Problems in *Chlorocypha* classification: four cases from West Africa and a discussion of the taxonomic pitfalls (Odonata: Chlorocyphidae)

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Abstract

The taxonomy of *Chlorocypha* species is problematic due to variability and the paucity of morphological characters. Subspecies *radix* of *C. glauca* is raised to specific rank. *C. sharpae* is found to be a synonym of *C. luminosa*. The synonymy of *C. jejuna* with *C. luminosa* is rejected. The former species is similar to the Southern African *C. consula* and differences are stated. *C. dispar ovulosa*, *Libellago dispar fraseri* and *C. mutans* are synonyms of *C. pyriformosa*, although the lost type series of *fraseri* appears to have contained immature specimens of *C. dispar*. Trends in African chlorocyphid variation, subsequent taxonomic pitfalls and suggested guidelines to deal with them are discussed. The main problems are age and environment related melanization intensity, dark patterns caused by reversible temperature-induced colour change, especially in terenals, and the switch between reddish and bluish colours in species with bicoloured abdomens.

Introduction

Species limits are notoriously difficult to define in the genus *Chlorocypha* Fraser, 1928. Structural distinctions are very limited and taxonomy is based largely on colour patterns. The latter is complicated by strong variation in melanization, related to age and environment, an issue many authors have called to mind (e.g. Longfield 1959; Pinhey 1967; Cammaerts 1978; Legrand & Couturier 1985) and that led Fraser (1949) to remark that “there is good evidence that these wide changes in colour and markings have been responsible for the same species being described under several names”. In the course of identifying material from Ghana, several new and incorrect synonymies were encountered. It proved necessary to review the status of the Upper Guinean relatives of *C. glauca* (Selys, 1879) once more, despite (but thanks to) the efforts of Lietinck (1973) and Gambles (1975). The paper concludes with a discussion of the taxonomic treatment
of variation and its pitfalls, as applied to chlorocyphid taxonomy in particular, and to Odontota taxonomy in general.

The following abbreviations for collections are used: BMNH – Natural History Museum, formerly British Museum (Natural History), London; MNH – Muséum National d’Histoire Naturelle, Paris; RMNH – Nationaal Natuurhistorisch Museum Naturalis, formerly Rijksmuseum voor Natuurlijke Historie, Leiden; USNM – National Museum of Natural History (Smithsonian Institution), Washington; ZMB – Museum für Naturkunde, Humboldt-Universität zu Berlin.

**Chlorocypha radix** Longfield, 1959 **stat. nov.**
(Figs 1K-M, 3A)

*Chlorocypha glauca radix* Longfield, 1959: 28 [type: Ado Ekiti, Nigeria; BMNH].
*Chlorocypha pavo* Lief tinck, label name; nomen nudum.
*Chlorocypha pavo* Lief tinck, 1973: 34 [type: Bismarckburg, German Togo; ZMB]; new synonymy.

**Specimens studied**


Numerous δ from Ghana (including four paratypes of *radix*), Liberia, Nigeria (including eight paratypes of *radix*) and Sierra Leone (one paratype of *radix*), and one with labels "Chl. glauca radix locality label wrong? det. R.M. Gambl. 1971." and "C. glauca (Selys) Cameroons, Bipindi, 14.viii.31. [Fraser’s hand-writing]" (in BMNH, RMNH and coll. J. Lemper). Additional taxa studied for reference were *aphrodite* (seven δ from Uele: Bambasa, Belgian Congo), *glauca* (two paratype δ from Mongoma Lobah, Cameroon, two δ from near Mambi, Cameroon and three δ from Budo, Belgian Congo) and *sydela* (four paratype δ from Luulala: Kabongo, Belgian Congo, and one δ from same locality) (all in BMNH).

Discussion

*C. glauca* was described from the highlands of Cameroon and Longfield (1959) described *radix* as a lowland subspecies of it occurring in Sierra Leone, Ghana and Nigeria. Lieftink (1973) examined *glauca* specimens reported as *rubida* by Karsch (1891; 1893) from Cameroon and German Togo. Realising they were distinct, he described the Togo specimen as *pavonis*, suggesting the type series of *radix* might include his new species. Gambles (1975) compared the type material of *glauca* and *radix* thoroughly, noting in the postscript that *radix* and *pavonis* were indeed the same. *Pavonis* was simply sunk into synonymy with the subspecies *radix* of *glauca* (e.g. Gambles 1980; Bridges 1994), disregarding Lieftink’s conclusion that it was specifically distinct from *glauca*.

