CONTENTS

These abstracts have been extracted from the 23rd Number of the British Simuliid Group Bulletin and cover the historic combined meeting of the European Simuliidae Symposium and the British Simulium Group, held in Berlin in September 2004. That this meeting ever happened is entirely due to the persistence of Doreen Werner of Humboldt University. Thank you Doreen and the Cytogenetics Group for all your efforts and for a well organised meeting.

John Davies, Editor

Report on the International Simuliidae Symposium (5th European Simuliidae-Symposium, including the 26th Annual Meeting of the British Simuliid Group) held from 15 to 18 September 2004 at the Institute of Biology of the Humboldt University of Berlin, Germany

The Simuliidae working groups of Central Europe and Great Britain met together to take part in an International Simuliidae Symposium held from 15 to 18 September 2004 at the Humboldt University of Berlin, Germany. The five-day meeting was organised by the Cytogenetics working-group at the Institute of Biology, and was opened with an introductory talk by Prof. Dr. H. Saumweber on the history and future prospects of the Institute..

With 38 delegates from 16 countries (Austria, Belgium, Canada, Czech Republic, Finland, France, Germany, Great Britain, Italy, Lithuania, Norway, Serbia-Montenegro, Russia, Slovakia, Sweden, USA), this was the largest European meeting of its kind to be held. There were 35 scientific presentations in total, with the emphasis predominantly on taxonomy and systematics, history, ecology, disease transmission, medical and veterinary aspects, and control. These stimulated discussions which not only took place during the coffee and lunch breaks and the poster session but also continued into the evenings, with the interesting and lively exchange of ideas within a pleasantly relaxed social framework and after the dinner at the "Die Zwölf Apostel" restaurant and the visit to the German State Opera's performance of Tchaikovsky's ballet "Swan Lake".

Summaries of the presentations are published below. The complete manuscripts will be published in 2005 as a Supplement volume of the *Studia Dipterologica*.

Excursions to Potsdam and to the River Oder generated considerable interest and enthusiasm, which in turn reflected the traditionally informal and friendly atmosphere during the symposium.

To maintain the impetus for scientific exchange and collaboration, it is planned to continue with this type of joint Symposium. Future enquiries and requests for information should be directed to Dr J. B. Davies, (Liverpool School of Tropical Medicine, Liverpool, UK, , daviesjb@liv.ac.uk) or to Dr Doreen Werner (Berlin, Germany, HU Berlin, h0662cer@rz.hu-berlin.de).

The next joint Symposium will take place in 2006. The meeting place has yet to be decided, but offers to host the next meeting have been received from Vilnius in Lithuania and Novi Sad in Serbia and Montenegro..

Doreen Werner

Abstracts of Presentations

RELATIONSHIPS OF THE NEARCTIC AND PALAEARCTIC SIMULIID FAUNAS

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The black fly faunas of the Nearctic and Palaearctic Regions are intimately related. About 33 species are Holarctic, occurring in both regions. By contrast, only 15 Nearctic species are shared with the Neotropical

Region. In the Nearctic Region, the number of species shared with the Palaearctic Region increases with latitude: 3 species between 30º and 40º N, 9 between 40º and 50º N, 19 between 50º and 60º N, and 33 between 60º and 70º N. Westernmost Alaska, which is only 88 km from the Palaearctic Region, shares 70% of its 38 species with that region, and the percentage shared is expected to increase as synonymies continue to be recognized. Faunal similarities decrease from west to east across the Nearctic Region, indicating the significance of the Beringian connection; in addition, most Holarctic species become progressively more differentiated chromosomally from west to east in the Nearctic Region. In the cytologically and morphologically well-surveyed country of Sweden, 36% of the 61 species are shared with the Nearctic Region. Non-feeding and ornithophilic species have statistically greater proportional representation among Holarctic black flies than among either Nearctic or Palaearctic black flies. Additional Holarctic species are expected to be revealed as type specimens are reexamined and chromosomal and structural characters are studied. Faunal similarities, rather than minute differences that result in the application of different species names, should continue to be emphasized between the two regions.

Keywords: Simuliidae, Beringia, cytotaxonomy, faunal studies, Holarctic Region, Nearctic Region, Palaearctic Region, systematics

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ON THE DISTRIBUTION OF BLACKFLY LARVAE IN DIFFERENT RIVERS IN LITHUANIA

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Our study of the blackflies in Lithuania began in the last decade of the 20th century, during which time 27 species of blackflies have been found in this country. The aim of the present work was to assess the characteristic features in the distribution and abundance of blackflies in different rivers in Lithuania.

The studies were carried out during 2001 – 2004 in 14 different rivers, at 16 study sites (in two paired study sites in the two largest rivers, the Neris and the Nemunas), from April to November. The annual water discharge varied from 0.1 to 500 m^3/s at the study sites. Larvae and pupae of blackflies were collected from aquatic plants every month. In the course of the fieldwork, data on the physical and chemical indices (water temperature, dissolved oxygen, phosphates, nitrates, nitrites, water hardness, ph, permanganatic oxidation of organic matter, current velocity) were gathered. Each sample was taken from 3 tufts of aquatic plants, torn from the stream at different depths. The composition of blackfly species and the abundance (ind./dm^2) of larvae and pupae of every species were determined for each sample.

To assess the impact of environmental factors on blackfly distribution and abundance, the correlation between the abundance of different blackfly species in rivers and the physical and chemical indices of the water was repeatedly measured using ANOVAs. The results of the study revealed that the species composition and abundance of each species of blackfly depend on the environmental factors of their habitats. However, individual species of blackflies differ in the impact of the various environmental factors on their occurrence and abundance. For example, the abundance of *Simulium maculatum* (MEIGEN) larvae depends on the river discharge ($R = 0.83$, $p = 0.03$) and the amount of organic matter ($R = 0.74$, $p = 0.014$), while the impact of other physical and chemical caracteristics was weaker or even nonsignificant.

Different species of blackflies thus differ in their reaction to the environmental factors that determine the quality of their habitats.

Keywords: Simuliidae, Lithuania, distribution, hydrochemical indices

INITIAL PRACTICAL EXPERIENCE WITH THE DIGITAL KEY TO THE LARVAE AND PUPAE OF SIMULIIDAE FROM CENTRAL AND WESTERN EUROPE

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The digital key for Simuliidae has been available since April 2004 as the first part of the programme "Biological Indicators", which will be continued with keys to the Trichoptera and Culicidae.

Initial experience in the first months of use have proved the advantages of a key based on original photographic images. In a trial, even high school students without any experience with the identification of freshwater organisms were able to identify many species. Because of the Morphological Atlas and the Gallery of 2400 microscopic images, it can easily be used for teaching and can therefore replace a reference collection.

For the specialised taxonomist, a digital key cannot replace books and species descriptions, but it makes the comparison of structures between different species much easier and clearer. This key to Simuliidae enables the non-specialised freshwater biologist to identify blackflies beyond the family or genus level. In this way this medically and ecologically important group of insects can be handled more easily and samples can be identified more frequently down to species level for ecological surveys and the assessment of water quality.

The key enables the user to determine the larvae and pupae of 69 blackfly species, which covers the Simuliidae fauna of 17 European countries: Andorra, Austria, Belgium, Czech Republic, Denmark, France, Germany, Great Britain, Hungary, Ireland, Lichtenstein, Luxembourg, Netherlands, Poland, Slovakia, Slovenia, Switzerland, and it includes more than two-thirds of the North and South European Simuliidae fauna.

The digital key consists of a set of Determination Programs: the Key, the Morphological Atlas, the Gallery, the Ecology, the Query Key.

Opening the Key, the user finds a number of pages on which two images of each relevant taxonomic feature are compared and explained in a text field beneath the images.

The Morphological Atlas provides numerous images of the morphological characteristics of larvae and pupae. Overlays describe the features, with the scientific names used in the key, and in this way the less experienced user can find his way easily.

Opening the Gallery, the whole photo database is available and enables sets of pictures to be compared. In this way, either all the features of one species or one feature in a set of species can be compared. This is an easy way to teach yourself the differences between species. Each database consists of thousands of photos.

In the menu Ecology, the user can find ecological and saprobiological data for each species. In addition, their distribution and a list of synonyms and their authors is given.

By entering the available features in a form, the Query Key enables a determination to be made even if only some body parts are available (e.g. a pupa without a cocoon).

Further information can be found on the Internet. On our homepage, the registered user can enter his password and immediately obtain the latest information and updates.

