# UV-Vis reflectance in East Asian crab spider, *Thomisus labefactus* (Araneae: Thomisidae)

by

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Ultraviolet-visible (UV-Vis) reflectance spectroscopy is one of the useful tools to evaluate the coloration of materials and living things. On crab spiders, sit-and-wait foragers on flowers, body coloration has been focused in the context of camouflage and/or prey attraction. For the first time, the present study shows UV-Vis reflectance spectra of *Thomisus labefactus*, a crab spider inhabits East Asia, reflects UV-Vis rays almost the same strength as an Australian crab spider *Thomisus spectabilis*, which also has substantial amount of UV reflection, unlike European species lacking UV reflection.

***Key words**: body coloration, kynurenine, ommochrome, spectrum, ultraviolet rays.*

## 1. Introduction

While our perception of electromagnetic waves does not include the ultraviolet (UV) range (wavelengths smaller than 400 nm) of the light spectrum, many other animals have vision in the UV region[1]. Therefore, we should keep in mind that their visual impressions may be quite different from ours[2]. Ultraviolet-visible (UV-Vis) spectroscopy is a method of material analysis using spectrophotometers as absorption or reflectance spectroscopy in part of the UV and visible spectral regions. UV-Vis spectroscopy has also applied to reveal that UV reflection is present in many animals like spiders and has functions in their ecology[1), 3)].

Crab spiders (members of the Thomisidae family), which consist of 169 genera and 2,150 species (including subspecies)[4], are extremely powerful predators for many insects visiting flowers so that, they have been regarded as sit-and-wait (ambush) foragers on flowers[5) ~ 9)]. Their body coloration is particularly fascinating and has gotten attention[8), 10) ~ 30)]. Some of them change their body coloration reversibly matching background to hide from their natural enemies and prey[17), 19)], enhancing prey capture[22), 24), 25), 27), 30)] (contrary, once reported that their camouflage had no positive effects on prey capture[2), 8), 31)]).

To my knowledge, UV-Vis reflectance spectra of crab spiders have been reported concerning only European, Indian and Australian, which are quite limited compared with the diversity of Thomisidae species around the world. European crab spiders *Misumena vatia*, *Synema globosum*, *Xysticus* sp. and *Thomisus onustus* lack almost UV reflection, but reflect visible rays[8), 16), 21), 22), 25), 28), 29)]. On the other hand, Indian crab spider *Thomisus* sp. and Australian crab spiders *Thomisus spectabilis*, *Diaea lactea* [now synonym to *Zygometis xanthogaster*], *Runcinia acuminata*, *Sidymella rubrosignata* and *Tharrhalea evanida* (and a Malaysian crab spider too) could reflect not only visible light but also UV rays[8), 21), 24), 25), 29)].

*Thomisus labefactus*, one of crab spiders belonging to the family Thomisidae, commonly inhabits Japan, Korea, and China[32)]. In Nagasaki, female adult individuals of the species were found on October 31 ~ November 1, 2019 (Photo 1)[33), 34)] and September 30, 2020 (Photo 2)[35)], though the adult individuals have rarely observed in the field after late September[5)]. In the present study, I first report UV-Vis reflectance spectra of an East Asian crab spider *T. labefactus*, subsequent to the first report of UV reflection in *T. labefactus* by ultraviolet photography[15)].

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Photo 1 *Thomisus labefactus* walking on the web after predation of *Argiope bruennchi* (November 1, 2019)[33), 34)].

Photo 2 A female individual of *T. labefactus* (white, alive) UV-Vis spectra was measured (September 30, 2020)[35)].

## 2. Materials and methods

A female individual of *T. labefactus* was collected on a leaf of Japanese knotweed *Reynoutria japonica* in the Campus of Nagasaki University on September 30, 2020[35)]. UV-Vis-NIR spectrophotometer (Jasco V670DS) was used for the measurement of UV-Vis reflectance spectra of the opisthosoma (the back) of *T. labefactus* (white, alive; Fig. 1). Thereafter, the crab spider died with body coloration changing from white to pale yellow a week later (Photo 3). UV-Vis reflectance spectrum of the pale-yellow *T. labefactus* (dead) opisthosoma was also measured. Regular reflectance measurement was conducted at first, whereas diffuse reflectance measurement with integrating sphere of barium sulfate was carried out after that (see Appendix).

