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# ***Crossopalpus* Bigot, 1857 (Diptera: Hybotidae) from Morocco: description of four new species with new data and some key highlights on ecology**

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**Abstract.** Nine species of *Crossopalpus* Bigot, 1857 (Diptera: Hybotidae) have been found recently in Morocco. Four species new for science are described: *Crossopalpus flavipes* Grootaert et Zouhair, **sp. n.**, *C. flavitibia* Grootaert et Zouhair, **sp. n.**, *C. nigriloides* Grootaert et Zouhair, **sp. n.** and *C. undulans* Grootaert et Zouhair, **sp. n.** New data and extended diagnoses on previously described species are provided for *Crossopalpus aeneus* (Walker, 1871), *C. atlanticus* (Raffone, 2015), *C. dilutipes* (Strobl, 1906), *C. nigritellus* (Zetterstedt, 1842) and *C. setiger* (Loew, 1859). New species-groups of *Crossopalpus* are proposed here for the first time. All species are figured based on specimens from Morocco to allow comparison with specimens from Europe. *Crossopalpus pilipes* (Loew, 1859) expected but not yet recorded from Morocco is illustrated based on a specimen from Romania. A key to the Moroccan species of *Crossopalpus* is also provided.

**Key words:** Diptera, Hybotidae, *Crossopalpus*, new species, Morocco, North Africa.

## ***Crossopalpus* Bigot, 1857 (Diptera: Hybotidae) из Марокко: описание четырех новых видов с новыми данными и некоторыми ключевыми моментами по экологии**

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**Резюме.** Девять видов рода *Crossopalpus* Bigot, 1857 были недавно обнаружены в Марокко. Описано четыре новых для науки вида: *Crossopalpus flavipes* Grootaert et Zouhair, **sp. n.**, *C. flavitibia* Grootaert et Zouhair, **sp. n.**, *C. nigriloides* Grootaert et Zouhair, **sp. n.** и *C. undulans* Grootaert et Zouhair, **sp. n.** Приведены новые данные и расширенные диагнозы для ранее описанных видов *Crossopalpus aeneus* (Walker, 1871), *C. atlanticus* (Raffone, 2015), *C. dilutipes* (Strobl, 1906), *C. nigritellus* (Zetterstedt, 1842) и *C. setiger* (Loew, 1859). Впервые предложены новые видовые группы для этого рода. Даны изображения экземпляров из Марокко для возможности сравнения с особями из Европы. Приведено изображение экземпляра из Румынии *Crossopalpus pilipes* (Loew, 1859) – ожидаемого, но еще не зарегистрированного в Марокко вида. Представлена определительная таблица для марокканских видов *Crossopalpus*.

**Ключевые слова:** Diptera, Hybotidae, *Crossopalpus*, новые виды, Марокко, Северная Африка.

## **Introduction**

Within the monophyletic tribe Drapetidini (Tachydromiinae), *Crossopalpus* Bigot, 1857 forms a group of small to medium-sized predaceous flies (1.2–2.5 mm), of which some species are known to occupy purely terrestrial habitats [Chvála, 1975], including agricultural fields and greenhouses, where they probably act as bioregulators of pests [Steinborn, Meyer, 1994; Rodríguez-Rodríguez et al., 2005; Tran et al., 2006], while other species prefer to inhabit edges of aquatic habitats including seashore areas [Chvála, 1975; Grootaert, Van de Velde, 2019]. In addition to the fact that adults feed on other insects through their predatory behaviour, some studies have proven that adults of some species (*C. aeneus* (Walker, 1871) and *C. humilis* (Frey, 1913)) also feed on the carcasses of certain vertebrates, thus being of forensic interest [Ventura et

al., 2012; Díaz-Martín, Saloña-Bordas, 2015; Al-Mekhlafi et al., 2020]. Adults of *Crossopalpus* can be encountered throughout the year, but fully active in winter, and even under snow [Broen, Mohrig, 1965; Chvála, 1975]. The larvae of *Crossopalpus* are certainly all predaceous like the adults [Smith, 1989], and they should be sought out in cow dung, fungi (*C. nigritellus* (Zetterstedt, 1842)) or in some cocoons (*C. curvipes* (Meigen, 1822)) [Chvála, 1975; Smith, 1989].

