PROCEEDINGS OF THE FIFTH INTERNATIONAL SYMPOSIUM ON CERATOPOGONIDAE, STRASBOURG, 1–3 JULY 1982

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A total of 25 specialists from 7 countries were in attendance presenting a total of 26 talks, abstracts of which are given here. M. Kremer and J. Boorman acted as chairmen for the program. Presentations covered such topics as systematics, chorology, ethology, physiology, ecology, disease transmission and biological control. Speakers were left free to submit their detailed presentations for publication elsewhere. The meetings did not lead to the presentation of resolutions, except for one in Systematics. Most of the participants wished to see conserved all well-described species for which a type or neotype exists in a public collection. They did not approve of the rehabilitation, without proof, of older names for presently known species, except when lost types are rediscovered. The World Ceratopogonidae Group expressed their thanks to the editor of Mosquito News for the opportunity to publish the abstracts of their 1982 Proceedings.

Preliminary Study for a Mosquito Eradication Operation in Northern Bas-Rhin (France): Possible Effects on Ceratopogonidae. Ph. Arnold and M. Kremer, Institut de Parasitologie de la Faculté de Médecine de Strasbourg, 3 rue Koeberlé, Strasbourg 67000, France.

A plan for limitation of mosquito nuisance was drawn up in 1981 on the French side of the Rhine in the northern region of Strasbourg. This operation to control noxious, but not vector populations of mosquitoes, was made essentially for developing tourism, camping, bathing and other outdoor activities.

The qualitative and quantitative study of Culicidae species has established that nuisance is principally due to adult Aedes vexans (Meigen) which swarm in some areas. Two control methods against larvae will be tested during 1983 in a pilot project by: 1) Spread of a lipid preparation that forms a film on the surface of the water and hinders larva and pupa

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1 Reprints may be requested from W. W. Wirth.
breathing; 2) Utilization of a proteinaceous endotoxin of bacterial origin, Bacillus thuringiensis var. israelensis, characterized by good specificity against Culicidae.

As a part of a study of the effects of these treatments on non-target fauna, we are making (1982) a qualitative and quantitative inventory of Ceratopogonidae present in the places concerned with mosquito eradication. These results will serve as reference for observations that should be made during and after treatment. The Ceratopogonidae species concerned so far are: Culicoides piettensis (Staeger), C. odibilis (Winnertz), C. musilator Kremer and Callot, Palponyia lineata (Meigen), Alluaudomyia peninsula Remm and Glukhova, and Bezzia flavicornis (Staeger).

Culicoides in the Mediterranean Area in Relation to Bluetongue Disease of Sheep and Cattle. J. Boorman, Animal Virus Research Institute, Pirbright, Woking, Surrey, GU24 ONF, U.K.

Bluetongue disease is widespread in Africa and the Middle East, and a potential threat to the EEC countries, especially those bordering the Mediterranean. It is transmitted by the bite of infected Culicoides. About a hundred Culicoides species are known from the Mediterranean area, but only a few are likely to be important in bluetongue epidemiology.

Culicoides nubeculosus (Meigen) and C. puncticollis (Becker) (subgenus Monobothroceroides) and C. schulzei (Kearfott) (subgenus Oecacta) are of potential importance, but need further study. The most likely vectors belong to the subgenus Avorita, represented by 8 species. Virus has been isolated from C. oboletus (Meigen), and C. imicola Kieffer is a known vector in Israel and Africa. Culicoides dawalii Goetteheuer, chiopertus (Meigen), simmiotis Tokunaga, and okamorii Arnaud are found mostly north of 40 degrees latitude; C. oboletus, montanus Shakirzjanov, and scitexes Downes and Keule may be found as far south as 30 degrees. Culicoides imicola is not found north of 40 degrees; it occurs in Spain and Turkey but whether these populations are augmented by migration from the south is unknown. It is of great importance to establish if it occurs in other regions south of 40 degrees, particularly Italy, Greece, Sicily and other islands.

Many problems remain, especially with the taxonomy, distribution and vector potential of Avorita species.

Culicoides Species Found in the Inflorescences of Arum elongatum in Israel. Y. Braverman and Y. Koach, Department of Entomology, Kimron Veterinary Institute and Department of Botany, Tel-Aviv University, Israel.

Culicoides spp. are known to be involved in the pollination of rubber trees. Two species, C. aricola Kieffer and C. bronophilus Kieffer, represented by females, were found in the inflorescences of Arum conophallodes Kotschy; however the present taxonomic status (i.e. synonymies) of these 2 species is not known. The attraction of Arum species inflorescences to haematophagous Diptera is derived primarily from the special odors that its club-like apex emits, which are similar to those of vertebrates. Additional attraction factors with short distance influences include warmth of the club-like apex (which is higher than the ambient temperature) and, probably also the color of the spathe.

