

1 **The spectral transmission of non-salticid spider corneas**

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20 **ABSTRACT**

21 Although many salticid spiders have been shown to have corneas that transmit
22 ultraviolet light (UV). Whether the corneas of non-salticid spiders transmit UV
23 has not been previously investigated. In this study, we determined the spectral
24 corneal transmission properties of 38 species belonging to 13 non-salticid
25 families. We used these data to estimate the T_{50} transmission cut-off value, the
26 wavelength corresponding to 50% maximal transmission for each species. The
27 corneas of almost all species from the families Deinopidae, Lycosidae,
28 Oxyopidae, Pisauridae, Sparassidae and Thomisidae, all of which have been
29 reported to rely to a substantial extent on vision, transmitted short wavelengths
30 below 400 nm, ranging from 306 to 381 nm. However, species from the families
31 Atypidae and Ctenizidae are not known to rely substantially on vision, and the
32 corneas of these species tended to absorb light of wavelengths below 380 nm,
33 which may not allow UV sensitivity in these spiders. Liphistiidae, the family
34 widely regarded as most basal among spiders, is of particular interest. The
35 species in this family are not known to make substantial use of vision, and yet
36 we found that liphistiid corneas transmitted UV light with a low T_{50} value (359
37 nm). T_{50} values of non-salticid spider corneas also varied with light habitat.
38 Species living in dim environments tended to have UV-opaque corneas, but
39 species inhabiting open areas had UV-transmitting corneas. However, there
40 was no evidence of corneal transmission properties being related to whether a
41 species is diurnal or nocturnal.

42 **KEY WORDS: Spiders, Cornea, Spectral transmission, Ultraviolet, Light**
43 **habitat, Circadian rhythms.**

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46 INTRODUCTION

47 Despite exposure to ultraviolet radiation (UV), which reaches Earth's surface at
48 wavelengths between 290 and 400 nm, being known to damage animal DNA and
49 tissues, including retinas (Zigman, 1983; Berghahn et al., 1993; Mason et al., 1998;
50 Williamson and Rose, 2010), UV vision is known to be widespread in animals
51 (Goldsmith, 1994; Tovée, 1995; Briscoe and Chittka, 2001; Hunt et al., 2001). One
52 requirement for UV vision is a retina that contains photoreceptors that are sensitive to
53 UV. However, another more basic requirement for UV vision is the tissues in the
54 anterior portion of the eye so-called ocular media (i.e., the lens, cornea and vitrea;
55 Douglas and Marshall, 1999; Siebeck and Marshall, 2001) that must also allow UV
56 light to reach the retina. The retina can not respond to UV in the absence of UV arriving
57 at the retina. If UV is not transmitted to the retina, the eye as a whole is not sensitive to
58 UV, and thus lacking UV vision, regardless of whether the retina contains
59 photoreceptors that respond physiologically to UV. Any consideration of UV vision in
60 animals must therefore take into account the spectral transmission properties of their
61 ocular media (e.g. Siebeck and Marshall, 2000; Siebeck and Marshall, 2001; Siebeck
62 and Marshall, 2007; Hu et al., 2012). Previous studies of ocular media transmission
63 have almost exclusively been conducted on vertebrates, particularly on fishes, and have
64 documented considerable variations in lens and corneal transmission properties (e.g.
65 Siebeck and Marshall, 2000, 2001, 2007; Eckes et al., 2008). However, very few
66 studies have been conducted to determine the spectral transmission of ocular media in
67 invertebrates, including spiders.

68 Spiders usually have eight eyes, and each eye consists of a cornea, which is the
69 main type of ocular medium (Land and Nilsson, 2012). A recent study measuring the
70 UV transmission properties of the principal-eye corneas of 128 salticid species revealed
71 that the corneas of all species examined transmit UV light above 290 nm (Hu et al.,
72 2012). With about 40,000 species of non-salticid spiders (Platnick, 2014), measuring
73 the spectral corneal transmission may be a quick way to assess the possibility of UV
74 vision in a large number of species (Siebeck and Marshall, 2000, 2001, 2007). However,
75 no study has been conducted to determine the spectral cornea transmission properties of
76 non-salticid spiders.

