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A BRIEF HISTORY OF ODONATOLOGY

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Six elements, or 'strands', in the progress of odonatology are identified, and the main features of each are discussed. During the immensely long (mainly pre-Linnaean) Exploring Strand, subjective perceptions and broad biological facts about dragonflies were established. Progress was rapid with the onset of the Codifying (1758-) and Classifying (1820-) Strands, as systems became available for formalising species-specific information and for visualising hierarchical relationships-achievements that made possible the Integrating Strand (1913-) during which biological information of many kinds was drawn together to produce a picture of the Order as a whole. The two most recent Strands arose in response to exogenous pressures : the Intercommunicating Strand (1971-) was necessitated by the information explosion, and the Conserving Strand (1980-) by the effects of habitat destruction due to increasing human impact. The future of odonatology as a viable and rewarding endeavour now depends largely on the success of the Conserving Strand.

PROLOGUE

In this brief essay I try to review the history of odonatology — a subject that, if dealt with comprehensively, would justify much more extensive treatment. Accordingly this account is very selective : for example it omits mention of the many and distinguished contributions to our knowledge of fossil Odonata and extensive work on physiology, anatomy and behaviour. 'History' has been defined as "a systematic account of natural phenomena" ; and the view has been expressed that history often tells one more about historians than about the phenomena they report. So at the outset I declare my indebtedness, when preparing this essay, to secondary sources in the fields of odonatology (KIRBY, 1901 ; TILLYARD, 1917 ; GLOYD, 1955 ; LONGFIELD, 1960 ; ASAHINA, 1974, 1989 ; GAMBLES, 1976 ; KIAUTA, 1978), the history of western science (COLE, 1949 ; SINGER, 1959), bibliography (EALES, 1969,

1975) and biography (BEIER, 1973 ; LINDROTH, 1973 ; TUXEN, 1973 ; GILBERT, 1977, but note also GAEDIKE, 1985).

In this account I identify what I perceive to be major elements — or 'strands' — in the development of odonatology. I have resisted the temptation to call them 'stages' or 'eras' because, unlike stage and eras, these strands begin but do not end. Once started, each continues as a part of odonatology which accordingly expands in scope and richness as its components increase. The poet and essayist SAMUEL TAYLOR COLERIDGE wrote (1818) : "the dwarf sees farther than the giant, when he has the giant's shoulder to mount on" — the giant being an individual whose contributions have been disproportionately great and influential. Odonatology is no exception to this statement, and some of the giants whose innovative approaches have provided the strands in contemporary odonatology are identified in this account.

Bibliographical citations in the text refer to the first edition of any publication so as to place the reference in its correct temporal context. Where it is desirable to do so, the existence of other editions is made clear.

Table I and Figure 1 show the six Strands that provide reference points for the remarks that follow. Where these are known to me, the full names and the dates of birth and death of deceased odonatologists mentioned in the text are given in the Appendix.

THE EXPLORING STRAND

This Strand spans an immensely long time during which any names assigned to dragonflies lacked formal or international status and when, more often than not, one name would apply to what we now recognize as groups of species, genera or even families. (This is not to say, of course, that a few distinctive and conspicuous species did not have vernacular names from early times (e.g. READ, 1977).) Thus, in his posthumously published *Insectorum sive minimorum theatrum* (1634) [1], Thomas MOUFET recognises just three kinds of adult dragonfly according to size : *Libella maxima*, *media* and *minima* [2] The great 17th-Century polymath JOHN RAY tried to meet the need for a nomenclature that reflected hierarchical resemblances, for example in his posthumously published *Historia insectorum* (1710), but his system lacked the simplicity and consistency required for universal adoption.

This Strand could be called 'innominate' also in that we know the names of very few of the observers who contributed to it. We shall of course never

[1] For the background to the publication of this work see KIAUTA (1978).
[2] Corresponding approximately to Aeshnidae, Libellulidae and the Zygoptera.

Table I

Strands in the history of odonatology

Strand	Beginning	Characteristics	Some prime movers
1. Exploring	Many millennia B.P.	Recognition of attributes of Odonata : their form, mode of reproduction and development	Unknown observers plus ALDROVANDI, SWAMMERDAM, LEEUWENHOEK and RÉAUMUR
2. Codifying	1758	Establishment of binominal nomenclature and hierarchical categories of resemblance	LINNAEUS ; FABRICIUS ; FOURCROY
3. Classifying	1820	Establishment of taxonomic and then phylogenetic classification within the Order	SÉLYS-LONGCHAMPS
4. Integrating	1913	Integration of knowledge from all known fields to construct a picture of the biology of the Odonata as a group, worldwide	WESENBERG-LUND ; TILLYARD ; PORTMANN
5. Intercommunicating	1971	Establishment through Societas Internationalis Odonatologica of a global network of contacts and information exchange	KIAUTA
6. Conserving	1980	Establishment by the International Union for the Conservation of Nature and Natural Resources of the Odonata Specialist Group	MOORE

