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

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The "World Ceratopogonidae Group" held its 5th Congress at the Institut de Parasitologie, Faculté de Médecine, Strasbourg, France, July 1–3, 1982, under the chairmanship of its organizer, M. Kremer. Previous congresses (with details of their resumes and abstracts) were held as follows: 1973, France, Strasbourg (Ann. Parasitol. Hum. Comp. 49:612–658, 1974); 1976, U.S.A., Washington, D.C. and Blacksburg, Virginia (Mosq. News 37:276–289; 1977); 1978, Poland, Warsaw (Ann. Parasitol. Hum. Comp. 54:247–260, 1979); and 1980, U.K., London (Israel J. Entomol. 15:109–128, 1981). The next meeting is scheduled for 1984 in Hamburg, W. Germany, in conjunction with the XVII International Congress of Entomology.

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

[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 pictipennis* (Staeger), *C. odibilis* (Winnertz), *C. musilator* Kremer and Callot, *Palpomyia lineata* (Meigen), *Alluaudomyia pentaspila* 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 *Monoculicoides*) and *C. schultzei* (Enderlein) (subgenus *Oecacta*) are of potential importance, but need further study. The most likely vectors belong to the subgenus *Avaritia*, represented by 8 species. Virus has been isolated from *C. obsoletus* (Meigen), and *C. imicola* Kieffer is a known vector in Israel and Africa. *Culicoides dewulfi* Goetghebuer, *chiopertus* (Meigen), *sinanoensis* Tokunaga, and *okumensis* Arnaud are found mostly north of 40 degrees latitude; *C. obsoletus, montanus* Shakirzjanova, and *scoticus* Downes and Kettle 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 *Avaritia* species.

Culicoides Species Found in the Inflorescenses 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. bromophilus* Kieffer, represented by females only, were found in the inflorescenses of *Arum conophalloides* Kotschy; however the present taxonomic status (i.e. synonymies) of these 2 species is not known. The attraction of *Arum* species inflorescenses 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 inflorescenses 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. cataneii* Clastrier and one female of *C. simulator* Edwards were

Table 1. *Culicoides* spp. collected from inflorescenses of *Aurum elongatum* at Hermon mountain, Israel.

Date of collection	No. of inflorescenses and their sex	No. of *Culicoides* spp. collected, their parity and sex (n = nulliparous; p = parous)
3.6.80	> 2 sex not stated	14♀ *C. circumscriptus* (7n + 7p)
		6♀ *C. cataneii* (3n + 3p)
30.6.80	> 5 sex not stated	35♀ *C. circumscriptus* (14n + 21p)
		10♀ *C. circumscriptus* parity not stated
		3♂ *C. circumscriptus*
22.4.81	1 ♀	8♀ *C. circumscriptus* (3n + 5p)
1.6.81	6 ♂	22♀ *C. circumscriptus* (2n + 20p)
	4 ♀	1♀ *C. circumscriptus* (n)
11.6.81	63 ♂	17♀ *C. circumscriptus* (9n + 8p)
	41 sex not stated	9♀ *C. circumscriptus* (7n + 2p)
		1♀ *C. simulator* (p)

also caught. This is the first record of *C. simulator* in Israel. The 3 species belong to the *odibilus* 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 *Arum* emits an odor similar to that of birds.

Culicoides 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, *Culicoides* 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 micro-organisms, 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 technics: 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.

