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THE CLINOCERINAE (DIPTERA, EMPIDIDAE) FROM MADEIRA, THE CANARY ISLANDS AND THE AZORES

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With 25 figures

SUMMARY: The following Empididae (Clinocerinae) are described: *Clinocera maderensis* n. sp., *C. biacuminata* n. sp., *C. tetracuminata* n. sp., all from Madeira, and *C. azorica* n.sp. from the Azores. Figures and descriptions of the male genitalia of the following species are provided: *C. haemorrhoidalis* BECKER (Madeira), *Wiedemannia lagunae* BECKER and *C. amarantha* BECKER (Canary Islands), *C. rabacali* FREY, *C. storai* FREY, *C. sexmaculata* FREY, *C. stagnalis* (HALIDAY), (Azores). A key for these taxa is given, and biogeographical relations to continental taxa are discussed.

RESUMO: OS CLINOCERÍNIOS (DIPTERA, EMPIDIDAE) DA MADEIRA, CANÁRIAS E AÇORES. São descritas as seguintes espécies de Empididae (Clinocerinae): *Clinocera maderensis* n. sp., *C. biacuminata* n. sp., *C. tetracuminata* n. sp. todas da Madeira, e *C. azorica* n. sp. dos Açores. Figuras e descrições das genitálias dos machos das espécies seguintes são fornecidas: *C. haemorrhoidalis* BECKER (Madeira), *Wiedemannia lagunae* BECKER and *C. amarantha* BECKER (Canary Islands), *C. rabacali* FREY, *C. storai* FREY, *C. sexmaculata* FREY, *C. stagnalis* (HALIDAY), (Açores). É dada uma chave para estas espécies. Discute-se a bibliografia de algumas espécies continentais.

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INTRODUCTION

The empidid fauna of Madeira, the Canary Islands and the Azores are comparatively well known from the publications of BECKER (1908a, b) as well as collections made in the Azores (1958) and Madeira (1935) by Scandinavian entomologists (FREY, 1940, 1944, 1948). The following species have been reported from the Azores: *Clinocera (Archiclinocera) sexmaculata* FREY, *C. (Hypoclinocera) storai* FREY, *C. (Hydrodromia) stagnalis* HALIDAY and *C. (Kowarzia) bipunctata* HALIDAY. To date, *Widemannia (Philolutra) lagunae* BECKER and *C. (Kowarzia) amarantha* BECKER are the only two clinocerins known from the Canary Islands. *Roederiodes longirostris* FREY, *C. (Kowarzia) haemorrhoidalis* BECKER and *C. (Kowarzia) rabacali* FREY have been recorded from Madeira.

The fresh water insects of Madeira have been studied recently by A. STAUDER. Among the Empididae-Clinocerinae the collection revealed a number of new species in addition to several previously described taxa. These discoveries have necessitated a taxonomic revision of the material collected previously in the 1930s and the 1950s and which are stored at the Finnish Museum of Natural History, Helsinki. A. STAUDER's collection also revealed a further new species, that had been incorrectly identified by previous authors. This paper encompasses all known clinocerid taxa..

DESCRIPTION OF THE COLLECTING SITES

Most of the specimens from Madeira were collected in the stream "Ribeira das Cales" in the southern part of the island, just above Funchal. This stream is about 9 km long and flows permanently. Its source lies just below the Pico do Areeiro, at about 1500 m a.s.l., but the prevailing geological conditions and the seasonal variability in rainfall can result in surface overflow only starting at around 1450 m a.s.l. No Clinocerinae were found in this uppermost area.

The stream then passes through a highland region with a low incline per 1 km., after which the incline increases, and boulders up to 2 m in diameter occur in the streambed. This area is characterized by a number of small waterfalls. A second spring in the streambed contributes to the stream flow at around 980 m a.s.l..

A system of irrigation channels, the so-called Levadas, utilize all or the greater part of the stream flow, resulting in an intermittent flow during the summer along the final 4 km (at 500 m height). However, in winter the stream flows from its source through its discharge into the Atlantic Ocean.

The water of the stream is poor in nutrients, with a low conductivity (30-70 $\mu\text{S}/\text{cm}$) and a pH of between 6.7 and 8.2 (for further information refer to STAUDER 1990).

