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INSTRUCTIONS TO AUTHORS

Authors are asked to study these instructions with care and to prepare their manuscripts accordingly, in order to avoid unnecessary delay in the editing of their manuscripts.

- Word-processed manuscripts should be submitted by e-mail, using Arial type face and font size 12. Line spacing should be exactly 16pt.

  o The following terms are used: `exuvia' for cast skin (plural: `exuviae'); `larva' (instead of `naiad' or `nymph'}; `prolarva' to designate the first larval instar.

  o Dates in the text should be expressed in the form '24 July 2020'.

  o References cited in the text should be in the form '(Longfield, 1949)' or '... as noted by Longfield (1949)'.

    ▪ All references cited in the text (and only these) should be listed alphabetically at the end of the article in one of the following forms:
      - Corbet, P.S., Longfield, C. & Moore, N.S. 1960. *Dragonflies*. Collins, London 260pp.
      - Smith, E.M. & Smith, R.W.J. 1995. *Somatochlora metallica* in Scotland. *Journal of the British Dragonfly Society* **1:** 37-38.

    ▪ Journal titles should be written out in full and be in italics; the volume number in bold. Book titles should also be in italics and the number of pages included. Note the use of '&' rather than 'and' where there are two or more authors.

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  o Figures, plates & tables should be referred to in the text in the form (Fig. 1), (Plate 1), (Table 1).

  o Do not use expressions such as 'Plate 2 shows ….'

  o Footnotes should be avoided.

- Figures, plates and tables should be presented on separate, unnumbered pages, **not** embedded in the text.

  o Figures and plates should be submitted as .jpg or .tiff files; tables using MS Word.

  o Legends for figures, plates and tables should be presented together in sequence on separate pages.
    ▪ Each legend should allow the content of the figure/plate/table to be understood fully without reference to the text.

- Video links can be included. They should be referenced in the text and listed separately as 'Video link(s)' after the references.

- Please contact the Journal Editor if any further help is needed.

Species Review 12: *Ischnura elegans* (Vander Linden), the Blue-tailed Damselfly, with notes on *I. genei* (Rambur), the Island Bluetail, and *I. graellsii* (Rambur), the Iberian Bluetail

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Introduction

The genus *Ischnura* was established by Charpentier and is in the family Coenagrionidae. In a study of 24 species of *Ischnura* (which is about one third of the total number), using COI and ITS DNA fragments, Dumont (2013) confirmed that the genus is monophyletic and contains two main clades – the *Ischnura elegans* and *Ischnura pumilio* groups. *Ischnura elegans* was first described by Vander Linden (1820); its type locality is Bologna, Italy. In Britain its common name is the Blue-tailed Damselfly; in continental Europe it is referred to as the Common Bluetail and in Ireland as the Common Bluetip. In North America the members of this genus are called 'Forktails'. *Ischnura elegans* has a very wide geographical range, extending from Ireland across Europe and Asia to China and Japan. However, it is locally scarce or absent in northern Scandinavia; also it is absent from Corsica, Sardinia, Sicily, Malta, Portugal and western Spain (Dijkstra *et al*., 2020; Askew, 2021).

Two subspecies of *I. elegans* are currently recognised as occurring in Europe but the variation in this species is still not well understood and the status of these subspecies is far from certain. *Ischnura elegans ebneri* (Schmidt, 1939) is found in southern Italy, Turkey, Crete, Cyprus and the Middle East while *I. elegans pontica* (Schmidt, 1939) is found from the Hungarian Great Plain and the northern Balkans east to central Asia (Dijkstra *et al*., 2020; Askew, 2021).

There are three other species of *Ischnura* in Europe, of which only one, *I. pumilio* (Charpentier) (Scarce Blue-tailed Damselfly or Small Bluetail) is found in the British Isles. *Ischnura genei* (Rambur) (Island Bluetail) is found in some of the Mediterranean islands, including Corsica, Sardinia, Sicily, Capri, Malta and Linosa (d'Aguilar *et al*., 1986; Dijkstra *et al*., 2020; Askew, 2021), while *I. graellsii* (Rambur) (Iberian Bluetail) is found in Spain and in North Africa north of the Atlas mountains (d'Aguilar *et al*., 1986; Dijkstra *et al*., 2020; Askew, 2021).