At the Hermon mountains in the Golan Heights, at an altitude of about 2000 m above sea level, specimens of 3 Culicoides species were collected from the inflorescences of Arum elongatum Stev. (Table 1). The dominant species was C. circumscriptus Kieffer (a few males were also recorded). More parous than nulliparous females of C. circumscriptus were recorded. As this species is known to be autogenous, it is probable that those females that have already laid their first batch of eggs and seek a vertebrate host are more attracted to the odor of Arum. A few females of C. catanectis Gastrer and one female of C. simulator Edwards were
<table>
<thead>
<tr>
<th>Date of collection</th>
<th>No. of inflorescences and their sex</th>
<th>No. of Culicoide spp. collected, their parity and sex (n = nulliparous; p = parous)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6.80</td>
<td>&gt; 2 sex not stated</td>
<td>14♀ C. circumscriptus (7n + 7p)</td>
</tr>
<tr>
<td>30.6.80</td>
<td>&gt; 5 sex not stated</td>
<td>6♀ C. catenatus (3n + 3p)</td>
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<tr>
<td>22.4.81</td>
<td>1 ♀</td>
<td>35♀ C. circumscriptus (14n + 21p)</td>
</tr>
<tr>
<td>1.6.81</td>
<td>6 ♂</td>
<td>10♀ C. circumscriptus parity not stated</td>
</tr>
<tr>
<td>11.6.81</td>
<td>4 ♀</td>
<td>35♀ C. circumscriptus</td>
</tr>
<tr>
<td></td>
<td>41 sex not stated</td>
<td>8♀ C. circumscriptus (3n + 5p)</td>
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<td></td>
<td></td>
<td>22♀ C. circumscriptus (2n + 20p)</td>
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<td></td>
<td></td>
<td>1♀ C. circumscriptus (n)</td>
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<td></td>
<td></td>
<td>17♀ C. circumscriptus (9n + 8p)</td>
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<tr>
<td></td>
<td></td>
<td>9♀ C. circumscriptus (7n + 2p)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1♀ C. simulator (p)</td>
</tr>
</tbody>
</table>

Table 1. Culicoide spp. collected from inflorescences of Aurum elongatum at Hermon mountain, Israel.

also caught. This is the first record of C. simulator in Israel. The 3 species belong to the odibilius group and the sensilla coeloconica pattern on the antenna of each of them is typical of a bird feeder. It is assumed therefore that the club-like apex of Aurum emits an odor similar to that of birds.

[Culicoide Larvae; Methods of Study and Mounting Techniques. E. Chaker, Institut de Parasitologie de la Faculté de Médecine, 3 rue Koeberlé, Strasbourg 67000, France.]

For the study of the 4th larval stage, Culicoide larvae are obtained by direct flotation (solution of magnesium sulphate, density 1.17 to 1.20) from mud samples and placed in small Petri-dishes (1 larva/dish) containing a 1% solution of agar. A nutritive solution of microorganisms, peptones, yeast extracts, vitamins, grass and dried cereals is added to the dishes. Dishes are placed in the insectary at 27-28°C and with 80 to 90% humidity. The periodicity cycle is 17 hours of day and 7 hours of night. Pupation occurs after 2 to 3 days. The shape and color of the cephalic capsule, shape of eyes, and the spots on the thorax can be noticed by examination under a binocular microscope. After pupation, the exuviae of the 4th larval stage, which remain intact, are recovered and mounted between slide and cover glass to allow morphological study of the epipharynx, hypopharynx, and mandibles. Other characters are studied after mounting of entire larvae on slides.

Mounting techniques: Step 1: Fix newly extracted larvae in alcohol at 70% for 8 hours at most. Step 2: Clear larvae by bathing in lactophenol for 2 to 3 minutes, then in alcohol-phenol for 2 to 3 minutes. Step 3: Mount on slides in an equal solution of balsam and alcohol-phenol. Step 4: Dry at 45°C. Often, the spots on the thorax vanish by this technic.
Fig. 1. Cephalic capsules. A. Culicoides fagineus. B. Culicoides sylvarum. C. Culicoides semimaculatus. D. Culicoides wuillardi.
Description of Larvae of Six Species of *Culicoides*. E. Chaker, Institut de Parasitologie de la Faculté de Médecine, 3 rue Koeberlé, Strasbourg 67000, France.

In Alsace there are 3 common species of *Culicoides* from tree holes: *C. semimaculatus* Clastrier, *C. sylvarum* Callot and Kremer, and *C. fagineus* Edwards, and 3 species from pool mud-banks: *C. musilator* Kremer and Callot, *C. obiibis* Austen, and *C. elastrii* Callot, Kremer and Deduit. *Culicoides semimaculatus* (Fig. 1C) and *C. sylvarum* (Fig. 1B). Larvae of these 2 species are morphologically similar: The cephalic capsule is yellow and triangular; the eyes are small, bilobate and simple in

Fig. 2. Cephalic capsules and epipharynx. A. *Culicoides obiibis*. B. *Culicoides elastrii.*
C. semimaculatus, and rounded in C. sylvarum; the spots on the thorax are light yellow; the mandibles are thin and show a membranous hook at their distal extremity; the hypopharynx comb is less developed in C. semimaculatus; in C. sylvarum 2 combs can be seen which cover the whole posterior part of the hypopharynx; the epipharynx of C. semimaculatus is made up of 3 combs, the dorsal one is wide and presents irregularly-shaped peaks; C. sylvarum presents 4 combs, the dorsal comb is narrow and ended by regular peaks; the anal papillae are short in C. semimaculatus and long in C. sylvarum; the anal segment presents long setae in both species.

Culicoides fagineus (Fig. 1A). This species is clearly characterized by its cephalic capsule which is orange-brown, oval-shaped, and large; its long eyes are made up of 2 distinct parts; the spots on the thorax are brown; the mandibles are strongly chitinized, with a wide base and a well-developed hook; the hypopharynx comb is short, the epipharynx has 2 combs, the dorsal one presents sharp peaks of variable shape; the anal papillae are long and tapered; the setae of the anal segment are long.