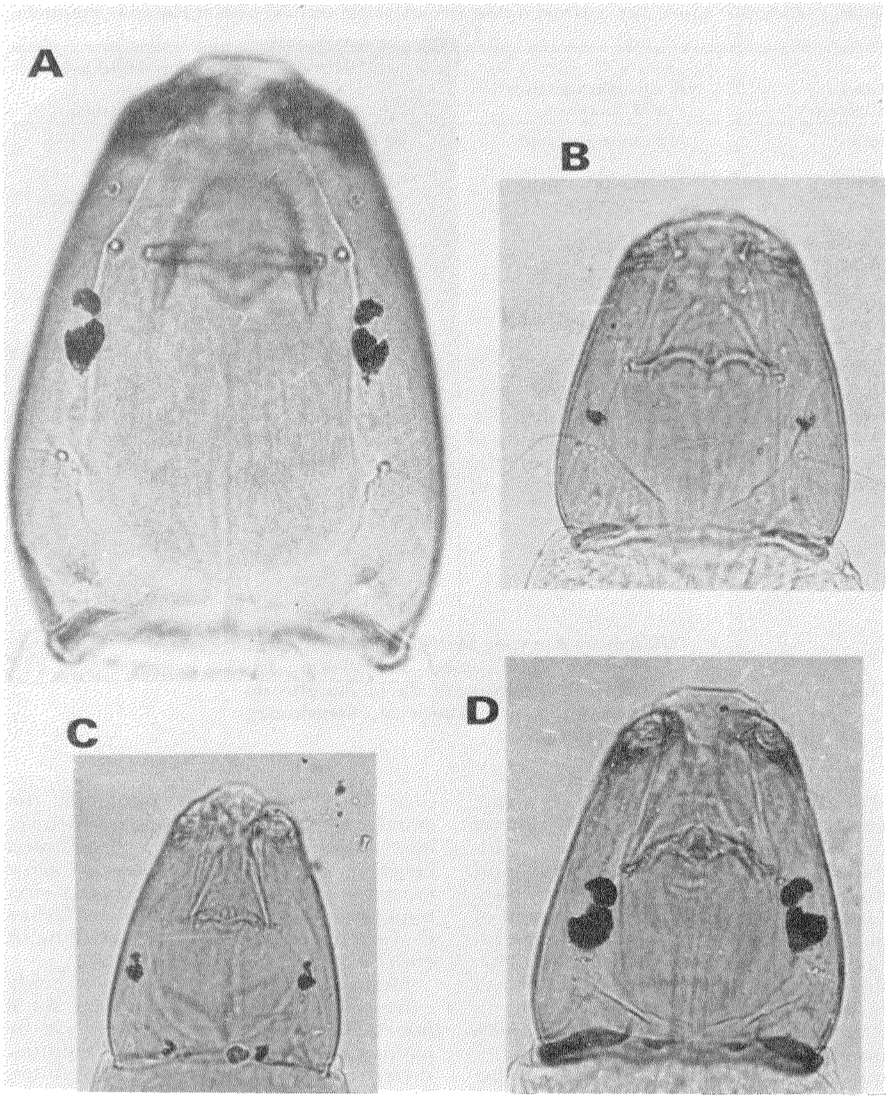

Fig. 1. Cephalic capsules. A. *Culicoides fagineus*. B. *Culicoides sylvarum*. C. *Culicoides semimaculatus*. D. *Culicoides musilator*.

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. odibilis* Austen, and *C. clastrieri* 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