Pinhey (1967) established the Glaucia-group of Chlorocypha, which includes all species with the abdomen partly blue. This heterogeneous assemblage holds entirely blue, red-based and red-tipped species. Within this group, *glauca* and *radix* appear to be closely related to *C. aphrodite* le Roi, 1915 and C. *seydeli* Fraser, 1958 (Figs 3A-D). All are rather large species (Hw 22-25 mm), with blue-based abdomens and similar synthoracic and abdominal markings. A comparison of the four reveals that all are about equally distinct (Table 1).

<table>
<thead>
<tr>
<th>Species</th>
<th>Distribution</th>
<th>Aphrodite</th>
<th>Seydeli</th>
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<tr>
<td>Radix</td>
<td>Sierra Leone to S Nigeria</td>
<td>East Nigeria to W of Congo Basin</td>
<td>Most of Congo Basin</td>
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**Libellago luminosa** Karsch, 1893: [type: Bismarckburg, German Togo; ZMB].
**Chlorocypha dispar luminosa** (Karsch). — Fraser (1947: 23).
**Chlorocypha luminosa** (Karsch). — Fraser (1947: 37).
**Chlorocypha sharpeae** Pinhey, 1972: [type: Mt. Coffee, Liberia; USNM]; new synonym.

**Specimens studied**


Discussion

Karsch (1893) reported five *Libellago* (now Chlorocypha) species from German Togo. Although he used different names, they are identifiable from his descriptions and drawings as *C. curta* (Selys, 1853), *C. dispar* (Beauvois, 1805), *C. luminosa*, *C. radix* (see above) and *C. selysi* (Karsch, 1899). My material from the area, nowadays in the Volta Region of Ghana, contains the same quintet. The *luminosa* specimens perfectly fit Karsch’s description and drawings. This species has remained obscure and unrecorded.
since its description, because of confusion with C. consueta (Karsch, 1899) and C. dispar. Fraser (1947) made luminosa one of several ill-defined subspecies of dispar, but later Fraser (1949) went on to regard it a distinct species with consueta as a synonym. Schmidt (1951) maintained luminosa as a subspecies of dispar, repeating Fraser’s characters, but also provided excellent drawings of a luminosa type, which he regarded as “nicht völlig ausgefärbtes” male of Fraser’s subspecies. Pinhey (1967) clarified the mix-up, showing consueta, dispar and luminosa were all distinct, and stating the unique characters of the latter. He went on to describe sharpea five years later.

Comparison of the lectotype and paralectotype of luminosa with Pinhey’s detailed description and topotypical material of sharpea shows no marked differences. The abdomen has characteristic black markings: S3 is marked with a thick, inverted U, S4-6 have an apical black cross-bar. Dark specimens have a thin or incomplete U on S4 and an apical bar on S7 too. These markings are already recognisable in the tergal state. The markings on the head, synthorax and legs are yellow (the latter white in other species). The wings are conspicuously all-yellow, instead of hyaline, a feature repeatedly stressed by Karsch (1893, 1899) and Pinhey (1967). The type material of both taxa was probably interpreted as being discoloured or immature, as their descriptions assumed they were red in life. This might explain the origin of all the confusion. Pinhey (1972) remarks, rather cryptically, that “the brownish yellow abdominal colour appears superficially to be of a pale red colour.” In fact, the mature adult differs from the modus in the genus in having an orange, not red, abdomen in life (own observations; Legrand 1985; Lempert 1988). When treated with acetone, the abdomen may become a bit reddish, especially ventrally. As luminosa and sharpea agree in all characters, they are regarded synonymous.

C. luminosa has been reported (as sharpea) from Guinea and Liberia (Pinhey 1972; Legrand 1985; Lempert 1988). It is found throughout Southern Ghana, occurring close to the Ivorian and Togolese borders (K.D.B. Dijkstra & H.A. Olsvik unpublished). Records from in-between Côte d’Ivoire are still wanting. Gamble (1980) listed consueta for Nigeria, remarking “= luminosa of authors, not of Karsch 1893,” which seems to preclude the presence of luminosa in that country, and no specimens by that name were found in the BMNH where Gamble’s collection is housed. The species has a typical Upper Guinean distribution. It inhabits large streams and small rivers in Ghana, but was reported from larger rivers in Liberia (Lempert 1988).

