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# OCCURRENCE OF *SCHIZODACTYLUS* (SCHIZODACTYLIDAE) IN VARIOUS LOCALITIES: REVEAL NEW DISTRIBUTION RECORDS FROM PAKISTAN

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## Abstract

The Genus Schizodactylus comprises nine species with their 09 nymphal stages respectively throughout the world. They have attractive features with large robustly body, aggressive physical features, long antennae strong mandibles and rolling wings. Among nine species only 3 species S. monstrous, S. minor and S. sindhensis found in Pakistan. Present study is designed to explore the incidence and other attractive features from various region of Pakistan. However, it has been observed that the incidence of Schizodactylus is affected by different factor affecting in which temperature and humidity is studied in detail. Approximately, 900 specimens were collected from different localities of Pakistan, among these specimens the abundant species was Schizodactylus monstrous. Present study also find the shape, length and width of the burrow, the size of burrow depends on the size of all nymphal stages shortest burrow was 2.8mm while the longest one with 70mm length.

**Key words:** Schizodactylus, mandibles, rolling wings, incidence, nymphal stages, burrow

## Introduction

The rolling wings insects of family *Schizodactylidae* with nine species found throughout the world included, *Schizodactylus inexpectatus* Werner (1901), *S. hesperus* Bei-Bienko, (1967); *S. brevinotus* Ingrisch, (2002); *S. monstrous,* (Drury); S. *minor* Ander, (1938); *S. burmanus* Uvarov, (1935); *S. tuberculatus* Ander, (1938); *S. jimo* He & liu, (2021); *S. sindhensis* Channa, (2014). Among them there are three species found in Pakistan *i.e*: *S. monstrosus* (Drury), *S. minor* Ander (1938) and *S. sindhensis* Channa, (2014**).** The population of *Schizodactylus monstrous* is more as compare to others, they are also known as Dune Cricket, maize cricket and monster crickets, (Khattar 1972) they are mostly known cricket of Bengal because they found mostly in Asian countries like Pakistan, India, Bangladesh, Burma not only these countries they also found in China, Turkey, Mayamar and Cylon, the Indians villagers also called them Bhewra of Bengal and Monchaar because of long antennae. They have large body with long antennae; they are famous due to their rolling wings. They are cannabolic, carnivore and nocturnal in nature. It is very difficult to find them in field because of their burrow excavating behavior, also their nocturnal behavior, their defence mechanism is highly recommended for study, because their morphological features like strong and well developed hind legs use for burrow making and

high jumping. The life cycle of *Schizodactylus* passes from 9 nymphal stages and all the nocturnal and burrow makers.

The present study is design to focus on incidence of *Schizodactylus* and their nine nymphal stages from river banks of various regions of Pakistan. Generally *Schizodactylus* are lives near the river banks and moist area where tunneling is easy, they are cannibalic and carnivore in nature so the female depend on male and male on other nymphal stage, it is also observed that the female *Schizodactylus monstrous* lay bunch of eggs consists approximately 23 eggs per bunch, the first hatch nymph depends of other eggs noted by borescope camera, also the favorite food of this species are beetles, But interesting fact of this study that when the *Schizodactylus monstrous* and their nymphal stage face any disaster or heavy flood due to climate change they quickly change their habitat from river banks to near villages. Pakistan has diverse number of habitat including desert areas, hilly habitats and desert areas (Sultana *et al.*, 2024). Lots of Research of family Schizodactylidae has been studied by Snodgrass, (1937 & 1957); Ragge, (1957); Imms, (1957); Khattar, (1958, 1959 & 1972); Khattar and Srivastava, (1962); Randell, (1964); Uvarov, (1952); Sultana & Channa, (2014); Chouduri & Bagh, (1974); Sultana & Wagan, (2010 & 2012) on physiology, anatomy, morphology, defense mechanism, digging behaviour, external genitalia and other taxonomical character of Group Orthoptera, extensive research about the morphology and burrow behavior of *Schizodactylus* done by (Channa & Sultana, 2013). However, relatively limited research has been dedicated to the highly distinctive genus *Schizodactylus*, a remarkable group of Orthopterans known for their unique characteristics that distinguish them from other members of the order. Unlike most Orthopterans, *Schizodactylus* species exhibit specialized traits such as: Rolling wings that provide a distinct mode of movement. Cannibalistic and carnivorous feeding behavior, a trait not commonly observed in other Orthopterans groups. Advanced burrowing techniques, using mandibles and forelegs to dig and hind tibia to push the excavated soil behind them. This research will help to bridge the knowledge gap by conducting a detailed investigation on three species of genus *Schizodactylus*.