Culicoides musilator (Fig. 1D). This species is clearly characterized by its large eyes of specific shape; the cephalic capsule is yellow and triangular; the spots on the thorax are orange-brown; the mandibles are wide and their distal part is incurved; the hypopharynx comb is bowed, and additional spines called "ornamentation" are present on the hypopharynx; the epipharynx has 4 combs, the peaks of the dorsal comb are evenly disposed; the anal papillae are long with tapered and sharp extremities; the setae of the anal segment are short.

Culicoides odibilis (Fig. 2A) and C. clastrieri (Fig. 2B). These 2 species are morphologically similar. Only the distinguishing characters are noted. These are the shape of the dorsal comb of the epipharynx and its peaks: the dorsal comb is shaped as an "opened fan" in C. odibilis and is narrower in C. clastrieri; the peaks are wide and sharp in C. odibilis and thin and regular in C. clastrieri. These 2 species also show an "ornamentation."

Morphological Characters of some Culicoides Species from Tunisia. E. Chaker, J. C. Delecotte and M. Kremer, Institut de Parasitologie de la Faculté de Médecine, 3 rue Koeberlé, Strasbourg 67000, France.

The detailed morphological study of 17 species of Culicoides found in Tunisia during 2 surveys made in different regions of the country, allows the authors to describe new distinctive characters between morphologically similar species and to notice some variations of wing spots. Thus they compare the following species:

Culicoides puncticollis (Becker) and C. riethi Kieffer. These species are distinguishable by the existence in C. puncticollis of: spines on the first 2 tarsomeres of the anterior legs; the short duct of the spermatheca; large spermatheca; the rounded distal extremity of the style; and a dark spot focused by a light spot on the scutellum.

Culicoides cantaneus Clastrier and C. gelegensis Dzhafarov. Females of C. gelegensis are characterized by the presence of a ring at the base of the spermatheca.

Culicoides langeroni Kieffer and C. pseudolangeroni [author not known]. These species are distinguishable by the following characters for C. pseudolangeroni: the smaller size of the spermathecae; darker color of the sclerotized ring; longer apicolateral process of the male ninth tergum with narrow base; and particularly in males, by the much darker color of the scapes.

Culicoides lailae Khalaf, Type A and Type B. C. lailae type A smaller and type B larger in size; larger wing spots for type B; in females of type A, 3rd palpal segment triangular and smaller, with deep and curved sensory pit; in type B, the 3rd segment greatly swollen at the base, and
with large, oval-shaped, and very deep sensory pit.

The authors notice variations of wing spots in *C. jumineri* Callot and Kremer.

The pale spots in cells R5, M1 and M2 can become very large and joined, thus making light strips. In the inverse case, the spots can vanish in these cells.

The Separation of *Ceratopogon, Brachytopogon and Isohelea*, W. L. Grogan, Jr., Department of Biological Sciences, Salisbury State College, Salisbury, Maryland 21801, U.S.A.

On the basis of 12 characters (Table 2), *Ceratopogon* and *Brachytopogon* are compared and contrasted as distinct genera, not congeneric as has been past practice. *Isohelea* is considered to be a synonym of *Brachytopogon* based on wing venation and spermathecae; the former is considered to be a subgenus of the latter. *Ceratopogon* and *Brachytopogon* are compared with such closely related genera as *Baeohelea*, *Ceratioculicoides*, *Macrohelea*, *Rhynchosite*, etc.

<table>
<thead>
<tr>
<th>Table 2. Comparison of <em>Brachytopogon</em> (including species formerly placed in <em>Isohelea</em>) and <em>Ceratopogon</em>.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brachytopogon</strong></td>
</tr>
<tr>
<td>1. Costa extending less than 0.6 of wing length.</td>
</tr>
<tr>
<td>2. Vein M2 of wing absent or widely interrupted at base.</td>
</tr>
<tr>
<td>3. Antenna of male with flagellomeres 2–11 usually fused.</td>
</tr>
<tr>
<td>4. Third palp segment with well defined pit.</td>
</tr>
<tr>
<td>5. Fourth tarsomeres of tarsi cylindrical or subcylindrical.</td>
</tr>
<tr>
<td>7. Tenth sternum of female with 2 large bristles.</td>
</tr>
<tr>
<td>10. One or 2 spermathecae.</td>
</tr>
<tr>
<td>12. Radial cells variable, from obsolete to two small cells of equal size.</td>
</tr>
</tbody>
</table>

Some Recently Discovered New Genera of *Ceratopogonidae*, W. L. Grogan, Jr., Department of Biological Sciences, Salisbury State College, Salisbury, Maryland 21801, U.S.A.

The diagnostic characters of the following 4 recently described new genera are presented: *Amerohelea* Grogan and Wirth from the New World, closely related to *Palpomyia and Bezzia*; *Nannohelena* Grogan and Wirth, Pantropical, closely related to *Baeohelea, Niphanohelea* Grogan and Wirth from Thailand, a highly modified member of the tribe Sphaeromini; and a new genus discovered in 1981 from Zimbabwe closely related to *Brachytopogon*. 
Fig. 3. Female genital sclerotization (A) and spermathecae (B) of Culicoides reconditus, C. segnis and C. riouxi.
Revision of Culicoides segnis, C. reconditus and C. rionzi, with a Check List of the Species of the subgenus Wirthomyia. J. C. Delecolle and M. Kremer. Institut de Parasitologie de la Faculté de Medecine de Strasbourg, 3 rue Koeberle, Strasbourg 67000, France.

