, respectively as follows: in the first season appeared two peaks during (February 3rd & March 20th), were reaching to (15 & 23 individual), respectively; the 2nd season recorded three peaks during (January4th , February 3rd & March 5th), were reaching to (15, 31 & 43 individual), respectively.

In the two districts, A. bilinear was recorded three peaks in both seasons except that the 1st season in Diarb-Nigm (2 peaks). The peaks appeared as follows: three peaks during (December 5th, January 19th &February 18th) and (December 20th, February 18th & March 20th), were reaching to (7, 5 & 4 and 4, 4 & 3individual) in both seasons in Zagazig, respectively; while they were on (December 19th & March 5th), reaching to (9 & 4 individual) in the 1st season, (December 5th, February 19th & March 5th), reaching to (5,9 &18 individual) in the 2nd in Diarb-Nigm, respectively. Interaction between the mites with soil temperature

recorded highly significant during 2020/2021-2021/2022 in both districts. The mite, N. pacifica was the most dominant mite species recorded (145 & 127 individual) during the 1st season in both districts, respectively. While, P. geotrupi recorded the highest average (171 & 139 individual) in both districts during the 2nd seasons, respectively. Therefore, A. bilinear recorded the lowest average (17 & 55 individual) in both districts during the two seasons. The correlation between P. geotrupi and soil temperature was significant negative (r= -0.65) (b= -0.23) in Zagazig during the 2nd season, but it was highly significant negative (r= -0.78**) (b= -0.14) regarding to N. pacifica during the 1st season. On the other hand, the correlation between the mites and soil temperature was non-significant in Diarb-Nigm during both seasons.*

Conclusively, *population dynamics of the three soil mites, Nesoribatula pacifica (Oribatulidae), Pediculaster geotrupi (Pygmephoridae) and Arctoseius bilinear (Ascidae) under wheat was carried out during two seasons 2020/2021-2021/2022 in two districts, Diarb-Nigm and Zagazig. Interaction between M. pacifica and soil temperature was highly significant in Zagazig, followed by P. geotrupi was significant in Diarb-Nigm; while, A. bilinear was non-significant. N. pacifica was the most dominant species recorded during the 1st season, followed by P. geotrupi during the 2nd season in both districts while A. bilinear was the lowest numbers.*

Key words: Population dynamics, wheat soil, temperature, Oribatida, Ascidae, Pygmephoridae

INTRODUCTION:

Wheat, *Triticum aestivum* L. (Poacceae) is the most important cereal food crop for human and animals in the world. Recently, the observations on wheat refers to existence some mite species have been found associated with plants and soil of wheat in different districts in Sharkia Governorate.

Soil mites such as oribatid, gamasid and actinedid mites live in a wide range of terrestrial ecosystems under very different environmental conditions. Most are predators and occupy a central position in the soil food web **(Koehler, 1999).** The oribatid mites are usually the most abundant and diverse arthropod in soils. The importance of these organisms in ecosystem energy and nutrient dynamics is mostly indirect, and lies in their relationships with decomposer microorganisms **(Seastedt, 1984).**

The density of soil mites is considered also as an indicator of soil condition and quality (**Curry & Good, 1992).** Distribution and community structure of these mites generally depend on biotic and abiotic environmental

conditions **(Chiba *et al*., 1993).** Population abundance of soil mites in soil vary in relation to various environmental factors like temperature, moisture, and organic matter **(Hansen & Coleman, 1998).** However, abiotic factors may determine the absolute population size at local or regional levels. **(Scheffer *et al*., 1997; Kitashima & Gotoh, 2003 and Gotoh *et al*., 2004**). Several studies have been done to study the distribution and abundance of the mites inhabiting soil and debris in different locations in Egypt and allover the world **(El-Kilf *et al*., 1974; Hassan *et al*., 1986; Zaki, 1992; Kandeel, 1993; Kalmosh& Yassin 2018 and Jun *et al*., 2021).**

Therefore, the objective of the current study was to: 1- Study the population density of the soil mites, *Nesoribatula pacifica* Aoki (Oribatulidae), *Pediculaster geotrupi* Mahunka (Pygmephoridae) and *Arctoseius bilinear* Nasr (Ascidae). 2- Evaluate the effect of soil temperature on the mite species in the two districts in Sharkia Governorate, Egypt during both seasons, 2020/2021-2021/2022.