77 Our recent study has also shown that the spectral transmission of salticid

78 corneas varies with light habitat (Hu et al., 2012): the corneas of salticids inhabiting
79 open bush have a higher relative transmission at short wavelengths in the UV spectrum
80 than do species living in the forest. Non-salticid spiders also live in a wide range of
81 habitats that differ greatly in photic conditions. The range of wavelengths to which a
82 spider is sensitive may be tuned to the specific optical habitat in which it lives (Lythgoe,
83 1972, 1979), which probably enhances its ability to detect mates, prey and predators
84 within its specific habitat. Because UV light varies in time and place (Endler, 1993;
85 Flint and Caldwell, 1998), it is instructive to relate the spectral transmission properties
86 of a spider's ocular media to its various optical habitats.

87 The substantial use of vision or other modalities varies with family and species.
88 Unlike salticids that have complex eyes and exceptional spatial acuity (Land, 1969;
89 Blest et al., 1981; Land and Nilsson, 2012; Harland, Li and Jackson, 2012), most
90 spiders have only poorly developed eyesight (Homann, 1971; Land and Nilsson, 2012)
91 and make substantial use of vibration and/or chemical cues for communication (Foelix,
92 2011). Spiders of the families Deinopidae, Lycosidae, Oxyopidae, Pisauridae,
93 Sparassidae and Thomisidae, all of which have been reported to rely to a substantial
94 extent on vision, tend to adopt a vision-based lifestyle (Blest and Land, 1977; Blest,
95 1978; Foelix, 2011). What is more, different spiders have evolved different circadian
96 rhythmic life styles. Some species such as thomisids are nocturnal and forage at night
97 (Laughlin et al., 1980; Nørgaard et al., 2008), whereas others such as deinopids and
98 sparassids are mainly active during the daytime. In addition, some spiders are active
99 both nocturnally and diurnally (Foelix, 2011). Consequently, non-salticid spiders may
100 have evolved visual systems to adapt to quite different light conditions specific to their
101 habitats and adopt different circadian rhythms. It is therefore plausible to ask whether
102 spiders of different non-salticid families with different lifestyles and living in different
103 optical habitats have corneas that exhibit different spectral transmission properties.

104 The aim of this study was, therefore, (1) to measure the spectral transmission
105 properties of the corneas of non-salticid species to determine how widespread UV
106 transmission of the corneas is in these spiders, and (2) to determine whether corneal
107 transmission characteristics vary with species, light environment, circadian rhythmic
108 lifestyle (diurnal, nocturnal or both) and the predominant sensory modality (visual,
109 tactile or both).

110 RESULTS

111 General spectral transmission of non-salticid spider corneas

112 In general, the spectra of the 38 non-salticid species examined had similar smooth
113 transmission curves with a single cut-off and with uniformly high transmission at long
114 wavelengths, whereas the spectra declined at shorter wavelengths (Fig. 1A). However,
115 the T_{50} cut-off transmission value for the cornea, which represents the wavelength
116 corresponding to 50% maximum transmission, varied considerably with the species
117 and had a wide range from 306 nm (anterior lateral eyes of the crab spider *Amyciaea*
118 *forticeps* (O. P.-Cambridge)) to 419 nm (anterior lateral eyes of the crab spider
119 *Ebrechtella tricuspadata* (Fabricius)) (Table 1).