Culicoides rionzi Callot and Kremer has often been mistaken for C. reconditus Campbell and Pelham-Clinton, and twice has been put in synonymy with C. cunctans (Winnett). The authors follow and affirm Campbell and Pelham-Clinton’s conclusion to consider C. cunctans as a “nomen dubium.” Females of these 2 closely related species are distinguished essentially by the abdominal sclerites (Fig. 3), average length 50μ for C. rionzi and only 29 μ for C. reconditus. Culicoides segnis is clearly distinguished by the arrangement of sensilla coeloconica, present on antennal segments 3 to 14 in females and on segments 3, 7 to 14 in males. For males, all characters given in the original descriptions are still available. However, it is important to stress that no intermediate forms have ever been observed between the parameres of C. rionzi which have long hairs at their extremities and those of C. reconditus which are smooth or have some little hairs.

The following species of the subgenus Wirthomyia Vargas are known: Palaeartic Region—C. crassipilus Tokunaga, C. fagholi Navai, C. mubahrensis Wada, C. omogenis Arnault, C. punitus (Winnett), C. reconditus Campbell and Pelham-Clinton, C. rionzi Callot and Kremer, and C. segnis Campbell and Pelham-Clinton; Nearctic Region—C. bottieri Wirth and Blanton and C. stilobezzioides Foote and Pratt.


Grundlage für die Aufnahme in eine Gefährdungskategorie der nachfolgenden Tabelle sind neben der eigenen Erfahrung und Einschätzung der Situation der Bericht oder das Auffinden der Art in Mitteleuropa während der vergangenen 80 Jahre. Es liegt in der Sache selbst begründet, dass sich für die Gefährdungsstufen A. 1, 1; A. 1, 2; A.2 noch relativ verlässliche Aussagen treffen lassen, für die Gefährdungsstufen A.3 und A.4 die Abschätzung jedoch besonders schwierig wird. Insgesamt wurden 169 Gnitzenarten einer der vorgegebenen Gefährdungskategorien zugeordnet. Die grösste Artenzahl findet sich dabei in der Gefährdungsstufe A.1, 1 mit 49 Arten.
Aus gegebenem Anlaß soll an dieser Stelle auf die besondere Situation der meisten Wirbeltieren im Artenschutz hingewiesen werden. Es wird insbesondere darauf aufmerksam gemacht, dass diese Liste weder als Grundlage dienen kann noch Anlass geben soll, jetzt in hektische, naturvernichtende „Scheinnaktivitäten“ mit dem Ziel ein manuelles Sammelverbot zu erwirken, zu verfallen.


Innerhalb der Dipteren stellen die Ceratopogoniden neben den Familien der Cecidomyiidae, Chironomidae, Scatopodae und Phoridae die arten- und individuenreichste Gruppe.

In den Jahren 1975 bis 1982 wurden an verschiedenen Aristolochia-Standorten in der Bundesrepublik (Linkenheim, Götzingen, Tübingen, Hagelloch, Spitzberg) und in Frankreich (Elne im Rosillon, Gigean, Montelmar) Beobachtungen durchgeführt und Proben genommen. Die Auswertung der Blütenfallenproben aus Mitteleuropa zeigte deutliche Unterschiede hinsichtlich des Artenspektrums gegenüber den Aufsammlungen aus dem Mediterraneobereich. Als häufigster Besucher der Blütenfallen fand sich in Mitteleuropa (alle Proben aus Baden-Württemberg) Atrichopogon lucorum (Meigen), eine hier sehr häufige Art, welche auch am Olkäfer Körpersäfte saugt. Im Mittelmeergebiet bei Elne war die häufigste Art dagegen Ficopomia pontica Remm.


Auffällig ist, dass die auf chemische Lockstoffe wie Cantharidin besonders sensible reagierende Atrichopogon lucorum auch die stärkste Fraktion in den Blütenfallen stellte.

Fertilization as a Stimulant of Oviposition in Culicoides nubeculosis. Mohammad-Taher Ismail, Institut de Parasitologie de la Faculté de Médecine de Strasbourg, 3 rue Koeberlé, Strasbourg 67000, France.

The effect of fertilization on the time of oviposition was studied in Culicoides nubeculosis (Meigen). In 3 series of females fertilized at 0 hr, 24 hr, and 48 hr
after the blood meal, the moment of oviposition was noted during 10 days. Virgin females were used as the control. Fertilized females were found to lay eggs earlier than fed virgin females. In fertilized females, oviposition occurred earlier when fertilization took place either just before, or 24 hours after the blood meal. 80–90% of the eggs hatched 2–5 days after oviposition. The mechanism responsible for the stimulation of oviposition has been discussed for different haematophagous insects. Substances produced by the male accessory glands could stimulate oviposition after mating.

The Ultrastructure of the Oenocyte and the Ventral Porous Area of the Abdomen; a Hypothesis of the Biosynthesis of the Sex Pheromone in Culicoides nubeculosus. Mohammad-Taheer Ismail, Institut de Parasitologie de la Faculté de Médecine de Strasbourg, 3 rue Koeberlé, Strasbourg 67000, France.

The present work was concerned with studying the sites of biosynthesis of the sex pheromone in the female of Culicoides nubeculosus (Meigen). The study is based on histological and cytological observations of the bare ventral areas of the abdomen and the tissue bordering on these areas.

A study of the surface of the female abdomen by scanning electron microscopy revealed the presence of bare areas on the first 8 abdominal segments. Four areas were situated on the sternum and 4 on the tergum. The bare sternal areas were densely covered with minute, discoid-shaped raised areas, each with a central papilla.

