Acarologia

Open Science in Acarology

Phoretic mites associated with *Rhynchophorus phoenicis* Fabricius (1880) (Coleoptera: Curculionidae) in the Kisangani region, D.R. Congo

Jean Claude Monzenga Lokela[a,b] , Guillaume Jean Le Goff[b] , Kalenga Kayisu[a] , Thierry Hance[b]

[a] Institut Facultaire des Sciences Agronomiques de Yangambi (IFA-YBI) à BP 1232 Kisangani DR Congo.
[b] Earth and life Institute, Biodiversity Research Centre, Université catholique de Louvain, L7.07.04, Croix du Sud, 4-5, b1348 Louvain-la-Neuve, Belgium.

Original research

ABSTRACT

We sampled the mites present on individuals of *Rhynchophorus phoenicis* collected at different sites in the Kisangani region of the Democratic Republic of the Congo. Two species belonging to two families (Uroactiniidae and Urodinychidae) were identified: *Centrouropoda almerodai* and *Uroobovella phoenicola*. This is the first time that *C. almerodai* has been reported on *R. phoenicis*. The number of mites per adult may reach 39 and differs between sexes and regions.

Keywords Acari; Congo; phoretic mite ; *R. phoenicis*; Uropodidae; Urodinychidae

Introduction

Many species of mites are closely associated with invertebrates, colonizing any part of their bodies and sometimes in large numbers (Bajerlein and Błoszyk 2004, Bajerlein and Przewozny 2005). All insect orders, including many families of beetles (Atakan *et al.* 2009, Pernek *et al.* 2012), take part in these associations that may correspond to different degrees of interactions such as commensalism, phoresy (Athias-Binche *et al.* 1993), ectoparasitoidism, parasitism or predation (El-Sharabasy 2010). In many cases, mites reduce the fitness potential of their host, even in some cases of phoresy, when the mites are particularly abundant.

Phoresy is a temporary association during which an organism, the phoront, uses its host as a means of transport between available resources (Farish and Axtell 1971). Phoresy was also defined by Athias-Binche *et al.* (1993) as a dispersal strategy in which one animal actively seeks out and attaches to another animal for transport (Athias-Binche *et al.* 1993, Szymkowiak *et al.* 2007). In the same way, Peter (1989) considered phoresy as a symbiotic interaction that leads to dispersal. The fitness benefit received by the phoront is thus linked to its dispersal and to the possibility of access to a new habitat (White *et al.* 2017). This mechanism of dispersal is usually caused by the existence of poor conditions in the initial habitat, overcrowding or lack of food and can be facultative or obligatory (Athias-Binche *et al.* 1993, Salmane and Telnov 2009). Normally, the phoront does not feed on its host, and in mites, it may correspond to a particular developmental stage, usually the deutonymph, which exhibits particular morphological adaptations for attaching to its host (Binns 1982, Lorber 2017).

The larvae of palm tree weevils of the *Rhynchophorus* genus feed on many species of palms, boring into the trunk while the adults feed on the terminal buds. These weevils are thus considered the main pests of *Arecaceae* but also of banana, cacao, sugarcane, and papaya (Beaudoin-Ollivier *et al.* 2017, Rochat *et al.* 2017). On the other hand, local human

Received 29 April 2020
Accepted 08 April 2021
Published 14 April 2021

Corresponding author
Guillaume Jean Le Goff:
guillaume.legoff@uclouvain.be

Academic editor
Faraji, Farid

DOI
10.24349/acarologia/20214431

ISSN 0044-586X (print)
ISSN 2107-7207 (electronic)

How to cite this article Monzenga Lokela J. C. *et al.* (2021), Phoretic mites associated with *Rhynchophorus phoenicis* Fabricius (1880) (Coleoptera: Curculionidae) in the Kisangani region, D.R. Congo. **Acarologia 61(2): 291-296; DOI 10.24349/acarologia/20214431**

populations consume the larvae of *Rhynchophorus phoenicis* because of their nutritional quality. This happens in several parts of central Africa, including the Democratic Republic of the Congo (DRC), where they are considered a delicacy and may contain special nutrients (Bahuchet 1975, Dounias 1993, Thies 1995, Malaisse 1997, Van Huis 2003, Monzenga Lokela *et al.* 2017).

