



Research Article

**A NEW SPECIES OF *SCHIZODACTYLUS* BRULLE, 1835
(SCHIZODACTYLINAE: SCHIZODACTYLIDAE: ENSIFERA
: ORTHOPTERA) FROM SINDH, PAKISTAN**

Sabir Ali Channa and Muhammad Saeed Wagan

Department of Zoology, University of Sindh, Jamshoro, Pakistan

Article History: Received 7th November 2022; Accepted 13th December 2022; Published 30st December 2022

ABSTRACT

Schizodactylus sindhensis is described as a new species from River Indus, Hyderabad, Sindh, Pakistan. This new species differs from all the known species of genus *Schizodactylus* Brulle, 1835 in having large size and both hind tibiae have four spines on the inner and outer sides whereas in all other species have 3-4 outer dorsal and 4 inner dorsal spines. This new species is related to *Schizodactylus monstrosus* (Drury 1773) and *Schizodactylus hesperus* B. Bienko 1967 in the structure of male sub genital plate have a triangular excision in middle but differs in the structure of epiproct which is elongated deeply furrowed in midline, rounded at base having water drop shaped projections, ridges, and many tubercles. A brief account of flying and swimming is also given.

Keywords: New species, River Indus, Burrowing, Flying, Life history, Swimming.

INTRODUCTION

Dune crickets are representatives of the genus *Schizodactylus* (Brulle, 1835) and are unique members of family Schizodactylidae. They display unexpected combination of characters showing resemblance with several other groups of Orthoptera (Aydin and Khomutov, 2008). The species of *Schizodactylus* play a very important role in an ecosystem that prevents certain insect populations from increasing and becoming dominant in sand dune habitats. These species also constitute an important part of the food items of many arthropod and vertebrate night prowlers, and they are themselves voracious carnivores with a tendency to predation (Channa *et al.*, 2011, 2013). These insects are nocturnally active on the surfaces of sandy arid environments, and their peculiar tarsi permit them to run on sand easily; they live inside burrows during the day. Their preference for sandy habitats might be due to their ability to form tunnels easily. The insect makes burrows in the sand, usually near rivers and streams. Both the adults and nymphs construct individual burrows (Channa *et al.*, 2011, 2013; Dawwrueng *et al.*, 2018). When constructing their burrows, they use their mandibles and anterior legs to scrape and loosen sand from

the burrow and then push it behind them out of the burrow using the abdomen and hind tibia. They possess several morphological modifications for digging in sandy environments.

The genus *Schizodactylus* Brulle, 1835 comprises nine described species: namely, *Schizodactylus monstrosus* (Drury, 1773) from India, *Schizodactylus inexpectatus* (Werner, 1901); from Turkey, *Schizodactylus burmanus* Uvarov, 1935 from Burma, *Schizodactylus minor* (Ander, 1938) from "Ganges", *Schizodactylus tuberculatus* (Ander, 1938) from Assam; and *Schizodactylus hesperus* (Bei-Bienko, 1967) from Afghanistan. During the present century four more species were added, *Schizodactylus brevinotus* (Ingrisch, 2002) from Bhutan, *Schizodactylus salweenensis* Dawwrueng, Panitvong, Mooltham, Meebenjamart *et al.*, from Thailand and *Schizodactylus jimo* (He, 2021) from China. *Schizodactylus groeningae* (Martins-Neto, 2007) from Brazil, known only from fossil records. Presently one new extant species *Schizodactylus sindhensis* sp. nov. is described as a new to science. The material of this new species includes both the adult males and females including eggs. Immature stages, collected from River Indus, Hyderabad, Sindh.

*Corresponding Author: Muhammad Saeed Wagan, Department of Zoology, University of Sindh, Jamshoro, Pakistan Email: mswagan@hotmail.com

MATERIALS AND METHODS

Specimens of *Schizodactylus* were collected 6 km from the Jamshoro by pass on the left bank of River Indus near Sahrish Nagar, Hussainabad, and Latifabad, No.4 Hyderabad, Sindh, during 2005-2008. The material was collected on moderate slopes or on the level in deep layers of loose and fine sand, with or without thin semi-desert vegetation, or in places to which layers of fine soil were deposited by wind.

Type material collected from the field, brought to the laboratory for preservation, sorting, studying their taxonomy, and taking photographs with Manual and Auto focus Canon camera with 55mm and 58mm close lenses. All the data collected were analysed using the software SPSS.10.00, ANOVA, and LSD test (1%) as per Channa *et al.* (2013). All body measurements and other parameters were identified using the terminology of Khattar (1972). Measurements of the holotype, paratypes and nymphal instars were made with the help of vernier calliper. The type material is deposited at the Department of Zoology, University of Sindh, Jamshoro.

