THE CHIRONOMIDAE AND THEIR ECOLOGY IN CHALK STREAMS

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More than 450 species of Chironomidae, or non-biting midges, are known to occur in the British Isles and undoubtedly many more are as yet undiscovered. Trapping of adult midges at a point on the Tadnoll Brook (Dorset) throughout one year yielded 75 species (Pinder 1974) of which seven were new to the British Isles and one was new to science (Pinder 1976). Chironomid larvae, of which the most familiar are the 'bloodworms' of *Chironomus* (Fig. 1), are to be found in almost every conceivable fresh and brackish-water habitat. Harp & Campbell (1967) found larvae of *Chironomus plumosus* in mineral acid lakes with a pH of 2·3 and potential free acidity as high as 9090 mg $CaCO_3\ l^{-1}$. Adult male midges (Fig. 2) are familiar to most people if only through their habit of forming dense, and sometimes very extensive, mating swarms, often a considerable distance from water. Occasionally, for example where housing developments adjoin lakes or water treatment beds, adult midges may occur in sufficient numbers to constitute a severe nuisance.

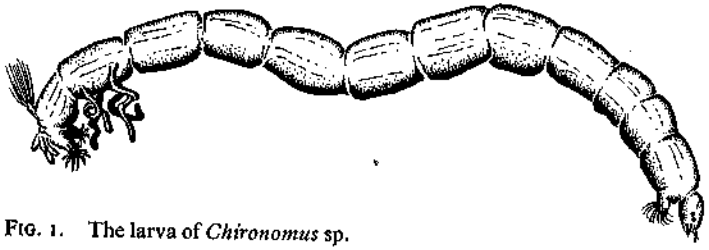

FIG. 1. The larva of *Chironomus* sp.

It is hardly surprising, in view of their ubiquity, that the Chironomidae have attracted a great deal of scientific attention; Thienemann's (1954) review of the family ran to 834 pages and cited well over 1000 references. It was his opinion that many general limnological and ecological problems could be resolved by studies of chironomid distribution. Indeed considerable advances have been made in studies of lake typology, river zonation and even transantarctic relationships on just this basis. Currently interest is being expressed in chironomids as possible indicators of the quality of river water (e.g. Wilson & Bright 1973). We know very little, however, about the life cycles or the ecology of individual chironomid species in flowing waters. This is largely because of the difficulty of identifying the larvae, very few of which have been adequately described. A recent report by the Natural Environment Research Council (1976) stressed the need for further research into the taxonomy of chironomid larvae. It therefore seems appropriate to consider some of the taxonomic problems involved in studies of the Chironomidae before going on to discuss some aspects of their ecology in chalk streams.

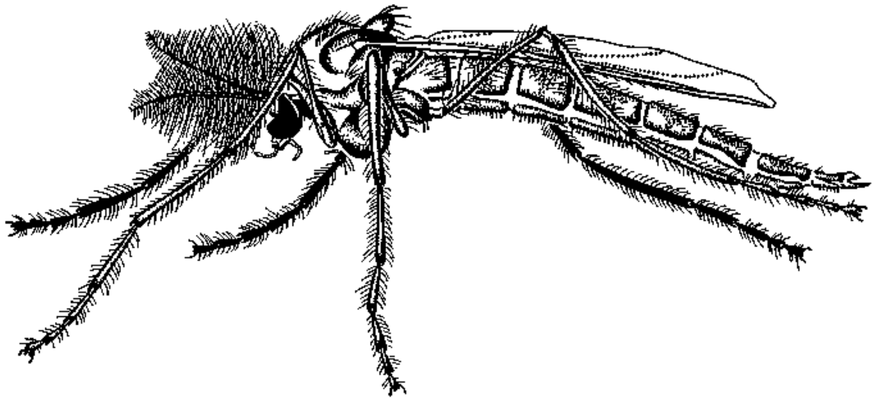

FIG. 2. An adult male chironomid.

Taxonomy

The considerable confusion over nomenclature of which the student of the Chironomidae quickly becomes aware stems from two main causes. Thienemann (1954) wrote 'Aber im Jahre 1908 begann das Chaos!'. He was referring to the rediscovery in that year of a paper by Meigen (1800). For over 100 years a system of nomenclature, based on Meigen's later (1803) work, had been generally accepted, but the rediscovery of the earlier work meant that a number of the commonly used names were invalidated by the rule of priority. One of the consequences was that for many years two names for the family, Tendipedidae and Chironomidae, were in common use. The situation was finally resolved by a ruling of the International Commission on Zoological Nomenclature (see Fittkau 1966) which suppressed Meigen's 1800 names. However, the confusion which persisted for many years is well entrenched in the literature.