Adults of *Rhynchophorus* sp. are large insects that disperse from trunk to trunk in search of a mate or to lay eggs. They are often colonized by mites belonging to different families and may contain up to several tens of individuals under their elytra or attached to various parts of their body (Atakan *et al.* 2009, Mazza *et al.* 2011, Kontschán *et al.* 2012). In particular, *R. phoenicis* usually houses a significant number of mites at all stages of their development (Monzenga Lokela 2015).

There are very few studies on the relationship between mites and *R. phoenicis*. The study of Kontschan *et al.* (2012) is the only study to identify the mites present on *R. phoenicis* from samples collected in Cameroon. As *R. phoenicis* may provoke damage to many economic *Arecaceae*, a better knowledge of its associated fauna in Africa in general and in the DRC in particular is particularly worthwhile. Moreover, in the context of mass rearing of this species on artificial substrates for human nutrition, associated mites are a potential problem that must be more deeply understood (Monzenga Lokela *et al.* 2017).

The purpose of this study was thus to identify the mites associated with *R. phoenicis* recovered under the elytra of males and females and cocoons in the Kisangani area to better understand the nature of their association.

Material and methods

Sampling of Mites

Rynchophorus phoenicis individuals were trapped using standing-type traps (Monzenga Lokela 2015). These standing traps consist of a young wild oil palm that is pruned to keep only ten internal leaves that form the arrow. The base of the arrow receives a large V-shaped wound that results in folding of the arrow, thus creating a shelter for the insects. The rest of the arrow is cut 1.3 m from its base. After the first 5 days, the wounds were refreshed with a machete to continue the release of volatile substances that attract insects.

During 2012, trapping was carried out at three different sites: Tshopo (00°34′ N 25°08′ E and at an altitude of 450 m), Lubunga (00°41′ N 25°15′ E and at an altitude of 438 m), and Bangboka (00°50′ N 25°29′ E at an altitude of 413 m). At each site, 10 traps were visited every day to check for the presence of adult *Rhynchophorus*. Collecting was performed by unfolding the arrow to recover the adults. Adults were then stored in aerated plastic boxes and brought back to the laboratory for identification.

One hundred beetles per site were chosen at random among sampled individuals (50 of each sex). Mites were then collected from each beetle using a moistened fine brush and transferred to an Eppendorf tube containing alcohol (86%). Drs. Durmus Ali Bal (Turkey) and Hans Klompen (U.S.A.) kindly performed specimen identification. Mites were slide-mounted in Hoyer's solution and voucher specimens were deposited in the collection of the Ohio State University Acarology Laboratory (OSAL), Columbus, Ohio by Dr. Hans Klompen.

Statistical analysis

A generalized linear model (Poisson distribution) was performed to test the potential influence of the site and of the host sex on the number of mites found on an individual. Statistical analyses were performed using R version 2.14.1 Copyright (C) 2011 The R Foundation for Statistical Computing for Mac. All tests were applied under two-tailed hypotheses, and the significance level, P, was set at 0.05.