RESULTS AND DISCUSSION

Diagnosis: *Schizodactylus sindhensis* sp. nov. differs from all the known species of genus *Schizodactylus* (Brulle, 1835) in having large size and both hind tibiae have four spines on the inner and outer sides whereas in all other species have 3-4 outer dorsal and 4 inner dorsal spines. This new species is most related to *Schizodactylus monstrosus* Drury 1773 and *Schizodactylus hesperus* (B. Bienko 1967) in the structure of male subgenital plate have a triangular excision in middle but differs in the structure of epiproct which is elongated furrowed in middle, rounded at base having three water drop shaped projections, ridges and many tubercles, whereas in *S. monstrosus* and *S. hesperus* epiproct is very narrow without ridges and tubercles. Furthermore, titillators are narrower and slenderer as compared to *S. monstrosus*. This new species is related to *Schizodactylus tuberculatus* (Ander, 1938), *Schizodactylus salweenensis* Dawwrueng, Panitvong, Mooltham, Meebenjamart *et al.* (Jaitrong 2018), and *Schizodactylus jimo*, (He 2021), in the general structure of epiproct. *Schizodactylus inexpectatus* possesses shorter wings than the new species. In *S. brevinotus* (Ingrisch, 2002) pronotum is very short as compared to this new species. This new species also differs from *S. hesperus* by the shape of spurs of the hind tibia and the shape of

ovipositor which is not strongly curved and has the apex truncate not rounded. Additionally, a variation has been noted in the female subgenital plate with hind margin rounded in middle in monstrosus and straight in *Hesperus* and truncated in this new species. *Holotype-male*; Pakistan, Sindh Province, sand dune besides riverbed of Indus River, Sahrish Nagar, Hyderabad 20.IV.2005 (S.A. Channa and M.S. Wagan) (Department of Zoology, University of Sindh).

Description: Male. Habitus as shown in (Figure 1a-b). Size large and robust. Frons long- ovoid, vertex steeply sloping between compound eyes; fastigial vertices small, deeply furrowed lying between dorsal margins of antennal scrobae (Figure 2a). The large diamond shaped labrum covers the mandibles in front. Mandibles (Figure 2, b) long, the incisor lobe of the mandibles has three dents, somewhat fused and distally extended to form a cutting and grasping hook. Pronotum (Figure 2c) transverse, anterior margin concave, lateral margins sinuate, posterior margin broadly concave and sinuate, transverse sulcus placed just behind anterior margin. Tegmen and wings greatly surpassing body, spirally rolled up apically at end (Figure 1 a-b). Legs: fore femur (Figure 3-A) with 6-10-minute spinules on ventro- internal margin, fore tibia (Figure 3-A) swollen with 4 long ventro- external and 4 long ventro- internal spines and with 2 apical spurs at each side, the internal spurs longer than the external ones, the ventro- internal spur the longest one. Mid femur (Figure 3-B), with 8-11 spinules on ventro- external margin; mid tibia (Figure 4-B) swollen with 4 long ventro- external and 3-4 short ventro- internal spines, 4 long dorso- internal spines and 1 shorter dorso- external spine just above the apical spurs; 2 apical spurs at each side, the internal spurs longer than the external ones, the dorso- internal spur being the longest one. Hind femur (Figure 3-C) with 12-20 minute spinules on both ventral margins. Knee lobes of all legs obtuse. Hind tibia (Figure 3-C) Ventral view with 4 dorso- external and 4 dorso- internal spines of medium length, with 3 apical spurs at each side, the internal spurs longer than the external ones; of these spurs, 1 external spur broad with subacute apex, the second and third outer spur smaller and almost of equal size, internal spur as in *S. monstrosus* (Figure 4c) ventro apical margin of hind tibia with 4 short spines just below apical spurs and with 1 longer spine at internal angle. Tarsi of all legs with 4 segments and a pair of apical claws, 2nd and 3rd segment very short and provided each with a pair of large plantulae; first segment of hind tarsus with a pair of large, compressed, triangular lateral projection.

Table 1. Showing: the measurement of different body parameter of adult *Schizodactylus sindhensis* sp. nov.

Body Parameter.	Male (n= 30) including holotype			Female (n= 30)		
	Mean ±SD	LSD	Minimum to Maximum	Mean ±SD	LSD	Minimum to Maximum
Head Width	14.96 ±0.27	A**	14.5-15.2	14.54±0.43	A**	14.1-15.1
Distance b/w eye	16.15 ±0.32	B	16.1-16.3	15.7±0.46	B	14.1-15.7
Pronotum length	7.67±0.46	C	7.1-8.2	6.7 ±0.40	C	6.3-7.2

Pronotum width	5.18±0.10	D	5.1-5.4	5.4 ±0.46	D	4.7-5.5
Fore femur	16.65 ±0.07	E	16.1-17.1	15.7± 1.17	E	15.2-16.2
Fore Tibia	14.91±0.32	F	14.1-15.1	13.91±0.39	F	13.3-14.2
Fore Tarsus	13.61±0.68	G	12.1-14.1	13.47±0.46	G	13.1-14.1
Mid femur	17.88±0.74	H	17.1-18.2	19.18±0.92	H	18.1-20.3
Mid Tibia	16.44 ±0.66	I	16.1-17.1	16.23±0.94	I	15.2-17.4
Mid tarsus	13.25±0.80	j	12.1-14.1	11.82±0.53	j	11.1-12.4
Hind Femur	28.84 ±1.22	K	27.4-29.1	27.93±0.41	K	27.3-28.4
Hind tibia	24.65±0.57	L	24.1-25.1	21.93±0.45	L	21.1-22.4
Hind Tarsus	18.77±0.68	M	18.1-19.2	15.84±0.43	M	15.3-16.3
Cercus	9.14±0.79	N	9.1-10.1	9.12±0.73	N	8.5-10.2
Total Body length	7.28 ±3.93	O	50.2-55.4	52.66±2.23	O	52-60.4

Note: The letter indicates a significant difference (P<0.01) according to LSD test

Table 2. The average of body size used to distinguish various instars of *S. sindhensis*.