120 Because all spectra showed about 100% transmission above 400 nm, we
121 classified the spectral curves primarily on the basis of the slope of the T_{50} cut-off
122 position. In general, three classes of corneal transmission spectra can be distinguished
123 (Fig. 1A). The Class I curve is characterised by a sharp cut-off and a steep slope (Fig.
124 1A, black curve). Class II consists of curves with a less steep slope and a gradual onset
125 of the cut-off (Fig. 1A, red curve). Class III is characterised by a more gradual single
126 cut-off and a gradual slope, which has a decrease of transmission in the long waveband
127 compared with Classes I and II. Nine (23.7%) of the 38 species had a Class I type
128 transmission curve, 26 (68.4%) had corneas with a Class II transmission curve, and
129 only 3 (7.9%) showed a Class III transmission curve (Fig. 1B).

130 The frequencies of the T_{50} values across the 38 species were distributed
131 normally (Kolmogorov-Smirnov = 0.121, $df = 38$, $p = 0.174$): most species had the
132 most prominent peak of the T_{50} value around either 340 nm or 370 nm, and a few
133 species had T_{50} values at shorter wavelengths (2 species: < 320 nm) or at longer
134 wavebands (2 species: > 400 nm) (Fig. 2).

135 Effects of light habitat, circadian rhythmic lifestyle and sensory modality

136 Geographic and ecological information of every collected spider was specifically
137 recorded, including habitat type, light environment and vegetation types. According to
138 these data, we classified the spiders into three groups (Table 1): (1) most lycosids, some
139 oxyopids, and most thomisids inhabiting open shrub, i.e. those active at shrub, fields

140 growing herbaceous plants and bare ground surface receiving full intensive sunlight; (2)
141 some agelenids, clubionids, some oxyopids, many pisaurids, and most sparassids living
142 in shade forests, including forest shade, woodland shade, and small and large gaps
143 under the forest, as described by Endler (1993); and (3) all atypids, ctenizids, deinopids,
144 gnaphosids, liphistiids and zodariids living in dark burrows, tree holes and under leaf
145 litter with dim light. In addition, we classified the spiders according to their circadian
146 rhythmic lifestyle as being nocturnal, diurnal, and both diurnal and nocturnal. Finally,
147 spiders that differ in the use of a particular communication modality to a substantial
148 extent were also sorted into three groups (Foelix, 2011): species that rely on tactile
149 communication; species that make substantial use of vision; and species that use both
150 tactile- and vision-based communication (Table 1).

151 Results from one-way ANOVAs with species as a confounding factor revealed
152 a significant difference in corneal transmission T_{50} values among non-salticid spiders
153 that adopted quite different sensory modes ($F_{2,36} = 5.53$, $p = 0.008$; Fig. 3).
154 Vision-based non-salticid spiders had corneal T_{50} cut-off values significantly lower
155 than those primarily relying on tactile signals for communication ($p = 0.002$), but there
156 were no significant differences in corneal T_{50} values between tactile-based only and
157 tactile- and vision-based spiders ($p = 0.221$) or between vision-based only and tactile-
158 and vision-based spiders ($p = 0.123$).

159 Although photic habitat had no overall significant effects on corneal
160 transmission T_{50} values ($F_{2,36} = 3.026$, $p = 0.061$; Fig. 3), post-hoc paired comparisons
161 showed that spiders living in burrows tended to have corneal T_{50} cut-off values
162 significantly higher than those inhabiting bright shrub and open areas ($p = 0.034$) and
163 shaded forests ($p = 0.035$) (e.g. Atypidae: *Calommata signata* Karsch = 382 nm;
164 Ctenizidae: *Latouchia cornuta* Song, Qiu & Zheng = 390 nm and *Latouchia* sp. 1 = 412
165 nm; Fig. 4). We found that circadian rhythms had no significant effects on corneal
166 transmission T_{50} values ($F_{2,36} = 0.642$, $p = 0.532$; Fig. 3).

