Notes on feeding, locomotor activity rhythms and orientation in the pygmy mole cricket *Afrotridactylus cf. usambaricus* in Kenya (Orthoptera: Tridactylinae)

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**Key words.** Orthoptera, Tridactylidae, *Afrotridactylus cf. usambaricus*, behaviour, activity rhythms, feeding, orientation, Kenya

**Abstract.** Immature individuals of *Afrotridactylus cf. usambaricus* (Sjöstedt, 1910) were recorded on a marine sandy beach probably feeding on bacteria, microalgae and mesosapromonic organisms. The larvae of this pygmy mole cricket probably obtain these organisms by manipulating grains of sand with their buccal apparatus during the excavation of tunnels close to the surface of the sand. This occurs in daytime during the ebb tide while direct migration to the sea is in progress. Therefore, the migration occurs according to a diurnal-tidal rhythm having been detected only in correspondence with the low diurnal tides. This rhythmic activity remains in phase with the diurnal-tidal periodicity even far from the sea, in a confined environment. Individuals tested in a transparent Plexiglas bowl are able to assume and maintain the sea-land direction of the beach constant throughout the day in the absence of the landscape vision.

**INTRODUCTION**

Tridactylidae is a group of Orthoptera, which strongly resemble tiny mole-crickets (also called Pigmy mole crickets). They are quite well known from a systematic and zoogeographic point of view (e.g. see Günther, 1975, 1977), but many aspects of their behavioural ecology are still poorly known. This information generally consists of brief notes in some of the many works published on the taxonomy and systematics of this group (e.g. see La Rivers, 1956; Deyrup & Eisner, 1996; Deyrup, 2005). Research on the behaviour and/or ecology of pigmy mole crickets is very rare. Burrows & Picker (2010) present a careful analysis of the jumping ability of *Xyla capensis var capensis* (Saussure, 1877) with brief notes on its ecology. Moriya & Ichinose (1988) report that when *Tridactylus japonicus* (De Haan, 1842) is attacked by lycosid spiders or ants it produces a secretion that it uses to protect itself. The relationship between jaw morphology and dietary preferences in *Xya pfaendleri* Harz, 1970 and *Xya variegata* (Latreille, 1809) is described by Kuravova & Kocarek (2016) along with a few hints on their ecology (for the morphology of the mouth parts see also Gangwere, 1965). Deyrup & Eisner (1996) for *Neotridactylus archboldi* Deyrup & Eisner, 1996; Deyrup (2005) for *Ellipes eisneri* Deyrup, 2005 and Woo (2020) for *Ellipes monticolus* Günther, 1977 report interesting but qualitative observations on habitat and digging behaviour of these species. Bastow et al. (2002) highlight the importance of tridactylids in the energy exchange between rivers and riparian food webs. The paucity of research on the behaviour of tridactylides stimulated me to propose some observations made many years ago thinking of providing a contribution which I hope will be useful to little known behaviour of a species of this family.

**MATERIALS AND METHODS**

Immature individuals of *Afrotridactylus cf. usambaricus* (Sjöstedt, 1910) were observed and collected on a sandy beach at Malindi, Kenya, in January 1994. The beach is located between Malindi (3°12´41S, 40°07´24E) and the Sabaki (Galana) river mouth (3°10´25S, 40°08´30E). In particular, the observations in nature were made on the marine beach, about 200 m from the mouth of the river. The insects were filmed with a video-camera (Sony Handycam Vision Hi8XR CCD-TRV87E) both in the field and in confined conditions under natural or infrared light.

**Feeding**

Feeding behaviour was observed on the beach during the digging of galleries and then filmed by a video camera in an insectarium. The handling of sand grains and the time spent handling was recorded. Drawing (Fig. 1) was made observing several series of freeze-frames.