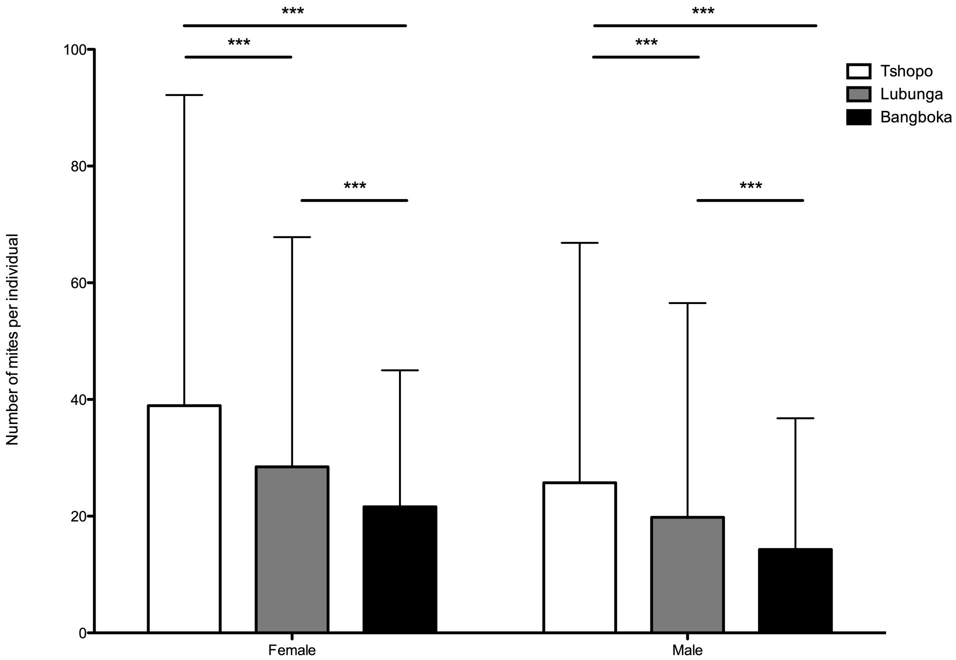

Figure 1 Average number of mites collected per sex and sites ± standard deviation.

Results

A total of 2991 and 4451 mites were collected from males and females, respectively. Females hosted significantly more mites than males, with approximately 30 mites per individual on females and 20 mites per individual on males ($X^2_{1, 298} = 12598$, $P < 0.001$) (Figure 1). By comparing the mean number of mites per individual between the three sites, we observed that more mites were found at the Tshopo site (33 mites per individual), followed by the Lubunga (24 mites per individual) and Bangboka site (17 mites per individual) ($X^2_{2, 296}= 12460$, $p < 0.001$) (Bangboka vs. Lubunga: Z=6.81, P<0.001; Bangboka vs. Tshopo: Z=15.51, P<0.001; Lubunga vs. Tshopo: Z=8.99, P<0.001) (Figure 1). No significant interaction was found between the sexes and the sites (X^2 2, 294= 12178, P >0.05).

Among the collected mites, two species of Mesostigmata Uropodina were dominant namely *Centrouropoda almerodai* (Wisniewski *et al.* 1992) and *Uroobovella phoenicola* (Kontschan *et al.* 2012).

Discussion

A summary of the available information of the mite species present on *Rhynchophorus* spp. is presented in Table 1. In total, twelve species of mites have been identified on *Rhynchophorus* spp., ten on *R. ferrugineus* and only two on *R. phoenicis*. This illustrates that there are few studies on these species. Among the mite species, only *Hypoaspis sardoa,* Berlese is recognized as a true parasite.

Centrouropoda almerodai was described in 1992 by Wisniewski *et al.* in the Philippines on *Rhynchophorus* spp. This mite is generally regarded as a phoretic mite and has accidentally been introduced into the island of Malta on *R. ferrugineus* (Ragusa *et al.* 2009). Moreover, Mazza *et al.* (2011) demonstrated that, in Italy, the individuals of *R. ferrugineus* associated with this species have life spans shortened by a third compared to those exempts of mites, suggesting that the interaction between these two species may not be limited to phoresy.

Table 1 Species of mites associated with certain species of *Rhynchophorus*.