## Materials & Methods

### *Description of study area*

This study was conducted in 2022 to 2023 at 05 locations of Sindh including Larkana, Sukkkur, Tharparkar, Hussainabad Hyderabad , Madeji Shikarpur, one locality of Punjab *i.e*: Bhawalpur, one locality of Balochistan *i.e*: Quetta and one locality of KPK *i.e*. Dera Ismail Khan (Table 1). The three species; *Schizodactylus monstrous, Schizodactylus minor* and *Schizodactylus sindhensis* were collected from various Regions of Pakistan (Fig. 1a, 1b and 1c).

**Table 1: Showing the locations with their longitude/latitude.**

| Localities | District | Province | Longitude/latitude |
|---|---|---|---|
| Hussainabad | Hyderabad | Sindh | 25.3780° N, 68.3235° E |
| Khairpur Bridge | Larkana | Sindh | 27.5570° N, 68.2028° E. |
| Sukkur Barrage / Sadu Belo Temple | Sukkur | Sindh | 27.7029° N,: 68.8585° E |
| Islamkot | Tharparkar | Sindh | 24.7014° N, 70.1783° E |
| Madeji | Shikarpur | Sindh | 27.7564° N, 68.4502° E, |
| River Indus | Dera Ismail khan | KPK | 31.8132° N, 70.9198° E |
| Wali Tangi Dam | Quetta | Baluchistan | 30.183270, N, 66.996452E |
| Sutlej River | Bahawalpur | Punjab | 29.395721, N, 71.683334 E |

***(a)*** ***(b)*** ***(c)***

**Figure 1. Showing the lateral view of a. *S. monstrous, b. S. minor* and *c. S. sindhensis.***

## Habitat selection of *Schizodactylus*

*Schizodactylus monstrous* occurs near the banks of river, about more than 200 species were collected from different regions of Pakistan. This species was collected from moist area because all nymphal stages are found in burrow. The swimming behaviour of *Schizodactylus* was also observed. They use their fore and hind limb for swimming.

### Searching of Nymphal stages

There are nine nymphal stages of *Schizodactylus*. To study the life cycle of *Schizodactylus*, weekly data was collected including stage wise specimens. According to Khattar, (1972a) that this species takes more than one year to complete entire life cycle. During all nymphal instar every nymph are burrow makers some of them collected from field while most of them were caught from burrow at night time, it was observed through borescope camera that female hatched 20-23 eggs at a time first hatched nymph feed on other eggs.

### Identification and burrow formation

All nymphal stages of *Schizodactylus* are burrow makers they make their burrow by using their strong morphological features especially the hind limbs, length and width of burrow directly proportional to the body size of *Schizodactylus.* This species always found in close burrow, when they leave in the burrow they never come back to the same burrow**.** It was also difficult to find them in close burrow of Adult *Schizodactylus* because they have ability to move from burrow to burrow. With the help of wax we find the burrow of *Schizodactylus*, first find the open burrow and ensure that no insect present in burrow, then raw wax melted under high temperature, after that the melted wax put in the burrow, wait for dry, in last dig the dry burrow and put out the dry wax (Fig. 2a and 2b).

**a** **b**

**Figure 2. Showing the a) open and b) close burrow of *Schizodactylus.***

## Results & Discussion

**Systematics:**

Phylum: Arthropoda

Order: Orthoptera

Super Family: Schizodactylideae

Family: Schizodactylida

Sub Family: Schizodactylinae

**Diagnostic analysis of *Schizodactylus***

The insects of *Schizodactylus* are commonly known as dune cricket, maize cricket and cricket of Bengal. They are also called Moochar by the villagers of India due to long antennae. They found in moist and sandy habitat near the shores of river bank. They are large in size with long segmented filliform antennae. Antennae are larger than their body size. They have highly modified fore and hind limb having broadly lobed tarsi, which use for digging. Spines are present in their tibia. Their body length from depends on their nymphal stages, from 10mm to 70mm. Expended hind tibia and tarsi gives the appearance of leaf like, which may help them for locomotion in sandy areas. They have rolling wings, rolling wing are found in adult only, wings are under development in every nymphal stage. Their wings are only use for short flight, maximum 10 seconds. They have well developed mandibles adaptation, make them strong carnivore and cannibalic in nature.