The second major source of confusion arises from the fact that two separate systems of nomenclature have developed side by side. British workers, notably F. W. Edwards, working primarily with the imagines favoured a system with large genera which were often divided into subgenera and species groups (e.g. Edwards 1929). On the other hand, Thienemann and other continental workers, who were mainly concerned with the immature stages, preferred the use of smaller, better-defined genera (e.g. Thienemann 1944). In more recent years some progress has been made towards reconciling the two systems through studies of all stages (e.g. Brundin 1956, Fittkau 1962) which should result in a more stable system in the future.

A number of keys are available for the identification of chironomid larvae (e.g. Bryce & Hobart 1972, Chernovskii 1949, Pankratova 1970, Thienemann 1944), but in most cases it is necessary to rear larvae through to the adult stage for positive identification since many species remain undescribed. A good degree of success in rearing chalk stream species has been attained by placing larvae individually in containers of river water kept continuously aerated and at a temperature of *c.* 10°C. No food is required if late fourth instar larvae are used and this has the additional advantage that the cast larval skin is much easier to locate in the absence of other organic debris.

The only keys currently available for the identification of adult British chironomids are those of Edwards (1929) and a revised version of this by Coe (1950). Neither of these is adequately illustrated and many species have been added to the British list since their publication. They are also based on pinned material, and often use coloration, which is altered by preservation in alcohol. Furthermore, many species are very variable in their coloration which may be modified by developmental temperature (Pinder 1976).

A new, extensively illustrated key to the adult British Chironomidae will shortly be published by the Freshwater Biological Association. The key will follow the nomenclature of the recently revised *Check list of British Insects* (Kloet & Hincks 1975) in the belief that this will assist in the establishment of a more stable nomenclature. Only characters which are readily seen in

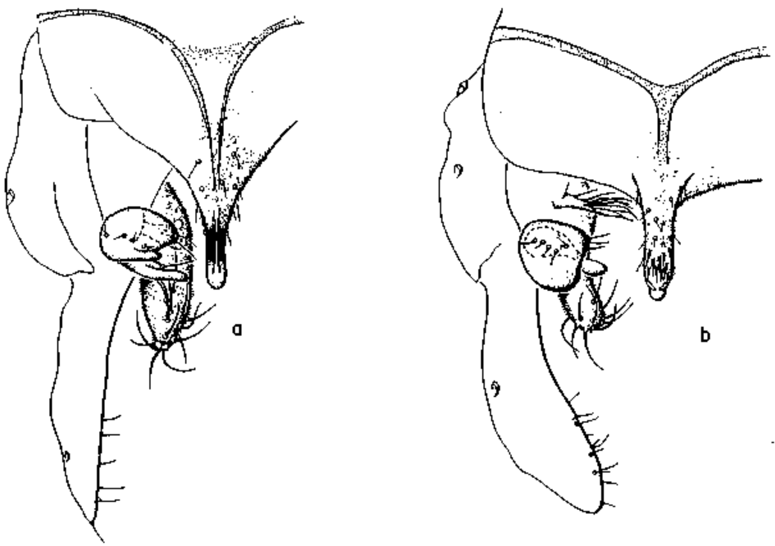

FIG. 3. The male genitalia of (a) *Tanytarsus nemorosus* Edwards and (b) *Tanytarsus usmaensis* Pagast (From the forthcoming FBA key).

specimens which have been preserved in alcohol, or mounted on slides for microscopic examination, have been used. The male genitalia of virtually every species have been illustrated (e.g. Fig. 3) from material kindly loaned

by the British Museum (Natural History) and the Max Planck Institut für Limnologie in Plön.

The Chironomidae of chalk streams

The earliest studies of the chironomids of chalk streams to be conducted at the species level were those of Ford (1957) and Hall (1951 and 1961) but little has been published since then and the following account derives mainly from preliminary studies on a reach of the Tadnoll Brook which was described by Pinder (1974).

Hall (1961) listed 57 species of Chironomidae from chalk streams in Hampshire which, when added to the list published by Pinder (1974), makes a total of 111 species. Thus almost a quarter of the known British fauna has been shown to occur in the chalk streams of southern England, which is an indication of the way in which a knowledge of taxonomy is essential before much ecology can be done. However, probably very few species, if any, are unique to this situation. In a comparison of chalk and acid streams in Hampshire, Hall (1951) found only one species, *Micropsectra subviridis* (Goet.) which was common in chalk streams but absent from acid streams. A second species *Micropsectra aristata* Pinder which is common in the Tadnoll Brook, is so far known only from the chalk streams of Dorset and Hampshire (Pinder 1976).