***Rhynchophorus* species**	**Mites and location**	**Relation and consequence for the host (reference)**
R. phoenicis	*Curculanoetus rhynchophorus* (DRC)	Phoresy, Phoretic Hypopus (Deutonymph) (Fain, 1974)
R. ferrugineus	*Uropoda orbicularis, Uroobovella marginata* (Turkey)	Phoresy, Consequence on flight behavior at high density (Atakan *et al.* 2009)
R. ferrugineus	*Trichouropoda patavina* , *Scutacarus* sp. (Egypt)	Unknown (EL-Sharabasy, 2010)
	Iphidosoma sp. , *Hypoaspis sardoa* , *Parasitus zaheri* (Egypt)	Parasitism (EL-Sharabasy, 2010)
	Histiostoma sp. (Egypt)	Ectoparasite or phoretic mite (EL-Sharabasy, 2010)
R. ferrugineus	*Centrouropoda almerodai* (Italy)	Negative effect on lifespan (Mazza *et al* . 2011)
R. ferrugineus	*Uropoda orbicularis, Uroobovella* sp., *Curculanoetus* sp. (United Arab Emirates)	Phoresy (Al-Deeb *et al* ., 2011)
R. phoenicis	*Uroobovella phoenicola* (Cameroon)	Predator of eggs and other stages (Kontschán *et al.* 2012)
R. ferrugineus	*Nenteria extremica* (Italy)	Predator/parasite? (Kontschán *et al.* , 2014)
R. phoenicis	*Centrouropoda almerodai, Uroobovella phoenicola* (DRC)	Phoresy and possible parasitism (Monzenga Lokela *et al* ., present study)

Uroobovella phoenicola was described in 2012 by Kontschan *et al.* (2012) from a sample of mites collected in Cameroon. Kontschan *et al.* (2012) suggested that it might be a predator of weevil eggs and early instar larvae and proposed its use for the biological management of the beetle. Eggs, larvae and adults of these mites heve been found under the elytra and on the abdomen of the weevil (Monzenga Lokela, 2015). This distribution of stages is hardly compatible with only phoresy. Indeed, after emergence, the larvae must grow and therefore feed. It is possible that they feed directly on the insect; in this case, the mites would use *Rhynchophorus* individuals as a means of transport, as a shelter and as a food source. The mites could then be considered ectoparasites of the beetles. These observations could confirm the survival reduction of *R. ferrugineus* in the presence of parasitic mites (Mazza *et al.* 2011). Furthermore, as observed by El-Sharabasy (2010), mites can be phoretic for a given stage of the insect and become predators or parasites for other stages of the same insect. Therefore, phoretic mites may represent a cost for their hosts, as they may increase the energy balance of the host, disrupt its aerodynamics in fixing their colonies under the elytra, or cause an extra weight that diminishes its velocity (Athias-Binche *et al.*, 1993). Other studies have also identified *C. almerodai* on *R. ferrugineus*, without being able to formally determine whether these mites are phoretic or not (Wattanapongsiri 1966, Atakan *et al.* 2009). This point has to be investigated in the future as well as the life cycle of the mite outside of its host.

We also observed a higher number of mites on females than on males, which confirms the results of Atakan *et al.* (2009). As there is no difference in size between males and females of *R. phoenicis* (Monzenga Lokela 2015), it is probably not their morphology but rather a difference in the behaviour or pheromone emissions between the two sexes that make the female a preferential host for the mite. Indeed, although the way a dispersing mite finds a new host is still unknown, the female could represent a good opportunity for such a mite to find a new host. The fact that *R. phoenicis* females remain slightly longer on palm trees than males to lay their eggs makes them easier to find than males. Moreover, these mites being considered as egg predators of the weevils (Kontshan *et al.*, 2012), infecting a female could then increase their opportunities to find a prey. However, these hypotheses remain to be verified.

Conclusions

The objective of this work was to identify the mites present on *R. phoenicis* in the Kisangani region and to understand the nature of their association. *Centrouropoda almerodai* (Wisniewski *et al.* 1992) and *Uroobovella phoenicola* (Kontschan *et al.* 2012) belonging to families Uropodidae and Urodinychidae respectively were identified. To our knowledge, *C. almerodai* has never been reported on *R. phoenicis* before our study. The role of this species remains to be determined. It is possible that in addition to pure phoresy, *C. almerodai* also has a negative impact on the host.

Finally, in the case of mass rearing of *R. phoenicis* to use the larvae as a food source, the presence of mites on the adult stage poses many difficulties for the production of these insects and could affect the final quality of the proposed product.

