The family Cixiidae SPINOLA 1839 (Hemiptera: Fulgoromorpha) - a Review

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Abstract

We present a short survey of the present knowledge of the family Cixiidae. A generic checklist, including data on their distribution in main zoogeographical regions and (estimated) species numbers is presented. The morphology of the inner female genitalia, of the wax pore plates and of some enigmatic sensory organs are poorly known today. We give a short description of their general structure and their variability within the family, as far as it is known. In addition, data on cixiid ecology and on their economic importance are summarized and hints on recent keys for the identification of cixiids are provided.

Key words: Cixiidae, female genitalia, wax pore plates, identification, ecology, economic importance

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Introduction

The first Cixiidae species described validly was *Cicada nervosa* (today *Cixius nervosus*), a common European species: It was reported by Carl von LINNE in his 10th edition of the famous book „Systema Naturae" (LINNAEUS 1758). About 30 other cixiids were described mainly by Johann Christian FABRICIUS and Ernst Friedrich GERMAR in the genera *Cicada*, *Flata*, *Fulgora* and *Issus*, until Pierre Andre LATREILLE described the genus *Cixius* in 1804 (LATREILLE 1804), and until the family itself was recognized by Massimiliano SPINOLA in 1839 (SPINOLA 1839).

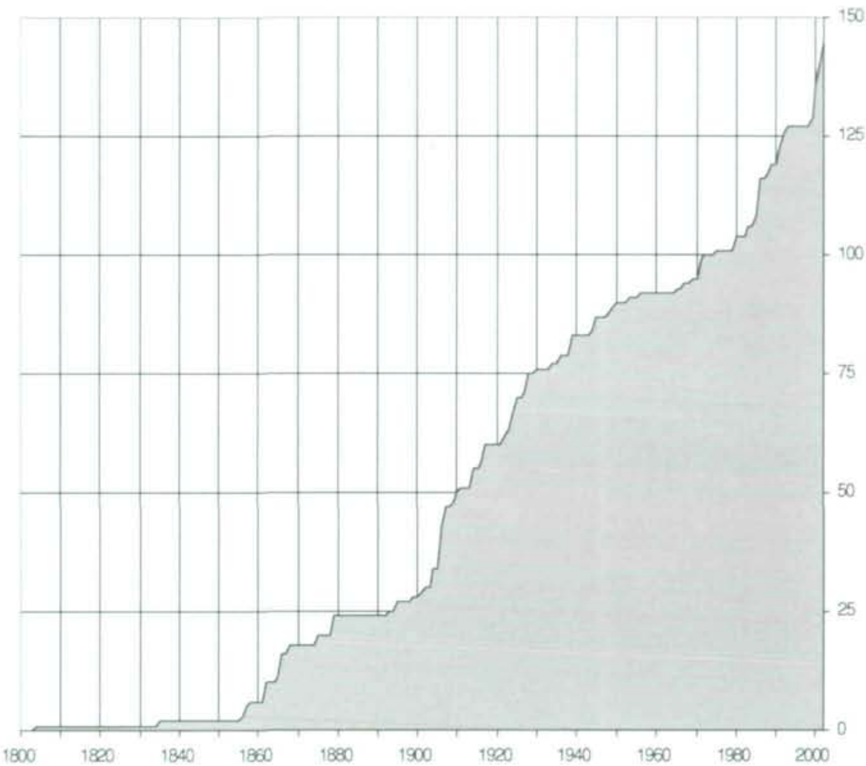


Fig. 1:
Increasing knowledge on biodiversity in cixiids, represented by the number of described genera of Cixiidae between 1800 and today.

During the next 100 years, Frederick MUIR, William L. DISTANT, George W. KIRKALDY, Shonen MATSUMURA and Francis WALKER were important pioneers investigating the species diversity of the cixiids (and other planthoppers and leafhoppers) of the world. In addition, many species and genera were also described by E.D. BALL, F.X. FIEBER, W.W. FOWLER, W.F. GIFFARD, G. HORVATH, A. JACOBI, C.L. KIRSCHBAUM, L. MELICHAR, J.G. MYERS, V. SIGNORET, C. STÅL, P.R. UHLER and others.

The Cixiidae volume of the „General Catalogue of the Hemiptera" was one of the first volumes of the series, published in 1936. At that time, 84 genera and 786 species were known (METCALF 1936). Beside this catalogue, Zeno Payne METCALF also described several Cixiid taxa by himself and published an important classification of the family in his contribution on the „Fulgorina of Barro Colorado and other parts of Panama" (METCALF 1938).

Since then, many authors have increased our knowledge of cixiids very much. From a taxonomic point of view, we have to mention - at least - Ronald G. FENNAH, Rauno E. LINNAVUORI, Jan VAN STALLE, Alexandr F. EMELJANOV and Hannelore HOCH working in world-wide aspect; W.E. CHINA, Jiri DLABOLA, Viktor N. KUSNEZOV, Valentina M. LOGVINENKO, Ivan D. MITJAEV, Reinhard REMANE and Wilhelm WAGNER concerning the Palaearctic, James P. KRAMER and John S. CALDWELL concerning the Americas, Henri SYNAVE concerning Africa, J.R. WILLIAMS concerning the Mascarenes, Shun-Chern TSAUR and Tung-Ching HSU concerning Taiwan, and Marie-Claude LARIVIÈRE and Murray J. FLETCHER concerning Australia and New Zealand.

Today, about 146 genera comprising almost 2000 species are described from all over the world (fig. 1 and table 1); in addition, the same number of species may actually be undescribed yet. Thus, cixiids are one of the largest families in Fulgoromorpha.

Morphology

General descriptions of cixiids are available in several publications (including O'BRIEN 2002, in this volume). Nevertheless it is hard to summarize at least „common diagnostic" characters, as cixiids have a great diversity in several morphological characters. Many of these characters are already described in the paper of EMELJANOV (2002; in this volume) and included in the cladogram (e. g. head structures, wing venation, leg spinulation, wax-pore plates in nymphs). Beyond these, other structures also worth mentioning will be described below.

Female genitalia

The wide range of variability in the male genitalia is very well known. In contrast to those, only very few studies on the female genitalia have been carried out yet. With the exception of the shape of the ovipositor (e. g. figs. 2.A-C,6.A, 6.B, 7.A, 7.B), characters of the female genitalia were rarely included in morphological and phylogenetic studies; thus, in many taxa, the identification of females is hardly possible.

The inner ectodermal structures of female cixiids have been described by IVANOV (1928) for the first time. Later, REMANE & ASCHE (1979) studied their appearance and variability in species of the genus *Cixius* from the Azorean Islands, and BOURGOIN (1993) gave a detailed description of the female genitalia in *Cixius nervosus* L. The female genitalia of *Hyalesthes* are figured and described by HOCH & REMANE (1985) and SFORZA & BOURGOIN (1998).

A comparatively plesiomorphic configuration in cixiids is shown in fig. 2.A: A medium-sized ovipositor slightly curved upwards, consisting of (in the terminology of BOURGOIN & HUANG 1991 and BOURGOIN 1993) paired gonoplacs, gonocoxae VIII and IX, and gonapophyses VIII and IX. The ectodermal genital duct opens between gonapophysis VIII and XI into the so-called vestibulum. Dorsally the vestibulum is closed by the basal apodeme of the gonapophysis IX and ventrally by the dorsal wall of the pregenital fold. The latter bears ventrally the sternite VII and dorsally a (reduced) sternite VIII.

Inwards, the vestibulum opens through the gonoporus into the posterior vagina. Sclerotized plates situated on the walls of the posterior vagina might be of high diagnostic value at the species level, as is exemplarily shown in Azorean *Cixius* species by REMANE & ASCHE (1979).

The anterior vagina bears two dorsal diverticula - the bursa copulatrix ductus leading into the bursa copulatrix, and the spermatheca. The latter might be divided into four parts: ductus receptaculi, diverticulum ductus, pars intermedialis and glandula apicalis (after BOURGOIN 1993; see fig. 2.A).

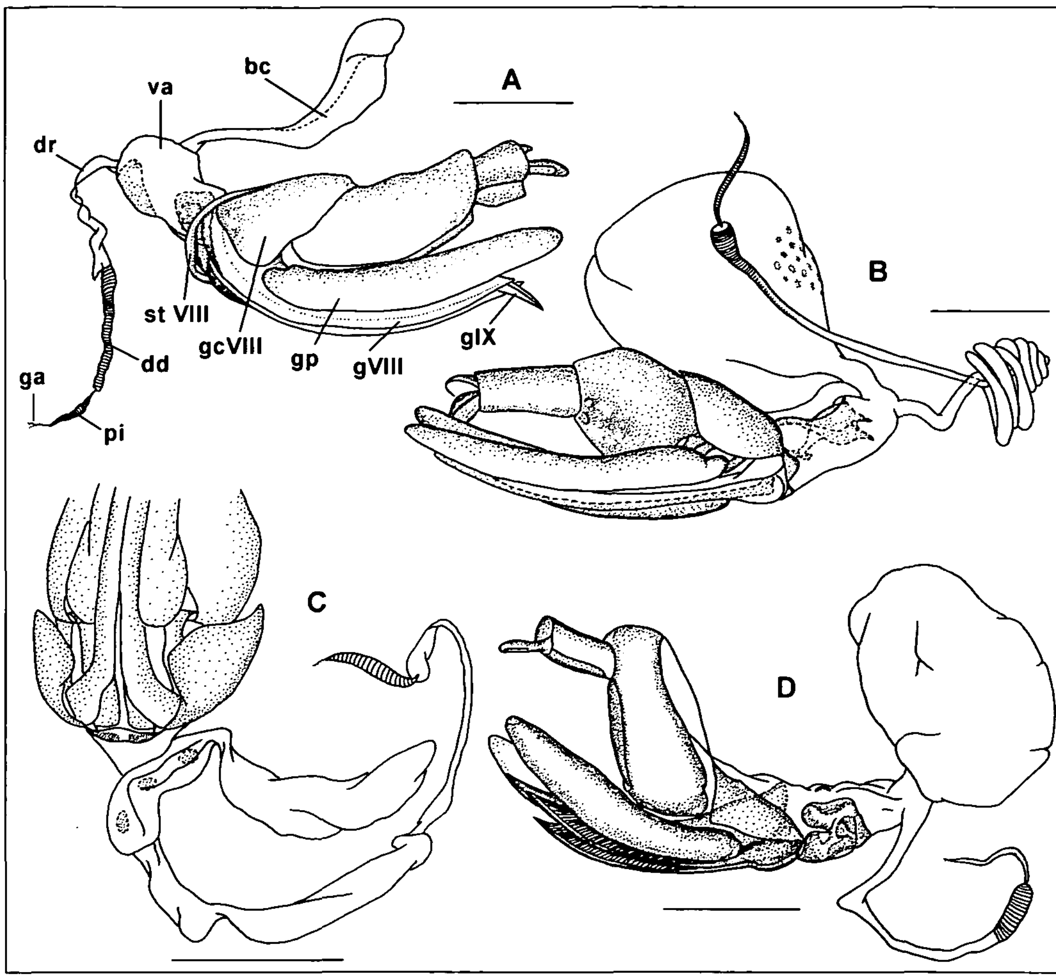


Fig. 2:
Female genitalia structures in Cixiidae, sternite VII omitted. Scale bar = 0.5 mm
A: *Dystheatias fuscata* KIRKALDY.
bc = bursa copulatrix, va = vagina, dr = ductus receptaculi, dd = diverticulum ductus, pi = pars intermedialis, ga = glandula apicalis, stVIII = sternite VIII, gc = gonocoxa VIII, gp = gonoplac, gVIII = gonapophysis VIII, gIX = gonapophysis IX.
B: *Pintalia erecta* METCALF (see also fig. 3.A).
C: *Bothrioceretta nigra* Fowler (see also fig. 3.B).
D: *Euryphlepsia cocos* MUIR.