This latter species is very closely related to *I. elegans* (Dumont, 2013; Blow *et al*., 2021).

Polymorphism is very common in the genus *Ischnura*. In *I. elegans* it "is determined by single allelic autosomal inheritance with a sex-linked expression" (Hinnekint, 1987) and three alleles are involved (Sánchez-Guillén *et al*., (2005). In females there is an andromorph (var. *typica*), i.e. with the same colour pattern, when mature, as the male, and two gynomorphs (var. *infuscans* & var. *rufescens-obsoleta,* (formerly *infuscans-obsoleta*)) with colour patterns which, at maturity, differ from that of the male.

Description

Egg

The egg is spindle-shaped and, on average, 0.98 mm long and 0.21 mm wide. It has a pointed anterior end and a rounded posterior end (Sahlén, 1995).

Larva

The length of the final instar larva is 13-15 mm with caudal lamellae adding an extra 5-6 mm (Plate 1). The head appears relatively small compared to the size of the body. There is usually a small, dark spot at the base of each wing, which is a diagnostic feature for this species and can be seen before the wing buds have started to appear (Plate 2) (Cham, 2009). However, these spots are absent in the exuvia. The sides of the abdomen bear thick setae. Each femora has a single dark band towards its distal end. The caudal lamellae are long and thin and terminate in a distinct point. They are obliquely subnodate, the stout setae being present from the base to the mid-point on one side but only reaching one third of the way along on the other (Plate 3) (Cham, 2009).

Adult

The overall length is 30 to 34mm with an abdominal length of 22 to 29mm and a hind-wing span of 14 to 21mm (Brooks *et al*., 2014; Dijkstra *et al*., 2020). In both sexes the pterostigma on the fore-wings is diamond-shaped, twice as long as wide and bi-coloured, the part nearer the body being dark, that nearer the wing tips whitish. However, this pattern is less clear in females. There is a circular blue spot behind each eye. The pronotum has a distinct narrow, median projection in the centre of its rear edge and this is particularly well marked in males (Plate 4A); it is smaller (and sometimes absent) in females. It is absent in *Ischnura elegans pontica* and in other species of *Ischnura* (Dijkstra *et al*.,

Plate 1. Final instar larva of *Ischnura elegans*. From Cham (2009). Photograph by Steve Cham.

Plate 2. Final instar larva of *Ischnura elegans*. Note the black spots (red lines) at the base of each wing. From Cham (2009). Photograph by Steve Cham.

Plate 3. The caudal lamellae of a larva of *Ischnura elegans* Note the pointed tips and the oblique node with the stout setae reaching the mid-point of the gill on one side but only reaching one third of the way along on the other (red lines). From Cham (2009). Photograph by Steve Cham.

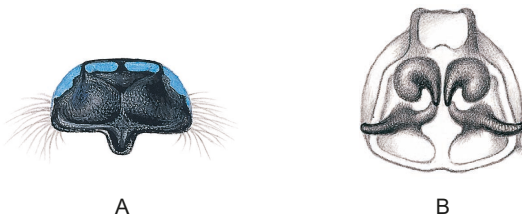A   B

Plate 4. Male I*schnura elegans*. (A) Dorsal view of the pronotum showing the projection on its rear edge, (B) Rear view of the inner and outer branches of the upper appendages. From Dijkstra *et al.* (2020). Artwork by Richard Lewington.

2020; Askew, 2021). The abdomen is mainly black on top except for the eighth segment (S8), which is completely blue or brown (e.g. Lucas, 1900; Brooks *et al*., 2014; Smallshire & Swash, 2014).

Males. Male *Ischnura elegans* is monomorphic. In immature males the thorax is greenish (Plate 5A), becoming blue-green before developing its full blue colouration (Fig. 1). In fully mature individuals the eyes, the sides and narrow shoulder stripes of the thorax, and the eighth abdominal segment (S8) are blue (Plate 5B). Using Mark-Release-Recapture (MRR) data, Parr (1973a) showed that some males have started to change colour by the second day but it is only after 9-12 days that almost 100% have reached the intermediate blue-green stage. Most individuals become fully blue after about 18 days but it is not until day 27 that all are blue (Fig. 2). Although the time taken for each thoracic colour change in an individual (i.e. green to blue-green and blue-green to blue) can take as little as one or two days, Parr (1973a) calculated that the mean ages at which these colour changes occur are 6.2 days and 17.1 days respectively (Fig. 1). Van Noordwijk (1978) found similar values. Under laboratory conditions Hinnekint (1987) recorded the change from green to turquoise (blue-green) as about 14 days and almost 20 days to become fully blue.