Keywords: Simuliidae, blackflies, digital key, taxonomy, ecology

ONCHOCERCIASIS TRANSMISSION BY THE BIOKO FORM OF *SIMULIUM YAHENSE* VAJIME & DUNBAR

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This paper will report on investigations of the vectorial abilities of the endemic form of *Simulium yahense* VAJIME & DUNBAR that occurs on the island of Bioko in the Gulf of Guinea in relation to ivermectin treatments. Although ivermectin has been administered in Bioko since 1990, coverage remains low with about half the island's population treated overall. There are no data on levels of parasitism with *Onchocerca volvulus* in *Simulium yahense* prior to the treatments, although one data-set from a site at Sampaca is based on flies collected in 1993. These data on transmission rates were compared with more recent ones at Sampaca, which did not show any evidence of a decrease. Data from other sites collected during the APOC project in 1999-2001 do not show any evidence of declines in transmission rates either. Transmission rates and levels of parasitism in the flies were typical for the West African forest zone.

Keywords: Simuliidae, *Simulium yahense*, onchocerciasis, transmission, Bioko

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ESTIMATING THE BITING RISK TO HUMANS BY THE BLACK FLY SPECIES THAT ARE MOST ABUNDANT IN THE REGION OF NOVI SAD (VOJVODINA PROVINCE, SERBIA AND MONTENEGRO)

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Black flies were recorded widely and abundantly in Serbia during the last century. Because of its suitable hydrological and climatic conditions, the province of Vojvodina can be considered one of the territories in the country most vulnerable to simuliid problems.

Studies of black flies have intensified in the region of Novi Sad in the last few years because these flies are a permanent nuisance for local inhabitants and are especially problematic in the areas close to the breeding sites: along the Danube river and on the slopes of the Fruska Gora mountain.

Dry-ice baited traps (type NS-2) have been successfully used for monitoring adult black fly populations at regular weekly intervals from March to September during the last four years (2001-2004). Adult captures and larval samples from the breeding sites confirmed that the three most abundant and most frequent species in the region are *Simulium ornatum* MEIGEN, 1818 (complex), *S. balcanicum* (ENDERLEIN, 1924) and *S. erythrocephalum* (DE GEER, 1776). Highly productive breeding sites have been found in the majority of streams flowing down from the Fruska Gora mountain, and in the case of *S. balcanicum* and *S. erythrocephalum* in the Danube river as well. Anthropophilic behaviour has been confirmed for all of these species.

Two methods of sampling adult black flies were employed simultaneously during the spring and summer of

2003 and 2004. Human biting catches were made during a period of five hours before sunset, while the exposure period for dry-ice baited traps was extended until the following morning. The results confirmed a significant correlation between these two methods of adult sampling. The data can be used as a valuable tool for estimating the risks to humans of being bitten by the main species present in the region.

The area identified as being most at risk of attacks by *S. ornatum* is limited to the right bank of the Danube river, formed by the slopes of the Fruska Gora mountain where there is an abundance of streams that provide excellent breeding conditions for black flies. There is no such strict delimitation in the case of *S. erythrocephalum* and *S. balcanicum*. Both banks of the Danube are affected, although localities on the right bank have a higher risk of black fly attacks.

Keywords: Simuliidae, *S. ornatum, S. erythrocephalum, S. balcanicum*, monitoring, traps, biting risks

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DIURNAL BITING PERIODICITY OF AMAZONIAN SIMULIIDAE

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We describe the hourly patterns of (parous) biting activity of the three main anthropophilic simuliids in the Amazonian region of southern Venezuela, namely, *Simulium guianense* WISE s.l.; *S. incrustatum* LUTZ; and *S. oyapockense* FLOCH & ABONNENC s.l. The time series of the hourly numbers of host-seeking parous flies caught in five Yanomami villages during the dry and wet seasons and their transition periods were investigated from 1995 to 2001 using harmonic analysis (assuming an underlying circadian rhythm) and periodic correlation (based on SPEARMAN's *r*). Parous *S. guianense* s.l. showed a bimodal activity pattern, with a minor peak in mid-morning and a major (statistically significant) peak at 1600 hours. *S. incrustatum* exhibited mainly unimodal activity either during early morning or around midday, according to locality. *S. oyapockense* s.l. bit humans throughout the day, mainly between 1000 and 1600 hours, but also showed a bimodal periodicity at some localities. Superimposed on these endogenous, species-specific cycles, the daily patterns of biting activity of each species showed variations according to locality, season, air temperature and relative humidity, with biting being promoted by warmer and drier hours during wet seasons/periods and reduced during hotter times in dry seasons or transitions. The results are discussed in terms of their implications for blackfly biology and ecology (e.g. the possible timing of oviposition and the proximity of breeding places to human settlements) as well as for the epidemiology and control of blackfly-transmitted infections.

Keywords: Simuliidae, *Simulium guianense* s.l., *S. incrustatum*, *S. oyapockense* s.l., harmonic analysis, circadian rhythms, host-seeking activity, Amazonas, Venezuela

CHANGES IN BLACKFLY COMMUNITIES CAUSED BY ANTHROPOGENIC INFLUENCE

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Our long-term research into the blackfly fauna of Slovakia has shown that anthropogenic pressure has a profound influence on blackfly communities. The most significant influences are engineering interventions to assist with the management of running waters and changes in the landscape structure on the banks.

The construction of the Gabčíkovo barrage on the River Danube in 1992 enabled us to study how blackflies may be influenced by such a dam. Data on the preimaginal stages of blackflies from this area were almost non-existent before 1991. During 1991-1992, the area of the Gabčíkovo project was studied, and 19 species were found. The most abundant were *S. balcanicum* (ENDERLEIN) and *S. reptans* (LINNAEUS), followed by *S. colombaschense* (FABRICIUS) and *S. lineatum* (MEIGEN). In the period immediately after the damming (1993-1997), several species disappeared (e.g. *Prosimulium* spp., *S. degrangei* DORIER & GRENIER, *S. morsitans* EDWARDS) and the abundance of the remaining species changed (*S. noelleri* FRIEDERICHS and *S. erythrocephalum* DE GEER became very abundant). Subsequently (2001-2004), several species that had disappeared were discovered again (*P. rufipes* (MEIGEN), *S. vernum* MACQUART), *S. erythrocephalum* became less abundant, and *S. balcanicum* and *S. noelleri* were again abundant. After 1992, new communities were formed in the upper parts of the adjacent tributaries, which are characterised by the great abundance of *S. balcanicum, S. noelleri* and *S. erythrocephalum,* but in the lower parts blackflies disappeared because there was no longer any running water.

In the Gidra stream, the influence of various factors on the blackfly communities was studied. This stream is subject to increasing levels of anthropogenic pressure along its course, such as channel modifications, bank vegetation without trees, and pollution. Where the stream channel has been strongly regulated, *S. brevidens* (RUBTSOV), *S. costatum* FRIEDERICHS and *S. cryophilum* (RUBTSOV) have disappeared. The relative abundance of the species also changed: an increase in the abundance of the *S. ornatum* MEIGEN complex, and a decrease of the *S. variegatum* MEIGEN group. We have also studied localities where anthropogenic pressure seems very low. We compared two adjacent mountain streams in the Eastern Carpathian forests, one flowing through primeval forest and the second through managed forests with open areas; more species were found in the second stream, including *S. ornatum, S. vernum,* and *S. auricoma* MEIGEN. Another anthropogenic influence is the construction of small water barrages. The stream sections above the barrages were usually inhabited by *P. tomosvaryi* (ENDERLEIN), *S. brevidens*, *S. cryophilum, S. ornatum*, and *S. vernum*, whereas the sections below the barrages were always inhabited by *S. noelleri* and also by *S. ornatum*. A special type of habitat, the small drainage channel, has been created in agricultural areas. Its features, such as the absence of natural bank vegetation, the simple morphology of the channels and the great concentration of agri-chemicals, have given rise to a specific blackfly community poor in species but with *S. ornatum* very abundant.