MATERIALS AND METHODS:

1- *Population dynamics of soil mites under wheat plants:*

Experimental area:

Wheat, *T. aestivum* was planted in the first week of November in Diarb-Nigm and Zagazig districts during two growing seasons (2020/2021-2021/2022). The total area of the wheat was one feddan (4200m^2) for every districts chosen and divided into four plots. To survey the mites inhabiting soil cultivated by wheat plants, four replicates were taken using iron cylinder of cubic liter at depth of 10 cm (500g soil/replicate) **(Gilyarov, 1975)**.

Samples:

Samples were taken randomly in the 3rd week of November and continued every two weeks intervals until the end of season in the 1st week of April. All collected samples were kept in polyethylene bags, labels put and all data available were recorded; then, transferred to the laboratory extracted the mite species using modified Tullgren funnels. The number of mites: *Nesoribatula pacifica*, *Pediculaster geotrupi* and *Arctoseius bilinear* were counted. All mite species were identified based on the world references keys according to **Evans (1992)**.

2- *Weather parameters*:

Soil temperature during both seasons were obtained from Central Laboratory for Agricultural Climatic. The daily values of temperature were averaged every two-week periods to obtain the means of temperature.

3- ***Statistical analysis:***

The obtained data were statistically analyzed according to **Snedecor & Cochran (1980)** and using **Costat (2004)** statistical analysis software, microcomputer program.

RESULTS & DISCUSSION:

1. Population dynamics of the soil mite taxa:

Population dynamics of soil mites under wheat, *Nesoribatula pacifica* Aoki (Oribatulidae), *Pediculaster geotrupi* Mahunka (Pygmephoridae) and *Arctoseius bilinear* Nasr (Ascidae) was carried out in two districts, Diarb-Nigm and Zagazig, Sharkia Governorate, during two growing seasons 2020/2021-2021/2022, (Figures., 1&2).

1.1. On *N. pacifica*:

In Zagazig district, the infestation with *N. pacifica* started on November 20th, was recording (7 & 11 individual) in both growing seasons, respectively. The population increased gradually forming two peaks; the first peak was recorded on December 20th, reaching to (24 & 9 individual) in both seasons. Then, the population decreased, was reaching to (18 & 6 individual). After that, the number of mite increased, was reaching to the second peak recorded on (January 19th & February 3^{ed}), reaching to (30 & 11 individual) at (15 & 17°C), for the two seasons, respectively. Then, the mean number of the species decreased, was reaching to (3 & 8 individual), at the end of the two growing seasons, respectively (Figs., 1&2). While in Diarb-Nigm, the infestation of *N. pacifica* started during November 20th, was reaching to (9 & 5 individual); then, the mite developed slowly, recording (3 & 4 peak) in both seasons, respectively as follow: during (January 4th, February 3rd & March 20th), reaching to (15, 26 & 28 individual) in the 1st season, respectively and during (December 5th, January 19th, February 18th & March 20th), reaching to (12, 7, 15 & 17 individual) in the 2nd season, respectively.

Then, the mean number of the species decreased, was reaching to (19 & 11 individual), at the end of the two growing seasons, respectively (Figs., 1 & 2). These results agree with **Amal (2021)** showed that two peaks of the population density of oribatid mites under wheat, in (February & March, 2018) with a total number of (33 & 32 individual), respectively. **(Kalmosh & Yassin, 2018)** mentioned that the oribatid and mesostigmatid mite species exhibited the higher number of soil mites in soil wheat followed by prostigmatid. **(Krantz &**

