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Field Guide to the Dragonflies of Britain and Europe

Second edition

Klaas-Douwe B Dijkstra
Asmus Schröter
Illustrated by Richard Lewington

BLOOMSBURY

Field Guide to the

Dragonflies

of Britain and Europe

including western Turkey and north-western Africa

SECOND EDITION

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With such a large and expert team it was not always easy to agree on how this 'next generation' field guide, as we liked to call it, should take form. As one author put it after another discussion: 'Editing: the final frontier… To boldly rewrite what everybody has written before…' We hope to have 'boldly rewritten' something new, that will take many on exciting voyages of odonatological enterprise.

K-D B Dijkstra and Richard Lewington

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Thoughts on field guides

▲ *Erythromma najas* pair mating.

I got my first field guide, to the birds of Europe, at the age of nine. We lived in Egypt, however, so on my tenth birthday I began to write and draw my own book. Then, with no reference for them at all, I started to describe and name dragonflies at the age of 12. Later, I'd learn that my 'blood-red dragonfly' and 'grass dragonfly' were the male and female of just one species, now called the Broad Scarlet. Eight years after naming one 'hairy dragonfly' as a boy, my friends and I found the first Vagrant Emperor in the Netherlands. From that moment on, my passion for dragonflies was fully fledged. And so, when this book's first edition came out in 2006, I felt I was fulfilling my destiny.

Fourteen years later, the field guide (now available in five languages) remains my proudest achievement. Reaching about ten new users every day in its first ten years, it surfed on a surge of interest. The dragons themselves, meanwhile, advanced as summers warmed, or rebounded as habitats recovered, while others declined. Regional dragonfly societies flourished and published atlases, and by 2015 all of Europe's species had been mapped. Six more species were found in the area covered, of which two were new to science. Most other continents now have guides or handbooks too, allowin and online platforms to amass tens of thousands of records each year. In the coming years, all of the approximately 6,300 known species will be assessed for the IUCN Red List of Threatened Species, and as such Odonata will be the first insect order to be completed worldwide.

Few creatures represent fresh water – probably life's most precious resource – as vividly as do dragonflies, which emerge from their watery habitats and enter our lives on land to drive the message home. I'm often envious of the attention received by insects as pollinators, or by fish in freshwater conservation, and while people often ask what dragonflies are good for, their greatest value is actually not their use to us. We admire them first for their beauty, not for the mosquitoes they may devour. And we protect them first for the sake of their health and that of their – and thus our own – environment. Only such an unconditional attitude towards all of nature may cure us of our destructive demands.

Field guides initiate that conviction with one potent idea: species have identities to honour, just like people do. Each has a face, a name and a story. Every guide (whether a book, or its edified user) offers a route into life's overwhelming diversity, allowing us to get to know other life forms and come to love the realms they inhabit. Effectively, through identification, species 'become' a second time, now not into being but into being seen. Thus, we gain awareness of an infinite universe of parallel worlds, each occupied by another species and all of which are humanity's equal.

To me, therefore, field guides are ultimately about all destinies. Biodiversity lets us see Earth's crises of inequality at their true scale, as a force that affects everything. Does the power to command all living space also give the right to take it? Our challenge is not to answer that question, but to make it rhetorical. Perhaps one day a global field guide movement will emerge to drive the message home, one species – and one observer – at a time.

Klaas-Douwe 'K-D' B Dijkstra

Introduction

Studying dragonflies

Time and place

Although adult dragonflies may be found almost anywhere, at any time, certain places and times can provide especially good opportunities to see them. To understand where and when to look for them, some knowledge of their behaviour and ecology is necessary (see: Dragonfly behaviour, Dragonfly occurrence). Adult dragonflies are most easily found near fresh water, under warm conditions. This generalisation, however, requires some qualification. Although salt water is uninhabitable for dragonfly larvae, slightly brackish conditions are tolerated by a few species. Very cold and wild water, such as meltwater torrents, are avoided. Special habitats such as bogs, seepages and large rivers harbour specialised species, which may be rare or difficult to find. The richest assemblages of species are found at sunny and sheltered ponds, on lake shores, and on rivers and calm streams, especially where these have a variety of aquatic and waterside vegetation. Many adult dragonflies may also be found away from water while foraging. Rough meadows, woodland glades, forest edges, roadside verges and other places rich in insect prey are particularly good. Shy species, for instance members of the family Gomphidae, may be found more easily in such situations than at their breeding habitat.

The best time to look for dragonflies is at midday, in summer, with calm, sunny weather. Different species, however, have different periods of adult activity (see: Flight season). In most of Europe, a minimum of one visit during the period May–June and another in July–August will be necessary to see adults of all the present species. Rain and wind are not conducive to observing dragonflies, although unusual weather conditions can sometimes result in interesting discoveries: an influx of vagrants or invasions of southern species is often associated with favourable wind directions. The majority of species are most active in direct sunshine, with some even leaving the breeding habitat when it clouds over. Nonetheless, there are many species, especially damselflies, that are also active in overcast weather, provided it is sufficiently warm. Although activity is greatest around midday, certain behaviour can merit an excursion at the start or close of the day. For example, many hawker species (Aeshnidae) hunt most actively from shortly before sunset until dark, while two mate predominantly around sunrise. Emergence, especially of anisopterans, is concentrated in the early hours of the morning.

Watching and catching

A pair of close-focus binoculars is essential in order to examine details in the field. Many people prefer the compact binoculars that fit into a breast pocket, but the better optics of a good pair of binoculars is well worth the investment. You should at least be able to focus up to just in front of your feet. However, many details cannot be seen even with good optical equipment, making a net indispensable (see: Dragonfly identification). Numerous species, especially in southern regions, can be identified reliably only at close quarters. The speed and agility of dragonflies demands a fairly large, light net – the type used for butterflies is generally suitable (net opening about 40–75cm wide, handle about 1–2m long). The net must be deep enough to fold closed, so the catch cannot escape. A net with a handle composed of loose segments or a telescopic rod is useful as the length can be varied. Dragonflies are best held with the wings folded together between the thumb and forefinger. Larger species (especially anisopterans) can be held at the thorax or legs, provided at least three legs (on one side) are grasped.

Although most dragonflies are sturdy and not easily damaged, careless or prolonged handling (especially with sweaty fingers) may lead to the loss of legs or damage to the wing membrane. Tenerals are too soft to handle safely. Some people object to the capture of animals, including dragonflies, but most individuals fly off unharmed after capture if handled carefully. Numerous studies in which dragonflies were caught, marked and released have shown that this procedure does not increase mortality. The impact on populations is negligible, and on the individual itself is probably minimal. Whether one catches dragonflies is a personal choice, and it is always good to bear in mind that some may prefer to see dragonflies behaving freely, rather than close up in the hand. The conservation status of a species should also be considered (see: Status). The protected status of certain species, and wildlife as a whole, also differs between nations, as do laws and attitudes concerning land access and the capture or collecting of dragonflies.

▲ Dutch dragonfly watchers focus in on a *Coenagrion armatum* in the Weerribben, shortly after the species' rediscovery in the Netherlands.

Research and collecting

Inspired by their beauty, mystery or dynamism, some may wish to develop an initial admiration of dragonflies into a more profound understanding of their distribution, behaviour, relationships or conservation. Yet surprisingly little is known about many aspects of these insects. There are huge gaps in the known distribution ranges, which are, moreover, changing (see: Range). In some regions, especially in south-eastern Europe, the taxonomic status of certain species is poorly known and demands critical examination of relevant characters. The status of most subspecies, in particular, is unclear (see: Scientific names, Subspecies). Besides establishing the correct names of dragonflies, such research may clarify how colonisations, extinctions and hybridisation have shaped our present-day dragonfly fauna (see: Range). The increased application of molecular techniques may be particularly useful in clarifying many of these issues. Aside from this more geographically oriented research, numerous challenges lie in ecological and behavioural studies. The life history of many species is poorly known, with simple questions, such as the length of larval development, still unanswered. Such answers may, for instance, explain how the rapid colonisation of new habitat by some species is physically possible, while others are vulnerable to change.

Most research requires some handling of dragonflies and, in many cases, the collection of specimens. As with catching dragonflies (see: Watching and catching), it is important to know the purpose of collecting. Some species, especially in the south-east of the region covered by this guide, can be identified reliably only under magnification. In such cases, a collected specimen is the best way to document a record, for instance of a range extension. In many areas, collecting is not essential as proof of a record (photographs generally suffice), but may be a tool to familiarise oneself with a species. In any case, it is important to document special records, as it is always possible to overlook details in the field that cannot be reproduced later.

If you are considering creating a collection, it is a good idea to contact a national or regional natural history museum, not only for advice, but also to ensure that material is preserved for posterity. Nowadays, most dragonflies are not pinned like butterflies, but kept in small plastic or paper envelopes. The most suitable preservation agent is acetone. Dragonflies that are soaked in acetone (which also kills them) for a night up to a maximum of 24 hours are dehydrated and dry quickly on exposure to air, limiting discoloration and decay. It should also be remembered that most of our species can be identified by their larval skin (exuvia), and collecting these is a less invasive alternative to collecting adults; they merely need to be dried.

A contemporary argument for collecting is its application in the analysis of dragonfly genes. Complex questions about the age, origin and relationships of species, subspecies and populations can be answered only with sufficiently large samples, spread across a representative geographical range. It seems likely that geneticists will increasingly seek the help of dragonfly observers. Although DNA can be extracted from dry samples, its structure may deteriorate with time. Preservation in concentrated alcohol (70% or more) is more reliable. In most cases, a single leg provides enough material for molecular purposes. Extracting DNA from exuviae seems ideal, as it does not require killing or damaging individuals, but it probably works only with very fresh, correctly preserved samples.

Literature

Many nations covered by this guide have regional societies, journals, mapping schemes, distribution atlases and/or handbooks. Altogether, hundreds of titles, in various languages, now exist on dragonflies. This is only a selection of books of either a general or comprehensive nature:

Boudot, J-P & Kalkman, V J (editors) 2015 *Atlas of the European dragonflies and damselflies*. KNNV Publishing, Zeist. 381pp. Comprehensive reference to the taxonomy, ecology, conservation and regional and global distribution of British and European species.

Boudot, J-P, Kalkman, V J, Azpilicueta Amorín, M, Bogdanović, T, Cordero Rivera, A, Degabriele, G, Dommanget, J L, Ferreira, S, Garrigós, B, Jović, M, Kotarac, M, Lopau, W, Marinov, M, Mihoković, N, Riservato, E, Samraoui, B & Schneider, W 2009 *Atlas of the Odonata of the Mediterranean and North Africa*. Libellula Supplement 9: 1–256. Complement to the European atlas, also treating the species from Turkey and North Africa covered by this guide.

Brochard, C, Groenendijk, D, van der Ploeg, E & Termaat, T 2012 *Fotogids Larvenhuidjes van Libellen*. KNNV Publishing, Zeist. 320pp. Sublimely illustrated guide to north-western European exuviae.

Brochard, C, & van der Ploeg, E 2014 *Fotogids Larven van Libellen*. KNNV Publishing, Zeist. 272pp (both in Dutch). Sublimely illustrated guide to north-western European larvae.

