Leaf or stem? – genderspecific differences in the whereabouts of *Rhainopomma usambaricum* (RAMME, 1929) (Orthoptera: Acridoidea: Lentulidae)

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Abstract: Leaf or stem? – genderspecific differences in the whereabouts of *Rhainopomma usambaricum* (Orthoptera: Acridoidea: Lentulidae)
Grasshoppers show many behavioural adaptations to their habitat. A typical behaviour of phytophilous species is resting at stems. *Rhainopomma usambaricum* (RAMME, 1929) is a phytophilous grasshopper endemic to the coastal and submontane rainforests of Northern Tanzania and Southern Kenya. The species can be found more common at stems than four other sympatric grasshoppers. When the sexes are compared, however, it becomes apparent that males can be found more common at stems than females. This difference occurs only during sunny conditions. During rain both sexes rest at stems. Females tend to use leaves more often during higher temperatures. These differences are mainly due to different energy budgets of the sexes. Females are bigger and need to produce eggs. They therefore need more energy, which they can find by feeding (on leaves) and basking in the sun (on leaves). Males do not need so much energy and rest more often at stems, which are advantagous for predator escape (dodging) and camouflage (striped colour). On leaves the species needs to escape potential predators by jumping away. Both sexes use leaves more often than stems for activities, such as feeding, defecation, copulation and cleaning. Locomotory activities, such as leg movements and climbing can be found in similar portion at stems and on leaves. Females were found more often feeding, defacating than males, while males were found more often in copulation trials (sometimes with nymphs or other males).

Key words: Eastern Arc Mountains, East Usambara Mountains, endemics, energy budget, escape strategy, feeding behaviour

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Grasshoppers are often divided into geophilous and phytophilous species, since they usually are associated to typical vegetation structures (UVAROV 1977). This distinction can also be made for species of tropical rainforests (HOCHKIRCH 1996). Associated to the prefered strata are typical behaviour patterns. Phytophilous species are more often orientated vertically than geophilous species (SÄNGER 1977). They rest preferably at stems. *Rhainopomma usambaricum* (RAMME 1929) is endemic to the coastal and submontane rainforests of Southern Kenya and Northern Tanzania (JAGO 1981). The species is phytophilous and can be found preferably in 30 to 70 cm high and dense vegetation (Hochkirch 1995). It has been recorded more common from stems than two sympatric grasshoppers, *Ixalidium transiens* RAMME 1929 and *Parepistaurus pygmaeus* (KARNY 1909) (HOCHKIRCH in prep.). However, the sexes have different energy budgets and demands to their environment. In this study a trial is made to find factors influencing the choice of the whereabouts in the sexes of *Rhainopomma usambaricum*.

Method

The practical fieldwork was done from 11 June until 13 November 1994. The 14 study sites were located near Amani and Magrotto (for exact location see HOCHKIRCH 1996). At these sites habitat records have been

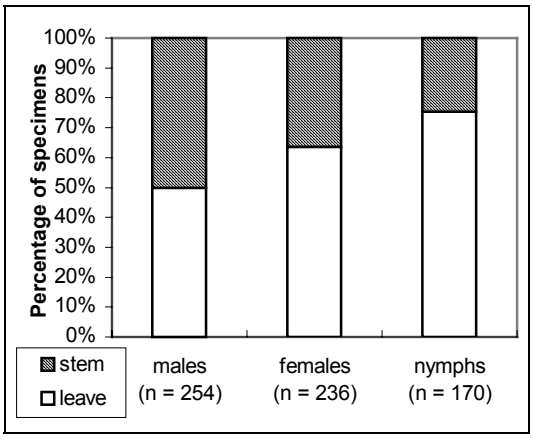

Fig. 1: Males are seated at stems more commonly than females or nymphs.

made for each specimen of the three species mentioned above. These records included day, time, species, sex, site, whereabouts, height of situation, vegetation height and density, wheather, shading, temperature, light intensity, behaviour and orientation (for other results see HOCHKIRCH 1995). The number of records for *Rhainopomma usambaricum* was 737. The analysis was made separately for species and sexes and resulted in differences in the whereabouts of the sexes. Subsequently other factors were proved in relation to the phenomenon. χ^2 crosstabulate tests were used to test the leaf : stem ratios (PRECHT 1979). Mann-Whitney U-tests adjusted for large sample size were used to test temperature data (SACHS 1974). The highest accepted P was 0.05. The data presented in the results usually consider median, Q1 and Q3.