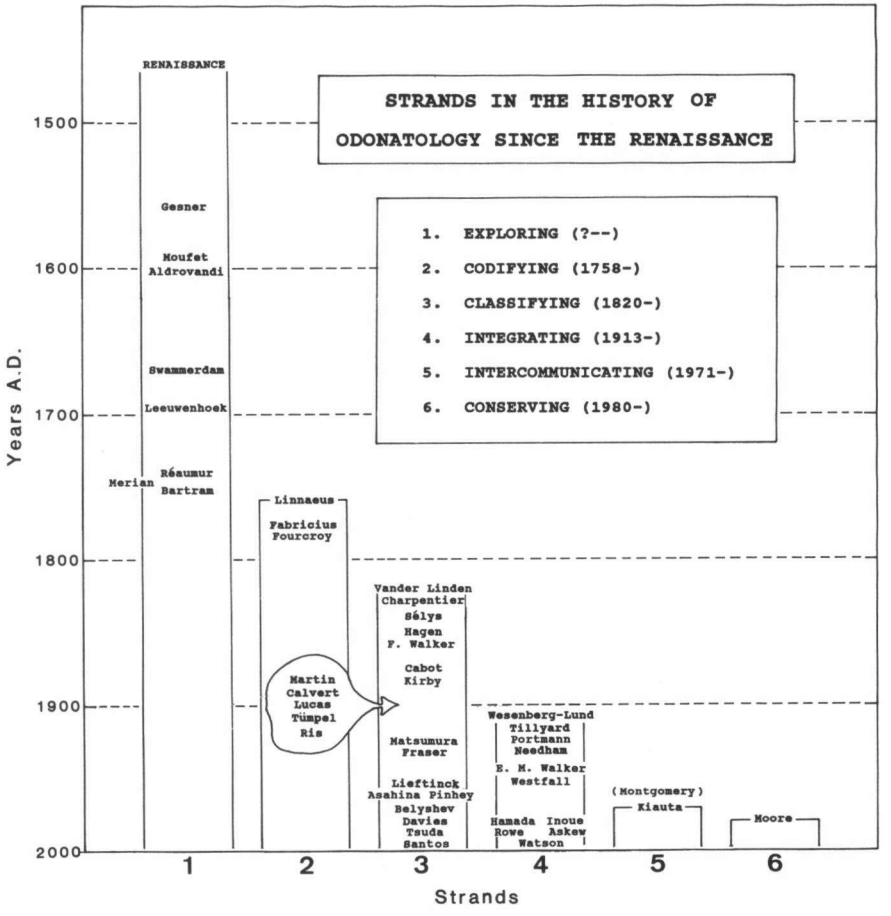

Fig. 1. Strands in the history of odonatology since the Renaissance. The names of many important contributors have been omitted, especially from Strands 3 and 4.

discover when our early forebears first noticed dragonflies, became curious about them, drew conclusions from what they saw, and communicated their observations and excitement to others. But we may safely assume that such witnesses lived tens of thousands of years ago and that it was they who laid the foundations of the place that dragonflies occupy in folklore (SAROT, 1958 ; WYMAN & BAILEY, 1964 ; NITSCHE, 1965 ; MONTGOMERY, 1973a ; HUNN, 1977), folk medicine (ASAHINA, 1974 ; READ, 1977), poetry (BLYTH, 1952 ; KIAUTA, 1986) and art (SMIT, 1972 ; ASAHINA, 1974 ; KEVAN & LEE, 1974). Presumably it was in these far-off times that the perceptions acquired by oriental and occidental peoples came to differ, the former regarding dragonflies as auspicious and benign, and the latter seeing them as inauspicious and threatening (see STOLK, 1977 ; FISCHER, 1982 ; HILLERMAN, 1989).

