

## The recent expansion of *Conocephalus discolor* (Thunberg) (Orthoptera: Tettigoniidae) in western Europe\*

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### Introduction

In Europe the genus *Conocephalus* is represented by nine species (Harz, 1969) of which only two are known from central and western Europe: the Short-winged Conehead (*C. dorsalis* (Latreille)) and the Long-winged Cone-head (*C. discolor* (Thunberg)). Both are small bush-crickets (15–20 mm), usually green with brown wings and a brown dorsal stripe on the head and pronotum. In side-view the head is cone-shaped, hence the common name. Normally, separation of the two species is easy on account of the wing length: *C. discolor* is fully winged (Fig. 1) and *C. dorsalis* is brachypterous. Identification is sometimes difficult because of the occurrence of a long-winged form of *C. dorsalis* (f. *burri* Ebner, 1910) and, to add to the complexity, extra-long-winged individuals of *C. discolor* are sometimes found.

*C. discolor* is found in a wide variety of open habitats, as long as the vegetation is dense and not too short. In coastal areas, sedge meadows, reedbeds, salt-marsh, as well as *Ammophila*-dominated dry dunes near the sea shore are populated. Inland, the species can be found in dry and wet heathland, on road verges with tall grasses, riverbanks, urban wasteland, edges of fields and in ruderal and chalk grassland vegetation (Hofmans & Barenbrug, 1987; Marshall & Haes, 1988; Decler & Devriese, 1992a). The knowledge that *C. discolor* is not confined to wet habitats but also colonizes dry (urban) wasteland is still spreading among orthopterists and has led to additional records in Germany (P. Detzel, pers. comm.).

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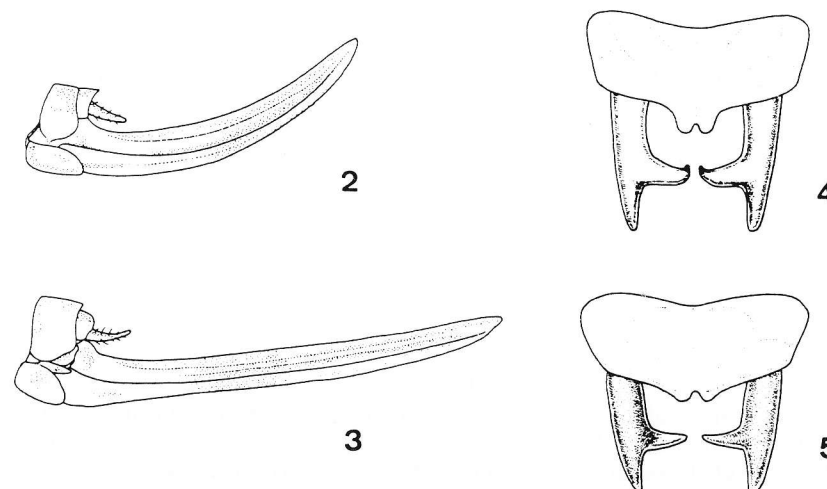
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Fig. 1. *Conocephalus discolor* (Thunberg), ♀; Belgium: Gulke Putten (Wingene), 1993. Photo. K. Decieer.

*C. dorsalis* is fairly common in central and western Europe and becomes increasingly scarce towards the south. In contrast, *C. discolor* is the more common species in southern Europe and becomes rarer towards the north-west. Until recently, populations north of 51°N were only known from the English and Belgian coasts (Harz, 1957; Devriese, 1988). During the last decades many useful identification keys, sound recordings and books on Orthoptera have been published (e.g. Duijm & Kruseman, 1983; Grein, 1984; Bellmann, 1985a, 1985b; Marshall & Haes, 1988). As a result many amateurs became interested in Orthoptera and mapping activity increased enormously. Bat-detectors became a tool in Orthoptera research and proved to be extremely useful in locating *Conocephalus* species (Froehlich & Holtzem, 1987). During these recent investigations in western Europe many new populations of *C. discolor* were discovered north of the known range.

In this paper an identification key to the two species is provided, new information from Belgium, Germany and Great Britain is summarized and the first records of *C. discolor* for the Netherlands are presented. It is argued that the new records represent a genuine expansion and cannot be the result of the more extensive investigations alone.



Figs 2–5. *Conocephalus* species. 2, 3, ovipositor of (2) *C. dorsalis* (Latreille), (3) *C. discolor* (Thunberg); 4, 5, supra-anal plate and cerci of (4) *C. dorsalis*, (5) *C. discolor*.