Stages	No.	Male Mean ±SD	LSD	Minimum to Maximum	No.	Female mean ± SD	LSD	Minimum to maximum
1 st Instar	10	1.32 ±1.02	A**	18.2-20.2	10	22.58 ±1.08	A**	22.2-24.10
2 nd Instar	10	25.9 ±0.43	B	25.1-26.3	10	28.78±0.58	B	28.12-29.23
3 rd Instar	10	29.82 ±0.32	C	26.3-27.6	10	30.88 ±0.62	C	30.24-31.42
4 th Instar	10	30.62±0.43	D	29.1-30.7	10	33.08± 0.56	D	32.10-33.08
5 th Instar	10	33.52±0.72	E	31.5-33.2	10	35.88 ± 0.88	E	34.12-35.12
6 th Instar	10	35.42 ±0.82	F	32.6-35.30	10	37.46±0.90	F	36.20-37.5
7 th Instar	10	36.52±0.72	G	35.2-36.1	10	38.40 ±0.84	G	37.3-39.30
8 th Instar	10	38.32±0.42	H	37.2-38.3	10	40.72±0.69	H	40.1-41.62
9 th Instar	10	40.20 ±0.62	I	39.3-40.43	10	42.61± 0.82	I	41.52-43.60

Note: ± Standard deviation the letter indicates a significant difference (P < 0.01) according to LSD test.

Table 3. Showing the measurement of burrow width and depth of the various nymphal instars of *S. sindhensis*.

Stages	Nons	Burrow width in millimeter (m. m)		Burrow depth in centimeter (c. m)	
		Range	Means± SE	Range	Means± SE
1 st Instar	10	6.1-7.2	6.54±0.55	14-16	15.0±1.10
2 nd Instar	10	9.1-10.1	9.52±0.53	16-18	17.2±0.83
3 rd Instar	10	10.2-13.1	12.12±1.18	19-24	21.6±2.07
4 th Instar	10	14.1-15.1	14.32±0.43	22-26	24.4±1.81
5 th Instar	10	15.1-16.2	15.56±0.54	28-32	31±2.23
6 th Instar	10	16.1-17.1	16.52±0.33	34-37	35.4±1.14
7 th Instar	10	17.1-18.1	17.74±0.49	39-46	42.2±2.58
8 th Instar	10	19.1-20.1	19.72±0.52	47-54	50.0±2.91
9 th Instar	10	24.1-28.2	26.12±1.56	55-60	57.8±2.28
Adult.		50-70			65.3±7.34

Last abdominal tergite transverse, sclerotised plate interrupted in middle, with a large membranous apical projection that is deeply furrowed in midline, medial areas of expansion with granular surface(Figure 5-a).Subgenital plate broader than long, lateral margins parallel in basal half convergent in apical half, apex with profound angulate

excision reaching near the middle of the plate, lobes angulate subacute apically(Figure 5-b&c).A pair of narrow elongate titillators protruding from underneath the subgenital plate. Their apex terminating into an acute sharp tooth, (Figure 5-b, TT). Epiproct (Figure 5b, E) with widened lateral expansions, medial areas of hind margin

slightly concave as truncate shape that is deeply furrowed in midline have a roughly circular thickened ridged area at base the upper half of circle have three obliquely water drop shape with rounded apex projections the one in the centre is large and the two small one on either side. The lower half circle have two flat ridges one on either side and deeply furrowed in middle with many distinct tubercles present in the middle area. Cerci compressed especially in apical area, with a conical base and digit form apical area, apex obtuse (Figure 5c).

The overall body coloration cream- yellowish, having black dots at dorsal, cream, and green at ventral. Head from above with three dark longitudinal stripes and with a long bow-shaped vertical stripe behind eyes. Head whitish with a green tinge front. Antenna pale brown except scape which is whitish in colour. Labrum whitish, pronotum pink in colour with light and dark brown patches present at dorsal side. Tegmen brown dorsally and light brown laterally. Cerci whitish brown and beset with numerous sensory hairs. General morphology is same as male. Last abdominal tergite short, transverse sub fused with epiproct, latter is triangular furrowed in midline, apex obtuse. Cerci 9.12 ± 0.73 mm large, compressed especially in apical area, with a conical base and a digital form apical area, apex obtuse (Figure 8-a). Subgenital plate simple, moderately elongated with hind margin somewhat truncated at the middle. Ovipositor 1.7-2.0mm not strongly curved and has the apex truncate not rounded. but clearly protruding from the sub genital plate, down curved at apex in lateral view (Figure 8-b). Paratypes. Same data as holotype. Paratypes. 17 males and 14 females; 20.IV.2006., 9 males 8 females from Hussainabad, Hyderabad (S.A.Channa, and M.S.Wagan), 16.VII.2006., 5 males 9 females (S. A. Channa, M.S. Wagan) from Latifabad No.4 Hyderabad. These agree generally with the above descriptions of holotype. The range of measurements is given in table 1. Male holotype and male para types have although some variation in body length. Besides, minor variation in the number of inverted water drop projections, ridges and number and size of tubercle son epiproct. Material examined. Type series of 31 males and 30 females, as indicated above.