**Chlorocypha jejuna** (Baumann, 1898)
(Figs 1N, 3J)

Libellago jejuna Baumann, 1898: 345 [type: Misähöhe, Togo; ZMB].
Libellago luminosa Karsch. — Fraser (1949: 20, 37); suggested synonymy.

**Specimens studied**

Holotype δ jejuna – with labels: blue, printed “Togo, Misähöhe, 1895, E. Baumann S.”; white, hand-written “Misähöhe, 11.V.95, Baumann”; red, printed “Typus”; white, hand-written “Libellago jejuna” (1898), E. Baumann” (in ZMB).

**Discussion**

*C. jejuna* was described by Baumann (1898) from a single male, which can thus be regarded as the holotype. It was said to be closest to *C. luminosa*, described from a locality only some 150 km away. The species and *C. consueta* were synonymized with *C. luminosa* by Fraser (1949). When Pinhey (1967) separated *consueta* again, *jejuna* was left in synonymy with *luminosa*. Because of the confusion surrounding *C. luminosa* described above, this synonymy demands a reassessment. Both Fraser (1949) and Schmidt (1951) believed the holotype is immature (“ein noch jüngeres Stadium” than *luminosa* according to the latter author), despite the fact that Baumann (1898) said it was “ein ausgefärbtes Männchen”.

The holotype is in fact fully mature, with dark brown pterostigmata and a clearly red abdomen. The thoracic and abdominal markings, as illustrated excellently by Schmidt (1951), are unlike those in *luminosa* (these markings are already distinct in the tergal state of that species), as are the red abdomen and the yellow restricted to the wing bases. Synonymy with that species can thus be ruled out.

The *C. jejuna* holotype is actually remarkably similar to the third party in the historic confusion, *C. consueta* (Fig. 1K). One year after the description of *C. jejuna*, *C. consueta* was described from Southern Tanzania, from where it ranges West into Angola and South to South Africa. Both share the large size (Hw 24 mm in *jejuna*; 23–25 mm in *consueta*) and the broad red abdomen with restricted black markings and both have a black head with a similar pattern of brown blotches. Unlike typical *consueta* the black markings on S2 are not complete from base to apex, but are separated subbasally. The extent of anterior white on the tibiae (35%, 55% and 100% of the length of the fore, mid and hind tibiae respectively) may fall within the variation of *consueta* (30–60%, 65–100% and 100% in six specimens examined). *C. consueta* has a complete broad black band below the humeral suture, even when tergial, whereas only the anterior portion of this marking is present in the *jejuna* holotype.

No conclusion can be drawn about these two taxa with only a single specimen of one of them available. Pinhey (1967) states that *consueta* also occurs in “Southern Nigeria, Togoland (overlapping with *luminosa*”). Gamble (1980) listed *consueta* for Nigeria, and his remark “= luminosa of authors, not of Karsch 1893” suggests that he specifically meant this species, despite the resulting gap in distribution of more than 2000 km. There are no Nigerian specimens of *consueta* in the BMNH, where Gamble’s collection is housed, and the species is also not mentioned in the unpublished manuscript of his “The Nigerian dragonflies”. Neither author says what the source of the West African records is. Following all the confusion, they might be based purely on misinterpretation. Perhaps they are *jejuna*, but for now all that can be done is to make that name available for future revision by revoking the incorrect synonymy with *luminosa*.

**Chlorocypha pyriformosa** Fraser, 1947 stat. nov.
(Figs 1O-P, 2, 3Q)

Chlorocypha dispar pyriformosa Fraser, 1947: 23 [type: Ivory Coast; BMNH].
Chlorocypha dispar ovalosa Fraser, 1947: 23 [type: Old Calabar; BMNH]; simultaneously introduced; relative precedence of *pyriformosa* defined by present act as first revisor.
since its description, because of confusion with C. consueta (Karsch, 1899) and C. dispar. Fraser (1947) made luminosa one of several ill-defined subspecies of dispar, but later Fraser (1949) went on to regard it a distinct species with consueta as a synonym. Schmidt (1951) maintained luminosa as a subspecies of dispar, repeating Fraser’s characters, but also provided excellent drawings of a luminosa type, which he regarded as “nicht völlig ausgefärbter” male of Fraser’s subspecies. Pinhey (1967) clarified the mix-up, showing consueta, dispar and luminosa were all distinct, and stating the unique characters of the latter. He went on to describe sharpea five years later.