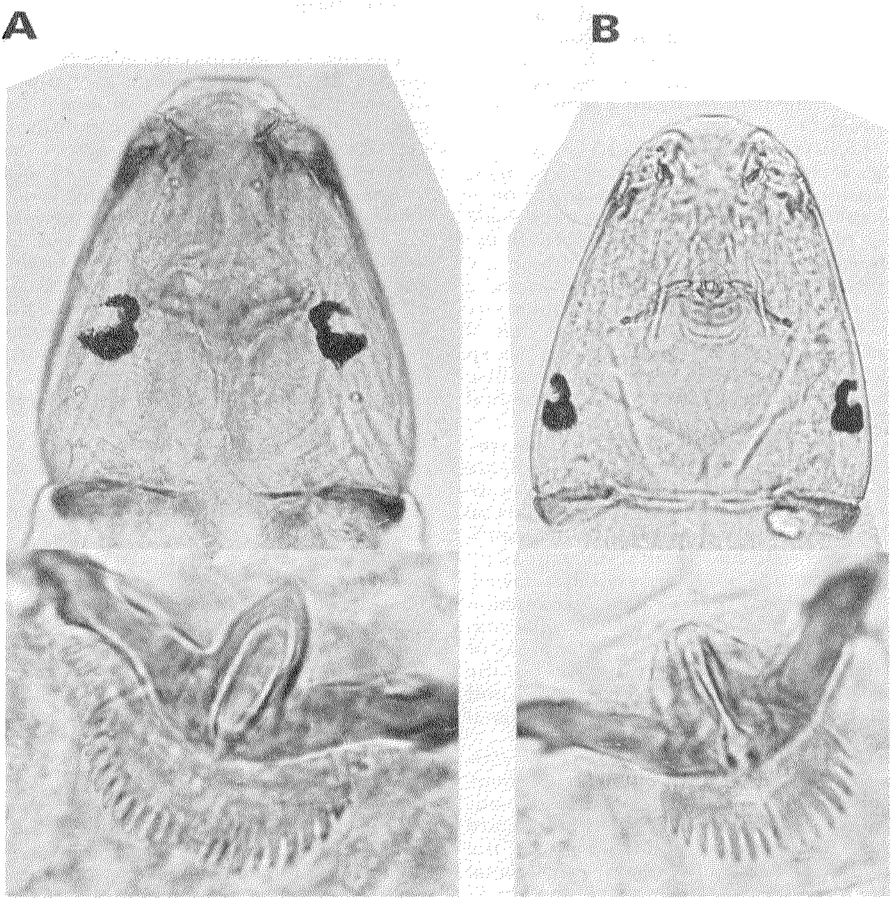

Fig. 2. Cephalic capsules and epipharynx. A. *Culicoides odibilis*. B. *Culicoides clastrieri*.

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. Delecolle 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 morphological 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 cantaneii Clastrier and *C. gejgelensis* Dzhafarov. Females of *C. gejgelensis* 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*, *Brachypogon* 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 *Brachypogon* are compared and contrasted as distinct genera, not congeneric as has been past practice. *Isohelea* is considered to be a synonym of *Brachypogon* based on wing venation and spermathecae; the former is considered to be a subgenus of the latter. *Ceratopogon* and *Brachypogon* are compared with such closely related genera as *Baeohelea*, *Ceratoculicoides*, *Macrurohelea*, *Rhynchohelea*, etc.

Table 2. Comparison of *Brachypogon* (including species formerly placed in *Isohelea*) and *Ceratopogon*.

Brachypogon	*Ceratopogon*
1. Costa extending less than 0.6 of wing length.	1. Costa extending 0.6–0.8 of wing length.
2. Vein M2 of wing absent or widely interrupted at base.	2. Vein M2 of wing complete to base.
3. Antenna of male with flagellomeres 2–11 usually fused.	3. Antenna of male with all flagellomeres free.
4. Third palpal segment with well defined pit.	4. Third palpal segment without pit or with small ill defined one.
5. Fourth tarsomeres of tarsi cylindrical or subcylindrical.	5. Fourth tarsomeres of tarsi deeply cordate or heart-shaped.
6. Eyes contiguous.	6. Eyes well separated.
7. Tenth sternum of female with 2 large bristles.	7. Tenth sternum of female with 6–10 bristles.
8. Ninth sternum halves of female with single arm.	8. Ninth sternum halves of female with divided arms (bifurcate).
9. Eighth sternum of female divided lengthwise.	9. Eighth sternum of female notched, not divided.
10. One or 2 spermathecae.	10. Three spermathecae.
11. Scutellum with 4 bristles.	11. Scutellum with 6–10 bristles.
12. Radial cells variable, from obsolete to two small cells of equal size.	12. Two radial cells present, the second about 1.5 times longer than first.

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; Nannohelea* Grogan and Wirth, Pantropical, closely related to *Baeohelea; Niphanohelea* Grogan and Wirth from Thailand, a highly modified member of the tribe Sphaeromiini; and a new genus discovered in 1981 from Zimbabwe closely related to *Brachypogon*.