Cham, S 2012 *Field guide to the larvae and exuviae of British dragonflies.* British Dragonfly Society, Peterborough. 152pp. Excellent alternative to Brochard et al. (2012) and Brochard & van der Ploeg (2014), for British species only.

Corbet, P S 1999 *Dragonflies: behaviour and ecology of Odonata.* Harley Books, Colchester. 829pp. Most comprehensive and detailed scientific account of all aspects of the group's life history yet written.

Paulson, D 2019 *Dragonflies and damselflies: A natural history.* Ivy Press, Brighton. 224pp. Richly illustrated popular introduction to the world's species.

Suhling, F, Sahlén, G, Gorb, S, Kalkman, V J, Dijkstra, K-D B, & van Tol, J 2015 *Order Odonata*. In: Thorp, J & Rodgers D C (editors). Ecology and general biology. *Thorp and Covich's freshwater invertebrates*. 4th edition. Academic Press: 893–932. General but detailed introduction to the order's diversity, morphology and habits.

Wildermuth, H, & Martens, A 2018 *Die Libellen Europas.* Quelle & Meyer, Wiebelsheim. 957pp (in German). Most detailed ecological and photographic account of the species found in Europe, from the Azores to the Urals.

Dragonfly behaviour

The limitations of space and the focus on identification mean that this guide does not include an extensive section on the ecology and life cycle of Odonata. In the species texts, only diagnostic behaviour that may aid identification is provided, e.g. tandem oviposition in a genus where solitary oviposition is the rule. However, numerous informative introductions about dragonfly biology exist in print (see above), including the monumental scientific treatise by Corbet (1999), as well as online. There are three elementary facts of dragonfly biology that explain most peculiarities of their behaviour:

1. Dragonflies are amphibiotic Larvae live in water, adults on land and in the air. The larva sheds its skin several times underwater, allowing it to grow. When it is fully grown, the larva leaves the water, moults a final time, expands its wings and abdomen and, when these have hardened sufficiently, flies off as an adult dragonfly. This is known as emergence; dragonflies

▲ *Sympetrum danae* pair mating. Dragonflies have a unique way of copulating, for which the males have specialised secondary genitalia.

do not pupate. The final larval skin, the exuvia, can be found at the waterside as proof of a completed life cycle at that site.

2. Dragonflies are obligate carnivores All species hunt, both as larvae and adults. Most prey is invertebrate, especially insects, but a large larva may, for instance, eat tadpoles or small fish.

3. Dragonflies have a unique mode of reproduction, with indirect insemination and delayed fertilisation Sperm is transferred by the male from the abdomen tip, where it is produced, to the secondary genitalia at his abdomen base, from where it is passed on to the female. Other animals either transfer sperm indirectly outside the body, or directly. Eggs are fertilised when they are laid, allowing males to remove sperm of rival males when they succeed in copulating with a mated female.

These facts have many consequences for dragonfly behaviour, explaining such characteristic sights as the fierce defence of waterside territories by males (good larval habitat, to which potential mates are lured when their eggs have matured), feeding swarms (e.g. where flying ants emerge), the heart-shaped mating wheel (achieved when insemination from the secondary genitalia takes place) and the male hovering above the female as she oviposits (guarding her against rivals that may attempt to replace his sperm with their own).

Dragonfly occurrence

The guide covers all species of Odonata that occur in the wild in Europe and Turkey west of Moscow and the line Samsun–Iskenderun, in north-western Africa up to the northern fringe of the Sahara, and on the islands of Cyprus, Madeira, the Canaries and the Azores. Species that have accidentally been introduced to our area, such as those imported with tropical plants as larvae, are not covered in the guide as none have been known to survive in the wild.

Given the large geographic area covered in this guide, there is no room to discuss each regional detail of occurrence in space (e.g. distribution and habitat), time (flight period) and the interaction of both these factors (decline, invasions). For example, *Aeshna juncea* inhabits most types of standing water at higher altitudes and latitudes, but in the low-lying areas of central Europe it is largely confined to acidic water, such as bog lakes. The habitat and location influence temperature and food availability, which in turn determine larval growth and adult emergence. Such scenarios are too complex for compact species texts, in which we have tried to describe general characteristics and mention only broad regional variation. This complexity is exacerbated by the lack of information for many areas, and the degree of recent change that has been observed. The many remaining 'white spots' and the dynamics of dragonfly distribution make future research urgent and, while attempting to provide information that is as up to date as possible, we call on the users of the field guide to contribute to that research.

Status

The abundance of a species in an area is susceptible to change in both the long and short term. Many species are known to have suffered as a result of the destruction and degradation of their habitats. One-fifth of the species covered in this field guide are listed either on the IUCN Red List of Threatened Species or the European Habitats Directive, and a similar number occur only in Europe and adjacent north-western Africa (see table opposite). Together, this means that, while two-thirds of our species are safe in their huge ranges stretching into Asia and Africa, almost a third deserve our direct conservation attention. Many additional species are included on national or regional red lists.

While some species are threatened with decline, numerous species have expanded or consolidated their range in recent years. These are mostly southern species such as *Erythromma viridulum*, *Anax imperator* and *Crocothemis erythraea*, which have benefited from the warm summers since the 1990s. Their increase is often not gradual, but invasive. With suitable weather, many individuals of *Aeshna affinis* or *Sympetrum fonscolombii* may appear and breed in an area where previously they had been rare or unknown. Some more eastern species are also known to be eruptive (such as *Sympetrum flaveolum*) or expansive (*S. pedemontanum*) in their occurrence. While many species have suffered through habitat change, others such as *Chalcolestes viridis* and *Orthetrum cancellatum* may benefit from ponds or gravel pits created by humans.

Range

The current distributions of dragonflies in our region were shaped by the impact of the ice ages on their environment and the species' capacities to colonise changing landscapes. Many dragonfly species were probably completely obliterated by the relatively severe glaciation in western Eurasia. As a consequence, our fauna is much poorer than that of other temperate regions such as Japan and North America. The fauna in most areas is relatively young, as the most recent glaciation ended only about 10,000 years ago. The most characteristic patterns are:

1. Southern species Although Europe was never entirely covered by ice, large areas were inhospitable to many species, and continued so for long periods after glaciation. These species survived glaciation where warm conditions persisted, recolonising as the landscape recovered. Such climatically favourable pockets probably lay near both ends of the Mediterranean Sea. Species with a distinctly south-western European range are thought to have survived at the western end – *Boyeria irene*, *Macromia splendens* and *Oxygastra curtisii* are the most charismatic examples. *Epallage fatime* and *Caliaeschna microstigma* just enter Europe in the Balkans, and must have survived somewhere at the eastern end; their closest relatives live in tropical Asia. Other species now range so widely that it is hard to trace their origin.

2. Northern species The species that were most tolerant of cold were able to expand their range when taiga and tundra dominated the European landscape, but became confined to high altitudes and latitudes as the world warmed up. Examples of such 'boreo-alpine' species are *Aeshna caerulea* and *Somatochlora alpestris.*

3. Eastern species These take a position between the southern and northern species, inhabiting an intermediate temperature range. They expanded from the east, and are associated with temperate woodlands and bogs. *Aeshna grandis* and the *Leucorrhinia* species are examples of dragonflies that are common in north-eastern Europe and Siberia, but peter out further west, often being confined to highlands. The fragmented fringes of their

Species	End.	Red List	Eur.	Med.	HD
Lestes macrostigma			VU	NT	
L. numidicus	N	DD		DD	
Sympecma paedisca				EN	IV
Calopteryx exul	N	EN		EN	
C. haemorrhoidalis	E+N				
C. xanthostoma	E				
Platycnemis acutipennis	E				
P. latipes	E				
P. subdilatata	N				
Ceriagrion georgifreyi		VU	CR	VU	
C. tenellum	E+N				
Coenagrion caerulescens	E+N				
C. hylas			VU		II+IV
C. intermedium	E	VU	VU	VU	
C. mercuriale	E+N	NT	NT	NT	II+IV
C. ornatum			NT	NT	II
C. syriacum		NT		NT	
Ischnura fountaineae			VU		
I. genei	E				
I. graellsii	E+N				
I. hastata			VU		
I. intermedia		NT	NT	NT	
Nehalennia speciosa		NT	NT	CR	
Pyrrhosoma elisabethae	E	CR	CR	CR	
Aeshna viridis			NT		IV
Anax immaculifrons			VU		
Boyeria cretensis	E	EN	EN	EN	
B. irene	E+N				
Gomphus graslinii	E	NT	NT	EN	II+IV
G. lucasii	N	VU		VU	
G. pulchellus	E				
G. simillimus	E+N			NT	

Species	End.	Red List	Eur.	Med.	HD
Lindenia tetraphylla			VU	NT	II+IV
Onychogomphus assimilis		VU		EN	
O. boudoti	N	CR		CR	
O. costae	E+N	NT	EN	NT	
O. flexuosus		VU		VU	
O. macrodon		VU		VU	
O. uncatus	E+N				
Ophiogomphus cecilia					II+IV
Stylurus flavipes				NT	IV
Cordulegaster bidentata	E			NT	
C. boltonii	E+N				
C. helladica	E	EN	EN	EN	
C. heros	E	NT	NT	VU	II+IV
C. insignis			EN	NT	
C. picta			VU	VU	
C. princeps	N				
C. trinacriae	E	NT	NT	NT	II+IV
Oxygastra curtisii	E+N	NT	NT	NT	II+IV
Macromia splendens	E	VU	VU	VU	II+IV
Somatochlora borisi	E	VU	VU	VU	
Brachythemis fuscopalliata		VU		VU	
Leucorrhinia albifrons				EN	IV
L. caudalis				NT	IV
L. pectoralis					II+IV
Libellula pontica		NT		NT	
Orthetrum nitidinerve	E+N		VU		
Sympetrum depressiusculum			VU	VU	
S. (striolatum) nigrifemur	N				
Zygonyx torridus			VU	NT	

International conservation status of species

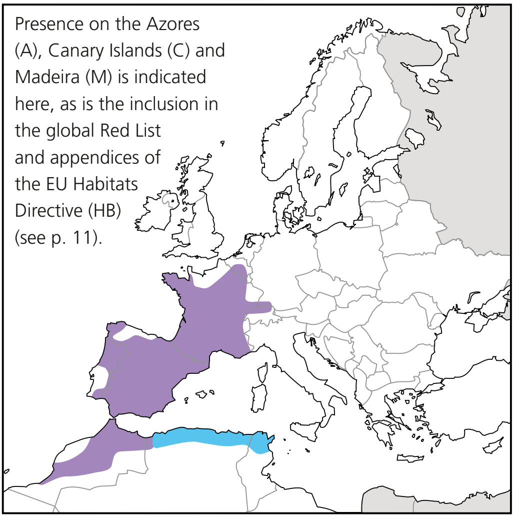
Species are endemic (**End.**) to Europe (**E**), north-western Africa (**N**) or both (**E+N**). They are assessed for the IUCN Red List (2019) as Critically Endangered (**CR**), Endangered (**EN**), Vulnerable (**VU**), Near Threatened (**NT**) or Data Deficient (**DD**), either globally (**Red List**) or within Europe (**Eur.**). The inclusion of species in the EU's Habitats Directive (**HD**) on Appendix **II** (species must be included in a national network of protected habitats) and/or **IV** (survival of national populations must be ensured) is also indicated, as is the Red List status in the Mediterranean Basin (**Med.**) for selected species.

ranges may be explained by a combination of only partial colonisation, as well as numerous subsequent local extinctions.