MATERIAL AND METHODS

Specimens collected by A. STAUDER were preserved in 70% ethanol. Material of the Museum was dried and pinned. For species identification, the abdomen was dissected, boiled in 10% KOH and then transferred to acetic acid (96%). This process was repeated, as necessary, until the genitalia were translucent. The clear abdomen was then transferred to a mixture of acetic acid and clove oil (1 : 1) and left for several hours until the acid had evaporated. Finally, the sclerotized parts were placed in a drop of pure clove oil. This enabled the viewer to observe the specimens from a number of positions, and drawings were made at magnifications of 100-200 x. Subsequently, the abdomena were returned to the vials with the rest of the specimens (ethanol material) or were placed in microvials with a drop of glycerine and pinned together with the specimen. Terminology of the genital components follows ULRICH (1972).

All material from the Helsinki Museum was returned, specimens collected by A. STAUDER are in the collection of R. WAGNER at the Limnologische Flußstation, Schlitz.

DESCRIPTION OF SPECIES

Clinocera maderensis n. sp.

Material: 1 male (holotype) Ribeira das Cales 13.9.1988, 580 m. a.s.l., leg. A. STAUDER

Description: entire body dark brown, wing opaque, translucent. Wing venation *Clinocera*-like, wing length: 6 mm. Body length: 5.5 mm.

Head: Dark brown with a single row of 11 postocular bristles, face below the eyes less than 0.5 the height of the eyes. Legs and thorax dark brown. Mesonotum with a double row of 5dc, a few ac in front. Legs brown, f_1 with two distinct setae at the tip.

Genitalia (Figs 1, 2): Hypandrium small, short and stout. Aedeagus large without specific features. Gonocoxite large, balloon-shaped with a large inner distal prolongation. The prolongation has two small dorsal hooks and one long prominent straight tip. Gonostyle small, approximately triangular with a short dorsal neck.

Distribution: Madeira.

Clinocera tetracuminata n. sp.

Material: 1 male (holotype) Ribeira das Cales, 18.8.1988, 580m a.s.l., 1 male (paratype) Ribeira das Cales 20.7.1988, 490 m a.s.l., 1 male (paratype) Ribeira das

Cales 13.9.1988, 580 m a.s.l., all *leg.* A. STAUDER.

Description: Body light brown, legs yellowish brown. Wings clear, translucent, with a small and faint pterostigma. Wing venation *Clinocera*-like, wing length: 4 mm.. Head with a single row of up to 10 postocular bristles. Face below the eyes very thin. Thorax medially with 3 yellowish and 2 dark brown bands. Mesonotum with 5 dc, and 2-3 pairs of ac. f_1 brown, with 6-8 longe bristles basally and with 'comb' of 10-12 bristles near the tip.

Genitalia (Figs 3, 4): Hypandrium short triangular with sinuous margins. Aedeagus basally wide, with a thin distal filament. Gonocoxite approximately circular with a short and stout inner prolongation. Gonostyle large with 4 dorsal tips. The basal one with a small dorsal field of setae. The three distal ones close together, the second being short with a few hairs, the third as short as the second with a few long hairs, the fourth as long as the first, slightly bent with a blunt tip.

Distribution: Madeira.

Clinocera biacuminata n. sp.

Material: 1 male (holotype), Ribeira das Cales 8.8.1988, 980 m a.s.l. 1 male (paratype) 17.8.1988, 980m a.s.l., *leg.* A. STAUDER

Description: large species, body length 7 mm., entire body dark-brown. Wings brownish translucent with a small elongate pterostigma, venation *Clinocera*-like, wing length 5.5 mm. Head below the eyes very small with a single row of up to 12 postocular bristles. Thorax with 2-3 pairs of ac, 5 pairs of dc. Mesonotum brown with a medial shining band. Legs dark brown with pulvilli and empodium. f_1 basally with 6-8 long setae ventrally and with 5-7 solitaire long setae at the tip.

Genitalia (Figs 5 - 7): Hypandrium short triangular, aedeagus thin but with an unusually shaped bipartite tip. Gonocoxite with a big rectangular inner appendage with rounded edges, gonostyle bipartite, wide u-shaped with fields of setae on the inner side near the tips.

Distribution: Madeira.

Clinocera haemorrhoidalis BECKER, 1908

Material: 2 males Ribeira das Cales 13.9.1988 580m a.s.l., 1 male 2 females Ribeira das Cales 27.7.1988, 820m a.s.l., 2 females Ribeira das Cales 8.8.1988, 980m a.s.l., 1 male Ribeira das Cales 9.9.1988 980m a.s.l., 1 male 1 female Ribeira das Cales 17.8.1988, 980m a.s.l., 1 male 2 females Ribeira das Cales 9.8.1988, 580m a.s.l., all *leg.* A. STAUDER.