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**Specimens studied**

Holotype & jejuna – with labels: blue, printed “Togo, Misahöhe, 1895, E. Baumann S.”; white, hand-written “Misahöhe, 11.V.95, Baumann”; red, printed “Typus”; white, hand-written “Libellago jejuna” (1898), E. Baumann” (in ZMB).

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No conclusion can be drawn about these two taxa with only a single specimen of one of them available. Pinhey (1967) states that consueta also occurs in “Southern Nigeria, Togoland (overlapping with luminosa)”. Gambles (1980) listed consueta for Nigeria, and his remark “luminosa of authors, not of Karsch 1893” suggests he specifically meant this species, despite the resulting gap in distribution of more than 2000 km. There are no Nigerian specimens of consueta in the BMNH, where Gambles’ collection is housed, and the species is also not mentioned in the unpublished manuscript of his “The Nigerian dragonflies”. Neither author says what the source of the West African records is. Following all the confusion, they might be based purely on misinterpretation. Perhaps they are jejuna, but for now all that can be done is to make that name available for future revision by revoking the incorrect synonymy with luminosa.

**Chlorocypha pyriformosa** Fraser, 1947 stat. nov.
(Figs 1O-P, 2, 3G)

*Chlorocypha dispar pyriformosa* Fraser, 1947: 23 [type: Ivory Coast; BMNH].
*Chlorocypha dispar ovulosa* Fraser, 1947: 23 [type: Old Calabar; BMNH]; simultaneously introduced; relative precedence of pyriformosa defined by present act as first revisor.
**Chlorocypha classification**

*Libellago dispar fraseri* Schmidt, 1951: 161 [syntypes: Boé, Portuguese Guinea; δ fig. 19c (p. 164) is designated here as lectotype]; new synonymy.

*Libellago mutans* Martin, label name. — Legrand & Couturier (1985: 144); nomen nudum.

*Chlorocypha mutans* Legrand & Couturier, 1985: 144 [type: Côte d’Ivoire; MNHN]; new synonymy.

**Specimens studied**


**Discussion**

Legrand & Couturier (1985) described *C. mutans* as a doppelganger of *C. dispar* that differs ecologically, *mutans* being found on rivers and *dispar* on streams. *Mutans* is smaller and differs in the distribution of white markings on the legs and more extensive and differently shaped black markings on the abdomen. Furthermore, in *mutans* the white line of the middorsal carina is much broader than in *dispar*. Before the description of *mutans*, five names have been linked as subspecies to *dispar*. Because of the similarity between the aforementioned species, it seems sensible to examine their identity. In a brief and rather messy discussion of variation in *dispar*, Fraser (1947) introduces four of these combinations. The history of *luminosa* is discussed above. Of three new names introduced by Fraser, a type was only designated for *C. cordosa* Fraser, 1947. This was found to be synonymous with *C. cyanifrons* (Selys, 1873) by Pinhey (1962, 1967).

*Pyriformosa* was based on a series of seven males and 11 females collected in the ‘Réserve forestière du Banco’ near Abidjan, South-eastern Côte d’Ivoire, by R. Paulian between 1941 and 1946. A male and a female were found under *C. dispar* in the BMNH, both labelled “Ivory Coast 22.vii.44 R. Paulian”, as well as four males of unspecified origin that may also have belonged to the series. Paulian was associated with the MNHN, but no material of the collection treated by Fraser (1947) has been found there (J. Legrand pers. comm.). As described by Fraser (1947), in *dispar* “the red dorsal spot on segment 2 occupies the middle two-fourths of the segment and is oval in shape” whereas in *pyriformosa* “this spot is much larger, extending the whole length of the segment and [is] bilobate in shape, one lobe occupying the basal three-fourths of the segment, the other, very much smaller and narrower, is a mere stalk connecting the larger lobe to the apical border of the segment.” Furthermore he states that “segments 4 and 5 have a pair of black apical spots confluent to the apical black ring, whilst segment 6 has a vestige
of this marking”. The single Paulian male demonstrates these distinctions, and was therefore selected as the lectotype of pyriformosa. Fraser’s description and illustration conform with the abdominal differences between dispar and mutans described by Legrand & Couturier (1985). Moreover, the pyriformosa lectotype agrees with mutans in its relatively small size, leg coloration and broad white lining of the middorsal carina. As pyriformosa and mutans are identical in all characters, they are regarded synonymous.