The histological study of the abdominal segments shows the presence of 2 groups of 2 large cells, each (15 μ length) proximal to the bare ventral area. These cells are bound to the epidermal cells by a cytoplasmic bridge. By transmission electron microscopy it was shown that: 1) the cells are a type of oenocyte; 2) epidermal cells are absent in the bare ventral area; 3) epidermal cells are present adjacent to the bare dorsal area; 4) the bare ventral area contains numerous canals opening to the surface of the cuticle (this area will be termed the ventral porous area); these canals are absent in the bare dorsal area.

These observations allow us to present the hypothesis that the pheromone of C. nubeculosus is synthesized by the oenocytes and then passes through the haemolymph and is emitted at the ventral porous area.

Factors Associated with Fertilization Inducing a Decrease in Pheromone Secretion by Females of Culicoides nubeculosus. Mohammad-Taheer Ismail and Michel Kremer, Institut de Parasitologie de la Faculté de Médecine de Strasbourg, 3 rue Koeberlé, Strasbourg 67000, France.

Fertilized females of Culicoides nubeculosus (Meigen) secrete less pheromone than virgin females. The simple contact between males and females, without mating, does not induce the decrease in pheromone secretion seen in fertilized females. The following factors, associated with fertilization, were investigated: a) act of copulation; b) presence of live spermatozoa in the spermatheca of the female; c) the seminal fluid.

To investigate the first factor, the level of pheromone secretion was compared in females mated for one minute with that in virgin females. For the second factor, pheromone secretion by females mated with fertile males was compared with the secretion of females mated with sterile males.

The study of the 2 factors associated with fertilization enables us to exclude the act of copulation and the presence of live spermatozoa as possible determining elements. The thiotepa used to sterilize the males has no other effect on the seminal fluid than killing the spermatozoa. Ruling out the unlikely effect of dead spermatozoa, we conclude that the seminal fluid alone is responsible for the decrease of pheromone secretion by fertilized females. We cannot eliminate the
possibility that the filling of the spermatheca by the seminal products has a mechanical effect, but we have found no way to study this factor.

The Role of the Abdomen in the Emission of Sex Pheromone in Culicoides nubeculosus. Mohammad-Taher Ismail and Michel Kremer, Institut de Parasitologie de la Faculté de Médecine de Strasbourg, 3 rue Koebeler, Strasbourg 67000, France.

The zone of emission of sex pheromone in the body of Culicoides nubeculosus (Meigen) was investigated. Three parts of the body were explored: head, thorax and abdomen. Each part was studied by neutralizing the others. The head was neutralized by decapitation; the females continued to emit pheromone. The head is therefore not indispensable for pheromone emission. The role of the thorax and abdomen was studied by coating these with paraffin wax. When the thorax is coated, pheromone emission continues, but when the abdomen is coated, it stops. It appears that the abdomen alone is responsible for emission of the sex pheromone.


A visit was made to Turkey in October 1981 for the collection of Culicoides species. The aim was to determine whether confirmed or potential vector species of bluetongue virus (BTV) were present in areas where bluetongue disease had been reported. Collections were made in 4 major provinces—Konya District on the Central Anatolian Plateau and the 3 western provinces of Antalya, Denizli and Aydin. Most collection sites were in rural situations near to cattle, sheep or goats. Collections were also made at Ankara and Istanbul, although here the sites were more urban.

Insects were collected at night, using 2 Monks Wood traps. 8,683 Culicoides were collected and 13 species were identified. The largest catches were from the western provinces. The samples from the Anatolian Plateau were small, with a limited number of species recorded, possibly owing to the cold night temperatures in this area at that time of year.

Culicoides imicola Kieffer, a proven vector of BTV in Africa, was collected from the western provinces in areas where BT disease had occurred. Culicoides obsoletus (Meigen) and C. schultzei (Enderlein), both considered to be possible BTV vectors, were also collected in these areas, the latter species in large numbers. Other species identified were: C. circumscriptus Kieffer, C. kurenisi Dzhafarov, C. laeae Khalaf, C. longipennis Khalaf, C. marsitimus Kieffer, C. neustadi Austen, C. parroti Kieffer, C. punctatus (Meigen), C. puncticollis (Becker), and C. saevus Kieffer. Four other ceratopogonid genera—Arichopogon, Bezzia, Dasyhelea, and Forcipomyia—were recorded. No virus isolation attempts were made during this survey.

Spatial Distribution of Selected Ceratopogonidae in a Restricted Habitat in Central Iowa, U.S.A. R. D. Keith and W. A. Rowley, Marin/Sonoma Mosquito Abatement District, Petaluma, California, and Department of Entomology, Iowa State University, Ames, Iowa 50011, U.S.A.

The spatial distribution of Culicoides and other ceratopogonids was examined in a restricted breeding site in central Iowa. Midges were collected weekly over a 9-week period. Factors such as wind, temperature, humidity and precipitation were also considered. 2,622 specimens were collected with cylindrical sticky traps set up in a centric systematic arrangement at heights of 1, 2, and 3 m above the ground. Dasyhelea, Forcipomyia, Arichopogon, and Culicoides species were collected in considerable numbers. Female Arichopogon were the most common, constituting 17% of all the ceratopogonids collected. The only species of Culicoides
taken in large enough numbers to be evaluated were *C. crepuscularis* Malloch and *C. haematorhitis* Malloch, although 8 other species of Culicoides were found on the sticky traps.