Description: A small brownish species, wing length 3.5-4.0 mm, body length 3.8-

4.2 mm. Face below the eyes very thin, one row of 10 postocular bristles. Mesonotum yellowish brown with a wide median yellow stripe, 5 dc and 1-2 ac in front.

Genitalia (Figs 8, 9): Hypandrium sinuous, slightly bent. Aedeagus stout with short and wide flagellum. Gonocoxite approximately triangular with rounded tips, and with a short and blunt inner prolongation. Gonostyle bipartite, basally wide and rounded, distally with a large bipartite appendage. The dorsal part thin, the distally pointing ventral part wide with a small incision.

Distribution: Madeira.

Clinocera rabacali FREY, 1940

One species that had not been in the collection of A. STAUDER is *Clinocera rabacali* FREY. However, this was among material from the Helsinki Museum and one specimen was prepared to provide a first description of the male genitalia. The description of FREY concerning the shape and colour of the body and the bristles is sufficient.

Genitalia (Figs 10, 11): Hypandrium large, slightly curved, aedeagus wide, distally spherical with a short flagellum. Gonocoxite ovate, with a distinct inner appendage. Two pairs of gonostyles, the inner one horizontal, elongate with medial u-shaped incision, the lateral bipartite, with large and small frontal tips, and a long caudal prolongation.

Distribution: Madeira.

Clinocera amarantha BECKER, 1908

A few specimens of this species were obtained by Dr. M. BAEZ and were compared with material from the Helsinki collection. Descriptions by BECKER of the colour pattern, shape and size of this species are sufficient.

Genitalia (Figs 12-15): Hypandrium and aedeagus without specific features. Gonocoxite approximately triangular, with an inner appendage that carries 4-5 distinct knob-shaped anterior setae. Gonostyle sickle-shaped, elongate and without distinct fields of setae.

In the present article figures of specimens from two different islands are provided. The genitalia appear similar, but the shape of the inner appendage of the gonocoxite as well as gonostyle differ. At the present moment it is impossible to decide whether these are micro vicariants from different islands or whether they fall within the natural variation of a single species, because of the small amount of material available from Tenerife and La Palma.

Distribution: Canary Islands.

Wiedemannia lagunae BECKER, 1908

A few specimens were available from the Helsinki collection. BECKER's description of the colour pattern and body size are sufficient. The genitalia were inadequately characterized and are described below.

Genitalia (Figs 16, 17): Hypandrium and aedeagus without specific features. Gonocoxite rectangular with a short inner appendage, gonostyle simple and elongate with a faint field of hairs basally on the inner side.

Distribution: Canary Islands.

Excellent descriptions of *Clinocera storai* FREY, and *Clinocera sexmaculata* FREY, both from the Azores, exist. However, only very poor or no figures of the genitalia were made. Descriptions and figures of these are provided below.

Clinocera storai FREY, 1945

Genitalia (Figs 18, 19): hypandrium small triangular, aedeagus wide, with only a very short flagellum. Gonocoxite ovate, with a large inner appendage, as long as the gonostyle. Gonostyle slightly bent, wide at its base, narrower distally.

Distribution: Azores.

Clinocera sexmaculata FREY, 1945

Genitalia (Figs 20, 21): hypandrium small triangular. Aedeagus wide with a distal incision, the apical part wider again and covered with a few setae. Flagellum short, inserting subapically. Gonocoxite ovate, inner appendage long and thin with a narrower area just before its tip. Gonostyle elongate with a straight basal part, bearing long hairs at the anterior margin. The distal part is turned at an angle of appr. 90°, narrower distally, with a blunt tip. The inner side near the tip of the distal part is covered by hairs.

Distribution: Azores.

The occurrence of *Clinocera (Hydrodromia) stagnalis* HALIDAY on the Azores was confirmed (genitalia: figs 22, 23). Further inspection of the specimens determined as *Clinocera (Kowarzia) bipunctata* HALIDAY by FREY revealed that these had been misidentified. All specimens in the collection under this name belong to a new species described below.

Clinocera (Kowarzia) azorica n. sp.

Material: 1 male (holotype), Azores: Flores, Ribeira Fazenda VI. (*leg.*) Stora, ("1224" small blue label), deposited in the Finnish Museum of Natural History, Helsinki.