Although not all distribution patterns fall clearly into one of the above scenarios (some species may have survived in several areas), in general they explain most of what we see today. The distribution of the three *Erythromma* species, for instance, suggests that they each developed from a single ancestor that was isolated in three areas: in the south-west (*E. lindenii*), south-east (*E. viridulum*) and east (*E. najas*). Nowadays, these species overlap but cannot interbreed. A similar scenario fits the genus *Platycnemis*. Populations that diverged genetically in isolation, but are still able to interbreed to variable degrees where they meet, may explain the complexity of *Calopteryx splendens* subspecies.

Maps

As a result of the dynamic nature of dragonfly ranges (see: Status) and the recent increase in recording intensity, we have attempted to be as up to date as possible in the species texts and distribution maps. Maps show the general range of species and are intended to facilitate the identification process. For any further details on distribution and precise regional occurrence of species we refer to the Atlas of the European dragonflies and damselflies (see: Literature p. 8). Nonetheless, great gaps in our knowledge remain. The most glaring blind spots are in Algeria (except the extreme north-east) and Russia, although large areas with low research intensity such as Fennoscandia, Spain, Romania, Belarus and Ukraine also require more data. Regions that are important for species of taxonomic or conservation concern, such as the southern Balkans, Turkey, Portugal and Poland, also need more work. Only the triangle formed between Ireland, Germany and Italy is really known well, but even there continuous monitoring is required as species decline or increase. With this in mind, it will be clear that the distribution maps in the guide are an estimate of species' ranges: data are still insufficient for many areas, and some regional recording schemes are only in a preliminary phase of preparation. In those regions, the presented ranges are sometimes founded on expert judgement. Thus, valuable new discoveries are possible everywhere.



Presence on the Azores (A), Canary Islands (C) and Madeira (M) is indicated here, as is the inclusion in the global Red List and appendices of the EU Habitats Directive (HB) (see p. 11).

Map key

Purple: main area of distribution; dots indicate either isolated populations or single records.

Blue: range of non-overlapping close relative, e.g. *Gomphus lucasii* on *G. simillimus* map.

Habitat

Considering the size of the region covered and the huge range of many species, it is difficult to provide comprehensive descriptions of each species' habitat. Many species have very specific requirements at the edge of their range but are more tolerant towards the centre. Central to each species' requirements is, of course, the water in which the larvae breed, but its surroundings are also important as a home to the adult dragonfly. A suitable pond may be devoid of larvae if forest for the adult's shelter is not available nearby. The primary determinants of dragonfly habitats are, in approximate order of importance:

▲ *Chalcolestes viridis* female ovipositing into a willow twig. Recognising the requirements of both the larva and adult is important in understanding a species' habitat preferences.

1. Water motion: flowing vs standing The majority of species are either wholly confined to water with a current (streams, rivers) or to still waters (ponds, lakes). This strict dichotomy operates at a high taxonomic level. The families Platycnemididae and Gomphidae, for instance, are almost entirely restricted to running water, while Coenagrionidae and Libellulidae are strongly associated with still-water habitats. These differences may be determined by the higher concentration of dissolved oxygen and the different bottom substrates (e.g. stones, sand) that are associated with moving water; some river species find suitable conditions provided by the motion of the waves along lake shores.

2. Water permanence: temporary vs permanent Many species are intolerant of the desiccation of their habitat, or the temperature fluctuations that are associated with water-level changes. Others, with drought-resistant eggs or larvae, may profit from the warm (and predator-free) conditions that prevail in shallow, ephemeral pools, stimulating rapid larval growth (e.g. *Chalcolestes, Lestes*, *Sympetrum*).

▶ A mass of Water-soldier (*Stratiotes aloides*) in a ditch in East Anglia, UK, where it is the main plant used for oviposition by *Aeshna isoceles*. On the continent this is the exclusive habitat of *A. viridis*.

3. Vegetation The presence and structure of submerged, floating, emergent or waterside plants provides a complex array of microhabitats for roosting, perching, oviposition and larval survival. Few relationships between plants and dragonflies are as simple as the preference of *Aeshna viridis* for Water-soldier (*Stratiotes aloides*) swamps, or that of *Nehalennia speciosa* for swathes of fine-leaved sedges (*Carex*).

4. Water chemistry The trophic status and pH of waterbodies influence their bottom substrate, vegetation and water clarity. Extreme conditions such as acidified or eutrophic lakes often support large numbers of only a few species, while intermediate conditions may harbour more diverse assemblages of specialised species. Such chemical balances are highly sensitive to environmental change, making dragonflies of mesotrophic lakes among the most vulnerable in our area.

Of course, these four factors, and the diverse variables they encompass, are intricately interrelated, as are the responses of dragonflies to them in their different life stages. Moreover, complex factors such as parasitism, predation and competition between dragonfly species for resources such as food further influence the suitability of a habitat for a species' survival.

Flight season

The life cycle of dragonflies, and thus the period in which the adults are on the wing, is determined largely by larval development. The adult dragonfly can emerge only once its larval development is complete. Larval growth rate is governed by water temperature and availability of food, which depend on habitat. As a result, flight periods differ regionally, but also annually. In the species texts, a general impression of seasonality is given, but it will always be possible to find adult individuals before or after the dates indicated.

In temperate regions, the warm season is generally too short to allow the emergence of more than one generation each year, but there is a notable dichotomy between species in which the larvae grow to their maximal size before winter or after it. Once the water warms up in spring, species with mostly full-grown larvae can emerge in great numbers as soon as conditions are favourable. The period in which most adults appear is therefore short and early, on average. Such species are known as 'spring species'. Larvae that are still small at the end of winter (or have yet to hatch from the egg) cannot emerge until their development is complete. The emergence of these so-called 'summer species' is spread out across a longer and, on average, later part of the warm season.

Although most species have only a single abundance peak each year, some are most numerous in two distinct periods. There may be various reasons for this. *Anax imperator* can complete its life cycle in one year and behave like a summer species, or in two years like a spring species. Sometimes both types inhabit the same water. *Sympecma* species are unusual because they hibernate as adults; the adults die after breeding in spring, and the next generation emerges in late summer and autumn, hibernating over winter. In arid regions (e.g. northern Africa), breeding habitats may dry up in summer. Adults are seen there only in spring when they emerge, they aestivate elsewhere (e.g. in montane forests) and they then return in autumn when rains replenish their habitat. Aestivation is the opposite of hibernation, although siccatation (inactivity during the dry season) is a better term, as it is the unfavourable dry season between emergence and breeding that the adults must survive. Warm conditions may allow fast-growing species such as *Sympetrum fonscolombii* to have several successive generations in one year. Influxes of this migratory species into central Europe may be early enough in spring to allow the development of a local generation by the end of the summer. The perpetual succession of generations is possible in some species in hot areas, such as at the fringes of the Sahara.

Dragonfly names

Some readers will prefer the familiarity of vernacular names, while others favour the international solidity of scientific nomenclature. We therefore provide both types of names. One must bear in mind, however, that any name is susceptible to interpretation and therefore to change.

Scientific names

Although the taxonomy of European Odonata is generally well resolved, some problems remain and there are often inconsistencies in the usage of scientific names. In recent literature and on the Internet, for instance, the alternative genus names *Anaciaeschna* for *Aeshna isoceles*, *Lestes* for *Chalcolestes viridis* and *Gomphus* for *Stylurus flavipes* are still frequent, as are incorrect spellings of the species names of *A. isoceles*, *Cordulegaster bidentata* and *Sympetrum fonscolombii*. This indicates a lack of consensus, generally brought on by the uncritical practice of those proposing and adopting name changes. Our choices for the affiliation of species to genera and whether certain subspecies are better treated as species are summarised in Appendix 1, while a checklist is provided in Appendix 3.

Vernacular names

Familiar names are instrumental in promoting dragonflies, and must be as applicable, compatible and usable as possible. The discussion on English names for European species has seen polarisation rather than consensus, producing a fragmentary and debated array. We saw the need to develop standardised international names for all species covered (see: Appendix 2). Sometimes these deviate from names used (or proposed) by the British Dragonfly Society, which have a more regional focus, and we provide those as alternatives. Alternative names for our species used in North America (NA) are also provided.

Dragonfly identification

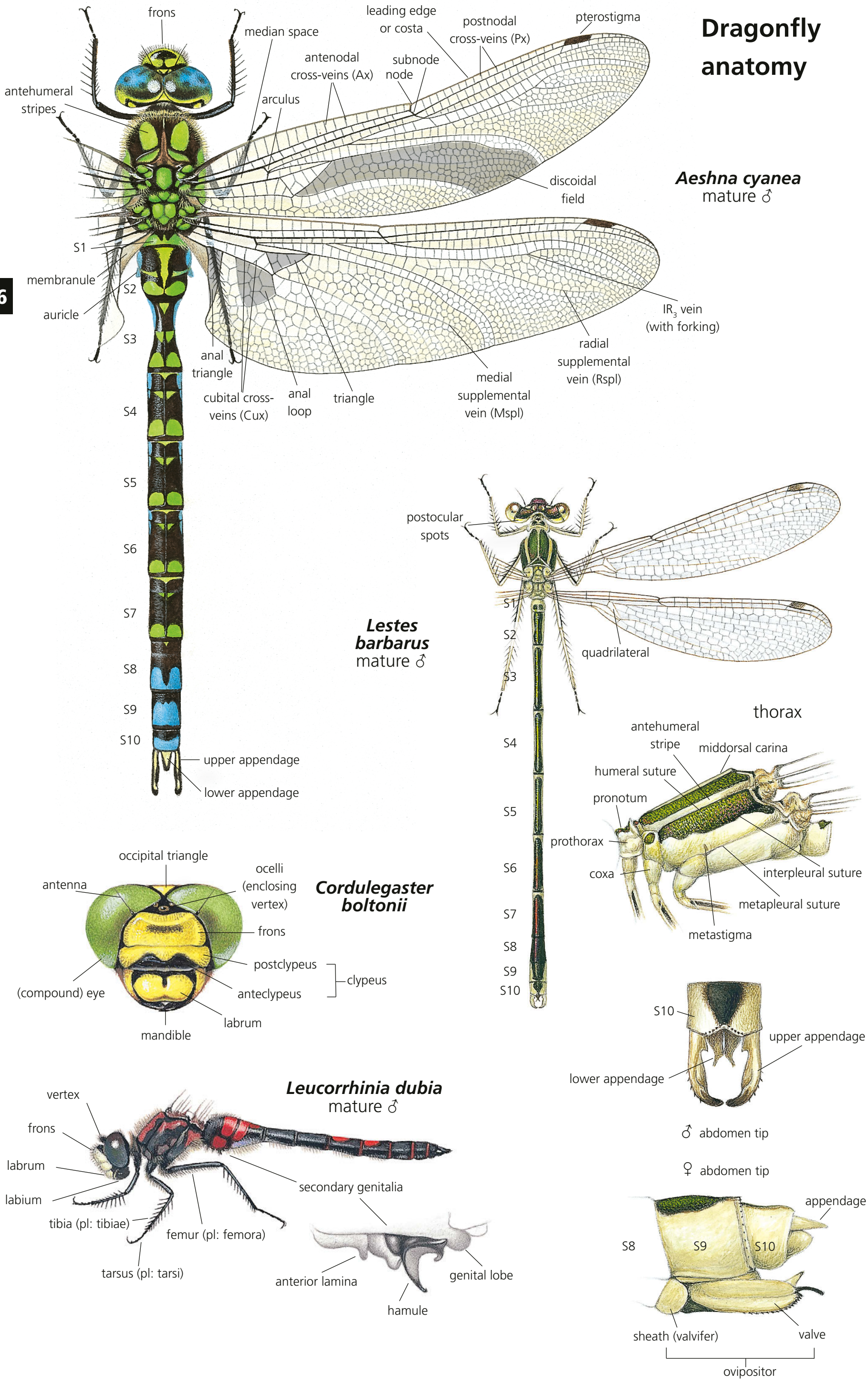
In this guide the illustrations form the basis for identifying species, and descriptions and diagnostic tables have been kept to a minimum, focusing on the diagnosis of a species and essential details of habitat, status and range. However, when identifying dragonflies, readers should be aware of their variability, especially in size, colour and markings. This range of variation cannot be covered fully in the artworks, or even in the text, but, despite this, dragonfly identification is not difficult. Once the observer knows the general differences between male and female or young and old individuals, it becomes easy to correct for variation that at first seems confusingly complex (see: Measurements, Field characters, Variation).