Several modifications are notable in different Cixiid taxa: Reductions and enlargements within the ovipositor complex are well known (e. g. EMELJANOV 1971, 1995, HOCH & REMANE 1985; see figs. 3.C, 3.E, 7.A, 7.B). In addition, also the inner genitalia structures show a wide range of morphological diversity. The ductus receptaculi of *Cixius*, *Tachycixius* and related taxa is twirled like a helix (BOURGOIN 1993, HOLZINGER 2002 in press, IVANOV 1928, REMANE & ASCHE 1979; see figs. 4 and 5). Instead of this helix, the medial part of the ductus receptaculi is expanded to a large bubble in two *Cixus* species of the subgenus *Scioci-*

xius, *C. stigmaticus* (GERMAR) and *C. similis* KIRSCHBAUM (fig. 3.D). In these taxa, the size of the bursa copulatrix is distinctively smaller than in investigated taxa with a helix-like ductus.

A similar situation - increase of the volume of the ductus receptaculi and a reduction of the size of the bursa copulatrix - is observed in *Bothrioceretta* (fig. 2.C), *Notocixius* and *Cubana*. In all species of Pentastirini examined, a comparatively simple (plesiomorphic?) configuration of the inner female genitalia is present, although the outer parts of the female genitalia (ovipositor, see above, and wax plate, see below) are highly apomorphic.

A comprehensive study of these structures in different Cixiid genera and an attempt of a phylogenetic interpretation is in preparation (KAMMERLANDER & HOLZINGER, in prep.).

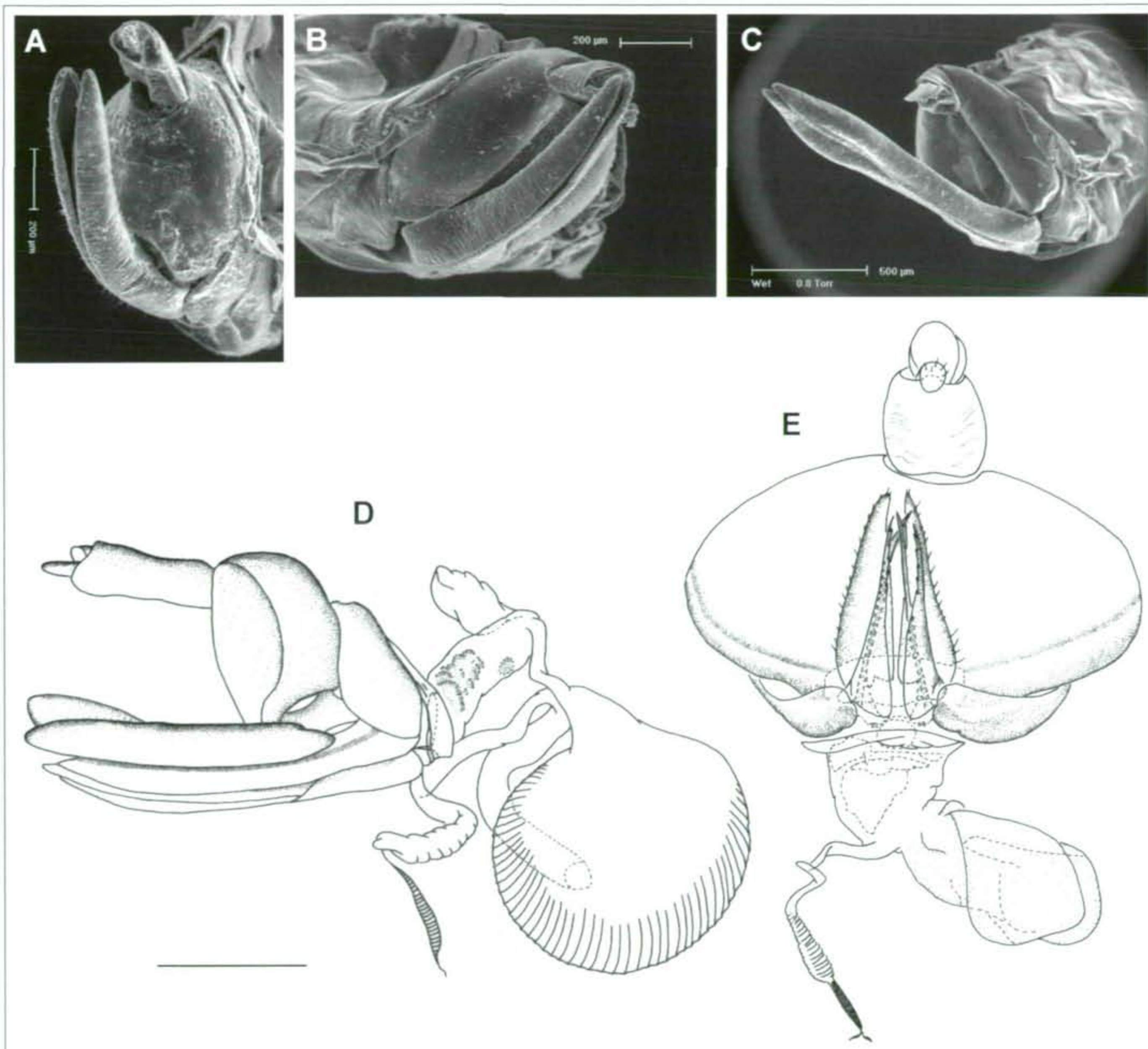


Fig 3:
Female genitalia in Cixiidae. Scale bar = 0.5 mm
A: Abdomen of *Pintalia erecta* METCALF, laterocaudal view (see also fig. 2.B; SEM-Photo: E. STABENTHEINER).
B: Abdomen of *Bothrioceretta nigra* FOWLER, laterocaudal view (see also fig. 2.C; SEM-Photo: E. STABENTHEINER).
C: Abdomen of *Muirolonia metallicus* FOWLER, laterocaudal view (SEM-Photo: E. STABENTHEINER).
D: Female genitalia structures in *Cixius stigmaticus* GERMAR, sternite VII omitted.
E: Female genitalia structures in *Reptalus panzeri* LOEW (see also fig. 7.A) , sternite VII omitted.

Fig. 4:
Female genitalia in *Tachycixius pilosus* OLIVIER, prepared as described in BOURGOIN (1993) and stained with „Chlorazol black E" (Photo: I. KAMMERLANDER).

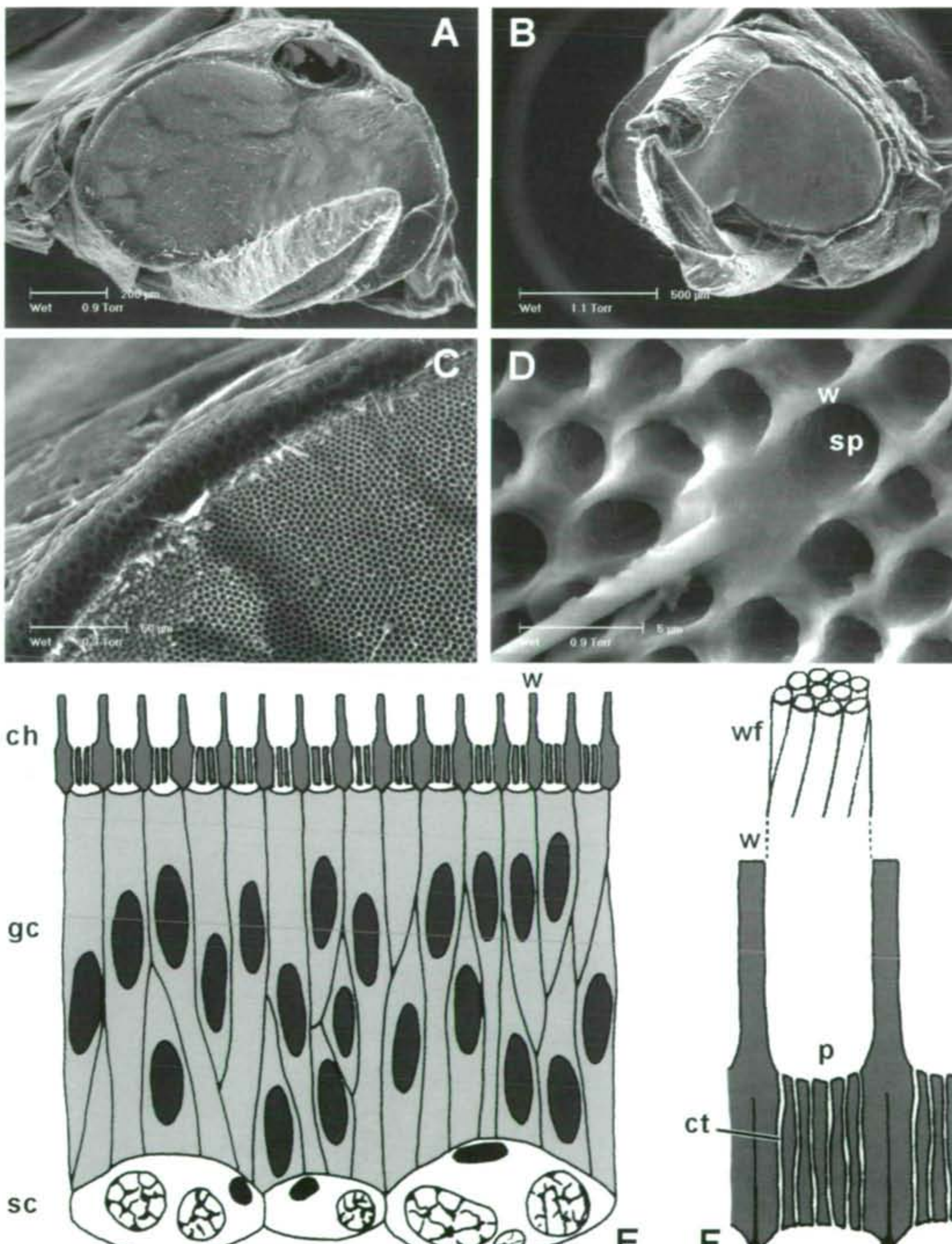
Fig. 5:
The helix-twirled part of the ductus receptaculi in *Tachycixius pilosus* OLIVIER, has 8 outer windings. (Photo: I. KAMMERLANDER).