167

168 **DISCUSSION**

169 Some salticids are known to have photoreceptors sensitive to UV (Harland et al., 2012)
170 and UV-transmitting corneas are widespread in salticids (Hu et al., 2012). By

171 measuring the corneal transmission of the eyes of 38 non-salticid spider species
172 belonging to 13 families, we found that the corneas of a majority of the species
173 transmitted the UV wavelengths below 400 nm, with a range from 306 to 381 nm. As
174 expected, the corneal spectral transmission of non-salticid species varied with species,
175 primary communication mode, and photic environment, but not with diurnal or
176 nocturnal lifestyle. This is the first investigation, to our knowledge, of corneal
177 transmission in spiders other than salticid spiders, and it suggests that UV vision may
178 be widespread in spiders that are known to rely to a substantial extent on vision.

179 An animal that possesses UV-sensitive photoreceptors may be insensitive to UV
180 wavelengths if its ocular media block UV light (Håstad et al., 2009). With both
181 UV-sensitive photoreceptors in the retina and UV-transmitting ocular media, the animal
182 should be UV sensitive. Our study showed that almost all species from the families
183 Deinopidae, Lycosidae, Oxyopidae, Pisauridae, Sparassidae and Thomisidae, all of
184 which are known to make substantial use of vision, have the corneas that transmit short
185 wavelengths ranging from 306 to 381 nm. Many thomisids are known to be sit-and-wait
186 predators that rest on flowers and ambush pollinating insects (e.g., Morse, 2007). Some
187 thomisids can reflect UV light and use UV contrast to enhance prey capture (Heiling et
188 al., 2003; Bhaskara et al., 2009; Gawryszewski, 2011; Herberstein and Gawryszewski,
189 2013; but Brechbühl et al., 2010). A recent study using electrophysiological recording
190 combined with selective adaptation revealed the presence of UV receptors in the eyes
191 of the thomisid *Misumena vatia* (Clerck) (Defrize et al., 2011). DeVoe (1972) found
192 that photoreceptor cells of both principal, i.e. the anterior median and anterior lateral
193 eyes of lycosids have dual peak sensitivities at both the UV wavelengths of 360-380 nm
194 and the human-visible wavelengths of 505-510 nm. Our findings here show that these
195 species also have corneas that transmit UV. Taken together, these findings indicate that
196 UV vision may be common in thomisids and lycosids. Although our results do not
197 definitely address whether there are any adaptive benefits for transmitting UV in these
198 spiders, this would be well worth examining.

199 Deinopids are nocturnal predators that catch insects passing beneath them by
200 throwing a silk net over them (Foelix, 2011). They have a pair of enlarged posterior
201 median eyes. Although, their eyes have a great visual capability and have been
202 modified for nocturnal vision (Blest and Land, 1977), there are only single-type

203 photoreceptor cells with sensitivity peaking at human-visible wavelengths around 517
204 nm in the posterior median retina of *Deinopis subrufa* L. Koch (Laughlin et al., 1980).
205 It is also known that the nocturnal hunting sparassid *Leucorchestris arenicola*
206 Lawrence (Sparassidae) has single-type photoreceptor cells that are sensitive to
207 human-visible wavelengths ranging from about 525 to 540 nm (Nørgaard et al., 2008).
208 Although these findings imply that deinopids and sparassids may be colour-blind, as at
209 least two types of photoreceptors are needed for an animal to be able to discriminate
210 between different wavelengths of light (Jacobs, 1981; Kelber et al., 2003), with corneas
211 transmitting wavelengths above 335 nm, deinopids and sparassids may be able to detect
212 UV light. In spite of having UV-transmitting corneas, UV-sensitive photoreceptors are
213 largely unknown in oxyopidid and pisauridid.