A lavishly illustrated field guide invites a different usage than a traditional identification manual with dichotomous keys. We expect users to approach species identification mainly through the artwork, comparing the insect in the field with similar illustrations before consulting the text. Tables to genera and species have been designed as reminders of the main characters and groups of similar species, or as simplified tools to select the best way forward where identification is complex (e.g. with many similar species). The tables (or any identification key, for that matter) should not be seen as the rigid presentation of perfectly reliable characters. Such perfection is utopian, considering the variability and complexity of dragonfly characters. Because of this and because of the numerous ways in which characters are presented in the book, we advocate an ‘organic’ approach to species identification. Feel free to browse through the information provided and try different routes from seeing a dragonfly to naming it, e.g. via the artwork or by trying a diagnostic table first. The most diagnostic (and thus decisive) information is always presented in the species texts, rather than in the tables or the annotation accompanying the artwork.

Anatomy and terminology

A little knowledge of how a dragonfly’s body works may help the observer to understand its topography. Built as aerial, visually inclined predators, dragonflies have large compound eyes to track their prey, powerful but flexible wings to give chase and strong, forward-directed legs to catch their prey. The male is equipped for the unique reproductive behaviour of Odonata (see: Dragonfly behaviour), with secondary genitalia on the underside of the abdomen base and claspers at its tip to hold the female. The female abdomen tip is either equipped with an ovipositor to insert eggs into plant tissues (Zygoptera and Aeshnidae), or a vulvar scale through which eggs are deposited into the water (all other Anisoptera).

Dragonfly anatomy



Glossary of terms, abbreviations and synonyms

Abdomen Posterior portion of body, comprising ten segments and terminating in appendages.
Accessory genitalia See: secondary genitalia.
Aestivation Change in adult activity in order to survive summer, e.g. moving to cooler areas. Antonym: hibernation. See also: siccatation.
Amber Yellowish or orangey colour typically seen at the wing base of many anisopterans.
Amphibiotic Aquatic as a larva, but terrestrial in the adult stage.
Anal loop Distinct field of cells in the anisopteran hindwing base; its shape is determined by a vein that loops around the field, starting close to the posterior corner of the triangle and ending close to the wing base. See text on identifying Corduliidae and relatives (p. 30).
Anal triangle Triangular field of two or more cells next to the membranule in the hindwing base of many Anisoptera.
Andromorph Presence of colours typical of mature male in female. Synonym: androchrome, homeomorph, homeochrome. Antonym: gynomorph.
Anisopteran Pertaining to the suborder of true dragonflies (Anisoptera).
Anteclypeus See: clypeus.
Antehumeral stripes Pale stripes on the thorax in front of the humeral suture. See text on identifying Coenagrionidae (p. 24).
Antenodal cross-veins Cross-veins that lie along the anterior wing border between node and base. Abbreviation: Ax, antenodals. See text on identifying Anisoptera (p. 26) and Libellulidae (p. 31).
Anterior Lying at the front, i.e. towards the head. Antonym: posterior.
Anterior lamina Transverse structure of secondary genitalia that lies in front of hamules.
Apex Extreme tip. Antonym: base.
Apical At or towards the tip. Antonym: basal.
Appendages Extremities at the end of the abdomen. In male dragonflies there are upper and lower appendages, which are used to clasp the female on the head (Anisoptera) or the pronotum (Zygoptera) during mating and when in tandem. Synonym: Anal appendages.
Appressed Pressed against the body.
Arculus Thick, bracket-like cross-vein that lies centrally in wing near base. Two longitudinal veins branch off the arculus.
Auricles Ear-like structures on sides of S2 in males of some Anisoptera.
Ax See: antenodal cross-veins.
Basal At or towards the base. Antonym: apical.
Bridge space An elongate triangular space on the basal side of the subnode. See text on identifying Libellulidae (p. 31).
Carina Keel- or ridge-like structure on thorax or abdomen. Plural: carinae.
Clypeus Middle portion of face, between frons and labrum, consisting of a lower/anterior (anteclypeus) and an upper/posterior part (postclypeus).
Coloration Pattern of colours and markings.
Converge Coming together terminally. Antonym: diverge.
Costa Thick vein on leading edge of wing, running from base to tip.
Coxa Segment of leg that connects it to the thorax ('hip'). Plural: coxae.
Cubital cross-veins Cross-veins in the wing between the triangle and the wing base. Abbreviation: Cux. See text on identifying Corduliidae (p. 30).
Cux See: cubital cross-veins.
Denticles Minute black teeth covering parts of the body.
Denticulate Bearing denticles.
Diapause A state of suspended development that may occur at one or more stages in the life cycle and that typically constitutes an anticipatory response to conditions unfavourable for uninterrupted development.
Discoidal cell Conspicuous (group of) cells near wing base, known as the quadrilateral in Zygoptera and the triangle in Anisoptera (see those definitions).
Discoidal field Field of cells that extends distally from the triangle towards the wing border. See text on identifying Libellulidae (p. 31).
Distal Away from the body. Antonym: proximal.
Diverge Going apart terminally. Antonym: converge.
Dorsal On or towards the upperside. Antonym: ventral.
Dorsal carina Central ridge over length of abdomen upperside.
Dorsum Upperside, literally back. Antonym: venter.
Eclipse Overlap of structures, so one is concealed by another when seen from a certain direction.
Emergence The moment when the dragonfly larva leaves the water, sheds its skin and departs as a flying adult.

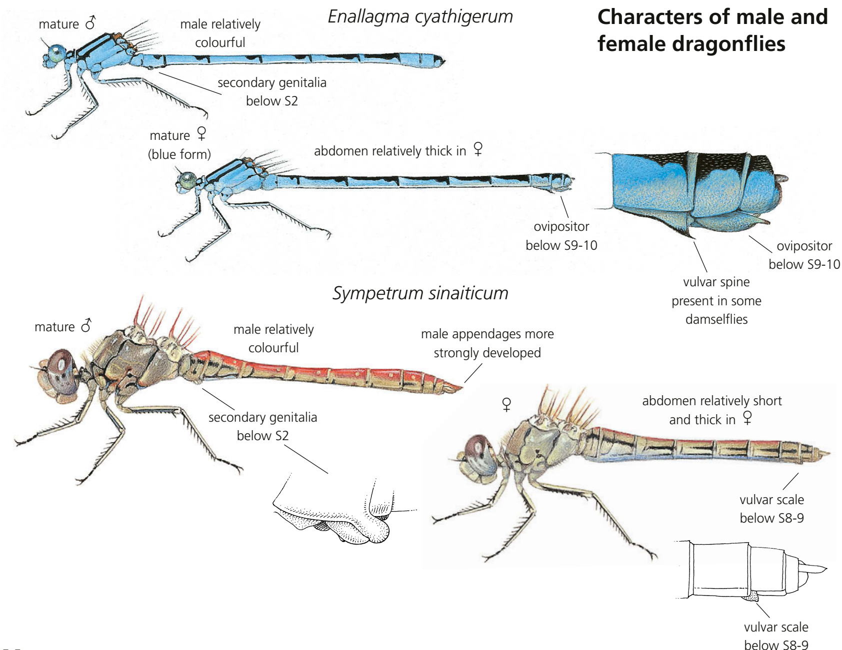
Exuvia The shed larval skin. Plural: exuviae.
Femur Long and relatively thick leg segment above the 'knee' ('thigh'). Plural: femora.
Foliation Leaf-like expansion on terminal abdomen segment ('flaps').
Form Discrete alternative appearances of individuals within populations, especially in colour of females.
Frons Dorsal part of face, i.e. the 'nose' or 'forehead'.
Fw Abbreviation for forewing.
Genera See: genus.
Genital lobes Ventral expansions of S2 that in secondary genitalia lie behind the hamules.
Genus A category in which species are classified, e.g. *Lestes sponsa* belongs to the genus *Lestes*. Plural: genera.
Gynomorph Presence of typical dull colours in female. Synonym: heterochrome, heteromorph, gynochrome. Antonym: andromorph.
Hamules Grasping organs of secondary genitalia, most clear in Libellulidae where typically they consist of a hook (anterior) and a lobe (posterior).
Humeral stripes Black stripes on the humeral suture of the thorax. See text on identifying Coenagrionidae (p. 24).
Hw Abbreviation for hindwing.
Interpleural stripes Black stripes on the thorax below the humeral suture. See text on identifying Coenagrionidae (p. 24).
Iridescent Reflectively glistening.
Jizz General appearance or first impression that one obtains of a species in the field.
Labium Lip-like structure covering the mandibles on the underside of the head, i.e. the 'underlip'.
Labrum Lower portion of face, a lip-like structure shielding the mandibles from the front, i.e. the 'upperlip'.
Lateral Along the sides. Antonym: medial.
Lateral carina Ridge over length of each side of abdomen, separating upper- and underside.
Lower appendage(s) See: appendages. Synonym: inferior appendage(s), epiproct (in Anisoptera, which have one lower appendage), paraprocts (in Zygoptera, which have two).
Maturation period The immature period before the adult dragonfly is sexually mature; also the time when some dragonflies disperse to new breeding grounds.
Medial Along the middle. Antonym: lateral.
Medial supplemental vein Longitudinal vein without clear beginning or end points that lies centrally in the anisopteran wing, roughly below the node. Abbreviation: Mspl. See text on identifying Aeshnidae (p. 28).
Median space Field in wing between base and arculus, which is free of cross-veins in all Anisoptera except some Aeshnidae.
Membranule Roughly triangular opaque membrane (i.e. not transparent like the majority of the true wing membrane) on posterior side of the anisopteran wing base, largest in hindwing.
Mesostigmal plate Dorsal region of the thorax directly behind the pronotum; its structure is distinctive for some zygopteran females.
Metapleural stripes Black stripes on the metapleural suture, which is the most ventral and posterior suture on the thorax sides.
Metastigma Respiratory opening visible as a spot on side of thorax, just in front of metapleural suture.
Mid-dorsal carina Keeled central suture on front of thorax, separating left and right sides.
Mspl See: medial supplemental vein.
Node Kink or break in leading edge of wing, roughly midway between base and pterostigma.
Ocellus Light-sensitive organ appearing as a small single-lens eye; three of these lie between and/or in front of the compound eyes. Plural: ocelli.
Occipital triangle Dorsal, triangular portion of occiput (back of head) lying between the eyes in Anisoptera (except Gomphidae).
Odonate A member of the insect order Odonata, i.e. a dragonfly or damselfly.
Oviposition Egg-laying.
Ovipositor Apparatus used to lay the eggs into plant tissue, located beneath the terminal abdominal segments in females of Zygoptera and Aeshnidae (other females have a vulvar scale).
Postclypeus See: clypeus.
Posterior Lying behind, i.e. towards the rear. Antonym: anterior.
Postnodal cross-veins Cross-veins that lie along the anterior wing border between the node and pterostigma. Abbreviation: Px, postnodals.
Postocular spots Paired, contrastingly coloured pale markings next to the eyes on the back of the head in many damselflies. See text on identifying Coenagrionidae (p. 24).
Pronotal hindlobe See: pronotum.
Pronotum A shield-like plate covering the top of the prothorax; the shape of the rear edge hindlobe is diagnostic in many damselflies, especially females.
Prothorax Small separate portion of thorax behind the head, bearing the forelegs.
Proximal Towards the body. Antonym: distal.