Keywords: Simuliidae, anthropogenic influence, blackfly communities, River Danube, Carpathians, water barrages

ON THE MORPHOLOGY OF SEVERAL BLACKFLY SPECIES OF THE *AMAZONICUM*-SPECIES GROUP, SUBGENUS *PSARONIOCOMPSA*, IN LATIN AMERICA

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Species of the *amazonicum*-species group of the subgenus *Psaroniocompsa* (Diptera: Simuliidae) are implicated in the transmission of mansonelliasis and onchocerciasis in the Neotropical region. In both cases, the simuliid vector species involved has been identified as *S. amazonicum* GOELDI, 1905. The redescription of *S. amazonicum* by several authorities (e.g. LUTZ, 1917) has resulted in many misidentifications of morphologically similar species, because of variation in the female and male scutal patterns and a lack of associated, reared material. In this paper, we discuss some morphological characters of the adults and pupae of some species in the *amazonicum* group (*S. amazonicum*, *S. ganalesense* VARGAS, MARTÍNEZ PALACIOS & DÍAZ NÁJERA, *S. minusculum* LUTZ, *S. oyapockense* FLOCH & ABONNENC s.l., *S. roraimense* NUNES DE MELLO and *S. sanguineum* KNAB). The taxonomic characters commonly used for species identification in Neotropical Simuliidae (e.g the structure of the female and male genitalia, cibarium, leg colour) are very similar in all these species. The most reliable taxonomic character is the thoracic pattern of the scutum, and in the pupa the number and configuration of the gill filaments. The females all have a black thorax with a pattern consisting of 1+1 sub-median silver pruinose vittae nearly extending to the posterior margin and 1+1 black cunae anteriorly (light source anterior). The males can be recognised by the black thorax with 1+1 sub-median, silver pruinose vittae ending in tails that may or may not extend to the posterior margin. The number of gill filaments varies from 6 to 8, all branching at different heights. However, variations in the thoracic pattern and the pupal gill configuration throughout the species distribution range make their identification a very difficult exercise. An integrated approach to assess their taxonomic status using molecular and/or cytogenetic techniques linked to morphological variation is discussed.
Keywords: Simuliidae, subgenus *Psaroniocompsa*, Neotropical region, taxonomy

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BLACK FLY STUDIES IN FINLAND: PAST, PRESENT AND FUTURE

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Black flies (Diptera: Simuliidae) are a relatively poorly studied insect family in Finland. Fries described *Simulium (Schoenbaueria) pusillum* in 1824, and LUNDSTRÖM described eight new species in 1911 from Finnish material. LUNDSTRÖM also made a very significant contribution to simuliidology by introducing the use of male genitalia in species identification. The most recent species described from Finnish material is *Metacnephia trigoniformis* YANKOVSKY, 2002. Only a few records of the Finnish black fly fauna were made in the five decades after LUNDSTRÖM. Ecological studies on black flies have been even fewer than faunistic studies in Finland. KUUSELA compiled the first checklist of the Finnish black fly fauna in 1971, giving a total of 31 species. The checklists by JENSEN (1997) and by CROSSKEY & HOWARD (1997) listed 33 and 37 recorded black fly species in Finland, respectively. Several new species have been recorded in Finland in the past three decades, especially in the most recent few years. The author of this paper has undertaken

studies of the distribution and habitat use of immature black flies in North Finland, the mating behaviour of adult black flies, and the black fly fauna of spring brooks in southern Finland. Since none of the recent new records have been included in the latest Inventory of World Blackflies, there is clearly a need for a revised checklist of the black flies of Finland. Combining all the recent or unpublished records with the records listed in the Inventory of World Blackflies, more than 50 species are obtained. The black fly fauna consists of more than 60 species in Sweden and more than 50 species in Norway. As almost no cytological studies have been carried out in Finland, contrary to the situation in Scandinavia, probably fewer than 10 new morphospecies can be expected in Finland. However, both morphological and cytological studies dealing with species-specific problems as well as studies on the ecology of all life stages of black flies in Finland are needed in the future.

Key words: black flies, Simuliidae, Finland, faunistics, distribution, behaviour

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DISTRIBUTION PATTERNS OF THREE HIGH ALTITUDE SPECIES OF EUROPEAN BLACKFLIES

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Prosimulium latimucro (ENDERLEIN, 1925)*, Twinnia hydroides* (NOVÁK, 1956), and *Simulium* (*Nevermannia*) *oligotuberculatum* (KNOZ, 1965) are distributed in the main European mountain ranges and can be considered true high-mountain blackfly species. *T. hydroides* is found in the montane, subalpine and alpine zones of both the Alpine-Carpathian and the Hercynian systems. *P. latimucro* has a wider range, being distributed in the mountain systems of southern and central Europe and in the British Isles. *S. oligotuberculatum* is a rare high-mountain species currently known from the West Carpathians, Jeseníky Mountains, Alps and Pyrenees. The vertical distribution of all three species is statistically significantly dependent on altitude. The regular occurrence of *T. hydroides* has been reported at altitudes from 900 m up to 1600 m a.s.l. with a relative frequency (F) of occurrence from 0.14 at altitudes of 900-1000 m a.s.l. to 0.8 at altitudes of 1400-1500 m a.s.l. In the West Carpathians, the occurrence of *P. latimucro* below 900 m a.s.l. is exceptional (F<0.01), and in the zone between 900 and 1300 m a.s.l. it is probable (F=0.06) but not frequent, whereas at altitudes of 1300-2000 m a.s.l. its occurrence is very constant (F=0.7). Throughout its entire distribution area it was found at altitudinal ranges from 400 to 2600 m a.s.l., with its centre over 1000 m a.s.l. Its occurrence at lower altitudes was recorded mainly in streams flowing down from the high mountains (Alps, Pirin) and at the northern limit of its distribution (UK). All the known breeding sites of *S. oligotuberculatum* were located at altitudes between 1200 and 2700 m a.s.l. at or above the timberline, in the subalpine and alpine zone.

All three species breed in the crenal and/or the rhithral. According to the thermal conditions of the breeding sites and the water temperatures recorded during the pupal stage, all three species are caltostenothermic. In the West Carpathians, the annual main water temperature in the breeding zone is below 4°C and the temperature during pupation is usually under 10°C. The species were recorded in a zone with a mean annual air temperature below 4°C, and a main air temperature in summer (July) up to 12°C; a mean daily temperature below 0°C lasts for 140 or more days, and a frost-free period lasts for 80-120 days; running waters begin to freeze at the end of November and remain frozen until the beginning of April.

The distribution of all three species is disjunctive oreal/oreoalpine and relict. It may be postulated that the distribution was wider and more contiguous, and that the species were also distributed at lower altitudes with a less differentiated georelief, during the LGM (Vislan/Würm) or early postglacial period (occurring both in springs and in fast currents, and tolerating much harsher climatic conditions). This wider distribution probably continued up to the end of the Younger Dryas and ended not later than the Preboreal (some 8 ky BP), when the present distribution area was formed and the immigration of *P. latimucro* into the British Isles

may have taken place. A later immigration is less probable due to the rupture of the land bridge with continental Europe and climate changes during the Boreal and Atlantic periods. The absence of these species from Scandinavia may be because large parts of Scandinavia were still covered by glaciers during this period. Based on this, it can be suggested that all three species belong to the dinodal biome type.

Keywords: Simuliidae, *Twinnia hydroides*, *Prosimulium latimucro, Simulium* (*Nevermannia*) *oligotuberculatum*, distribution

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THE ANTHROPOPHILIC MEMBERS OF THE *SIMULIUM DAMNOSUM* THEOBALD COMPLEX IN ETHIOPIA, MALAWI AND TANZANIA

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The southernmost foci of onchocerciasis in Africa are found in southern Tanzania and Malawi, and consist of rather isolated and relatively small areas. By contrast, towards northeastern Africa, in western Ethiopia, huge areas are affected by onchocerciasis and resemble the West African situation. Both for the northern and southern foci of eastern Africa, little was previously known about the local *S. damnosum* THEOBALD s.l. cytoform composition and the exact vector identity.

Using recent technical advances in cytotaxonomy and DNA typing, we are now able to detect 10 cytoforms and cytospecies of *S. damnosum* s.l. in and around the southern foci and two (three) additional ones in Ethiopia. A size comparison of the rDNA ITS-1 polymerase chain reaction amplicons derived from cytologically identified larvae with those from adult female flies caught on human bait have revealed that there is only one species/cytoform each in the northern and the southern foci responsible for human-biting, and hence most likely also for transmission.

In Malawi and southern Tanzania, *S. thyolense* VAJIME, TAMBALA, KRUEGER & POST could be identified as the most abundant species within all foci, while outside the foci other species were dominant. Furthermore, all biting female flies from the different areas were identified as *S. thyolense,* which suggests that this species is the only significant vector. Specimens identical chromosomally to *S. kilibanum* GOUTEUX, which is a proven vector in western Uganda and adjacent areas, were also found breeding at some localities, but there was no evidence here for anthropophily. Vice versa, in parts of central Tanzania the vector seems to be the cytoform 'Nkusi', which is otherwise regarded as non-anthropophilic (e.g. in Uganda). Morphological and molecular differences between the Ugandan and Malawian/Tanzanian populations of *S. kilibanum* and 'Nkusi' respectively raise the question of whether identical chromosomal traits have evolved independently or have been conserved for a much longer time than usual.

In central-western Ethiopia, the anthropophilic form of the *S. damnosum* complex is thought to be identical with cytoform 'Jimma', whereas the cytoforms 'Kulfo' and 'Kisiwani E' are probably zoophilic. However, DNA analyses suggest a very close relationship of the 'Jimma' and 'Kulfo' forms and their phylogenetic proximity to the 'Kibwezi' group, although 'Kulfo' was originally assigned to the 'squamosum' subcomplex of the *S. damnosum* complex. 'Jimma' form clearly differs chromosomally from the two northernmost vector species of the complex, cytoform 'Hamedense' from Sudan and *S. rasyani* GARMS, KERNER & MEREDITH from Yemen, but we cannot rule out the occurrence of additional anthropophilic cytoforms in the central-northern parts of Ethiopia, which might be related to these two members of the 'damnosum' subcomplex.