*Crossopalpus* is considered a species-poor genus [Freitas-Silva, Ale-Rocha, 2019], currently numbering 90 species worldwide [Grootaert, Shamshev, 2014; Grootaert, Van de Velde, 2019; Freitas-Silva, Ale-Rocha, 2019] distributed in all zoogeographical regions except Antarctica [Sinclair, Cumming, 2017], and only 24 of them are recorded from the Palearctic realm [Freitas-Silva, Ale-Rocha, 2019]. In North Africa, even if *Crossopalpus* has

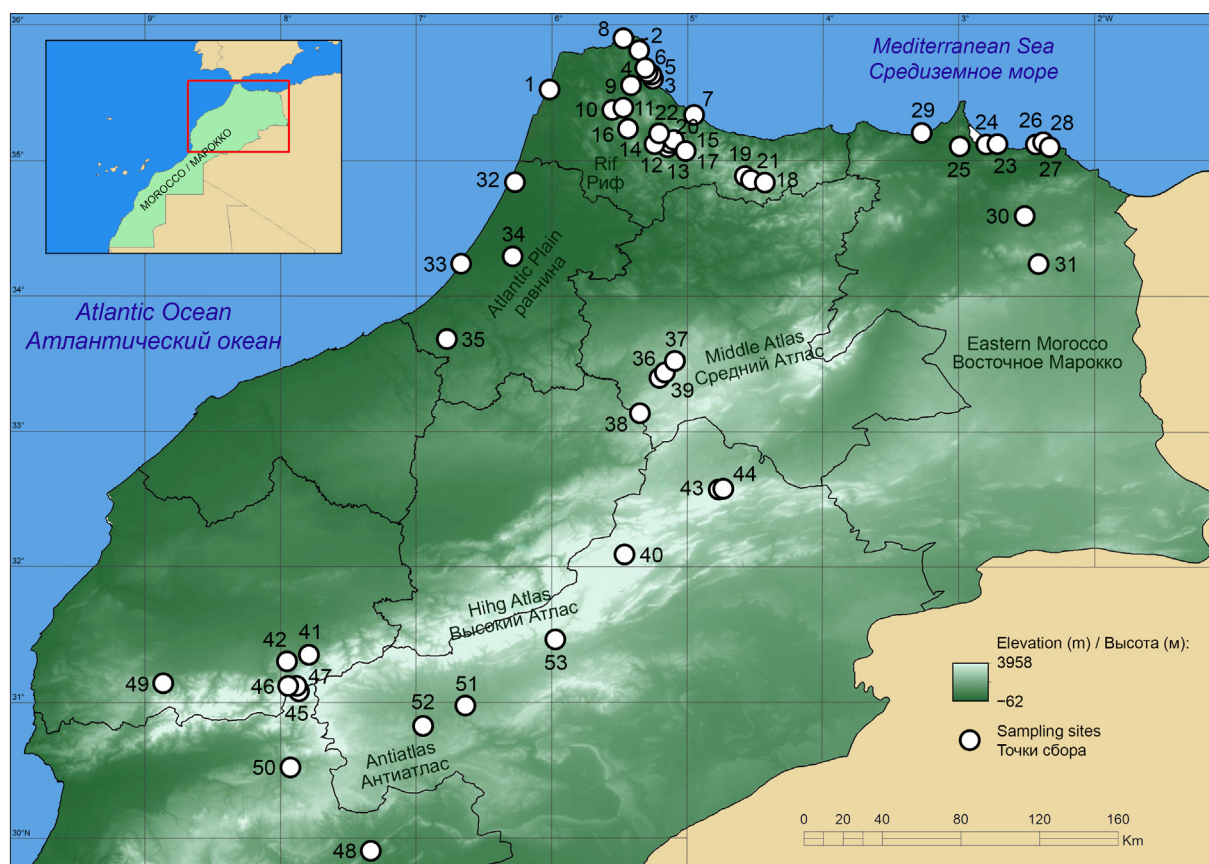


Fig. 1. Location of the studied sites in Moroccan territory.