Pruinescence See: pruinosity.
Pruinosity A waxy grey or bluish bloom that develops on various parts of the body as the dragonfly matures; especially noticeable on some male libellulids. Synonym: pruinescence.
Pseudopterostigma Replaces pterostigma in *Calopteryx* females; differs because it is not well marked and is crossed by veins.
Pt See: pterostigma.
Pterostigma Conspicuously thickened and often darkened area on leading edge of wings near wing tips, present in most odonates. Abbreviation: Pt.
Px See: postnodal cross-veins.
Quadrilateral Conspicuous four-sided cell (or series of cells) near the base of all wings in Zygoptera. See text on identifying Zygoptera (p. 22).
Radial supplemental vein Longitudinal vein without clear beginning and end points, that lies centrally in apical half of the anisopteran wing. Abbreviation: Rspl. See text on identifying Aeshnidae (p. 28) and Libellulidae (p. 31).
Rspl See: radial supplemental vein.
S1 First abdominal segment
S2–4 Second to fourth abdominal segment, etc.
Secondary genitalia Apparatus for storage and transfer of sperm, located beneath the male's abdomen base (S2). The male transfers sperm from his primary genitalia (in abdomen tip) to his secondary genitalia, enabling him to clasp (see: appendages) and inseminate the female at the same time. Synonym: accessory genitalia.
Siccatation Change in adult activity, e.g. reduced sexual activity, in order to survive periods of drought.
Sub- Prefix indicating proximity to a certain state, e.g. sub-basal is near but not exactly at the base.
Subnode Oblique vein that runs down from the node.
Subspecies Category in which discrete regional varieties of a species are classified.
Subtriangle Roughly triangular field of one or more cells that lies basal of the forewing triangle in some Anisoptera. See text on identifying Corduliidae (p. 30) and Libellulidae (p. 31).
Sutures Fine grooves separating parts of the body, e.g. on the thorax sides and in the face.
Tail-light Conspicuous patch of colour near end of abdomen.
Tarsal claws Paired hooks at tips of legs.
Tarsus Group of small terminal leg segments ('foot'). Plural: tarsi.
Teneral A newly emerged ('fresh') adult dragonfly, soft and shiny, without the full coloration of the mature adult.
Thorax Middle portion of body, bearing legs and wings.
Tibia Long and relatively thin leg segment below the 'knee' ('shin'). Plural: tibiae.
Triangle Conspicuous small triangular field of one or more cells near the base of all wings in Anisoptera. See text on identifying Anisoptera (p. 26), Corduliidae (p. 30) and Libellulidae (p. 31).
Upper appendages See: appendages. Synonym: superior appendages, cerci.
Venation The network of veins in the wings.
Venter Underside, literally belly. Antonym: dorsum.
Ventral On or towards the underside. Antonym: dorsal.
Vertex Raised structure on the most dorsal part of head, enclosed by ocelli.
Vulvar scale A lip-, spout- or funnel-like structure below S8 in females, along which the eggs leave the body, present in those species that do not oviposit into plant tissue.
Vulvar spine Spine on the underside of S8 at the base of the ovipositor found in some damselflies. See text on identifying Coenagrionidae (p. 24).
Zygopteran Pertaining to the suborder of damselflies (Zygoptera).

Sexes

It is important to be able to determine the sex of a dragonfly, since males and females, even of the same species, often look very different. Males can best be separated by the presence of secondary genitalia. In most cases, these protrude distinctly below the male's abdomen base (view abdomen from the side). Males also tend to be more colourful, with well-developed clasping appendages at the abdomen tip; females are generally plumper and have saw- or spout-like organs below the abdomen tip, which are used to lay eggs. In any work on dragonfly identification, a strong focus on males is inevitable: because they behave more conspicuously, the majority of individuals encountered are likely to be male. Moreover, many characters, such as pruinosity and bright colours (but also secondary genitalia), are male-specific. Other characters, such as venation and markings, apply equally well to females.

Characters of male and female dragonflies



Measurements

All given measurements are approximate and must be regarded as an indication of scale, not as a species' total range. The lengths provided are: total (Tot), from head to abdomen tip; abdomen (Ab) only; and hindwing (Hw) length. Data often originate from varied (often limited or invalidated) sources. Furthermore, most species vary considerably in size. Because of this, and because size difference between sexes is limited, we have not provided separate values for males and females, except for the large *Cordulegaster* species, where differences are more substantial (see: Variation).

Field characters

As the title implies, this guide is intended for use in the field, since most characters are visible with the naked eye or through binoculars. Some field characters may seem vague or subjective, such as the species' general hairiness or hue. Such characters describe the 'jizz' of a species – the general appearance or first impression in the field. Jizz often determines whether an individual requires closer inspection. With experience, the majority of species can be recognised in the field, simply by sight. Nonetheless, all users, especially inexperienced ones, are recommended to examine specimens in the hand (see: Watching and catching). The most reliable characters are often small and demand detailed examination (see below). In the 'Field characters' sections of the species texts we have attempted to compare each species with the most similar ones, frequently referring to other texts for more information.

Hand characters

Characters of general appearance (colour, markings) that are visible with the naked eye or with close-focus binoculars are treated as field characters (see above). Hand characters include more technical features, mainly sexual characters (male's appendages and secondary genitalia, female's pronotum and ovipositor) and wing venation. These often require slight magnification, in which case a 10× hand lens generally suffices. Many difficult characters of venation are required to separate families and genera. These are explained in the Glossary and the section 'Identification of suborders, families and genera'.

Variation

In all species, size, colour and markings can vary depending on sex, age and origin. In the species texts, sexual dimorphism and size variation are generally covered under 'Field characters', but all other variation is treated under 'Variation'. Individual variation is substantial, making it impossible to cover comprehensively in illustrations and descriptions. *Most confusion originates from age-related variation.* Generally bright colours (especially red) and pruinosity develop only as the adult dragonfly matures. All libellulids, for instance, appear yellowish or brownish with black markings at emergence. In many odonates, even the black markings are restricted at emergence. Similarly, wing colour, especially yellowish shades, is often age-dependent; some species lose the amber tones present at emergence, while others develop smoky wings with age. Some variations occur frequently, and have therefore been named. These may be regional in occurrence (see: Subspecies) or are found together within populations (see: Forms).

Subspecies

In the past, numerous subspecies have been named, often on the basis of unstable characters (e.g. extent of black markings) and without geographic and genetic considerations (e.g. regional variation in blackness may merely reflect climatic gradients). Moreover, many areas and species are poorly known, and variation may even be greater than is currently recognised. We believe that many subspecies will not prove to be genetically distinct entities worthy of recognition once patterns of geographic variation in characters, especially of DNA, are analysed. For this guide, decisions on the inclusion of subspecies could not be taken consistently and have been left to the discretion of the authors. Generally, only diagnosable subspecies, which are reasonably discrete in their characters and geography, are included. Since precise range limits are generally poorly known (if they exist), subspecies are not marked on the distribution maps.

Forms

While males are rather uniform in their appearance within populations, females of many species can appear more different from one another, most importantly in the presence or absence of 'male-like' coloration. It is likely that some of these females, called andromorphs, have obtained their unusual coloration only with great age. However, in Coenagrionidae, female colour forms are genetically determined, independent of age. Clear examples are seen in the red damselfly genera *Ceriagrion* and *Pyrrhosoma*, where wholly red andromorph forms exist, as well as wholly black so-called gynomorphs and intermediate (part red, part black) forms. The distinction between andromorphs and gynomorphs can thus be gradual and is not always clear. This variation is taken a level further in the genus *Ischnura*, where there is both a genetic and a developmental component: discrete, brightly coloured (violet, pink, orange) teneral forms obtain brownish 'female' or blue 'male' colours with maturity (see Glossary for synonyms in confusing terminology of andro- and gynomorphs).

Identification of suborders, families and genera

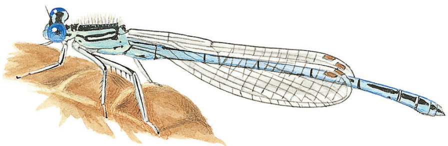
The insect order Odonata is traditionally divided into three suborders: Zygoptera, Anisoptera and Anisozygoptera. Zygoptera are known as damselflies, but both the Anisoptera in a strict sense and the Odonata as a whole are referred to as dragonflies. This confusing usage is especially prevalent in Europe; throughout the Americas, dragonflies are regarded more in their strict sense. For absolute clarity, members of the two suborders are often called 'zygopterans' and 'anisopterans', respectively; combined, they are 'odonates'. Worldwide, the Zygoptera and Anisoptera each number more than 3,000 species, while the Anisozygoptera includes only one Japanese, one Himalayan, and two somewhat disputed Chinese species. These are most like anisopterans, but are named for their damsel-like wings.