Keywords: Diptera, Simuliidae, *S. damnosum* complex, onchocerciasis, Ethiopia, Malawi, Tanzania

THE IDENTITY, TAXONOMY AND BIONOMICS OF SIMULIUM MAXIMUM (KNOZ)

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Simulium maximum (KNOZ, 1961) was described from the Jeseníky Mountains in the Czech Republic (as *Odagmia maxima*). In addition to the Czech Republic, it is known from Spain, France, Switzerland, Germany, Italy, Austria, Slovakia, Poland, Romania, Serbia, Bosnia and Bulgaria; it is found only in mountain streams. In Slovakia, *S. maximum* has been recorded at altitudes between 485 and 1520 m a.s.l., with the localities concentrated in 12 geomorphological units in the highest part of the Western Carpathian Mountains. The closely related *S. monticola* FRIEDERICHS is known from the same countries but also from other areas of Europe (Scandinavia, Russia); in Slovakia it has been recorded at altitudes between 130 and 1650 m a.s.l., with the localities in 33 geomorphological units of differing characters. The emergence of adults of *S. maximum* occurs in late spring, and the existence of a second generation is uncertain.

According to the description, *S. maximum* does not differ from *S. monticola* in most of its morphological characters However, both species are said to differ in body length in all stages (*S. maximum* is said to be considerably larger); the larvae are said to have different colour patterns, and *S. maximum* is said to have more rays in the large labral fan and more branches in the rectal papillae. In the pupa of *S. maximum*, the lower pair of the gill filaments is said to be branched on a common stalk, whereas in *S. monticola* it is said to arise directly from the basal stem. Males of the two species are said to differ in a few details of the genitalia, mainly in the shape of the dorsal plate. Females are said to differ in the shape of the ovipositor. These differences are rather weak, and in view of the variability of many blackfly characters, the validity of the two species is doubtful. We have studied the gill filaments in 135 *S. monticola*/*S.maximum* pupae. The results showed that these individuals could not be divided into two groups and that there is no strict division between a long stalk and a very short or absent stalk. However, these individuals could easily be divided into two groups (*S. monticola* 1 and *S. monticola* 2) according to the distribution of their thoracic tubercles. Further comparison of *S. monticola* 1 and 2 showed that they differ significantly in 53 of the 72 measured characters of the gills and that they were clearly separated from each other in the ISSR DNA analysis. The structure of the male and female terminalia of *S. monticola* 1 and 2 is very similar and does not correspond exactly to *S. monticola* or *S. maximum* sensu Knoz, but the shape of the median sclerite in *S. monticola* 2 was very similar to *S. maximum*. The occurrence of both forms was studied in the mountain stream Varínka (Malá Fatra Mountains, Western Carpathians). The pupation time and the pupation sites overlapped, but *S. monticola* 1 and *S. monticola* 2 were abundant in the upper part of the stream, whereas in the lower part only *S. monticola* 1 occurred. The maximum abundance of *S. monticola* 1 pupae was recorded in late April and early May, whereas the maximum abundance of *S. monticola* 2 pupae was recorded in late May and early June. In August and September, *S. monticola* 1 pupae were abundant again and only two pupae of *S. monticola* 2 were found. It seems probable that two (at least) closely related species really do inhabit the mountain regions of South-west, Central and Eastern Europe. A detailed comparison of *S. monticola* 2 with the type material of *S. maximum* is needed in order to determine whether these two are identical.

Keywords: Simuliidae, *Simulium monticola*, *Simulium maximum*, taxonomy, bionomics, distribution, morphology, variability

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ISSR IN TAXONOMY AT THE SPECIES LEVEL

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There has been a continuing need to search for further practical methods for species separation among blackflies, mainly because of persistent problems in the taxonomy at the species level. In addition to traditional morphological methods, cytotaxonomic methods have become increasingly important, and they are very effective in revealing sibling species. Most recently, molecular methods based on the study of nucleic acids or proteins have been tested. DNA analysis has been successfully used to discover the basal divergences within blackflies. ISSR (Inter Simple Sequence Repeats) are widely used in plants but less commonly in vertebrates, and only a few reports have been published on invertebrates. The preliminary results obtained in certain insect groups (Diptera: Culicidae and Tachinidae, Lepidoptera, Hemiptera, Hymenoptera) indicate that different species (including closely related species) show different DNA profiles. The intraspecific variability of the specific insect DNA profiles has never been widely studied but differences between individuals and populations have been found. We have studied 47 individuals of nine blackfly species. Five different primers have been tried: $(GACA)_4$, $(ACAG)_4$, $(ACTG)_4$, $(GATA)_4$, $(CAA)_5$; and the following material from the area of the Western Carpathian Mountains was analysed: *Prosimulium rufipes* (MEIGEN, 1830) – 14 individuals, *Simulium costatum* FRIEDERICHS, 1920 – 1, *Simulium lundstromi* (ENDERLEIN, 1921) – 1, *Simulium ornatum* MEIGEN, 1818 – 1, *Simulium variegatum* MEIGEN, 1818 – 3, *Simulium monticola* FRIEDERICHS, 1920 – 22 (*S. monticola* 1 – 6 and *S. monticola* 2 – 16), *Simulium argyreatum* MEIGEN, 1818 – 3, *Simulium equinum* (LINNAEUS, 1758) – 1, and *Simulium balcanicum* (ENDERLEIN, 1924) – 1. The primer $(CAA)_5$ did not produce clear patterns and was not analysed further. At first, single individuals from the analysed species were compared. Considerable differences were found among the species, and no identical or similar profiles were found. The analyses were then focused on the variability in *P. rufipes* and the *S. variegatum* species group, and considerable individual variability was found. By comparing individuals using the UPGMA method of clustering, similarity trees were constructed. The species of the *S. variegatum* group and also the two morphological forms of *S. monticola* were clearly separated from each other. Two different subgroups were identified within *S. monticola* 2: the first subgroup was represented by the individuals from the Malá Fatra Mountains and the second from the Tatra Mountains, the localities being approximately 100 km distant from each other. Because the existence of sibling species in blackflies is always a probability, further research is needed to determine the sensitivity of this method for differentiating between related species, populations, and intraspecific variability.

Keywords: molecular taxonomy, DNA, ISSR, Simuliidae

BLACKFLIES IN NORTHERN SWEDEN: USING RIVER REGULATION AS A LARGE-SCALE EXPERIMENT TO STUDY THEIR IMPORTANCE

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River regulation alters the flow of rivers. In northern Scandinavia, many rivers have been transformed into series of elongated lakes, providing a minimum of habitat for current-loving invertebrates, such as larval blackflies. Running in parallel, however, there are free-flowing rivers protected from hydropower exploitation. These support huge populations of simuliid larvae. Taking a comparative approach, we have studied the importance of blackflies in this boreal landscape. Trapping flying adults, using a vehicle-

mounted net, showed patterns of diel and seasonal activity and species composition, and provided information on many other aspects of blackflies in this landscape. Large-river species were more numerous than typical stream species, with *Metacnephia lyra* (LUNDSTRÖM) and *Simulium reptans* (LINNAEUS) being the most abundant species. Males of *M. lyra* remained in large numbers near their native rivers, whereas the females dispersed. Blood analyses showed that engorged blackfly females were either mammalophilic or ornithophilic, and that large hosts were preferred. Mammalophilic species were more specialised than ornithophilic ones. Carbon-dioxide baited traps (CDC) captured relatively more small-stream species than car trapping, suggesting a different behaviour among these species. Biting problems in humans were greater along free-flowing rather than along regulated rivers, as reflected in a higher frequency of hospital visits. *Leucocytozoon*, a blood parasite in birds, occurred at a somewhat higher frequency along the free-flowing rivers, but it is not clear at present whether this parasite can affect bird populations. Insectivorous birds might be favoured by the mass occurrence of blackflies, as was suggested by pied flycatcher nestling survival. Our investigations show that blackflies make up a considerable part of the flying insects in the boreal forests of northern Sweden and indicate that they play important roles in terrestrial ecosystems.

Keywords: blackfly hosts, dispersal, phenology, Scandinavia, Simuliidae

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SIMULIUM (EUSIMULIUM) PETRICOLUM RIVOSECCHI IN NORTH-WEST EUROPE

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Simulium petricolum (RIVOSECCHI) is a common member of the *S. aureum* group around the Mediterranean, and is known from Portugal, Spain, France, Italy, Czech Republic, Serbia, Bosnia, Greece, Cyprus, Libya, Morocco, and Madeira. However, there are unauthenticated records from Russia and Ireland, bringing into question the assumed circum-Mediterranean distribution. We report the discovery of this species pupating and emerging from a seasonal muddy ditch in winter-early spring in the south of England.