All species were non-randomly distributed in space. Male Forecipomyia occurred within 1 m of the ground. Male *Dasyhelea*, female *Atrichopogon*, and female Forecipomyia were aggregated in the middle stratum while female *C. crepuscularis* were strongly aggregated in the upper stratum, 3 m above the ground. Female *Dasyhelea* were evenly distributed in all 3 strata.

**Bluetongue Virus and Culicoides in the Sudan.** P. S. Mellor, Animal Virus Research Institute, Pirbright, Woking, Surrey, GU24 ONF, U.K.

Bluetongue virus causes an infectious arthropod-borne disease of ruminants. Sheep are usually the most severely affected animals. The distribution of the disease includes North and South America, Australia, Asia and Africa. Biting midges of the genus *Culicoides* are the only known biological vectors.

In the Sudan, BTV is endemic in the far south of the country and is epizootic farther north. In these epizootic areas seroconversions in cattle indicate that virus transmission is taking place at the end of the rainy season in August, September and October. Eleven species of *Culicoides* have been collected from the vicinity of cattle pens in BT epizootic areas at this time of the year. Two of these 11 species, *C. kingi* Austen and *C. imicola* Kieffer, have been found to be dominant in each of 6 collecting sites. *Culicoides kingi* comprised nearly 90% of the *Culicoides* taken, while *C. imicola* comprised about 10%. *Culicoides imicola* is known to be a vector of BTV in other parts of Africa and the Middle East but *C. kingi* has not yet been implicated in virus transmission. Nevertheless, because of its prevalence in an epizootic area, its breeding in and around cattle pens, and as it routinely bites cattle, *C. kingi* must be suspect as a vector of BTV in the Sudan. Further work now in progress involves the attempted isolation of BTV from suspected vectors in the Sudan.

**Study of a Birnavirus Isolated from a Natural Population of Larvae of Culicoides sp.** E. Mialhe, G. Crozier, J. C. Veyrunes, J. M. Quiot, and J. P. Rieb,* Station de Recherches de Pathologie comparee, 30380 Saint-Christol-Les-Ales, France (* Laboratoire de Parasitologie et de Pathologie tropicale, Faculte de Medecine, 3 rue Koeberlé, 67000 Strasbourg, France).

A virus has been isolated from a natural population of larvae of *Culicoides* sp. collected at Ichtratzheim, near Strasbourg. The viral particles are naked, icosahedral with an electron microscopic diameter of 54 nm. They band at a density of 1.32 in CsCl. The genome consists of 2 pieces of dsRNA with molecular weights of 2.5 and $2.6 \times 10^6$ d. The proteins have been resolved into 6 polypeptides by polyacrylamide gel electrophoresis. Their molecular weights are comprised between 24500 and 105,000 d.

By these characteristics, this *Culicoides* virus is akin to I.P.N. virus, I.B.D. virus, D.X. virus, T. virus and O. virus, recently
grouped as Birnaviruses. It has also been proposed that a new viral family be formed, named Birnaviridae (Dobos et al. 1979, J. Virol. 32:593–605). Thus, the Ceratopogonidae, with the genus Culicoides, are associated with an additional family of viruses. In this group of viruses, the Culicoides Birnavirus is closely related to the D.X. virus which comes from foetal calf serum.

Therefore, it is indispensable to carry on the study of this virus in order to understand its epidemiology in the populations of Culicoides and to search for possible vertebrate hosts.


An intracellular procaryote was observed in epidermal and fat cells of Culicoides, probably C. elatieri Callot, Kremer and Deduit or C. edulis Austen, at larval stage, collected at Ichtratzheim near Strasbourg (France).

The morphogenic cycle, very close to that found in the order Chlamydiales of the class Rickettsia, was studied by electron microscopy. There are 3 main developmental stages: 1) The disk-shaped elementary body, 600–700 nm in diameter and 150–140 nm in thickness, limited by a pentalamellar system corresponding to a cell wall and a cytoplasmic membrane. The nucleoid is lateral and ribosome-like particles are arranged in parallel arrays. 2) The initial body, globular, 600–700 nm in diameter, contains ribosomal elements in an electron-clear cytoplasm. It divides by binary fission. 3) The intermediate body, which is a transitional stage between the 2 others, is characterized by lateral condensation of the nucleoidic material and by progressive flattening. In addition, there are also giant cells including a fibrillary mass.

This cycle is very similar to that of the genus Porochlamydia, recently described by Morel (J. Invertebr. Pathol. 28:167–175, 1976). It seems different from the only Porochlamydia (Porochlamydia = Rickettsiella chronometra) described in insects (Federici, B.A., J. Bacteriol. 143:995–1002, 1980), mainly owing to the greater thickness of elementary bodies. This is the first observation of a chlamydia associated with an insect vector of medical importance.

Behavior Patterns of Culicoides spp. Deduced from Collections in Light Traps and on Human Host. A. M. Fuca, Agriculture Canada, Communications Branch, Sir John Carling Bldg., Ottawa K1A 0C7, Canada.

During the course of studies of the biometrics of Ceratopogonidae at Lac Serpent near Notre Dame du Laus, Quebec, Canada, large numbers of Culicoides sanguinipes (Coquillett) were collected in miniature New Jersey light traps during 3 consecutive summers. At the same time during 2 of those years, landing rates were recorded on a human host. Daily readings of temperature, humidity, and occasionally evaporation rate were taken at the collecting site.