Separating the two suborders found in our region is the first step to identification. Usually the posture is enough: anisopterans are robust and rest with outstretched wings, while zygopterans are slender and rest with the wings folded together. However, there are exceptions to the

Separating suborders of dragonflies and damselflies (Odonata)

Hw base shape	Eyes	Wings at rest	Suborder
Similar to Fw base	Widely separated by head	Usually held shut	Zygoptera
Much wider than Fw base	Envelop head and often touch each other	Spread out	Anisoptera

Blue Featherleg *Platycnemis pennipes* – a typical zygopteran



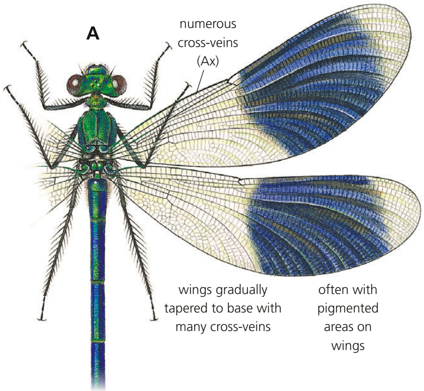
Four-spotted Chaser *Libellula quadrimaculata* – a typical anisopteran

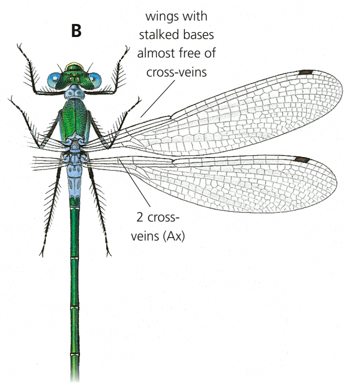
rule: the *Chalcolestes* and *Lestes* species perch with half-open wings, as their vernacular name 'spreadwings' suggests. A multitude of characters distinguish the suborders, but wing shape and the position and size of the eyes are easiest to recognise (see below).

This section provides the tools to separate the higher categories (suborders, families, genera) of Odonata covered in the guide. Characters are compared in tables, and difficult ones (e.g. of wing venation) are explained in the accompanying text, where they are in bold for quick reference. Many groups are easily distinguished by one or more **diagnostic characters**. These are generally unique features that separate them from other groups in the same table, e.g. if 'absent postocular spots' is diagnostic for one group, the other groups may be expected always to possess these spots, unless stated otherwise. Because there are frequently exceptions, even to diagnostic characters, words such as 'often' and 'usually' are used to indicate where exceptions are possible. Genera can also be identified by reading the genus texts, or by first scanning the artwork and then confirming a suspected identification with the tables.

Identifying Zygoptera

All families have a combination of characters that facilitate swift recognition. Because Coenagrionidae, which includes the majority of damselflies encountered in the field, is a large and diverse group, it is easiest to exclude the four other families by their diagnostic features first. Two families with relatively few species are instantly separated from the three other ones by their large size and dense venation. The families can also be separated by the shape of the **quadrilateral**. This four-sided structure lies centrally near the wing base and is formed by a single cell in all families except Calopterygidae, where it is a narrow rectangular series of many cells. The anterior side of the quadrilateral in Coenagrionidae and Lestidae is so short that the cell appears like a skewed trapezium, or even almost like a triangle in Lestidae. In Euphaeidae and Platycnemididae, the anterior side is about as long as the posterior and therefore the quadrilateral is more or less rectangular.





Separating families of damselflies (Zygoptera)

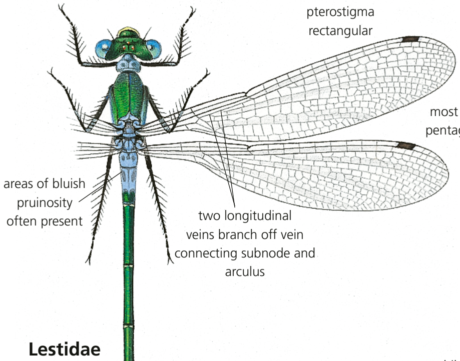
Hw length	Ax in forewing	Wings	Family	▶
23–37mm	12 or more	Often coloured. Gradually narrowed towards base, with many cross-veins right up to point of attachment to body	Calopterygidae Euphaeidae	A
11–28mm	2	Always clear. With narrow stalk-like bases that are almost devoid of cross-veins	Lestidae Platycnemididae Coenagrionidae	B

A: Large damselflies

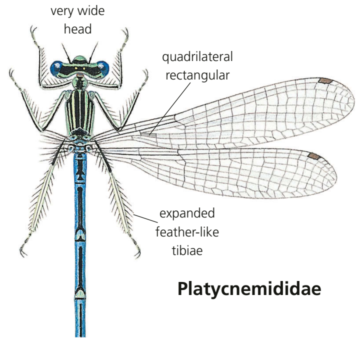
Body	Pterostigmas	Ax in forewing	▶
Metallic green to blue	Absent in ♂, but ♀ with whitish 'pseudopterostigmas' (crossed by veins)	18 or more	Calopterygidae: *Calopteryx* (p. 84)
Pale to dark, becoming grey pruinose	Very long in both sexes, whitish to black	12–14	Euphaeidae: *Epallage* (p. 93)

B: Small damselflies

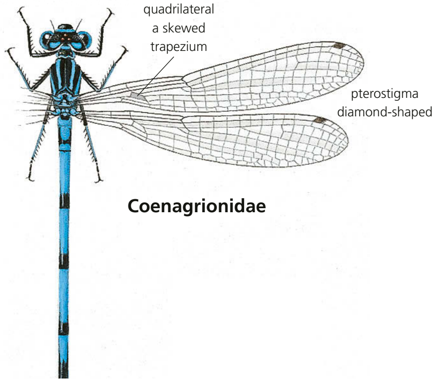
Diagnostic characters	▶
Pt rectangular, longer than high, not diamond-shaped. Many cells in wings pentagonal, not the majority quadrangular. Two longitudinal veins branch off the vein connecting the arculus and subnode, about halfway down that vein. Body often metallic green and/or with bluish pruinosity	Lestidae
Tibiae feather-like: partly pale and often expanded, not dark and entirely thin. Head very wide (3× as wide as long) with pale band across vertex from eye to eye. Quadrilateral is rectangular, not a skewed trapezium	Platycnemididae: *Platycnemis* (p. 95)
None of the above, but the following combination is distinctive. Pt typically a diamond. Most cells in wings quadrangular. Quadrilateral is a skewed trapezium. Body rarely metallic green or pruinose. Head about 2× as wide as long, at most with pale band in front of vertex (on frons) or behind it (or with postocular spots there). Tibiae thin and often dark	Coenagrionidae



Lestidae



Platycnemididae



Coenagrionidae

Separating genera of spreadwings (Lestidae)

Pterostigmas	Body	Wings at rest	▶
Equidistant from wing tips in Fw and Hw	Metallic green to bronze and/or bluish pruinose	Usually half-spread	*Chalcolestes* and *Lestes* (p. 69)
Clearly closer to tips in Fw	Buff marked with glossy brown	Always closed	*Sympecma* (p. 80)

Identifying Coenagrionidae

Aside from the numerous southern libellulid genera, separating coenagrionid genera may give novice enthusiasts most identification problems. Mature males of most species are easily allocated to two groups, based on the presence or absence of postocular spots and bright red coloration, particularly of the eyes. Immature males, as well as females, may be more confusing, but the presence in *Enallagma* and *Ischnura* females of a **vulvar spine** on the underside of S8, at the base of the ovipositor (visible with a hand lens), prevents much confusion. Orange *Ischnura* females, for instance, may be mistaken for red damsels, but have large postocular spots and a distinct vulvar spine. *Pseudagrion* and *Nehalennia* each have only one species that fall outside these groups, but are highly localised in occurrence (see below).

The genera of bluets and bluetails (table B) are often mistaken for one another. The thorax markings are informative in most cases. The **antehumeral stripes** are the pale 'shoulder' stripes that lie anteriorly on the thorax. They can be narrow (i.e. narrower than the black humeral stripes below) or wide (equally wide or wider than the humeral stripes). The **interpleural stripes** are short black stripes on the sutures below the humeral sutures. The appearance of these markings is variable in *Ischnura*, in part because of the diverse female colour forms; here, the vulvar spine may again aid identification.

Separating genera of small damselflies (Coenagrionidae)

Diagnostic characters	Genus	▶
Postocular spots absent. Eyes and often body red. Note: females especially may have no red, but always lack both postocular spots and a vulvar spine	*Ceriagrion* *Erythromma* *Pyrrhosoma*	A
Not as above. Note: all damselflies with two distinct postocular spots and without red colour belong here, as does any female with a vulvar spine	*Coenagrion* *Enallagma* *Erythromma* *Ischnura*	B
Morocco only. Mature ♂ combines red face, postocular spots and pruinose body	*Pseudagrion* (p. 145)	
Virtually exclusive to bogs with slender sedges, very local from the Alps north and east. Hw usually less than 15mm. Body bright metallic green. Rear of head bears a pale bow-shaped marking, rather than two distinct postocular spots	*Nehalennia* (p. 144)	

A: Red and red-eyed damselflies

Diagnostic characters	▶
Legs and Pt reddish, not black. Frons with transverse ridge between antennae	*Ceriagrion* (p. 142)
♂ body not largely red, but dark marked with blue. ♀ body with blue and green but never red tints	*Erythromma* (p. 135)
None of the above, but combination of red(dish) body (except in some ♀) and black legs distinctive	*Pyrrhosoma* (p. 139)

B: Bluet and bluetail damselflies

Diagnostic characters	Ante-humeral stripes	Inter-pleural stripes	♂ S2 upper-side	♀ vulvar spine	▶
Entire upperside S8 in ♂ black, not blue. ♂ upper appendages longer than lowers and S10. ♀ has a knob on both sides of the thorax, just behind the pronotum	Wide	Present	Black	Absent	*Erythromma* (p. 135)
Combination of narrow antehumeral stripes and presence of interpleural stripes is diagnostic in most cases	Narrow	Present	Blue	Absent	*Coenagrion* (p. 120)
♀ combines torpedo-shaped black markings on abdomen with a vulvar spine. Diagnostic combination of thorax and S2 markings in ♂	Wide	Absent	Blue	Present	*Enallagma* (p. 117)
Pt of Fw in ♂ and some ♀ black and white, not uniformly coloured	Variable	Variable	Black	Present	*Ischnura* (p. 103)

Identifying Anisoptera

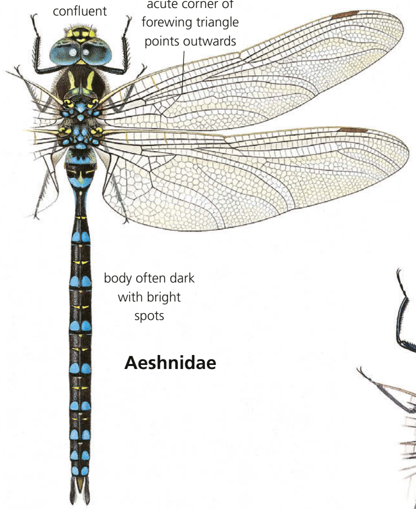
With a little practice, separation of the anisopteran families becomes second nature. In particular, the three families that are considered as more primitive (sharing certain features of wing venation) are easily distinguished by the eyes: either distinctly separated (Gomphidae), just touching (Cordulegastridae) or broadly confluent (Aeshnidae). As a group, they are most easily distinguished by the shape of the triangles, which is similar in the fore- and hindwings. In the Corduliidae and Libellulidae, the **acute corner of forewing triangle** points in a different direction, because the triangle is shifted a quarter-turn. Therefore, the long axis of the triangle is parallel to the long axis of the wing in the hindwing, but perpendicular to it in the forewing. Another feature of the 'primitive' families is seen in two of the many **antenodal cross-veins**, which are relatively thick and cross a longitudinal vein, i.e. their anterior and posterior sections are aligned. The other antenodal cross-veins are thinner, and the numerous cross-veins on both sides of that vein are not aligned. In the Corduliidae and Libellulidae, all antenodal cross-veins are of similar thickness and alignment. Males of all anisopterans, except *Anax* (Aeshnidae) and all Libellulidae, possess an **anal triangle**, a conspicuous triangular field at the hindwing base next to the membranule, which coincides with a pair of **auricles**, two ear-like structures on the sides of S2, and often with an angled posterior border of the hindwing.