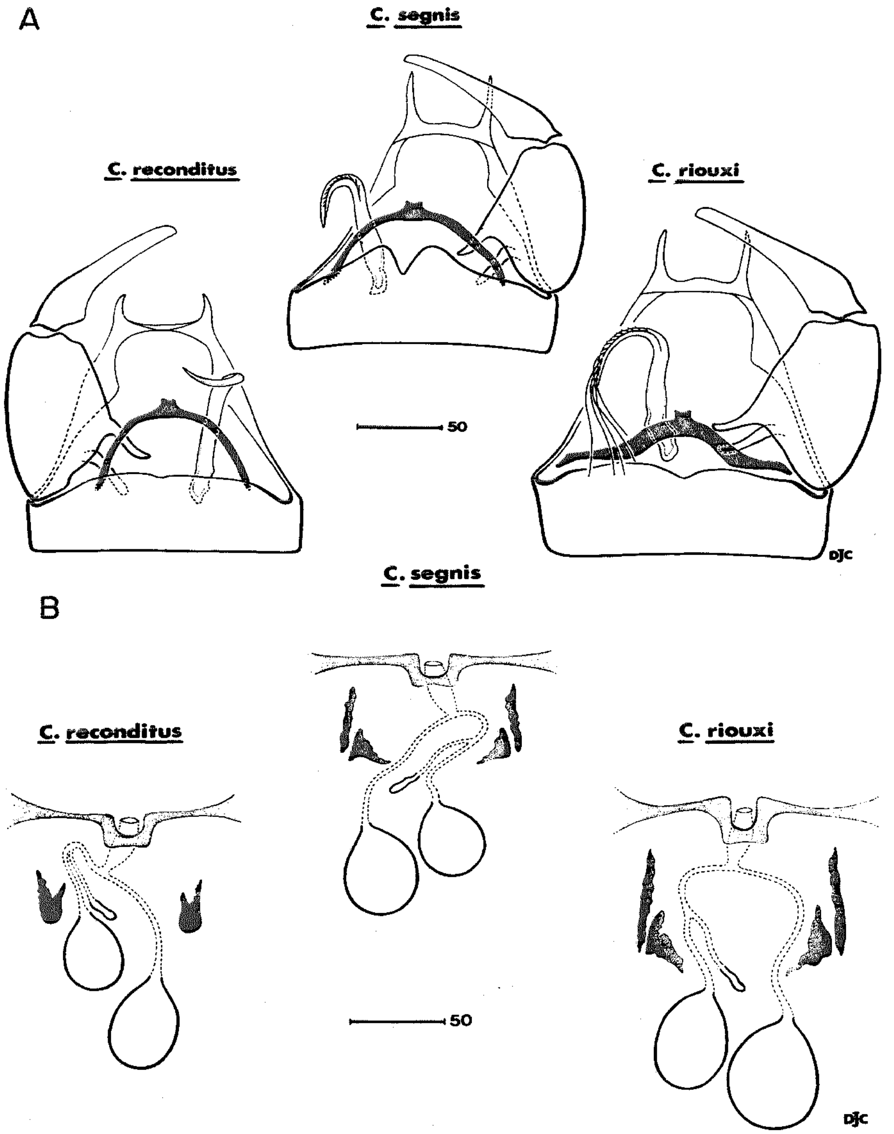

Fig. 3. Female genital sclerotization (A) and spermathecae (B) of *Culicoides reconditus*, *C. segnis* and *C. riouxi*.

Revision of *Culicoides segnis*, *C. reconditus* and *C. riouxi*, with a Check List of the Species of the subgenus *Wirthomyia*. **J. C. Delecolle and M. Kremer, Institut de Parasitologie de la Faculté de Médecine de Strasbourg, 3 rue Koeberlé, Strasbourg 67000, France.**

Culicoides riouxi Callot and Kremer has often been mistaken for *C. reconditus* Campbell and Pelham-Clinton, and twice has been put in synonymy with *C. cunctans* (Winnertz). 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. riouxi* 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. riouxi* 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: Palaearctic Region—*C. crassipilosus* Tokunaga, *C. faghihi* Navai, *C. nukabirensis* Wada, *C. omogensis* Arnaud, *C. pumilus* (Winnertz), *C. reconditus* Campbell and Pelham-Clinton, *C. riouxi* Callot and Kremer, and *C. segnis* Campbell and Pelham-Clinton; Nearctic Region—*C. bottimeri* Wirth and Blanton and *C. stilobezzioides* Foote and Pratt.