The inner branches of the upper (superior) appendages are almost parallel to each other and point downwards. The inner branches of the lower (inferior) appendages curve inwards and upwards and there is an internal tooth on the lower appendages. In *I. elegans ebneri* the inner branches of the upper appendages are crossed, while in *I. elegans pontica*. the upright projection on the pronotum is reduced or absent (Dijkstra *et al*., 2020; Askew, 2021).

Females. In females of *I. elegans* there are three morphs, one androchrome and two gynomorphs. Five clearly recognisable colour forms can be distinguished in the field (Lucas, 1900; Longfield, 1937, 1949), three of which relate to the adults of the three morphs, the other two being immatures (Fig. 1) (Killington, 1924; Lord, 1961; Parr 1973a). One immature form has a thorax with violet/lilac sides and black humeral (shoulder) stripes and a blue eighth abdominal segment (S8) (*violacea*) (Plate 6A). As it matures, it either develops the blue male colouration and retains a blue S8 (*typica*), i.e. is an andromorph (Plate 6B), or the thorax becomes olive-green and S8 turns brown (*infuscans*) (a gynomorph) (Plate 6C). The other immature form (*rufescens*) has a thorax with orange-pink sides and a blue S8 but the black humeral stripes are absent (Plate 7A). As it matures the orange-pink on the thorax becomes pale brown and S8 becomes dull brown (*rufescens-obsoleta*) (Plate 7B) (e.g. Brooks *et al*., 2014; Smallshire & Swash, 2014). The timing of the changes in thoracic ground colour are variable and differ between individuals and between studies. From MRR data Parr (1973a) estimated that the mean time spent in the *violacea* stage was around six or

A

B

Plate 5. Male *Ischnura elegans*. (A) immature, (B) mature. Photographs by D.Green.

♂♂

green with blue S8
(Plate 5A)   ⟶   blue with blue S8
(Plate 5B)

♀♀

violet/lilac with blue S8
violacea
(Plate 6A)

blue with blue S8
typica (andromorph)
(Plate 6B)

olive-green with brown S8
infuscans (gynomorph)
(Plate 6C)

orange/pink with blue S8
rufescens
(Plate 7A)   ⟶   pale brown with dull brown S8
rufescens-obsoleta (gynomorph)
(Plate 7B)
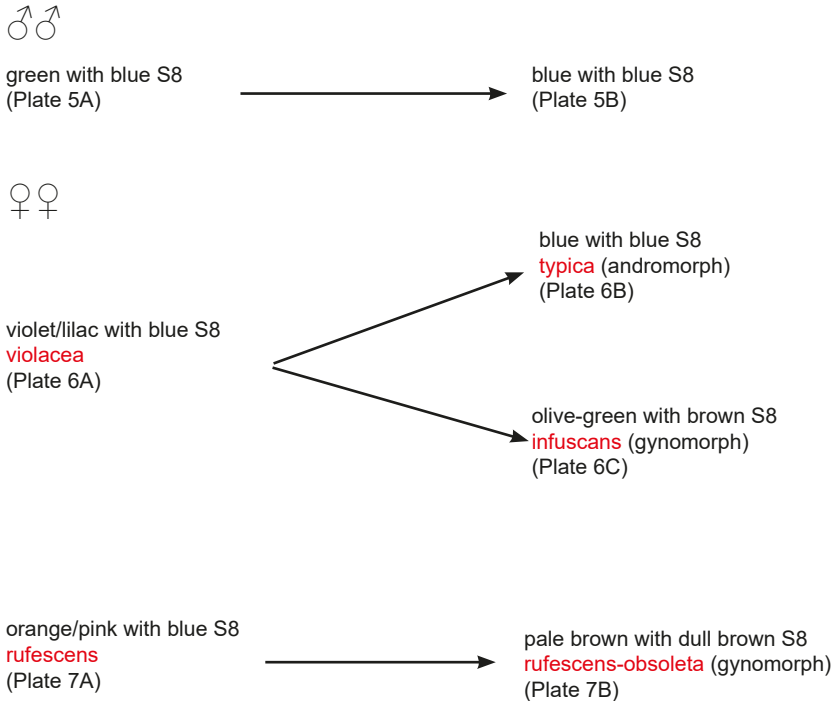
Figure 1. The ground colour of the thorax and the colour of the eighth abdominal segment (S8) in *Ischnura elegans*, showing the relationship between the different colour forms in males and in the three female morphs. In *rufescens* and *rufescens-obsoleta* the humeral stripe is absent.