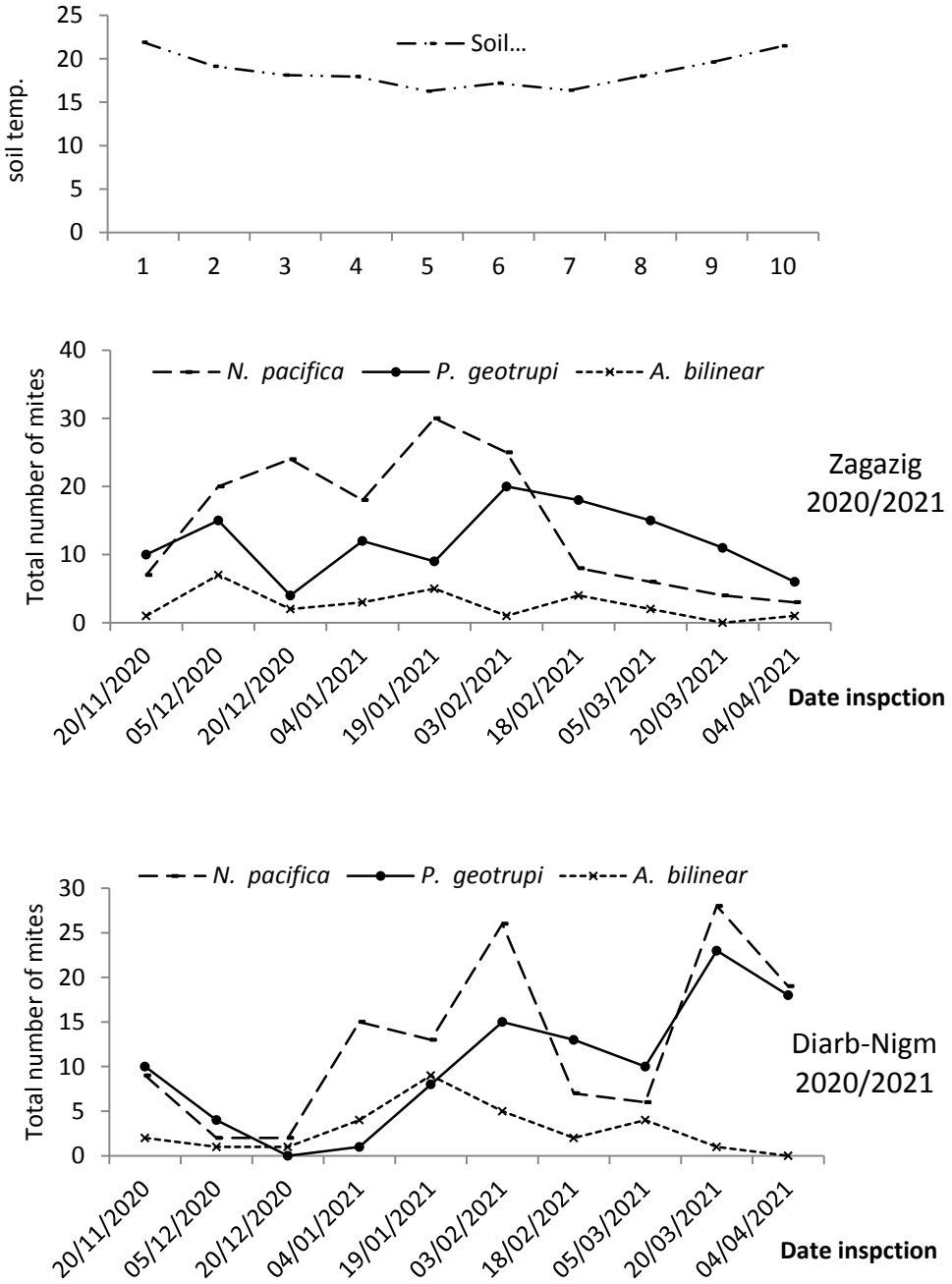

Fig., (1): Seasonal abundance of soil mites inhabiting wheat in Diarb-Nigm and Zagazig districts, Sharkia Governorate during season 2020/2021.