Fundamentally, to assess the life history of *Schizodactylus sindhensis* new species, frequent visits were carried out in the field to collect large numbers of specimens. Burrow was identified for excavation by locating the talus piles left at the entrance. All the burrows were dug out with a long stick. The stick was placed inside each burrow until it touched the end of it. Then the digging began carefully with the upper part of the stick while being directed towards the outside of each burrow, to avoid any insect injuries. Both adults and nymphs are burrow makers. They hide themselves in burrow during the daytime. While at night they came out from burrow and performed their all activities i-e copulation and feeding etc. The adult and nymphs usually dig their burrow near or close to river shore (Figure 9). The opening of burrow was found open or closed (Figure 10,a&b). Laboratory experiments demonstrated that the species of *Schizodactylus* seems to prefer to burrow in

damp, cohesive sand because dry sand would collapse on them. All the burrows excavated during the present study were simple and unbranched, usually straight, descending at an oblique angle into slope (Figure 11a&b). Burrow diameter varied with the age and size of the insect. The average size and depth of the burrows of adult and various nymphal stages of *Schizodactylus sindhensis* new species is given in table (2). All the removed material was carefully examined for the collection of eggs and nymphs.

With the findings of *Schizodactylus sindhensis* sp. nov. The total number of extant species in the genus *Schizodactylus* comes to 10. Of these 4 species viz: *S. monstrosus* Drury 1773, *S. minor* Ander 1938, *S. hesperus* Bei-bienko 1967, and *S. sindhensis* sp. Nov a rerecorded from Sindh, Pakistan. These are carnivorous and cannibalistic occurring in the same area and living side by side along Sahrish Nagar. Hussainabad, and Latifabad NO.4, an area of about 5 Km. on the left bank of River Indus, Hyderabad, Sindh. In field, it has been observed that adults and nymphal stages are cannibalistic; different individuals attack, each other once they find themselves in confined places, or when they are placed in glass- jars for transferring to the laboratory. The mouthparts of these species are of carnivorous type and pro- and meso- legs are raptorial and are developed for catching and holding prey. Mostly the stronger insects eat the weaker ones. Cannibalism in *S. monstrosus* was studied by Uvarov (1952), Khattar, (1972), Hazara and Tandon, (1991) while in *S. inexpectatus* by Aydin and Khomutov (2008).

Due to cannibalistic behaviour the injured insects became easy prey to predators or collectors (Figure 8 a,b,c). Several hundred burrows were excavated for the collection of eggs and nymphs. The eggs were found only on one occasion. Eggs are small, rounded 43 in number laid by a female at the bottom of a burrow in a pit. (Figure.12). whereas large number of nymphs were available for the study of life cycle. The life cycle took more than one year for completion and passes through nine nymphal instars (Figure 13.a-j). Khattar, (1972) and Aydin and Khomutov (2008) reported 9 nymphal instars in *Schizodactylus monstrosus* and *S. inexpectatus* respectively. Presently we are also reporting nine nymphal instars for this new species. The comparison of the body length of the various nymphal instars of this new species *Schizodactylus sindhensis* is shown in (Table 2). This indicated that there is a significant difference in the measurement of nymphal instars from the first instar to the adult. The total body length slightly increased in the first instar onwards but was significantly increased in the adult stage. These results are statistically important (Aydin and Khomutov, 2008 and Channa *et. al*, 2011).

Ramme (1931) stated that flexible spurs of hind tarsi of *Schizodactylus* in digging process while Carpentier (1953) suggested that the digging was done exclusively with jaws. The present study agreed with later one. Carpenter (1953) also observed that some *S. monstrosus* live in open burrows, our study showed that *S. sindhensis* live in an open or closed burrow. Khattar, in (1972) reported that burrows