Рис. 1. Расположение исследованных местонахождений на территории Марокко.

been recorded throughout the region (except in Mauritania) [Chvála, Kovalev, 1989; Ventura et al., 2012], these records remain very poor, as is the case for all genera of Hybotidae. In Morocco, five species of *Crossopalpus* are known to occur: *C. aeneus* was recorded by Shamshev et al. [2005] from the High Atlas Mountains and also represents the first country record for the genus, *C. atlanticus* (Raffone, 2015) described by Raffone [2015] from the Atlantic Plain, and most recently Ebejer et al. [2019] added *C. dilutipes* (Strobl, 1906) found in the Atlantic Plain and *C. nigritellus* and *C. setiger* (Loew, 1859) found in the Rif Mountains.

The present study represents the first comprehensive review of the genus *Crossopalpus* from North Africa. We complete here the Moroccan *Crossopalpus* data, by extending the range of the majority of species previously recorded in the country, and describing four new species for science, thus increasing the number of Moroccan species of Hybotidae from 69 [Kettani et al., 2022; Zouhair, Kettani, 2022; Zouhair et al., 2022, 2024] to 73 species. In addition, we propose in this study new *Crossopalpus* species-groups based on the observations of the Moroccan fauna and consolidated with other Palaearctic regions. An emphasis of species ecology is also provided. All the new species are described and illustrated herein. Illustrations and extended diagnoses for previously described species along with a key to the Moroccan species of *Crossopalpus* are also presented.

## Material and methods

The specimens of *Crossopalpus* under study here were collected mainly by the third author and her students between 2008 and 2024. The remainder material comes from some recent surveys conducted by the second author between the years 2019 and 2024. The majority of specimens were sampled using a sweep net and, in some cases, a Malaise trap. The studied sites (Table 1) are distributed across the different regions of Morocco (Fig. 1), including the Rif, Eastern Morocco, the Atlantic Plain, the Middle Atlas, the High Atlas and the Anti-Atlas, thus involving a wide variety of ecosystems and habitats surveyed under different orographic and climatic conditions.

The relevant specimens are conserved in ethanol and deposited in the Royal Belgian Institute for Natural Sciences (Brussels, Belgium). The specimens received a register number in the collection e.g. M001 where M stands for Morocco and the number refers to the tube in which the specimens are conserved. All drawings of male terminalia given in this paper were made by the senior author, using a camera lucida attached to a compound microscope, after maceration of the terminalia in KOH. The specimens were photographed using a Leica S9i microscope. The morphological terms used here follow Sinclair and Cumming [2006].

Table 1. Coordinates, altitudes and habitats of the studied sites (Fig. 1) (PNPB – Project of Natural Park of Bouhachem; NPTL – National Park of Talassemtane; NPIF – National Park of Ifrane; NPKH – National Park of Khénifra; NPTB – National Park of Toubkal).

Таблица 1. Координаты, высоты и местообитания исследованных участков (рис. 1) (PNPB – проект природного парка «Буашем»; NPTL – национальный парк «Талассемтан»; NPIF – национальный парк «Ифран»; NPKH – национальный парк «Хенифра»; NPTB – Национальный парк «Тубкаль»).