Keywords: Simuliidae, *Simulium petricolum*, UK, distribution

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ON THE HISTORY OF NORTH EUROPEAN BLACKFLIES (SIMULIIDAE)

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European blackfly nomenclature dates back to the Swedish biologist Carl LINNÉ (1746, 1758, 1767). Though all the Linnaean types appear to be lost, some of his names in Simuliidae are still standing. Shortly after LINNÉ, numerous blackfly species were described by the well known European entomologists of the time, FABRICIUS (1775, 1781, 1787, 1805), MEIGEN (1800, 1803, 1804, 1806, 1818, 1830, 1838), LATREILLE (1802, 1805) and MACQUART (1826). There were also further important contributions from Sweden, e.g. by DE GEER (1776), ZETTERSTEDT (1822, 1833, 1838, 1840, 1850, 1855, 1860), FRIES (1824, 1829), and WAHLBERG (1844). The first and only Norwegian contribution at this time was the brief mention of blackfly records by SIEBKE (1877).

WAHLGREN (1905, 1922) seems to have been the first to make a 'complete' list and key to Scandinavian blackfly species. Further important contributions involving Scandinavian species are found in the papers published by LUNDSTRÖM (1910, 1911, 1913). At the same time, EDWARDS (e.g. 1915, 1921, 1924, 1927) and ENDERLEIN (1921, etc.) published many well-known papers, which, together with two papers by PURI

(1925, 1926), were of great importance for the understanding of the Scandinavian fauna. Several papers on Danish blackflies were published by PETERSEN (1924) and USSING (1925).

Russian contributions were also appearing at this time, e.g. by DOROGOSTAISKI et al. (1935). RUBTSOV (1940, 1956, 1959-64, 1971) was soon dominating the arena of blackfly taxonomy in Europe, and was gradually succeeded by CROSSKEY (e.g. 1988, 2004). Major changes in blackfly nomenclature have been made by ZWICK (1995), CROSSKEY & DAVIES (1972), and ZWICK & CROSSKEY (1981).

Returning to Scandinavia, we now had important contributions by USOVA (1961), CARLSSON (1962), and RUBTSOV & CARLSSON (1965). Some papers on local faunas have appeared (KUUSELA 1971, RAASTAD 1979, 1981, JENSEN 1984, 1997). The most recent publication is a comprehensive investigation of the Swedish fauna (ADLER et al. 1999).

According to present knowledge, we have some 70 valid blackfly species in Scandinavia. It seems that we must expect the discovery of further new synonyms and name changes in the North European species, resulting from earlier misunderstandings and the incorrect usage of names. Some of these problems will be discussed in this oral presentation.

Keywords: Simuliidae, history, nomenclature, synonymy

THE FEASIBILITY OF ONCHOCERCIASIS ERADICATION? RESULTS FROM A 17-YEAR FOLLOW-UP OF *SIMULIUM* BITING RATES AND *ONCHOCERCA VOLVULUS* TRANSMISSION POTENTIALS IN A MECTIZAN-MASS-TREATED AREA IN NORTH CAMEROON INDICATE THE NEED FOR NEW MACROFILARICIDES

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Follow-up studies of the human-biting rates of *Simulium damnosum* THEOBALD s.l. and the transmission dynamics of *Onchocerca volvulus* before and 17 years after the start of ivermectin mass treatments in the Vina river valley in North Cameroon indicate that transmission still continues at a level sufficient for the survival of the parasite. Annual Transmission Potentials still exceed the tolerable level of 100 infective larvae per human and year, but as long as the individual human microfilarial load is kept low by regular annual retreatments, the risk of developing onchocerciasis eye-lesions is probably low.

In addition to the reduced transmission of *O. volvulus* L3, the proportional increase of bovine *O. ochengi* L3 stimulates cross-reacting immunization of the human population and thereby assists with maintaining onchocerciasis at a tolerably low level. Such zooprophylaxis, as a synergic result of ivermectin mass-chemotherapy, could be combined with other, rather simple means to further minimize the transmission of human onchocerciasis.

However, since the parasite cannot be eradicated, the development of ivermectin-resistance in humans, as has already happened with other nematodes in cattle and sheep, is an increasing threat as long as mectizan remains the only drug available. As an aid to the development of new drugs or vaccines against human onchocerciasis, the bovine filaria *Onchocerca ochengi* has proved to be an excellent model for chemotherapy and immunological studies.

Epidemiological and experimental data also strongly indicate that there is a density-dependent regulation of the *Onchocerca* adult worm load and microfilarial density in the skin, both in humans and in cattle. The possibility of vaccination was successfully demonstrated in calves immunized with a heterologous vaccine, namely live L3 of *O. volvulus*.

Keywords: Simuliidae, Cameroon, *Simulium damnosum*, onchocerciasis, infectivity, control

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THE VARIATION OF PUPAL GILLS IN *PROSIMULIUM RUFIPES* (MEIGEN)

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Many details of pupal gills, such as their form, number, branching etc, are used for the identification of black flies. Previous studies made on the *Simulium ornatum* Meigen, 1818 species group have shown that certain characters of the gills exhibit considerable intraspecific variation.
The respiratory organs of *Prosimulium rufipes* (MEIGEN, 1830) were studied from 9 sites in Slovakia. In total, 91 metric characters of the pupae were measured on each pupal gill in 90 individuals mounted on microscope slides: the length of all filaments and trunks, width of all trunks and filaments on their proximal and distal ends, and the body length of each pupa. The variation in the measured characters was analysed by ANOVA. The termination of each filament (broken, not broken) was noted, in order to compute the actual surface area for each individual, because the filaments of pupae developing under natural conditions are often broken.

P. rufipes generally has 16 filaments on each side of the thorax, growing from three trunks: dorsal trunk (3+2+3), medial trunk (2+2) and ventral trunk (2+2). The most frequent variation in the branching was reported on the dorsal trunk, and some variability was also recorded in the branching of the ventral trunk and of the medial trunk. We also recorded individuals with 14, 15, and 17 respiratory filaments.

In the population of *P. rufipes* from Račková Dolina Valley, we found that no specimens were laterally symmetrical in their gill measurements. Significant differences were found between the right and left side of the body in the case of the fifth metric and one meristic characters. *Prosimulium rufipes* showed a high level of individual variation in the characters analyzed. The lowest variability was found in the body length of pupae (coefficient of variation 9.31%) and in the potential respiratory surface area (coefficient of variation 14.66%). The highest variation was recorded in the length of the sixth base (coefficient of variation 80.10%) and also in the surface area of this base (coefficient of variation 64.40%).

Keywords: Simuliidae, *Prosimulium rufipes*, variation, pupal gills, respiratory surface area

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BLACKFLIES AND THEIR NATURAL PREDATORS: NEW RESULTS ON DIPTERA

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Blackflies have a wide range of natural enemies, and in many instances the insects are the most important invertebrate predators. At least 9 orders are known to feed on blackflies. Caddisflies (Trichoptera), bugs (Heteroptera), and flies (Diptera), which are obligate predators as adults or as larvae or as both, are the most numerous and most effective natural enamies. Our research and fieldwork have shown that at least 12 families of Diptera that actively prey on blackflies. Other families, such as the Sciomyzidae and certain Anthomyiidae, have been seen feeding on the bodies of dead blackflies.

Some of the associations are undoubtedly fortuitous or opportunistic. For example, larvae of the Chaoboridae have been recorded on a few occasions as taking adult and larval blackflies as food, but chaoborid larvae live in standing water and so can only pick larvae that have drifted into an area of standing water or adults that have fallen on to the water surface. Adult Asilidae have been recorded on a number of occasions as taking adult blackflies as prey, but in a recently published database of prey records, blackflies form only 0.18% of the total number of records listed.

In the course of our recent fieldwork, we have been able to record new predators of the aquatic stages of blackflies in the families Chaoboridae, Chironomidae, Phoridae, Ephydridae, and Scathophagidae. In Germany, Armenia, USA, and the UK, we have focused on the predators of adult blackflies and have new information on Empididae, Hybotidae, Dolichopodidae, Scathophagidae, Anthomyiidae, and Muscidae. We have been able to record on camera many of our observations on hunting strategies, details of life cycles, and courtship and mating rituals in the muscid genera *Limnophora* and *Lispe*.

Contrary to what is generally written and accepted about predation, not all predators are promiscuous in their choice of prey. It is clear that there are some very specific associations between certain Diptera predators and blackflies, as larvae feeding on larvae and as adults feeding on larvae and/or adults. So far as larvae are concerned, this is evident in the association between certain Hemerodromiinae (Empididae) and blackfly larvae, and between *Limnophora* (Muscidae) and *Simulium noelleri* FRIEDERICHS. But our observations have also shown that there are behavioural strategies in several adult Empididae and Muscidae that are specifically adapted for preying on adult blackflies.

Within the broad context of the management of blackfly populations, Diptera predators undoubtedly have a role to play. Our work has shown that this is not an insignificant role, and our continuing investigations of both larval and adult predators are confirming this and are revealing additional associations.