Seasonal Abundance. Light trap collections showed 2 main peaks of C. sanguinipes, a chief one at the end of June and the other in the second week of July, as well as smaller peaks. These are considered to be peaks of emergence. This staggered emergence may have been caused by differences in temperature and food at the breeding sites.

Daily Activity. As indicated in light trap collections and landing rate studies, females of C. sanguinipes have been found to be active in early morning, to reach their peak in the evening shortly before sunset, and to continue their activity for a considerable time after sunset until very high humidity and low temperature conditions prevailed.
Emergence Traps used to Collect Ceratopogonidae and Dixidae in Quebec, Canada. A. M. Pucat, Agriculture Canada, Communications Branch, Sir John Carling Bldg., Ottawa K1A 0C7, Canada.

At Lac Serpent near Notre Dame du Lacs, Quebec, Canada, the following species were collected from 2 types of emergence traps and reared from substrate brought into the laboratory: Altanudomyia bella (Coquillett), A. megasparamera Williams, A. paraspatha Wirth, Culicoides bignutatus (Coquillett), and C. crepuscularis Malloch. Species of the following genera were also collected: A.ichthopagon, Bezza, Ceratopogon, Forcipomyia, Mallochobates and Stilobezzio.

In July 1967, 1 specimen of Dixa sp. was collected from a cone-type trap on the lake shore. In the same month and at the same site a larva of Dixa (probably D. nigra (Johansen)) was collected. As far as is known, this is the first record of the genus Dixa from Quebec.

Ceratopogonidae Larvae Infected by an Iridovirus. J-P Rieb*, E. Mialhe** and J.-M. Quiot**, (**) Institut de Parasitologie de la Faculté de Médecine, 3 rue Rochebrune, Strasbourg 67000, France, and (***) Station de Recherches de Pathologie Comparée, Saint-Christol-Les-Ales 30380, France.

Since 1977, Ceratopogonidae larvae colored turquoise-blue and infected by an iridovirus, are regularly found in a fluvial mud-bank near Strasbourg (France). The infected species are: Culicoides odibilis Austen (49%), C. clastrieri Callot, Kremer and Deduit (33%), C. cubitoils Edwards (0.8%), and Bezza frysanae Goeghebuer (0.4%). The average level of infection is about 1%; it remains constant all year round. The infection is lethal in the last larval instar. It is the first known case of iridovirosis in European Ceratopogonidae. The association of several species with the iridovirus allows us to consider an interspecific larval transmission interfering in the breeding-site population regulation.

The DNA-virus has a hexagonal section corresponding to an icosahedral structure, and measures 150 nm side to side. It is exclusively intracytoplasmic and develops principally in the epidermal and adipose cells, where it produces a crystalline lattice. Several arguments are given to show that the virus particles may be packed in a face-centered cubic network. The smallest interparticle space is 235 ± 9 nm. The lattice produces interference colors by diffraction of the light. The planes (200) give a blue color and the planes (111) a green one. The size of the iridovirus crystal is about 2 μm.

Biting Midge of the Genus Forcipomyia from Algeria. Ryszard Szaadzieski, Department of Invertebrate Zoology, University of Gdansk, Czolgistow 46, 81-378 Gdynia, Poland.

The author collected 25 species of Forcipomyia in Algeria. They are as follows: Forcipomyia vstr. (9 species) - bipunctata (L.), crassipes (Winnertz) nigra (Winnertz), regulus (Winnertz), rustica Kieffer, saharensis Kieffer, suberis Clastrer, tentinsiquama Kieffer, sp. A; Subgenus Microbeleia (1) - jaligousa (Meigen); Subgenus Euproaonumia (5) - alaera (Winnertz), menissitic Remm, phlebotomoides Bangerter, pilonosa Kieffer, sp. B; Subgenus Thyrridomyia (5) - biskraensis Kieffer, fruticorum (Winnertz), biarxaus (Ingram and Macfie), monilicornis (Coquillett), rugosa Saunders; Subgenus Synthyrydonymia (2) - marina (Winnertz), sp. C; Subgenus Lasiolepolea (1) - velax (Winnertz); Subgenus Lepidotolea (1) - formosa (Kieffer); Subgenus Panbeleia (1) - pontico Remm.

Three species (A, B, C) belonging to the subgenera Forcipomyia, Euproaonumia, and Synthyrydonymia are hitherto unknown to science. Sixteen new synonyms are here proposed: acetilcola Tokunaga (syn.: colemani Wirth); biskraensis Kieffer (syns.: sergenti Clastrer, imerevic Remm); for-
mosae Kiëffer (syn.: lepidota Ingram and Macfie); fructetorum (Winnertz) (syn.: senesveti Kiëffer); knoekensis Goetheheuber (syn.: bequernis Goetheheuber); bluararee (Ingram and Macfie) (syn.: minutissima Remm); marina (Winnertz) (syns.: sulfurea Kiëffer, hirtipalpis Kiëffer, saxe Kiëffer); polonota Kiëffer (syn.: hastor Kiëffer); regulis (Winnertz) (syn.: stratiomnis Kiëffer nec Dessart); rustica Kiëffer (syn.: caranei Kiëffer); sahariensis Kiëffer (syns.: armatocerus Kiëffer, onusta Remm); suberis Clastrier (syn.: flaviusrustic Remm).