Bartmücken und Naturschutz, Überlegungen zur Erstellung einer vorläufigen Roten Liste. **Peter Havelka, Landesanstalt f. Umweltschutz Inst. f. Ökologie und Naturschutz, Bannwaldealle 32, D-75 Karlsruhe 21, W. Germany.**

In den vergangenen Jahren nimmt der Artenschutz in vielen Staaten einen immer grösseren Stellenwert ein. Bislang wurden jedoch viele Tierfamilien, insbesondere aus der Gruppe der Insekten recht stiefmütterlich behandelt. Damit geriet das ganze Unterfangen—unter Berücksichtigung des hohen biologischen Stellenwertes des Tierstammes—in den Verdacht einer Alibifunktion. Um diesem offensichtlichem Mangel abzuhelfen wurden zur Objektivierung und Optimierung sowie zur Erhöhung des Wirkungsgrades der Schutzmassnahmen verstärkte Anstrengungen unternommen.und bislang vom Natureschutz wegen ihrer geringen Auffälligkeit vernächlässigte,—jedoch im Gesamtartengefüge besonders wirksame Vertreter unterschiedlicher Taxa—mit in die Betrachtungen einzubeziehen. Dies stösst jedoch befremdlicher Weise gerade beim amtlichen Naturschutz wegen der dort gehäuft auftretenden geringen zoologischen Sachkunde sowie des vielfach fehlenden ökologischen Verständnisses von sog. "Fachleuten" auf Ablehnung. Es erfordert sicherlich grundsätzliches Umdenken um nach Jahren einseitig ausgerichteter oder geduldeter Bekämpfungsstrategie nunmehr in verschiedenen Gruppen wie z.Bsp. bei den Gnitzen auch Gedanken an die Gesamtsituation verschiedener Arten zu verwenden.

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 Mitteleurope 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 Anlab soll an dieser Stelle auf die besondere Situation der meisten Wirbellosen im Artenschutz hingewiessen werden. Es wird insbesonder darauf aufmerksam gemacht, dass diese Liste weder als Grundlage dienen kann noch Anlass geben soll, jetzt in hektische, naturschützerische "Scheinaktivitäten" mit dem Ziel ein manuelles Sammelverbot zu erwirken, zu verfallen.

Die Ceratopogonidenfauna der Osterluzei *(Aristolochia clematitis)*. **Peter Havelka. Landesanstalt f. Umweltschutz Inst. f. Ökologie und Naturschutz, Banwaldealle 32, D-75 Karlsruhe 21, W. Germany.**

Die Osterluzei, ein submediterranes Geoelement, in der Vergangenheit häufig zur Drogenherstellung benutzt, war wegen der Besonderheit ihres Bastäubungsmechanismus mehrfach Untersuchungs-objekt der Wissenschaft. Die auf diesen Gebiet wichtigsten Biologen waren Christian Konrad Sprengel (1793), Correns (1891) sowie Daumann (1959). Bereits Sprengel stellte fest, dass sich in den Blüten der *Aristolochia* kleine Insekten einfinden, welche durch die mit Reusenhaaren besetzten Blütenröhren in den Kessel gelangen, in welchem sie bis zur Reifung der Antheren und der Entleerung des Pollen verbleiben.

In den Blüten der Osterluzei wurden bisher folgende Insektengruppen festgestellt: Thysanoptera, Homoptera, Hymenoptera und Diptera. Die stärkste Fraktion bei den Blütenbesuchern stellen die Dipteren. Dies hängt wohl mit der Art der Insektenanlockung zusammen, welche bei der Osterluzei durch chemische Lockstoffe bewirkt wird. Der typisch süssliche, herbe Geruch wird im übrigen von der *Aristolochia* nur während ihres weiblichen Blütenstadiums ausgesendet.