Fraser (1947) adds that “in the McLachlan collection, a male from Old Calabar [south-eastern Nigeria] is closely similar to these Ivory Coast specimens [pyriformosa] in possessing a red oval dorsal spot on segment 2, but it is unibolute and regularly oval in shape.” He names this taxon ovulosa. In the BMNH I found two males from Old Calabar originating from the McLaclhan collection, which agree in all aspects with the pyriformosa lectotype. The most complete specimen is designated as the lectotype of ovulosa. Both names are introduced on the same page, but because the pyriformosa description is more extensive and ovulosa is only characterized in comparison with pyriformosa, I give pyriformosa priority and regard ovulosa as a synonym of it.

Schmidt (1951) recognizes four so-called “geographisch geschiedene Formen” of C. dispar, but ignores pyriformosa and ovulosa. Two of the four ‘forms’ were later regarded distinct species (Figs 3F-I): C. luminosa (see above) under that name, and the subspecies cordosa (sensu Schmidt 1951, nec Fraser 1947) as C. schmidt Pinhey, 1967. The other two are nomenotypic dispar and Schmidt’s subspecies fraseri. The latter was based on a series of 25 males and 10 females from Boé in present-day Guinea-Bissau. Fraser differed from dispar in details of the black markings on the abdomen, and in its smaller size. S2-3 of fraseri are similar to the condition of pyriformosa, but S4-6 are not so extensively black. Schmidt did not mention that the middorsal carina was broadly white-lined, although this is apparent in his figure 19c (Fig. 2). He describes the distribution of white on the legs as follows: “Die adulten Männchen haben die Beine schwarz. Vorderschenien basales Drittel innen gelblichweiss, Mittelschenien basale Hälfte und Hinterschenien innen ganz weiss.” Whereas the other character states given for fraseri suggest pyriformosa, this is the character state of dispar. The origin of this conflicting information may be sought in Schmidt’s remark: “In der Serie sind neben den meisten Adulten einige nicht völlig ausgefärbte Stücke, … Bei den adulten Männchen der Boé-Serie ist die Zeichnung der Abdomenbasis auffallend konstant, auch bei den anderen Untertypen nach unserem Material, sodass diese als gut begründet angesehen werden: Variationen der Boé-Serie Männchen führen wir, wie oben erwähnt, auf Ausfärbung zurück.” Schmidt depicts an abdomen (fig. 18f) and two synthoraces (figs 19a-b) of such ‘not fully coloured’ specimens. The abdomen may have belonged either to dispar or pyriformosa, as the markings are not yet fully developed in teneral. One of the synthoraces shows only narrow white lining of the middorsal carina (Fig. 2), suggesting the series contained immature specimens of dispar. From Schmidt’s remarks and illustrations it seems that his series included both dispar and pyriformosa. Schmidt did not designate a holotype and unfortunately his entire series appears to be lost. It has not been found in the museum in La Chaux-de-Fonds, where Schmidt indicates it was. Possibly the material was lost when the collection was attacked by pests in the 1960s (M. Jacquet pers. comm.). Pinhey (1962) states (probably by default) the holotype is in the Schmidt collection, but no specimens of the series could be found there (M. Tomokuni pers. comm.). It seems best to designate the specimen in figure 19c of Schmidt (1951: 164) as the lectotype of fraseri, because this clearly depicts a reliable feature, and to place it into synonymy with pyriformosa.

As is obvious from the obscurity of the names pyriformosa, ovulosa and fraseri, as well as the late description of mutans, this species has been much confused with dispar (see also next paragraph). Legrand & Couturier (1985) give a good summary of the distinguishing characters. Having seen many males from across West Africa, I can add the following about their reliability: specimens of pyriformosa among those of dispar can be picked out by their smaller size (Hw 18-19 mm in pyriformosa; 20-21 mm in dispar), the relatively short abdomen of pyriformosa reinforces this distinction. The extent of black markings on the abdomen is very variable in both species, though greater on average in pyriformosa. The shape of the red mark on S2 seems to be the most reliable difference. The mark is long and entire in pyriformosa (“tête de loup” of Legrand & Couturier), short and normally severed longitudinally by a black line in dispar (“grain de café”). The red marking on S3 is, on the other hand, normally more extensive in dispar, usually expanded across the full breadth of the segment, a condition I have only seen in one very pale male of pyriformosa. Mature males, with an all black synthorax, of pyriformosa always retain some white along the middorsal carina, although this can be extremely thin. The most reliable character is the leg markings: in pyriformosa the fore tibiae are all black, while the anterior side of the mid and hind tibiae are entirely white, whereas in dispar the anterior sides are respectively about one-, two- and three-thirds white.