Fig. 3 showing the monthly population counts of three species over a year. The data reveals fluctuations in population sizes across the months for each species. *S. monstrous* ranked first with the highest population (54.84%), with a total population count 493. Its numbers peak in April (120) and June (100) while *S. minor* ranked second (28.92%) with a total population of 260. The highest no. of individuals were found in April (50) and July (40) while lowest was recorded in December. However, *S. sindhensis* ranked third (16.24%), has the lowest total population of 147. The highest peak in June (32) while no specimen of *S. monstrous* and *S. sindhensis* were recorded during January and December. The data suggests seasonal variations in the populations of these species, with peaks generally occurring in the April (spring) (21.69%) and June (summer) (19.69%) and declines in the winter. This could be due to factors such as breeding cycles, food availability, or environmental conditions.

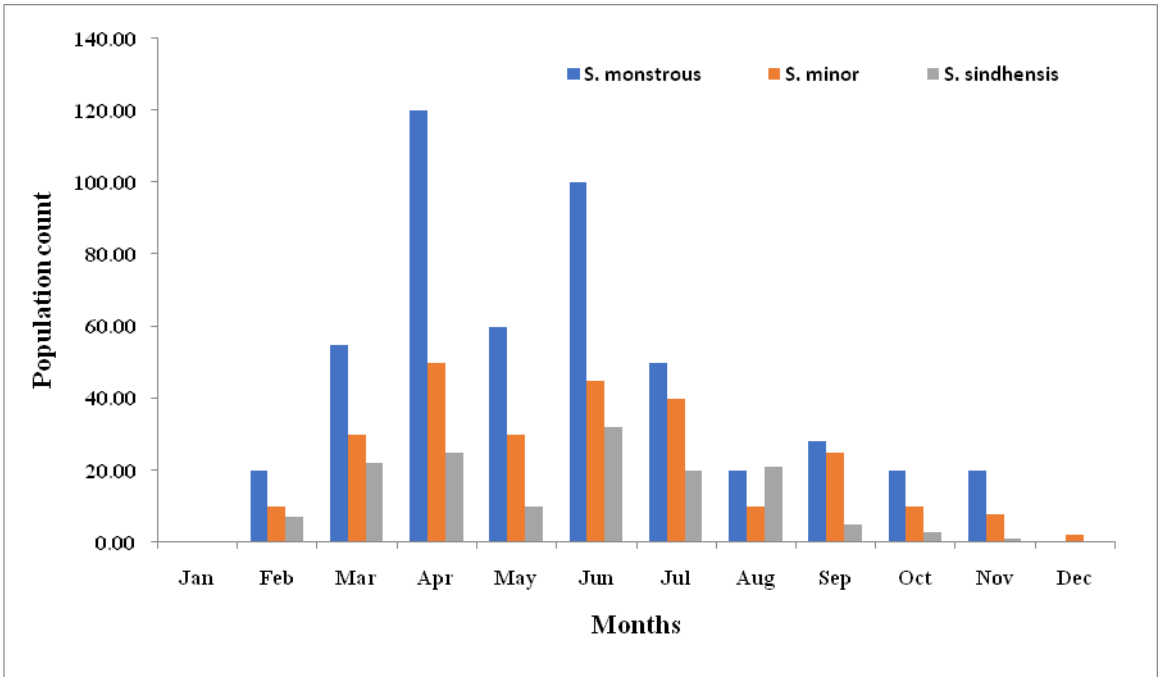


**Figure 3. Showing the population of *S.monstrous, S.minor, S.sindhensis* from various region of Pakistan.**

Table 3. presents a comparison of diversity indices for three different groups, as *S. monstrous*, *S. minor* and *S. sindhensis*. These indices provide insights into the species richness, abundance, and evenness within each group. *S. minor* has the highest species richness with 11 taxa, while *S. monstrous* and *S. sindhensis* have 10 taxa each. The data represents that *S. monstrous* has the highest number of individuals, followed by *S. minor* and *S. sindhensis* while *S. minor* exhibits the lowest dominance, indicating a more even distribution of individuals among species with the highest Shannon diversity index, suggesting greater species diversity compared to the other two groups. *S. monstrous* has the highest evenness value, indicating a more equitable distribution of individuals among species.