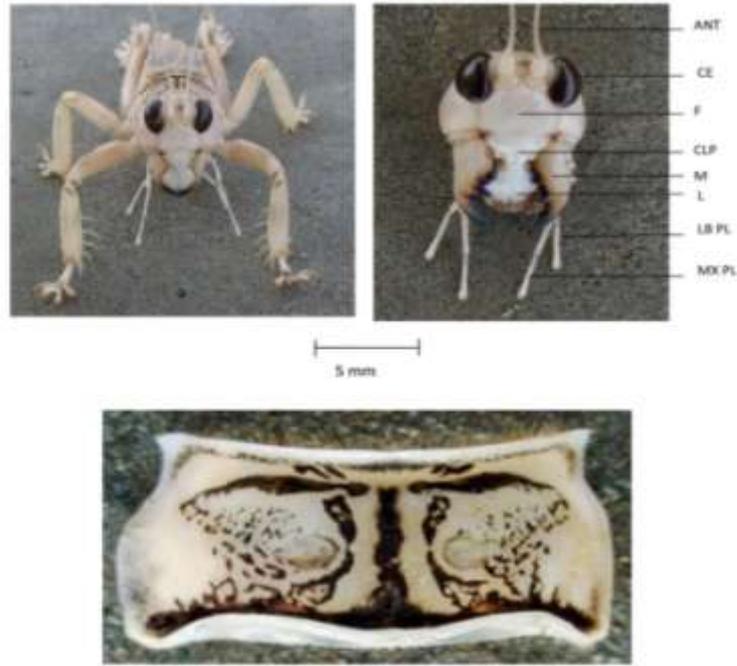
of *S. monstrosus* were excavated at 60°, while Aydin & Khomutov reported 40 degrees in *S.* In expectant whereas in this new species we are reporting that the burrow descends at an angle of 50-60 degree. The antennae of *Schizodactylus sindhensis* new species (Figure 9) is longer than the body like other species of Schizodactylidae (Channa *et al.*, 2013; Leubner *et al.*, 2017). This is related to the special behaviour of Schizodactylidae lurking at the bottom of their burrow using the long antennae to explore their surroundings (Khattar, 1972; Channa *et al.*, 2013; Leubner *et al.*, 2017). Choudhuri and Bagh, (1974) reported that the female of *S. monstrosus* lays eggs towards the end of the burrow; at the present we observed that females of this new species lay eggs at the end of a burrow in a pit (Figure 12).The ovipositor of *Schizodactylus sindhensis* is short hence female lay the eggs in a protective burrow. Reduction of the primarily blade- like ensiferan ovipositor in Schizodactylidae is correlated to the burrowing

behaviour in sand and the subsequent deposition of the eggs in their burrow (Ramme, 1931; Channa *et al.*,2013, Leubner *et al*, 2017).

Schizodactylus is very famous due to it rolled up capability at winged region. Khattar (1972) observed that they are flightless insects, while Carpentier (1953) and Dawwrueng *et al*, 2018) reported that they fly at night. At the present we observed flight of *Schizodactylus sindhensis* at early morning. We observed that adult insect taking flight first they run fast on triangular plate for considerable distance and then fly (Figure 14 A&B), they open their wings in the air when they need their help or coming down to earth (Figure 14 C-F).It was not possibly to observe whether the journey is completed in single flight or with few breaks. On one early morning it was observed that some adults *Schizodactylus* were flying and landing on the riverbed with their wings completely stretched possibly to take heavy load of the body (Figure 15).



Figure 1. *Schizodactylus sindhensis* sp. nov male (Holotype) a) Lateral view, b) Dorsal view.



Schizodactylus sindhensis

a) Frontal view b) Showing mandibles c) Pronotum dorsal (enlarged view)

Figure2. Ant=Antennae; CE=Compound Eye; CLP=Clypeus; F=Frons; L=Labrum; LB PL=Labial Palp; M= Mandible, MXPL=Maxillary Palp.

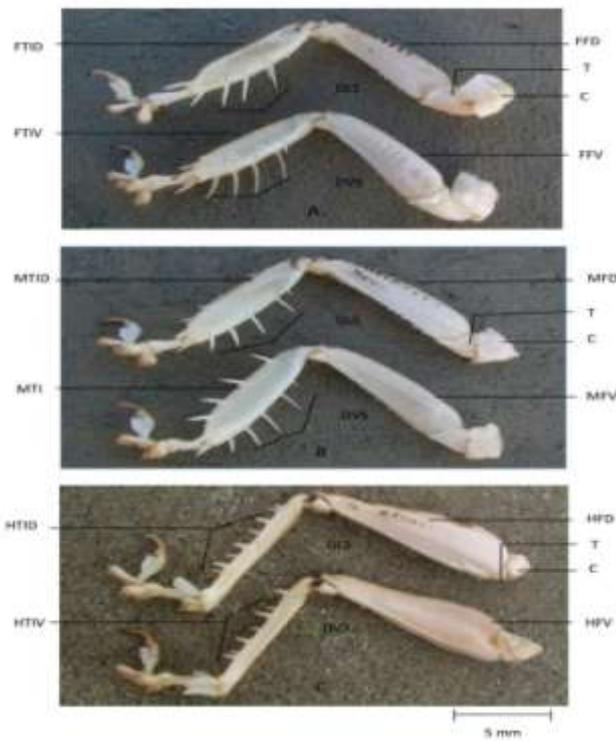
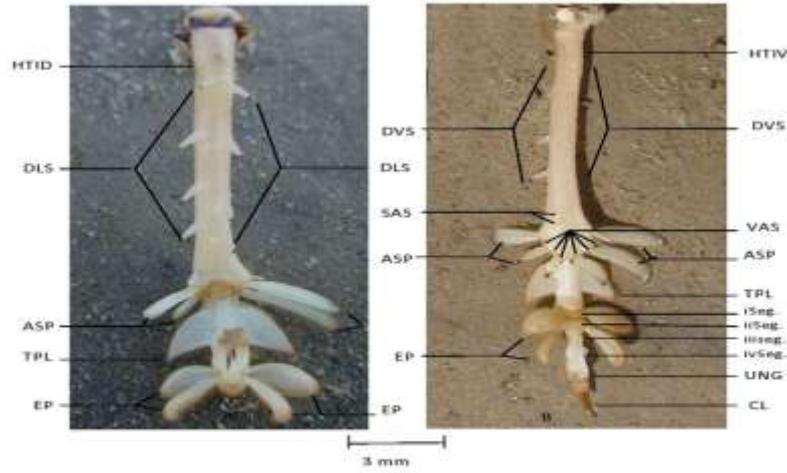
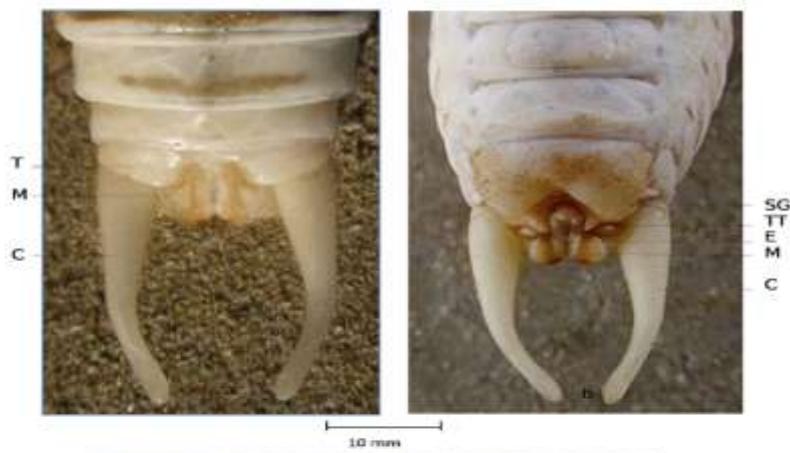


