DIVERSITY AND ABUNDANCE OF IMMATURE OEDIPODINAE (ACRIDIDAE: ORTHOPTERA)

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خلاصہ

پاکستان اوڈیپوڈینی زراعت شعبے میں خطرناک ترین حشرات کی طور پر جانا جاتا ہے۔ اسکی بنیادی وجہ اسکا مختلف جگہوں پہ مسکن بنانا اور کثیر تعداد میں پایا جانا شامل ہے۔ موجودہ حقیقی م طالع ے م ی ں ا 4334 ے نمت ق ی ر ی ا ف ت آ کیے گئے ہیں جس میں 3141 نابالغ جبکہ 1193 بالغ حشرات شامل ہیں جو کہ حیدر آباد ڈویژن کے مختلف اضلاع سے جمع کیے گئے جمع شدہ ن م ون ہ 9 ج ن ر ی ا ب مشتمل ہیں۔ جس میں تین جینز اوڈیلیس، اکروٹالس اور اسفنگونوٹس شامل ہیں۔ اور ان کے شرح فیصد کا حسب بل ترتیب 26.3 ، 17.5 اور 17.05 % ہے جبکہ یہ شرح بہت قلیل تناسب کے ساتھ جو کہ 10.26, 9.73, 5.28,1.77,0.57 اور 11.46 % ہے جو کہ لوکسٹا، مواسکراسٹس، گیسٹرومارگھس، ھیلیتھیرا، سانتھرا اور الوپس شامل ہیں جبکہ انوا میں تنوع کا شرح فیصد زیادہ سے زیادہ 11.65,12.54,16.54 اور 9.73% بل ترتیب اوڈیلس روزیلنس، اسفنگونوٹس روبیسینس روبیسینس، اکروٹالس ھمبر ٹینس اور لوکسٹا گروٹیریا میں نوٹ کیا گیا۔ تاھم شرح تنوع کم اسفنگونوٹس سندھیانسس اور لوکسٹا مارگوریڑیا میں 0.34 اور 0.57% فیصد نوٹ کی گئی جبکہ اوڈیپوڈینی کی چند دوسری انواجن میں ایلوپس، اسفنگونوٹس، گیسٹرومارگھس اور مواسکراٹس کی انوا شامل ہیں ان کی تعداد کا وافر مقدار میں ان کی آبادی مسکن میں موجود ہونے کا مشاہدہ کیا گیا۔

Abstract

The Oedipodinae (Orthoptera: Acrididae: *Oedipodinae*) of commonly known as grass hopper of Pakistan stands as a major pest in agriculture due to its occurrence and diversity in different habitats. During present study about 4334 specimens of Oedipodinae comprised 3141 instars and 1193 adults procured in collections from different districts of Hyderabad division. About 9 genera i.e., *Oedaleus* (Fieber, 1853) with 26.30%, *Acrotylus* (Fieber, 1853) with 17.51% and *Sphingonotus* (Perroud, 1855), 17.07%, found while lowest ratio i-e 0.57, 1.77, 5.28, 9.73, 10.26 and 11.46% was reported for *Locusta* (Fieb), *Mioscritus* (Saussure, 1884), *Gastrimargus* (Saussure, 1884), *Hilethera* (Uvarov), *Scintharista* and *Aiolopus* (Fiber) respectively. Species diversity was noted significantly highest i-e 16.54%, 12.15%, 11.65% and 9.73% in *Oedaleusrosescens*, *S. rubescensrubescens*, *Acrotylushumbertianus* and *Hiletheraaelopoides* respectively, while lower ratios were noted in *S. sindhensis* and *Locustamigratoria*i.e 0.34% and 0.57% respectively. Beside this, other notable collected species are *A. longipessubfasciatus*, *Aiolopusthalassinusthalassinus*, *A. thalassinustamulus*, *Gastrimargus African aussulphurus*, *O. sengalensis*, *S. notabilispallipes*, *Mioscrituswagnerirogenhoferi*, *Sphingonotussavignyi*, *A. longipeslongipes* and *S. akbari* that have been found with richdiversity in same area.
Keywords: Biodiversity, Oedipodinae, immaure, adult, habitats, rice, area