Besides South-eastern Côte d’Ivoire, South-eastern Nigeria and Guinea-Bissau, C. pyriformosa has been reported (as mutans) from Guinea, Liberia and South-western Côte d’Ivoire where it inhabits larger rivers (Legrand & Couturier 1985; Lempert 1988). K.-D.B. Dijkstra & H. Olsvik (unpubl.) report the species from two Ghanian rivers, near the Ivorian and Togolese borders. A specimen published as C. neptunus (Sjöstedt, 1899) from Sierra Leone by Carli & D’Andrea (1994) was re-examined and found to be pyriformosa. The locality there, a river, conforms with its known habitat. Among material placed under C. dispar (some labelled “very dark”) by R.M. Gambles in the BMNH were further one male from Sierra Leone and seven more from Nigeria (from Sapoba Forest Reserve, Sobo Plain and Port Harcourt). S. Tchibozo sent me a single male from Lokoli Forest in South Benin (in RMNH).

**General discussion**

Fraser (1949) already complained that “whilst the comparatively simple colouring and markings of the body and the invariable nature of the colouring and markings of the wings in most genera of the family Chlorocycloidae render the task of identification of the species a matter of simplicity, it is far otherwise in the case of the genus Chlorocypha.” The four cases discussed above illustrate these problems. They came to light while investigating the species of a rather small part of West Africa. It may therefore be expected that many more problems remain, especially in Central Africa where the ranges of many
(so-called) species may be expected to meet and where the available material is fragmentary. In particular the Rubida-group of Pinhey (1967) is potentially problematic. This group is rich in species that differ principally in details of black abdominal markings and colour-patterns on the face. The latter factor at least is partially age-dependent. The overall complexity of African chlorocyphid taxonomy can be brought back to two factors:

1. General absence of structural characters.
2. Great age- and environment-related variation, especially in melanization and size.

The first factor is typical of taxa that use visual, instead of tactile, cues as the principal means to recognize conspecifics. The second factor plagues all odonate taxonomy, and is discussed in more detail below.

**Change of colours and markings with age and temperature**

Fraser (1949) continues that "quite often the teneral or subadult state is entirely different from the adult .... a number of teneral forms have been described as new species and thus synonymy has grown which is extremely difficult to check without the availability of long series of each of the species involved." In many Chlorocypha species, but not all, the pale markings on the head and synthorax become obliterated by black with increasing age. *C. dispar* and *C. luminosa*, for instance, have a virtually identical sharply-marked black and yellow synthorax when teneral. That of *dispar* becomes entirely black with age, while *luminosa* does not blacken at all. Degrees of blackening may also vary between parts of the body. Some species of Chlorocypha retain brightly coloured markings in the face, apparently with a signalling function, while other markings darken. Abdominal melanization may also be less extensive in tenerals.

Teneral specimens lack the bright colours of adults, their abdomens tending to be yellowish and often partially darkened. The darkened areas can be of a colour completely unlike that of the adult (e.g. blue-grey in red species) and contrast with paler parts, creating patterns not seen in mature specimens. This phenomenon is probably physiologically similar to so-called Reversible Temperature-Induced Colour Change (RTCC). Such colour-changes have been observed in numerous odonate species (Corbet 1999: 280, 638), and is described for *C. trifaria* (Karsch, 1899) by Miller (1993). He observed that bright red turns to dark grey when specimens are cooled below 25°C. Possibly the darkening of tenerals results from them exposing themselves less to sun, or having recently emerged from relatively cool water. The most dramatic colour changes occur in *Africocypha lacuselephantum* (Karsch, 1899) and are still not fully understood (Pinhey 1971). Teneral females are almost entirely orange, and become black with blue dorsal abdominal spots. Males also start off largely orange, blacken and develop various combinations of orange, red and blue dorsal spots. As has been suggested by Corbet (1999: 280) these changes may partly reflect RTCC, though increasing melanization is interwoven into the complexity.