214 Spiders from the families Atypidae and Ctenizidae living in burrows are not
215 known to rely substantially on vision, and the corneas of these species tended to have a
216 T_{50} cut-off wavelength value above 390 nm (Table 1). Although it is not known whether
217 they have UV-sensitive photoreceptors, we can predict that these spiders may not be
218 UV sensitive because their corneas block UV light. Being the family widely regarded as
219 “living fossils”, an ancient lineage that is sister to all extant spiders, Liphistiidae is of
220 particular interest. The species in this family are not known for making substantial use
221 of vision, and yet we found that UV radiation readily passes through the liphistiid
222 corneas. However, future work is needed to determine the presence of UV-sensitive
223 photoreceptors in liphistiids and the importance of the detection of UV in their
224 behaviour. It is also worth noting that although our results show considerable
225 species-specific variation in the spectral transmission properties, such differences must
226 still be tested using a phylogenetic framework.

227 Interestingly, there is a substantial difference in the corneal transmission T_{50}
228 cut-off values among non-salticid spiders living in different habitats. This implies that
229 there may be a strong correlation between the light habitat and corneal transmission of
230 these spiders. In spite of some exceptions (e.g., the crab spider *E. tricuspidata*; Table 1),
231 spiders inhabiting forest shades and burrows where there is a lower level of
232 illumination or the shift in the ambient light spectrum to longer wavelength tended to
233 have corneas with a higher T_{50} cut-off value than those living in open areas, where there
234 are high levels of sunlight. This is consistent with the salticids that have already been

235 examined (Hu et al., 2012).

236 Diurnal or nocturnal lifestyle does not seem to strongly correlated with the
237 corneal transmission characteristics of non-salticid spiders. One possible explanation is
238 that some vision-based non-salticid spiders have a shorter T_{50} cut-off wavelength but
239 they are active at night, e.g. *Deinopis liukuensis* Yin, Griswold & Yan (Deinopidae: 335
240 nm), *Heteropoda helge* Jäger (Sparassidae: 343 nm) and *Heteropoda* sp. 1 (Sparassidae:
241 323 nm). However, spiders from both of these families (Deinopidae and Sparassidae)
242 are found to have only one type of photoreceptor in their eyes, with sensitivity peaking
243 at human-visible wavelengths around 517 nm in deinopids (Laughlin et al., 1980) and
244 ranging from about 525 to 540 nm in *L. arenicola* (Sparassidae) (Nørgaard et al., 2008).
245 They may be able to detect UV, however, with only a single pigment they can not
246 differentiate UV from non UV light, and any UV photons may just contribute to the
247 sensation of light present.

248 It has long been recognised that UV sensitivity comes at a cost because in
249 many animals, high-energy solar UV has the potential to damage the ocular tissues of
250 their eyes (Zigman, 1971; Berghahn et al., 1993; Williamson and Rose, 2010),
251 including the retina (Paul and Gwynn-Jones, 2003). It seems obvious then that an
252 animal that is habitually exposed to high levels of UV would benefit from a
253 UV-blocking filter that prevents these wavelengths from reaching the retina. However,
254 the occurrence of UV transmission in the corneas of many of the measured non-salticid
255 species implies that the majority of these species do not have such a UV-blocking filter.
256 Although it is unclear whether UV radiation has the potential to damage the ocular
257 tissues of spider eyes, the results from our study suggest that seeing UV light may
258 confer an advantage that overrides the potential cost of UV damage. Alternatively,
259 since non-salticid spiders are short lived, the DNA damage caused by UV radiation may
260 not have significant impact on them even though they lack UV-blocking filters in their
261 eyes.

262 **MATERIALS AND METHODS**

263 **Study subjects**

264 We collected 59 individuals of spiders belonging to 38 species and 13 families from
265 China (Hubei, Hunan, Shandong, Shanxi and Yunnan Provinces) (Table 1). Spiders

266 were maintained by following a protocol similar to that of earlier studies (Lim and Li,
267 2004; Lim and Li, 2006; Lim et al., 2007; Li et al., 2008; Hu et al., 2012). They were
268 individually housed in plastic cylindrical cages (diameter \times height: 60 \times 80 mm), fed
269 with a diet of fruit flies (*Drosophila melanogaster* Meigen) once a week, and
270 maintained in a laboratory with controlled environmental conditions (temperature: 25 \pm
271 1°C; relative humidity: 70-90%; light regime: 12/12 h light/dark cycle; lights on at 0800
272 h). The spiders were used for the measurement of corneal transmission within a week
273 after collection. Only living specimens were used for measurements.