Introduction

The members of Oedipodnae are very important in terms of economics. They eat major crops and damage it severely. They are often found in irrigated land and cultivated crops. They are notorious and harmful pests for all types of crops. They not only decrease the number of leaves and productivity of plants but also render plants unfit to be used as fodder for cattle feeding. Generally, they are major and minor pests of many valued crops. Up to now this subfamily comprises of large numbers of species, while in Pakistan its 34 species are found in Riffat and Wagan (2015). Most notorious pest of Oedipodinae grasshoppers is *Locustamigratoria* Linnaeus, whose swarming behaviour destroyed the vegetation, crops and other plants studied by Vickery and Kevin (1990). Oedipodinae are diverse in form and habitats. They prefer to feed on agricultural crops, fodder plants, vegetables and grasses etc. Cotes (1993) worked on *Aiolopus* species and observed damage to human economy, while Wagan and Solangi (1990) verified destruction of Oedipodinae on different crops in Sindh. Riffat *et al.*, (2012) documented Oedipodinae grasshoppers as polyphagous insects that cause considerable damage to the valuable crops. Moreover, members of Acrotylini are dangerous pests; they are entirely vegetarian and voracious feeders. They cause destruction to barley, sugarcane, wheat, and their surrounding grasses. Commonly adults and nymphs are energetic during the brightest time of day and cause massive damage to crops. Soomro *et al.*, (2014) observed the occurrence of Oedipodinae from desert Nara Khairpur they reported 6 genera and 9 species. Sharma (2017) carried out an extensive survey of Punjab (India) and collected 17 species pertaining about 15 genera with 2 families. Walker (1870) was the first who established family Oedipodinae

grouped as subfamily Kirby (1914), and Bei-Bienko and Mishchenko (1951). However, it was renamed as a subfamily AcridinaeDarish (1956) again separated from subfamily Acridinae by Uvarov (1966). Dirsh (1975), and Vickery and Keven (1983) gave the status of subfamily from that considered as a subfamily. Very limited data is avialabe on the distribution and diversity of this group therefore, a present attempt is being made to highlight the occurence of this group in various habitats in Hyderabad division. This study will help to devise a strategy on how to control grasshoppers and reduce their feeding interest in commercially important plants.

Material and Methods

Sampling technique

The stock of Oedipodinae is collected from different agricultural fields i.e rice, cotton, sugarcane, millets, mustard and from encompassing vegetation with the assistance of examination script-net as well as by hand picking. Main attention was paid towards the first instar from the field to identify exact number and timing of hatching of different species. Study trips were conducted to various neighbourhoods of different districts of Hyderabad division which were different in their geographical features, habitat, and vegetation in order to obtain a maximum number of specimens. When one sense of species availability was confirmed then planned to trip to different localities in order to record exact timing of instars hatching. After those weekly trips were carried out during hatching season to obtain a complete sequence of instars of various species. The active period was noted in the field to get maximum collection in a short time. In one trip, collection was made two times, first in the break of day to afternoon and second two to three hours before sunset.

Killing and preservation of samples

Nymph and adults were collected during the field survey followed by twice carefully placing into large plastic jars and transferred to the laboratory. In the laboratory insects were sorted out into different stages and then few were killed with Potassium Cyanide (KCN) and others were kept for rearing in different jars individually and in captivity. Preservation of immature hopper and adults' specimens that were collected from different fields were brought into laboratory and then after killing preserved into 90% Ethanol (mostly 1st and 2nd instars) while stage 3rd onwards was pinned and preserved into insect cabinet with proper ID, host plant, date, and collector information. Same method was adopted for the preservation of adults. For longer preservation of insect naphthalene balls were put into cabinets (Vickery & Kevan 1983).

Table 1. Total instar wise collection of Oedipodinae from Hyderabad 2017-18

Tribe	Genus	Species	1st	2nd	3rd	4th	5th	6th	Total	%
Acrotylini	*Acrotylus*	*Acrotylushumbertianus*	06	17	63	38	79	154	357	11.36
		A.longipeslongipes	00	01	06	15	17	08	47	1.49
		A.longipessubfasciatus	00	18	28	35	44	33	158	5.03
Epacromini	*Aiolopus*	*Aiolopusthalassinustha lassinus*	08	36	54	62	51	28	239	7.6
		A.thalassinustamulus	03	04	22	33	28	14	104	3.31
	Hilethera	*Hiletheraaelopoides*	05	24	71	88	54	59	301	9.58
Locustini	*Locusta*	*Locustamigratoria*	00	00	03	05	04	06	18	0.57
	Gastrimargus	*Gastrimargusafricanau ssulphurus*	04	23	56	42	24	41	190	6.04
	Oedaleus	*Oedaleusrosescens*	13	32	101	89	121	133	489	15.56
		O.sengalensis	08	24	80	72	78	63	325	10.34
	Scintharista	*S. notabilispallipes*	05	21	121	106	68	43	364	11.58
Oedipodini	*Mioscritus*	*Mioscrituswagneriroge nhoferi*	00	00	08	11	27	10	56	1.78
Sphingonotini	*Sphingonotus*	*Sphingonotussavignyi*S aussure	01	02	23	42	29	24	121	3.85
		S.sindhensis	00	00	05	04	03	04	16	0.50
		S. akbari	00	00	07	07	04	03	21	0.66
		S.rubescensrubescens	01	04	111	101	62	56	335	10.66
			54	206	759	750	693	679	3141	100