As early pictorial and written records become available, we obtain tantalising glimpses of dragonflies in literature and art. Thus adult dragonflies feature in prehistoric art of the Late Bronze Age from the Aegean region (YOUNGER, 1983) and of the American Indians in British Columbia (CANNINGS & STUART, 1977) whereas larvae are portrayed on Incan or pre-Incan pottery from Chile and Peru (KENNEDY, 1947). If the word 'dragonfly' is translated correctly we read in *The epic of Gilgamesh* [3] (ca 3,000-2,000 B.C.) that adult dragonflies emerge from aquatic larvae (SANDARS, 1972). Dragonflies are among the insects referred to in the oldest known book on zoology — the Sumerian and Akadian (Babylonian) Hubulla tablets from the 18th Century B.C. (HARPAZ, 1973) ; they feature in Egyptian paintings executed in the 15th Century B.C. (WILKINSON, 1837 ; KRUYT, 1969) ; and symbols of dragonflies appear often on copper vessels, oracle bones and tortoise shells of the Yin (= Shang) Dynasty (15th to 11th Century B.C.) in China (CHOU, 1980, 1988). Much later, we find dragonflies beautifully depicted in the Gutenberg Bible of 1453 (RUDOLPH, 1991) and in certain medieval breviaries, for example the Breviario Grimani (CONCI & NEILSEN, 1956), the Belleville Breviary from the workshop of JEAN PUCELLE in Paris (HUTCHINSON, 1978) and the *Livre d'Heures d'Anne de Bretagne* illustrated by JEAN BOURDICHON (FRAIN, 1989). In Europe it required the invention of printing and the intellectual liberation of the Renaissance to reveal what contemporary observers knew about dragonflies.

Progress during the 16th Century was marked by the impressive activities of the encyclopaedists, among whom CONRAD GESNER, a Swiss, and especially ULISSE ALDROVANDI [4], an Italian, had interesting observations to record about

[3] A renowned Mesopotamian king.

[4] The author of *De animalibus insectis libri septem* (1602), the world's first book devoted entirely to entomology. ALDROVANDI called dragonflies "perlae" and provided woodcuts that show convincing likenesses of Zygoptera, Aeshnidae and Libellulidae. This book is better known in the 1638 edition.

dragonflies. Nevertheless, these authors described adult dragonflies, and their larvae, without knowing that both were forms of the same kind of insect (GESNER, 1558 ; ALDROVANDI, 1602). Thomas MOUFET, mentioned above, shared their limitations in this respect, surmising (1634) that dragonflies were produced from putrefying bulrushes [5].

During this Strand several observers known to us deserve special mention for their gifts of observation and description. In the mid-17th Century the Dutch biologist, Johann SWAMMERDAM, correctly described the developmental stages, the life-history and the mating posture of dragonflies in his *Historia insectorum generalis* (1669), in which he also made clear which of the aquatic animals described by the encyclopaedists (and variously termed 'water-crickets', '-fleas', '-lizards' and '-lice') were actually dragonfly larvae. Colour illustrations of outstandingly high quality, depicting adult dragonflies, were produced by an Austrian, Johann Weichard von VALVASOR, in 1685 and, according to Bastiaan KIAUTA (personal communication, 1990), constitute by far the best pictures of dragonflies made before the middle of the 18th Century. Soon afterwards a compatriot of SWAMMERDAM, Antoni van LEEUWENHOEK, provided in his celebrated *Arcana naturae detecta* (1695) descriptions and illustrations of oviposition and also a convincing account of the fully formed embryo as seen within the egg. Precise and accurate drawings of the main developmental stages and the copulation of dragonflies appear in the monumental *Bybel der Natuure* (1737, 1738, 1758), attributed to SWAMMERDAM ; it is difficult, however, to be certain of the attribution of all the material in this book, published, as it was, long after SWAMMERDAM's death. The Frenchman, R. A. F. de RÉAUMUR, regarded by COLE (1949) as "a modern Leonardo", produced inspiring accounts, and elegant illustrations, of emergence, mating and oviposition (RÉAUMUR, 1742), as did his well known contemporary Maria Sibylla MERIAN whose work (posthumously published in 1750) deserves special notice for the high quality of its illustrations (KIAUTA, 1988). Here I should also mention John BARTRAM, a resident of Pennsylvania, who communicated to the Royal Society of London (1752) an accurate account of the main events in the life of the adult dragonfly, including the maturation period, inter-male interaction, mating and oviposition. Despite the existence of such perceptive observers, however, the absence of an agreed and rational system for naming species meant that the progress of odonatology could at best be fitful and diffuse.

[5] This was not an unreasonable supposition : several species of Lestidae and Aeshnidae lay eggs in bulrushes, the eggs hatching after the winter, when the stems have started to rot.

THE CODIFYING STRAND

Carl VON LINNAEUS of Uppsala, Sweden, progressively devised a system of nomenclature in which each species, when first described, was assigned two (and only two) names, the first being shared with other closely related species and the second being unique. (Much earlier RAY (1710) had followed the same hierarchical principle but had given each species a variable number of names.) By the tenth edition of his *Systema naturae* (1758), LINNAEUS' system of nomeclature had been improved enough that it could be applied consistently to all animals and plants; so it was adopted thereafter for international use. In this tenth edition LINNAEUS describes 18 species of dragonfly, all of which he places in the newly constructed genus *Libellula*, thus using a name that had been applied to dragonflies for at least 150 years, although to this day its etymology remains elusive (FRASER, 1950; JARRY, 1962; NITSCHE, 1965; MONTGOMERY, 1973a, b).