Photo 3 A female individual of *T. labefactus* (pale-yellow, dead) UV-Vis spectra was measured (October 8, 2020).

## 3. Results and Discussion

UV-Vis reflectance spectra of each opisthosomata (backs) of *T. labefactus* specimen are shown in Fig. 1 (white, alive) and Fig. 2 (pale yellow, dead), respectively. By comparing the first specimen with the last one, UV reflection of the white individual is stronger than the pale-yellow specimen. However, the pale-yellow specimen could rather reflect UV, meaning that it has not lost all UV reflection.

It is indicated previously that the yellow coloration of spiders results from ommochrome and/or their precursors (xanthommatin and 3-hydroxykynurenine), which are pigments deposited in transparent hypodermal layers[29), 36) ~ 39)]. Although 3-hydroxykynurenine (the precursor of ommochrome) is yellow, kynurenine is transparent[29), 37), 39)]. It is supposed that the white individual of *T. labefactus* had much transparent kynurenine but little yellow 3-hydroxykynurenine, and in the case of the pale-yellow specimen, oxidation reaction of kynurenine increased 3-hydroxykynurenine otherwise decreased kynurenine.

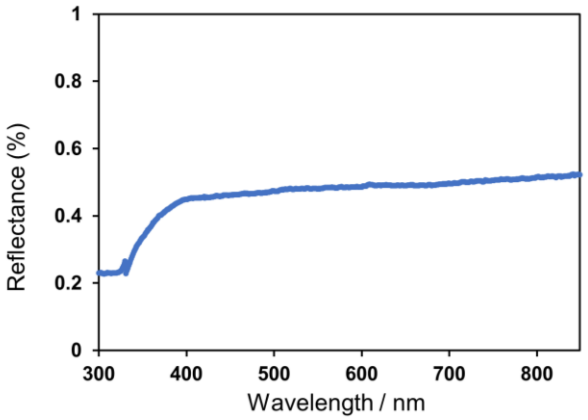


Fig. 1 UV-Vis reflectance spectrum of *T. labefactus* (white, alive).

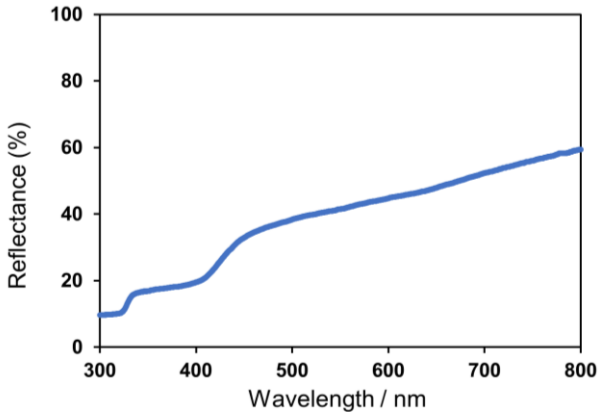


Fig. 2 UV-Vis reflectance spectrum of *T. labefactus* (pale-yellow, dead).

Comparing the East Asian crab spider *T. labefactus* with other crab spiders, whose UV-Vis reflectance spectra were reported under 400 nm of UV regions, *T. labefactus* reflects UV nearly as strong as *T. spectabilis*, known as substantial amount of UV light (as well as blue and green light) reflective Australian crab spider species[8), 18)]. A question had already been raised; is UV reflection a common trait amongst crab spiders, or an isolated curiosity? And they answered: UV reflection is not unique to Australian crab spiders and to fully answer the question, we require detailed morphological and colorimetric studies of a wider selection of species and regions[8)]. Herein, I could newly add UV-Vis spectra of an East Asian crab spider *T. labefactus*, strongly reflects UV light in addition to visible rays. This information will make it possible to better answer the question[8)] confirming that UV reflection is not unique to Australian, Indian, Malaysian and now in addition to the East Asian crab spider, except for the European crab spider species that have no UV reflection.