Wax pore plates

Pores of wax glands can be found on different parts of the body in larval and adult cixiids, as in other Fulgoromorpha families. These structures are scarcely studied; the only papers dealing extensively with wax pores in cixiids are published by ŠULC (1928, 1929). He described the morphology and histology of these glands and pores in detail in three species, *Pentastiridius leporinus* L. (adult), *Reptalus panzeri* LOEW (nymph) and *Cixius nervosus* L. (adult and nymph). Additional information on nymphal wax pores in *Haplaxius crudus* (VAN DUZEE) is provided by POPE (1985).

The most striking wax pores in cixiids are those arranged in wax plates on the tergites VI, VII and VIII in nymphs and on - as far as we know - tergite IX in adults.

Fig. 6:
Wax plates on tergite IX in adult females of the genus *Cixius*: The wax plate is covered with „sieve-plate" wax pores („sp"). These pores a formed by subsided plates („p") pierced by several capillary tubes („ct") and enclosed by chitinous side walls („w"). Below the chitinous plate („cp"), a layer of glandular cells („gc") and a layer of „subglandular" cells („sc") are present. The wax thread („wf") produced by this pore consists of several smaller filaments wound like a rope (ŠULC 1929).
A: *Cixius similis* KIRSCHBAUM, abdomen from behind (SEM-Photo: E. STABENTHEINER).
B: *Cixius ladon* FENNAH, abdomen from behind (SEM-Photo: E. STABENTHEINER).
C: *Cixius similis* KIRSCHBAUM, marginal area of the wax plate (SEM-Photo: E. STABENTHEINER).
D: *Cixius nervosus* L., wax pores in higher magnification (SEM-Photo: E. STABENTHEINER).
E: Cross section of a wax plate of *Cixius nervosus* L.; after ŠULC (1929), modified.
F: Cross section of a the chitinous surface of the wax plate of *Cixius nervosus* L.; redrawn after ŠULC (1929), modified.



In adults of *Cixius* and several other Cixidae genera, the wax plate is a more or less large, homogenous area, covered with uniform „sieve-plate" wax pores and dispersed hairs (figs. 6.A, 6.B). In higher magnification, the wax pores are clearly visible in the SEM (figs. 6.C, 6.D). Each of the wax threads produced by one of these pores consists of several smaller filaments wound like a rope (fig. 6.F). An excellent description of the histological structure of these wax pores and wax glands is provided by ŠULC (1929; see figs. 6.E, 6.F): Chitinous side walls enclose a subsided plate pierced by several capillary tubes. Inside (proximally) of this chitinous plate, a layer of glandular cells is present. Every wax pore is maintained by one cell of this layer. Those glandular cells are situated on another unicellular layer of „subglandular" cells (ŠULC 1929).

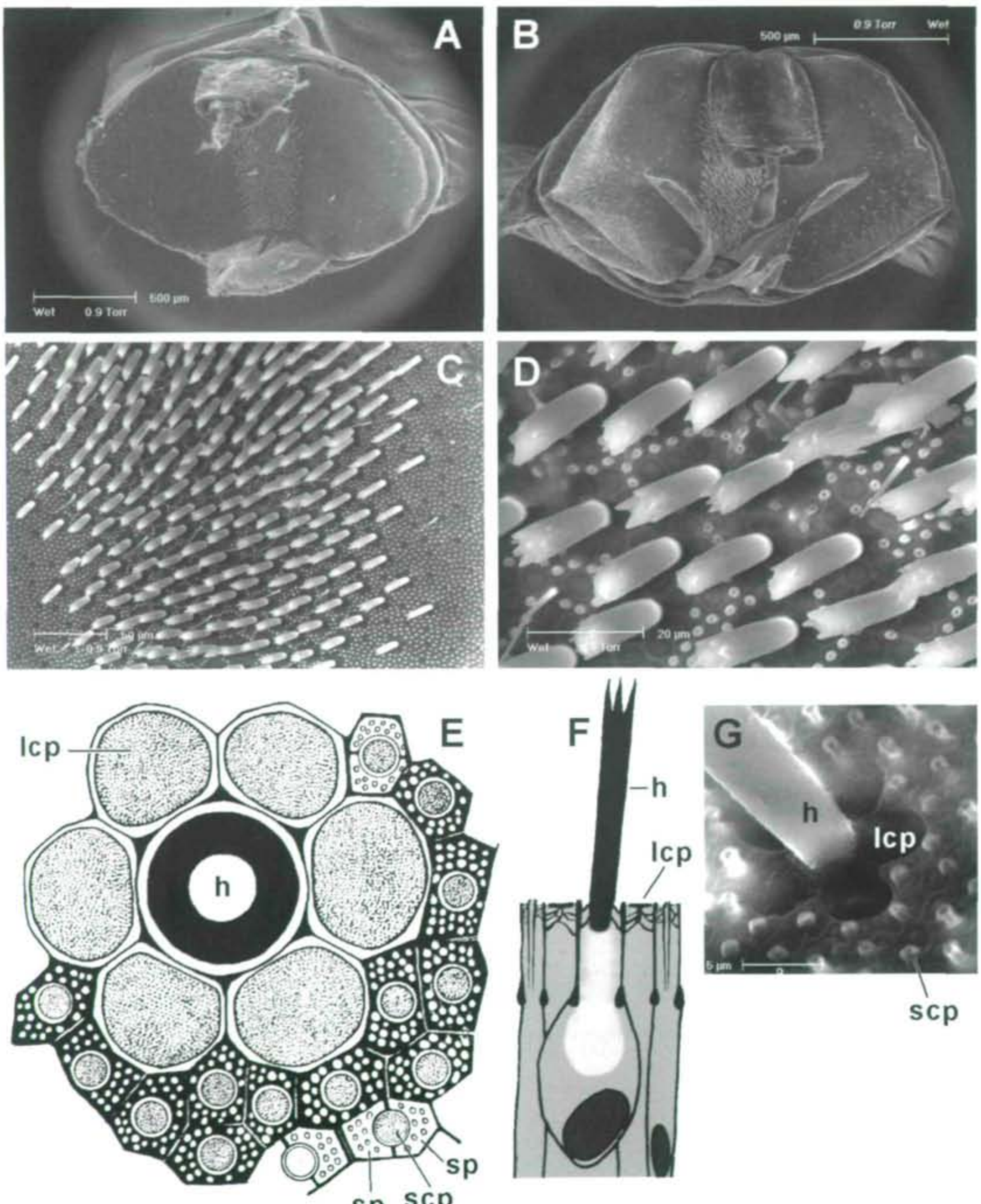


Fig. 7:
Wax plates on tergite IX in adult females of the genera *Reptalus* and *Afroreptalus* (Pentastirini): The wax plate is divided into a central „hairy" and a lateral „smooth" part (A, B). In the central part, multi-pointed hairs („h") are surrounded by „large circular-cleft wax pores" („lcp"). Around these, groups of three wax pores can be recognized, each consisting of two „sieve-plate" wax pores („sp") and one „small circular-cleft wax pore" (scp") emerging in the wall separating the two sieve-plate pores.
A: *Reptalus panzeri* LOEW, abdomen from behind (SEM-Photo: E. STABENTHEINER).
B: *Afroreptalus rustenburgi* SYNAVE, abdomen from behind (SEM-Photo: E. STABENTHEINER).
C, D: *Reptalus panzeri* LOEW, central part of the wax plate with large, multi-pointed hairs in two different magnifications SEM-Photo: E. STABENTHEINER).
E: Central area of the wax plate of *Reptalus cuspidatus* FIEBER, top view. From ŠULC (1929).
F: Central area of the wax plate of *Reptalus cuspidatus* FIEBER, cross section of cell bearing a multi-pointed hair, and its adjacenting cells. Redrawn after ŠULC (1929), modified.
G: *Afroreptalus rustenburgi* SYNAVE, detail within the central part of the wax plate: A large hair, surrunded by „large circular-cleft wax pores" (SEM-Photo: E. STABENTHEINER).

Wax plates on tergite IX in adult females of the genera *Pentastiridius*, *Reptalus* and *Afroreptalus* (Pentastirini) are distinctively different from those in *Cixius*: Two areas are distinguishable: A central „hairy" and lateral „smooth" part (figs. 7.A, 7.B) (ŠULC 1929).

In the central part, large, black, multipointed hairs are surrounded by usually five or six „large circular-cleft wax pores" (Fig. 7.C - G). In these wax pores, a large disc is situated in the middle of the pore, fixed by chitinous clasps to the side walls. The wax is produced by a large wax cell below this pore and pressed through the small circular clasp, thus forming a hollow cylinder.

In addition, complexes of three wax pores deriving from one wax producing cell can be recognized around the large circular-cleft wax pores: Each complex consists of two sieve-plate wax pores („sp"), morphologically - according to ŠULC (1929) - similar to those described above, and of a „small circular-cleft wax pore" emerging in the wall separating the two sieve-plate pores and rising distinctly above the level of the latter.