*S. minor* shows the highest Brillouin index, another measure of diversity, while *S. sindhensis* has the lowest value. Menhinick index showing that *S. sindhensis* has the highest diversity which is a simple measure of species richness. *S. sindhensis* exhibits the highest Margalef index, another measure of species richness, followed closely by *S. minor*. The results depicted that *S. minor* has the lowest Berger-Parker dominance index, indicating lower dominance by any single species. The highest equitability value of *S. monstrous* suggesting a more even distribution of individuals among species. *S. sindhensis* has the highest Fisher's alpha, a measure of species diversity that is less sensitive to sample size. S. minor has the highest estimated species richness based on the Chao-1 estimator. *S. minor* has the highest Simpson diversity index, suggesting higher diversity, while S. sindhensis has the lowest.

It might be concluded that *S. minor* and *S. sindhensis* generally exhibit higher species diversity and richness compared to *S. monstrous*, while *S. monstrous* tends to have higher evenness.

**Table 3 Showing the Diversity indices of *S. monstrous, S. minor, S. sindhensis***

| Diversity indices | *S. monstrous* | *S. minor* | *S. sindhensis* |
|---|---|---|---|
| Taxa_S | 10 | 11 | 10 |
| Individuals | 493 | 260 | 146 |
| Dominance_D | 0.1477 | 0.1319 | 0.1482 |
| Shannon_H | 2.084 | 2.153 | 2.03 |
| Evenness_e^H/S | 0.8033 | 0.7825 | 0.7615 |
| Brillouin | 2.036 | 2.068 | 1.911 |
| Menhinick | 0.4504 | 0.6822 | 0.8276 |
| Margalef | 1.451 | 1.798 | 1.806 |
| Equitability_J | 0.9049 | 0.8977 | 0.8816 |
| Fisher_alpha | 1.776 | 2.328 | 2.432 |
| Berger-Parker | 0.2434 | 0.1923 | 0.2192 |
| Chao-1 | 10 | 11 | 10 |
| **Simpson_1-D** | **0.8523** | **0.8681** | **0.8518** |

The bar graph is displaying the distribution of three samples *S. monstronus, S. minor,* and *S. sindhensis* across different temperature ranges throughout the months of the year and their total numbers. The samples are most prevalent between March and June, particularly in the 20-50°C range. The distribution indicates a preference for warmer temperatures, with minimal presence in colder months (November to February). The chart provides a clear visualization of how the distribution of these samples varies with temperature and time of the year (Fig. 4). The bar graph illustrates the distribution of three species *S. monstrous, S. minor* and *S. sindhensis* across different months and a maximum range of humidity. The total shows the highest counts of humidity, with *S. monstrous* reaching approximately 500, *S. minor* around 250, and *S. sindhensis* just above 100. The distribution across months varies, with peaks for each species. For instance, *S. monstrous* shows notable counts in April and June. The monthly ranges between 32-39% might represent a specific parameter or condition associated with the samples during those months (Fig. 5).

According to Khattar (1972) *Schizodactylus monstrous* makes their burrow in high humidity which is 88.5-98.5 percent. The most specimen in dry season, in extreme humidity they found less in number, *S. monstrous* is strictly nocturnal khattar (1972) most of the specimen collected between 3am to 5am, the body of *S. monstrous* is hard, while color of *S. monstrous* is creamy yellow with brown spot, two long pairs of rolling wings use for fly, abdomen is segmented, large dominant compound eyes, head large in size, long pair of antennae, antennae is longer their body, three pairs of legs with spines use for digging. It was observed the swimming, flying, feeding and burrow excavating behavior at night time but unable to notice the mating or

copulation process, through dissecting it is observed they are not hermaphrodite, 23 eggs were found inside the body of female *Schizodactylus* while vas difference were noticed in male *Schizodactylus.*