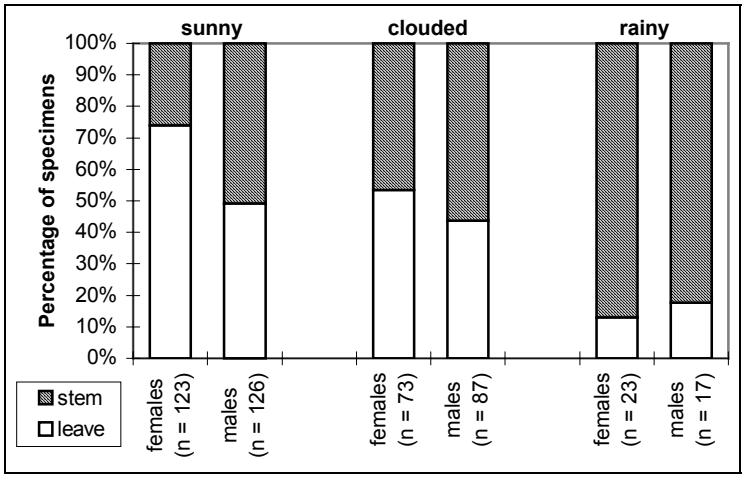

Fig. 2: The gender-specific difference is only significant, when the weather is sunny.

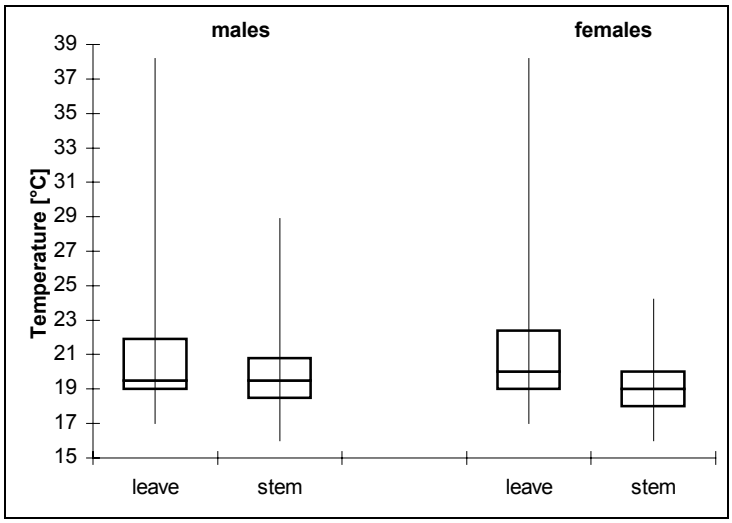

Fig. 3: The temperature of the locality differs significantly in females, but not in males (Mann-Whitney-test).

Results

A comparison of the sexes (Fig. 1) shows, that males can be found more common at stems (50%) than females (36%) or nymphs (25%). Those differences are significant (χ^2 crosstabulate Test, DF = 1). Considering the weather this difference is only visible and significant during sunny conditions (Fig. 2). Females tend to use leaves more often during sun than males do, while during rain both sexes can be found at stems. The temperatures of specimens on leaves and on stems differs significantly from each other in females, but not in males (Mann-Whitney-test, Fig. 3). Comparing behaviour records from insects sitting on leaves and those at stems, it becomes apparent that feeding, defacation, cleaning and copulation occur more often on leaves, while locomotory behaviour, such as climbing and leg movement occur in similar quantities at both items. The percentage of inactive individuals is much higher at stems in both sexes (χ^2 test, DF = 6, Fig. 4). It is also visible that females were found more often defacating and feeding than males, while males were found more often in copulation or copulation trials (χ^2 crosstabulate Test, DF = 6).