As is apparent from the above, extreme caution must be taken when identifying immature specimens, especially as RTCC-related darkening is retained by preserved specimens (Miller 1993; K.-D.B. Dijkstra pers. obs.). It must be noted that if adults collected are allowed to cool before they die, they will be preserved with a darkened abdomen, especially on the central segments.

**Chlorocypha classification**

**Melanization variation: intensity versus configuration**

In Odonata the most obvious manifestation of melanization, the presence of melanin, is black markings. Blacker specimens also tend to have more deeply and extensively coloured wings. Melanization intensity can be defined as the extent of black markings, and is often under the influence of age (see above) and environment. Black pigment appears to become more extensive with increasing humidity and shading (e.g. savannah vs forest), at least in these tropical zygopterans. Intensity variation in chlorocyphids can be most easily recognised by the extent of the paired (sub)apical markings on the segments, the so-called "hynps" (small markings not touching the posterior border of the segment) and "bolllards" (large markings fused with the border) of Pinhey (1967).

Due to the problems of intensity variation of black markings, it is only their configuration that is taxonomically informative. Configuration can be defined as variation in markings between species that is not positively correlated with overall variation of their intensity, i.e. variation trends that are inverse to or independent of intensity trends. Such trends result in the unexpected expression (presence, shape) of black markings if intensity was the only predictor. An example of an inverse trend between species is the reduced extent of black bolllards on S3-5 of *C. glauca* compared with *C. radix*, while the synthorax is relatively dark. Similarly, *C. dispar* has more black than *C. pyriformal* on the synthorax, mid tibiae and S2, with the reverse on the fore tibiae and S3-6.

Odonate taxonomy counts numerous examples of taxa, especially subspecies, based solely on intensity of melanization (e.g. Dijkstra & Dingemans 2000). Such taxa are superfluous, as purely phenotypic factors can not be ruled out as the only cause of their distinctiveness. Moreover this distinctiveness can often be questioned, considering the fragmentary nature of material available for descriptions. An example of such a subspecies in Chlorocyphidae is *C. selysi nigeriensis* Gamble, 1975. This name was given to Nigerian specimens that were much paler than those of the nominotypical subspecies in adjoining Cameroon. In the same paper Gamble described *Pseudagron gjosedti nigeriens*, a member of the notoriously variable 'group B' (Pinhey 1964) of the genus. Again the Nigerian taxon is much paler than the nominotypical subspecies from Cameroon. Specimens of both species from Ghana are intermediate between the examples from Nigeria and Cameroon, and this pattern appears to be simply environmentally induced.

The 'intensity vs configuration' guideline can be difficult and subjective in its use, but it does offer a degree of objectivity in evaluating taxa where more qualitative characters, such as morphological differences in the genitalia, are lacking. This rule has here been applied to regard one taxon as specifically distinct from its closest relatives, and to render several others synonyms. It must be noted that this account, and chlorocyphid classification in general, is based entirely on characters of the males. Females lack the bright colour patterns of the males (with the mentioned exception of *A. lacuselephantum*), being brown with extensive black markings. These patterns are susceptible to strong variation too, but may differ in configuration as well.
Reds and blues: a quick switch?

Another trend is found in those *Chlorocypha* species with a bicoloured abdomen (Figs 3A-C, 4). Here the basal four to six segments are of a different colour from the remaining segments, the two opposing colours being shades of blue and red respectively. In some species there is polymorphism regarding the point of this colour-switch, and in preserved specimens the transition can be vague. This variation is summarized in Table 2. The partly sympatric *C. cancellata* (Selys, 1879) and *C. hintzi* (Grinberg, 1914) are listed as one species, as they only differ in the colour of S6 and Pinhey (1967) remarks that “it is probable that the two species ... are colour variants of the same species (vide *C. glauca* and *C. curta*).” It can be noted from the Table that the switch takes place on S5 in blue-based species, and S6 in red-based ones. Furthermore, the form in which the ‘switch-segment’ takes the colour of the basal segments seems to be the commoner one.