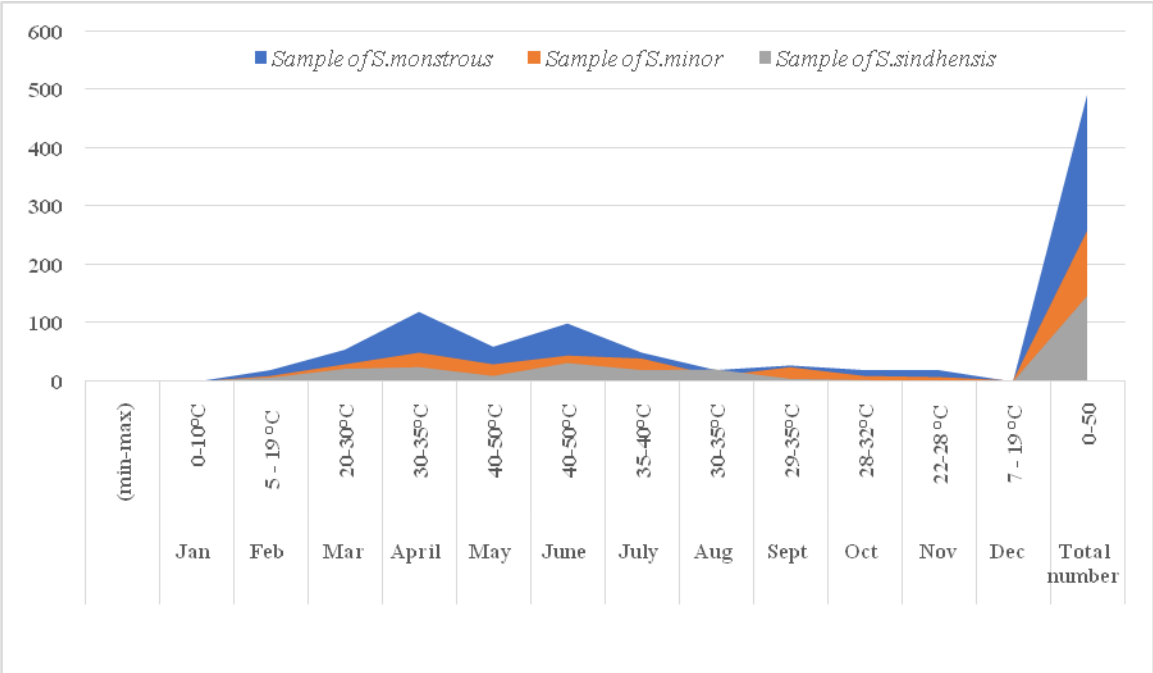


**Figure 4. Showing the *Schizodactylus* population affected by temperature.**

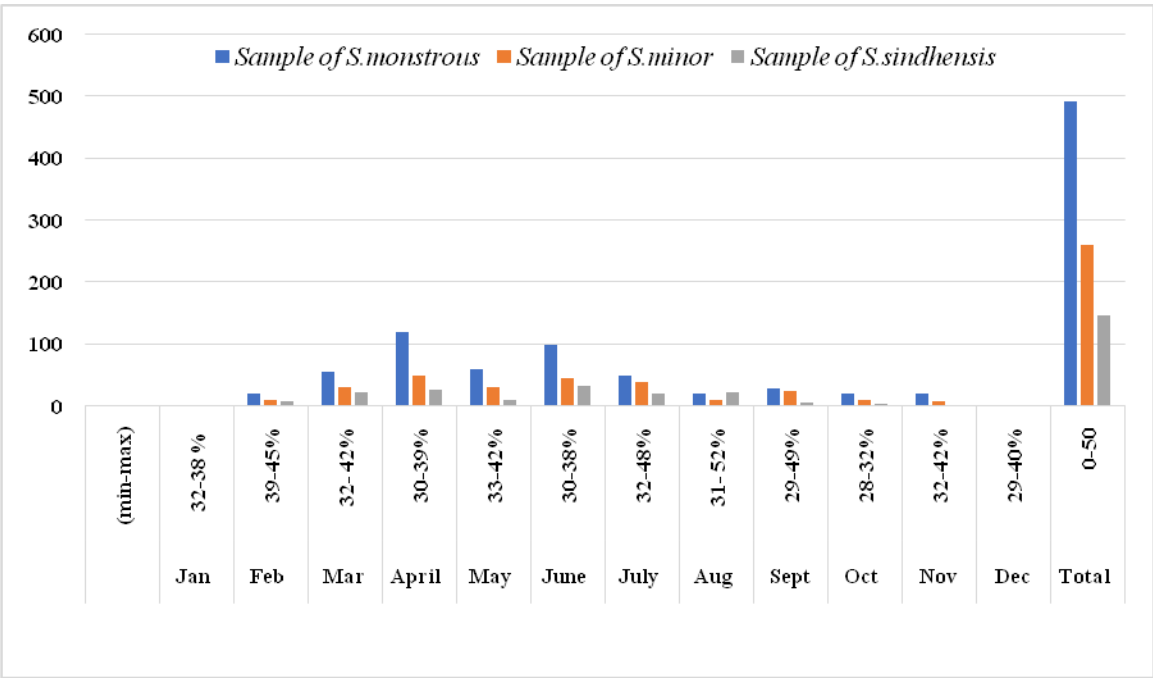


**Figure 5: Showing the *Schizodactylus* population affected by Humidity.**

During field survey the shortest burrow 2.8mm and the deepest burrow 70cm was recorded. Their wings are matured only in Adult *Schizodactylus*, however the wings are observed under developing in remaining 8 nymphal stages. *H. daganensis* Krauss and *H. oryzivorus* Carl are the most diverse species of Orthoptera which can swim in water (Sultana, 2007**).** The swimming behavior of *Schizodactylus* is very interesting; they swim by the help of their fore and hind limb.

*Schizodactylus i*s popular due to its wing rolling capability (Channa et al., 2013). Khattar (1972) noticed that they are flightless, while Carpentier (1953) observed that they can fly during night time, however it was observed that the S. *monstrous* can fly during day time as much as 10 sec. According to Carpenteir, (1953) some *S. monstrous* lives in open burrow but during the study no specimen were found in open burrows. Most of the species of Orthopterans directly affected due to climate change with rising temperature (Bhanger and Sultana, 2024). *S. monstrous* is cannibalic in nature, adult feed on nymph, female depends on male so, it is difficult to notice the mating behavior, cannibalic behavior of *S. monstrous* and *S. inexpectatus* studied by (Uvarov, 1952; Khattar, 1972; and hazra and Tandon, 1991).

In all over the world *S. inexpectatus* has been decreased up to 60% due to destroying their habitat during 7 year period, this specie is discovered from Turkey by Martin Holtz, (1897) but now it is considered as endemic species of Turkey (Aydin and Khomutov, 2008). This specie still not added in IUCN's (world conservation union's) Red List of Endangered species it should be added under the CR category *i.e.* critically endangered species). From the above research it has been notice that this should be conserve by providing isolated, protected areas if it is not done immediately this specie might be extent soon.