In the lateral parts of the wax plate, similar but slightly smaller wax pores are present (fig. 8.A - D). Instead of large circular-cleft wax pores, medium-sized pores can be found. Pore complexes built of two sieve-plate pores and one small circular-cleft wax pore are pre-

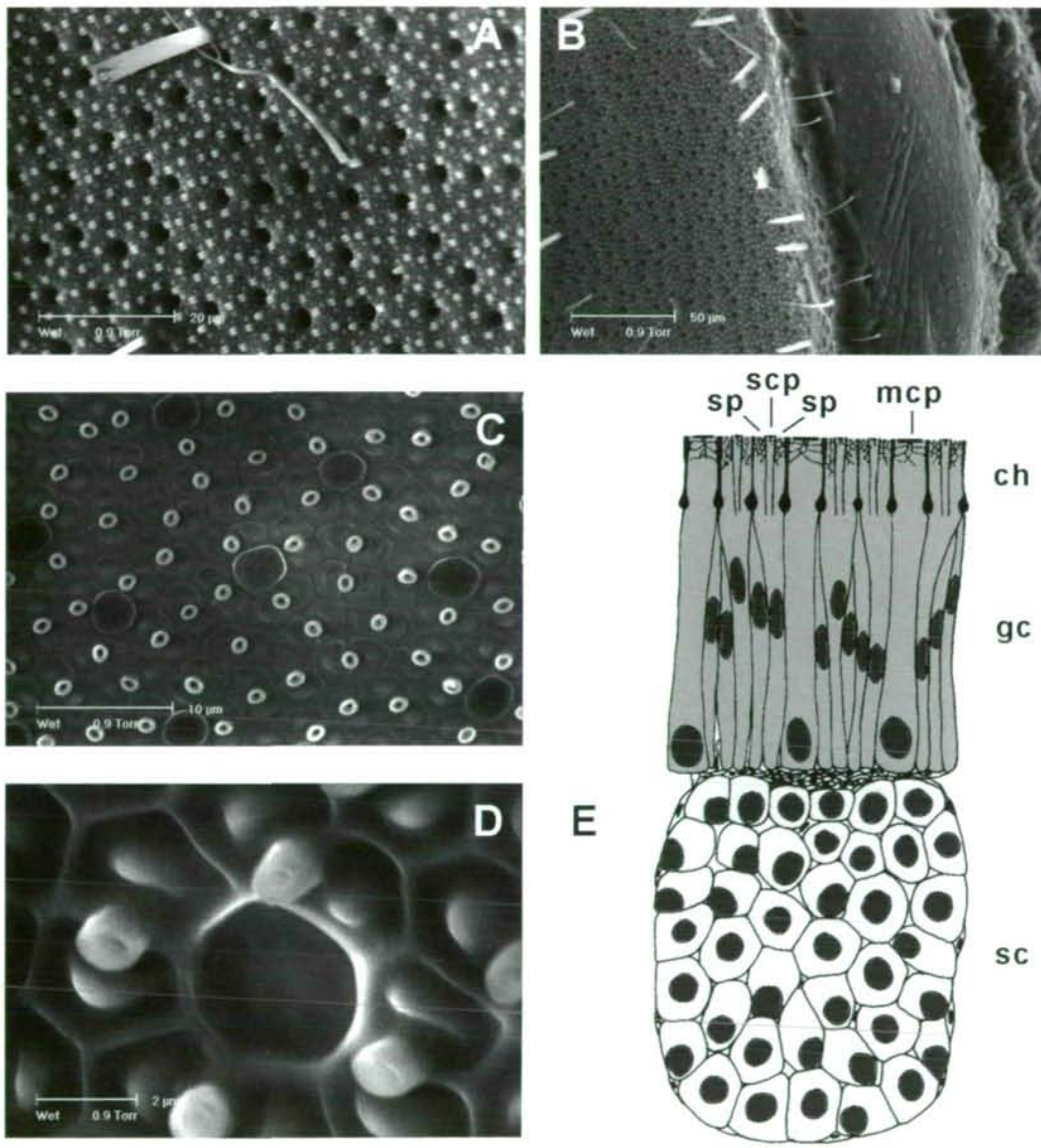


Fig. 8:
In the lateral parts of the wax plate in female *Reptalus panzeri* LOEW, „medium-sized circular-cleft wax pores" („mcp"), and complexes of two sieve-plate pores („sp") and one central „small circular-cleft wax pore" (scp") are present.
A: *Reptalus panzeri* LOEW, lateral part of the wax plate, lateral view
(SEM-Photo: E. STABENTHEINER).
B: *Reptalus panzeri* LOEW, lateral border of the wax plate
(SEM-Photo: E. STABENTHEINER).
C: *Reptalus panzeri* LOEW, lateral part of the wax plate, frontal view
(SEM-Photo: E. STABENTHEINER).
D: *Reptalus panzeri* LOEW: A „medium-sized circular-cleft wax pore" surrounded by complex wax cells bearing two „sieve-plate" pores and a central „small circular-cleft wax pore"
(SEM-Photo: E. STABENTHEINER).
E: Cross section of a wax plate of *Reptalus cuspidatus* FIEBER: Three different pore types - medium-sized circular-cleft wax pores (mcp), sieve-plate pores (sp) and small circular-cleft wax pores are distinguishable in the chitinous surface layer (ch). Proximally, a layer of glandular cells („gc") and clusters of „subglandular" cells („sc") are present. Redrawn after ŠULC (1929).

sent, too, but again slightly smaller. In addition to wax pores, some hairs are recognizable. At the border of the wax plate, simple wax pores of the sieve-plate type can be found.

The cell layers below these wax plates are also described by ŠULC (1929) (Fig. 8.E): A layer of glandular cells is maintaining the pores, one cell per large or medium-sized circular-cleft wax pores, and one per complex pore as described above. Below these glandular cells, subglandular cells („sc") are present. In contrast to *Cixius*, they are aggregated to clusters and fixed and surrounded by connective tissue cells.

In Cixiid nymphs, the wax pores on the wax plates of the tergites VI - VIII are distinctively different: POPE (1985) called them „flower-like wax moulding organs"; descripti-

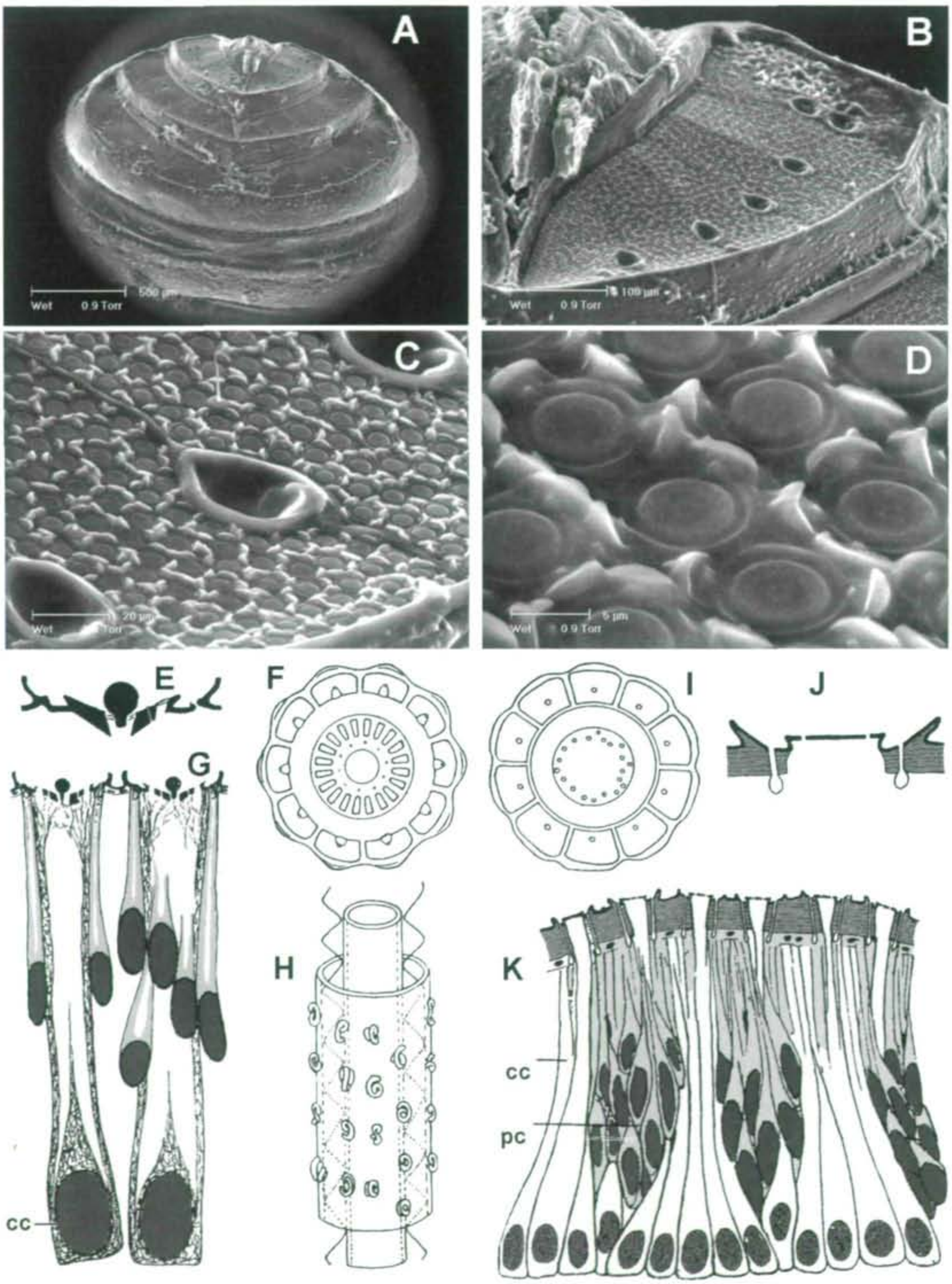


Fig. 9:
Wax glands on tergites VI - VIII in Cixiidae nymphs.
A: Wax plates on tergites VI - VIII of a Pentastirini nymph, overview
(SEM-Photo: E. STABENTHEINER).
B: Wax plate on tergite VIII of a Pentastirini nymph, overview: The plate is divided in six fields by small keels posessing one or two sensory pits
(SEM-Photo: E. STABENTHEINER).
C: Pentastirini nymph, detail of a wax plate in higher magnification
(SEM-Photo: E. STABENTHEINER).
D: Pentastirini nymph, „flower-like" wax moulding organs
(SEM-Photo: E. STABENTHEINER).
E: Surface of a „flower-like" wax moulding organ of *Reptalus panzeri* LOEW, cross section. From ŠULC (1928).
F: same as E, top view. From ŠULC (1928).
G: *Reptalus panzeri*, wax gland, cross section. From ŠULC (1928), modified. „cc" = central cell.
H: Wax thread produced by a „flower-like" wax moulding organ of *Reptalus panzeri* LOEW: From ŠULC (1928).
I: „Flower-like" wax moulding organ of *Cixius nervosus* L., top view. From ŠULC (1928).
J: Surface of a „flower-like" wax moulding organ of *Cixius nervosus* L., cross section. From ŠULC (1928).
K: *Cixius nervosus* L., wax gland, cross section. From ŠULC (1928), modified. „cc" = central cell, „pc" = peripheral cell".

ons are known of three species: *Cixius nervosus*, *Reptalus panzeri* and *Haplaxius crudus* (ŠULC 1928, POPE 1985).