![Figure 4. Dorsal views of abdomens of bicoloured Chlorocypha and Platycypha species — C. hintzi (A), common variety of *C. curta* (B), *P. ruftibia lacilloenasis* Pinhey (C), *P. pinheyi Fraser* (D), *P. amboniensis* (E), pale (F) and very dark (G) examples of *P. caligata f. lacus*. Dotted areas are reddish, undotted blue.](image)

**Table 2.** The distribution of colour on abdominal segments of bicoloured *Chlorocypha* species, following Legrand (1984) and Pinhey (1967). In polymorphic species the variety that appears to be rarer is bracketed. Species are sorted according to colour pattern.

<table>
<thead>
<tr>
<th></th>
<th>S1-4</th>
<th>S5</th>
<th>S6</th>
<th>S7-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>seymeli</td>
<td>blue</td>
<td>blue</td>
<td>red</td>
<td>red</td>
</tr>
<tr>
<td>glauca</td>
<td>blue</td>
<td>blue (red)</td>
<td>red</td>
<td>red</td>
</tr>
<tr>
<td>radix</td>
<td>blue</td>
<td>red</td>
<td>red</td>
<td>red</td>
</tr>
<tr>
<td>curta</td>
<td>red</td>
<td>red</td>
<td>red (blue)</td>
<td>blue</td>
</tr>
<tr>
<td>helenae</td>
<td>red</td>
<td>red</td>
<td>blue</td>
<td>blue</td>
</tr>
<tr>
<td>cancellata (hintzi)</td>
<td>reddish</td>
<td>reddish</td>
<td>reddish (dark blue)</td>
<td>dark blue</td>
</tr>
</tbody>
</table>

This two-tone variation also occurs in the related genus *Platycypha*, in which several red-based, blue-tipped species are known (Figs 4C-G). Here variation between species is much greater, there being species with as few as four — *P. amboniensis* (Martin, 1915) — and as many as seven basal segments reddish — *P. ruftibia* (Pinhey, 1961) —, while the variation appears to be absent within species. Bicoloured species may be very closely related to all-blue or all-red species. *Platycypha* includes all-red — *P. auripes* (Forster, 1906) — and all-blue species — *P. caligata* (Selys, 1853) —. The all-blue *C. aphrodite* has already been placed close to three red-tipped species, especially *C. seymeli*. *C. wittei* Fraser, 1955, from Shaba and adjacent Angola and Zambia, appears rather like an all-red form of the widespread *C. curta* (Figs 3L, 4B). The BMNH houses a Nigerian series under the name *wittei* and these seemingly disjunct representatives do not differ from sympatric *curta* other than having the terminal segments red instead of blue.

The above suggests that the red and blue colour have a physiologically similar origin. According to Longfield (1959) the “blue on some [Chlorocypha] will begin as light red”, and I have observed the reverse in *P. caligata f. lacus* Pinhey, 1982. In the aforementioned example of *A. lacuselephtanum* a complex colour change involving shades of red and blue occurs. It is conceivable that the colour-switch is influenced by just a single gene, or is even merely a phenotypic expression. Pinhey (1967) observed regional variation in the frequency of the forms of *curta* and *cancellata* + *hintzi*, while genetic drift may have led to conformity in the species without this variation (e.g. *C. radix* and *Platycypha* species). At present we see that there is some taxonomic information in this two-tone variation, and it is clearly a factor to consider when dealing with the specific status of taxa like *cancellata*, *hintzi*, *curta* and *wittei*, although here too caution is required.

Other clues: ecology and behaviour

As noted above, an important difference in the sympatric species pair *C. dispar* and *C. pyriformosa*, besides the configuration of markings, is that the two occur in different habitats. Such differences may prove useful to assess species limits in African chlorocyphids in the future: In West Africa the species occur on different sections of running
waters, with seldom more than two species occurring together (Dijkstra & Lempert 2003). Nonetheless there is some danger of interpretation here too. Pinhey (1982) describes a lacustrine form of the normally riverine *P. calligata* from Lake Malawi. This form is smaller, as Pinhey describes, but also has a different age-related melanization pattern (K.-D.B. Dijkstra pers. obs., Figs 4F-G). Obviously careful study is needed here to determine whether they are two different species, or distinct phenotypes of only one.

In species where visual signals appear to be the main cue for specific recognition, differences in reproductive behaviour and agonistic interaction may also prove to be of taxonomic value. Robertson (1982) describes different mating behaviour in three chirocophyids (two of them African). Lempert (1988) and Dijkstra & Olsvik (2004) describe differing male-male and male-female interactions in several West African *Chlorocypha* species.

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