The conservation of *Schizodactylus* is much needed to prevent from declining. This study is continuous for finding out their conservation strategies and their reproductive activities including mating behavior. Also *Schizodactylus* plays an important role in food chain as they consume the pest which found in desert area, the desert locust has been considered as the serious pest since ancient time (Samejo et al., 2021). It is very difficult to find the mating activity of *Schizodactylus*, after extensive research it has been concluded that female depends on male and male to other nymph, by the help of borescope camera it was noted that the female *Schizodactylus* lay bunch of eggs consist approximately 23 eggs per bunch. The first hatch nymph depends on other eggs as nutrition. *Schizodactylus* passes from nine nymphal stages, the consume nutrient by increasing their size from nymphal stages to adult, and the survival rate is high from stage six to adult. This observation was also applied on *Schistocerca gregaria* (Samejo and Sultana, 2019).

## Conclusion

The present study was designed for detailed observation about the diversity, abundance, habitat destruction; factor affecting and morphological features of three species of *Schizodactylus* included *S. monstrous, S. minor* and *S. sindhensis*. *Schizodactylus* considered as rare species but

our study prove that they are abundantly found from Pakistan especially from Sindh. The *Schizodactylus* prefer to live in moist and sandy area, mostly burrow found from the slope region, they select those area where tunneling is easy. They are nocturnal, carnivore and cannibalic in nature, they prefer to eat beetle species. Recent study explore that they can also flight during day time for maximum 10 seconds. Their modified legs adapted for digging ability, swimming and high jump. Temperature and humidity are most important factor in activity of *Schizodactylus* in field.

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## Conflict of interest

Authors declared that there is no conflict of interest.

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