In *Reptalus panzeri*, the flower-like structure visible from above consists of a funnel-shaped disc with one large pore in the center, 10 very small in an inner and 20 large and elongate pores in an outer circle. Above the central pore, an elongate chitinous „ball" is present. Outside of the disc, two elevated circular „walls" are adjacenting; the outer wall is mounding in 8 to 12 risen „petals", each with a small pore (Fig. 9.E and F).

The wax thread produced by this organ is figured in fig. 9.H. It consists of a central hollow cylinder, surrounded first by ten very fine, zigzag wound wax filaments (only two are drawn in fig. 9.H!) and second by a larger hollow cylinder produced by the mentioned large, elongate wax pores. On the surface of this outward cylinder, pretzel-shaped wax filaments produced by the petal pores are recognizable.

The cell complex maintaining the wax moulding organ is described again by ŠULC (1928): The glandular cells are formed by one large central cell („cc") and 8 to 12 surrounding smaller cells per wax moulding organ. As in wax plates of adults, subglandular cells aggregated to clusters are lying below these central cells.

The flower-like wax moulding organs of *Cixius* are simpler than in *Reptalus* (Fig. 9.I - K): Instead of a funnel-shaped disc, a flat disc without central pore and central ball is present. Laterally 20 pores are visible, and additional very small pores are supposed on the disc outside of these larger pores. The lateral parts of the organ is very similar to those in *Reptalus*.

The wax thread produced by this organ also consists of a central hollow cylinder. The surface of this cylinder is covered by many thin spiral wax filaments, and outside of this filament layer, very small hollow spiral wax pieces are arranged.

In *Cixius*, the cell complex is simpler: the glandular cells are similar, consisting of one large central cell („cc") and 8 to 12 surrounding smaller peripheral cells („pc") per wax moulding organ. According to ŠULC (1928), subglandular cells are missing.

The aims of these wax products in cixiids and other Fulgoromorpha are not sufficiently clarified yet, experimental studies are lacking completely (see also O'BRIEN 2002, in this volume). They may protect against wetting and desiccation, especially in nymphs. ŠULC (1928) describes, that nymphs of *Reptalus panzeri* covered the walls of their burrows with wax by „wagging" with the abdomen. In adults, the wax filaments are supposed to protect against getting smudged with own honeydew, and might cover eggs and protect them against desiccation. Also protection against enemies is assumed.

Enigmatic sensory organs

The sensory organ equipment of cixiids (and other Fulgoromorpha taxa) is impressive, but the morphology and function of these structures are still unclear in many cases. Perhaps the comparatively best investigated, but still insufficiently known, sensory organs are those of the antennae (see MARSHALL & LEWIS 1971, BOURGOIN & DEISS 1994, SHIH & YANG 1996).

Beyond the antennae, sensory organs can be found on different parts of the body (see larval descriptions in e. g. CUMBER 1952c, ŠULC 1928, WILSON & TSAI 1982, WILSON et al. 1983 and YANG & YEH 1994): Sensory pits with horizontal hairs (fig. 10.A - C) are the most numerous, present on tergal parts in nymphs in most families, and showing a wide range of morphological variation. A comprehensive description and discussion is given by EMELJANOV (2001). The function of these sensory pits is unclear; ŠULC (1928) considers them to obtain information about atmospheric humidity.

Studying nymphs of *Cixius nervosus*, ŠULC (1928) also found several very long, thin hairs on the lateral parts of the sternites V and VI (fig. 10.D). He called them „anemestheterias" and assumed a sensory function concerning air movements.

Very eyecatching processes are present in Bennini and Bennarellini (PENNY 1980, EMELJANOV 1989). In Bennini, obviously sensitive structures are present at the top of the long, rod-shaped process (fig. 10.E, 10.F). Again, the function of these structures remains completely unknown.

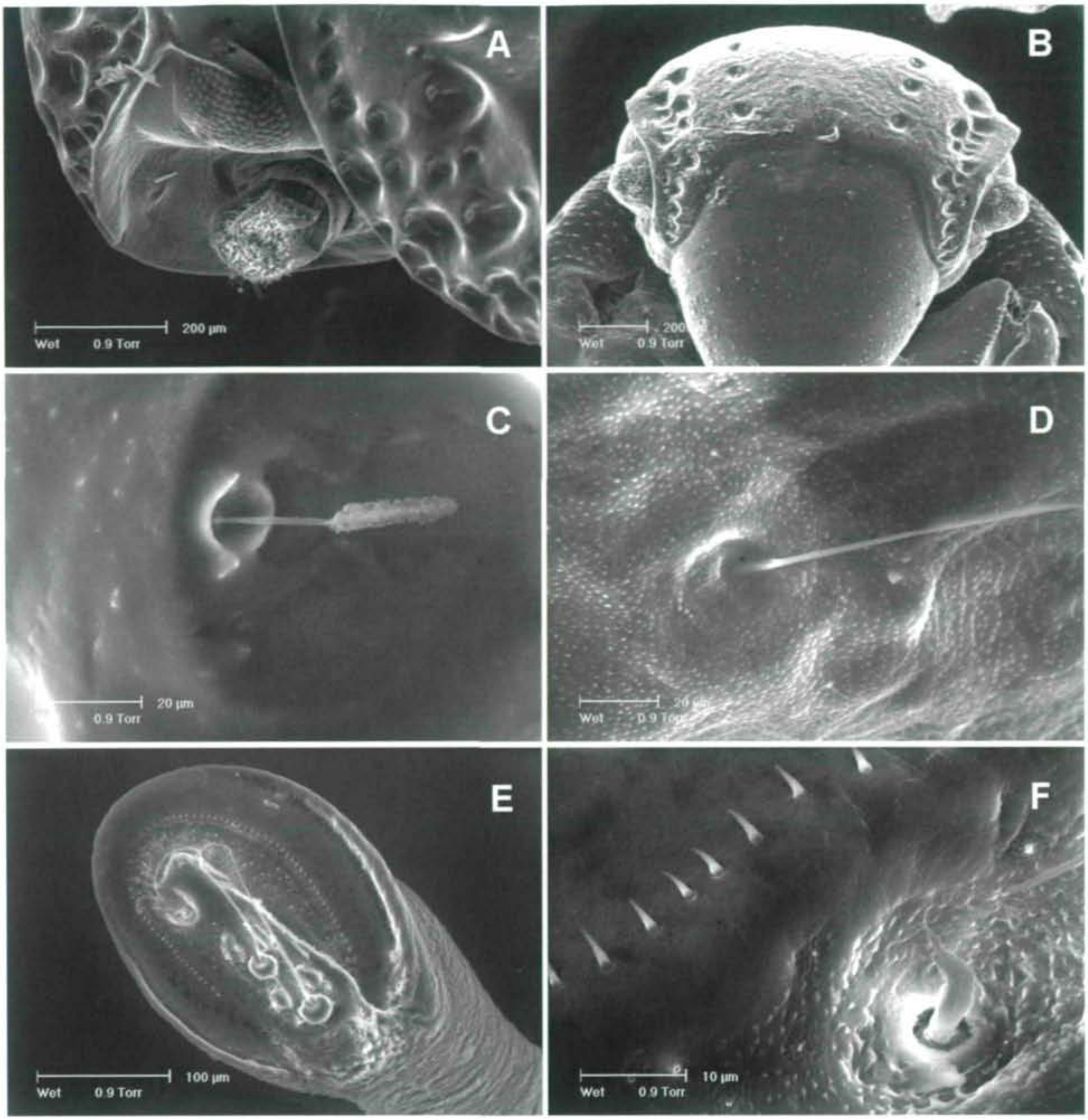


Fig. 10:
Enigmatic sensory organs in Cixiidae.
A: Head and pronotum of a Cixiini nymph in dorsolateral view. Sensory pits with horizontal hairs are accumulated laterally on head and pronotum.
B: Penstastirini nymph with sensory pits mainly on the lateral borders of the head.
C: Sensory pit in higher magnification.
D: Cixiini nymph. ŠULC (1928) called those very long, thin hairs situated in low numbers on the lateral parts of the sternites V and VI „anemestheteria".
E: Tip of the abdominal lateral projection of *Bennaria praestans* WALKER with sensory organ.
F: As fig. E, distal part in higher magnification

Phylogeny, Classification and Identification

Generic checklist

A possible evolutionary scenario of the family Cixiidae is described by EMELJANOV (2002) in this volume. Based on this paper, a classification of the Cixiidae genera known today is provided in table 1. A comprehensive world checklist is in preparation (EMELJANOV in prep.).

Table 1:
Cixiidae genera of the world: A preliminary checklist, with comments on distribution in zoogeographical regions and estimated species numbers. Taxa are arranged in alphabetical order within higher groups. Abbreviations: Pa = Palaearctic, Na = Nearctic, Et = Ethiopian, Or = Oriental, Au = Australian and Oceanic, Nt = Neotropical Region. spp = estimated number of hitherto described species. A comprehensive checklist of the family Cixiidae is in preparation (Emeljanov in prep).

Note: (1) Species occuring both in the Palaearcic Region and in Taiwan are signed as „Palaearctic", taiwanese endemics and species recorded from Taiwan and the Oriental Region are signed as „Oriental".
(2) At the present state of knowledge, it is unclear whether the genus *Bodecia* Walker 1870 (T. gen.: *B. varipes* Walker 1870) belongs to the family Cixiidae or to another Fulgoromorpha family.