seven days while that in the *rufescens* stage was about eight days.

The proportions of the three female morphs vary widely, even between ponds in the same general locality (Parr, 1965). Gosden *et al*. (2011) compared this variation in 120 populations from 10 European countries. They found very large differences between sites, leading them to conclude that this polymorphism is "highly dynamic, with stable morph frequencies at the core of the species range but fluctuating morph dynamics at the range limits." They noted a significant increase in androchome frequency with increase in latitude.

Habitat

Ischnura elegans is found at standing waters such as ditches, canals, ponds and lakes; also at slow-flowing streams but not at fast-flowing sites. It tolerates

brackish conditions as well as some degree of pollution. However, it is less common in acidic waters and is absent from *Sphagnum* bogs (Smallshire & Swash, 2014; Dijkstra *et al*., 2020; Askew, 2021).

Distribution in the British Isles

Ischnura elegans is found throughout most of the British isles and is one of our commonest species, being particularly numerous in lowland regions. It tends to be less conspicuous than some other damselflies as, to quote Lucas (1900), it "flies low amongst the herbage of sedgy ditches, canals, and ponds". Parr (1973a) noted that it was active except when winds were above 20 knots, there was heavy rain or the day temperature fell below 15°C, Smallshire & Swash (2014) adding that it can be seen flying in cloudy conditions more often than most damselflies.

A

B

C

Plate 6. Female *Ischnura elegans*. (A) Immature var *violacea,* (B) Mature var. t*ypica*, (C) Mature var. *infuscans*. Photographs by D.Green.

A

B

Plate 7. Female *Ischnura elegans*. A) Immature var. *rufescens,* B) Mature var. *rufescens-obsoleta*. Photoghraphs by D.Green.
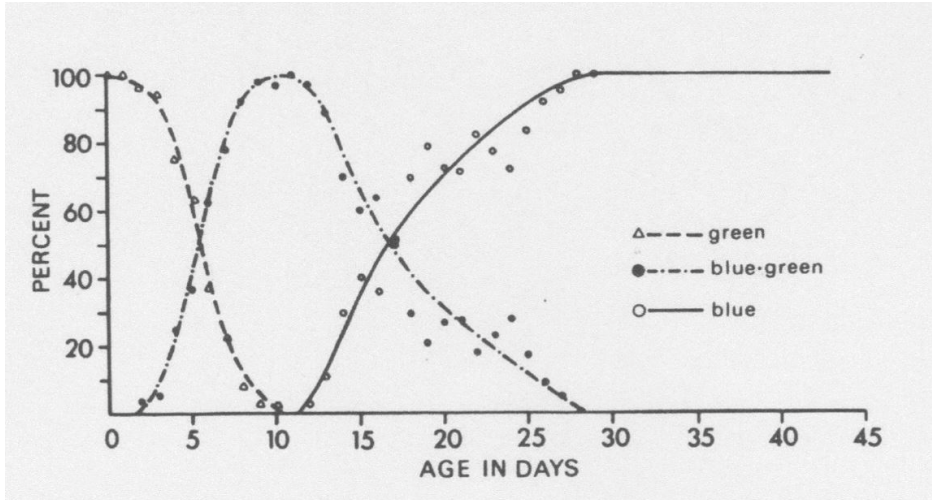
Figure 2. Timing of the changes of the thoracic ground colour with age in male *Ischnura elegans*. This is based on recaptures of individuals marked when teneral, teneral green or green, utilising three-day moving averages. The curves are fitted by eye. From Parr (1973a).

Table 1. Daily survival rates of males at ponds in northern England. Data from Parr & Parr (1972) and Parr (1973b).