Table 2. District and species wise collection of Oedipodinae 2017-18

Species	Hyderabad	Thatta	Badin	Matiari	Jamshoro	Sujawal	Tando Muh'd Khan	Tando Allah yar	Dadu	Total
Acrotylushumbertianus	93	21	28	146	72	03	83	40	19	505
A.longipeslongipes	14	06	02	12	05	05	07	03	04	58
A.longipessubfasciatus	32	09	14	46	26	12	14	34	09	196
Aiolopusthalassinusthalassinus	56	18	24	74	66	17	56	35	00	346
A.thalassinustamulus	24	00	16	12	23	00	19	16	01	151
Hiletheraaelopoides	52	12	30	123	87	06	24	58	30	422
Locustamigratoria	02	00	04	03	02	0	05	04	05	25
Gastrimargusafricanaussulphurus	31	13	8	25	34	14	53	38	13	229
Oedaleusrosescens	168	43	54	114	97	22	89	78	52	717
O.sengalensis	45	10	27	93	68	11	59	81	29	423
Scintharistanotabilispallipes	102	23	43	96	87	08	46	33	07	445
Mioscrituswagnerirogenhoferi	12	03	06	09	14	02	11	17	03	77
Sphingonotussavignyi Saussure	74	14	05	32	07	00	09	14	05	160
S.sindhensis	08	00	02	01	06	00	03	00	01	21
S. akbari	06	05	00	03	02	07	01	02	06	32
S.rubescensrubescens	126	39	79	88	82	18	52	26	17	527
Total	845	216	342	907	688	125	531	479	201	4334

Table 3. Intars wise collection of Oedipodinae in Hyderabad division 2017-18

District	instars							
	First	Second	Third	Fourth	Fifth	Sixth	Total	%
Hyderabad	15	47	162	149	162	155	690	21.96
Thatta	01	23	28	42	34	27	155	4.93
Badin	04	12	31	85	53	62	247	7.86
Matiari	12	40	178	122	183	159	694	22.09
Jamshoro	01	37	103	105	132	121	499	15.88
Sujawal	00	03	29	22	08	11	73	2.32
TandoMuh'd khan	10	16	98	103	48	69	344	10.95
Tando Allah Yar	07	20	84	89	58	62	320	10.18
Dadu	04	08	46	33	15	13	119	3.78
Total	54	206	759	750	693	679	3141	100

Table 4. Intars and adult collection of Oedipodinae from different district of Hyderabad 2017-18

S#	District	Instars	Adults	Total Collection	%
1	Hyderabad	690	155	845	19.49
2	Thatta	155	61	216	4.98
3	Badin	247	95	342	7.89
4	Matiari	694	213	907	20.93
5	Jamshoro	499	189	688	15.87
6	Sujawal	73	52	125	2.88
7	TandoM.khan	344	187	531	12.25
8	Tando Allah Yar	320	159	479	11.05
9	Dadu	119	82	201	4.63
	Total	3141	1193	4334	100

Table 5. Biodiversity and Sampsons' Index of collected samples of Oedipodinae in Hyderabad 2017-18

Tribe	Genus	Species	Total	$D=(n/N)^2$	S=1— D
Acrotylini	*Acrotylus*	*Acrotylushumbertianus*	505	0.01357	0.9864
		A. longipeslongipes	58	0.000179	0.99998
		A. longipessubfasciatus	196	0.00204	0.99796
Epacromini	*Aiolopus*	*Aiolopusthalassinusthalassinus*	346	0.06373	0.9936
		A. thalassinustamulus	151	0.001212	0.9987
	Hilethera	*Hiletheraaelopoides*	422	0.00947	0.99052
Locustini	*Locusta*	*Locustamigratoria*	25	0.0000333	0.99996
	Gastrimargus	*Gastrimargusafricanaussulphurus*	229	0.002791	0.99720
	Oedaleus	*Oedaleusrosescens*	717	0.02736	0.97263
		O. sengalensis	423	0.00957	0.9904
	Scintharists	*S. notabilispallipes*	445	0.01054	0.98946
Oedipodini	*Mioscritus*	*Mioscrituswagnerirogenhoeferi*	77	0.0003156	0.9996
Sphingonotini	*Sphingonotus*	*Sphingonotussavignyi*Saussure	160	0.0013622	0.9986
		S.sindhensis	21	0.0000235	0.99997
		S. akbari	32	0.00005389	0.99994
		S.rubescensrubescens	527	0.01477	0.98522
Total			4334	-	-