	Pa	Na	Et	Or	Au	Nt	spp
1. Subfamily Borystheninae Emeljanov 1989							
Borysthenes Stål 1866 (T. gen.: *Cixius finitus* Walker 1857) Syn.: *Barma* Distant 1906 (T. gen.: *B. diversa* Distant 1906) Syn.: *Vademela* Melichar 1914 (T. gen.: *V. fusconotata* Melichar 1914)			+	+			>20
2. Subfamily Bothriocerinae Muir 1923							
Bothriocera Burmeister 1835 (T. gen.: *B. tinealis* Burmeister 1835) Syn.: *Adana* Stål 1856 (T. gen.: *A. westwoodi* Stål 1856)		+				+	~40
Bothrioceretta Caldwell 1950 (T. gen.: *Bothriocera nigra* Fowler 1904) Syn.: *Adanella* Fennah 1971 (T. gen.: *Bothriocera albidipennis* Fowler 1904)						+	4
3. Subfamily Cixiinae Spinola 1839							
1. Tribe Andini Emeljanov 2002							
Andes Stål 1866 (T. gen.: *A. undulatus* Stål 1870) Syn.: *Leirioessa* Kirkaldy 1907 (T. gen.: *L. tortriocomorpha* Kirkaldy 1907)	+		+	+	+		>100
Parandes Muir 1925 (T. gen.: *P. simplus* Muir 1925)				+			1
2. Tribe Bennarellini Emeljanov 1989							
Amazobenna Penny 1980 (T. gen.: *A. reticulata* Penny 1980)						+	1
Bennarella Muir 1930 (T. gen.: *B. bicoloripennis* Muir 1930)						+	2
3. Tribe Bennini Metcalf 1938							
Benna Walker 1857 (T. gen.: *B. capitulata* Walker 1857)				+			~10
Bennaria Melichar 1914 (T. gen.: *B. bimaculata* Melichar 1914)				+			~10
4. Tribe Brixidiini Emeljanov 2002							
Brixidia Haglund 1899 (T. gen.: *B. nebulosa* Haglund 1899)			+				11
5. Tribe Brixiini Emeljanov 2002							
Brixia Stål 1856 (T. gen.: *Derbe natalicola* Stål 1855) Syn.: *Triopsis* Signoret 1860 (T. gen.: *T. fasciata* Signoret 1860) Syn.: *Curiatius* Distant 1917 (T. gen.: *C. insignis* Distant 1917)			+	+			~120

	Pa	Na	Et	Or	Au	Nt	spp
Caffrocixius Fennah 1967 (T. gen.: *C. personatus* Fennah 1967)			+				6
Innobindus Jacobi 1928 (T. gen.: *I. multimaculatus* Jacobi 1928)					+		1
Ithma Fennah 1969 (T. gen.: *I. charondas* Fennah 1969)					+		3
Melandeva Distant 1906 (T. gen.: *M. ocellata* Distant 1906)				+			1
Solonaima Kirkaldy 1906 (T. gen.: *S. solonaima* Kirkaldy 1906) Syn.: *Talaloa* Distant 1907 (T. gen.: *T. pallescens* Distant 1907)					+		13
Typhlobrixia Synave 1953 (T. gen.: *T. namorokensis* Synave 1953)			+				1
Undarana Hoch & Howarth 1989 (T. gen.: *U. tamborina* Hoch & Howarth 1989)					+		6
6. Tribe Cajetini Emeljanov 2002							
Cajeta Stål 1866 (T. gen.: *C. singularia* Stål 1866) Syn.: *Bathymeria* Muir 1922 (T. gen.: *B. helmsi* Muir 1922)					+		1
7. Tribe Cixiini Spinola 1839							
Achaemenes Stål 1866 (T. gen.: *A. notatinervis* Stål 1866)			+				~40
Aka White 1879 (T. gen.: *Cixius finitimus* Walker 1858)					+		7
Anila Distant 1906 (T. gen.: *A. fuliginosa* Distant 1906)				+			2
Ankistrus Tsaur & Hsu 1991 (T. gen.: *A. montanus* Tsaur & Hsu 1991)				+			7
Apartus Holzinger 2002 (T. gen.: *Neocixius michalki* Wagner 1948)	+						2
Aselgeoides Distant 1917 (T. gen.: *A. insularis* Distant 1917)				+	+		4
Asotocixius Kramer 1983 (T. gen.: *A. diopter* Kramer 1983)		+					1
Calamister Kirkaldy 1906 (T. gen.: *C. obscurus* Kirkaldy 1906)					+		1
Cermada Emeljanov 2000 (T. gen.: *Cixius kermadecensis* Myers 1924)					+		9
Chathamaka Lariviere 1999 (T. gen.: *Ch. andrei* Lariviere 1999)					+		1
Chidaea Emeljanov 2000 (T. gen.: *Ch. dayi* Emeljanov 2000)					+		3
Cixiosoma Berg 1879 (T. gen.: *C. platense* Berg 1879)						+	3
Cixius Latreille 1804 (T. gen.: *Cicada nervosa* Linnaeus 1758) Sg. *Acanthocixus* Wagner 1939 (T. gen.: *C. carniolicus* Wagner 1939) Sg. *Alcixius* Emeljanov 1992 (T. gen.: *Cixius stigmaticalis* Melichar 1911)	+	+	+	+	+	+	>260

	Pa	Na	Et	Or	Au	Nt	spp
Sg. *Ceratocixius* Wagner 1939 (T. gen.: *Cicada cunicularius* Linnaeus 1767 Sg. *Issomimus* Jacobi 1910 (T. gen.: *I. meruanus* Jacobi 1910) Sg. *Olibroma* Emeljanov 1964 (T. gen.: *O. nitidum* Emeljanov 1964) Sg. *Orinocixius* Wagner 1939 (T. gen.: *Cixius heydeni* Kirschbaum 1868) Sg. *Paracixius* Wagner 1939 (T. gen.: *Cixius distinguendus* Kirschbaum 1868) Sg. *Pseudocixius* Caldwell 1950 (T. gen.: *P. bandarus* Caldwell 1950) Sg. *Sciocixius* Wagner 1939 (t. gen. *Flata stigmatica* Germar 1818) Sg. *Tetracixus* Ribaut 1960 (T. gen.: *Cixius lineolatus* Ribaut 1960) Sg. *Ussuricixius* Vilbaste 1968 (T. gen.: *Cixius remmi* Vilbaste 1968)							
Discophorellus Tsaur & Hsu 1991 (T. gen.: *D. major* Tsaur & Hsu 1991)				+			1
Flachaemus Van Stalle 1986 (T. gen.: *F. mosselensis* Van Stalle 1986)			+				8
Gonophallus Tsaur & Hsu 1991 (T. gen.: *G. trinus* Tsaur & Hsu 1991)				+			1
Iolania Kirkaldy 1902 (T. gen.: *I. perkinsi* Kirkaldy 1902)					+		7
Koroana Myers 1924 (T. gen.: *Cixius rufifrons* Walker 1858)					+		4
Leades Jacobi 1928 (T. gen.: *L. rufinus* Jacobi 1928)					+		1
Leptolamia Metcalf 1936; n. nov. pro *Leptochlamys* Kirkaldy 1907, n. praeocc. (T. gen.: *L. compressa* Kirkaldy 1907)					+		1
Macrocixius Matsumura 1914 (T. gen.: *M. giganteus* Matsumura 1914)	+			+			2
Malpha Myers 1924 (T. gen.: *M. muiri* Myers 1924)					+		2
Microledrida Fowler 1904 (T. gen.: *M. asperata* Fowler 1904)		+				+	6
Monomalpha Emeljanov 2000 (T. gen.: *M. gratiosa* Emeljanov 2000)					+		2
Nanocixius Wagner 1939 (T. gen.: *Cixius discrepans* Fieber 1876)	+						1
Neocixius Wagner 1939 (T. gen.: *Cixius limbatus* Signoret 1862)	+						1
Pachyntheisa Fowler 1904 (T. gen.: *P. concinna* Fowler 1904)						+	2
Platycixius Van Duzee 1914 (T. gen.: *P. calvus* Van Duzee 1914)		+					1
Sardocixius Holzinger 2002 (T. gen.: *Trirhacus formosissimus* Costa 1883)	+						1
Semicixius Tsaur & Hsu 1991 (T. gen.: *S. denticulus* Tsaur & Hsu 1991)				+			1
Simplicixius Holzinger 2002 (T. gen.: *Trirhacus trichophorus* Melichar 1914)	+						1
Sphaerocixius Wagner 1939 (T. gen.: *Cixius globuliferus* Wagner 1939)	+						1

	Pa	Na	Et	Or	Au	Nt	spp
Stegocixius Kramer 1983 (T. gen.: *S. loohites* Kramer 1983)		+					1
Tachycixius Wagner 1939 (T. gen.: *Fulgora pilosa* Olivier 1791) Syn: *Siculus* Dlabola 1981 syn. nov. (T. gen.: *S. osellai* Dlabola 1981)	+						25
Trirhacus Fieber 1875 (T. gen.: *T. setulosus* Fieber 1876)	+						4

8. Tribe Duiliini Emeljanov 2002

	Pa	Na	Et	Or	Au	Nt	spp
Duilius Stål 1858 (T. gen.: *D. tenuis* Stål 1858) Syn.: *Hemitropis* Fieber 1866 (T. gen.: *H. bipunctata* Fieber 1866) Syn.: *Haplacha* Lethierry 1874 (T. gen.: *H. seticulosa* Lethierry 1874) Syn.: *Duiliopsis* Bergevin 1933 (T. gen.: *D. balachowskyi* Bergevin 1933) Syn.: *Bitropis* Dlabola 1985 (T. gen.: *Hemitropis fasciata* Horváth 1894)	+		+				~25

9. Tribe Eucarpiini Emeljanov 2002

	Pa	Na	Et	Or	Au	Nt	spp
Adolendana Distant 1917 (T. gen.: *A. typica* Distant 1917)	+			+			2
Bajauana Distant 1907 (T. gen.: *Brixia rufula* Walker 1870) Syn.: *Australoma* Kirkaldy 1907 (T. gen.: *A. austrina* Kirkaldy 1907)					+		>50
Caneirona Distant 1916 (T. gen.: *C. maculipennis* Distant 1917)				+			1
Dilacreon Fennah 1980 (T. gen.: *Dystheatias orphus* Fennah 1956) Sg. *Eluzalmon* Fennah 1980 (T. gen.: *Dilacreon* (*E.*) *caudatus* Fennah 1980)					+		16
Dystheatias Kirkaldy 1907 (T. gen.: *D. beecheyi* Kirkaldy 1907) Syn.: *Quirosia* Kirkaldy 1907 (T. gen.: *Q. vitiensis* Kirkaldy 1907) Syn.: *Epaustraloma* Fennah 1950 (T. gen.: *E. simois* Fennah 1950)				+	+		~20
Eucarpia Walker 1857 (T. gen.: *E. univitta* Walker 1857) Syn.: *Ambalangoda* Distant 1912 (T. gen.: *A. insignis* Distant 1912) Syn.: *Ptoleria* Stål 1859 (T. gen.: *P. arcuigera* Stål 1859)			+		+		~15
Kirbyana Distant 1906 n. nov. pro *Kirbya* Melichar 1903, n. praeocc. (T. gen.: *K. pagana* Melichar 1903) Syn.: *Kirbyella* Kirkaldy 1906, n.nov. pro *Kirbya* Melichar 1903 Syn.: *Saccharias* Kirkaldy 1907 (T. gen.: *S. deventeri* Kirkaldy 1907) Syn.: *Commolenda* Distant 1911 (T. gen.: *C. deusta* Distant 1911)				+			5
Nesochlamys Kirkaldy 1907 n. nov. pro *Nesocharis* Kirkaldy 1907, n. praeocc. (T. gen.: *N. vitiensis* Kirkaldy 1907)					+		3
Nothocharis Muir 1925 (T. gen.: *N. bakeri* Muir 1925)				+			2
Phytocentor Fennah 1980 (T. gen.: *P. longicornis* Fennah 1980)					+		1

