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Vítězslav Krejsa
Student, Faculty of Education, University of South Bohemia, České Budějovice, The Czech Republic

Correspondence Author;
Vítězslav Krejsa
Student, Faculty of Education, University of South Bohemia, České Budějovice, The Czech Republic

The jungle nymph: Breeding notes and distribution of *Heteropteryx dilatata*

Vítězslav Krejsa

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Abstract
Phasmatodea is in many ways still an unexplored order of insects. Each year brings with it a discovery of a new species or a reassessment of the current state of knowledge. One of the most distinctive stick insects, *Heteropteryx dilatata*, is no exception to this fact. Its appearance attracts the attention of researchers and wildlife photographers, providing valuable information about its distribution. It has made it possible to map the range of this stick insect. *Heteropteryx dilatata* has been part of breeding worldwide for decades. This has shown it to be an adaptable species, able to feed on a wide variety of plants. However, there are still some requirements that need to be taken into account for a successful captive breeding of the jungle nymph.

Keywords: Distribution, breeding, observation, stick insect

Introduction
Heteropteryx dilatata is a species of stick insect (Phasmatodea) that occurs naturally in South-East Asia and is one of the largest insects (Wüst-Ackermann *et al*. 2018) [1]. Adult females are among the most iconic phasmids, this has led to the species being subject of capture and sale to tourists as a souvenir of their visit to Malaysia (Smith, 2007) [3]. However, these activities do not appear to have had an impact on the population, as other orders of insects, such as the Coleoptera or the Lepidoptera, are more often used for these purposes. On the other hand, their attractive appearance, which led to their massive expansion in captivity, has made it possible to learn much about how they live and behave.

Materials and Methods
The part related to breeding and description of the species is based on the author's experience gained while working with these stick insects. *Heteropteryx dilatata*, as evidenced by its wide distribution among breeders, does not appear to be a difficult phasmid to keep. A 50 x 30 x 40 cm enclosure was used for breeding, which, considering the size of this species, provided enough space for moulting. The top of the enclosure was made of mesh to allow air circulation, peat was used as a substrate at the bottom.

The maps were created using ArcGIS Online to show the areas where the jungle nymph has been recorded. The first one is based on data obtained from the GBIF database. It is likely that not all records identified as '*Heteropteryx dilatata*' are in fact this species, but may be a different, previously undescribed species, given the recent findings of Bank *et al*. (2021) [4].

Results and Discussion
Distribution of *Heteropteryx dilatata* covers mainly Peninsular Malaysia and Sarawak, with observations in Kuching province. Based on the distribution map, it appears like the species prefers areas of highlands as multiple observations took place in number of localities falling within Titiwangsa Mountains. Recent record comes also from Jambi province, Sumatra (Seow-Choen 2020) [5].

Thailand has been reported as the range of the jungle nymph, but the study of Bank *et al*. (2021) [4] showed that the specimen collected in the area of Khao Lak (Southern Thailand) was genetically separated from *Heteropteryx dilatata*. The implication is that there are at least 2 species of Heteropteryx in the Malay Peninsula which raises the question whether the Sumatra specimen is a member of this species or not. Further research is needed to provide detailed information regarding specimens collected in the bordering area and other parts of Thailand. *Heteropteryx dilatata* was formerly present also in Singapore but has long been regarded as extinct (Seow-Choen 1997) [6].