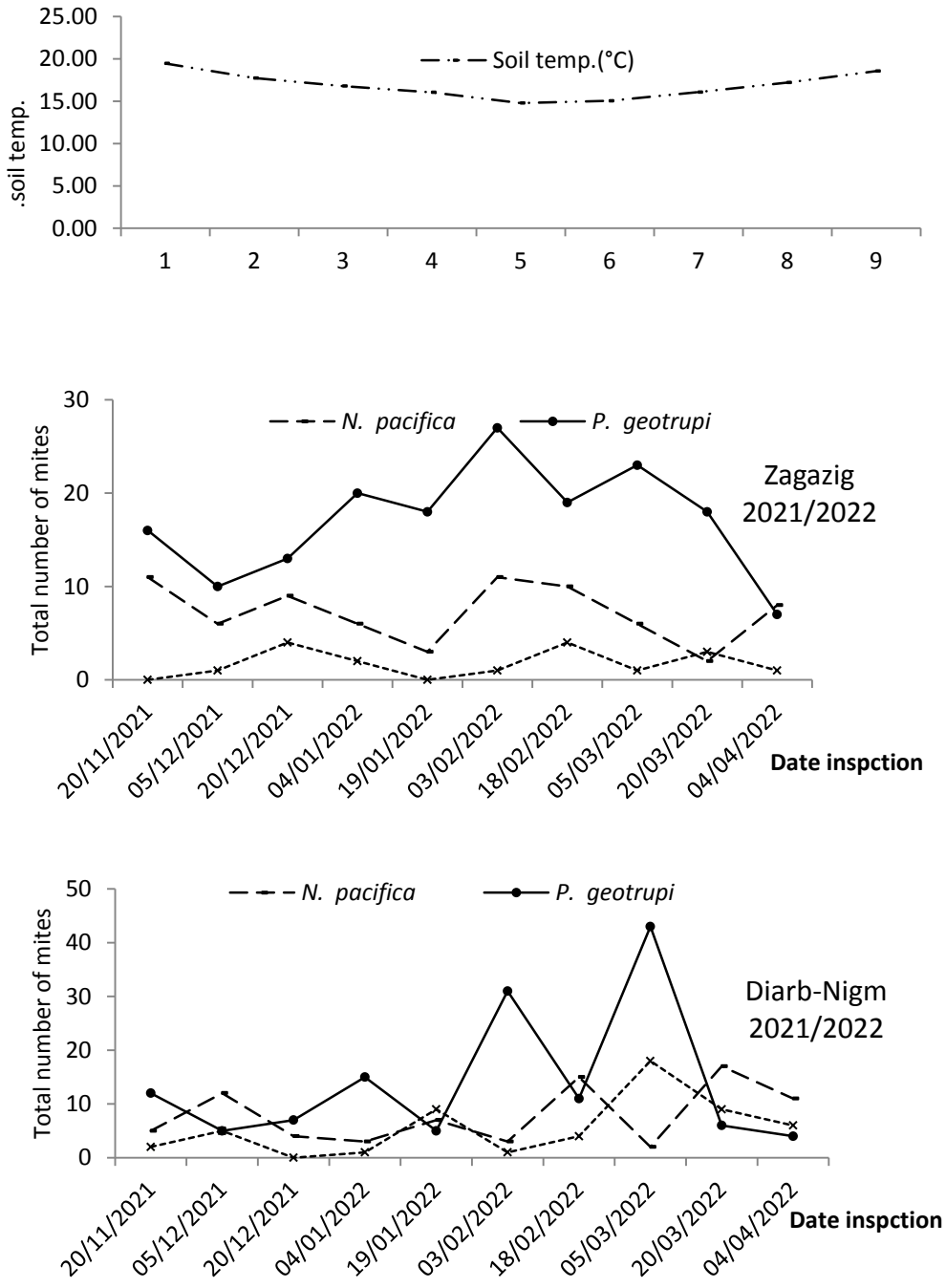

Fig., (2): Seasonal abundance of soil mites infesting wheat in Diarb-Nigm and Zagazig districts, Sharkia Governorate during 2021/2022.

Walter, 2009) found that oribatida were the most dominant more than the other groups, Gamasida, Actindida and Acaridida, those might be based on host plant. **(Zaki & Abo-Shnaf, 2008)** mentioned that the highest number of soil mites was presented by the families Oribatidae and Eupodidae in chamomile. **(Walia & Mathur, 1994)** mentioned that that Oribatida was the most frequent and abundant followed by Actindida, Gamasida and Acaridida in survey of soil samples under field crops, fruit trees, vegetable plants and forest plantation.

1.2. *On P. geotrupi*:

In Zagazig, as shown in (Figs., 1 & 2) *P. geotrupi* started the infestation directly on November 20th, was reaching to (10 & 16 individual) in both seasons, respectively. Thereafter, the mite reached three peaks during (December 5th, January 4th & February 3rd) and (January 4th & February 3rd & March 5th), was reaching to (15, 12 & 20 and 20, 27 & 23 individual); then, the mean number of the species decreased, was reaching to (6 &7 individual), at the end of the two growing seasons, respectively. Also, in Diarb-Nigm, *P. geotrupi* started the infestation on November 20th , was reaching to (10 &12 individual) in both seasons, respectively.