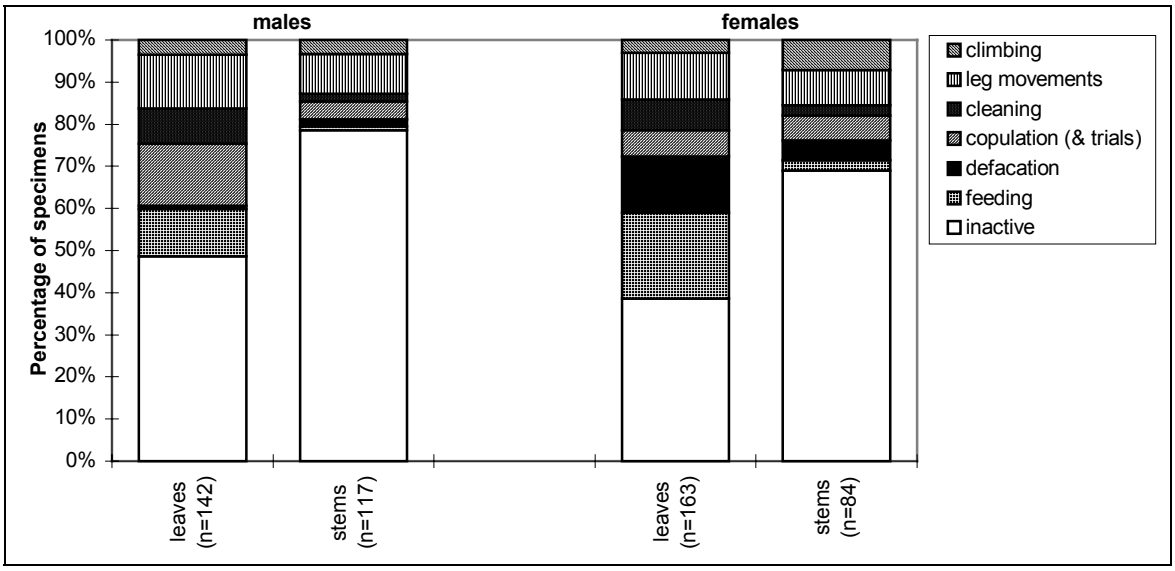

Fig. 4: Behaviour records of males and females at stems and on leaves. Both sexes show more activities on leaves, including feeding, defecation, copulation and cleaning. At stems they are less active.

Sometimes such copulation trials were made with nymphs or other males. Another difference occurred in the escape strategy of females seated on leaves or stems. Insects at stems were nearly exclusively dodging (Fig. 5), while those on leaves adopted a cocked posture, which is typical prior to jump (PEARSON & O'SHEA 1984). When only inactive insects were compared, no significant gender-specific difference in whereabouts was found (χ^2 cross-tabulate Test, DF = 1), although the percentage of females sitting on leaves was still higher. The gender-specific differences remained, when only the active specimens were compared (χ^2 crosstabulate Test, DF = 1).

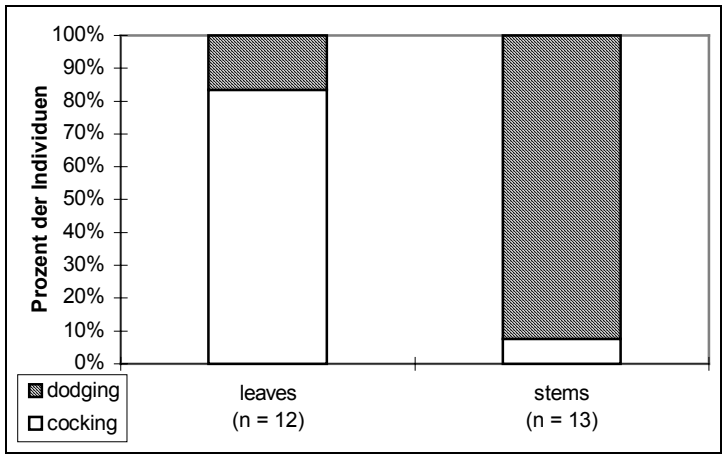

Fig. 5: On leaves females react on disturbance by cocking their hind legs, at stems they dodge behind the stem.