Description: A small brown green species. Wings translucent with a small ovate pterostigma. Wing length 3.5-4.2 mm., body length 3.8-4.4 mm. Head green with a single row of 10-11 postocular bristles. Thorax brown-green, mesonotum with 5 dc, and a few ac in front. Legs dark-greenish-brown, f_1 with a distal 'comb' of 8-10 setae.

Genitalia (Figs 24, 25): Hypandrium short triangular. Aedeagus extraordinarily large, with a short distally pointing tip, without flagellum. Gonocoxite ovoid with basal incision and a markedly large inner axe-shaped appendage. Gonostyle broad at the base, sickle shaped, tip pointing ahead. The distal tip has a second short and blunt inner prolongation with a few setae near the tip.

Distribution: Azores.

SUBGENERIC RANKING OF THE CLINOCERINS FROM THE AZORES, MADEIRA
AND THE CANARIES AND THEIR BIOGEOGRAPHICAL CONNECTIONS

To date, 13 species of Empididae-Clinocerinae have been reported from these three groups of islands. They belong to three genera: *Roederiodes* COQUILLET, *Wiedemannia* ZETTERSTEDT, and *Clinocera* MEIGEN.

Roederiodes is mainly distributed in the Nearctic Region (CHILLCOTT, 1961, CHVALA & WAGNER, 1989), but during the 1980s a further taxon was described from the Mediterranean island of Crete (WAGNER 1981), and several more taxa appear to exist in the Mediterranean region (own observations, B. HORVAT, LJUBLJANA pers. comm.). Material of *R. longirostris* FREY was not available, neither from the museum or recent field collections. There are probably more species belonging to this genus in the Palaearctic region, but these are difficult to collect because of their specialized biology and small size.

Species in the genus *Wiedemannia* are mainly restricted to continental parts of the northern hemisphere. Adults prefer cold streams in mountainous and alpine regions. The only species occurring on the Atlantic islands is *W. lagunae* BECKER. With regard to the shape of the male genitalia, this is the most closely related to *W. azurea* VAILLANT, distributed in the North African mountains, and *W. lota* HALIDAY, with a wide distribution in the European part of the Palaearctic Region. However, the present classification of subgenera retains *W. lota* in *Chamaedipsia* MIK, and the other two in *Philolutra* MIK. However, subgeneric ranking in the Clinocerinae needs to be revised because the main feature used to distinguish these subgenera from one

another is the number of setae near the tip of f_1 in front. In the context of the current study it is remarkable that the only species of *Wiedemannia* occurs on the Canary Islands, which are situated closest to the North African coast. It must have reached the Canary Islands during the last glacial era or even earlier, when sea levels were lower. Increased speciation, due to isolation, would then have occurred as water levels rose and climatic conditions changed.

Clinocera MEIGEN is represented by a number of species on all three groups of the islands. *Clinocera (Kowarzia) amarantha* BECKER of the Canary Islands is the only species with a close relationship to a continental species group. The shape of the gonostyle shows it to be a member of the *plectrum*-group, which contains *C. plectrum* MIK from the Alps, Carpathian Mountains, and the Caucasus, *C. jalonae* WAGNER from the Sierra de Guadarrama, Spain, *C. sandaliae* WAGNER from Sardinia and *C. subplectrum* VAILLANT from the Pyrénées (VAILLANT, 1986, WAGNER, 1984). They all seem to prefer cold streams in mountainous regions. Speciation, predominantly in the western mediterranean area, took place after the glaciers had vanished as temperatures rose. Populations were restricted to areas of streams with low maximum temperatures in summer.

The remaining *Clinocera* species from the Azores do not show any obvious relationship with either North American or European taxa. There is a superficial similarity between *Clinocera (Kowarzia) azorica* n. sp. and the continental European *C. (K.) bipunctata* HALIDAY, but the genitalia differ markedly in the shape of the gonocoxite and gonostyle. The flagellum, the distal part of the aedeagus is strongly reduced.

A similar reduction of the aedeagus is evident in *C. (K.) storai* FREY, where the flagellum is absent. A comparatively short flagellum is present in *C. (K.) sexmaculata* Frey. The inner appendage of the gonocoxite is quite large, and nearly as long as the gonostyle. As an exception, this appendage is still markedly larger in *C. (K.) dahli* VAILLANT, a species that could not be included in the present study. No differences in the colour pattern or morphological features were observed in *C. (Hydrodromia) stagnalis* HALIDAY. The occurrence of this species on the Azores appears to have taken place long ago, rather as a recent event resulting from transportation by ships or wind. However, it is surprising, that no morphological changes are evident in this species, as seen in *C. dahli*.