Number of site Номер участка	Site Участок	Protected area, locality / Охраняемая территория, местонахождение	Province Провинция	Altitude, m Высота, м	Geographical Coordinates / Географические координаты	Habitat Местообитание
Rif / Риф						
1	Beach of Briyech	Asilah	Asilah	0	35.532036°N –6.006864°W	Sandy dunes Песчаные дюны
2	Oued Negro	Fnideq	Tétouan	1	35.80331°N –5.35348°W	Riverbank (downstream) / Берег реки (нижнее течение)
3	Oued El maleh	Martil	Tétouan	1	35.6389713°N –5.2779191°W	Estuarine dunes Эстуарные дюны
4	Beach of Cabo Negro I	Martil	Tétouan	1	35.667777°N –5.283277°W	Rocky shore Скалистый берег
5	Beach of Cabo Negro II	Martil	Tétouan	2	35.665°N –5.284444°W	Sandy dunes Песчаные дюны
6	Beach of Martil	Martil	Tétouan	2	35.6389713°N –5.2779191°W	Sandy dunes Песчаные дюны
7	Beach of Stehat	Stehat	Chefchaouen	2	35.349837°N –4.957649°W	Vegetable garden (100 m away from beach) / Огород (100 м от пляжа)
8	Beach of Dalia	Ksar Sghir	Fahs-Anjra	14	35.904166°N –5.478333°W	Beach forest Лес на пляже
9	Oued Mhannech	Tamouda	Tétouan	20	35.560283°N –5.412212°W	Riverbank Берег реки
10	Oued Mhajrate	Ben Karrich	Tétouan	194	35.3902°N –5.459122°W	Riverbank Берег реки
11	Adrou	PNPB, Tazrout	Larache	580	35.375023°N –5.543782°W	Mixed forest Смешанный лес
12	Amrah	NPTL, Machekralla	Chefchaouen	816	35.136667°N –5.251944°W	Peat bog Торфяное болото
13	Oued Amsemlil	PNPB, Jbel Bouhachem	Tétouan	1065	35.15657°N –5.26159°W	Riverbank Берег реки
14	Tourbière Amsemlil	PNPB, Jbel Bouhachem	Tétouan	1067	35.26234°N –5.43341°W	Bog edge Берег болота
15	Zawya Merja souk	Bni Selmane	Chefchaouen	1076	35.0692694°N –5.0062777°W	Meadow Луг
16	Amsemlil	PNPB, Jbel Bouhachem	Tétouan	1102	35.260117°N –5.431833°W	Pine forest Сосновый лес
17	Bni M'hamed	NPTL, Talassemtane	Chefchaouen	1330	35.158888°N –5.129691°W	Mixed forest Смешанный лес
18	Bni Bounsar	Targuist, Jbel Tidghine	Al Hoceima	1340	34.841929°N –4.423233°W	Mixed forest Смешанный лес
19	Oued Taâounia	Ketama, Koudiat Ajira	Al Hoceima	1493	34.87962°N –4.56523°W	Riverbank Берег реки
20	Maison forestière	NPTL, Talassemtane	Chefchaouen	1696	35.135030°N –5.138349°W	Fir forest Еловый лес
21	Moulay Staëjil	Jbel Tidghine	Al Hoceima	1701	34.853983°N –4.538186°W	Cedar forest Кедровый лес
22	Sefihat Telj	NPTL, Sefihat Telj	Chefchaouen	1720	35.1841607°N –5.2155876°W	Mixed forest Смешанный лес
Eastern Morocco / Восточное Марокко						
23	Beach of Kariat Arekmane	Kariat Arekmane	Nador	0	35.121944°N –2.733888°W	Rocky shore Скалистый берег



Table 1 (continuation).  
Таблица 1 (продолжение).

