W.R. LOURENÇO J. KOVOOR A. MUÑOZ CUEVAS
Museum national d'Histoire naturelle et C.N.R.S.
Laboratoire de Zoologie-Arthropodes, 61 rue de Buffon,
75231 Paris Cedex 05 FRANCE

OBSERVATIONS ON SPIDERS IN ULTRAVIOLET LIGHT

INTRODUCTION

Spiders and the silk which they produce have been rarely examined in ultraviolet light. According to TURCHINI (1925), silk threads from a Tegenaria (Agelenidae) showed a bluish fluorescence. In the next year, TURCHINI and MILLOT provided some other data on the blue or pale yellow fluorescence of the silk, silk glands and hemocytes in four araneomorph species. Among other arthropods, a single mygalomorph of Harpactira genus was examined by LAWRENCE (1954) who found a faint fluorescence of the intersegmentary membranes on the ventral surface of the specimen. In 1967, YOUNG and WANLESS studied the fluorescence of corneas with the aim of establishing a relationship between this phenomenon and eye function in spiders. This work is valuable in view of the large number of spider families from which specimens were investigated.

Following the recent discovery of a fluorescent oxyopid spider in Colombia, we decided to reinvestigate the fluorescence of spiders during their life cycle.

MATERIAL AND METHODS

Observations were made on spiders reared in the laboratory and on specimens preserved in alcohol.

The initial tests were made on an adult female of Peucetia *) genus (Oxyopidae) which was collected at night by W.R. L., while on a scorpion collecting mission in South-Western Colombia, at

*) This specimen may be that of a new species which is to be described and named elsewhere by W.R.L..

about 60 km N.-W. from Cali, in the Loboguerrero region of the department of Valle del Cauca.

Kept alive in the laboratory, this female laid four batches of eggs between 9th March and 23rd June 1988. Development of juveniles is in progress and will be followed until the adult stage.

Observations were made in a dark room on the female before and after laying eggs, on the developing eggs, the chorions after hatching, the juveniles of 1st and 2nd instars and the 2nd exuvias. For comparisons, specimens belonging to several families of Mygalomorphae or Araneomorphae were examined in the same way (see list of material below, in Table 1).

A portable quartz-mercury vapour lamp was used as an ultra-violet source. This lamp emits radiant energy of the mercury spectrum with a peak at 365 nm and a wattage of 3500 $\mu W / cm^2$. The specimens were placed at about 20 cm from the UV- source.

RESULTS

The adult female spider, examined at first, was mainly green and exhibited the morphological characteristics of the genus Peucetia. Its body fluoresced light yellow but not evenly in all parts. The cephalothorax was brighter than the abdomen, though the ocular region appeared very dark. The abdomen fluoresced weakly, except in the brighter dorsal apical region; on the ventral face, the lung plates and epigynewere brightly rimmed; appendages were also fluorescent.

The egg-case shape, size and structure were as described by WHITCOMB and coll. (1966) for Peucetia viridans. The unevenly pale green silk used for egg-case construction appeared bright yellow-white in ultraviolet light, while the silk threads of the web did not fluoresce.

The first two batches laid by the female contained 140 golden-yellow eggs while the last two contained less, and were enclosed in smaller cocoons.

Developing eggs strongly fluoresced yellow; abortive dry eggs did not. Juveniles of the 1st post-embryonary stage, still containing vitellus, fluoresced mostly in their abdomen. After the second moult, the juvenile body began to be green and acquired a fluorescence similar to that of the mother. Chorions of eggs, coated internally by the first exuvia left by 1st stage juveniles, showed a strong white fluorescence; the second exuvias, on the other hand, did not fluoresce at all, but, from the third stage, fluorescence was detected in all exuvias.

All specimens belonging to different Peucetia species preserved in alcohol fluoresced in some region or other of their bodies. The results of observations made on 23 species belonging to 13 families of spiders are summarized in Table 1.

The most striking result was the fluorescence of all eggs examined, whether alive or preserved in alcohol; egg chorions also generally fluoresced; cocoon silk gave a fluorescence in a majority of cases, but not in all.

DISCUSSION

Among 23 spider species examined in ultraviolet light, Peucetia species were the only ones presenting a fluorescence of the whole body. In some other spiders, clear fluorescence of the abdomen, wholy or partly, was detected.

