Abdominal colour polymorphism in female Asian Golden Web Spider
_Nephila antipodiana_ (Araneae: Nephilidae)

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Abstract *Nephila antipodiana* (Batik Golden Web Spider) occurred in large numbers in several localities in Kelantan and Terengganu, east coast of Peninsular Malaysia. Three abdominal (opisthosomal) colour morphs – yellow, greenish-yellow and reddish-brown – were present in adult female spiders. Only two colour morphs appear to be present in a particular locality. The yellow morph occurred in all the localities investigated. Of the two non-yellow morphs, the reddish-brown morph was found only in one locality while the greenish-yellow morph was more widespread. The present study does not show unequivocally the association of colouration with habitat usage. Whether yellow colour in *N. antipodiana* confers a selective advantage remains to be verified. In addition to opisthosomal colour polymorphism, the colour and number of spots (or sigillae) on the dorsal surface of the abdomen of female *N. antipodiana* are also variable. The juvenile spiders have different colour pattern from the adults.

Keywords polymorphism – golden web spider – Arachnida – Malaysia – opisthosoma colour

INTRODUCTION

The Batik (or Asian) Golden Web Spider _Nephila antipodiana_ (Walckenaer 1842) was first reported in Peninsular Malaysia (and Malaysia) in 2009 [1]. It was originally described as _Epeira antipodiana_ Walckenaer 1842. It is distributed in China, Philippines to New Guinea, Solomon Is., and Queensland [2]. In Southeast Asia it has been recorded in Singapore, Indonesia, Thailand and the Philippines [3, 4]. It has also been found in Borneo (Joseph K.H. Koh, pers. comm.).

It is evident from the literature that _N. antipodiana_ is a variable species [1, 3-5]. In the Philippines the dorsal colour of the abdomen (opisthosoma) in the female is yellow, with six pairs of subovate yellow spots dorsally arranged longitudinally in rows, each spot with a thin black margin [4]. The abdomen of the female spider in Australasia is pale yellow, with darker markings on anterior and posterior margins, and without large yellow spots [5]. In Singapore the dorsal colour of the abdomen may be yellowish green [3] or reddish brown [1] with yellow spots.

Although abdominal (opisthosomal) colour variation occurs in the species, as evidenced in the different colour morphs, there is no report on polymorphism. We report here the occurrence of polymorphism in the dorsal abdominal colour of adult female *N. antipodiana* in Peninsular Malaysia.

MATERIALS AND METHODS

A field survey of _N. antipodiana_ was carried out from 12-15 February 2010 in Kelantan and Terengganu, Peninsular Malaysia. The dorsal colour (yellow, greenish-yellow, and reddish-brown) of the abdomen of every adult female spider in a chosen locality was recorded. The number of juvenile and associated male individuals was also recorded. Five localities were studied – four in Kelantan (Pantai Melawi and Sungai Dua in Bachok, Tok Bok in Machang, and Gua Musang highway) and one in Terengganu (Lata Belatan). Pantai Melawi consisted of eight patches which were separated although not far from each other.

Bachok is situated near the coast, with typical Malay village setting. Both Machang and Gua Musang are in the interior. Lata Belatan is a forest
recreation park – the study was carried out along the road bordered by plantation.

Representative specimens were collected and preserved in ethanol. Photographs were also taken of the various colour morphs and life stages.

RESULTS

Three principal abdominal colour morphs – yellow (Figs. 1, 2), greenish yellow (Fig. 3) and reddish brown (Fig. 4) – were observed in the adult female *N. antipodiana*. Their occurrence and abundance in four localities in Kelantan and one in Terengganu are summarized in Table 1. The juveniles (Fig. 5) and males were not included as the former had different colour pattern and the male did not show colour variation.

The yellow morph was present in all the five localities. Of the other two morphs, the greenish-yellow morph was found only in Kelantan while the reddish-brown morph was observed in Lata Belatan, Terengganu. The frequency of the yellow morph ranged from 7.69% in Sungai Dua, Bachok to 25.71% in Lata Belatan, Terengganu (Table 1).

DISCUSSION

Colour and pattern variation in spiders has been widely investigated [6]. To-date three major classes of pigments – ommochromes (yellow, red, brown), bilins (blue, green) and guanine (white, silver) – have been identified. The earlier work before 1998 on the evolution and ecology of spider colouration has been well reviewed [6]. Although polymorphisms have been reported for a number of species, the genetic bases have generally not been elucidated. In general, sex linkage appears to be absent but sex limitation is quite common. It is acknowledged that the manifestation of spider colouration is very complex, involving a host of possible factors. Various functions have been suggested – cryptic/disruptive, mimetic and aposematic as well as thermoregulatory.

The Hawaiian happy-face spider, *Theridion grallator* Simon (Therididae) provided the most spectacular example of colour polymorphism in spiders. In this spider, the opisthosomal colour may be controlled by simple Mendelian alleles at a single autosomal locus or multiple closely linked loci. The plain yellow morph is recessive to the other colour morphs [7, 8]. More recently, another species *Theridion californicum* Banks has been found to exhibit an equally extraordinary visible colour and pattern polymorphism [9]. The polymorphism comprises one common morph (Yellow) and at least ten relatively rare patterned morphs, with Yellow probably recessive to all other morphs.