The family Chironomidae may be divided into several subfamilies and tribes. Those represented in chalk streams are listed in Table 1. The

TABLE 1

The common species of chironomid larvae in the bottom deposits of the Tadnoll Brook

Subfamily TANYPODINAE
Apsectrotanypus trifascipennis (Zett.); *Procladius choreus* (Meig.)

Subfamily ORTHOCLADIINAE
Tribe DIAMESINI
Potthastia gaedii (Meig.)
Tribe ORTHOCLADIINI
Heterotrissocladius marcidus (Walk.); *Odontomesa fulva (Kieff.); Prodiamesa olivacea* (Meig.); *Synorthocladius semivirens* (Kieff.)

Subfamily CHIRONOMINAE
Tribe CHIRONOMINI
Paracladopelma camptolabis (Kieff.); *Paratendipes albimanus* (Meig.); *Polypedilum convictum* (Walk.); *Polypedilum cultellatum* Goet.
Tribe TANYTARSINI
Cladotanytarsus vanderwulpi (Edw.); *Micropsectra* sp.; *Micropsectra aristata* Pinder; *Tanytarsus brundini* Lindeberg.

chironomid fauna of submerged macrophytes is dominated by the subfamily Orthocladiinae with the principal species on *Ranunculus* in the Tadnoll Brook being *Cricotopus bicinctus* (Meigen), *C. intersectus* (Staeger), *C. trifasciatus* (Panzer), *Eukiefferiella calvescens* (Edwards), *E. claripennis* (Lundbeck) and *E. ilkleyensis* (Edwards). At times *Orthocladius rivulorum* Kieffer and *Thienemanniella vittata* (Edwards) are also abundant. Only one species of Chironominae, *Rheotanytarsus curtistylus* (Goetghebuer) is a true member of the epiphytic community although several species commonly occur at the sediment – macrophyte interface. In contrast the fauna of the river bed is dominated, in number of species (Table 1) though not necessarily in number of individuals (Fig. 4), by the Chironominae.

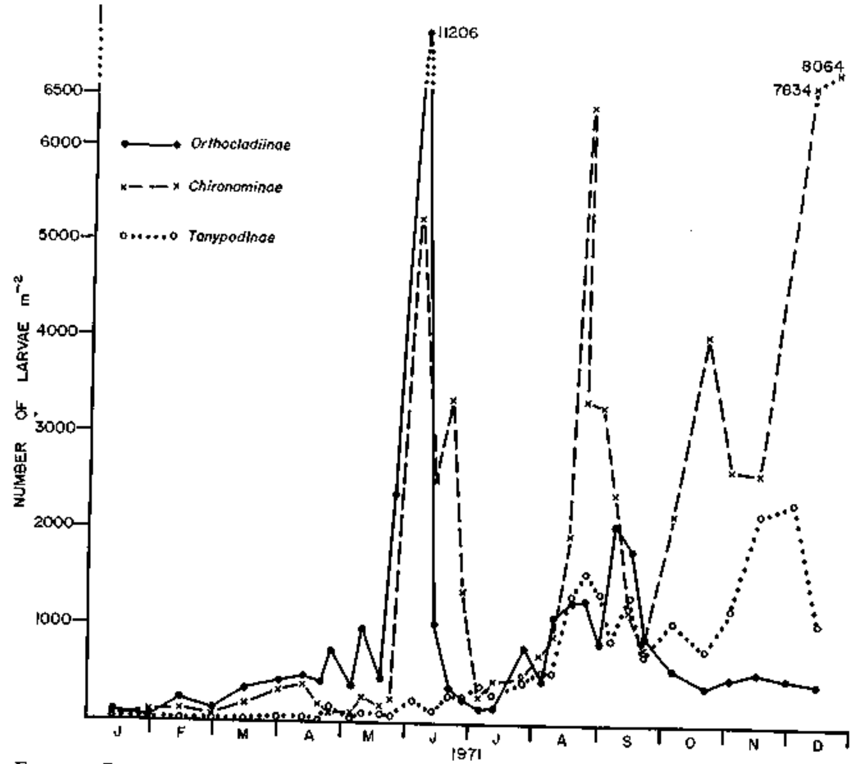

FIG. 4. Population densities of chironomid larvae in bottom sediments of the Tadnoll Brook during 1971.