Number of site Номер участка	Site Участок	Protected area, locality / Охраняемая территория, местонахождение	Province Провинция	Altitude, m Высота, м	Geographical Coordinates / Географические координаты	Habitat Местообитание
24	Marchica lagoon	Marchica lagoon	Nador	0	35.123333°N –2.756388°W	Lagoon edge Берег лагуны
25	Beach of Saïdia,	Saïdia	Berkane	1	35.113333°N –2.994444°W	Sandy dunes Песчаные дюны
26	Estuaire Moulouya, Laisse de mer	Saïdia	Berkane	1	35.123333°N –2.344444°W	Estuary, foreshore detritus / Эстуарий, прибрежный детрит
27	Estuaire Moulouya	Saïdia	Berkane	1	35.122777°N –2.344722°W	Sandy dunes Песчаные дюны
28	Beach Cap de l'eau	Cap de l'eau	Nador	2	35.138333°N –2.4125°W	Sandy dunes / Песчаные дюны
29	Beach of Sidi Boussaid	Beach of Sidi Boussaid	Nador	9	35.209861°N –3.276202°W	Rocky cave Скальная ниша
30	El Aïoun Sidi Mellouk	El Aïoun Sidi Mellouk	Taourirt	589	34.590379°N –2.517850°W	Olive grove Оливковая роща
31	Oued Gafaït	Gafaït	Jerada	800	34.239755°N –2.408054°W	Riverbank Берег реки
Atlantic Plain / Равнина на атлантическом побережье						
32	Merja Zerka	Moulay Bouselham	Kénitra	6	34.84444°N –6.270°W	Lagoon edge Берег лагуны
33	Réserve de Sidi Boughaba	Sidi Boughaba	Kénitra	15	34.252786°N –6.66806°W	Lakeshore Берег озера
34	Sidi Yahya Gharb	Sidi Yahya El Gharb	Sidi Slimane	24	34.305574°N –6.285728°W	Lakeshore Берег озера
35	Ain Aouda	Ain Aouda	Skhirate- Témara	223	33.687714°N –6.776913°W	Wetland Водно-болотное угодье
Middle Atlas / Средний Атлас						
36	Oued Sidi Rached	NPIF, Sidi Rached, Azrou	Ifrane	1577	33.458139°N –5.148344°W	Riverbank Берег реки
37	Lake of Zerrouka	NPIF, Ifrane	Ifrane	1615	33.5433°N –5.095910°W	Lakeshore Берег озера
38	Lake of Ouiouane	NPKH	Khénifra	1641	33.132816°N –5.345033°W	Lakeshore Берег озера
39	La Maison de la Cédraie	NPIF, Azrou	Ifrane	1748	33.419908°N –5.177274°W	Cedrus atlantica forest Лес из Cedrus atlantica
High Atlas / Высокий Атлас						
40	Oued Ahansal	Zaouiat Ahansal	Azilal	752	32.100°N –5.450°W	Riverbank Берег реки
41	Tagadirte	NPTB, Ourika	Al Haouz	894	31.365363°N –7.780122°W	Riverbank Берег реки
42	Oued Réghaya	SIBE Oued Réghaya, Marrakech	Al Haouz	988	31.317495°N –7.957965°W	Riverbank Берег реки
43	Titaouine valley	Titaouine	Midelt	1695	32.590067°N –4.766988°W	Riverbank Берег реки
44	Source Titaouine	Titaouine	Midelt	1732	32.581734°N –4.766488°W	Spring edge Берег ручья
45	Imlil	NPTB, Imlil	Al Haouz	1805	31.135683°N –7.92025°W	Agricultural field / Сельскохозяйственное поле
46	Cascade Imlil	NPTB, Imlil	Al Haouz	1927	31.128516°N –7.9194°W	Edges of waterfall Окраина водопада
47	Azib Tifni	NPTB, Taliouine	Taroudant	3100	31.1229417°N –7.8922006°W	Agricultural field / Сельскохозяйственное поле

Таблица 1 (окончание).  
Table 1 (completion).

Number of site Номер участка	Site Участок	Protected area, locality / Охраняемая территория, местонахождение	Province Провинция	Altitude, m Высота, м	Geographical Coordinates / Географические координаты	Habitat Местообитание
Anti-Atlas / Антиатлас						
48	Tissint	Tissint	Tata	526	29.918333°N –7.331944°W	Irrigated vegetable gardens Орошаемые огороды
49	Oued Agadir Wamsa	Imintanoute	Chichaoua	924	31.156156°N –8.850341°W	Riverbank Берег реки
50	Boragua	Taliouine	Taroudant	1014	30.5314043°N –7.9280871°W	Agricultural field Сельскохозяйственное поле
51	Afra oasis	Afegou	Ouarzazate	1145	30.979990°N –6.635933°W	Oasis edges Окраины оазиса
52	Fint oasis	Fint oasis	Ouarzazate	1188	30.831096°N –6.953226°W	Oasis edges Окраины оазиса
53	Dades valley	Tinghir	Tinghir	1581	31.457147°N –5.9751614°W	Riverbank Берег реки

The identification of *Crossopalpus* species is hindered by the lack of the correct recognition of the different parts of the male genitalia and absence of labelling of the various parts of the genitalia by some authors [e.g., Chvála, 1975; Raffone, 2015]. The large left cercus (lc) can be confused sometimes with the left epandrial lamella. However, in *Crossopalpus* the left epandrial lamella is reduced in size, indistinct and fused with the hypandrium (Figs 3–5). To add to the confusion, there is a pair of papilla-like structures resembling cerci, but actually they are the lobes of the left surstylus (ls1, ls2), which are present on the apex of the remnant of the left epandrial lamella. Finally, all the appendages are generally folded together.