Thereafter, the mite decreased, was recording (2 & 3 peak) in the 1st and 2nd seasons, respectively as follows: in the first season appeared two peaks during (February 3rd & March 20th), was reaching to (15 & 23 individual), respectively; while, the 2nd season has been noticed three peaks during (January 4th, February 3rd & March 5th), was reaching to (15, 31 & 43 individual), respectively; then, the mean number of the species decreased, was reaching to (18 & 4 individual), at the end of the two growing seasons, respectively. **Kalmosh & Yassin, (2018**) revealed that the number of soil mites inhabiting soil in Sharkeia was more than that recorded in Beheira.

Khaustov & Frolov, (2018) declared that the pygmephoroid mite, existence in the soil to be due to its relationships with a wide range of scarab beetles, mostly with dung beetles of the families Geotrupidae and Scarabaeidae**. Pfingstl, (2013)** studied the population dynamics of three species of the oribatid mites showing a clear seasonal pattern, with reproduction from spring to late autumn and a complete standstill of egg production in winter.

1.3. On *Arctoseius bilinear*:

Data given in (Figs., 1 & 2) showed that the infestation in both districts recorded three peaks in both seasons except that the 1st season in Diarb-Nigm (two peaks). The peaks as follows: three peaks during (December 5th, January 19th &February 18th) and (December 20th, February 18th & March 20th), were reaching

to (7, 5 & 4 and 4, 4 & 3 individual) in both seasons in Zagazig district, respectively; while they were on (December 19th & March 5th), reaching to (9 & 4 individual) in the 1st season, (December 5th, February 19th & March 5th), reaching to(5, 9 & 18 individual) in the 2nd in Diarb-Nigm, respectively. Agree with **Amal Abbas (2021)** studied the population dynamics of the gamasid mites (Ascidae and Uropodidae) in loamy soil under wheat and she noticed two peaks in clay soil during the last of January and February with a total number (31 & 22 individual), respectively; but it recorded one peak in March with a total number (6 mite). **Kalmosh & Yassin,(2018)** mentioned that *Arectoseius butleri* Hughes (Ascidae**)** was dominance in soil mite (4.13* & 2.34*) in Sharkia and Beheira governorates, respectively. **Japhyassu-Britto *et al.*,(2015)** recorded that the highest population levels of mite species of Ascidae occurred at the beginning and at the end of the year, coinciding with the highest levels of temperature when plant flowers were most numerous and vigorous.

2. Average number of the soil mites under wheat during 2020/2021-2021/2022:

Average number of the mites associated with wheat soil during two seasons 2020/2021-2021/2022 in Diarb-Nigm and Zagazig recorded highly significant at F(0.05) (Table 1).

The obtained data revealed that *N. pacifica* was the most dominant mite species recorded (145 & 127 individual) during the 1st season in both districts, respectively. On the other hand, *P. geotrupi* was the highest number (171 & 139 individual) in both districts during the 2nd seasons, respectively.

Therefore, *A. bilinear* recorded the lowest average (17 & 55 individual) in both districts during the two seasons. Agree with **Sharma & Parwez (2017)** showed that among Acarina, Oribatida and Gamasida were the most abundant when the soil temperature was (18-33 ℃) whereas, the lowest population for Acaridida during most of the sampling period and reached high abundance only in October 2012.

Parwez & Sharma,(2014) stated that the effect of seasonal variation of Acari in the present investigation was attributed to cumulative effect of all physicochemical factors rather than a single factor influence. **Amal Abbas, (2021)** recoded the population of actinedid mites (Pygmephoridae and Scutacaridae) under wheat at clay and loamy soil during season 2018/2019.

Table (1): Average numbers of soil mites associated with wheat during 2020/2021-2021/2022 seasons in Diarb-Nigm and Zagazig districts

Taxa	Average numbers of mites associated with wheat soil during 2020/2021-2021/202022 seasons in Diarb-Nigm and Zagazig districts			
	Zagazig		Diarb-Nigm	
	2020/2021	2021/2022	2020/2021	2021/2022
N. pacifica	145^{a}	72^{b}	127^{a}	79^{b}
P. geotrupi	123^{a}	171^{a}	102^{a}	139^{a}
A. bilinear	26^{b}	17^{c}	29^{b}	55^{b}
F(0.05)	40.40***	165.09***	16.89**	12.77**
LSD (0.05)	34.47	21.02	42.88	41.89

a/b= Means given the same alphabet have n't significant differences

3- ***Interaction between the three mite taxa and soil temperature*:**

As shown in Table (2), data and statistical analysis cleared that the correlation between *P. geotrupi* with soil temperature was significant (r= -0.65*) (b= -0.23) in Zagazig district during the 2nd season, but it was highly significant (r= -0.78**) (b= -0.14), and regarding to *N. pacifica* during the 1st season.