Behaviour is a good aid to diagnose anisopteran families, and is best observed in territorial males or foraging individuals. 'Fliers' patrol their hunting or breeding territory constantly, and seldom perch. They rest with a hanging posture, the abdomen raised slightly above vertical at most. 'Perchers' make flights from a perch, holding the body well above vertical (unless they are weak or teneral) and often even above horizontal. The genera *Pantala*, *Tramea* and *Zygonyx* are the only fliers among the Libellulidae, while all Corduliidae are fliers. Although Corduliidae and Libellulidae are easily separated by jizz (see artwork), structural differences are either subtle or restricted to males. This includes the diagnostic presence of long and low pale keels on the anterior side of the tibiae in corduliid males (not necessarily on all leg pairs).

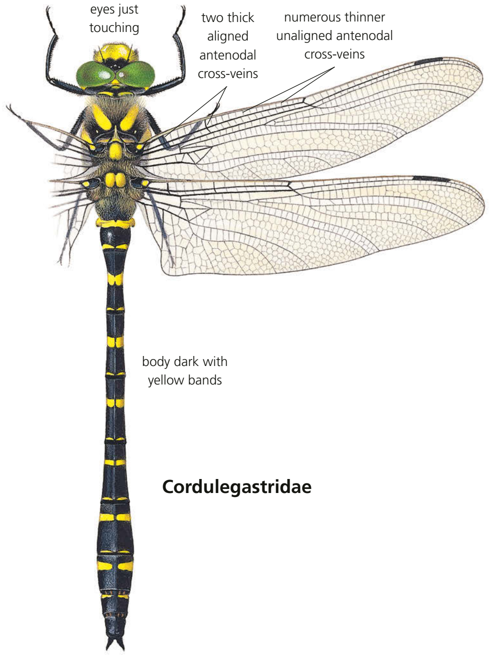
Separating families of true dragonflies (Anisoptera)

Diagnostic characters	**♂ Anal triangle and auricles**	**Acute corner of forewing triangle points**	**Behaviour**	▶
Eyes separated by ridge, not touching	Present	Outward	Percher	Gomphidae (p. 29)
Abdomen often dark with blue spots that are coloured by internal pigments, not pruinosity (i.e. brighter and cannot be scraped off). ♀ with complete ovipositor	Present or absent	Outwards	Flier	Aeshnidae (p. 28)
Eyes only just touching, not widely confluent. ♀ with long spike-like vulvar scale, extending well beyond abdomen tip	Present	Outwards	Flier	Cordulegastridae: *Cordulegaster* (p. 220)
Hind margin of eyes shortly but abruptly arched at about mid-height. Body often metallic green	Present	Backwards	Flier	Corduliidae (p. 30)
Abdomen often bluish pruinose or red	Absent	Backwards	Percher	Libellulidae (p. 31)

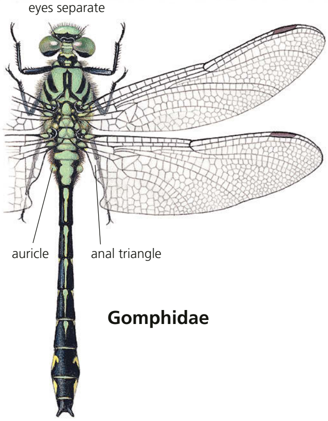
Anisopteran families



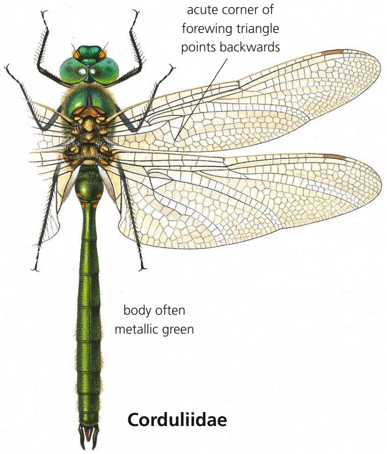
Aeshnidae



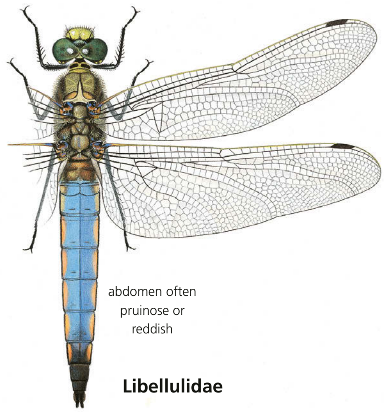
Cordulegastridae



Gomphidae



Corduliidae

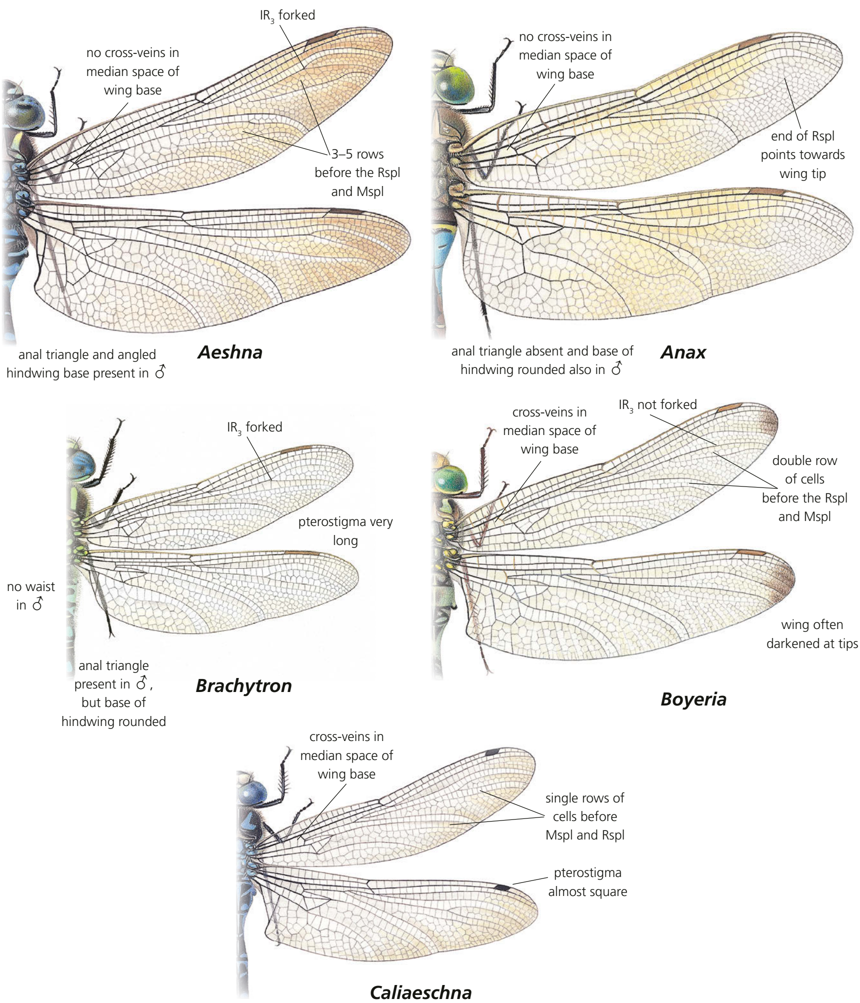


Libellulidae

Identifying Aeshnidae

Separating the genera in this family is straightforward with some knowledge of wing venation. The absence of several (usually two to four) **cross-veins in the median space of the wing bases** is very apparent because it is in marked contrast to the other spaces at the wing base, which always have cross-veins. The **IR_3 fork**, when present, can be found centrally in the apical half of the wings, as a prominent forking in a longitudinal vein between the radial supplemental vein and pterostigma. There may be one or more (1–5) **rows of cells before the radial and medial supplemental veins** (the rows lie between these veins and the longitudinal vein anterior to them). Whether the end of the radial supplemental vein is directed towards a part of the wing anterior of the tip (*Anax*) or posterior of it (other genera) is also informative. Although all aeshnid females lack auricles on S2 and angled hindwing bases, and most have abdomens that are not waisted near their base, the presence of the first character in males is diagnostic for *Anax* and that of the latter for *Brachytron*.

Aeshnidae wings Images to scale. Examples of features listed in tables are shown.



Separating genera of hawkers (Aeshnidae)

Diagnostic characters	Cross-veins in median space of wing base	IR_3 fork	Rows of cells above Rspl and Mspl	▶
None of the following	Absent	Present	3–5	*Aeshna* (p. 147)
Thorax often uniform, not banded. ♂ Hw base round, not angled, anal triangle and auricles on S2 absent. End of Rspl points between Pt and wing tip	Absent	Absent	4–5	*Anax* (p. 170)
Wings often darkened at tip	Present	Absent	2	*Boyeria* (p. 184)
♂ abdomen cylindrical near base, not waisted. ♂ Hw base rounded, but anal triangle and auricles present. Pt very long	Absent	Present	1 (2)	*Brachytron* (p. 182)
Pt only slightly longer than broad	Present	Present	1	*Caliaeschna* (p. 186)

Identifying Gomphidae

Although the genera in this family are superficially alike, males can instantly be assigned to the correct genus by the shape of their **appendages**. Females may pose more problems. The genera *Gomphus* and *Stylurus* can be recognised by the narrow, pale central line running down the upperside of the abdomen, but due to variation some familiarity with this feature is required. The **anal loop** is a distinct field of one or a few cells, which lies between the triangle and anal triangle in the hindwing. If present, it interrupts a straight perpendicular vein that runs from the wing's hind margin to the most posterior thick longitudinal vein in the wing base.