In the descriptions, the right and left side of the male terminalia are based on their unrotated position viewed posteriorly, so that in the illustrations the right surstylus appears on the reader's left side and the left cercus to the right. When the right epandrial lamella is illustrated in lateral view, the setation on the right border is indicated as setae on the right border (morphologically ventral margin of right epandrial lamella).

Abbreviations: a – anus; a1 – appendage 1 of right epandrial lamella; a2 – appendage 2 of right epandrial lamella; eja – ejaculatory apodeme; dp – dorso-apical projection of the right epandrial lamella; hy – hypandrium; L – left; lc – left cercus; lel – left epandrial lamella; ls1 – left surstylus 1; ls2 – left surstylus 2; R – right; rc – right cercus; rel – right epandrial lamella; rs – right surstylus; rs1 – right surstylus 1; rs2 – right surstylus 2.

## Previous records

An annotated checklist of the Diptera of Morocco, along with distributions and bibliography can be found in Kettani et al. [2022]. In this checklist, the primary reference to each species record is listed, as well as details on the studied specimens. *Crossopalpus atlanticus* described by

Raffone [2015] was overlooked in this catalogue within the Hybotidae section [Kettani, Gatt, 2022: 229–232].

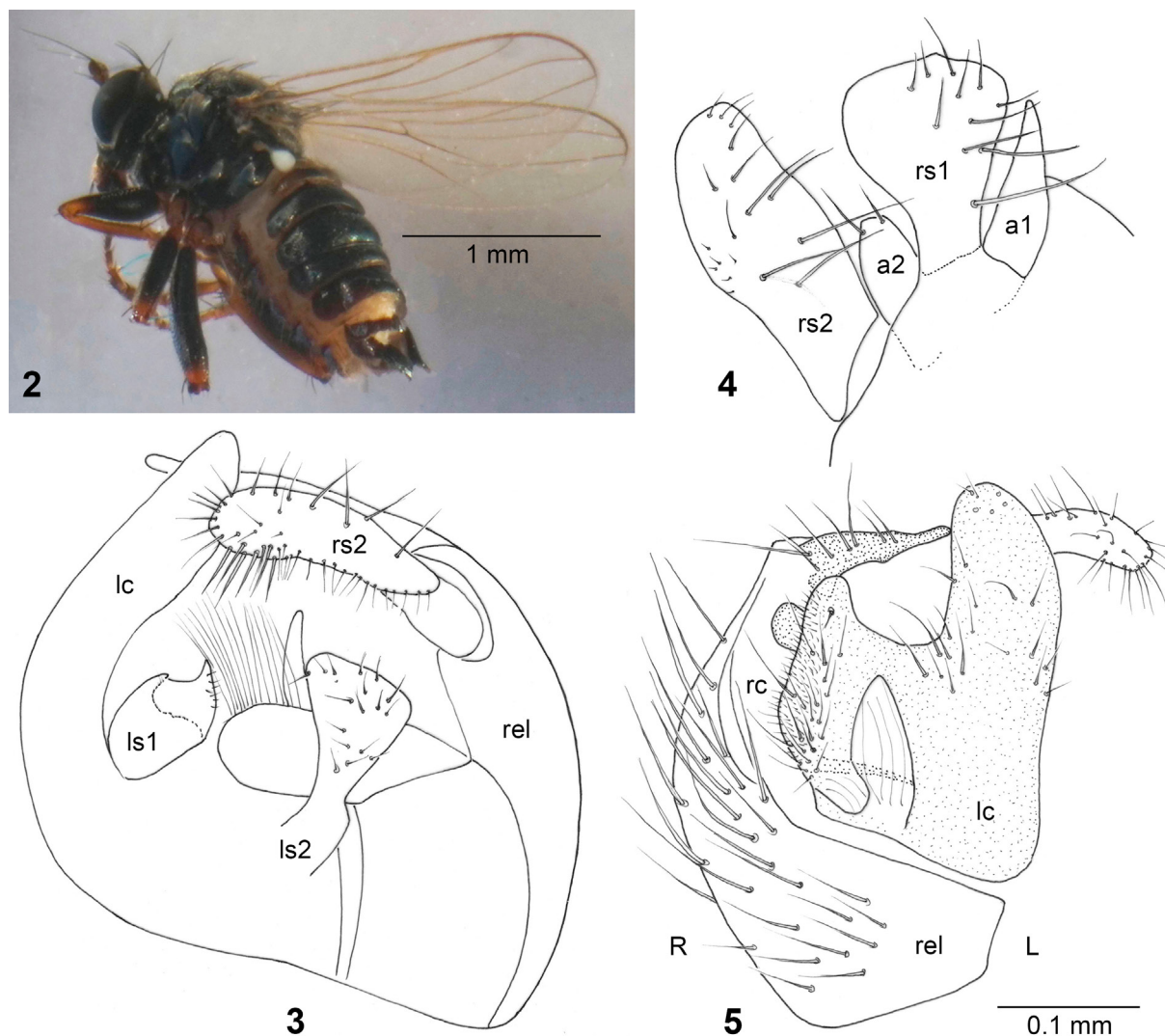
## Taxonomic account

### Genus *Crossopalpus* Bigot, 1857

*Crossopalpus* Bigot, 1857: 563 (type species *Platypalpus ambiguus* Macquart, 1827 (by monotypy)).

*Eudrapetis* Melander, 1918: 187 (as a subgenus of *Drapetis* Meigen, 1822) (type species *Drapetis spectabilis* Melander, 1902 (by original designation)).

**Diagnosis** (after Chvála [1975], modified). Small to medium-sized (1.6–4 mm), mainly polished black species. Head broad, with deep jowls below eyes. Proboscis strong, beak-like. Occiput slightly concave below neck. A pair of long vertical bristles distinct from other short occipital hairs, posterior pair of ocellar bristles almost as long as verticals but anterior pair quite absent. Antennae placed above middle of head in profile, postpedicel with lower edge convex and with an apical stylus. Pedicel with a single, very long bristle beneath. Thorax broad, when viewed from above, large bristles distinct, and