Peucetia fluorescence is light yellow, while in ordinary light, their body appears mainly light green. In a Sparassidae, Micrommata roseum, whose mature females and juveniles are evenly green, HOLL and RUDIGER (1975) identified the pigment as a mixture of biliverdine conjugates, named micromatabilin. The same pigment has been detected in the yolk of eggs of the same species (HOLL, 1982). Nevertheless, biliverdine pigments fluoresce red (PETRIER, 1978), while specimens of Micrommata roseum, preserved in alcohol, showed a yellow fluorescence.

Peucetia egg-case silk fluoresced yellow-white. This fluorescence is similar to that of fibroin, the main component of Bombyx mori silk studied by POLICARD and PAILLOT (1925).

TABLE I.— Comparative results of observations on spiders in ultraviolet light. 0 = no fluorescence; ±, +, ++, +++ been made on living specimens.

Spider species	Cephalothorax dorsal	Cephalothorax ventral	Abdomen dorsal	Abdomen ventral	Appendages Chélic.	Appendages Legs
MYGALOMORPHAE						
Dipluridae : *Ischnothele guyanensis* (Walck.)*	0	0	0	0	0	0
Theraphosidae : Species non det.*	0	0	0	0	0	0
ARANEOMORPHAE						
Zoropsidae : *Zoropsis spinimana* (Dufour)	0	0	0	0	0	0
Amaurobiidae : *Amaurobius similis* (Blackwall)*	0	0	0	0	0	0
Agelenidae : *Agelena gracilens* C.L. Koch *	0	0	++	+	0	0
Lycosidae : *Trochosa* sp. (C.L. Koch)	/	/	/	/	/	/
Lycosa tarentula (Linne)*	0	0	0	0	0	0
Pisauridae : *Pisaura mirabilis* (Clerck)	eyes +	0	0	0	0	0
Sparassidae : *Isopoda insignis* (Thorell)	0	0	++	++	0	0
Micrommata roseum (Clerck)	eyes +	0	++	++	0	0
Oxyopidae : *Oxyopes lineatus* (Latreille)	0	0	0	0	0	0
Peucetia sp.*	++	+	+, ++	+, ++	+	+, ++
Peucetia viridans (Hentz)	0	+	++	++	+	++
Peucetia poeyi (Lucas)	+	+	+	+	+	+
Peucetia macroglossa M.-Leitao	0	++	+++	+	0	++
Peucetia pulchra (Blackwall)	0	0	+	+	0	++
Theredíidae : *Theridium bimaculatum* (Linne)	0	0	+++ (patch)	0	0	0
Mimetidae : *Ero aphana* (Walckenaer)	/	/	/	/	/	/
Araneidae : *Nephila madagascariensis* (Vinson)*	+ (patch)	0	++	+	0	0
Araneus diadematus (Clerck)	++	+	++	++	♂ palps +++	++
Araniella cucurbitina (Petrunk.)	0	0	+++	++	0	0
Singa hamata C.L. Koch	eyes +	0	++	0	0	0
Tetragnathidae : *Pachygnatha clercki* (Sundevall)	/	/	/	/	/	/

= fluorescence of increasing intensity. * indicates that observations have

Egg-case	Eggs	Egg-chorion	1st Exuv.	Juveniles 1st Stage	2nd Exuv.	Juveniles 2nd Stage
+	++	+++	/	++	0	0
0	/	+++	/	/	/	/
+	++	++	/	++	/	/
+	++	+++	/	+	/	+
+	++	++	/	+	/	0
++	+++	/	/	/	/	/
0	+++	/	/	+	/	/
++	+++	/	/	/	/	/
++	+++	/	/	/	/	/
/	/	/	/	/	/	/
+	+++	/	/	/	/	/
++	+++	++	0	++	0	++
/	/	/	/	/	/	/
/	/	/	/	/	/	/
/	/	/	/	/	/	/
/	/	/	/	/	/	/
±	+++	/	/	/	/	/
±	++	/	/	/	/	/
+	++	+++	/	/	0	0
++	+++	/	/	/	/	/
+	++	/	/	/	/	/
0	++	/	/	/	/	/
+, ++	+++	/	/	/	/	/

Cocoon silk, in 13 out of 18 species examined, gave various colours of fluorescence (Table 1). This observation is to be related to the secretion of a coloured protein together with the silk protein proper in the tubuliform glands from which the thick cocoon fibers originate. This coloured protein differs from one species to another (KOVOOR, 1977).