No biologist has had a greater impact on odonatology than LINNAEUS because he provided the basis for all subsequent advances, including the theory of evolution by natural selection associated with Charles DARWIN who, it is interesting to note, used dragonflies as one of his examples to illustrate sexual selection (DARWIN, 1871). But of course LINNAEUS was not a dedicated odonatologist; nor were certain other taxonomists who increased the inventory of named dragonflies during the second half of the 18th Century. The most prolific of these was probably E. L. GEOFFROY. In his *Histoire abrégée des insectes* (1752), however, he used not the Linnaean system but French girls' names (e.g. *cecilia*) which in due course were modified to conform with the binomial system by A. F. DE FOURCROY in 1785. Surprisingly, for a long time this work remained unknown by many western European taxonomists, though known in Russia. So one finds the literature from western Europe referring to (for example) *Ophiogomphus serpentinus* (Charpentier) and that from Russia referring (correctly) to the same species as *O. cecilia* (de Fourcroy). A distinguished taxonomist of this period was J. C. FABRICIUS, a disciple of LINNAEUS: in the 1775 edition of his *Systema entomologiae* he includes 30 species of dragonflies, assigning them to three genera — *Aeshna*, *Agrion* and *Libellula*; and by 1798 his list of described species of dragonfly stands at 69 (KIRBY, 1901) although not all of these were necessarily described originally by him (see ZIMSEN, 1964). It was FABRICIUS who, in 1793, gave dragonflies separate, ordinal status under the name 'Odonata'[6]. Among other taxonomists who named dragonflies during the 18th Century are Carl DEGEER,

[6] From the Greek word meaning a tooth. If the stem of the Greek word is used correctly, the name of the Order becomes Odontata (see TILLYARD, 1917, p. 1). It is unusual for an Order of insects not to be named for a feature of the wings.

Dru DRURY, O. F. MÜLLER and J. H. SULZER. I should also mention here the British engraver and miniature painter Moses HARRIS who made valuable contributions to entomology. The accurate and beautiful paintings of dragonflies (Zygoptera as well as Anisoptera) contained in his *Exposition of English insects* (1782) have probably inspired may people to develop an interest in Odonata.

THE CLASSIFYING STRAND

An undisputed odonatological giant of this Strand was the Belgian naturalist, Baron Edmond de SÉLYS-LONGCHAMPS. He discovered that wing venation provides a reliable guide to relatedness at several hierarchical levels, and he applied this knowledge with great success to the classification of most families of Odonata. One might say that this Strand began with the publication of two monographs (1820a, b — on Aeshnidae and Zygoptera) by P. L. VANDER LINDEN who soon afterwards (1825) produced his treatise on the dragonflies of Europe [7]. There promptly appeared four additional monographs on European Odonata : by T. DE CHARPENTIER [8] (1840), H. A. HAGEN (1840) and SÉLYS (1840, 1850). It was SÉLYS' great contribution to provide the hierarchical classification that has served odonatologists so well ever since. SÉLYS assembled a magnificent personal collection of dragonflies, and with great perseverance and skill produced a succession of monographs on different subfamilies (now mostly regarded as families), leaving at his death two to be completed by René MARTIN (1906, 1908-1909) and one — the formidable Libellulinae — to be completed by F. RIS (1909-1916) [9]. SÉLYS exerted a profound influence by placing the taxonomy of the Order on a firm footing. Indeed, almost all subsequent work in odonatology owes something, directly or indirectly, to the system he devised ; so it is fitting that the international newsletter of odonatology, started in 1963 by B. E. MONTGOMERY, should be called *Selysia.*

The 19th Century saw great odonatological activity by other taxonomists, among whom should be mentioned J. Pierre RAMBUR, Hermann BURMEISTER, William KIRBY and Franz KARSCH. (KIRBY (1890, p. vii) has provided a list of authors who described dragonflies between 1758 and 1890.) World catalogues were compiled by Francis WALKER (1853) [10] and KIRBY (1890)

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[7] Although it is realistic to regard the Classifying Strand as having begun with VANDER LINDEN's two publications in 1820, the first regional monograph after Linnaeus was that of J. A. SCOPOLI published in 1763 (see KIAUTA, 1963).

[8] T. de CHARPENTIER's monograph is illustrated with hand-coloured lithographs, as also is the book by W. F. EVANS (1845) (KIAUTA, 1988).