Acknowledgments

We thank the Belgian technical co-operation (CTB) for the financial support of Jean-Claude Monzenga. We would also like to thank Drs. Durmus Ali Bal for mite identification, and Hans Klompen for mite identification and manuscript revision. This publication is paper n°BRC271 of the Biodiversity Research Centre, UCL, Belgium.

References

Al-Deeb M.A., Bin Muzaffar S., Abuagla A.M., Sharif E.M. 2011. Distribution and abundance of phoretic mites (Astigmata, Mesostigmata) on *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae). Florida Entomol., 94: 748-755. doi:10.1653/024.094.0403

Atakan E., Çobanoğlu S., Yüksel O., Bal D.A. 2009. Phoretic uropodid mites (Acarina: Uropodidae) on the red palm weevil *Rhynchophorus ferrugineus* (Oliver, 1790) (Coleoptera: Curculionidae). Türk entomol. Derg., 33: 93-105.

Athias-Binche F., Schwarz H.H., Meierhofer I. 1993. Phoretic association of *Neoseius novus* (Ouds., 1902) (Acari: Uropodina) with *Nicrophorus spp*. (Coleoptera: Silphidae): A case of sympatric speciation? Int. J. Acarol., 19: 75-86. doi:10.1080/01647959308683542

Bahuchet S. 1975. Ethnozoologie des Pygmées BaBinga de la Lobaye. In: L'Homme et l'Animal, Premier colloque d'Ethnozoologie. Institut International d'Ethnosciences (Paris), p 53-61.

Bajerlein D., Błoszyk J. 2004. Phoresy of *Uropoda orbicularis* (Acari: Mesostigmata) by beetles (Coleoptera) associated with cattle dung in Poland. Eur. J. Entomol., 101: 185-188. doi:10.14411/eje.2004.022

Bajerlein D., Przewoźny M. 2005. Coprophagous hydrophilid beetles (Coleoptera: Hydrophilidae) as carriers of phoretic deutonymphs of *Uropoda orbicularis* (Acari: Mesostigmata) in Poland. Eur. J. Entomol., 102: 119-122. doi:10.14411/eje.2005.017

Beaudoin□Ollivier L., Isidoro N., Jaques J.A., Riolo P., Kamal M., Rochat D. 2017. Some Representative Palm Pests: Ecological and Practical Data. In: Handbook of Major Palm Pests. John Wiley & Sons, Ltd, pp 1-38. doi:10.1002/9781119057468.ch1

Binns E.S. 1982. Phoresy as Migration - Some Functional Aspects of Phoresy in Mites. Biol. Rev., 57:571-620. doi:10.1111/j.1469-185X.1982.tb00374.x

Dounias E. 1993. Dynamique et gestion différentielle du système de production à domaine agricole des Mvae du sud Cameroun forestier. Université de Montpelliers II. pp. 616.

El-sharabasy H.M. 2010. A Survey of Mites Associated with the Red Palm Weevil, *Rhynchophorus ferrugineus* (Olivier) in Egypt. Egypt J. Biol. Pest Control, 20: 67-70.

Fain A. 1974. Notes sur quelques hypopes d'Anotidae (Acarina: Sarcoptiformes). Bull. Ann. Soc. r. belge Ent., 110: 58-68.

Farish D.J., Axtell R.C. 1971. Phoresy redefined and examined in *Macrocheles muscaedomesticae* (Acarina: Macrochelidae). Acarologia, 13: 16-29.

Kontschán J., Mazza G., Nannelli R., Roversi P.F. 2014. *Nenteria extremica* n. sp., a new Uropodina mite (Acari Mesostigmata) collected on *Rhynchophorus ferrugineus* in Italy, with notes on other Uropodina mites associated with the Red Palm Weevil. Redia, 97: 63-69.