On the other hand, the correlation between the mites and soil temperature was non-significant in Diarb-Nigm district during both seasons. Obtained results agreed with **Kalmosh & Yassin (2018)** they recorded that the infestation of the 26th and 31st of March (x2) showed relatively high effect on yield (b = -1.84 & - 2.86) than in the first peak (x1) on 12th and 3rd March (b= -1.39 & -2.14) for the two localities, respectively.

Karmakar *et al*., (2017) declared that the temperature and relative humidity were observed to be a positive relationship with the mite population. **Amal Abbas,(2021)** mentioned that the correlation coefficient between actinedid mite's population (Pygmephoridae, Tarsonemidae and Scutacaridae) and minimum temperature was negative and insignificant (r=-0.289 & -0.251) in clay soil and loamy soil, respectively.

Conclusively, population dynamics of the three soil mites, Nesoribatula pacifica (Oribatulidae), Pediculaster geotrupi (Pygmephoridae) and Arctoseius bilinear (Ascidae) under wheat was carried out during two seasons 2020/2021-2021/2022 in two districts, Diarb-Nigm and Zagazig. Interaction between M. pacifica and soil temperature was highly significant in Zagazig, followed by P.

Table (2): Simple correlation coefficients and partial regression between soil temperature and the soil mites under wheat during two seasons 2020/2021-2021/2022 in Diarb-Nigm and Zagazig districts.

Taxa	Zagazig district			
	Simple correlation		Partial regression	
	2020/2021	2021/2022	2020/2021	2021/2022
	r	r	b	b
N. pacifica	-0.78**	0.13	-0.14	0.09
P. geotrupi	-0.49	-0.65*	-0.15	-0.23
A. bilinear	-0.51	-0.34	-0.43	-0.48
Taxa	**Diarb-Negm district**			
	Simple correlation		**Partial regression**	
	2020/2021	**2021/2022**	**2020/2021**	**2021/2022**
	r	**r**	**b**	**b**
N. pacifica	-0.15	0.05	-0.03	0.02
P. geotrupi	0.18	0.42	0.04	-0.07
A. bilinear	-0.56	-0.20	-0.38	-0.08

r= Correlation coefficient for temperature, b = Partial regression values for temperature

geotrupi was significant in Diarb-Nigm; while, A. bilinear was non-significant. N. pacifica was the most dominant species recorded during the 1st season, followed by P. geotrupi during the 2nd season in both districts while A. bilinear was the lowest numbers.

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دراسة الكثافة السكانية لحلم التربة القاطنة تحت القمح بمحافظة الشرقية – مصر

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أُجريت دراسة تذبذات الأعداد لثلاثة أنواع من حلم التربة: *Nesoribatula pacifica* (Oribatulidae) و*Pediculaster geotrupi* (Pygmephoridae) و *Arctoseius bilinear* (Ascidae) تحت القمح بمنطقتي الزقازيق وديرب نجم، بمحافظة الشرقية، مصر خلال موسمين نمو ٢٠٢٠/٢٠٢١-٢٠٢١/٢٠٢٢. **وكانت النتائج المتحصل عليها كالاتى:**

أولاً بالسبة للنوع*N. pacifica*:

- في الزقازيق، زادت أعداد النوع مكونة قمتين؛ القمة الأولى في ٢٠ ديسمبر لتصل (٢٤ و ٩ فردًا) لكلا الموسمين، بينما سجلت القمة الثانية في ١٩ يناير و٣ فبراير لتصل (٣٠ و١١ فردًا) للموسمين على التوالي.