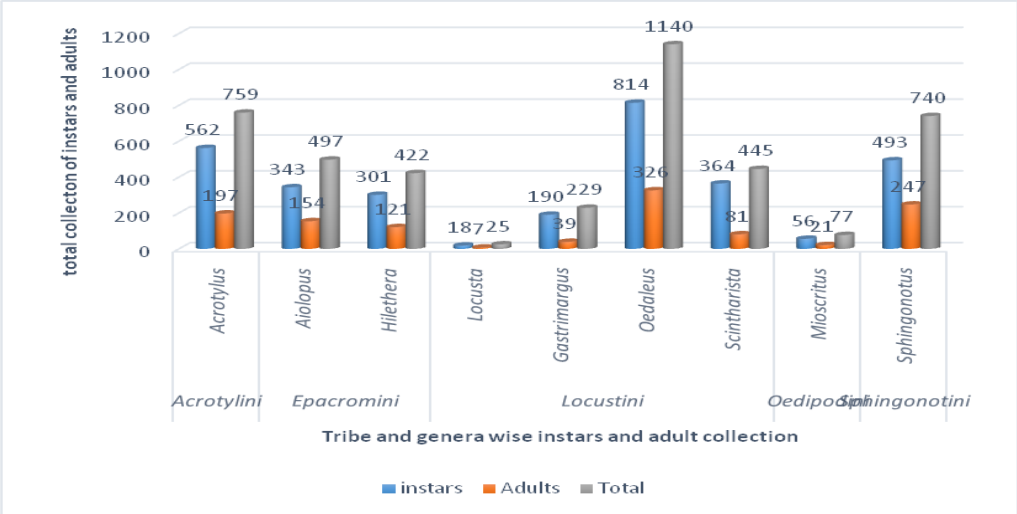

Fig. 1. Tribes and genera wise collection from Hyderabad 2017-18

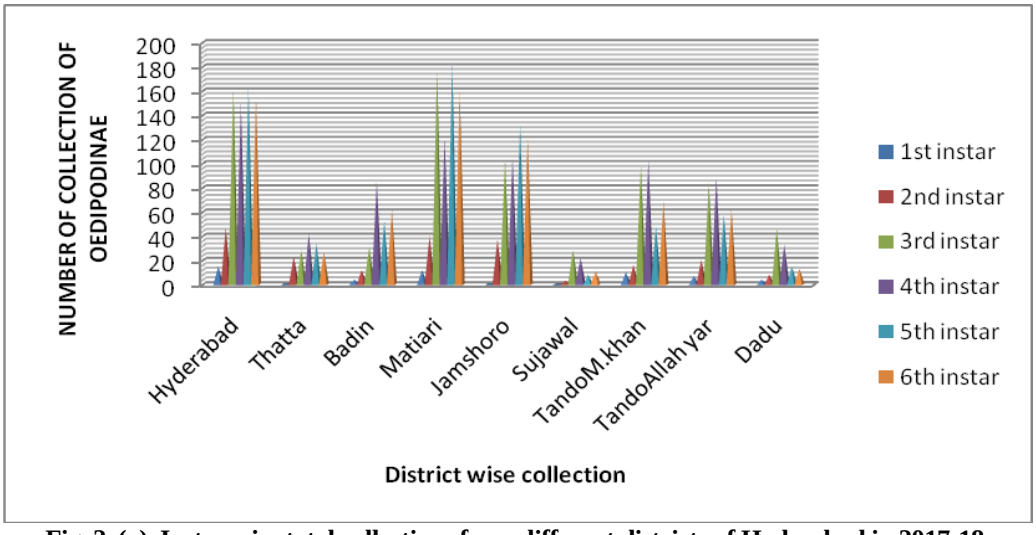

Fig. 2. (a). Instar wise total collections from different districts of Hyderabad in 2017-18

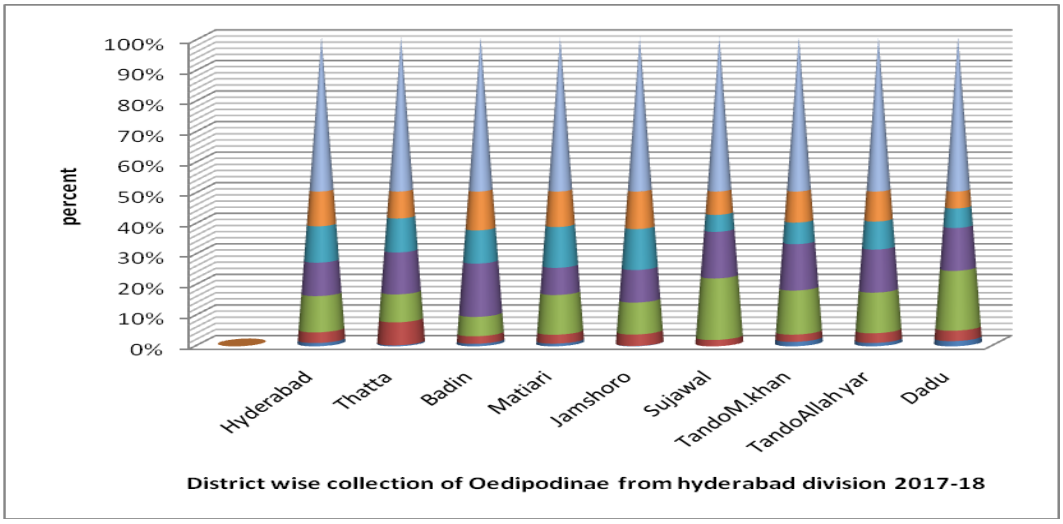

Fig. 2. (b). Percentage of instars collected from different districts of Hyderabad division 2017-18.