#### Identification key to *C. dorsalis* and *C. discolor*

The number of stridulatory pegs is based on Heller (1988); the indication of the wing-length of *C. discolor* is based on Ando & Hartley (1982) and our own measurements of Dutch specimens, and for *C. dorsalis* on our own measurements of Dutch specimens.

#### Females

- |   |  |   |
|---|--|---|
| 1 | Forewing short (5–8 mm), not extending beyond end of abdomen . . . . .       | <i>C. dorsalis</i>                          |
| – | Forewing longer (13–23 mm), extending beyond end of the abdomen . . . . .    | 2   |
| 2 | Ovipositor distinctly upcurved (Fig. 2) . . . . .                            | <i>C. dorsalis</i> , long-winged form       |
| – | Ovipositor almost straight (Fig. 3) . . . . .                                | 3   |
| 3 | Forewing 13–15 mm, hindwing usually extending 1 mm beyond forewing . . . . . | <i>C. discolor</i>                          |
| – | Forewing 17.0–22.5 mm, hindwing extending 2–3 mm beyond forewing . . . . .   | <i>C. discolor</i> , extra-long-winged form |

**Males**

- 1 Forewing short (7–10 mm), not extending beyond end of the abdomen; forewing extending 1–3 mm beyond hindwing . . . . . *C. dorsalis*  
 – Forewing longer than 12 mm, extending beyond end of abdomen; hindwing extending 1–3 mm beyond forewing . . . . . 2
- 2 Supra-anal plate with distinct protrusion (Fig. 4); stridulatory file with *ca* 60 pegs; song with alternation of continuous hissing and phases with ticking noises . . . . . *C. dorsalis*, long-winged form  
 – Supra-anal plate without distinct protrusion (Fig. 5); stridulatory file with *ca* 40 pegs; song continuous, no ticking noises . . . . . 3
- 3 Forewing 12–14 mm; hindwing extending 1 mm beyond forewing . . . . . *C. discolor*  
 – Forewing 16–19 mm; hindwing extending 2–3 mm beyond forewing . . . . .  
 . . . . . *C. discolor*, extra-long-winged form

***Conocephalus discolor* in Germany**

B. THOMAS &amp; P. KOLSHORN

*C. discolor* has been known in Germany for a long time (Zacher, 1917). The species is most abundant in the southern half, where lowland under 200 m is preferred (Ingrisch, 1979; Detzel, 1991: few records over 800 m). In the east there are enclaves far north of 53°N (Köhler, 1988); in the west no confirmed records are known north of 52°N (Martens & Gillandt, 1985; Grein, 1990; Dierking-Westphal, 1990).

During the last decade and in the early 1990s no indication of a change in distribution of *C. discolor* was noticed in Hessen (Ingrisch, 1979; M. Reich, pers. comm.) or Rheinland-Pfalz (Froehlich, 1990; Simon *et al.*, 1991), but in adjacent Nordrhein-Westfalen a distinct northward shift was observed. Zacher (1917) names Aix-la-Chapelle and Bonn, both south of 51°N, as the northernmost sites. Today the rivers Rhine and Lippe form the northern limit of the range, near 52°N. About 130 km north of Bonn *C. discolor* was observed in 1990 and 1993 at two locations near Emmerich (F. Distelrath & D. Pohlmann, pers. comm.). South of these outposts the species could be found in each investigated grid square (about 31 km<sup>2</sup>) but it decreased in numbers and locations towards the north and at a greater distance from the river Rhine. Even medium altitudes over 300 m (Bergisches Land) are consistently populated (Volpers *et al.*, 1994). The spread could be observed closely in the district of Viersen where Orthoptera have been mapped since 1987. The first individuals of *C. discolor* were found in 1989 near the Dutch border. In subsequent years the species was found in many places where it had been lacking before (Thomas *et al.*, 1993).

G. Köhler (pers. comm.) refutes the idea that the new finds of *C. discolor* in the former DDR (e.g. Thomas & Grein, 1993) indicate a spread. It seems unlikely that the populations north of Bonn have been totally overlooked after Zacher (1917), but it cannot be excluded that part of the spread in the western part of Germany took place unnoticed before the 1980s.