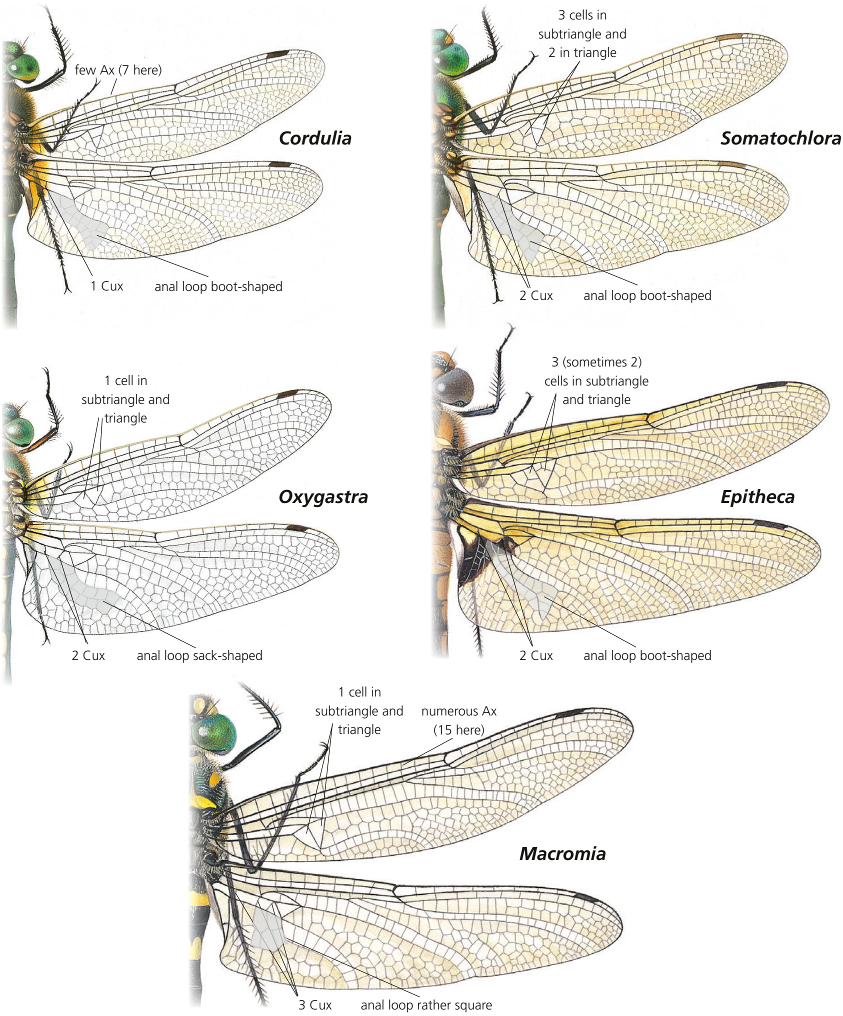
Separating genera of clubtails (Gomphidae)

Diagnostic characters	♂ upper appendages and branches of lower	Anal loop	▶
Total length more than 65mm. Triangles in wings of more than one cell. Broad foliations on S7–8	Uppers much longer than lower and parallel, like fingers 	Present	*Lindenia* (p. 218)
Broad foliations on S8–9	Uppers much longer than lower and parallel, with tips curved down like hooks 	Absent	*Paragomphus* (p. 216)
Upperside of abdomen marked with pale line that is much narrower than abdomen is broad	All similarly long and diverging 	Absent	*Gomphus* and *Stylurus* (p. 188)
♀ occiput with thorny horns	All similarly long and parallel 	Present	*Ophiogomphus* (p. 202)
None of the above	All similarly long and arched towards each other, with tips meeting, like a grasper 	Present	*Onychogomphus* (p. 204)

Identifying Corduliidae, Macromiidae and *Oxygastra*

The family Corduliidae traditionally included genera that are related to Libellulidae, but possess a number of characters (often seen as primitive) that have been lost in that family. Not all genera are closely related, and *Macromia* and *Oxygastra* are considered to belong in other families. Separating genera is quite easy, especially in males, but three features of venation require explanation. The **forewing triangle and subtriangle** (the latter is the triangular field that lies basal of the triangle) can lack a cross-vein, thus being of one cell (1), or be split up into more cells (2–3) by one or more cross-veins. The number of **cubital cross-veins in the hindwing** is counted between the triangle and the wing base. The **anal loop shape** is determined by a vein that loops around a distinct field of cells in the hindwing base, starting close to the posterior corner of the triangle and ending close to the wing base. The enclosed area may be boot-shaped (elongate with a distinct heel and toe, as in all Libellulidae), sack-shaped (elongate without a 'foot') or not elongate but rather square.

Corduliidae wings Images to scale. Examples of features listed in tables are shown.



Separating genera of emeralds (Corduliidae), cruisers (Macromiidae) and Orange-spotted Emerald (*Oxygastra curtisii*)

Diagnostic characters	Face	Fw triangle and subtriangle	Cux in Hw	Anal loop shape	♂ lower appendage central cleft	▶
Hw base with large, dark brown spot. Body mainly brown, not metallic and/ or black. Abdomen tapers gradually from broad base to narrow tip	Largely yellow	3 (2)	2	Boot	Absent	*Epitheca* (p. 250)
Abdomen usually thickest at S5–7, rather than more basally or terminally	Marked yellow	2–3	2 (1)	Boot	Absent	*Somatochlora* (p. 238)
♂ lower appendage with upturned teeth not only at tip, but also just before it	All dark	2–3	1	Boot	Present	*Cordulia* (p. 236)
♂ S10 with high pale crest on upperside	All dark	1	2	Sack	Present	*Oxygastra* (p. 232)
Total length 70mm or more. 13–15 Ax in forewing, not 7–10	Largely yellow	1	3 or more	Square	Absent	*Macromia* (p. 234)

Identifying Libellulidae

Separating genera in this family relies mostly on wing venation, and may be difficult. Only the genera in bold in the table on the next page are widespread, and their identification is straightforward if two features are combined. (1) The possible **blackish spot at the hindwing base** is very dark brown and should not be confused with **amber at the hindwing base**, which may form a marked yellow to brown-orange patch covering a considerable part of the wing (e.g. coming near triangle). (2) The **number of antenodal cross-veins in the forewing** is counted along the anterior wing border between the base and node. The **last (i.e. most distal) antenodal cross-vein in the forewing** is closest to the node and can be complete like all other antenodal cross-veins, crossing a longitudinal vein, or incomplete, with only the anterior half present (indicated as ½).

The numerous additional genera are found only in southern regions, or as vagrants, and mostly have just one or two species in our area. For convenience, they are split into four groups on the same criteria, and compared further in separate tables, where in most cases they are separated by a combination of venation features. The **forewing discoidal field** extends distally from the triangle and has a distinctive number of rows of cells at its base (1–4), and may narrow or widen towards the wing border. The **forewing triangle** can lack a cross-vein, thus being of one cell (1), or be split up into more cells (2–3) by one or two cross-veins. Basal of the forewing triangle lies the **subtriangle**, a roughly triangular field that may consist of one or more cells (1–6). There may be a single (1) or double (2) **row of cells before the radial supplemental vein** (**Rspl**) – the rows lie between this vein and the longitudinal vein anterior to it. Finally, the genus *Libellula* is characterised by having additional (two or more, rather than one) **cross-veins in the bridge space**, an elongate triangular space on the basal side of the oblique vein that runs down from the node.

Always remember that venation characters are not written in stone, but in a flexible network of veins that may be altered in development. Exceptions to the stated characters can occur, as is shown by some variation in the tables, but also by the artwork in this book, which is based on real individuals and not on the taxonomist's ideal of a species. Some examples are shown on p. 34.

Separating genera of Libellulidae

	Blackish spot at Hw base	
	Absent	**Present**
8½–20 Ax in Fw, often two rows of cells above Rspl	▶ **A** ***Crocothemis*** ***Orthetrum*** *Pantala* *Trithemis* *Zygonyx*	▶ **B** ***Libellula*** *Tramea* *Trithemis*
6–8 Ax in Fw,* usually one row of cells above Rspl	▶ **C** ***Sympetrum*** *Acisoma** *Brachythemis* *Diplacodes** *Pachydiplax* *Selysiothemis*	▶ **D** ***Leucorrhinia*** *Brachythemis* *Diplacodes** *Pachydiplax* *Rhyothemis* *Urothemis*

* *Acisoma* and *Diplacodes* occasionally have 8½ Ax.

A: Skimmers without blackish hindwing spot and with 8½ or more antenodal cross-veins in forewing

Diagnostic characters	Amber at Hw base	Fw discoidal field	Rows of cells before Rspl	▶
No black on legs	Marked	Widens	1	*Crocothemis* (p. 301)
Last Ax in Fw is complete. ♂ abdomen often becomes grey-blue pruinose	Absent or faint	Widens	1–2	*Orthetrum* (p. 259)
Hw length 45mm or more. Patrols without perching and does not rest in horizontal position. Abdomen dark with 6–7 pale rings	Absent	Narrows	1–2	*Zygonyx* (p. 322)
Pt in Hw much smaller than in Fw. R_3 very wavy. Two Cux in hindwing, not one. S4–5 with transverse ridges like that on S3	Faint	Narrows	2	*Pantala* (p. 316)
None of the above	Marked	Narrows	2 (1)	*Trithemis* (p.304)

B: Skimmers with blackish hindwing spot and 8½ or more antenodal cross-veins in forewing

Diagnostic characters	Number of Ax in Fw	Fw discoidal field	▶
Two or more cross-veins in bridge space of both wings	12–20	Widens	*Libellula* (p. 252)
Hw base marked with dark 'keyhole'. Pt in Hw much smaller than in Fw. Two rows of cells subtending Mspl in Fw	10½–12½	Narrows	*Tramea* (p. 318)
Total length less than 40mm. Face dorsally often with metallic lustre	9½–12½	Narrows	*Trithemis* (p. 304)

C: Skimmers without blackish hindwing spot and with eight or fewer antenodal cross-veins in forewing

Diagnostic characters	Last Ax in Fw	Fw discoidal field	Fw triangle	Subtriangle	▶
Vagrant from North America. Face white, contrasting with dark metallic base of frons. Hw base yellow, crossed by two dark bars	1	3	2	3	*Pachydiplax* (p. 315)
Abdomen often red	½	3 (2–4)	2	3	*Sympetrum* (p. 281)
None of other stated characters	½	2	1	1–2	*Diplacodes* (p. 312)
S4 with transverse ridge like that on S3. All wings may be extensively marked with brown away from their base. There may be two rows of cells above Rspl	½	3	1	1	*Brachythemis* (p. 309)
NW Africa only. Abdomen parsnip-shaped, black with fragmented whitish spots	½	2	1	1	*Acisoma* (p. 314)
Venation very pale, almost invisible	1	2	1	1	*Selysiothemis* (p.313)

D: Skimmers with blackish hindwing spot and eight or fewer antenodal cross-veins in forewing

Diagnostic characters	Last Ax in Fw	Fw discoidal field	Fw triangle	Subtriangle	▶
NW Africa only. Dark area covering basal third of Hw. Body entirely bronzy	½	3–4	2–3	4–6	*Rhyothemis* (p. 320)
Entire face white	1	3	2	3	*Leucorrhinia* (p. 274)
Vagrant from North America. Face white, contrasting with dark metallic base of frons. Hw base yellow, crossed by two dark bars	1	3	2	3	*Pachydiplax* (p. 315)
NW Africa only. ♂ abdomen becomes dark blue, not pale blue, pruinose	1	2	1	3	*Urothemis* (p. 321)
None of other stated characters	½	2	1	1–2	*Diplacodes* (p. 312)
S4 with transverse ridge like that on S3	½ (1)	3	1	1 (3)	*Brachythemis* (p. 309)