[9] RIS's monograph on the Libellulinae is the largest taxonomic text ever published on Odonata.

[10] WALKER's catalogue is incomplete and to some extent supplemented by that of PREUDHOMME DE BORRE (1890) which deals with the "libellulines".

and many regional monographs were published, examples of which are given in Table II. For most of the 19th Century such monographs focussed on the adult stage, and on classification and identification ; but in 1893 Philip P. CALVERT, in his *Catalogue of the Odonata in the vicinity of Philadelphia*, included an extensive, general account of the Order, treating structure, development and distribution, and providing a bibliography classified according to topic. A somewhat similar approach was adopted by R. TÜMPEL in the introduction to *Die Geradflügler Mitteleuropas* (1901), although his bibliography was unclassified and very much shorter than CALVERT's. Of much greater importance in establishing the trend towards including a review of literature on Odonata was the work by G. G. YAKOBSON & L. V. BIANKI (1902-1905) : using TÜMPEL's illustrations (which were of high quality) these authors produced a monograph on the Palaearctic Odonata which included 946 bibliographical references — by far the most comprehensive up to that time (see review published in 1957 by Erich SCHMIDT).

Table II

Examples of regional monographs of Odonata
not necessarily mentioned elsewhere in the text

Region	Author(s)
Africa	PINHEY, 1962
Australia	HOUSTON & WATSON, 1988
Canada and Alaska	WALKER, 1953, 1958 ; WALKER & CORBET, 1975
Central America	CALVERT, 1901-1908
China	NEEDHAM, 1930
Europe	ROBERT, 1958 ; ASKEW, 1988 ; JURZITZA, 1988
India, Burma and Ceylon	FRASER, 1933, 1934, 1936
Malaysia	LIEFTINCK, 1954
Mediterranean Basin	AGUESSE, 1968
New Zealand	ROWE, 1987
North America	HAGEN, 1861 ; MUTTKOWSKI, 1910 ; NEEDHAM & HEYWOOD, 1929 ; NEEDHAM & WESTFALL, 1955
Russia	BARTENEV, 1915 ; BELYSHEV & HARITONOV, 1977 ; BELYSHEV *et al.*, 1989
Russia and Asia	YAKOBSON & BIANKI, 1902-1905
Siberia	BELYSHEV, 1973, 1974
South Africa	RIS, 1921

It was during the 19th Century that the first serious attempts were made to develop the taxonomy of larvae, based on careful descriptions, often of reared material. The two main contributors to this initiative were Louis CABOT (e.g. 1872) and HAGEN (e.g. 1885). CABOT set an excellent example for those who followed by providing illustrations of high quality and by stating clearly whether the identification of each larva was based on unequivocal evidence (e.g. emergence in captivity) or on supposition. (Would that all his successors had done likewise !) HAGEN (1885), who, like CABOT, also gave the evidence

on which each identification was based, attempted a key to larvae of some subfamilies. The taxonomy of larvae continues to lag far behind that of adults, although some authors have made valuable contributions to this challenging field, for example Ris (1909), Lucas (1930), Popova (1953), Needham & Westfall (1955), Walker (e.g. 1953, 1958) and Santos (1988); and Lieftinck (see Geijskes & Kiauta, 1984) and Asahina (see Inoue & Eda, 1984) by the careful descriptions in many of their papers. Here one may note that it is not only larval and adult dragonflies that confine themselves to different media; often odonatologists do as well! Witness the instance of *Megalopreprus caerulatus*, one of the largest dragonflies in the world: described as an adult by Dru Drury in 1782, its larva was not discovered until almost two centuries later — by Willis Snow (1949) in Guatemala and then independently by Ola Fincke in Panama (Fincke, 1984).

Before leaving the subject of larval taxonomy I should mention the important contribution made by Frank Balfour-Browne who in 1909 was the first to describe all the larval instars of a dragonfly (even though the prolarva and instar 2 had been reported by Leeuwenhoek in 1695).

Taxonomy, even in the best-known Orders of insects, is a continuing process, and this branch of odonatology remains an active one, producing descriptions of new taxa (see Kiauta, 1981), revisions, monographs and catalogues too numerous to list in this brief account. Certain publications, however, (apart from those already referred to or listed in Table II) deserve particular mention because, by enabling or encouraging synthetic work, they have made a disproportionately great contribution to odonatology. These comprise *A reclassification of the Order Odonata* by Tillyard & Fraser (1938-1940) and by Fraser (1957) and catalogues of world genera (numbering 630) by Davies (1981) and of world species (numbering 4875) by Davies & Tobin (1984, 1985) and Tsuda (1986). These publications owe much to Sélys' inspired groundwork, executed during what has been called the "Classical Period" of odonatology (Tillyard, 1917). Also we should remember here those taxonomists, for example E. B. Williamson (e.g. 1923, p. 41), who enriched their papers with poetic and magically evocative accounts of encounters with dragonflies in nature.