In the present study, the yellow morph of female *N. antipodiana* occurred in all the localities investigated (Table 1). Lata Belatan had the highest percentage (25.71%). This locality had denser vegetation, being in a plantation area. In Gua Musang highway, an open area, the percentage was 16.98%. Although it has been suggested that yellow colour is most cryptic in the below-leaf environment and hence selected for

<table>
<thead>
<tr>
<th>Locality</th>
<th>Greenish Yellow</th>
<th>Yellow</th>
<th>Reddish Brown</th>
<th>% Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachok: Pantai Melawi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 outside chalet</td>
<td>2</td>
<td>2</td>
<td></td>
<td>50.00</td>
</tr>
<tr>
<td>2 coconut palms</td>
<td>28</td>
<td>3</td>
<td></td>
<td>9.68</td>
</tr>
<tr>
<td>3 house compound</td>
<td>39</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>4 waste land</td>
<td>18</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>5 coconut palms</td>
<td>26</td>
<td>1</td>
<td></td>
<td>3.70</td>
</tr>
<tr>
<td>6 <em>Hibiscus tiliaceus</em></td>
<td>33</td>
<td>5</td>
<td></td>
<td>13.16</td>
</tr>
<tr>
<td>7 coconut palms</td>
<td>8</td>
<td>6</td>
<td></td>
<td>42.86</td>
</tr>
<tr>
<td>8 open space</td>
<td>7</td>
<td>2</td>
<td></td>
<td>22.22</td>
</tr>
<tr>
<td>Total (1 – 8)</td>
<td>161</td>
<td>19</td>
<td></td>
<td>10.56</td>
</tr>
<tr>
<td>Bachok: Sungai Dua</td>
<td>24</td>
<td>2</td>
<td></td>
<td>7.69</td>
</tr>
<tr>
<td>Machang: Tok Bok</td>
<td>82</td>
<td>10</td>
<td></td>
<td>10.87</td>
</tr>
<tr>
<td>Gua Musang: highway</td>
<td>44</td>
<td>9</td>
<td></td>
<td>16.98</td>
</tr>
<tr>
<td>Terengganu: Lata Belatan</td>
<td>27</td>
<td>78</td>
<td></td>
<td>25.71</td>
</tr>
</tbody>
</table>
[9], the present study does not show unequivocally the association of colouration with habitat usage. Whether yellow colour in \textit{N. antipodiana} confers a selective advantage remains to be verified. In Pantai Melawi with a mixture of micro-habitats, the percentage of yellow morph ranged from 9.68\% to 42.86\% in patches with coconut palms while in an open space it was 22.22\% in contrast to 13.16\% in an area with \textit{Hibiscus tiliaceus} (Table 1).

It is noteworthy that in the present study only two colour morphs appear to be present in a particular locality (Table 1). Of the two non-yellow morphs, the reddish-brown morph was found only in one locality (Lata Belatan) whereas the greenish-yellow morph...
was more widespread. The reddish-brown morph was found in Teluk Chempedak, Pahang where *N. antipodiana* was first reported for Peninsular Malaysia [1]. In this locality, a yellow individual had been observed in the hill forest (H. S. Yong, unpublished information). At the University of Malaya, a single individual of the greenish morph had been found among ornamental palms (H. S. Yong, personal observation). The significance of the presence of only a single non-yellow morph in a particular locality remains to be elucidated.

In addition to opisthosomal colour polymorphism, the colour and number of spots (or sigillae) on the dorsal surface of the abdomen of *N. antipodiana* are also variable. The dorsum may be marked with spots or sigillae. In the Philippines, the yellow morph has six pairs of subovate yellow spots, each with a thin black margin [4]. In Australasia, the dorsal surface has four pairs of sigillae [5]. The yellow morph in the present study (Peninsular Malaysia) is characterized by five pairs of yellow spots/sigillae, each well defined by black margin. There may also be a sigilla/spot situated at the middle of the dorsal surface (Fig. 1).

The yellow morph of *N. antipodiana* in general appears to possess fewer spots than the non-yellow morphs. In the present study, the yellow morph had five pairs of spots/sigillae. On the other hand, the greenish-yellow and reddish-brown morphs had nine pairs of spots which were variable in size. Another difference is the spots in the yellow morph tended to assume the appearance of sigillae – depression at least at the posterior part of the spot. The intensity and dimension of the black outline are also variable. Spots in the greenish-yellow and reddish-brown morphs are not marked by black outline.

In sum, *N. antipodiana* is highly variable in colouration and pattern/marking. Cursory observations indicate the presence of other colour morphs. Detailed studies are needed to elucidate the ontogeny of colour and pattern development, and the function and mechanism of the variation and polymorphism. *N. antipodiana* could be an excellent model for evolutionary and ecological studies.

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REFERENCES