274 **Measurements of corneal transmission**

275 We used a procedure similar to that described in an early study (Hu et al., 2012) to
276 measure the transmission spectra (280-700 nm) of the non-salticid spider corneas. The
277 transmission measurements were made with an Ocean Optics USB2000 spectrometer
278 (Ocean Optics, Dunedin, FL, USA). Before the measurements, we anaesthetised each
279 spider with CO₂ gas, immersed it in a 0.9% physiological salt solution (in millimoles
280 per liter: Na, 223; K, 6.8; Ca, 4; Cl, 258) (DeVoe, 1972) in a small Petri dish (9 \times 2 cm),
281 cut the whole eye from the cephalothorax and isolated the cornea from other parts of the
282 eye under a stereomicroscope as soon as possible to avoid artifacts of tissue degradation
283 (Douglas and McGuigan, 1989). For the measurements, we directly mounted the
284 isolated cornea on the pinhole of a quartz fiberoptic probe (50 μ m diameter) (Ocean
285 Optics, Dunedin, FL, USA), which was held by a modified microscope stand. To
286 ensure that the cornea was well mounted on the pinhole, a portable magnifying glass
287 was used to monitor this procedure. The cornea was then illuminated from above by a
288 full-spectrum (200-1100 nm) light source (DH-2000; Ocean Optics, Dunedin, FL,
289 USA). The light signal directly penetrated the cornea, passed through the underlying
290 pinhole into the fiberoptic probe receiver, and was delivered to the USB2000
291 spectrometer (Siebeck and Marshall, 2001, 2007; Hu et al., 2012). We measured only
292 the central area of the cornea. All of the transmission readings were obtained relative to
293 a dark reference (lights off in a dark room). Five measurements of light transmission
294 were taken and averaged for each cornea.

295 **Estimation of T₅₀ cut-off transmission value**

296 The absolute transmission of the cornea could be altered by artifactual changes in the

297 position of the cornea covering the pinhole of the quartz fiberoptic probe during each
298 measurement (Douglas and McGuigan, 1989; Hu et al., 2012). Therefore, to eliminate
299 any artifactual variation in absolute transmission and to characterise the corneal
300 transmission, we estimated the T_{50} cut-off transmission value for the cornea, which
301 represents the wavelength corresponding to 50% maximum transmission in the
302 equation of linear regression, similar to that in earlier studies (Partridge 1989; Douglas
303 and McGuigan, 1989; Hu et al., 2012). In doing so, transmission spectra were first
304 normalised by making a spectral scan (1219 points between 280 and 700 nm) equal to
305 100% transmission at 700 nm in each spectrum. We then found out a point at 50% of
306 the maximum transmission among these 1219 points and used 30 points on either side
307 of this point (range of 22 nm) to generate the equation of the linear regression line.
308 Finally, the wavelength corresponding to 50% maximum transmission on the
309 regression line was considered the T_{50} cut-off wavelength value. For convenience, we
310 used the terms T_{50} value and T_{50} cut-off value interchangeably.

311

312 **LIST OF SYMBOLS AND ABBREVIATIONS**

313 AM: anterior median eyes

314 AL: anterior lateral eyes

315 BS: open shrub

316 D: diurnal

317 DB: dark burrows

318 D-N: diurnal-nocturnal

319 N: nocturnal

320 PA: posterior median eyes

321 PL: posterior lateral eyes

322 SF: shade forests

323 T: tactile-based

324 T_{50} : the wavelength corresponding to 50% maximum transmission

325 T-V: tactile- and vision-based

326 UV: ultraviolet

327 V: vision-based

328 VIS: human-visible wavelengths

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344 **AUTHOR CONTRIBUTIONS**

345 Z.Y.H., X.X., Z.Q.C., J.C. and D.L. were involved in the conception of the study
346 and experimental design. Z.Y.H., X.X., Z.Q.C., H.Z.L., X.Y.W., L.B.W. and F.X.L.
347 performed the experiments. Z.Y.H., X.X., Z.Q.C. and D.L. performed data
348 analyses and drafted the manuscript. Z.Y.H., X.X., Z.Q.C., H.Z.L., X.Y.W.,
349 L.B.W., J.C. and D.L. revised the manuscript.