	Pa	Na	Et	Or	Au	Nt	spp
10. Tribe Gelastocephalini Emeljanov 2000							
Subtribe Gelastocephalina Emeljanov 2000							
Carolus Kirkaldy 1906 (T. gen.: *C. crispus* Kirkaldy 1906)					+		1
Gelastocephalus Kirkaldy 1906 (T. gen.: *G. ornithoides* Kirkaldy 1906)					+		1
Metaplacha Emeljanov 2000 (T. gen.: *M. tobiasi* Emeljanov 2000)					+		1
Ronaldia Emeljanov 2000 (T. gen.: *R. fennahi* Emeljanov 2000)					+		1
Tarberus Jacobi 1928 (T. gen.: *T. semicarinatus* Jacobi 1928)					+		2
Subtribe Rhigedanina Emeljanov 2000							
Dysoliarus Fennah 1949 (T. gen.: *D. unicornis* Fennah 1949)					+		1
Orphninus Emeljanov 2000 (T. gen.: *O. mouldsi* Emeljanov 2000)					+		1
Rhigedanus Emeljanov 2000 (T. gen.: *Rh. fomibundus* Emeljanov 2000)					+		2
11. Tribe Oecleini Muir 1922 (Syn.: Myndini Muir 1923)							
Achaebana Attié, Bourgoin & Bonfils 2002 (T. gen.: *Cubana insularis* Muir 1924)			+				1
Antillixius Myers 1928 (T. gen.: *A. greyi* Myers 1928)						+	1
Borbonomyndus Attié, Bourgoin & Bonfils 2002 (T. gen.: *B. pandanicola* Attié, Bourgoin & Bonfils 2002)			+				2
Colvanalia Muir 1925 (T. gen.: *Brixia concinnula* Walker 1870) Syn.: *Myndorus* Metcalf 1954 (t.gen.: *M. apicalis* Metcalf 1954)				+	+		48
Confuga Fennah 1975 (T. gen.: *C. persephone* Fennah 1975)					+		1
Eumyndus Synave 1956 (T. gen.: *E. madagascariensis* Synave 1956)			+				3
Haplaxius Fowler 1904 (T. gen.: *H. laevis* Fowler 1904) Syn.: *Paramyndus* Fennah 1945 (T. gen.: *P. cocois* Fennah 1945 (=*Myndus crudus* Van Duzee 1907))		+				+	~60
Mundopa Distant 1906 (T. gen.: *M. cingalensis* Distant 1906)				+			19
Myndodus Emeljanov 1992 (T. gen.: *Myndus velox* Emeljanov 1992)			+				23
Myndus Stål 1862 (T. gen.: *Flata musiva* Germar 1825) Syn.: *Entithena* Fieber 1866 (T. gen.: *Flata musiva* Germar 1825)	+						4
Nesomyndus Jacobi 1917 (T. gen.: *N. australis* Jacobi 1917)			+				1
Notolathrus de Remes Lenicov 1993 (T. gen.: *N. sensitivus* de Remes Lenicov 1993)						+	1

	Pa	Na	Et	Or	Au	Nt	spp
Nymphocixia Van Duzee 1923 (T. gen.: *N. unipunctata* Van Duzee 1923)		+				+	3
Oecleus Stål 1862 (T. gen.: *Oe. seminiger* Stål 1862)		+				+	~50
Perindus Emeljanov 1989 (T. gen.: *P. binundatus* Emeljanov 1989)	+						1
Pinacites Emeljanov 1972 (T. gen.: *Myndus calvipennis* Emeljanov 1972)							1
Rhamphixius Fowler 1904 (T. gen.: *Rh. championi* Fowler 1904)						+	2
Tiriteana Myers 1924 (T. gen.: *T. clarkei* Myers 1924)					+		1
Trigonocranus Fieber 1875 (T. gen.: *T. emmeae* Fieber 1876)	+						1
Volcanalia Distant 1917 (T. gen.: *V. typica* Distant 1917)			+				12

12. Tribe Pentastirini Emeljanov 1971

Subtribe Pentastirina Emeljanov 1971
(Syn.: Oliarina Emeljanov 1971)

	Pa	Na	Et	Or	Au	Nt	spp
Afroreptalus Van Stalle 1986 (T. gen.: *Oliarus rustenburgi* Synave 1952)			+				3
Anoculiarus Dlabola 1985 (T. gen.: *A. ornatus* Dlabola 1985)	+						1
Atonurus Emeljanov 1992 (T. gen.: *Cixius natalensis* Stål 1855) Sg. *Olipara* Emeljanov 1992 (T. gen.: *Oliarus guineensis* Van Stalle 1987)			+				~45
Cyclopoliarus Fennah 1945 (T. gen.: *Oliarus biperforatus* Fennah 1945)						+	8
Dorialus Van Stalle 1986 (T. gen.: *Oliarus gezira* Linnavuori 1973)			+				1
Epoliarus Matsumura 1910 (T. gen.: *E. politus* Matsumura 1910)	+						1
Eumecurus Emeljanov 1971 (T. gen.: *E. caudatus* Emeljanov 1971 (= *Oliarus longivertex* Kusnezov 1937)) Syn.: *Pseumecurus* Dlabola 1985 (T. gen.: *Oliarus frontalis* Melichar 1904)	+		+	+			>100
Helenolius Van Stalle 1986 (T. gen.: *H. insulicola* Van Stalle 1986)			+				2
Hyalesthes Signoret 1865 (T. gen.: *H. obsoletus* Signoret 1865) Syn.: *Liorhinus* Kirschbaum 1868 (T. gen.: *L. albolimbatus* Kirschbaum 1868 (= *H. obsoletus* Signoret 1865)) Syn.: *Pseudyalesthes* Kusnezov 1935 (T. gen.: *P. carinifrons* Kusnezov 1935)	+						~30
Indolipa Emeljanov 2001 (T. gen.: *Oliarus indiensis* Van Stalle 1991				+			16
Kibofascius Van Stalle 1986 (T. gen.: *Oliarus frenatus* Jacobi 1910)			+				1
Lalobidius Van Stalle 1985 (T. gen.: *Oliarus lootensi* Synave 1956)			+				3
Melanoliarus Fennah 1945 (T. gen.: *Oliarus maidis* Fennah 1945)						+	~75

	Pa	Na	Et	Or	Au	Nt	spp
Mesoliarus Matsumura 1910 (T. gen.: *M. malagensis* Matsumura 1910)	+						1
Miclucha Emeljanov 2001 (T. gen.: *Oliarus laratensis* Muir 1924)				+			3
Narravertus Van Stalle 1986 (T. gen.: *Oliarus ballista* Fennah 1958)			+				1
Nesoliarus Kirkaldy 1909 (T. gen.: *Oliarus (N.) tamehameha* Kirkaldy 1909)					+		~55
Norialsus Van Stalle 1986 (T. gen.: *Oliarus capeneri* Synave 1953)			+				34
Oecleopsis Emeljanov 1971 (T. gen.: *Oliarus artemisiae* Matsumura 1914)	+						8
Oliarellus Emeljanov 1971 (T. gen.: *Hyalesthes fulvus* Kusnezov 1935)	+						1
Oliarissa Fennah 1945 n. nov. pro *Paracixius* Fennah 1944 nec Wagner 1939 (T. gen.: *P. armiger* Fennah 1944)						+	1
Oliaronus Ball 1934 (T. gen.: *O. tontonus* Ball 1934)		+					1
Oliarus Stål 1862 (T. gen.: *Cixius walkeri* Stål 1859)	+			+	+		~45
Olipa Emeljanov 2001 (T. gen.: *Oliarus decumbens* Jacobi 1941)				+			1
Oliparisca Emeljanov 2001 (T. gen.: *Oliarus muluensis* Van Stalle 1991				+			10
Peartolus Van Stalle 1986 (T. gen.: *Oliarus macarangae* Van Stalle 1984)			+				3
Pentastira Kirschbaum 1868 (T. gen.: *P. major* Kirschbaum 1868)	+						~10
Pentastiridius Kirschbaum 1868 (T. gen.: *Flata pallens* Germar 1821) Sg. *Dicopolia* Emeljanov 1995 (T. gen.: *Oliarus breviceps* Kusnezov 1937) Sg. *Haliarus* Emeljanov 1995 (T. gen.: *Oliarus dagestanicus* Kusnezov 1937) Sg. *Moysella* Horváth 1913 (T. gen.: *M. sinaitica* Horváth 1913) Sg. *Nesopompe* Kirkaldy 1907 (T. gen.: *Oliarus (N.) felis* Kirkaldy 1907) Sg. *Podaplus* Emeljanov 1995 (T. gen.: *Oliarus haloxyli* Mitjaev 1971) Sg. *Polania* Emeljanov 1995 (T. gen.: *Oliarus nanus* Ivanoff 1885) Sg. *Stiraphana* Emeljanov 1995 (T. gen.: *Oliarus liocara* Emeljanov 1978)	+	+	+	+			~50
Prosops Buckton 1893 (T. gen.: *P. pedisequus* Buckton 1893)					+		1
Pseudoliarus Haupt 1927 (T. gen.: *Oliarus fuscofasciatus* Melichar 1902) Sg. *Paroliarus* Emeljanov 1995 (T. gen.: *Oliarus jaxartus* Mitjaev 1969)	+		+				9
Reptalus Emeljanov 1971 (T. gen.: *Cixius quinquecostatus* Dufour 1833) Sg. *Trepalus* Emeljanov 1995 (T. gen.: *Oliarus rufocarinatus* Kusnezov 1937)	+	+					~35
Setapius Dlabola 1988 (T. gen.: *S. brinki* Dlabola 1988)	+						5

	Pa	Na	Et	Or	Au	Nt	spp
Suriola Emeljanov 1992 (T. gen.: *Oliarus fici* Van Stalle 1987)			+				4
Urvillea Kirkaldy 1907 (T. gen.: *U. melanesica* Kirkaldy 1907)					+		1
Vincentia Uhler 1895 (T. gen.: *V. interrupta* Uhler 1895)						+	5