The Clinoceridae of Madeira have also developed unique features. Compared with their continental counterparts, the aedeagus is strong and the flagellum is short. The size of the inner appendage of the gonocoxite has increased, but only in *C. (K.) maderensis* n.sp. is it larger than the gonostyle. The shape of the gonostyle is much more variable, and *C. (K.) rabacali* has developed two pairs of gonostyles, as otherwise known only from continental species of the genus *Bergenstammia* MIK. No morpho-

logical similarities could be found between these and any of the continental Clinoceridae. However, only part of the aquatic dance fly fauna, and in particular the Clinoceridae, of the Iberian Peninsula are known.

To summarize, the only close relationships of the Clinoceridae occur between the Canary Islands and North Africa. Further faunistic affinities between populations of the Azores, Madeira, and continental Europe or Africa could not be detected. Reductions and changes in various parts of the male genitalia support the hypothesis, that they may be related to the preglacial fauna of Europe and North Africa. The relatively constant conditions of the oceanic climate, as well as the isolation of the islands, may have facilitated the survival of these species in the absence of dramatic pressures from environmental changes or invasion by competitors.

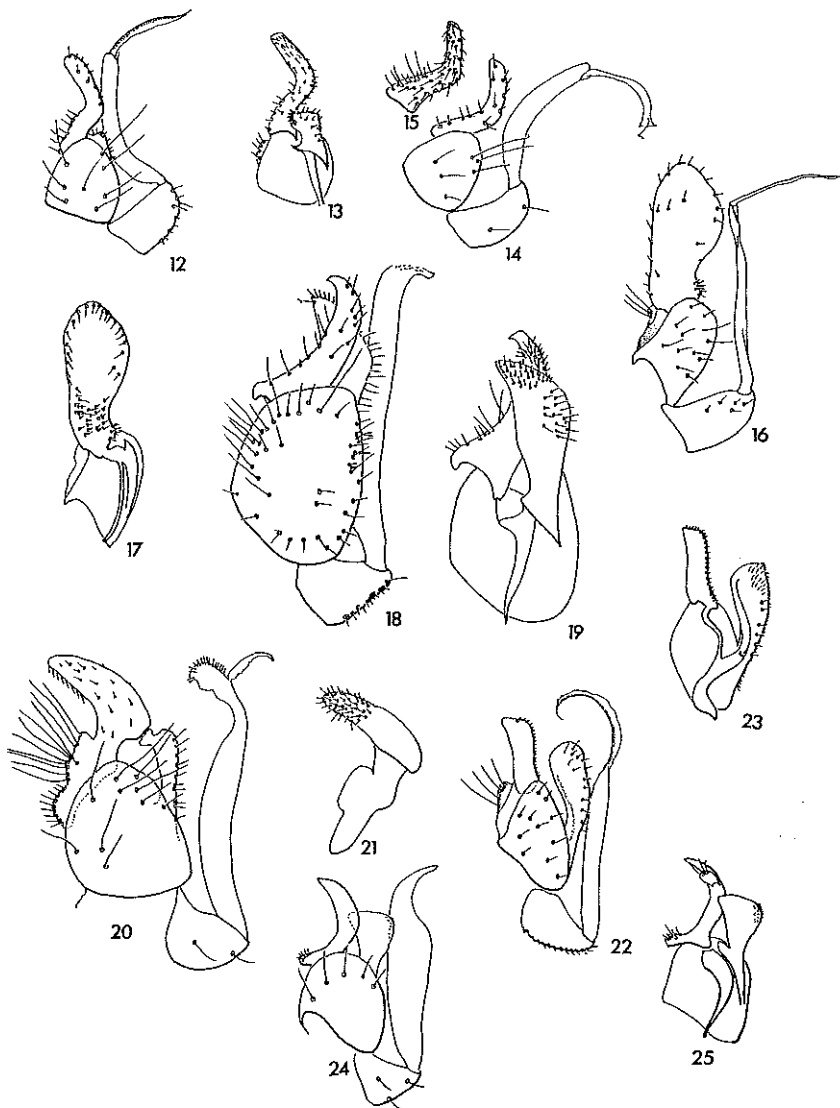
KEY TO THE MALE CLINOCERINAE OF MADEIRA, THE AZORES
AND THE CANARY ISLANDS

- 1 - Face and jowls more or less coalescent below the eyes, jowls consequently wider, sometimes very wide *Wiedemannia* Zetterstedt
(only *Wiedemannia lagunae* Becker, Canary Islands)
- face highly elongated below the eyes, small specimens *Roederiodes* Coquillett
(only *Roederiodes longirostris* Frey, Madeira)
- face separated from jowls by an excision below the eyes from the base of which the palpi arise *Clinocera* Meigen 2
- 2 - no 'comb' of tiny bristles at the end of anterior femura, wings immaculate
..... subgenus *Clinocera* s.str.
- no 'comb' of bristles at the end of front femora, front legs with lateral elongated bristles subgenus *Hypoclinocera* Frey
(only *Clinocera storai* Frey, from the Azores)
- a 'comb' of tiny bristles at the distal end of front femora, wing with darkened patches, front legs slightly raptorial, gonocoxite with a large elongated inner appendage
..... subgenus *Hydrodromia* Macquart
(only *Hydrodromia stagnalis* Haliday, hitherto known only from the Azores)
- wings with three distinct, circular dark spots subgenus *Archiclinocera* Frey
(only *Clinocera sexmacuata* Frey, from the Azores)