Pond no.	Year	Daily survival rate	
		*Fisher-Ford	**Life Table
1	1965	0.8958	0.8370
	1970	0.8979	
2	1965	0.8724	0.7450
3	1966	0.9234	0.9150
	1970	0.9278	

Life Cycle

The length of the life cycle of *Ischnura elegans* is dependent on latitude, being shorter in the southern part of its range where the higher temperatures allow for more rapid development. In Scotland it takes two years to complete a generation (semivoltine), in northern England, The Netherlands and Italy it takes only one year (univoltine). In Belgium, northern France and Germany it

Table 2. Proportions in the adult population and proportions of matings of the three mature female phenotypes. Mating success is measured as the ratio of the percentage of matings to the percentage in the population. Data from Cordero *et al*. (1997).

Phenotype	% of population	% of matings	Mating success
Androchrome	55	43	0.78
Gynochromes			
infuscans	27	40	1.48
infuscans-obsoleta	18	17	0.94

is bivoltine (two generations each year), while in Spain, southern France and Greece it is multivoltine with two or even three generations per year (*e.g.* Corbet *et al*., 2006; Martens et al., 2017).

Egg

The female lays her egg on the submerged portions of floating plants. She does this individually without a male in attendance. In some cases the female submerges completely (*e.g.* Corbet, 1999). The shortest time from oviposition to adult emergence has been determined as 63 days in Greek rice fields (Schnapauff *et al*., 2000) and 55 days in a flooded maize field south of Karlsruhe, Germany (Martens *et al*., 2017)

Larva

In the north of England, larval growth begins in late March to early April and finishes at the end of September to the beginning of October, the lower temperature threshold for larval development being between about 8°C and 10°C (Thompson, 1978c). The sex ratio is not significantly different from 1:1, Parr & Palmer (1971) finding a small but nonsignificant excess of males. There are as many as 12 instars (Thompson 1978b; Lawton *et al*., 1980).

Thomson (1978a) found that, in the field, the larvae consumed different prey items in about the same proportions as they occurred. In a more detailed analysis, using faecal pellet analysis, he analysed the prey items captured and found that entomostracans (*e.g.* ostracods and copepods) were numerically the most important but that the most biomass they consumed was insect larvae, especially chironomids (Thompson, 1978b). Lawton *et al*. (1980) concluded that starvation is unlikely to be a major cause of mortality in this species and that, in

the laboratory at least, increase in development rate increases with increase in prey availability.

Emergence

There is an extended period of emergence lasting throughout most of the flight season and Parr (1973a) found evidence for two main peaks of emergence, one in June, the other in July/August. At emergence the sex ratio is not significantly different from 1:1, Jahn (1991) recording 50.8% males (n=183) (see Corbet & Hoess, 1998). In southern Sweden, it was found that, in the field, androchrome and *rufescens-obsoleta* females emerged significantly earlier than *infuscans* females. In a laboratory study, males emerged earlier than females and the offspring of *rufescens-obsoleta* females emerged significantly earlier than those of the other two female morphs (Abbott & Svensson, 2005)

After emergence, individuals tend to leave the vicinity of water but return when they are mature, which is after about 10 days for males; somewhat longer for females. Emergence often occurs with the larva upside down (Butler, 1990; Förster, 1995) but the reason for this is obscure. Thickett (1991) found more than 80% in this position; Mackenzie Dodds (1992) 48.5%.

Adult

The proportion of males at water increases with overall increase in population density (Parr, 1969; Hinnekint, 1987). Parr (1965) found an excess of males (c. 65%). However, Parr & Palmer (1971) suggested that the real sex ration was close to 1:1 and indeed Hinnekint (1987), using MRR data, confirmed that the sex ratio is not significantly different from 1:1. The observed excess of males at water is almost certainly due to males spending a higher proportion of their time at water; females come to water when they are ready to mate. Parr (1973b) noted a tendency for many individuals of *I. elegans* to stay close to water during their maturation period, which he estimated to be about three days for males and four days for females. Hinnekint (1987) also found that females take longer to mature but that male and female longevities are identical.

Kunz & Wildermuth (2006) have noted instances of adults feeding on the larvae of grasshoppers *Phaneroptera falcata* and *Leptophyes punctatissima*, the latter recorded by S. Behrends.

