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Fluorescence in scorpions under UV light; can chaerilids be a possible exception?

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ABSTRACT

The fluorescence of scorpions in ultraviolet light, a well-known phenomenon, was discovered more than 60 years ago. Its possible function remains, however, a matter of discussion. Even during very recent studies, no conclusion has been reached. As suggested in these recent publications, the lack of or reduction of fluorescence could be a useful tool to explain the phenomenon. It is suggested here that, in at least some species of the family Chaerilidae Simon, this phenomenon is absent. This new discovery may initiate important comparative eco-physiological studies.

RÉSUMÉ

La fluorescence des scorpions sous lumière ultraviolet, c'est un phénomène bien connu, découvert depuis plus de 60 ans. Sa possible fonction demeure cependant un sujet de discussion. Même des études récentes n'ont abouti à aucune conclusion. Comme cela a été suggéré dans ces publications récentes, l'absence ou une réduction de la fluorescence pourrait représenter un outil important dans l'explication du phénomène. Il est suggéré à présent qu'au moins chez quelques espèces de la famille des Chaerilidae Simon, ce phénomène est absent. Cette nouvelle découverte pourra amener à des importantes études écophysiologiques comparatives.

1. Introduction

It has long been known that most scorpions fluoresce very strongly when exposed to ultraviolet light (Fig. 1) in the range 320–400 nm (3200–4000 Å). This phenomenon has been discussed by a number of authors [1–3]. The main conclusion has been that this ecophysiological particularity may potentially be useful in the study and collection of scorpions in the field [4–6]. Some authors have even stated that, with the discovery of fluorescence in UV light, scorpions represent an almost ideal organism for all types of ecological and behavioural investigation [4].

It may be important, however, to recall that fluorescence under UV light also occurs in a variety of Arthropoda, although especially in Arachnida and Myriapoda. These taxa include Solifugae [7], Spiders [8,9] and Opiliones [10,11]. Although the presence of fluorescence under UV light is an important and useful tool in the studies of zoologists and ecologists, the function of scorpion fluorescence remains an enigmatic question to be answered by ecophysiologists. Many attempts to define a function for it have been carried out, without achieving any success [12]. In recent publications, more detailed experiments suggested some possibly new aspects of scorpion behaviour that may explain fluorescence [13,14]. A final response could not, however, be obtained and, as suggested by Kloock [15], "There is no known function of scorpion fluorescence. Although it is

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Fig. 1. Scorpion under UV light. *Tityus kuryi* Lourenço from rainforest, showing a positive reaction (photo T. Porto).

certainly possible that fluorescence has no function, it is only by testing and falsifying potential functions that they can be eliminated from consideration''. Just after this, the author adds: ''In order to test potential functions of scorpion fluorescence, having scorpions with reduced fluorescence could be a powerful tool''. Curiously, Kloock [15] did not imagine the possible absence of fluorescence from at least some scorpions. In this article, it is established that at least some species (maybe all), belonging to the Asian family Chaerilidae, do not react to UV light and consequently do not fluoresce. Once again, the absence of reaction to UV light by chaerilids remains a mystery. However, this new eco-physiological characteristic may open the door to very interesting comparative eco-physiological studies.

2. Material and methods

Scorpions of families Buthidae, Pseudochactidae and Chaerilidae were tested individually using a LED portable UV light which emitted some light at a range of 320–360 nm. Most specimens had been preserved in 75% ethanol, but none of the preservations was older than 5 years (2007). The specimens which react to the UV light showed a very intense fluorescence, which supposes that recent preservations does not alter tegument's capacity to react to UV light. Photos were taken with the use of similar LED portable UV lights, using a dark surface as bottom.

3. Results

The preliminary objective of the analysis with UV light was to test the ability of certain cave species of the family Pseudochactidae Gromov to fluoresce (Fig. 2A). The