Eleven species are recorded for the first time from North Africa and 3 from Algeria, and now there are 30 species known from North Africa and 26 species from Algeria. Amongst these Fove proporpyla species of Algeria, 6 zoogeographic elements can be distinguished: cosmopolitan (1 species), Holarctic (5), west Palaearctic (6), south Palaearctic (2), Mediterranean (5), Afrotropical (3). Four species are known only from Algeria. Fove proporpyla, unlike any other genus of Ceratopoona, has a large number of widespread species, i.e. cosmopolitan, Holarctic-Afrotropical, Holarctic-Afrotropical-Oriental, Afrotropical-west Palaearctic.


During April and May 1981 the author collected more than 140 species of Ceratopoona in northern Algeria. Thirty species of the genus Culicoides were recorded: Subgenus Pomoculicoides (2 species) - saevus Kiëffer, sefodine Dzhaforov; Subgenus Asyriata (3) - imiola Kiëffer, obsoletus (Meigen), scoticus Downes & Kettle; Subgenus Culicoides (3) - neastadi Austen, pucaerei (L.), punctatus (Meigen); Subgenus Remus (1) - subfacipennis Kiëffer; Subgenus Oecacta (16) - azerbajdzhanicus Dzhaforov, catarac Clastrier, cirrinitelluss Kiëffer, dzhafarov Remm, heterolotics Kremer & Callot, jumneri Cal-

lot and Kremer, kilunensis Tokunaga, laloe Khalaf, landerei Kiëffer, marcleti Callot, Kremer & Bassett, martinoens Kiëffer, paciensen (Staeger), petrens Goetheheuber, pseudopallidus Khalaf, saenianus Dzhaforov, sahariensis Kiëffer, santonicens Callot, Kremer, Rault and Bach, Subgenus Belvannmata (2) - circumscriptus Kiëffer, sp. aff. homocroous Remm; Subgenus Monoculicoides (1) - puncticollis (Becker).

Ten new synonyms are proposed. They are: Culicoides saevus Kiëffer (syn.: micraculithorax Khalaf); kingi Austen (syn.: nilotes Kiëffer); cirrinitelluss Kiëffer (syn.: mulsulensis Khalaf); pseudopallidus Khalaf (syn.: shogolei Remm); sahariensis Kiëffer (syns.: baghdaensis Khalaf, flavismilis Dzhaforov); leucostictus Kiëffer (syn.: phareo Kiëffer), and puncticollis (Becker) (syns.: distigma Kiëffer, griswittatus Vimmer, luteoignatus Vimmer).

Twenty species are recorded for the first time from Algeria, and amongst them one, C. pofferingsius, from North Africa. Thus, there are now 42 species known from Algeria. Algerian species of the genus Culicoides represent 5 zoogeographic elements: Holarctic (2 species), Palaearctic (7), Mediterranean (22), south Palaearctic or arid Afro-Eurasian (4), Afrotropical (3). Four species (soleus Kieff, nudipennis Kiëffer, sergenti Kiëffer, sp. aff. homocroous) are known only from Algeria. The name "C. numidicus" used by Mayer (1955) is a nomen nudum.

Turf-Moss Culicoides in the Hauts-Vosges (France). J. Waller, M. Kremer and J. C. Delecuelle. Institut de Parasitologie de la Faculté de Médecine de Strasbourg, 3 rue Koeberle, Strasbourg 67000, France.

As part of the "Projet Interdisciplinaire de Recherche sur l’Environnement (PIREN)" studying water ecology in Alsace (France) and granted by the CNRS (National Center of Scientific Research), the authors have made a faunistic list of
the Culicoides from turf-mosses in the Hautes-Voges. These turf-mosses are special biotopes: oligotrophic, acid (3.5<pH<4) and with low pH and temperature. These parameters are stable all year round. The following species were collected in 1981: Culicoides cibalis Edwards, fascipennis (Staeger), griseascens Edwards, impunctatus Goetghebuer, obsoletus (Meigen), punctatus (Meigen), reconditus Campbell and Pelham-Clinton, segnis Campbell and Pelham-Clinton, sphagnumenis Williams, stigma (Meigen), subfascipennis Kieffer, and truncorum Edwards. In cow-dung: Culicoides chiopterus (Meigen), demulsi Goetghebuer, and scoticus Downes and Kettle.

Culicoides albicans, carjalaensis, fascipennis, griseascens, heliophilus, impunctatus, and sphagnumenis are considered as specific turf-moss species. The differences between our report and the previous reports can be due to the small number of samples, the disappearing of a species, or a temporary eclipse of a species.

A GENETIC-SEXING STRAIN BASED ON MALATHION RESISTANCE FOR CULEX TARSALIS

P. T. McDonald and S. M. Asman

ABSTRACT. A genetic-sexing strain of Culex tarsalis that links malathion resistance and male-determining genes via a translocation was established. In this strain females are susceptible to malathion and males are malathion resistant. A discriminating dose of 0.1 ppm malathion applied to first as well as fourth instars eliminates over 99 percent of the females while permitting the males to survive.

In the last decade the possibility of using genetic methods as alternatives to pesticides for control has been explored for Culex tarsalis Coq. The SMR (sterility male release) approach has recently been under consideration, and its implementation requires efficient mass production procedures. The development of a reliable, safe and accurate method of eliminating females from the release population is also necessary for the establishment of an efficient program. Sex separation by genetic means is the most desirable approach where accurate and non-damaging mechanical methods are not available.

Sex separation by sex-linked conditional lethal systems has been developed for 5 species of mosquitoes (Baker et al. 1978, Baker et al. 1981, Curtis 1978, Curtis et al. 1976, Seawright et al. 1978). The conditional lethal for the Culex