350 **COMPETING INTERESTS**

351 No competing interests are declared.

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480

481 **Figure Legends**

482 **Fig. 1. General corneal transmission characteristics of non-salticid**
483 **spiders.** (A) Representative examples of the three different classes, Class I,
484 Class II and Class III, of corneal transmission curves of non-salticid spiders.
485 Class I: corneal transmission spectrum of *Pardosa falcata* (Lycosidae) (black);
486 Class II: corneal transmission spectrum of *Oxytate hoshizuna*
487 (Thomisidae)(red:); and Class III: corneal transmission spectrum of Zodariidae
488 (green). (B) Frequency (number of species) distribution of corneal transmission
489 curve classes (I, II, III) across sensory modalities (T: tactile-based; V:
490 vision-based; T-V: tactile- and vision-based).

491 **Fig. 2. Frequency distribution of T_{50} cut-off wavelengths for the corneas**
492 **of 38 non-salticid spider species.**

493 **Fig. 3. Boxplot of the T_{50} cut-off wavelengths of corneal transmission of**
494 **38 non-salticid spider species** according to the light habitat (BS: bright shrub;
495 SF: shaded forest; DB: dark burrow), circadian rhythmic lifestyle (D: diurnal; N:
496 nocturnal; D-N: diurnal-nocturnal) and sensory modality (T: tactile-based; V:
497 vision-based; T-V: tactile- and vision-based). Boxes show median (line within
498 the box) and upper (75%) and lower (25%) quartiles, whiskers indicate 95th
499 percentiles, and circles/stars are outliers. Different lowercase letters indicate
500 significant differences.

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504 Table 1. List of the 38 non-salticid spider species with T_{50} (50% maximal transmission) cut-off wavelength (nm), corneal diameter (mm) of the anterior middle
 505 (AM), anterior lateral (AL), and posterior (PM) eye, corneal transmission Classes (I, II and III), and carapace width (CW: mm). N: number of specimens