Figure3. *Schizodactylus sindhensis* sp. nov male (Holotype) a). Fore leg dorsal view above, ventral view below b). Mid leg dorsal view above ,ventral view below, Hind leg a) dorsal view above, ventral view below C:Coxa,F:femur,T: Tibia T:trochanter.



Schizodactylus sindhensis
 a) Hind tibia & tarsus dorsal view, b) Hind tibia & tarsus ventral view

Figure 4. ASP: Apical spurs Cl =Claw, EP=Euplantulae , TPL,=Triangular plate DLS=Dorsolateral spines, SAS=Sub Apical Spines, VAS= Ventro Apical Spines, UNG=Unigenitali Seg =1st Tarsal Segment, ii Seg=2nd Tarsal segment, iii Seg=3rd Tarsal segment iv Seg= 4th Tarsal segment.



Schizodactylus sindhensis Male, abdominal terminal.
 a) Dorsal view, b) Ventral view, c) Lateral view

Figure 5. C=Cercus; E= Epiproct; M=Membranous; S=Subgenital plate; T=Tergum, TT= Titillators.



Figure 6. *Schizodactylusindhensis* Female A) Lateral view B) Dorsal view.



Figure 7. *Schizodactylusindhensis* Female, abdominal terminal. Dorsal view, b) Lateral view C-Cercus, E-Epiproct, O-ovipositor, P-Paraproct,SG-Subgenital plate.



A



B



Figure 8. (A & B) Strong one attacked prey holding it among strong pro-and meso- legs and squeezing with abdomen. C) prey killed.



Figure 9. Typical burrowing activity of *S.indhensis*.



Figure 10. a & b.

a) Open

b) Closed



a) Straight b) Oblique

Figure 11 a & b. *S.indhensis* burrows internal view oblique burrow.



Figure.12. *S. sindhensis* Eggs in a pit.



Figure 13. a-i) *Schizodactylus sindhensis* sp. nov, Instars. a) 1st instar b) 2nd instar c) 3rd instar d) 4th instar e) 5th instar f) 6th instar g) 7th instar h) 8th instar i) 9th instar.



Figure 14. *Schizodactylus sindhensis* sp. nov. Fast running and take-off (Figure A&B). Wings open during fly (Figure C-F).

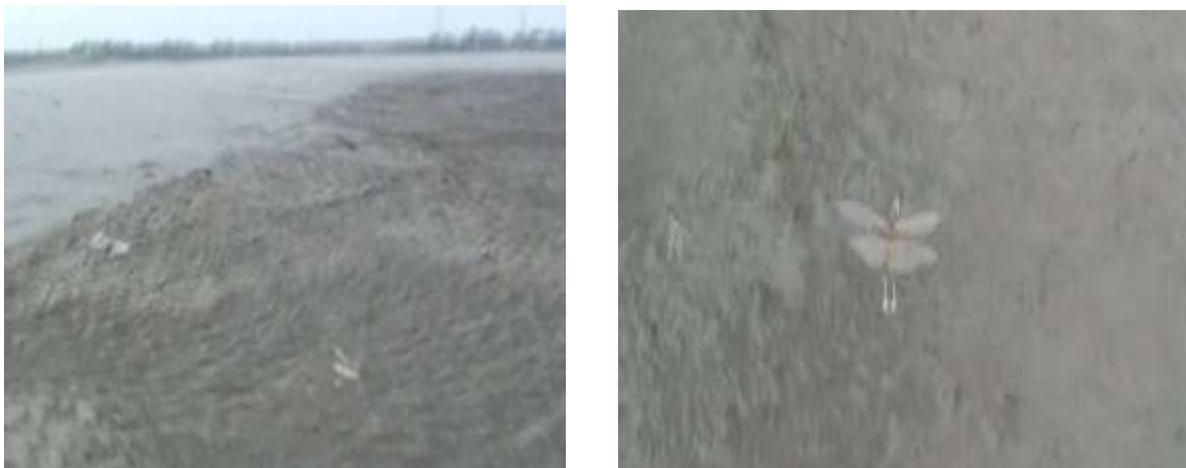


Figure 15. *Schizodactylus sindhensis* sp. nov, flying *Schizodactylus* touching down the riverbed on early morning.