- wings with a more or less distinct stigma, face with a few pale hairs on each side, a 'comb' of bristles at tip of front femora subgenus *Kowarzia* Mik 3

- 3 - inner appendage of gonocoxite distinctly larger than gonostyle
 *Clinocera (Kowarzia) dahli* Vaillant
 (Azores)
- inner appendage of gonocoxite smaller than gonostyle 4
- 4 - one pair of gonostyles and an inner appendage of the gonocoxites 5
- two pairs of gonostyles and an inner appendage of the gonocoxites
 *Clinocera (Kowarzia) rabacali* Frey
 (Azores)
- 5 - gonostyle in upright position, thin, sickle shaped with a single tip 6
- gonostyle with a different shape 7
- 6 - inner appendage of gonocoxite small, gonostyle with medial angle
 *Clinocera (Kowarzia) amarantha* Becker
 (Canaries)
- inner appendage of gonocoxite large, gonostyle with a second blunt inner tip
 *Clinocera (Kowarzia) azorica* n.sp.
 (Azores)
- 7 - gonostyle wide at the base triangular, with a short upright tip
 *Clinocera (Kowarzia) maderensis* n.sp.
 (Madeira)
- gonostyle with two or more tips 8
- 8 - gonostyle with two tips and a wide u-shaped incision in between, inner appendage
 of gonocoxite large, appr. quadrate, tip of flagellum short, wide with a dorsal incision
 *Clinocera (Kowarzia) biacuminata* n.sp.
 (Madeira)
- gonostyle with four dorsal tips, lateral tips longer than the medial tips, inner append
 age of the gonocoxite comparatively large with an anterior tip
 *Clinocera (Kowarzia) haemorrhoidalis* (Becker)
 (Madeira)
- gonostyle with four dorsal tip, the laterals longer than the medians, inner appendage
 of gonocoxite comparatively big with an anterior tip
 *Clinocera (Kowarzia) tetracuminata* n.sp.
 (Madeira)



Figs. 1-11- Lateral view of male genitalia and internal view of gonocoxite and gonostyle of *Clinocera maderensis* n. sp. (1, 2); *C. tetracuminata* n. sp. (3, 4); *C. biacuminata* n. sp. (5, 6); *C. haemorrhoidalis* BECKER (8, 9); *C. rabacali* FREY (10, 11). *C. biacuminata* n. sp. tip of aedeagus (7).



Figs. 12-25 - *C. amarantha* BECKER (Tenerife - 12, 13; La Palma 14, 15); genitalia lateral view 12, 14; gonostyle internal view (13); gonocoxite, gonostyle internal view (15). *Weidemannia lagunae* BECKER genitalia lateral view (16); gonocoxite, gonostyle internal view (17). *C. storai* FREY genitalia lateral view (18); gonocoxite, gonostyle internal view (19). *C. sexmaculata* FREY genitalia lateral view (20); gonostyle internal view (21). *C. stagnalis* (HALIDAY) genitalia lateral view (22), gonocoxite, gonostyle internal view (23). *C. azorica* n. sp. genitalia lateral view (24), internal view (25).

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