Odonatology in general, and the Classifying Strand in particular, have been influenced by the inspiration provided for more than half a century by Maus Lieftinck, a man who used his talents to set high standards of taxonomic work and to give unstinting help to many odonatologists.

THE INTEGRATING STRAND

With taxonomy on a sound footing, and with attractive regional monographs available to provide the incentive, odonatologists were in a position to integrate scattered observations on ecology and behaviour of individual

species and so open the way for comparative and autecological studies. It came to be recognised that the dossier of a species need no longer be confined to its morphology and systematic position, but could embrace its physiology and behaviour as well. Although such an advance was foreshadowed by the detailed observations of earlier observers such as SWAMMERDAM and RÉAUMUR, it could not come to fruition without the foundation provided by the Codifying and Classifying Strands.

The giant who may be said to have established the Integrating Strand was R. J. TILLYARD, a resident of Australia, who drew together existing knowledge of the Order in his now-classic book *The biology of dragonflies* (1917). The emphases in this book are on morphology, embryology and phylogeny. Only one chapter (entitled "Bionomics, etc.") treats natural history ; but, although it contains relatively little information about ecology and behaviour, this chapter whets the appetite wonderfully, even today. Two aspects of this magnificent book deserve mention. First, much of the information it contains derives from TILLYARD's original work, there being few fields of odonatology to which he had not made a major contribution. Second, since 1914, when he was involved in a railway accident, his back was crippled and very painful (EVANS, 1963) ; indeed, so serious was his condition in 1914 that it was believed that he would never be able to work again ; nevertheless he continued his extraordinarily high research output, which included this book.

Another remarkable publication contributed importantly to the launching of the Integrating Strand. This is the two-part monograph *Odonaten-Studien* (1913) by C. J. WESENBERG-LUND. Unfortunately this was seen by TILLYARD too late to be included in his book. WESENBERG-LUND, a Dane, was a prolific biologist with wide interests that fortunately included dragonflies. The second part of *Odonaten-Studien* comprises a scholarly review of odonatological literature on a number of topics, such as duration of seasonal development, association of larvae with certain aquatic plants, crepuscular flight, natural enemies, migration, colour variation and hybridisation. With its emphasis on ecology and behaviour, and with its attempt to synthesise existing knowledge, *Odonaten-Studien* belongs squarely in the Integrating Strand. Its coverage of literature was about as extensive as that of TILLYARD's book, but its impact was less, perhaps because it was published in a specialised scientific journal and not as a book. A few years after the publication of TILLYARD's book, Adolf PORTMANN produced his famous doctoral dissertation (1921) which adopted a comparative and phylogenetic ethological approach and which therefore constitutes a key work of modern odonatology.

With the publications by WESENBERG-LUND, TILLYARD and PORTMANN as reference points, information on the behaviour and ecology of dragonflies accumulated rapidly and soon came to be included among descriptions of species in regional monographs. Building on the approach pioneered by these

three authors I later attempted syntheses of knowledge of the behaviour and ecology of world Odonata, incorporating information about tropical species that had become available in the intervening years (CORBET, 1962, 1980).

Because the Integrating Strand will continue for the foreseeable future, no list of milestones within it can be other than provisional. I would, however, wish to mention four discoveries that I believe have been, or will be, especially influential in odonatology. These are: territorial and female recognition behaviour of adult males (ST. QUENTIN, 1934; BUCHHOLTZ, 1951; MOORE, 1952; JACOBS, 1955); territorial behaviour of larvae (MACHADO, 1977; ROWE, 1980); sperm displacement (WAAGE, 1979); and the successful use, by Anthony SEBASTIAN, of dragonfly larvae for the inundative biological control of mosquitoes (see SEBASTIAN *et al.*, 1980, 1990; CORBET, 1986). A fine example of the way in which the knowledge gained from the first and third of these discoveries can contribute to a general understanding of reproductive behaviour in Odonata is the book on dragonfly mating systems published recently in Japan (HIGASHI *et al.*, 1987).

THE INTERCOMMUNICATING STRAND

By producing his *Bibliotheca entomologica* in 1862, Herman HAGEN showed recognition that entomologists might be finding it difficult to keep abreast of the literature. As early as 1890 William BEUTENMULLER compiled a useful list of published descriptions of emergence; and in 1933 Erich SCHMIDT published the first (and only) part of his ambitious *Bibliographia odonatologica*. Valuable though such initiatives were then, they are needed even more today. The explosive increase of scientific publication since the Second World War has demanded measures to come to terms with it. Odonatologists are exceptionally fortunate that intitiatives have been generated within their science to develop effective systems for communicating and disseminating information.