Kontschan J., Tambe J.T., Riolo P. 2012. *Uroobovella phoenicicola* sp. n., a new Uropodina mite (Acari: Mesostigmata) associated with the African palm weevil (*Rhynchophorus phoenicis* Fabricius, 1801) from Cameroon. African Invertebr., 53: 593-600. doi:10.5733/afin.053.0205

Lorber B. 2017. Les acariens. https://hal.archives-ouvertes.fr/hal-01652171

Malaisse F. 1997. Se nourrir en forêt claire africaine: approche écologique et nutritionnelle. Presses Agronomiques de Gembloux. pp. 384.

Mazza G., Cini A., Cervo R., Longo S. 2011. Just phoresy? Reduced lifespan in red palm weevils *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae) infested by the mite *Centrouropoda almerodai* (Uroactiniinae: Uropodina). Ital. J. Zool., 78: 101-105. doi:10.1080/11250003.2010.509135

Monzenga Lokela J.-C. 2015. Ecologie appliquée de *Rhynchophorus phoenicis* Fabricius (Dryophthoridae : Coleoptera) : phénologie et optimisation des conditions d'élevage à Kisangani, R.D.Congo. Université catholique de Louvain. Available at : https://dial.uclouvain.be/pr/boreal/fr/object/boreal%3A157580/datastreams

Monzenga Lokela J.-C., Le Goff G.J., Bundo K., Hance T. 2017. Influence of substrates on the rearing success of *Rhynchophorus phoenicis* (Fabricius). African J. Food. Sci. Technol., 81: 7.

Pernek M., Wirth S., Blomquist S.R., Avtzis D.N., Moser J.C. 2012. New associations of phoretic mites on *Pityokteines curvidens* (Coleoptera, Curculionidae, Scolytinae). Cent. Eur. J. Biol., 7: 63-68. doi:10.2478/s11535-011-0096-7

Peter C. 1989. A note on the mites associated with the red palm weevil, *Rhyncophorus ferrugineus* Oliv. in Tamil Nadu. J. Insect. Sci., 2: 160-161.

Ragusa E., Porcelli F., Di Palma A., Ragusa D.I. Chiara S. 2009. Una specie di acaro associato al punteruolo rosso delle palme: *Centrouropoda almerodai* (Uroactiniinae, Uropodina). In: La ricerca scientifica sul punteruolo rosso e gli altri fitofagi delle palme in Sicilia, Regione Si, pp 79-82.
Rochat D., Dembilio O., Jaques J., Suma P., La Pergola A., Hamidi R., Kontodimas D., Soroker V. 2017. *Rhynchophorus ferrugineus*: taxonomy, distribution, biology, and life cycle. In: Handbook of Major Palm Pests: Biology and Management. John Wiley & Sons. P 69-104. doi:10.1002/9781119057468.ch4
Salmane I., Telnov D. 2009. Mesostigmata Mites (Acari: Parasitiformes) Associated with Beetles (Insecta: Coleoptera) in Latvia. Latv. Entomol., 47: 58-70.
Szymkowiak P., Górski G., Bajerlein D. 2007. Passive dispersal in arachnids. Biol. Lett., 44: 75-101.
Thies E. 1995. Principal (agro-) forestry woody species of the Guinea transition zone: Guinea-Bissau, Guinea, Côte d'Ivoire, Ghana, Togo, Benin, Nigeria, Cameroon. Schriftenr der GTZ. pp. 540.
van Huis A. 2003. Insects as Food in sub-Saharan Africa. Insect. Sci. its Appl., 23: 163-185. doi:10.1017/S1742758400023572
Wattanapongsiri A. 1966. A revision to the genera *Rhynchophorus* and *Dynamis* (Coleoptera : Curculionidae). Oregon State University. pp. 418.
White P.S., Morran L., de Roode J. 2017. Phoresy. Curr. Biol., 27: 578-580. doi:10.1016/j.cub.2017.03.073
Wisniewski J., Hirschmann W., Hiramatsu N. 1992. New species of *Centroupoda* (Uroactiniinae, Uropodina) from Philippines, Brazil and middle Africa. Acarologia, 33: 313-320.