Discussion

The differences in whereabouts of males and females are due to different energy budgets. Females need to use leaves more common for feeding and thermoregulation. They profit from the higher heat gain (basking) on leaves and nutrition, since they need more energy for egg production and due to their greater size. Males can afford to sit more often at stems, which are advantagous for camouflage and predator escape (dodging). The high amount of feeding (14.2%) and defacating (10.5%) females is in clear contrast to feeding (6.6%) and defacating (1.2%) males. Both sexes, however, seem to have a strong tendency to rest at stems when they are inactive. The most striking profit of the stem is the advantagous predator escape (Fig. 6). This leads to the conclusion that predators play an important role in the life strategy of *Rh. usambaricum*, and certainly also other forest grasshoppers. As already pointed our (Hochkirch, in press), nearly all forest grasshoppers are K-strategists, which means they have small egg-pods, are flightless and long-living, occur in small abundance, have a continuous reproduction and are partly nocturnal. The few

exceptions of this have big egg-pods, are fully winged, have a strong seasonality with adults only during the hottest season of the year, occur in great abundance and are poisonous. This correlation leads to the conclusion that most forest grasshoppers have developed an economization strategy, which allows them to show as less activities as possible to avoid predators. The preferred whereabouts of *Rh. usambaricum*, therefore, has to be the stem. The leaf is the major locality for activities which always have a risk for the species.

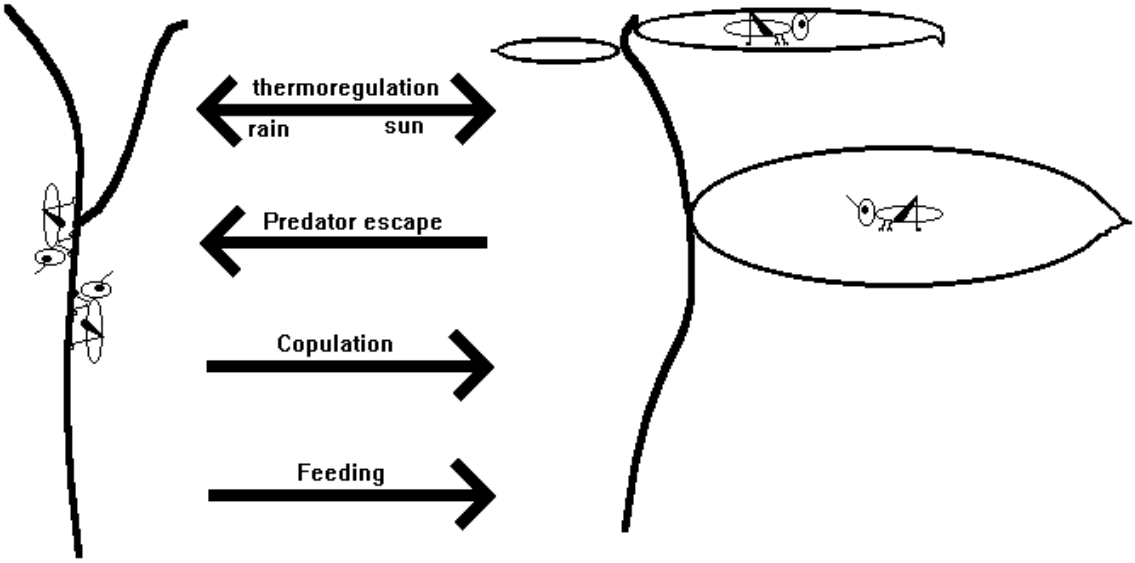

Fig. 6: Factors influencing the whereabouts of *Rhainopomma usambaricum*. Note that the main factor for resting at stems is the predator escpape, while several behaviours are mainly shown on leaves, including copulation, feeding and basking

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