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

In den Jahren 1975 bis 1982 wurden an verschiedenen Aristolochia-standorten in der Bundesrepublik (Linkenheim, Grötzingen, Tübingen, Hagelloch, Spitzberg) und in Frankreich (Elne im Rousillon, Gigean, Montelimar) Beobachtungen dürchgeführt und Proben genommen. Die Auswertung der Blütenfallenproben aus Mitteleuropa zeigte deutliche Unterschiede hinsichtlich des Artenspektrums gegenüber den Aufsammlungen aus dem Mediterranbereich. 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 *Forcipomyia pontica* Remm.

An weiteren Gnitzenarten wurden in den Blütenfallen in Mitteleuropa *Atrichopogon hirtidorsum* Remm, *Culicoides achrayi* Kettle und Lawson, *C. pumilus* (Winnertz), *C. jurensis* Callot, Kremer und Deduit, *Dasyhelea flaviventris* Goetghebuer, *D. flavoscutellata* (Zetterstedt), *D. paludicola* Kieffer, *D. versicolor* (Winnertz), *Forcipomyia monilicornis* (Coquillett), *F. bipunctata* (L.), *F. frutetorum* (Winnertz), *F. minutissima* Remm, *F. nigra* (Winnertz), und *F. velox* (Winnertz) gefunden. Im Mittelmeerraum wurden bisher nur *Dasyhelea versicolor*, *Forcipomyia pontica*, und *F. sergenti* Clastrier festgestellt.

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

Fertilization as a Stimulant of Oviposition in *Culicoides nubeculosus*. **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 nubeculosus* (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 accessary 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-Taher 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 oenocyte cells 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-Taher 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 Koeberlé, 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.

***Culicoides* Collected in Turkey in October 1981.** **M. Jennings, Animal Virus Research Institute, Pirbright, Woking, Surrey, GU24 ONF, U.K.**

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 Antayla, Denizli and Aydein. 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 light, 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. kurensis* Dzhafarov, *C. lailae* Khalaf, *C. longipennis* Khalaf, *C. maritimus* Kieffer, *C. newsteadi* Austen, *C. parroti* Kieffer, *C. punctatus* (Meigen), *C. puncticollis* (Becker), and *C. saevus* Kieffer. Four other ceratopogonid genera—*Atrichopogon, 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, Atrichopogon,* and *Culicoides* species were collected in considerable numbers. Female *Atrichopogon* 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. haematopotus* Malloch, although 8 other species of *Culicoides* were found on the sticky traps.

All species were non-randomly distributed in space. Male *Forcipomyia* occurred within 1 m of the ground. Male *Dasyhelea*, female *Atrichopogon*, and female *Forcipomyia* 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 comparée, 30380 Saint-Christol-Les-Alés, France (* Laboratoire de Parasitologie et de Pathologie tropicale, Faculté de Médecine, 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 CsC1. 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.

Evidence and Study of a Chlamydial Infection in *Culicoides* sp. E. Mialhe, C. Louis, J.-M. Quiot, J.-P. Rieb*, and C. Vaga. Station de Recherches de Pathologie comparée, 30380 Saint-Christol-Les-Alès, France. (*Laboratoire de Parasitologie et de Pathologie tropicale, Faculté de Médecine, 3 rue Koeberlé, 67000 Strasbourg, France.)

An intracellular procaryote was observed in epidermal and fat cells of *Culicoides,* probably *C. clastrieri* Callot, Kremer and Deduit or *C. odibilis* 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 130–140 nm in thickness, limited by a pentalaminar 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 chironomi)* 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. Pucat, Agriculture Canada, Communications Branch, Sir John Carling Bldg., Ottawa K1A 0C7, Canada.