***Conocephalus discolor* in Belgium**

K. DECLEER

The first Belgian record of *C. discolor* dates from the second half of the 19th century. It was discovered by the famous entomologist Baron Michel-Edmond De Sélys-Longchamps in the southernmost dunes along the Belgian coast near De Panne, where the population has managed to survive up till now. Other, isolated, populations were recorded from the southernmost tip of Belgium (Prov. Luxembourg: Virton, 1937, Torgny, 1950; Prov. Namur: Oizy, 1976) (Devriese, 1988).

In the 1980s several new sites were detected in the southern Lorraine region (Jacob, 1989) and the Viroin valley (Hofmans & Barenbrug, 1987). In 1991 two additional colonies were found near the French-Belgian border during the annual meeting of Benelux orthopterists in Vierves (K. Hofmans, pers. comm.). In 1993 five new populations were discovered in the northern Famenne region (Devriese, 1993). The expansion in the southern part of Belgium was confirmed by the discovery of six new sites in 1994 (A. Gosseries, pers. comm.). Likewise, in the Flemish part of Belgium, the dunes in De Panne no longer remained the only site with a *C. discolor* population. More than five new colonies were discovered during an inventory of the Orthoptera fauna along the Belgian coast (Decler & Devriese, 1992b). In its steady drift to the north, the crossing of the estuary of the river IJzer apparently did not pose a problem. The Belgian coast has always been a favoured sampling area for entomologists and therefore there is reason to believe that the recent increase of records is indeed an illustration of the northerly expansion of its range. This was confirmed by two inland colonies which were discovered in 1992; both are in nature reserves which were visited before without a trace of *C. discolor*, however. One of the sites, the nature reserve Gulke Putten (Wingene), a small wet heathland area ( $\pm 1$  ha), was thoroughly investigated and frequently visited during the period 1985–1988. It is almost impossible that even a small population of the species was overlooked. In 1992 a large colony was recorded, independently and almost simultaneously, by different persons. The arrival of one or a few immigrants must have taken place in the period 1988–1990. In 1994 one male was found in another well-studied nature reserve (Leiemeersen-Oostkamp), nearly 15 km north of Gulke Putten.

***Conocephalus discolor* in the Netherlands**

R. M. J. C. KLEUKERS

The first report of *C. discolor* for the Netherlands (Van der Weele, 1907) proved to be a misidentification of a female of *C. dorsalis* (Willemsse, 1917). The first indication that *C. discolor* was really present in the Netherlands came from the observation of P. Kolshorn who caught a male in 1991 in the Dutch nature reserve Meinweg, five metres across the border from Germany (Kreis Viersen), where large populations of *C. discolor* are present. Encouraged by this find the Dutch border area was investigated in August and September 1992. Next to several sites with long-winged *C. dorsalis*, one male *C. discolor* was found near

Tegelen, and east of Swalmen a site with one male and two females of *C. discolor*, one long-winged male of *C. dorsalis* and one unidentified male *Conocephalus* were discovered. In 1993 B. Odé observed only a few specimens in the same location, but during the annual meeting of the Benelux orthopterists in 1994 more than 25 males were counted. Re-examination of all the available Dutch long-winged *Conocephalus* specimens in the collections of the National Museum of Natural History, Leiden, and the Zoological Museum, Amsterdam, provided further records of *C. discolor*, the first one dating from 1990 (Table 1). Interestingly, most records in the Netherlands relate to extra-long-winged singletons.

The most surprising discovery was made in 1994, when an extra-long-winged male of *C. discolor* was found near Oost-Voorne, 125 km west of the westernmost sites. Further research will have to be done to confirm the presence of populations in this area.

**Table 1.** Records of *C. discolor* in the Netherlands

UTM = Universal Transverse Mercator-grid

LB = Prov. Limburg, GL: Prov. Gelderland, ZH: Prov. Zuid-Holland

*Population*

date	UTM (5x5 km)	location	observer
1992-1994	KB9575	Swalmen (LB)	R. Kleukers c.s.
12.ix.1992	FT9545	Tiengeboden (GL)	R. Kleukers
1992-1994	FT8850	Ewijk (GL)	W. Bosman

*Male singletons* (all extra long-winged, except \* not measured)

date	UTM (5x5 km)	location	observer
31.vii.1990	FS9085	Ospel (LB)	R. Kleukers
26.viii.1991*	KB9570	Meinweg (LB)	P. Kolshorn
17.viii.1992	KB9080	Kesseleik (LB)	R. Kleukers
9.ix.1992	LB0090	Tegelen (LB)	B. Thomas
21.viii.1994	GS0570	Isabellagreend (LB)	G. Kurstjens
22.viii.1994	ET7545	Oost-Voorne (ZH)	K. Mostert