Subtribe Mnemosynina Emeljanov 1992

Mnemosyne Stål 1866 (T. gen.: *M. cubana* Stål 1866)			+	+		+	~50

13. Tribe Pintaliini Metcalf 1938

Aulocorypha Berg 1879 (T. gen.: *A. punctulata* Berg 1879)						+	1
Cubana Uhler 1895 (T. gen.: *C. tortrix* Uhler 1895) Syn.: *Bothriocerodes* Fowler 1904 (T. gen.: *B. variegatus* Fowler 1904)			+			+	~10
Cubanella Fennah 1948 (T. gen.: *Cubana irrorata* Uhler 1895)						+	4
Diastrocixius Caldwell 1944 (T. gen.: *D. thelyus* Caldwell 1944)						+	4
Monorachis Uhler 1901 (T. gen.: *M. sordulentus* Uhler 1901)		+				+	3
Muirolonia Metcalf 1936 = *Olonia* Muir 1925, nec Stål, n.praeocc. (T. gen.: *Bothriocerodes metallicus* Fowler 1904)						+	1
Notocixius Fennah 1965 (T. gen.: *Cixius fulvicollis* Blanchard 1852)						+	8
Pintalia Stål 1862 (T. gen.: *P. lateralis* Stål 1862) Syn.: *Ciocixius* Metcalf 1923 (T. gen.: *Cixius dorsivittatus* Van Duzee 1909) Syn.: *Cotyleceps* Uhler 1895 (T. gen.: *C. decorata* Uhler 1895) Syn.: *Metabrixia* Fowler 1904 (T. gen.: *M. delicata* Fowler 1904 (= *Cixius dorsovittatus* Van Duzee 1909))		+				+	~70

14. Tribe Semonini Emeljanov 2002

Betacixius Matsumura 1914 (T. gen.: *B. ocellatus* Matsumura 1914)	+			+			23
Huttia Myers 1924 (T. gen.: *H. nigrifrons* Myers 1924)					+		2
Kuvera Distant 1906 (T. gen.: *K. semihyalina* Distant 1906) Syn.: *Latoliarus* Dlabola 1952 (T. gen.: *L. brunneus* Dlabola 1952)	+			+			~17
Parasemo Lariviere 1999 (T. gen.: *P. hutchesoni* Lariviere 1999)					+		1
Semo White 1879 (T. gen.: *S. clypeatus* White 1879)					+		4

15. Tribe Stenophlepsiini Metcalf 1938

Euryphlepsia Muir 1922 (T. gen.: *E. amboinensis* Muir 1922)				+	+		~10
Stenophlepsia Muir 1922 (T. gen.: *S. flava* Muir. 1922)				+			3

	Pa	Na	Et	Or	Au	Nt	spp
not placed yet							
Meenocixius ATTIÉ, BOURGOIN & BONFILS 2002 (T. gen.: *M. bebourensis* ATTIÉ, BOURGOIN & BONFILS 2002)			+				2
Total number of genera	31	14	33	35	44	27	

Fig. 11:
Cixiini nymph.
Photo: I. KAMMERLANDER.

Identifying cixiid genera

A key to Fulgoromorpha families with general descriptions is provided by O'BRIEN & WILSON (1985). Within cixiids, more or less up-to-date keys to described genera (and species) of many regions of the world are available. In the Palaearctic Region e. g. ANUFRIEV & EMELJANOV (1988), DLABOLA (1988), DUBOVSKY (1966), EMELJANOV (1964), HOLZINGER (2002, in press), LOGVINENKO (1975) and MITJAEV (1971), in the Americas MEAD & KRAMER (1982), KRAMER (1977, 1979, 1981, 1983) and VAN STALLE (1987b) (but these are mostly nearctic), in the Ethiopian Region ATTIÉ et al. (2002, in press), EMELJANOV (1992), VAN STALLE (1985a, b, 1986a, b, c, d, 1987a, 1988a), in the Oriental Region TSAUR (1989), TSAUR et al. (1988, 1991a, b), TSAUR & LEE (1987) and VAN STALLE (1988b, 1991), and in the Australian and Pacific Region DEITZ & HELMORE (1979), EMELJANOV (2000), FENNAH (1956, 1958), FLETCHER & LARIVIÉRE (2001), LARIVIÉRE (1999) and VAN STALLE (1989). Nevertheless current keys for several genera and several parts of the world are still incomplete or missing totally, and - as mentioned in the introduction - many species and genera still await (re)description.

Ecology

Adult cixiids live on a wide variety of plants, feeding on phloem. The host plant range of most species is unknown, as no more information than a diagnostic description is present in the literature. A generally better knowledge of host plants is only available for species from Europe, North America and New Zealand, despite taxa of economic interest (see below), and few others. In those regions, the majority of the species feed mainly on trees and shrubs, most of them polyphagous, a smaller part of the fauna obviously oligo- or monophagous (e. g. NICKEL in prep., LARIVIERE 1999, KRAMER 1977 and subsequent papers, WILSON et al. 1994).

Although the percentage of polyphagous species in cixiids is higher than in many other Auchenorrhyncha families, most taxa seem to be closely restricted to species specific, distinct habitat types (see e.g. NICKEL et al. 2002, in this volume). This could be caused by the influence of various (abiotic) parameters to the adults, but in our opinion, the greatest influence might be an „ecological bottleneck" derived from habitat parameters (host plants, soil chemistry, structure, moisture...) affecting to the nymphs.

Cixiid nymphs (fig. 11) live subterraneously, feeding on roots of their - often herbaceous - hostplants and/or as fungivorous on rotten wood (see YANG & YEH 1994). Only very few data about their ecology are available. The life cycle (of those species, where we know something about it) usually lasts one year, with hibernation - if necessary - in nymphal instar; in *Oliarus atkinsoni* MYERS, two years are reported (CUMBER 1952c). Cixiid nymphs, as many other Hemiptera taxa, sometimes are associated with ants (e. g. MITJAEV 1967, SHEPPARD et al. 1979, THOMPSON 1984, BOURGOIN 1997).

Adult cixiids are both diurnal and nocturnal, but with a distinct priority to daytime activity (HOWARD 1981 and several other data). As other Fulgoromorpha, they communicate by substrate-borne vibrations (e. g. HOWARTH et al. 1990). Compared to other families, the acoustic repertoire of cixiids seems to be rather simple, territorial signals and rivalry calls are obviously missing (TISHECHKIN 1997).

Females use their ovipositors to deposit their eggs into the soil. The eggs are covered and thus protected by wax filaments (MÜLLER 1942 and subsequent authors). In some species, females obviously creep along clefts deep into the soil, as they are sometimes recorded from traps several decimeters beyond the soil surface (e. g. *Tachycixius* spp. from the Canary Islands, see HOCH & ASCHE 1993; many females of *Apartus michalki* (WAGNER), HOLZINGER, unpublished data).

By this means, cixiids might be predisposed to spending their whole life below the earth's surface: In fact, at least one european species, *Trigonocranus emmeae* FIEBER, seems to live in (stony/sandy) soil (NICKEL in prep.), and many cavernicolous Cixiid species are reported from various parts of the world (see HOCH 1994 and 2002, in this volume).

**Fig. 12:
Coconut palms killed by Lethal Yellowing in Calabash Caye, Belize, December 1995.
Photo: C. BERLIN.**

Economic importance

A survey of planthoppers as pests of economically important plants is provided by WILSON & O'BRIEN (1987). In this paper, 11 Cixiid species are recorded as pests on various plants. A few more species feeding on palms and rice have been described later (WILSON 1988a, BOURGOIN & WILSON 1992, BOURGOIN et al. 1998).

The highest number of economically important Cixiid species can be found on palms, where they act as phytoplasma vectors, causing diseases of the Lethal Yellowing (LY)-type in tropical and subtropical regions. Infested trees first drop mature and immature coconuts, then the flower stalks blacken, the fronds turn yellow, beginning by the lower, older ones and progressing up through the crown, until the tree is dead and only a „telephone pole"-like stem remains (see fig. 12). Unless treated, the tree dies within three to six months after the apperance of the first symptoms. Up to now, there is no cure for LY. Effective control is only possible by regular antibiotic injections (osytetracycline) to the trunk, but the most efficient way to deal with LY is by replanting with resistant coconut palms.

LY was first recognized in the Caribbean region about 100 years ago. Here, devastating outbreaks with dramatically economic consequences have happened several times since the 1950s. In Belize for example, the first LY was detected in 1992 in the northern parts of the country. Six years later, up to 95 % of the trees of the infested area have died already. In the Americas, an Oecleini planthopper formerly placed in *Myndus* s.l., *Haplaxius crudus* (VAN DUZEE), is the vector of the disease (HOWARD et al. 1983).

In tropical Africa, extensive damage is reported from coconut plantations both in the east and west. In this case, the assumed vector is another species formerly placed in *Myndus* s.l., *Myndodus adiopodoumensis* (SYNAVE). Three more „pest" species of Coconut are known from islands within the Pacific: *Euryphlepsia cocos* MUIR, *Colvanalia taffini* (BONFILS) and *Colvanalia chazeaui* (BOURGOIN & WILSON). Surprisingly, despite of the economic importance of these species, our knowledge concerning their biology is still very poor (see WILSON 1988b, EDEN-GREEN & OFORI 1997 and many others).

Hyalesthes obsoletus SIGNORET is the economically most important cixiid in Europe, causing damages on different plants including potato, tomato and grapevine (see e.g. ALMA 2002, in this volume). In addition, *Hyalesthes mlokosiewiczi* SIGNORET transmits diseases in the Caucasus region (SAMUNDZHEVA 1953), and a species of the genus *Pentastiridius* might be the vector of stolbur phytoplasma on sugarbeet in France (GATINEAU et al. 2001).

Oliarus atkinsoni MYERS is an important pest, too, as it is monophagous on flax (*Phormium tenax*, *P. cookianum*) and transmits a phytoplasma called „Candidatus Phytoplasma australiense". This phytoplasma causes *Phormium* yellow leaf diseases in New Zealand (CUMBER 1952a, b, c and subsequent papers, LIEFTING et al. 1998).

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Zusammenfassung

Wir präsentieren einen kurzen Überblick über die artenreiche Familie der Glasflügelzikaden (Cixiidae). Ein Verzeichnis der Gattungen mit Angaben zur Verbreitung in den tiergeographischen Regionen der Erde und mit Artenzahlen wird vorgelegt. Die innere weibliche Genitalarmatur, die Wachsplatten und verschiedene rätselhafte Sinnesorgane sind bislang wenig bekannte Merkmalskomplexe, die hier hinsichtlich ihrer Morphologie und der uns bisher bekannten Variabilität kurz beschrieben werden. Zudem werden die aktuellen Kenntnisse zur Ökologie und zur wirtschaftlichen Bedeutung der Cixiidae sowie Hinweise zu wichtiger Bestimmungsliteratur zusammengefasst.

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