During the course of studies of the bionomics of Ceratopogonidae at Lac Serpent near Notre Dame du Laus, Quebec, Canada, large numbers of *Culicoides sanguisuga* (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. sanguisuga,* 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. sanguisuga* 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 Laus, Quebec, Canada, the following species were collected from 2 types of emergence traps and reared from substrate brought into the laboratory: *Alluaudomyia bella* (Coquillett), *A. megaparamera* Williams, *A. paraspina* Wirth, *Culicoides biguttatus* (Coquillett), and *C. crepuscularis* Malloch. Species of the following genera were also collected: *Atrichopogon, Bezzia, Ceratopogon, Forcipomyia, Mallochohelea* and *Stilobezzia*.

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. aliciae* (Johannsen)) 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 Koeberlé, Strasbourg 67000, France, and (**) Station de Recherches de Pathologie Comparée, Saint-Christol-Les-Àles 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. cubitalis* Edwards (0.8%), and *Bezzia pygmaea* Goetghebuer (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 130 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 Midges of the Genus *Forcipomyia* from Algeria. **Ryszard Szadziewski, 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* s.str. (9 species)- *bipunctata* (L.), *crassipes* (Winnertz) *nigra* (Winnertz), *regulus* (Winnertz), *rustica* Kieffer, *sahariensis* Kieffer, *suberis* Clastrier, *tenuisquama* Kieffer, sp. A; Subgenus *Microhelea* (1) - *fuliginosa* (Meigen); Subgenus *Euprojoannisia* (5) - *alacris* (Winnertz), *mesasiatica* Remm, *phlebotomoides* Bangerter, *psilonota* Kieffer, sp. B; Subgenus *Thryridomyia* (5) - *biskraensis* Kieffer, *frutetorum* (Winnertz), *litoraurea* (Ingram and Macfie), *monilicornis* (Coquillett), *rugosa* Saunders; Subgenus *Synthryidomyia* (2) - *murina* (Winnertz), sp. C; Subgenus *Lasiohelea* (1) - *velox* (Winnertz); Subgenus *Lepidohelea* (1) - *formosae* (Kieffer); Subgenus *Panhelea (1)* - *pontica* Remm.

Three species (A,B,C) belonging to the subgenera *Forcipomyia, Euprojoannisia,* and *Synthyridomyia* are hitherto unknown to science. Sixteen new synonyms are here proposed: *acidicola* Tokunaga (syn.: *colemani* Wirth); *biskraensis* Kieffer (syns.: *sergenti* Clastrier, *imeretica* Remm); *for-*

mosae Kieffer (syn.: *lepidota* Ingram and Macfie); *frutetorum* (Winnertz) (syn.: *seneveti* Kieffer); *knockensis* Goetghebuer (syn.: *bequaerti* Goetghebuer); *litoraurea* (Ingram and Macfie) (syn.: *minutissima* Remm); *murina* (Winnertz) (syns.: *sulfurea* Kieffer, *hirtipalpis* Kieffer, *sate* Kieffer); *psilonota* Kieffer (syn.: *hathor* Kieffer); *regulus* (Winnertz) (syn.: *striaticornis* Kieffer nec Dessart); *rustica* Kieffer (syn.: *cataneii* Kieffer); *sahariensis* Kieffer (syns.: *armaticrus* Kieffer, *onusta* Remm); *suberis* Clastrier (syn.: *flavirustica* 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 the *Forcipomyia* 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. *Forcipomyia*, unlike any other genus of Ceratopogonidae, has a large number of widespread species, i.e. cosmopolitan, Holarctic-Afrotropical, Holarctic-Afrotropical-Oriental, Afrotropical-west Palaearctic.

Biting Midges of the Genus *Culicoides* from Algeria; Preliminary note. **Ryszard Szadziewski. Department of Invertebrate Zoology, University of Gdansk, Czolgistow 46, 81–378, Gdynia, Poland.**