- في ديرب نجم، سجل النوع ٣و٤ قمم لكلا الموسمين على النحو التالي: كانت الثلاث قمم خلال (٤ يناير و٣ فبراير و٢٠ مارس) لتصل الى (٢٦، ١٥، ٢٨ فردًا) للموسم الأول، وبخصوص الاربع قمم كانت خلال (٥ ديسمبر، ١٩يناير، ١٨فبراير و٢٠مارس) لتصل الى (١٢و٧ و١٥و١٧ فردًا) للموسم الثاني على التوالي.

ثانياً بالنسبة للنوع *P. geotrupi*:

- في الزقازيق، سجل النوع ثلاث قمم خلال الموسمين في (٥ ديسمبر و٤ يناير و٣ فبراير) و (٤ يناير و ٣ فبراير و ٥ مارس) لتصل إلى (١٥ و ١٢ و ٢٠) و (٢٠ و ٢٧ و ٢٣) فردًا ، على التوالي.
- في ديرب نجم، سجل النوع ٢ و ٣ قمم للموسمين الأول والثاني على النحو التالي: ظهرت قمتان في الموسم الأول خلال (٣ فبراير و٢٠مارس) لتصل الى (١٥ و٢٣ فردًا)، بينما فى الموسم الثاني سجل ثلاث قمم خلال (٤ يناير و٣ فبراير و٥ مارس) لتصل الى (١٥ و ٣١ و ٤٣) فردًا على التوالي.

ثالثاً بالنسبة للنوع*A. bilinear*:

- سجل النوع *A. bilinear* ثلاث قمم في منطقتي الدراسة لكلا الموسمين باستثناء الموسم الأول في ديرب نجم سجل (قمتان).
- في الزقازيق، ظهرت القمم على النحو التالي: ثلاث قمم خلال (٥ ديسمبر و١٩ يناير و١٨ فبراير) و (٢٠ ديسمبر و١٨ فبراير و٢٠ مارس) لتصل إلى (٧ و ٥ و ٤) و (٤ و ٤ و ٣) فردًا لكلا الموسمين، على التوالي.
- في ديرب نجم، سجل النوع قمتين خلال (١٩ ديسمبر و٥ مارس) لتصل الى (٩ و٤ فردًا) للموسم الأول، بينما الثلاث قمم خلال (٥ ديسمبر و١٩ فبراير و٥ مارس) لتصل (٥ و٩ و١٨فردًا) للموسم الثاني في، على التوالي.

رابعاً: سجلت الأنواع معنوية عالية خلال الموسمين لكلا المنطقتين عند (F= 0.05). وكان النوع *N. pacifica* الأكثر إنتشارًا (١٤٥ و١٢٧ فردًا) خلال الموسم الأول في كلا المنطقتين؛ بينما سجل *P. geotrupi* أعلى معدل (١٧١ و١٣٩ فردًا) في كلا المنطقتين خلال الموسم الثاني على التوالي، ولذلك سجل النوع *A. bilinear* أدنى متوسط (١٧و٥٥ فردًا) في كلا المنطقتين خلال الموسمين. كان معامل الإرتباط بين *P. geotrupi* ودرجة حرارة التربة معنويًا سلبيًا (*r= -0.65) (b= -0.23) في الزقازيق خلال الموسم الثاني؛ في حين كان الارتباط عالى المعنوية سلبيا للنوع *N. pacifica* (r= -0.78**) (b= -0.14) خلال الموسم الأول. من ناحية أخرى ، كان الارتباط بين أنواع الحلم ودرجة حرارة التربة غير معنوي في ديرب نجم خلال موسمي الدراسة.

التوصية: أجريت دراسة تذبذات الأعداد لثلاثة أنواع من حلم التربة: *Nesoribatula pacifica* (Oribatulidae) و*Pediculaster geotrupi* (Pygmephoridae) و *Arctoseius bilinear* (Ascidae) تحت القمح بمنطقتي الزقازيق وديرب نجم خلال موسمين نمو ٢٠٢١/٢٠٢٠-٢٠٢٢/٢٠٢١، و كان التفاعل كان التفاعل بين *M. pacifica* ودرجة حرارة التربة عالي المعنوية في الزقازيق ، يليه *P. geotrupi* كان معنويا في ديرب نجم. في حين كان *A. bilinear* غير معنوي.و قد كان *N. pacifica* أكثر الأنواع إنتشارًا خلال الموسم الأول ، يليه *P. geotrupi* خلال الموسم الثاني في كلا المنطقتين، بينما كان *A. bilinear* الأقل عدداً.