Damselflies can keep flying even when their wings are damaged. Flight speed in *I. elegans* has been measured at between 0.2 ms^{-1} and 0.8 ms^{-1} and the loss of a hindwing had no significant effect on their speed (Kassner *et al*., 2016). The wingbeat amplitude was shown to be the same in the forewings and the

hindwings. However, in the absence of a hindwing, the wingbeat frequency increased to compensate for the reduced lift, while the remaining hindwing reduced its amplitude and the forewings changed their stroke plane angle so that steady, straight flight could be maintained (Kassner *et al*. 2016). This is possible because odonates, unlike most insects, have independent control of each wing.

Flight Season The flight season of *Ischnura elegans* extends from late April to late September in northern and central Europe with a peak between May and August; it is longer in southern Europe, where there is more than one generation each year (Dijkstra *et al*., 2020). In Britain it may be seen as late as October (Longfield, 1949). In a population in south Wales the number of adults (both males and females) reached a peak at the end of June/beginning of July (Parr, 1965). In this study, more males (65.55%) than females were found to be flying, but this is usually the case with zygopterans as the females tend to live away from water for longer periods than males.

Survival There have been several estimates of survival rate. Using the Fisher-Ford model (Fisher & Ford, 1947), Parr (1965) estimated a daily survival rate of 0.816 for males and 0.711 for females at a site in south Wales and he demonstrated that survival was age dependent (Parr, 1973b). In Belgium Van Noordwijk (1978) used two models to estimate the survival rate of males: 0.87 using Jolly-Seber and 0.78 using a regression model. With the latter he determined that the survival rate was similar for tenerals and all colour stages of males.

Again using the Fisher-Ford model, Parr & Parr (1972) estimated daily survival rates for males at a site in northern England. At one pond the survival rates were 0.8958 in 1965 and 0.8979 in 1970; at another it was 0.9234 in 1966 and 0.9278 in 1970 (Table 1). Thus, while the estimates at each pond were consistent between years, the values at one pond were higher than at the other. Parr & Parr (1972) suggested that the differences in male survival rate were influenced by the nature of the ponds. Thus, the one with the lower survival rates was exposed, and thus liable to high bird predation, whereas the one with the higher survival rates was very sheltered. This is supported by a value of 0.8724 recorded at another exposed pond (Parr & Parr, 1972). Parr (1973b) reanalysed their data for 1965 and 1966 using the Life Table method and this confirmed the trend, with the daily survival rate being 0.8370 and 0.7450 for the exposed ponds and 0.9150 for the sheltered one (Table 1). Under laboratory conditions Hinnekint (1987) estimated that survival rate increased from 0.8907 on day 1 to 0.9362 on day 50. These latter rates may be on the high side since laboratory populations are not subject to predation.

In a population of *I. elegans* near Rome, Italy, Cordero *et al*. (1997) found that the three female colour morphs (phenotypes) have similar survivorship but that they differed in mating frequency, the two gynochromes both being more successful than the androchrome (Table 2). Similarly, in northwest Spain, where androchrome frequency varies considerably between populations (Sánchez-Guillén *et al*., 2005), Cordero *et al*. (2007) looked at four populations with androchrome frequencies varying from 8% to 90% and found that in all but one of 23 samples androchrome females mated less frequently than expected from their frequency in the samples.

In a laboratory study, Bouton *et al*. (2011) found that individuals born to the three 'mature' colour morphs and subjected to two different temperature regimes showed similar egg survival and hatching times. However, they found differences between the two populations from which they obtained eggs reared at both temperatures, those from one population having lower egg survival but faster hatching time than those from the other, indicating local adaptation.

Longevity Lord (1961) estimated the average length of life (longevity) as 5.5 days for males and 5.3 days for females. Similar estimates were obtained by Parr (1965), i.e. 5.4 days for males and 3.5 days for females. However, individuals can live considerably longer. Thus, the maximum recorded in a laboratory reared population is 42 days (Hinnekint,1987) and in semi-natural conditions 41 days (Lord, 1961), which are similar values to those observed in the field – 45 days (Parr 1969), 39 days (Parr & Parr, 1972) and 42 days for males and 50 days for females (Parr (1973b). However, as Hinnekint (1987) noted, the 45 days recorded by Parr (1969) was an underestimate by at least five days because the individual was first marked as a mature andromorph female, having already passed through its '*violacea*' stage.