White-yellow fluorescence, general for eggs of all spider species examined, was also exhibited by eggs of the opilion Ischyropsalis luteipes. These observations can be related to the few made on insect eggs. In eggs of Drosophila melanogaster studied with a fluorescence microscope, MUCKENTHALER (1971) showed that the main fluorescing blue-white material was localized in particles corresponding to the protein spheres of the yolk. This brilliant blue-white fluorescence corresponded to that of kinurenine, a component derived from tryptophan, extracted from the ovary of Drosophila melanogaster. Kinurenine is not the only substance which causes the fluorescence of eggs in Bombyx mori (KOGA and OSANAI, 1967); indeed the fluorescence in Ephestia kühniella eggs is not produced by kinurenine (EGELHAAF, 1956, 1957).

It should be noted that the egg chorion was always fluorescent, but not the integument of 1st stage juveniles. Juveniles of the second stage progressively acquired the pigmentation of the adult female; correlatively, as it seemed, the exuvia which they left after moulting appeared fluorescent. The fluorescence of scorpion integuments follows the same chronological development after the first postembryonary moult (PAVAN and VAGHON, 1954).

The fluorescence linked to the vitellus should be distinguished from that exhibited by the integument of the 2nd stage juveniles. The latter may be due to a different substance appearing during the process of pigment differentiation.

The functional interpretation of fluorescent phenomena is far from clear, although fluorescent substances exist in all living beings. Very little interest has been paid to fluorescence in Chelicerates, considering that, as shown in our study, such phenomena seem to be universal in these animals where they could be related to the complex metabolism of pigments.

REFERENCES

EGELHAAF A (1956) Quantitativer Vergleich der Fluoreszenzmuster der Eier dreier Genotypen von Ephestia kühniella. Naturwiss. 43 : 165-166.

EGELHAAF A (1957) Der Gehalt an freiem Tryptophan und Kynurenin bei den Genotypen a^+ und a von Ephestia kühniella während der Entwicklung. Z. Naturforsch. 12b : 465-472.

GRAF G E (1957) Biochemical predetermination in Drosophila. Experientia 13 : 404-405.

HOLL A (1982) Temperaturabhängiger Farbwechsel bei Larven der grünen Huschspinne Micromata rosea (Sparassidae). Z. Naturforsch. 37 C : 1040-1041.

HOLL A , RUDIGER W (1982) Micromatabilin, a new biliverdin conjugate in the spider Micromata rosea (Sparassidae). J. comp. Physiol. : 98 : 189-191.

KOGA N, OSANAI M (1967) Der Gehalt an Tryptophan, Kynurenin, 3-Hydroxy-Kynurenin und Ommochromen bei den überwinternden Eier des Seidenspinners Bombyx mori während der Entwicklung. Hoppe-Seyler's Z. physiol Chem. 348 : 979-982.

KOVOOR J (1977) La soie et les glandes séricigènes des Arachnides. Année biol. 16 : 97-171.

LAWRENCE R F (1954) Fluorescence in Arthropoda. J. ent. Soc. S. Africa 17 : 167-170.

MUCKENTHALER F A (1971) Kynurenine-localization in the egg of Drosophila melanogaster. Experientia 27 : 828-830.

PAVAN M, VACHON M (1954) Sur l'existence d'une substance fluorescente dans les téguments des scorpions. C.R. Acad. Sc. 239 : 1700-1702.

PETRIER C (1978) Etude photophysique des biliverdines et métabiliverdines IX. Thèse Doct. 3e Cycle, Univ.scient.med. Grenoble.

POLICARD A, PAILLOT A (1925) Etude de la sécrétion de la soie à l'aide des rayons ultraviolets filtrés (lumière de Wood). C.R. Acad. Sc. 181 : 378-380.

TURCHINI J (1925) Nouvelles observations en lumière de Wood (rayons ultra-violets filtrés). C.R. Soc. Biol. 93 : 1088-1090.

TURCHINI J, MILLOT J (1926) Sur la fluorescence en lumière ultraviolette filtrée (lumière de Wood) des glandes séricigènes et de certains éléments figurés du sang des Aranéides. C.R. Soc. Biol. 94 : 171-173.

WHITCOMB W H , HITE M, EASON R (1966) Life history of the green lynx spider, Peucetia viridans (Araneidae : Oxyopidae). J. Kansas ent. Soc. 39 : 259-267

YOUNG M R, WANLESS F (1967) Observations on the fluorescence and function of spiders'eyes. J. Zool. Lond. 151 : 1-16.

Krapf: Are there any correlations in the fluorescence and the habitate the spiders are living in?

J. Kovoor: Les recherches actuelles, encore très préliminaires, ne permettent pas d'établir une corrélation entre la fluorescence des animaux étudiés et leur mode de vie ou leur habitat.

Barth: What is the functional significance of fluorescence? Or is it just a byproduct of chemistry without behavioural significance?

Kovoor: C'est encore inconnu.