Population densities in the bottom sediments are generally much lower than on *Ranunculus*. The maximum density recorded in the bottom sediments was about 17 000 m^{-2} in June 1971 whereas densities of almost

100 000 m^{-2} have been recorded on *Ranunculus*. This is probably simply a reflection of the greater surface area available for colonization in weed-beds, which are frequently as much as 50 cm deep in the Tadnoll Brook, whereas larvae rarely penetrate more than 5 cm into the bottom deposits.

Hall (1961) found that the predatory Tanypodinae, *Apsectrotanypus trifascipennis* and *Procladius choreus*, regularly composed 75% of the total chironomid fauna in the streams which he examined. In contrast, in the Tadnoll Brook the Tanypodinae have never been found to constitute more than 63%, and usually make up less than 20%, of the total.

The bottom sediments of the Tadnoll Brook are composed almost exclusively of sand and organic detritus and the majority of chironomid species exhibit a clear preference for one or the other. The Tanypodinae for example are almost entirely confined to deposits containing a high proportion of organic detritus.

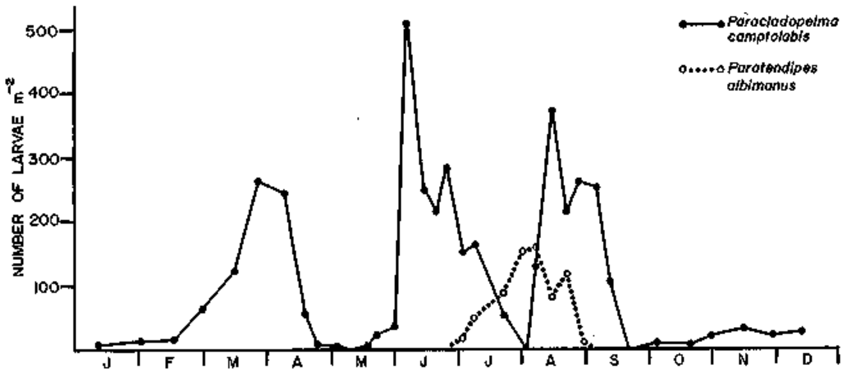

FIG. 5. Numbers of *Paracladopelma camptolabis* and *Paratendipes albimanus* in the Tadnoll Brook during 1971.

Life cycles and seasonal population dynamics

All of the common Chironominae in the Tadnoll Brook have distinctly separate generations varying from a single generation per year in the case of *Paratendipes albimanus* to three in species such as *Paracladopelma camptolabis* (Fig. 5) and exceptionally four as is the case with *Rheotanytarsus curtistylus* (Pinder & Clare in press). The common species of Tanypodinae and most of the Orthocladiinae, on the other hand, are multivoltine with overlapping generations. Ford (1957) considered *Apsectrotanypus trifascipennis* to be bivoltine. In the Tadnoll Brook, however, it probably has four generations a year, although numbers are very low in the first half of the year which makes interpretation of the life-cycle difficult.

Of the Orthocladiinae, only one species, *Orthocladius rivulorum*, was found to be univoltine whilst the *Cricotopus* spp. and *Eukiefferiella* spp., which made up the bulk of the population, had an indeterminate number of generations with continuous recruitment through oviposition for much of the year. The maximum population of all species recorded on *Ranunculus* over a two year period was 100 000 m^{-2} during early May 1976, the previous peak having been 30 000 m^{-2} the preceding October. Whereas all three *Eukiefferiella* spp. together with *Cricotopus bicinctus, C. trifasciatus* and *O. rivulorum* contributed to the spring peak, the October peak was entirely attributable to an increase in the population of *C. intersectus.*

Very little information is available on the factors influencing the size of chironomid populations in rivers. In the case of the Orthocladiinae mentioned above, the quantity or the quality of the available food supply seem to be probable factors, since the spring peak appears to coincide with the timing of the spring diatom bloom.

Chironomids are often mentioned as being a major source of food for a variety of fish species but the influence of fish predation on chironomid populations has not been assessed. The emergence success of adult *R. curtistylus* in the Tadnoll Brook was very much lower in summer than in spring, a fact tentatively attributed to higher levels of predation by trout and salmon parr in the summer (Pinder & Clare in press).

A second major factor thought to influence the success of the summer generation of *R. curtistylus* was the amount of suitable habitat available. In 1974 the biomass of *Ranunculus* in the Tadnoll Brook decreased dramatically after flowering, and in consequence the summer generation of *R. curtistylus* achieved only 25% of the production of the preceding generation (Pinder & Clare in press).