***Conocephalus discolor* in Great Britain**

E. C. M. HAES

Although there were two references to this species in England in the nineteenth century (Curtis, 1829; Westwood, 1838), neither was substantiated and it is generally assumed that they were based on misidentified specimens of the long-known *C. dorsalis*. However, Westwood referred to the bush-cricket in the Isle of Wight, where the first authentic British examples were collected in the Chale area by K. G. Blair in September 1931. Originally Blair assumed he had collected the long-winged form of *C. dorsalis* (f. *burri*), but in discussion with K. H. Chapman in 1936, he checked his specimens against European material and realised that he had added *C. discolor* to the British list (Blair, 1936).

Between 1940 and 1960 further sites were discovered on the coast, in both East and West Sussex, Dorset and East Kent (Marshall & Haes, 1988). During the 1960s, despite further finds near the coasts of Sussex and Dorset, the species showed little sign of further expansion of its British range, and seemed to be confined to a few particularly warm places, only within Sussex and Dorset, although some of its colonies were of considerable size. Over the next decade, however, some of its best populations were damaged or destroyed by urban development on the Sussex coast and by extensive grant-aided ploughing of the chalk grassland on the South Downs, mainly for cereal production. However, by the late 1970s it slowly became apparent that the insect was beginning to extend its range and to appear in new habitats.

The first records for Hampshire were made in this decade. The first recorded finds were by D. Appleton in October 1970. His initial discovery was of a single male by an inland stream in Botley Wood, near Southampton, which, because of the atypical habitat, caused much interest at The Natural History Museum, London, when D. R. Ragge received the specimen. Two days later Appleton found a colony of the insect on the coast at Fareham. By 1974 there was a substantial population in Botley Wood at the site of the original find, and on the coast it was found to be numerous on coastal wasteland at Portsmouth (Janssen, 1977), and on nearby Farlington Marshes and the warm chalk upland of Portsdown. Further localities were discovered in the Isle of Wight; on coastal dunes near St. Helens, by the writer in September 1975, and at three sites in the north-east of the island by D. G. Rands in August 1978. Further sites were also found in Dorset and Sussex in the late 1970s.

With hindsight the most interesting finds of the 1970s were the two in the New Forest district of Hampshire; in the Forest itself at Broom Hill near Brockenhurst, by A. Bolton, in September 1977, and on adjacent coast at Boscombe, by M. J. Skelton, in October of that year. In both cases only single specimens were found, but they were the forerunners of the extensive population that was to occupy the district within 10 years, in areas that had been thoroughly covered by entomologists for almost 200 years.

A few specimens, including extra-long-winged individuals, were recorded in and around the New Forest in 1980 and 1981, but in the late summer of 1982 it became clear that the bush-cricket was present in considerable numbers, and in the hot summer of 1983, A. R. and N. I. Welstead, in the course of a special survey of New Forest orthopteroids, found it to be extensively distributed and common, even in quaking bogs, a hitherto unknown habitat for this species. In the same summer a detailed investigation by staff of the (then) Nature Conservancy revealed that the insect was widespread over the heathlands of eastern Dorset, in many previously explored places, from which there were certainly no earlier records (Haes, 1984). A similar population increase was noted along the South Downs and coastline of Sussex in 1984 and, despite the mainly poor summers of the following four years, the spread continued unchecked: as far as Weymouth to the west, where it was found by J. R. White of the Nature Conservancy in September 1984, and to Hastings and Rye Harbour, close to the Kentish border in the east, with the first records here by S. C. Newall in September 1989. It was also found for the first time in Wiltshire,

near Landford in the northern limit of the New Forest in October 1985 (Paul, 1987).

The summer of 1990 was of great significance in the history of this insect in Britain. The very hot summers of 1989 and 1990 clearly precipitated its extraordinary spread. Although long-known from the South Downs in Sussex the insect had not been located very far into the Weald, to the north of the chalk. Then, quite unexpectedly, it was located by I. S. Menzies, with the aid of a bat-detector, on Bookham Common in Surrey, in August 1990, some 30 km north of its previously known range. It was then found in North Hampshire, by J. Denton, in September 1990, and along the Thames Valley in Berkshire, by M. J. Skelton, in August 1991. In the following summer it was found in Kent, near the Surrey border by D. W. Baldock, using a bat-detector, at Edenbridge, in September. Along the Thames it was found at three places in Oxfordshire, the first, by C. M. T. Raper, near Goring in early August, the second at the end of the month, by M. J. Skelton, at Lower Shiplake, and the last, the most northerly British record so far, at Cowley Marsh, near Oxford, by S. Gregory, in September 1992. It is now widespread across Surrey and along the middle reaches of the Thames.