At the national level, the first step was taken in Japan, by Syoziro ASAHINA, with the establishment in 1958 of *Tombo*, a journal devoted exclusively to reports about Odonata. At the international level, an important move was made by B. Elwood MONTGOMERY when he convened a Colloquium on Odonata at Purdue University, Indiana in 1963 (MONTGOMERY, 1963), the year in which he started *Selysia*, the first international newsletter of odonatology. But by far the most significant development for the subject as a whole has been the formation in 1971 of the Societas Internationalis Odonatologica (S.I.O.) (KIAUTA & VAN BRINK, 1972). The prime mover and current President of S.I.O. is Bastiaan KIAUTA, the magnitude of whose contribution to this conspicuously successful venture cannot be exaggerated: it includes editing *Odonatologica* — a journal of international standing now in its twentieth year of publication — compiling research abstracts, arranging

biennial international symposia and generally facilitating and overseeing initiatives in the Society. As one of the many fortunate users of the services offered by S.I.O., I may mention here a provision that is of inestimable value : the section of the journal *Odonatologica* that is devoted to abstracts of articles published elsewhere on dragonflies. These Odonatological Abstracts, now numbering more than 7,000, constitute an essential source of reference for the serious student of Odonata (CORBET *et al.*, 1984a, b).

THE CONSERVING STRAND

Biologists have long been aware that the survival of certain animals and plants can be threatened by man's activities. As long ago as 1900, W. J. LUCAS wrote in his book *British dragonflies* that "in all probability future changes in the total number of species of British Dragonflies must be looked for in the way of decrease only." Especially during the last 50 years, with the application of high-energy technology to the clearing and drainage of land, LUCAS' words have proved to be prophetic. In 1979, the late Sir Peter SCOTT, Chairman of the Survival Service Commission of the International Union for the Consrvation of Nature and Natural Resources (I.U.C.N.), invited Norman MOORE to form an Odonata Specialist Group whose main remit would be to determine conservation priorities for Odonata and to support proposals for incorporation into I.U.C.N.'s Action Plan (MOORE, 1982). The Group was formed and held its inaugural meeting in 1980, in Kyoto, Japan — a fitting venue, having regard to Japan's signal contribution to odonatology. This action provided a needed focus for coordinating conservation projects at the international level and built on an earlier commitment to the conservation of dragonflies and their habitats embodied in the Constitution of the Societas Internationalis Odonatologica (ANON., 1983).

As dragonflies become progressively threatened by the increasing pressures caused by the numbers and activities of humans, odonatologists will need to develop a corresponding resolve to help to conserve these magnificent insects, primarily through prevention of habitat destruction. From an historical point of view it is satisfying to note that any progress made on this front will owe much to the knowledge and awareness generated by earlier odonatologists whose accomplishments I have reviewed in this essay.

Recognition of the need for habitat conservation is now widespread among odonatologists (e.g. BICK, 1983) and is reflected also in legislation enacted by the Council of Europe (1988a, b ; VAN TOL & VERDONK, 1988) as well as by national odonatological societies. For example, the British Dragonfly Society, founded in 1983, and with a current membership exceeding 600, has a standing Dragonfly Conservation Group that works closely with local and national conservation bodies and that gives specialist advice to the government body responsible for conservation (GABB, 1986). Such activity and enthusiasm

continue to be generated or reinforced by attractively illustrated handbooks (e.g. MATSUMURA, 1933) which to an increasing extent emphasize the need for conservation (e.g. KNAPP *et al.*, 1983 ; HAMADA & INOUE, 1985 ; SUGIMURA, 1985 ; MILLER, 1987 ; JURZITZA, 1988).

EPILOGUE

As we approach the end of the 20th Century — a quarter of a millennium after LINNAEUS gave us the means to codify species-specific information — we find odonatology in good heart : students of all branches of the science, and in all parts of the world, can now keep abreast of each other's contributions to the study of dragonflies. This is something to be very thankful for ; but it is no exaggeration to say that the future of odonatology as a viable and rewarding pursuit now depends largely on the success of measures taken to conserve dragonfly habitats. This in turn will depend on an increasing proportion of people, especially young people, coming to regard dragonflies as sources of wonder and delight, and as a part of our biological heritage that we cannot afford to destroy.

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APPENDIX

Names and lifespans of deceased odonatologists mentioned in this essay [1].