Keywords: Diptera, Simuliidae, predation, prey

BLACKFLY LARVAE AND AGGREGATION

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There are three types of aggregation affecting blackfly larvae and the flowing water in which they live:

(i) Formation of dense aggregations by some species
Blackfly larvae attach to substrata and may be spaced, arranged into lines, or form aggregations. The type of dispersion depends on species, current velocity, and the characteristics of water flow. One species, *Simulium noelleri* FRIEDERICHS, often forms dense aggregations at lake outlets and there is evidence that individuals from the most dense parts of aggregations grow more rapidly and produce larger individuals than those from less dense aggregations. What is the explanation?

(ii) Feeding by larvae on aggregations of organic matter and (speculatively) the role of the feeding fans in promoting the formation of aggregates
Blackfly larvae are capable of intercepting and ingesting colloids and other dissolved organic matter. The majority of the particles in their guts (usually > 95%) are < 10 μm in diameter, so the gut contents contain a huge surface area for digestion and for lysis. But how many particles (including those in the dissolved category) are intercepted individually and how many are in the form of naturally-occurring flocs and aggregates? Does the blackfly labral fan play a role in aggregation processes?

(iii) The importance of blackfly larval faeces in the transformation of organic matter

Blackfly larvae are "ecosystem engineers", converting dissolved matter, particles, and flocs into compacted aggregates - faecal pellets. As larvae digest little of the material that they ingest, and as they feed almost continuously, they produce very large numbers (probably hundreds) of faecal pellets per larva each day. When larvae are abundant they transform significant quantities of organic matter into much larger, dense faecal pellets that sink rapidly in calm water. Potential nutrients are therefore transported from the water column to the substratum and we know this to be an important process in both small streams and large rivers. In addition to feeding themselves, blackfly larvae thus help to retain nutrients that are otherwise carried downstream and, eventually, to the sea.

Keywords: Simuliidae, larvae, aggregations, flocs, aggregates, faecal pellets

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THE DISCOVERY OF A FOSSIL BLACKFLY FEMALE (DIPTERA: SIMULIIDAE) IN BALTIC AMBER

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A blackfly female was found in a piece of Baltic amber from the sea coast of Lithuania (35-40 million years b.p., Eocene-Oligocene). According to the modern classification of the family Simuliidae, it belongs to the genus *Ectemnia* ENDERLEIN, 1930. The generic characters are the deep and bulbous katepisternum, the shallow mesepisternal sulcus, vein Rs not forked, costal vein with hairs and spinules, hind legs without calcipala and pedisulcus, claws with a large basal tooth, body length almost 5.5 mm (rare in Simuliidae). This specimen is being described as a new species in the genus *Ectemnia* (YANKOVSKY & BERNOTIENĖ 2004, in litt.). This is only the sixth known species of blackfly in Baltic amber. It differs from all the other known Baltic amber species by the following characters: from *Hellichiella oligocenica* (RUBTSOV, 1936) and *Greniera importuna* (MEUNIER, 1904) – by the 11-segmented antenna (unlike the 10-segmented antenna in these species); from *Greniera pulchella* (MEUNIER, 1904) and *G. affinis* (MEUNIER, 1904) – by the large body length (5.5 mm, unlike the 1.5-2.5 mm in these species); from the related fossil species *Ectemnia cerberus* (ENDERLEIN, 1921) (redescription in CROSSKEY, 1994), *Ectemnia* new species differs by the peculiar length of the wings (twice as long as the body length), whilst in *E. cerberus* the wings are shorter than the body length, and by the peculiar small size of the head (compared to the body size). All the blackfly species found in Baltic amber belong to the archaic subfamily Prosimuliinae (or, according to another classification, at least to the archaic genera of the family Simuliidae – *Greniera* and *Ectemnia*) (CROSSKEY, 2002). The exception is *Hellichiella oligocenica* (RUBTSOV, 1936), but the characters of this genus place it in an intermediate position between the subfamilies Prosimuliinae and Simuliinae. The findings of blackflies in Eocene/Oligocene Baltic amber are very rare and are restricted to one small geographic region, but we can suggest that at that time and in that area the Prosimuliinae formed the main part of the Simuliidae fauna.

Keywords: Simuliidae, black flies, taxonomy, fossils, Baltic amber

Abstracts of Posters

REPEATED MATING IN *SIMULIUM (WILHELMIA) LINEATUM* (MEIGEN) (DIPTERA: SIMULIIDAE)

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Male mating success and the number of offspring strongly depend on the number of copulations as well as on the effectiveness of sperm transfer. Males of blackflies can copulate more than once. However, the effectiveness of multiple matings has not been investigated in polygamous simuliid males. The aim of the present research was to compare the male behaviour in the first and the second matings and also the spermatophore transfer parameters in the stenogamous species *Simulium* (*Wilhelmia) lineatum* (MEIGEN).

Mating behaviour. Under laboratory conditions, from 80 to 92% of *S.* (*W.) lineatum* males copulated for a first and a second time, irrespective of the time that elapsed after the first copulation, an interval that ranged from 1 minute to 24 hours. The duration of the male pre-copulatory period during the first and subsequent matings remained the same. The majority of males (from 70 to 96%) started to copulate during the first minute of meeting with a virgin female. Therefore, during the the second mating, the sensitivity of *S.* (*W.) lineatum* males to signals transmitted by females remains approximately the same as it was before the first mating and that it does not change even 1 minute after copulation.

The duration of the first and second copulations was different. The mean duration of the first copulation of *S.* (*W.) lineatum* individuals was 5.48 $\pm$ 2.72 min. The mean duration of the second copulation just 1 minute after the first mating was almost twice that length at 12.98 $\pm$ 5.62 min. These results demonstrate that *S.* (*W.) lineatum* males are able to repeat a copulation very quickly (within a minute or less) and that they react to females with the same intensity as when virgin, but that their mating behaviour changes. It was only after 24 hours that the mean duration of the second copulation (4.85 $\pm$ 2.11 min) did not significantly differ statistically and equalled the mean duration of the first one. After 24 hours, therefore, the copulatory behaviour of the males is the same as that during the first-time mating.

Spermatophore parameters. The results showed that the length and width of spermatophores from the first copulation are greater than those from the second mating. The spermatophore length from the first copulation was 0.194 $\pm$ 0.015 mm, and the width was 0.191 $\pm$ 0.015 mm. The spermatophore length from the second copulation (after 1 minute) was 0.183 $\pm$ 0.017 mm, and the width was 0.164 $\pm$ 0.016 mm. When the second copulation took place 24 hours after the first mating, the spermatophore length was 0.187 $\pm$ 0.017 mm, and the width was 0.166 $\pm$ 0.018 mm.

The behavioural reactions of *S.* (*W.) lineatum* males return to the normal state more quickly than do the spermatophore-transfer parameters. Smaller spermatophores are likely to contain fewer spermatozoa and smaller quantities of other sperm substances. Our data thus indicate that for females to copulate with an already-mated male is less rewarding than with a virgin male.

Keywords: Simuliidae, mating behaviour, polygamous males, duration of copulation, spermatophore

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SIMULIID VERNACULAR NAMES PROJECT – PRESENT STATE OF PROGRESS

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In most countries, languages and cultures, very specific names are usually given to things which cause discomfort. This applies to pestiferous animals and plants and particularly to biting insects which are often perceived as something to be endured. Not least amongst these are the Simuliidae which, as we all know, can at times be present in enormous numbers and can make life miserable and well nigh impossible in some areas of the world.

For some years I have been noting down the names given to simuliids by indigenous peoples in their own languages as well as those found in published reports by explorers, naturalists and entomologists. With help from colleagues I have so far compiled a list of nearly 170 names from 32 countries. A summary of these names will be shown as a poster display and everyone is invited to add to the list.

Keywords: Simuliidae, blackflies, common names, vernacular names, distribution

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ECOLOGICAL CONDITIONS AND SPECIES COMPOSITION OF BLACK FLIES IN THE RIVER HRAZDAN, ARMENIA

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The River Hrazdan is the main waterway in the Republic of Armenia and is of great importance to the country's economy. The Hrazdan is a highly regulated river and is used for many purposes, such as water supply, irrigation, energy, and recreation. Since the break-up of the Soviet Union, the ecological conditions of the River Hrazdan and the biodiversity of invertebrate animals inhabiting it have changed, but little biological information exists on this subject. Because of the close connection between water quality and biodiversity, monitoring of the river by means of these indices will enable its current ecological condition to be determined.

The River Hrazdan begins in Lake Sevan and enters the River Araks in southern Armenia. The length is 146 km, the mean slope is 0.077%, and the average annual discharge is 22 cubic m/sec. The basin of the River Hrazdan runs through different climatic and landscape zones, and has both relatively clean and polluted sections. Before the break-up of the Soviet Union, this river basin was widely used for industry, agriculture, and hydroelectric power. Along the river are a number of settlements and towns, such as Sevan, Hrazdan, Charentsavan, Bjni, Arzni, Yerevan, and Masis, with a total population of 1,130,000 people.