The most unexpected finds in 1990 were the discoveries of several extra-long-winged singletons and several small colonies in Cornwall, the most easterly, a small colony found by R. S. Cropper in September 1990 at Lantic bay, some 140 km west of its known sites in Dorset.

The first Cornish record had been made a month earlier, by the county Odonata recorder, S. P. Jones, whilst searching for sites of *Ischnura pumilio* (Charpentier), at Devoran, south-west of Truro. Further finds were made on the mainland by the writer, R. S. Cropper and D. J. Veevers, in August-September. However, the most astonishing finds of all were of small colonies on St. Mary's and St. Martin's in the Isles of Scilly by M. Lynes in late August 1990. At least two of the colonies in Cornwall were still present in the cold, wet summer of 1992, with one certainly present up to August 1993, and another (found in 1992) had over 30 adults in September 1994. In the Isles of Scilly, C. J. Timmins confirmed its continuing presence at three places on St. Mary's, in September 1994.

The first records for Devon were made in 1994, with a colony near Dartmouth, found by D. Buckingham in August, and another on urban wasteland in Plymouth, in October, by R. A. Stevens. A colony was also found near Bridport in western Dorset, in August, by I. Cross. North of London, J. P. Widgery found extra-long-winged, single specimens at several sites in Hertfordshire, in August. There are no previous records from this well-surveyed county.

### Discussion

During recent investigations in western Europe many new populations of *C. discolor* were discovered (Fig. 6). In Belgium numerous locations were discovered, up to 70 km to the north and north-east of the only known site on the coast. In Great Britain and in the Rhine valley in Germany populations were found 120–130 km to the north. In the Netherlands the species was discovered

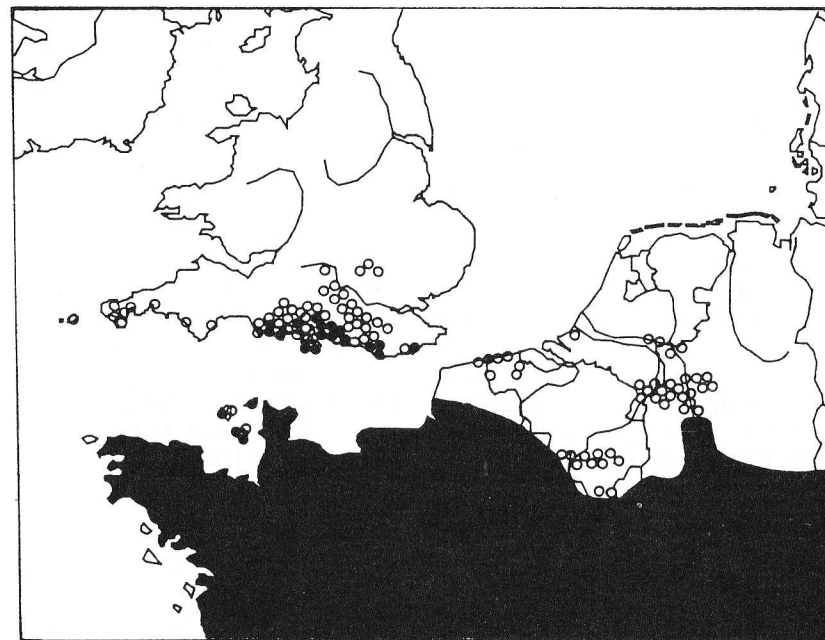


Fig. 6. Distribution of *C. discolor* (Thunberg) in north-western Europe. Black: distribution before 1980; open circles: records after 1 January 1980. Additional information used for the map: Froehlich (1990), Ingrisch (1979), Kinn & Meyer (1988), Kruseman (1988), Ministerium für Umwelt (1992), Simon *et al.* (1991), Voisin (1991).

along the German border and one specimen was collected near the coast, 100 km north of the Belgian sites and 125 km west of the other Dutch populations.