Reproduction The females of *I. elegans* lay their eggs in the submerged parts of floating vegetation, sometimes going completely under the water (Jurzitza, 1986) without any mate-guarding by the male. Copulation lasts a long time in this species, Krieger & Krieger (1958) noting that it often took over three hours and sometimes as long as five hours. In a high density population in the south of France, Miller (1987) recorded 324 ± 90 (s.d.) minutes overall copulation time, with stages I and II lasting 239 ± 112 minutes and 85 ± 48 minutes respectively. However, both stages included long inactive periods. Miller (1987) suggested that this long copulation may be a form of mate-guarding, delaying female oviposition until later in the day. Indeed, Van Noordwijk (1978) found that oviposition is usually delayed after copulation until late afternoon, when other zygopterans have left the water. He also observed that mating sometimes occurred away from water. The male has been observed to clap its forewings together during mating (Gibson, 2004).

No difference in mating behaviour between the two female gynomorphs was observed by Lord (1961) and Parr & Palmer (1971) but they both had a higher mating frequency than andromorph females, presumably because males do not always recognise the latter as females. Cordero *et al*. (1997) confirmed the higher mating frequency of the gynomorphs but also found that the *infuscans* gynomorph had a higher mating frequency than the *rufescens-obsoleta* gynomorph (Table 2). Subrero *et al*. (2021) also found a male preference for *infuscans* females (*rufescens-obsoleta* were rare in their study) even though androchomes were present in similar numbers. In contrast, Tyrrell (2007) found that breeding frequency was directly related to the proportion of each female morph in both a high and a low density population. Males will mate with both immature female morphs (*violacea* and *rufescens*) (Plate 8) but at a

Plate 8. Male *Ischnura elegans*. mating with a female var. v*iolacea*. Photograph by D.Green.

lower frequency than mature morphs (Hammers *et al*., 2009). This implies that sexual maturity is attained before the final colour stage is reached. Subrero *et al*. (2021) found that the survival and emergence success of the larvae of *androchrome* females was higher than those of *infuscans* females.

Although both sexes mate well into their old age (Parr & Palmer, 1971), aggressive behaviour results in newly matured males outcompeting older ones and hence comprising the largest proportion of the population at water. All other age groups of males, along with females, tending to be dispersed in the hinterland away from the pond margins (Hinnekint, 1987).

Hinnekint & Dumont (1989) analysed the data of Lord (1961) and Parr & Palmer (1971). They noted that, at low population densities where the proportion of males is between 50% and 62%, there is a minimal level of sexual aggression and matings with immature females are low at about 5% of the total number of matings. As population density increases, the proportion of males in the population also increases. When this exceeds 62%, the resulting increase in sexual aggression causes a fall in the overall mating frequency due to the reduction in the proportion of females in the population. It also results in an increase in the number of matings with immature females. This reaches a maximum when the proportion of males is 70%, beyond which both general and sexual aggression decrease and the number of matings with immature females decreases, even though the proportion of males in the population continues to increase. Furthermore, they found that these data supported the suggestion by Hinnekint (1987) that there is a six year population cycle, with the maximum proportion of matings with immature females occurring one year after the maximum overall mating frequency was reached and one year before the recorded peak population density (Hinnekint & Dumont, 1989).

Dispersal

Little is known about the dispersal of *Ischnura elegans* but a study near Rouen, Normandy, showed that those that emerged from open-field ponds moved greater distances than those from urban ponds; also, when a pond was drying up, movement to another pond was only observed in the case of open-field ponds (Le Gall *et al*., 2017). Conrad *et al*. (2002) found that male I*. elegans* which dispersed had significantly longer forewings than those that did not. They found no difference in dispersal rates between the three colour morphs but females, which spent longer away from water than males, were more likely to move between ponds.