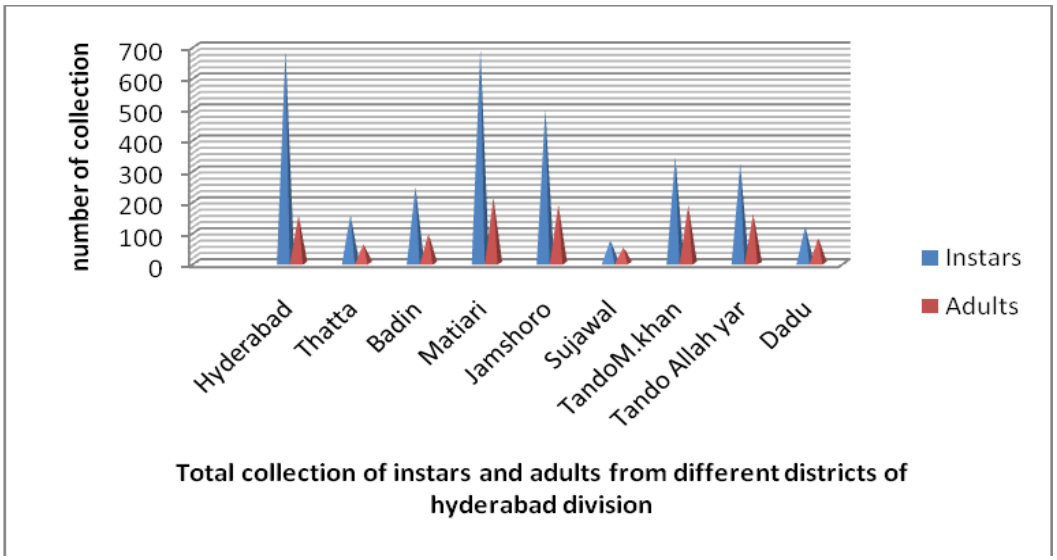

Fig. 3. Total collection of instars and adults from different districts of Hyderabad 2017-18