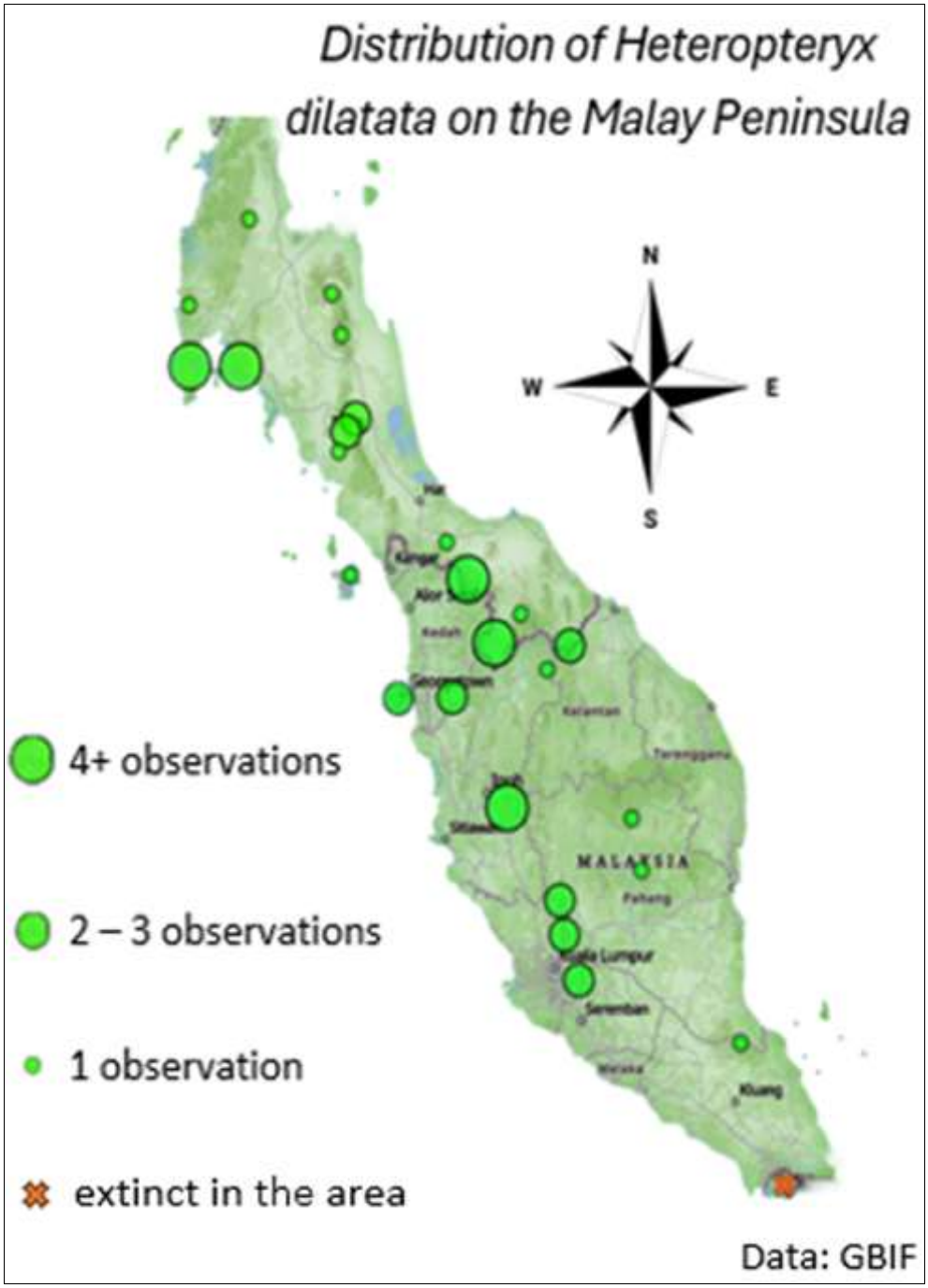

Fig 1: Map showing the distribution on Malay Peninsula

A surprising find was made in 2004 when an adult female was observed on Psidium guajava in the vicinity of the Andasibe-Mantadia National Park in Madagascar. It was most likely a specimen that had escaped from a nearby facility where these phasmids were kept (Cliquennois 2007) [7]. Madagascar has other stick insects that are not endemic to the island, such as Carausius morosus and Sipyloidea sipylus (Cliquennois 2012) [8]. Both species are polyphagous and feed on a wide variety of plants, which has helped them to adapt to the conditions on the island. Monophagous stick insects would be much less likely to adapt. The endemism of vascular plants on Madagascar, excluding ferns, is 92% (Goodman & Benstead 2005) [9].