Variations in the amount of suitable habitat undoubtedly play a major role in determining the population density of many species in chalk streams, but this may be difficult to separate from the direct influence of changes in flow. Many chironomid larvae are protected to some extent from increases in current speed by their cases, which are often firmly attached to the underlying substratum. The Tanypodinae, however, do not construct cases and the two common species in the Tadnoll Brook are restricted to marginal deposits of detritus which accumulate in areas of slow current speed.

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References

Brundin, L. (1956). Zur Systematik der Orthocladiinae (Dipt. Chironomidae). *Rep. Inst. Freshwat. Res. Drottningholm* **37,** 5–185.

Bryce, D. & Hobart, A. (1972). The biology and identification of the larvae of the Chironomidae (Diptera). *Entomologist's Gaz.,* **23,** 175–217.

Chernovskii, A. A. (1949). Identification of larvae of the midge family Tendipedidae. Moskva. Akad. Nauk SSR. NLL Translation (1961).

Coe, R. L. (1950). Family Chironomidae. *Handbk Ident. Br. Insects,* **9,** 2, 121–206.

Edwards, F. W. (1929). British non-biting midges (Diptera, Chironomidae). *Trans. R. ent. Soc. Lond.,* **77,** 279–430.

Fittkau, E. J. (1962). Die Tanypodinae (Diptera: Chironomidae). (Die Tribus Anatopyniini, Macropelopiini und Pentaneurini). *Abh. Larvalsyst. Insekten,* No. 6, 453 pp.

Fittkau, E. J. (1966). *Chironomus,* nicht *Tendipes. Arch. Hydrobiol.* **62,** 269–71.

Ford, J. B. (1957). A study of the biology and distribution of mud-dwelling chironomid larvae in a chalk stream. Unpublished PhD thesis, Southampton Univ.

Hall, R. E. (1951). Comparative observations on the chironomid fauna of a chalk stream and a system of acid streams. *J. Soc. Br. Ent.* **3,** 253–62.

Hall, R. E. (1961). The Chironomidae of three chalk streams in southern England. *Proc. 11th int. Congr. Ent.,* Vienna 1960, **1,** 178–81.

Harp, G. L. & Campbell, R. S. (1967). The distribution of *Tendipes plumosus* (Linné) in mineral acid water. *Limnol. Oceanogr.,* **12,** 260–3.

Kloet, G. S. & Hincks, W. D. (1975). A check list of British insects. 2nd edn Part 5: Diptera & Siphonaptera. *Handbk Ident. Br. Insects,* No. 11, 139 pp.

Meigen, J. W. (1800). Nouvelle classification des mouches à deux ailes (Diptera L.) d'àpres un plan tout nouveau. Paris.

Meigen, J. W. (1803). Versuch einer neuen Gattungseinteilung der europäischen Zweiflügeligen Insekten. *Magazin fuer Insektenkunde (Illiger),* 259–81.

Natural Environment Research Council (1976). The role of taxonomy in ecological research. *Publs nat. Environ. Res. Coun.* Ser. B, No. 14, 48 pp.

Pankratova, V. Ya. (1970). Larvae and pupae of midges of the subfamily Orthocladiinae of the fauna of the U.S.S.R. Leningrad, Nauka. (Translation of some keys available as *FBA Transl. (N.S.)* No. 54 & No. 64).

Pinder, L. C. V. (1974). The Chironomidae of a small chalk stream in southern England. *Ent. Tidskr.,* **95,** Suppl., 195–202.

Pinder, L. C. V. (1976). *Micropsectra aristata,* a new species of chironomid (Dipt. Nematocera) from southern England. *Hydrobiologia,* **51,** 275–80.

Pinder, L. C. V. & Clare, P. C. (in press). The life history and production of *Rheotanytarsus curtistylus* in a small stream in southern England. *Acta Univ. Carol.*

Thienemann, A. (1944). Bestimmungstabellen für die bis jetzt bekannten Larven und Puppen der Orthocladiinen. *Arch. Hydrobiol.,* **39,** 551–664.

Thienemann, A. (1954). *Chironomus.* Leben, Verbreitung und wirtschaftliche Bedeutung der Chironomiden. *Binnengewässer,* **20,** 1–834.

Wilson, R. S. & Bright, P. L. (1973). The use of chironomid pupal exuviae for characterizing streams. *Freshwat. Biol.,* **3,** 283–302.