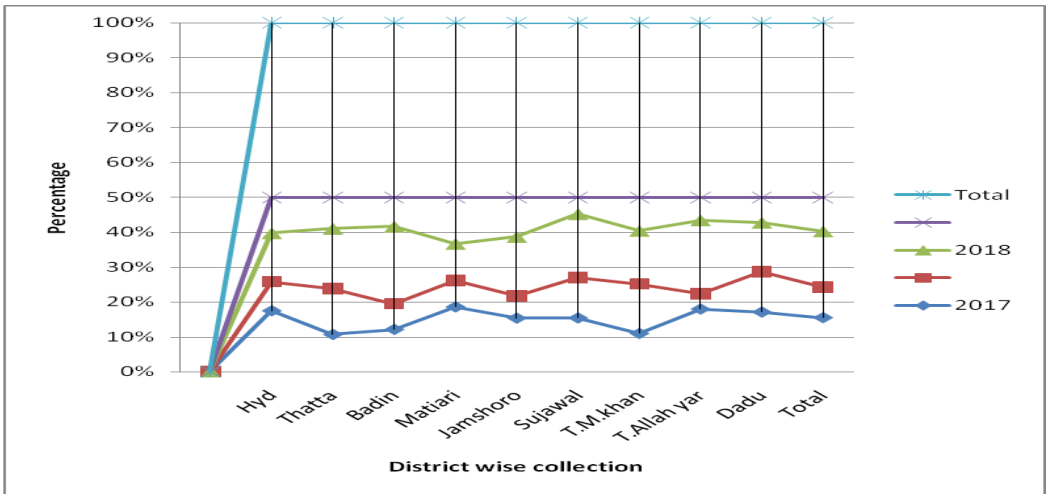

Fig. 4.Total collection of Oedipodinaed 2017-18

Results and Discussion

It seems from Table 1 highest collection of *Oedaleusrosescens, S. notabilispallipes, Acrotylushumbertianus* was reported with 15.56%, 11.58%, 11.36% respectively, while for *S. sindhensis, L. migratoria S. akbari, A. longipeslongipes, Mioscrituswagnerirogenhoferi, A. thalassinustamulus, Hiletheraaelopoides, Sphingonotussavignyi, A. longipessubfasciatus, Gastrimargusafricanaussulphurus, Aiolopusthalassinusthalassinus, S. rubescensrubescens* i.e 0.50%, 0.57%, 0.66%, 1.49%%, 1.78%, 3.31%, 3.31%, 3.85%, 5.03%, 6.04%, 7.60% and 10.66% respectively. The total collection was 3141 from that first to sixth instari.e 54, 206, 759, 750, 693 and 679 respectively. First instar highest collection i. e 13 was reported for *O. rosescens*, 36 for second instar of *A. thalassinusthalasinus*, 121, 106 for third and fourth *S. notabilispallipes* respectively, and 121 for fifth instars of *O. rosescens* and 154 for sixth instars of *A. humbertianus*. Figure 1 to 3 showed that a total of 4334 samples were collected and identified into 9 genera. The highest collection was recorded for *Oedaleus* and *Acrotylus*i.e 26.30, 17.51% respectively. Minimum number of *Locusta Mioscritus, Gastrimargus, Hilethera*and *Scintharista* was recorded i-e. 0.57, 1.77, 5.28, 9.73 and 10.26 % respectively. Table 2 shows the highest number of instars collected from Matiari (22.09%), followed by Hyderabad, Jamshoro and Tando Muhammad Khan i.e 21.94%, 15.88% and 10.95% respectively, while minimum number of intars collected from Sujawal and Dadui.e 2.32% and 3.78% followed by Thatta, Badin, Tando Allah Yar and Tando Muhammad Khan i.e 4.93%, 7.83%, 10.18% and 10.95% respectively.

It is observed from table 3 and figure 4 that district wise instars collection was highest from Matiari i.e 22.09%, followed by Hyderabad, Jamshoro and Tando Muhammad Khan i.e 21.94%, 15.88%, 10.95% respectively, while minimum number of intars were collected from Sujawal and Dadu i.e 2.32% and 3.78% followed by Thatta, Badin, Tando Allah Yar and Tando Muhammad Khan i.e 4.93%, 7.83%, 10.18% and 10.95% respectively. Total number of 1st instars was 54 from Hyderabad, Matiari, Tando Muhammad Khan, Tando Allah Yar, Badin and Dadu i.e 15, 12, 10, 07, 4 and 4 instars respectively, while minimum number was recorded from Sujawal, Jamshoro and Thatta. Total number of second instars was 206 was calculated from Hyderabad, Matiari, Jamshoro, Thatta, TandoYar and Tando Muhammad Khan i.e 47, 40, 37, 23, 20 and 16 respectively, while lowest number was recorded from Sujawal, Dadu, Badini.e 3, 8, 12 respectively.The highest collecction was recorded from Matiari, Hyderabad, Jamshoroo and Tando Muhammad Khan i.e 178, 162, 103 and 93 respectively. Lowest from Thatta, Sujawal, Badin, Dadu, Tando Allah Yar and Tando Muhammad Khan i.e 28, 29, 31, 46, 84 and 98 respectivelty. Total 4th instars collection was recorded as 750 from them highest collection was recorded from Hyderabad, Matiari, Jamshoro, Tando Muhammad Khan i.e 149, 122, 105,103, while minimum collection was observed from Sujawal, Dadu, Thatta, Badin and Tando Allah Yari.e 22, 33, 42, 85 and 89 respectively. A total of 693 specimens of 5th instars were collected from different districts of Hyderabad division; that highest collection was recorded from Matiari, Hyderabad and Jamshoro i-e 183, 162 and 132 respectively. While minimum was from Sujawal, Dadu, Thatta, Tando Muhammad khan, Badin and Tando Allah yar i.e 8, 15, 34, 48, 53, and 58 respectively. While 679 6th in stars were collected from Matiari, Hyderabad, Jamshoro and Tando Muhammad Khan with break up of 159, 155, 121 and 69 respectively. Minimum collection was noted from Dadu, Sujawal, Thatta, Tando Allah Yar and Badin i. e 13, 11, 27 and 62 respectively. Table 4 shows that highest collection was recorded from Matiari, Hyderabad, Jamshoro i.e 20.93%, 19.49%, 15.87%, while least collection recorded from Sujawal, Dadu, Thatta, Badin, Tando Allah Yar andTando Muhammad Khan i.e 2.88%, 4.63%, 4.98%, 7.89%, 11.05% and 12.25% respectively.

It was analysed from table 5 that a total adult collection in 2017 was comprise of 369 females and 210 males captrured from different districts of Hyderabad division and district wise collection was reported as (54♀ and 26♂) Hyderabad, (13♀ and 16♂) Thatta, (23♀ and 14♂) Badin, (79♀ and 32♂) Matiari, (58♀ and 24♂) Jamshoro, (16♀ and 12♂) Sujawal, (41♀ and 53♂) Tando Muhammad Khan, (57♀ and 14♂) Tando Allah Yar and (28♀ and 19♂) Dadu were collected. During 2018 collection ratio was recorded 381 females and 233 males and district wise collection recorded as (43♀ and 32♂) Hyderabad, (21♀ and 11♂) Thatta, (42♀ and 16♂) Badin, (45♀ and 57♂) Matiari, (64♀ and 43♂) Jamshoro, (19♀ and 05♂) Sujawal, (57♀ and 36♂) Tando Muhammad Khan, (67♀ and 21♂) Tando Allah Yar and (23♀ and 12♂) Dadu.