One might try to explain the observed extension of the range by the major increase in faunistic research on Orthoptera, the more advanced techniques to locate the insects (e.g. using bat-detectors), a better knowledge of the habitats and a better understanding and discrimination of the different wing-forms of *C. discolor* and *C. dorsalis*. However, several of the newly found sites (Kreis Viersen, Gulke Putten, the Belgian dunes, several sites in Great Britain) were investigated before by orthopterists (sometimes extensively) and *C. discolor* was never found. Thus it must be concluded that the new records represent a genuine expansion.

A recent expansion of the northern range has also been shown in other well-studied invertebrates. In Belgium, for instance, there has been a continuous spread of the southern dragonflies *Crocothemis erythraea* (Brullé), *Sympetrum fonscolombei* (Sélys) and *Cercion lindeni* (Sélys), since the second half of the 1980s (Anselin, 1993; A. Anselin, pers. comm.). Another example is the well-known tiger spider *Argiope bruennichi* (Scopoli) (Von Helsdingen, 1982). Further examples can also be found among the Orthoptera. *Meconema meridionale* (Costa), an

obligate short-winged bush-cricket, was not known north of the Alps until the second half of this century. In the last decades more and more sites have been discovered in France and Germany and recently large populations were found near Rotterdam in the Netherlands (Van As & Kleukers, 1994). Luquet (1993) assumes that this inconspicuous species has always been overlooked, but it is generally thought that the expansion is brought about by transportation of the insects by cars (Tröger, 1986). *Oecanthus pellucens* (Scopoli) is thought to disperse in a more natural manner. This cricket was recently found in Bonn, the first record in Nordrhein-Westfalen, and in 1994 in Düsseldorf, 80 km to the north of Bonn (Sander, 1992; U. Sander, pers. comm.). *Phaneroptera falcata* (Poda) also seems to move along the Rhine to the north, and was recently found near Emmerich (Hermans & Krüner, 1991; B. Jendral, pers. comm.).

It seems reasonable to assume that the northern expansion of the range of these species that had a southern distribution is made possible by favourable weather conditions, possibly caused by macro-climatological changes. In this respect it is not surprising that species like *C. discolor* and *P. falcata* react quickly. Whereas in many Tettigoniidae the eggs develop from 2–8 years, those of these two species overwinter just once (Ingrisch, 1978), enabling dispersal every year.

Polymorphism in wing-length is a widespread phenomenon among insects. It is known in Coleoptera, Heteroptera, Homoptera, Psocoptera, Thysanoptera and Plecoptera (Richards & Davies, 1977). In Orthoptera many normally short-winged species occasionally produce long-winged individuals. In Europe this is known in species with simple shortened wings, such as *Metrioptera brachyptera* (Linnaeus), *Chorthippus parallelus* (Zetterstedt) and *Chrysochraon dispar* (Germar). In species which have more reduced, scale-like wings, brachypterism seems to be irreversible (e.g. *Ephippiger ephippiger* (Fiebig), *Leptophyes punctatissima* (Bosc), *Pholidoptera griseoptera* (De Geer)). Also in the Tetrigidae many species are dimorphic with respect to wing-length.

The function of long-winged individuals seems to be evident. The animals may disperse to new localities and found new colonies. However, Ritchie, Butlin & Hewitt (1987) conclude, after laboratory experiments with *C. parallelus*, that the long-winged individuals cannot fly and that therefore macropterism is not a dispersal mechanism in the Gomphocerinae. Recently it has nevertheless been demonstrated that long-winged *C. parallelus* are capable of flight, and occasionally fly off in large groups (Bruckhaus, 1988; U. Manzke, pers. comm.).

In several brachypterous species of Tettigoniidae (e.g. *Metrioptera roeselii* (Hagenbach), *Conocephalus dorsalis*) it has been observed that when singletons are found, this is mostly in atypical habitats and that these individuals are often long-winged (pers. obs.: R. Kleukers, B. Thomas, L. Willemse). The first records for *C. discolor* in the Netherlands are predominantly extra-long-winged singletons. Thus it seems reasonable to assume that (extra-)macropterous individuals play a role in colonization. In the case of *C. discolor* this is especially likely because Ando & Hartley (1982) observed in the laboratory that extra-long-winged individuals, occurring especially after crowding of the nymphs, flew better and more readily, while normally-winged individuals were inclined to seek cover. Because the extra-long-winged animals had a lower overall fec-

undity it is difficult to determine what their relative importance in the colonizing process is, in comparison with the dispersal of nymphs and normal-winged animals and the river-borne transport of eggs in plant stems.

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