According to A. E. TERTERYAN (1960), 7 species were found in the River Hrazdan before 1953: *Wilhelmia paraequina* PURI, *W. mediterranea* PURI, *W. turgaica* RUBTSOV, *Obuchovia popovae* RUBTSOV, *Simulium variegatum* MEIGEN, *S. caucasicum* RUBTSOV, and *S. tarnogradskii* RUBTSOV. Once the Sevan-Hrazdan hydroelectric power station began operating, the hydrological conditions of the river changed. TERTERYAN noted that this change entailed a sharp reduction in the numbers of black fly larvae, followed by their

complete elimination along the river in the first year of the hydroelectric power station's operations. TERTERYAN made annual observations of the River Hrazdan from 1953 to 1960, but he recorded no recovery of these populations.

From 2002 to 2004, we investigated the water quality and concentration of heavy metals in the River Hrazdan, from its headwaters to its mouth, including its tributaries, and documented the species of black flies that developed in the river during spring, summer, autumn, and winter. In conjunction with the water analyses, we investigated the species composition of black flies in the river and its tributaries, demonstrating differences in the species diversity in relation to season and anthropogenic impacts.

Analysis of the water quality of the River Hrazdan showed only small concentrations of heavy metals, probably as a result of the partial functioning of the numerous industrial facilities along the river. Only lead and zinc were found, but at concentrations lower than the maximum level permitted. However, within the city limits of Yerevan and at the mouth of the river, we found levels of coliform bacteria that exceeded the accepted standards. This high level of pollution is reflected in the small numbers of black flies and the low species richness in this area. Ten kilometres from the source of the River Hrazdan, we found *Simulium variegatum*, *S. kiritshenkoi* RUBTSOV, *S. bezzii* (CORTI), and *S. lineatum* (MEIGEN). We also found *S. pseudequinum* SÉGUY and *S. australe* (RUBTSOV) in the Middle Hrazdan. These species develop along the river up to its entry into the city of Yerevan. In the city itself, the following species were found at the Kanaker hydroelectric power station and Ahktanak Park: *Simulium aureum* group, *S. australe*, *S. chubarevae* (KACHVORYAN & TERTERYAN), *S. kiritshenkoi*, *S. noelleri* FRIEDERICHS, and *S. pseudequinum*.

A rich simuliid assemblage occurs in the tributaries Marmarik and Jrvezh. Species associated with the forest landscape in the upper Marmarik include *Metacnephia subalpina* (RUBTSOV), *S. delizhanense* (RUBTSOV), *S. fontium* (RUBTSOV), *S. australe*, *S. chubarevae*, *S. vernum* group, *S. variegatum*, and *S. kiritshenkoi*. In the middle Marmarik, where there is only a sparse growth of trees, the following species develop: *Prosimulium tomosvaryi* (ENDERLEIN), *P. rachiliense* DJAFAROV, *S. bezzii*, *S. variegatum*, and *S. kiritshenkoi.* The following species develop in the forest-steppe zone: *S. noelleri*, *S. margaritae* (RUBTSOV), *S. debacli* TERTERYAN, and *S. pseudequinum*. In the Jrvezh tributary, we found *S. akopi* (CHUBAREVA & KACHVORYAN), *S. aureum* group, *S. pseudequinum*, *S. variegatum*, and *S. kiritshenkoi.*

Some changes in biodiversity are also seasonal in nature. For example, in the Marmarik tributary (village Aghavnadzor) in June, we found *P. rachiliense*, *P. tomosvaryi*, *M. subalpina*, and *S. australe*, whereas in July we found *S. australe*, *S. chubarevae*, *S. bezzii*, and *Simulium* sp. By September, the species composition had changed markedly, consisting of *S. bergi* RUBTSOV, *S. debacli*, *S. australe*, and *S. kiritshenkoi.* These seasonal changes in biodiversity emphasize the importance of repeated visits to the same areas over the course of a year to inventory the fauna of the Armenian watersheds.

On leaving the city of Yerevan, we found only *S. pseudequinum*, *S. lineatum*, and *S. paraequinum* PURI in the Hrazdan River. Species richness in the river is thus poorer than in the tributaries. The most tolerant species, *S. kiritshenkoi* and members of the subgenus *Wilhelmia*, were dominant in the river.

Our continuing study of the black flies of the River Hrazdan, from its source to its mouth, including its tributaries, indicates that this catchment area is a hot spot for black fly biodiversity. Our analyses indicate that the water is generally clean. The number of black fly species in the Hrazdan River system is greater now than in recent historical times (ca. 1953-1990), suggesting that the water quality has improved.

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Keywords: Aquatic habitat, biodiversity, Armenia, Simuliidae, water quality

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THE BIODIVERSITY OF BLACK FLIES IN ARMENIA

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Our investigation of the black flies in Armenia, combined with historical records, indicates that the Armenian fauna consists of 5 genera and 50 species. We currently regard about 11 of these species (22%) as endemic to Armenia, although some eventually may be found in neighbouring countries. An additional 16 species (31%) are endemic to the Caucasus. Overall, 27 (53%) of Armenia's species are restricted to the Caucasus, based on current knowledge. About 12 (23%) of the species in Armenia are widespread in the Palaearctic Region. The most widespread and abundant species in Armenia is *Simulium kiritshenkoi* RUBTSOV.

Our discovery of a large breeding population of *Simulium noelleri* FRIEDERICHS in an organically polluted stream in the center of Yerevan (Ahktanak Park) represents the first Armenian record of this anthropogenic species. It has since been eradicated from the Park as the result of development, but in 2004 we rediscovered the species in the River Hrazdan, near the village of Meghradzor. Using a chromosomal approach, we identified *S. angustipes* EDWARDS for the first time from Armenia, including the type locality of *S. reginae* TERTERYAN; the name "reginae", therefore, falls as a synonym of *angustipes*. Similarly, *S. petricolum* (RIVOSECCHI) and *S. cryophilum* (RUBTSOV) were found for the first time in Armenia, representing a significant eastward extension of their ranges. Preliminary analyses from our joint field expedition in mid-June 2004 revealed a number of infrequently collected species, including *Metacnephia persica* (RUBTSOV), *M. subalpina* (RUBTSOV), *Simulium aureofulgens* TERTERYAN, *S. debacli* TERTERYAN, and *S. margaritae* (RUBTSOV). Morphological examination of material of the subgenus *Montisimulium* suggested the presence of an undescribed species in Armenia; chromosomal analyses will be conducted to test this hypothesis.

Using a cytogenetic approach, we have shown that the Armenian black fly fauna has both unique elements and shared relationships with the rest of the Palaearctic Region. These findings suggest that the black fly fauna in Armenia is incompletely known and that additional new species will be discovered in the country in the future.

This research was supported by Award No. BI 059 – 02 from the National Foundation of Science and Advanced Technologies (NFSAT) to E.A. KACHVORYAN; Award No. 12005 from the U.S. Civilian Research & Development Foundation for the Independent States of the Former Soviet Union (CRDF) to P.H. ADLER and E.A. KACHVORYAN; and Award No. A676 from the International Science and Technology Center (ISTC) to E.A. KACHVORYAN, K.V. HARUTYUNOVA, and M.V. HARUTYUNOVA.

Keywords: Armenia, biodiversity, endemism, faunistics, range extensions, Simuliidae

NOTES ON THE DISTRIBUTION OF BLACKFLIES ON THE CANARY ISLAND OF LA GOMERA

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In early February 1988, the aquatic stages of blackflies were sampled by hand at 9 locations along some of the few remaining streams in the northern part of Gomera (Canary Islands, west of Morocco). Adults were reared individually from pupae. *Simulium (E.) guimari* BECKER, *S. (E.) tenerificum* CROSSKEY, *S. (E.) velutinum* (SANTOS ABREU), *S. (N.) ruficorne* MACQUART, *S. (S.) intermedium* ROUBAUD, and *S. (W.) pseudequinum* SÉGUY were identified. In addition, numerous specimens of intermediate forms that combine the characters of different species of the *S. (E.) aureum*-group were found. With these six species, Gomera seems to be the island with the highest number of species among the Canaries. *S. intermedium* was the most abundant species. *S. ruficorne* was also abundant and, like *S. intermedium*, was found at 8 of the 9 stations. At a single stream, the Barranco de Monteforte, 5 samples were taken along a longitudinal (ca. 7 km) and altitudinal (3 - 720 m a.s.l.) gradient. A species endemic to the Canary Islands, *S. guimari*, seems to prefer very small headwaters at elevations above 500 m. The second endemic species, *S. tenerificum*, and associated forms, as well as *S. ruficorne* apparently prefer lower altitudes. No clear preference could be detected for *S. intermedium*. All species were found in the pupal stage and all species-groups in the larval stage at the same time in February.