Table 5 showed the biodiversity of *A.humbertianus, A.longipeslongipes, A.longipessubfasciatus, Aiolopusthalassinusthalassinus, A. thalassinus tumulus, Hiletheraaelopoides, Locustamigratoria, G. africanaussulphurus, O. rosescens, O. sengalensis, S. notabilispallipes, M. wagnerirogenhoeferi, S. savignyi*Saussure, *S. sindhensis, S. akbari, S. rubescensrubescens* was i.e 0.01357, 0.000179, 0.00204, 0.06373, 0.001212, 0.00947, 0.0000333, 0.002791, 0.02736, 0.00957, 0.01054, 0.0003156, 0.0013622, 0.0000235, 0.00005389 and 0.01477 respectively while their Sampsons' Index values were 0.9864, 0.99998, 0.99796, 0.9936, 0.9987, 0.99052, 0.99996, 0.99720, 0.97263, 0.9904, 0.98946, 0.9996, 0.9986, 0.99997, 0.99994 and 0.98522 respectively.

Dicussion

Oedipodine covers the wide range of different habitats with relation to plant chemistry, I have found that the concentration of different chemical elements like oxygen, carbon, nitrogen, and hydrogen including different secondary nutrients that plants need including magnesium, calcium, Silicon, potassium, and sulfur showed variation amongst different plants eaten by various species of Oedipodine. Furthermore, to stimulate plant growth, gardeners and farmers use fertilizers that contain the three essential macronutrients. Review shows that Oedipodinae is diversified in distribution, its species varies from habitat-to-habitat Bernays and Graham (1988). In addition, Kariuki *et al*., (2019), Çiplak (2021) and Riffat *et al*., (2021) also carried work on the different aspect of Acrididae. During this study, a comprehensive account of biodiversity and food preference of various species of Oedipodinae was figured out. It was noted that many Oedipodinae are abundant in the field and damage the different agricultural crops on regular basis. Roonwal (1953) also studied the food preference in *S. gregaria* and kept several host plants in a cage inhabited by starved *S. gregaria*. This technique may be open to some criticism because his method of maintaining random distribution of grasshoppers may result in alteration of behavior, because starved grasshoppers are not likely to be very selective in their choice of food, and because the number of feeding individuals may be subjected to counting error during this study, we have kept the insects isolated in different feeding jars it provide clear view to observe its feeding and other activities.

However, for many biologists have appreciated the value of using structural characteristics of animals as to diagnosis of their habitat; this indirect method of studying food selection has been ignored for the most part by entomologists. The sole feature frequently used by Orthopterists is the armature of the legs, such as the powerful armature of legs of Mantids and sagines has rightfully been taken as indicative of predacious habitats. Moreover, correlations between the structural characteristics of Orthoptera and their food habitat were anticipated, to a degree, by Smith (1892). Isely (1988) was the first, however, to show the close correlation between their feeding habits. Gangwere (1960, 1962ab) revealed correlation between the food habits of Orthoptera and the structure of their mouth parts and digestive tract. Present study recommends that it should be done in future by other researchers. According to Gangwere (1964) the outcome of the differential feeding tests was uniform. True grasses were almost always accepted; sedges, rushes, and the horse tail (*Equisetum arvense*) were often accepted; forbs and woody plants were seldom accepted and then only to the extent of being nibbled. Present study recommends that availability is decided not solely by using the fairly abundance of a precise plant species, but additionally with the aid of its phonological, nutritional, and pathological condition. Diet breadth can also additionally be affected by measurement of insects, its dietary status, its previous two experiences, and in particular, different factors of its behavior. There is no proof that Poaceae is characterized by ownership of characteristic auxiliary compounds and no proof has been found within the work of nourishment determination by graminivorous grasshoppers. Chemically, the reorganization of grasses shows up to depend on recognizing what are not grasses, each thing but grasses “tastes bad” and so as it were grasses are eaten. Chapman (1988) has contended that the assortment of chemoreceptors on mouth parts of grasshoppers may repress impact on the advancement of plant specialization by tending to act against the improvement of labeled tactile lines. The legitimacy of this contention will not be known until the chemosensory frameworks of monophagous and oligophagous species have been examined neuro-physiologically. This study could be also fruitful to undertake control methods at the time.

Conclusion

A long-term study is needed to observe the oedipodinae species occurrence in all seasons and their interaction with the environment to get better and comprehensive information. However, this study will give a baseline data for carrying out future research in immature stages. A greater understanding by the public and land managers about the importance of immature stages of insects is a need of the hour to adopt the control measures at appropriate time in future.

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References

Bernays, E.A. and Graham, M. (1988). On the evolution of host specificity in phytophagous arthropods. Eco.(69) 886-892.

Bei-Beinko, Y. and Mishchenko,F. (1951). Locustus and grasshopper of the USSR and adjacent countries. Part II (in Russian),*"* In: key of fauna of USSAR vol. 40. Zoology institute of the USSR, Acad. of Sci., Moscow Lenigrad, vol. 40, pp, 18-66.