Heteropteryx dilatata in its natural habitat feeds on various species of plants; Rubus moluccanus (Rosaceae), Eugenia aquea (Myrtaceae), Grewia acuminata (Tilaceae) and others (Brock 1999) [10]. The only recorded specimen was observed on Psidium guajava, but it can probably also feed on other plants. The question remains whether the species has managed to acclimatize to Madagascar. Although conditions there are less favourable than in Malaysia, with greater temperature fluctuations and months with less rainfall, it is possible that the conditions for *Heteropteryx dilatata* are sufficient. The climate in the sampled national park is very humid with an average annual rainfall of 1700 mm (Casse *et al*. 2022) [11]. Further observations of the species in the area are necessary to confirm their occurrence in Andasibe-Mantadia National Park and its surroundings.

The polyphagous nature of the jungle nymph can be used for breeding purposes, as *Heteropteryx dilatata* accepts a wide range of plant species: oak, beech, bramble, ivy and others (Brag 1992) [2]. Eggs are about 1 cm in size, making them one of the largest among stick insects. The incubation period is long, often exceeding 12 months.

Fig 2: The observation in Madagascar

Fig 3: Eggs of *Heteropteryx dilatata*

The body length of the nymphs after hatching is usually more than 2 cm. Nymphs of *Heteropteryx dilatata* are very passive, as observed with many other stick insects. Body colour varies depending on the environment in which the species is kept. Colours can range from light brown/beige to red to dark brown/black. Nymphs can also be very quick to change colour in response to their environment. In some instances, this change could be observed within hours. This happens when the nymphs are transferred to a habitat that is completely different from the one in which they were previously held. It is one of the strategies which helps the species in its survival in the wild.

Development is complete after about 12 months. Males develop earlier. There is a clear sexual dimorphism in this species. Adult females reach a length of about 15 cm and are usually deep green in colour, although there are also yellow-coloured specimens. The wings are underdeveloped, and the females are therefore unable to fly. Males are much smaller, about 10 cm in length, and much less robust. In general, their body colour is brown. In contrast to the females, they have fully developed wings and can fly. However, their flight is not very manoeuvrable, and it is often more of a gliding flight that can be observed, meaning that males are not able to fly for long periods of time.

Fig 4: *Heteropteryx dilatata*, adult female

Fig 5: *Heteropteryx dilatata*, adult male

In this species it is also possible to find gynandromorphism, typically with bilateral symmetry, in which one part of the body bears male characteristics and the other female ones. However, the occurrence of such an individual is a relatively rare event. Despite this, *Heteropteryx dilatata* is a stick insect in which this condition has been observed several times. On the other hand, there are species that have been in captivity for a long time in which gynandromorphism has not yet been observed.

Fig 6: Gynandromorphism in *Heteropteryx dilatata*

The species can stridulate, which is used to defend against predators. (Carlberg 1989) [12]. Another defence mechanism observed in *Heteropteryx dilatata* is raising of the abdomen when disturbed. This makes the jungle nymph appear larger. At the same time, the phasmid tries to trap the predator between its hind legs. Similar defensive strategies can be observed also in other stick insects, typically Eurycantha spp.

In captive conditions, they thrive in high humidity enclosures of 70% or higher. This approximates the humidity conditions found in the equatorial forests of south-east Asia, where the species occurs naturally. Females have a secondary ovipositor used for laying eggs in the soil. In captivity, therefore, a sufficient layer of substrate should be provided for this purpose to allow the eggs to be laid without difficulty. A very common practice used by breeders is to place a layer of paper towels on the bottom of the enclosure where stick insects are kept, but this is not recommended for breeding of this species. A suitable substrate is damp peat, for instance, which inter alia helps to maintain a stable humidity in the box. Incubation can be carried out in the original substrate, but eggs can also be removed and hatched in other ways, for example on the surface of a moist substrate such as vermiculite or sand.

Fig 7: *Heteropteryx dilatata*, nymph in the wild

Conclusion

Heteropteryx dilatata is a highly attractive phasmid with interesting defensive mechanisms and a long-life cycle. For decades new specimens of this species have been imported each year for breeding in Europe and other parts of the world. As a result, their way of life is widely known. It turns out that the range of this phasmid is probably not as large as it was thought to be until recently, and that this area may be covered by more species of Heteropteryx. Further research is also needed to learn more about the stick insects' ability to adapt to other conditions, and to help answer the question of whether the jungle nymph can spread beyond Madagascar, where it has been recorded, and possibly to other areas as well.

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