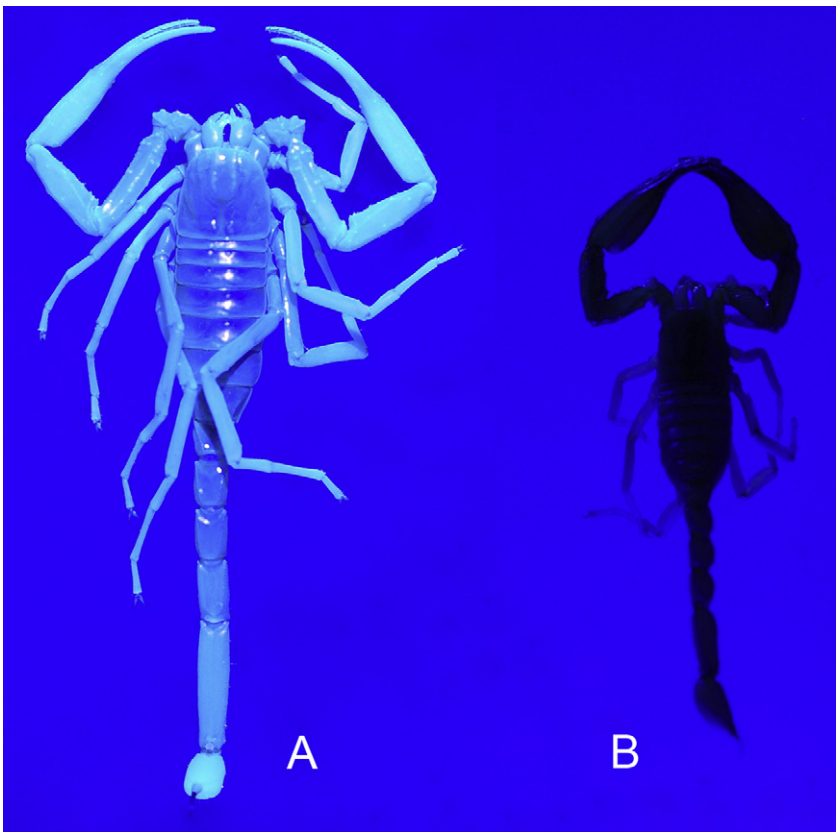

Fig. 2. Scorpions under UV light. A. *Vietbocap thienduongensis* Lourenço & Pham (male holotype), a cave dweller found at 1800 m from cave entrance; positive reaction. B. *Chaerilus telnovi* Lourenço, soil dweller; negative reaction.

Table 1
Species tested in this study for fluorescence with UV light.

Species	Family	Environment	Type of habitat	Reaction to UV light
Ananteris balzanii	Buthidae	Savanna	Epigean	Positive
Buthus occitanus	Buthidae	Desert	Epigean	Positive
Centruroides gracilis	Buthidae	Dryforest	Epigean	Positive
Rhopalurus amazonicus	Buthidae	Savanna	Epigean	Positive
Tityus kuryi	Buthidae	Rainforest	Epigean	Positive
Tityus obscurus	Buthidae	Rainforest	Epigean	Positive
Troglokhammouanus steineri	Pseudochactidae	Rainforest	Cave dweller	Positive
Vietbocap canhi	Pseudochactidae	Rainforest	Cave dweller	Positive
Vietbocap thienduongensis	Pseudochactidae	Rainforest	Cave dweller	Positive
Vietbocap lao	Pseudochactidae	Rainforest	Cave dweller	Positive
Chaerilus telnovi	Chaerilidae	Rainforest	Soil dweller	Negative
Chaerilus spinatus	Chaerilidae	Rainforest	Epigean	Negative
Chaerilus celebensis	Chaerilidae	Rainforest	Epigean	Negative
Chaerilus anneae	Chaerilidae	Rainforest	Epigean	Negative
Chaerilus kampuchea	Chaerilidae	Rainforest	Epigean	Negative
Chaerilus petrzelkai	Chaerilidae	Rainforest	Epigean	Negative
Chaerilus julietteae	Chaerilidae	Rainforest	Epigean	Negative
Chaerilus truncatus	Chaerilidae	Mountain forest	Epigean	Negative
Chaerilus sabinae	Chaerilidae	Rainforest	Cave dweller	Negative

ecological distribution of cave animals remains enigmatic in face of these reactions, which are normally attributed to species living in an epigean environment.

Tests were undertaken with four species of troglobitic scorpions belonging to the family Pseudochactidae, recently described from caves in Southeast Asia. These proved to react positively to UV light and fluoresced intensely. In order to have a comparative parameter, a test was also carried out with a humicolous, eyeless species of *Chaerilus*, *C. telnovi* Lourenço, described from the soil of a rain forest in the Island of Halmahera, Indonesia. Surprisingly, no reaction to UV light was shown by these species, which did not fluoresce (Fig. 2B). At first, this result was tentatively imputed to the fact that *C. telnovi* was not an epigean species, but a soil dweller. To exclude this possibility, tests were undertaken with another *Chaerilus* species from Halmahera, *C. spinatus* Lourenço & Duhem. This is definitely an epigean species. Nevertheless once again no reaction to UV light was observed. Subsequently, other species of *Chaerilus* were tested. The results are presented in Table 1.

4. Discussion

The family Chaerilidae comprises a small group of Asian scorpions, most of which are cryptic. They are placed along the most basal groups within the order [16]. According to Lamoral (1980), the protoelements of the chaeriloids evolved in Laurasia during Pangean times. If this group is today restricted to the Asian faunal region it is probably because it is a relic of an eastern Laurasian element that moved in after the Indian conjunction [17]. Recent amber fossils found in Myanmar suggest that the protoelements of buthids, chaerilids and pseudochactids were already present in Asia and Southeast Asia in the Cretaceous period, and that some phylogenetic connections may possibly have existed among these groups [18–21].

A negative reaction of chaerilids to UV light has been observed in epigean species, living in rainforest and mountain forest, and for both soil dweller and cave species (Table 1). This result tends to exclude the possibility of any ecological adaptation. Moreover, in other families such as the buthids, fluorescence is observed among species inhabiting all types of ecological environment, such as deserts, savannas, or rainforests. Consequently, the negative reaction of chaerilids to UV light appears to be more like a phylogenetic characteristic which evolved in response to some kind of adaptation in Tertiary times. The function of this negative reaction in chaerilids remains unknown. One more question arises: although fluorescence was confirmed in a large majority of scorpion species, the totality of the order has not yet been tested. It is quite possible that other exceptions will be demonstrated and these may bring some further clarification to this phenomenon.

Disclosure of interest

The author declares that he has no conflicts of interest concerning this article.

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