**Locomotor activity rhythm and orientation**

During the observations in the wild, a count was made of the individuals seen, every hour traveling along transects orthogonal to the shoreline of about 3 m wide in the intertidal belt starting from the limit of the previous high tide. The observations carried out in a confined environment were made in a terrarium, a transparent Plexiglas box (20 × 50 cm) with 3–4 cm of damp sand
The pigmy mole crickets begin to be active moving down the beach orthogonally to the shore line as the tide starts to ebb (Fig. 2A, B). The highest number of active individuals are especially observed in the strip of sand also frequented by the sand bubbler crab, *Dotilla fenestrata* Hilgendorf, 1899 just before the tide reaches its lowest point (Fig. 2D). During the rising tide they move landward, and is followed by a reduction in locomotor activity, which ceases when the high tide is about its maximum (Fig. 2H) and resumes about 2 h after the peak of the high tide (Fig. 3A). The maximum number of active individuals is recorded 1–2 h before the minimum of the low tide (Fig. 3A). My observations do not allow to identify what are the external (and/or internal) stimuli that regulate the activity rhythm. However, since no nocturnal migrations were observed, and the migration begins and ends in a temporal “window” related to the tidal rhythm (Fig. 3B) it is reasonable to infer that the organic material adhering to the sand granules is removed by rubbing against the buccal parts provided with numerous bristles. Once handled, the granules are not used for the tunnel but are discarded. The scant beached material does not seem to be attractive to individuals.

**RESULTS AND DISCUSSION**

**Feeding**

The individuals seem to feed on bacteria and, perhaps, on mesopsammic organisms present on the surface of sand grains, which they roll in front of their mouth (Fig. 1). The grains seem actively selected from those available during the digging of the galleries, dug by the individuals very superficially into the substrate using the first pair of legs duly modified. The manipulation of sand grain is very fast, in 60 seconds they can handle 80 grains (*n* = 87) with an average time per grain of 0.41 seconds (minimum time 0.12 seconds, maximum recorded time 0.58). It is likely that the organic material adhering to the sand granules is removed by rubbing against the buccal parts provided with numerous bristles. Once handled, the granules are not used for the tunnel but are discarded. The scant beached material does not seem to be attractive to individuals.

**Locomotor activity rhythm and orientation**

The pigmy mole crickets begin to be active moving down the beach orthogonally to the shore line as the tide starts to ebb (Fig. 2A, B). The highest number of active individuals are especially observed in the strip of sand also frequented by the sand bubbler crab, *Dotilla fenestrata* Hilgendorf, 1899 just before the tide reaches its lowest point (Fig. 2D). During the rising tide they move landward, and is followed by a reduction in locomotor activity, which ceases when the high tide is about its maximum (Fig. 2H) and resumes about 2 h after the peak of the high tide (Fig. 3A). The maximum number of active individuals is recorded 1–2 h before the minimum of the low tide (Fig. 3A). My observations do not allow to identify what is the external (and/or internal) stimuli that regulate the activity rhythm. However, since no nocturnal migrations were observed, and the migration begins and ends in a temporal “window” related to the tidal rhythm (Fig. 3B) it is reasonable to infer...
that it shows a diurnal-tidal rhythm, which they also exhibit in confined conditions far from the sea (Fig. 3B).

These migrations seem performed mainly, if not entirely, in order to feed. Cicindelid beetles (*Lophyra somalia* Fairmaire, 1882) and small riparian birds, prey on individuals during these migrations (personal observations).

This species of pygmy mole cricket is able to maintain the direction of the sea-land axis of the beach without the landscape vision (Fig. 4) as the mean angles of the first order analyses of individual circular distributions are well clustered around the sea-land axis of the beach (*G* = 19.833, *df* = 1, *P* < 0.001, G test). Unfortunately, the small number of individuals tested and not being able to manipulate some of the possible orienting factors allow only some considerations and hypotheses. Although it is not possible to exclude the possibility that this species uses the natural magnetic field as a compass, as demonstrated for the Equatorial sandhopper *Talorchestia martensii* Weber, 1892 living in the same ecosystem, i.e. East African sandy beaches, (Ugolini, 2001; Ugolini et al., 2021) it is possible that the orientation along the sea-land axis of the beach is maintained constant and independent of the variation in the solar azimuth as demonstrated in other species of Orthoptera (e.g. see Felicioni & Ugolini, 1991; Ugolini & Felicioni, 1991). Moreover, it is also noteworthy that most of the directions recorded in the morning (during ebb tide) are directed towards the sea, whilst those recorded in the afternoon (rising tide) are landward and therefore, in accordance with the tidal rhythm.

CONCLUSIONS

These brief notes demonstrate that *A. cf. usambaricus* (1) can be found on sandy sea shores (although the area where the observations were made is located near the mouth of a river) and feeds by grazing the grains of sand; (2) it performs migrations based on a diurnal – tidal rhythm, and (3) it probably orientates by using celestial references (sun and sky) and/or the natural magnetic field (e.g. see Ugolini, 2001) during its excursions along the sea – land axis of the beach.

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