It was previously presented that the color polyphenism, the occurrence of several phenotypes (the differences between which are not the result of genetic differences), exists in the body coloration of crab spiders like *T. spectabilis*[29)]. Regrettably, the present study would not enough to discuss whether some color phenotypes of *T. labefactus* are lacking UV reflection or not. Accordingly, further research should be necessary to clarify how the color polyphenism in *T. labefactus* would be, by means of measuring UV-Vis reflectance spectra of plural number of specimens, including not only the white individuals but also the yellow ones[15)] and be compared with each other.

## 4. Conclusions

Based on the above, a summary is the following:

1. UV-Vis reflectance spectra of an East Asian crab spider *T. labefactus* was first measured and compared with the UV-Vis spectra from other crab spiders (Australian, European and Indian) reported before.
2. According to the previous reports, the body coloration of *T. labefactus* is changeable amongst white and yellow, and the fact is re-confirmed and shown clearer quantitatively by the present UV-Vis reflectance spectra of both the white and the pale-yellow states.
3. In the crab spiders, *T. labefactus* is able to reflect UV and visible rays strongly as an Australian crab spider, which reflects the substantial amount of UV-Vis light.

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Appendix: In the optical system of regular reflectance, not almost diffuse reflected light but regular reflected light is detectable. In the case of with strong scattering and diffuse reflection specimen, quantitative measurements are impossible in this system, because detected light is not so much (Fig. S1). Alternatively, in the system of diffuse reflectance with integrating sphere, both regular and diffuse reflection are uniformized in integrating sphere (barium sulfate) and detected (Fig. S2).

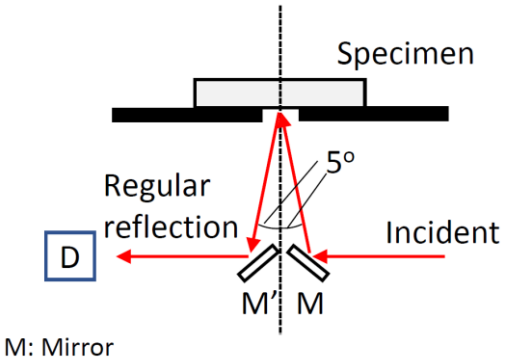


Fig. S1 Optical system of regular reflectance measurement.

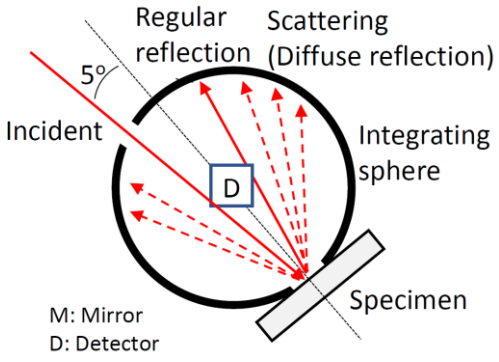


Fig. S2 Diffuse reflectance with integrating sphere.

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# 東アジア産のアズチグモ *Thomisus labefactus*（クモ目：カニグモ科）における紫外・可視反射スペクトル

野口大介*

紫外・可視（UV-Vis）反射分光法は，材料や生物の色彩を評価する有益なツールの一つである．カニグモは花の上で獲物を待ち伏せする捕食者であり，擬態および／あるいは餌誘引における文脈で，体の色彩に焦点が当てられてきた．本研究では，東アジアに生息するカニグモ科の一種であるアズチグモ *Thomisus labefactus* では最初となる UV-Vis 反射スペクトルの測定から，紫外線反射を欠いているヨーロッパ産の種とは異なり，相当量の紫外線を反射するオーストラリア産のカニグモ科の一種 *Thomisus spectabilis* と同程度の強さで紫外線と可視光を反射することが示される．

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