During April and May 1981 the author collected more than 140 species of Ceratopogonidae in northern Algeria. Thirty species of the genus *Culicoides* were recorded: Subgenus *Pontoculicoides* (2 species) - *saevus* Kieffer, *sejfadinei* Dzhafarov; Subgenus *Avaritia* (3) - *imicola* Kieffer, *obsoletus* (Meigen), *scoticus* Downes & Kettle; Subgenus *Culicoides (3)* - *newsteadi* Austen, *pulicaris* (L.), *punctatus* (Meigen); Subgenus *Remmia* (1) - *subfasciipennis* Kieffer; Subgenus *Oecacta* (16) - *azerbajdzhanicus* Dzhafarov, *cataneii* Clastrier, *citrinellus* Kieffer, *dzhafarovi* Remm, *heteroclitus* Kremer & Callot, *jumineri* Callot and Kremer, *kibunensis* Tokunaga, *lailae* Khalaf, *langeroni* Kieffer, *marcleti* Callot, Kremer & Bassett, *maritimus* Kieffer, *pictipennis* (Staeger), *poperinghensis* Goetghebuer, *pseudopallidus* Khalaf, *saevanicus* Dzafarov, *sahariensis* Kieffer, *santonicus* Callot, Kremer, Rault and Bach; Subgenus *Beltranmyia* (2) - *circumscriptus* Kieffer, sp. aff. *homochrous* Remm; Subgenus *Monoculicoides (1)* - *puncticollis* (Becker).

Ten new synonyms are proposed. They are : *Culicoides saevus* Kieffer (syn.: *micromaculithorax* Khalaf); *kingi* Austen (syn.: *nilotes* Kieffer); *citrinellus* Kieffer (syn.: *mosulensis* Khalaf); *pseudopallidus* Khalaf (syn.: *zhogolevi* Remm); *sahariensis* Kieffer (syns.: *baghdadensis* Khalaf, *flavisimilis* Dzhafarov); *leucostictus* Kieffer (syn.: *pharao* Kieffer), and *puncticollis* (Becker) (syns.: *distigma* Kieffer, *griseovittatus* Vimmer, *luteosignatus* Vimmer).

Twenty species are recorded for the first time from Algeria, and amongst them one, *C. poperinghensis*, 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-Euroasian (4), Afrotropical (3). Four species (*foleyi* Kieffer, *nudipennis* Kieffer, *sergenti* Kieffer, sp. aff. *homochrous*) are known only from Algeria. The name "*C. numidicus*" used by Mayer (1955) is a nomen nudum.

Turf-Moss *Culicoides* in the Hautes-Vosges (France). **J. Waller, M. Kremer and J. C. Delecolle. Institut de Parasitologie de la Faculté de Médecine de Strasbourg, 3 rue Koeberlé, 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-Vosges. These turf-mosses are special biotopes: oligotrophic, acid (3.5<pH<4) and with low pO^2 and temperature. These parameters are stable all year round. The following species were collected in 1981: *Culicoides cubitalis* Edwards, *fascipennis* (Staeger), *grisescens* Edwards, *impunctatus* Goetghebuer, *obsoletus* (Meigen), *punctatus* (Meigen), *reconditus* Campbell and Pelham-Clinton, *stigma* (Meigen), *truncorum* Edwards. The following was found in cow-dung: *chiopterus* (Meigen).

Kettle in Scotland and Callot and Kremer in France and in Switzerland found in the same biotopes: *achrayi* Kettle and Lawson, *albicans* (Winnertz), *carjalaensis* Glukhova, *cubitalis* Edwards, *fascipennis* (Staeger), *grisescens* Edwards, *heliophilus* Edwards, *impunctatus* Goetghebuer, *odibilis* Austen, *pallidicornis* Kieffer, *pseudoheliophilus* Callot and Kremer, *pulicaris* (L.), *pumilus* (Winnertz), *punctatus* (Meigen), *reconditus* Campbell and Pelham Clinton, *segnis* Campbell and Pelham Clinton, *sphagnumensis* Williams, *stigma* (Meigen), *subfascipennis* Kieffer, and *truncorum* Edwards. In cow-dung: *Culicoides chiopterus* (Meigen), *dewulfi* Goetghebuer, and *scoticus* Downes and Kettle.

Culicoides albicans, carjalaensis, fascipennis, grisescens, heliophilus, impunctatus, and *sphagnumensis* 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*[1]

P. T. McDONALD[2] AND S. M. ASMAN[2, 3]

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 (sterile 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*

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