Figure16. *Schizodactylus sindhensis* sp. nov. Swimming. Fast swimming (Above & below). Note: Right foreleg is injured, hence not fully stretched (Below).



Figure 17. *Schizodactylus sindhensis* sp. nov Swimming. Medium (A&B), slow (C&D). resting (E&F), Coming out from water to find suitable place for burrowing.



Figure 18. Habitat of *Schizodactylus sindhensis* sp. nov. along Sahrish Nagar, Hussainabad, and Latifabad NO.4, an area of about 5 Km. on the left bank of River Indus, Hyderabad, Sindh. A. Fields stretching between the river and the village Sahrish Nagar, Hyderabad. B. light layer of sand near the edge of water having scattered vegetation of tamarisk. C. shifting dunes along shoreline (so-called white dunes,) with the vegetation cover represented by *Acacia nilotica*, (Bhabhur) *Acacia jacquemontii*, (Davi). Also showing the footprints of *Schizodactylus* species. Hussainabad, Hyderabad. D. Edge of water, sand dunes having *Alhagi maurorum*. (kanderi) Latifabad, Hyderabad. E. Showing burrows in the field of *pennisetum glaucum* (Bajra). Hussainabad, Hyderabad. F. Showing the burrows in the tilled agriculture field Latifabad, No.4, Hyderabad. G. Agriculture crop, pea nut plants, sugar cane and *tamarixpassernioides*. (Lao). Hussainabad, Hyderabad.

He, (2020) was first to report the swimming ability in *Schizodactylus jimo*. We also observed swimming in *Schizodactylus sindhensis* new species. Early morning the insects collected from the field were dropped singly in a river having about 6 feet high water in order to observe the swimming activity, within few seconds insect started swimming with very fast speed (Figure 1-2). It was further observed that body of the swimming insect was submerged under water and antennae (which are much longer than the body) are in upright position possibly serving the navigations. The fore legs are stretched completely straight and closely pressed or placed together apically; mid legs are stretched backward. Hind legs specially the tibiae and spurs beat so vigorously that the insect swim with very fast speed in water and the spurs possible serving like an oar. When fast swimming insect comes near the shallow water it reduces the speed the antennae is relaxed, moving back forth to explore their surroundings for food etc. Forelegs apically separated but straight in position, and somewhat closely placed, hind legs beat slow and insect swim medium/slowly in water (Figure 17, A-D). In slow swim the insect is free relax the fore legs are separated middle legs move slowly and the hind legs also move very slowly and relaxed. After swimming, insect relax for some time (Figure 17 E&F). After coming out of the water it searches some suitable place for the construction of burrow. The more detailed study is in progress. Presently, it was also observed that *S. sindhensis* is sensitive in nature and die if did not find any moisture. Insects prefer high moisture content, low temperature, and moisture for living. They spend most of their time in burrow. Carpentier (1953) reported that *S. monstrosus* avoid the direct sunlight contact similar behaviour was also recorded for *S. sindhensis* during present study it was found that in high hot day these insects prefer to stay in water for some time to avoid hot condition and desiccation.

CONCLUSION

Apart from their all-obliterating activities *Schizodactylus sindhensis* new species played a very important role in the local food chain that prevents certain insect population from increasing and becoming dominant in field. Besides, this species is important food source for reptiles-e (snakes, lizards) and birds such as Shaheen, *Alectoris chukar* and *Dendrocygna bicolor* in Pakistan. The adults and nymphs of this new species were found in the white dune sand fixed grey dunes along the shore line's with the vegetation cover represented by important plants such as *Acacia nilotica*, (Babur), *Acacia jacquemontii*, (Davi), *Tamarisks Passernioides*, (Lao), *Tamarisksaphylla*, (laee), *Salvadora persica*, (Khabar) *Azadirachta indica* (Nim) *Sueda fruticosa*, (Lani) *Solanum surattense* (Candari), *Albizia lebbeck*, (Sirenh) and *Capparis deciduas*, (Kireer) which were surrounded by Zea mays (Makai), sugarcane, vegetables, fodder crops and grasses. During the field observation little flight of this insect was noticed.

ACKNOWLEDGMENT

The authors express sincere thanks to the head of the Department of Zoology, University of Sindh, Jamshoro, Pakistan for the facilities provided to carry out this research work.