Family	Genus	Species	Habitat	Circadia rhythms	Sensory mode	T_{50} (nm)	Cornea (mm)	CW	Class	Eye	N
Agelenidae	<i>Allagelena</i>	<i>difficilis</i> Fox	BS	D	T	340	0.17	2.46	I	AM	3
	<i>Pireneitega</i>	<i>neglecta</i> (Hu)	DB	D	T	375	0.28	5.24	II	AL	3
	<i>Pireneitega</i>	<i>spinivulva</i> (Simon)	DB	D	T	371	0.23	4.18	II	AL	3
Atypidae	<i>Calommata</i>	<i>signata</i> Karsch	DB	D-N	T	382	0.23	6.09	III	AM	1
Clubionidae	<i>Clubiona</i>	<i>coreana</i> Paik	SF	N	T	369	0.15	1.97	II	AL	1
	<i>Clubiona</i>	sp.1	SF	N	T	370	0.13	1.87	II	AL	1
Ctenizidae	<i>Latouchia</i>	<i>cornuta</i> Song, Qiu & Zheng	DB	N	T	390	0.31	7.44	III	AM	1
	<i>Latouchia</i>	sp.1	DB	N	T	412	0.24	3.55	III	AM	2
Deinopidae	<i>Deinopis</i>	<i>liukuensis</i> Yin, Griswold & Yan	DB	N	V	335	0.46	2.07	II	PM	1
Gnaphosidae			DB	N	T	362	0.09	1.08	II	AM	1
Liphistiidae	<i>Heptathela</i>	<i>xianningensis</i> Yin et al.	DB	N	T	359	0.26	4.5	II	AL	1
Lycosidae	<i>Alopecosa</i>	sp.1	BS	D-N	T-V	370	0.41	4.29	II	AM	1
	<i>Ocyale</i>	sp.1	BS	D-N	T-V	368	0.27	2.89	II	AM	1
	<i>Pardosa</i>	<i>astrigera</i> L. Koch	BS	D-N	T-V	351	0.22	2.65	I	AM	4
	<i>Pardosa</i>	<i>falcata</i> Schenkel	BS	D-N	T-V	369	0.2	2.2	I	AM	1
	<i>Pardosa</i>	<i>laura</i> Karsch	BS	D-N	T-V	371	0.23	2.74	I	AM	1
	<i>Pardosa</i>	<i>pseudoannulata</i> Bösenberg & Strand	BS	D-N	T-V	381	0.25	3.71	I	AM	2
	<i>Pardosa</i>										
Oxyopidae	<i>Oxyopes</i>	<i>fujianicus</i> Song & Zhu	SF	D-N	V	344	0.22	2.27	II	AL	1
	<i>Oxyopes</i>	<i>lineatipes</i> (C. L. Koch)	SF	D-N	V	368	0.27	2.46	I	AL	2
	<i>Oxyopes</i>	<i>macilentus</i> L. Koch	SF	D-N	V	350	0.26	2.21	II	AL	1
	<i>Oxyopes</i>	<i>sertatoides</i> Xie & Kim	BS	D-N	V	348	0.22	2.83	I	AL	3
	<i>Oxyopes</i>	<i>sertatus</i> L. Koch	BS	D-N	V	343	0.22	2.7	II	AL	3
	<i>Oxyopes</i>	sp.1	SF	D-N	V	368	0.18	2.21	II	AL	1
	<i>Oxyopes</i>	sp.2	BS	D-N	V	341	0.24	3.1	II	AL	1
Pisauridae	<i>Dolomedes</i>	sp.1	SF	D-N	T-V	331	0.14	3.32	II	AM	1
	<i>Dolomedes</i>	<i>sulfureus</i> L. Koch	SF	D-N	T-V	348	0.27	4.12	II	AM	1
Sparassidae	<i>Heteropoda</i>	<i>helge</i> Jäger	SF	N	V	343	0.32	3.11	I	AL	1
	<i>Heteropoda</i>	sp.1	SF	N	V	323	0.21	2.56	I	AL	1
Thomisidae	<i>Amyciaea</i>	<i>forticeps</i> O. P.-Cambridge	BS	D	V	306	0.18	1.51	II	AL	1
	<i>Camaricus</i>	<i>formosus</i> Thorell	BS	D	V	358	0.17	2.69	II	AL	2
	<i>Ebrechtella</i>	<i>tricuspidata</i> (Fabricius)	BS	D	V	419	0.09	1.7	II	AL	4
	<i>Monaeses</i>	sp.1	BS	D	V	343	0.18	3.31	II	AL	1
	<i>Oxytate</i>	<i>hoshizuna</i> Ono	BS	D	V	335	0.16	2.96	II	AL	1

	<i>Ozyptila</i>	<i>wuchangensis</i> Tang & Song	BS	D	V	343	0.17	2.79	II	AL	2
	<i>Thomisus</i>	<i>labefactus</i> Kansch	BS	D	V	341	0.1	1.6	II	AL	1
	<i>Xysticus</i>	<i>ephippiatus</i> Simon	BS	D	V	359	0.14	1.74	II	AL	1
	<i>Xysticus</i>	sp.1	BS	D	V	339	0.12	1.41	II	AL	1
Zodariidae			DB	N	T	371	0.19	2.24	II	AL	1