ALDROVANDI (ALDROVANDUS), Ulisse (Ulysses) (1522-1605)
BALFOUR-BROWNE, William Alexander Francis (1874-1967)
BARTENEV, Aleksander Nikolaevich (1882-1946) [2]
BARTRAM, John (1701-1778)
BEUTENMULLER, William (1864-1934)
BIANKI, Leo Valentinovich (1884-1936)
BURMEISTER, Carl Hermann (1807-1892)
CABOT, Louis (fl. 1872)
CALVERT, Philip Powell (1871-1961) [3]
CHARPENTIER, Toussaint de (1779-1847)
DEGEER, Carl (1720-1778)
DRURY, Dru (1725-1803)
EVANS, William Frederick (fl. 1845)
FABRICIUS, Johann Christian (1745-1808)
FOURCROY, Antoine François de (1755-1809)
FRASER, Frederic Charles (1880-1963)
GEIJSKES, Dirk Cornelis (1907-1985) [4]
GEOFFROY, Etiènne Louis (1727-1810)
GESNER, Conrad (1516-1558)
HAGEN, Herman(n) August (1817-1893)
HARRIS, Moses (1731-1788)
KARSCH, Ferdinand Anton Franz (1853-1936)
KENNEDY, Clarence Hamilton (1870-1952)
KIRBY, William Forsell (1844-1912)
LEEUWENHOEK, Antony van (1632-1723)
LIEFTINCK, Maurits Anne (1904-1985) [5]
LINNAEUS (LINNE), Carl [on](1707-1778) [6]
LUCAS, William John (1858-1932)
MARTIN, Réné (1846-1925)
MATSUMURA, Shonen (1872-1960)
MERIAN, Maria Sibylla (1647-1717)
MONTGOMERY, Basil Elwood (1899-1983) [7]
MOUFET (MOUFFET, MOFFETT, MOFET), Thomas (1553-1604)
MÜLLER, Otto Friedrich (1730-1784)
MUTTKOWSKI, Richard Anthony (1887-1843)
NEEDHAM, James George(1868-1957)

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[1] Many important odonatologists are of course unrepresented in this list. Citations to some published biographical and bibliographical notices in respect of persons listed may be found in GILBERT (1977) or in footnotes below.
[2] See HUSANOIVA & BELYSHEV (1971).
[3] See also WHITE (1984).
[4] See WAGENAAR HUMMELINCK (1972).
[5] See HEYMER (1970), GEIJSKES (1984), ANON. (1985) and ASAHINA (1985).
[6] VOISIN (1989) discusses the correct spelling of LINNAEUS.
[7] See MACKLIN (1974), ANON. (1983) and WESTFALL (1983).

NIELSEN, Cesare (1898-1984) [8]
POPOVA, Ariadna Nikolaevna (1897-1972) [9]
PORTMANN, Adolf (1897-1982) [10]
PREUDHOMME DE BORRE, François Paul Charles Alfred (1833-1905)
RAMBUR, Jules Pierre (1801-1870)
RAY (WRAY), John (1628-1705)
RÉAUMUR, Réné Antoine Ferchault de (1683-1757)
RIS, Friedrich (1867-1931)
ROBERT, Paul-André (1901-1977) [11]
ST. QUENTIN, Douglas (1899-1982) [12]
SANTOS, Newton Dias dos (1916-1989) [13]
SCHMIDT, Erich Walther (1890-1969)
SCOPOLI, Johann Anton (1723-1788)
SÉLYS-LONGCHAMPS, Michel Edmond de (1813-1900)
SNOW, Willis Everett (1918-1959)
SULZER, Johann Heinrich (1735-1813)
SWAMMERDAM, Johann Jacob (1637-1680)
TILLYARD, Robin John (1881-1937)
TÜMPEL, Rudolph (1863-1938)
VALVASOR, Janez Vajkard (1641-1693) [14]
VANDER LINDEN, Pierre Léonard (1797-1831)
WALKER, Edmund Murton (1877-1969) [15]
WALKER, Francis (1809-1874)
WESENBERG-LUND, Carl Jørgen (1867-1955) [16]
WILLIAMSON, Edward Bruce (1877-1933)
YAKOBSON, Gheorgii Gheorhievich (1871-1926)

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[8] See BUCCIARELLI (1973) and UTZERI (1989).
[9] See AKRAMOWSKI & ZHILTSOVA (1973).
[10] See ILLIES (1981) and MILIČ LOHMAN *et al.* (1982).
[11] See WENGER (1978).
[12] See THEISCHINGER & STARK (1974) and WARINGER (1983).
[13] See MACHADO & COSTA (1990).
[14] See WRABER *et al.* (1990).
[15] See CORBET (1966).
[16] See BERG (1949).

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