REFERENCES

- Ander, K. (1938). Diaganosen Zwei neuer *Schizodactylus* Arten. Entom. Tidskr., 59. (1-2)37-150 .
- Aydin, G., & Khomutov, A. (2008). The biology, nymphal stages, and life habits of the endemic sand dune cricket *Schizodactylus inexpectatus* (Werner, 1901)(Orthoptera: Schizodactylidae). *Turkish Journal of Zoology*, 32(4), 427-432.
- Bei-Bienko, G. Y. (1967). On the taxonomy and biology of a new *Schizodactylus* from Afghanistan. *Acta Musei Moraviae*, 52, 187-194.
- Carpentier, F. (1953). Observations sur *Schizodactylus monstrosus* Drury (Orthoptera: Gryllacridoidea). Bull. et. Ann. Soc. Ent. De. Belgique. 89 (vii-viii): 184-186.
- Channa, S. A., Sultana, R., & Wagan, M. S. (2011). Studies on the immature stages and burrow excavating behavior of *Schizodactylus monstrosus* (Drury) (Grylloptera: Gryllodea: Schizodactylidae) from Sindh, Pakistan. *African Journal of Biotechnology*, 10(12), 2328-2333
- Channa, S.A., Sultana, R. & Wagan, M.S. (2013) Morphology and Burrowing Behaviour of *Schizodactylus minor* (Ander, 1938)(Grylloptera: Schizodactylidae) Orthoptera Pakistan. *Pakistan Journal of Zoology*, 45 (5), 1191-1196.
- Choudhuri, D. K., & Bagh, R. K. (1974). On the sub-social behaviour and cannibalism in *Schizodactylus monstrosus* (Orthoptera: Schizodactylidae). *Revue d'Ecologie et de Biologie du Sol (France)*. 11, 569-573.
- Cigliano, M.M., Braun, H., Eades, D.C. & Otte, D. (2021) Orthoptera Species File Online Version 5 (5.0). Availabl from: <http://Orthoptera.SpeciesFile.org> (accessed 13 june 2021),
- Dawwrueng, P. Panitvong, N., Mooltham, K., Meebenjamart, P. O&Jaitrong, W. (2018). First record of the family Schizodactylidae (Orthoptera: Ensifera) from Thailand, with the description of a new species. *Zootaxa*, 4472(1), 60-70.
- Drury, D. (1773). Illustrations of natural history, wherein are exhibited upwards of 240 figures of Exotic Insects. White, London, [vii] + 90 pp
- Hazra, A.K. and Tandon, S.K. (1991). Ecology and Behaviour of a Sand Burrowing Insect, *Schizodactylus monstrosus* (Orthoptera: Schizodactylidae). 805-809 In Advances in Management and Conservation of Soil

- Fauna (Eds: G.K. Veeresh, D. Rajagopal and C.A. Viraktamath). Bombay, Calcutta, New Delhi, 925 pp.
- Hazra, A. K., Barman, R. S., Mondal, S. K., & Choudhuri, D. K. (1983). Population ecology of *Schizodactylus monstrosus* (Drury)(Orthoptera) along the sand bed of Damodar river, West Bengal, India. *Proceedings: Animal Sciences*, 92(6), 453-466.
- He, Zhu-Qing & YI-JiaoLiu(2021) A new species of Dune Cricket from China (Orthoptera: Ensifera: Schizodactylidae). *Zootaxa*, 4999(4):356-362
- Ingrisch, S. (2002). Orthoptera from Bhutan, Nepal and North India in the Natural History Museum Basel. *Entomologica Basiliensia*, 24, 123-159.
- Khattar, N. (1972). A description of the adult and the nymphal stages of *Schizodactylus monstrosus* (Drury)(Orthoptera). *Journal of Natural History*, 6(5), 589-600.
- Leubner, F., Bradler, S. & Wipfler, B. (2017) The thoracic morphology of the wingless dune cricket *Comicuscalcaris* (Orthoptera: Schizodactylidae): novel apomorphic characters for the group and adaptations to sand desert environments. *Arthropod Structure & Development*, 46(4), 449-461. <https://doi.org/10.1016/j.asd.2017.03.006>
- Martins-Neto RG (2007). New Orthoptera Stenopelmatoidea and Hagloidea (Ensifera) the Santana Formation (Lower Cretaceous, northeast Brazil) with description one new taxa. *Gaea* 3, 3-8.
- Ramme, W. (1931). Systematisches, verbreitung und morpho-biologisches aus der gryllacriden unterfamilie schizodactylinae (orth). *Zeitschrift für Morphologie und Ökologie der Tiere*, 22(1), 163-172.
- Uvarov, B. P. (1935). XI.A new species of the genus *Schizodactylus* from Burma (Orthoptera, Gryllacridæ). *Annals and Magazine of Natural History*, 15(85), 150-153.
- Uvarov, B. P. (1952). LXXX-Description of adult *Schizodactylus inexpectatus* (Werner) from Turkey (Orthoptera, Gryllacrididae). *Annals and Magazine of Natural History*, 5(56), 772-774.
- Wagan, M.S and Soomro, M.H., (1993). A new record of *Schizodactylus hesperus* B. Bienko (Grylloptera: Grylloidea: Schizodactylidae) from Sindh, Pakistan. *Proc. Pakistan congress of Zoology*. 13:367-368.