Chapman R.F, Bernays E.A. and Wyatt T. (1988), "Chemical aspects of host plants specificity in three Larrea feeding grasshopper". *Journal of Chemical Ecology*, vol. 14, pp. 550-575.

Çiplak, B. (2021) Locust and grasshopper outbreaks in the near east: Review under global warming context. Agronomy 11:111.

Cotes,E.C. (1993). A conspectus of the insects which affect crops in India*",* Ind. Mus. Notes (2), 145-176.

Dirsh, V.M. (1956). Orthoptera: Acridoidea; In H angstrom, Brinck and Rudebeck," South African Animal Life, Resutls of the lund University Expecdition, vol. 3, pp. 121-272.

Dirsh, V.M. (1975). Classification of Acridomorphoid Insects. Farringdon E.W. Classey Ltd. Oxford shire (8)171.

Gangwere, S.K. (1960). "The use of the mouthparts of Orthoptera during feeding", *Entomology News*, vol. 71, pp. 193-206.

Gangwere, S.K. (1962a). "The mechanical handling of food by the aliementary canal of Orthoptera", *In Press 661-670.*

Gangwere, S.K. (1962) "Acomparative study of the structural adaptations of mouth parts for feeding (Orthoptera, *sens.lat*)", *In Press* 681-692.

Gangwere, S.K., Chavin, W. and Evans. F.C. (1964). "Methods of markning insects with especial preference to Orthoptera (Sens. Lat.)", *Annals Entomology Society America*, vol. 57, pp. 667-669,

Isely, F.B. (1944).Corelation between mandibular morphology and food specificity in grasshoppers", *Annals of the Entomological Society America*. Vol.37, pp. 47-67.

Kariuki, Faith T, George O, John M, N, Eunice, O, andAnthony K.O. 2019. Diversity and Abundance of Grasshopper and Locust Species in Nakuru County, Kenya Peter Kairu. Asian J. Cons. Biol, Vol. 8 No. 2, pp. 102-109.

Kirby,W. F. (1914). The fauna of British India including Ceylon and Burma: Orthoptera. (Acrididae), New Delhi (India): Today and tomorrow's Printers and Publishers, PP.X-276.

Luong, S.M.H. and Balanca, G. (1999) *Bryophymadebillis* (Karsch, 1986) Nymphal instars (Orthoptera: Acrdidae: Cyrtacanthacridinae*).* J. of Orth. Res. (8) 110-118.

Riffat, S., Bughio, B. A., Waheed. A. P. and Haji, K. (2012). Studies on the immature stages of Oxyavelox (Fabricius) a rice grasshopper from distric Jamshoro," FUUAST J. Bio. (2)57-62.

Riffat, S. andWagan, M. S. (2015).Comperative study on the morphology of egg pods, egg development and hatching of three *Hieroglyphus* Species (Acrididae: Orthoptera)", Pak. J. Zoo.(41)143-148.

Riffat S., Kumar S., Samejo, A. A , Soomro, S. Lecoq ,M. 2021. The 2019–2020 upsurge of the desert locust and its impact in Pakistan. Journal of Orthoptera Research 2021, 30(2): 145–154. DOI: 10.3897/jor.30.65971.

Roonwal, M. L. (1953). Food preference experiments on the desert locust, *Schistocercagregaria*(Forskal), in its permanent breeding grounds in Mekran. J. l Zoo.Socie. India, vol.5, pp. 44-58.

Soomro, F.Wagan.M. S. and Riffat, S. (2014). On the incidences of Oedipodinae (Orthoptera: Acrododae) from Nara desert Khairpur, Sindh, Pakistan.J. Biodiv.andEnvir. Sci.(5) 12-12.

Sharma, N. (2017). Acridoidea (Orthoptera) diversity of takhnirehmapur wildlife sanctuary, Punjab. Mun.Ento.andZoo. (12-2)389-396.

Smith, J. B. (1892) "Grasshoppers, Locusts, and crickets", *Bulletin of New Jersey Agriculture Experimental Study*, vol. 90, pp. 1-34.

Uvarov, B. P. (1966). Grasshoppers and locust: A handbook of general acridology", Cambridge University Press. (1)1-481.

Vickery, V. R. and Kevan D. K. (1983). A monograph of the Orthopteroid Insects of the Cananda and adjacent regions Lyman Entmological Museum and Research Laboratory. Memorial (1-2) 681-1462.

Wagan, M.S. and Solangi, S.M. (1990). Distribution and incidence of grasshoppers (Acrididae) of Sindh.Boletin de Sanidad Vegetal Plagas (Feuradeserie).(20)125-129.

Walker, F (1870). Catalogue of Specimens of Dermapterasaltotoria in the collection of the British Mueseum, London, 3: i-iv +425-604, 4: iiv +605-809. ES (Walker, 1870) Orthoptera, Acrididae)", Proceeding of the Royal Entomological Society, London (10) 91-97.