Predation

In a study of the effects of predator cues Sniegula *et al*. (2020) subjected larvae of *I. elegans* to chemical cues derived from a fish predator (perch). These caused an increase in development time and a decrease in survival of the larvae. In the presence of a free-swimming predator (*Anax imperator*) foraging activity and growth were both reduced significantly (Schaffner & Anholt, 1998). Parr & Parr (1972) noted that *Tetragnatha* spp. (Spiders), *Gerris* spp. (Water Boatman) and *Vespa* sp. (Wasp) all predated teneral and post-teneral zygopterans, presumably including *Ischnura elegans*, which were common at their study site. Also, individuals were taken by *Hirudo rustica* (Swallow), *Riparia riparia* (Sand Martin), *Delichon urbica* (House Martin) and *Apus apus* (Swift) at the more open ponds.

Parasites

Two species of mite belonging to the genus *Arrenurus* (*A. cuspidator* and *A. tricuspidator*) have been recorded on adult *Ischnura elegans* in Poland (Baker *et al*., 2006, 2007). Subrero *et al*. (2021) found that males and androchrome females had a higher parasite (mites) load than *infuscans* females. As noted above, they found that the larvae of androchrome females were more successful than those of *infuscans* females. This observation led them to suggest that this may counterbalance the higher parasite load and lower mating success of the former.

Other European species similar to *Ischnura elegans*

Ischnura genei replaces *I. elegans* on islands to the west of mainland Italy, while *I graellsii*'s Euorpean distribution is in Spain and Portugal. Both of these species are slightly smaller than *I. elegans* with a maximum overall length of 32 mm, abdominal length 26 mm and hind wing length 19 mm.

Ischnura graellsii can hybridise with *I. elegans* where they overlap (i.e. in Spain). In a laboratory situation it has been shown that while males of *I. elegans* will mate with females of *I graellsii*, producing hybrid offspring, the reverse "cross was almost impossible", probably due to mechanical difficulties in forming the tandem (Monetti *et al*., 2002).

Ischnura genei (Rambur, 1842) Island Bluetail

There is a lobe on the posterior margin of the pronotum and its apex is distinctly incised in both sexes but it lacks an upright projection (Plate 9A). The tips of the inner branches of the upper appendages cross over (Plate 9B) and the internal tooth on the lower appendages is much smaller than in *I. elegans* (d'Aguilar *et al*. 1986; Dijkstra *et al*., 2020; Askew, 2021). The colour of the face, thorax, pronotum and the base of the abdomen are usually green in males and andromorph females (Dijkstra *et al*., 2020). It usually inhabits standing water, but has been recorded in running water (d'Aguilar *et al*., 1986).

A   B

Plate 9. *Ischnura genei*. (A) Dorsal view of the pronotum showing the projection on its rear edge, (B) Rear view of the inner and outer branches of the upper appendages. From Dijkstra *et al.* (2020). Artwork by Richard Lewington.

Ischnura graellsii (Rambur, 1842) Iberian Bluetail

The lobe on the posterior margin of the pronotum is very small in both sexes and lacks an upright projection (Plate 10A). The tips of the inner branches of the upper appendages diverge and the tips of the lower appendages point inwards (Plate 10B). There is no internal tooth on the lower appendages. In both sexes the postocular spots and antehumeral stripes tend to be reduced or absent (Dijkstra *et al*., 2020; Askew, 2021). The wings are narrower and the tibiae shorter than in *I. elegans* (Monetti *et al*., 2002). It inhabits standing water and can tolerate slightly brackish conditions (d'Aguilar *et al*., 1986; Askew, 2021).

A   B

Plate 10. *Ischnura graellsii*. (A) Dorsal view of the pronotum showing the projection on its rear edge, (B) Rear view of the inner and outer branches of the upper appendages. From Dijkstra *et al.* (2020). Artwork by Richard Lewington.

Discussion

Dragonflies are often used as indicators of the quality of freshwater systems. Harabiš & Hronková (2020) noted that to protect freshwater ecosystems we need to understand the traits of individual species. Accordingly, they have initiated a comprehensive European database, listing those features of both larvae and adults which they consider important for understanding interactions with their environment (Shipley, 2010). For *Ischnura elegans* 38% of the morphological features, 91% of habitat characteristics, 63% of dispersal and territoriality, 71% of reproduction and 78% of the life cycle details are recorded (Harabiš & Hronková, 2020).

Behaviourally, *Ischnura elegans* differs from most zygopterans in being active in cool and dull weather, having rapid maturation, some females remaining at water and a very long mating time (Parr, 1973b).

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