Keywords: Simuliidae, faunistics, new record, small-scale distribution, zonation, Canary Islands, Gomera

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PARASITIC MITES (ACARI: HYDRACHNIDIA) ON PUPAE AND ADULTS OF SIMULIIDAE (INSECTA: DIPTERA)

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The larvae of various species of water mites (Hydrachnidia) are known as parasites of adult blackflies. Typically, the larvae of these mites are seen in pupal cocoons of Simuliidae, where they wait until the imago hatches. Then they attach to the emerging adult flies, engorge by feeding upon the host's haemolymph, and profit from its upstream movement to compensate for downstream drift and thus repopulate the seasonally fast-flowing breeding sites.

Recently, and in contrast to former results, we frequently observed parasitic water mites on simuliid pupae. In 2003 and again in 2004, extraordinarily high numbers of *Sperchon* cf. *setiger* THOR larvae were seen in the rivers around Tübingen in Southern Germany (e.g. in the moderately polluted perennial river Ammer, populated by *Simulium ornatum* MEIGEN, *Simulium equinum* (LINNAEUS), and in the Schlierbach and its temporary flowing tributary Kirchgraben, both with *Eusimulium vernum* (MEIGEN)). On the other hand, these mites were not observed in a population of *S. ornatum* in a very slightly polluted river draining the protected forest area of Schönbuch in the same river-catchment area. In the parasitized populations, infestation rates were high, 80 to 90 % in over 100 pupae examined, and the average number of larvae was 3-5 mites per *Simulium* pupa, with a typical negative-binomial distribution pattern. Mites were seen crawling eagerly over and into the pupal cocoons, but were not attracted to *Simulium* larvae even when these were situated close to the pupae. Mite larvae of different sizes but of the same species were seen together in the same cocoon, and this might indicate that the mites grow by feeding on the *Simulium* pupae.

Although these mites are commonly considered to be mainly phoretic parasites, their numbers and the fact that they may also suck haemolymph makes them potential regulators of *Simulium* populations. This is also indicated by a low percentage of adult flies that emerge from such infested pupae when kept in emergence cages: only one mite was seen attached to the ventral abdominal surface of a newly-hatched blackfly, together with signs of melanization which probably resulted from the previous feeding of the mite.
These facts suggest that *Sperchon* cf. *setiger* larvae feed on the blackfly pupae and may not even need the adult Simuliids to complete their life cycle.

Keywords: Hydrachnidia, *Sperchon*, Simuliidae, adults, pupae, ectoparasites

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PATTERNS OF BLACKFLY DISTRIBUTION IN RELATION TO HABITAT STRUCTURE, STREAM DEGRADATION AND LAND USE IN STREAMS IN THE RIVER RUHR CATCHMENT AREA (GERMANY)

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Blackfly species were sampled over a period of two years at 32 sites in the catchment area of the River Ruhr during all seasons. Each sample was restricted to a 15-minute time period. During the spring season, 9 taxa were found: *Prosimulium hirtipes* (FRIES), *Simulium argyreatum* MEIGEN, *S. variegatum* MEIGEN, *S. ornatum* group, *S. equinum* (LINNAEUS), *S. aureum* group, *S. morsitans* EDWARDS, *S. reptans* (LINNAEUS), and *S. vernum* group.

Hydrochemical parameters, such as pH, conductivity, oxygen levels, and current velocity, were recorded on each sampling date. Substrates covering the sampled reach were recorded in 5% steps. Land use was calculated by a GIS approach, using ATKIS land cover data.

At the local scale, parameters of habitat quality (amount of woody debris, CPOM, FPOM, etc.) were correlated with blackfly distributions. At the stream scale, blackfly distributions depend on the width of the riparian vegetation. Riparian vegetation is known to be an important factor influencing oviposition sites for adult females (TIMM 1993, 1995). At a larger scale (catchment area), *P. hirtipes* shows strong correlations with land use (% urbanisation) and with geomorphological parameters (altitude).

Keywords: Simuliidae, Germany, River Ruhr catchment area, ecology, distribution patterns

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CURRENT KNOWLEDGE OF THE KARYOTYPES OF THE WORLD BLACKFLY FAUNA (DIPTERA, SIMULIIDAE)

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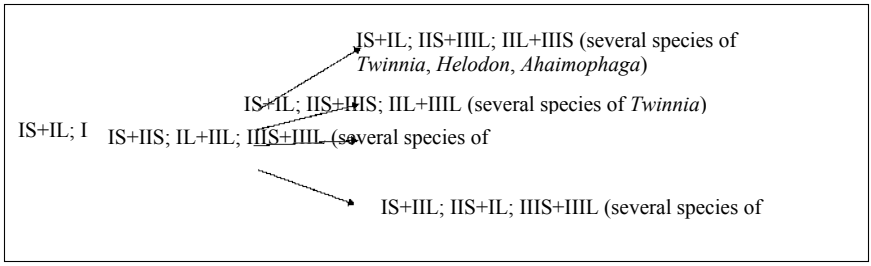
So far 310 blackfly species have been karyotyped. Among the 80 forms that have been described as cytotypes or “species”, nearly all are potentially valid species. Studies of blackflies are being carried out in many regions of the world, including Europe, Africa, America, Australia and New Zealand. This interest is

due to the significant medical and veterinary importance of this group, which includes blood-suckers and carriers of dangerous human and animal diseases.

Here we are presenting a summary of our original results and of the published data on blackfly karyotypes that has appeared between Kunze's reviews (1952, 1953) and 2001.

The majority of blackfly species (96%) have 2n=6. Several species (about 10) have 2n=4; parthenogenetic triploid populations have been found in some species of the genus *Prosimulium*, 3n=9. Isolated triploid individuals resulting from spontaneous mutations have been described in bisexual populations of *Cnephia*, *Odagmia*, *Wilhelmia*, and *Nevermannia*.

The modal karyotype is 2n = 6: IS + IL, IIS + IIL, IIIS + IIIL.



A characteristic feature of the family is the stable localisation of the main chromosomal markers: the Sim-end in IS, paracentromeric section with 5 dense thick bands and BRs in IIS, two puffs separated by the heterochromatin band and the fan-end in IIIS. Such constancy in the localisation of the chromosomal markers implies a cytological unity of this insect group that suggests the monophyletic occurrence of the family and the conservation of the optimum adaptive karyotype in the evolutionary process.

Evolution of the karyotype in the family takes place on the basis of: (1) fixed homozygous inversions; (2) formation of different sex-determining systems; (3) tandem chromosome fusions (macromutations) (*Astega*, *Eusimulium*); (4) transposition of the nucleolar organising region (macromutation) from IS into IIIL (*Ahaimophaga* - *Helodon*, *Odagmia* - *Simulium*); (5) reciprocal translocations of chromosome arms (macromutations): (6) small structural rearrangements (micromutations): "puff - band", "thin band - thick band"; (7) changes in morphology of the centromeric regions; (8) appearance of B chromosomes.

The evolution of the blackfly karyotype thus includes a wide spectrum of chromosomal rearrangements.

Keywords: Simuliidae, blackflies, karyotype, polytene chromosomes, world fauna

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THE BIOTOPE OF *SIMULIUM (RUBZOVIA) LAMACHI* DOBY & DAVID (DIPTERA, SIMULIIDAE) IN THE NORTHERN LIMESTONE ALPS NEAR BERCHTESGADEN (GERMANY)

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The species *Simulium (Rubzovia) lamachi* DOBY & DAVID has a very restricted distribution and is known only from small areas in Southern France (South Alps, Massif Central, Pyrenees), Spain (Sierra Tejeda in Andalusia) und Morocco (High Atlas, Rif) (CLERGUE-GAZEAU & VINÇON 1990). A spring rivulet in Germany can now be added as a further locality for this species. The breeding site is in the Berchtesgaden Alps, part of the northern limestone Alps, some 600 kilometres north-east of the most eastern known locality in the

French Alps. The potential distribution range of this West Mediterranean species is considerably enlarged by this new record.

The preimaginal stages were found colonising the thin film of water that generally covers the lithic in a spring rivulet issuing from the foot of a north-facing slope at 760 metres above sea level. After a few metres this rivulet flows into a mountain stream belonging to the catchment area of the river Inn or the river Danube respectively. Two individuals of the *Simulium vernum*-group were identified as accompanying taxa of this simuliid species.

Further details may be found in: SEITZ, G. & M. FORSTER (2004): Erstnachweis von *Simulium (Rubzovia) lamachi* (Diptera, Simuliidae) in Deutschland. [First record of *Simulium (R.) lamachi* in Germany (Diptera, Simuliidae)]. - Lauterbornia 49: 33-36, Dinkelscherben.

Keywords: Simuliidae, *Rubzovia*, Bavaria, Germany, first record, zoogeography

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