sometimes with numerous, similar, long, bristly-hairs evenly distributed over mesonotum; anepisternum (mesopleuron) bare. Legs. Fore and mid tibiae with 2 distinct preapical setae. Hind tibiae sometimes with long anterodorsal and posterodorsal setae, with a more or less developed posterior apical tooth-like projection. Wings clear, Rs vein very short. Male terminalia with large right epandrial lamella (sometimes with a dorso-apical projection). Right surstylus distinctly separated from or fused to right epandrial lamella. Right surstylus often consisting of two lobes. In some species, additional lobe present on inner side of right epandrial lamella (sometimes divided into two appendages). Right cercus much smaller and narrower than large left cercus. Left epandrial lamella reduced to relatively small sclerite



Figs 2–5. *Crossopalpus aeneus*, male, habitus (Beach of Cabo Negro I, M052) and terminalia (Oued Mhajrate, M004).

2 – habitus, lateral view; 3–5 – terminalia: 3 – epandrium with left cercus, left surstyli, right epandrial lamella with right surstylus, ventral view (hypandrium omitted), 4 – apex of right epandrial lamella, lateral view, 5 – right epandrial lamella and cerci, dorsal view. Abbreviations are given in “Material and methods”.

Рис. 2–5. *Crossopalpus aeneus*, самец, габитус (Beach of Cabo Negro I, M052) и терминалии (Oued Mhajrate, M004).

2 – габитус, вид сбоку; 3–5 – терминалии: 3 – эпандрий и левый церк, вентрально (типандрий не показан), 4 – вершина правой эпандриальной пластинки, латерально, 5 – правая эпандриальная пластинка и церки, дорсально. Расшифровка сокращений приведена в разделе «Material and methods».

bearing dorsal and apical appendages, which are present in the form of two papilla-like structures marked herein as ls1 and ls2.

**Notes.** *Crossopalpus* resembles *Drapetis* Meigen, 1822, but in the latter the jowls (gena) are very narrow (almost linear), an anterior pair of ocellar setae is present, the pedicel bears only short ventral seta(e) rarely as long as pedicel and Rs vein is longer.

*Crossopalpus aeneus* (Walker, 1871)  
(Figs 2–5)

*Drapetis aeneus* Walker, 1871: 273 (type locality: Egypt, Cairo).

*Crossopalpus aeneus*: Collin, 1960: 386 (notes); Kovalev, 1975: 581, figs 4–6 (male terminalia).

*Drapetis (Crossopalpus) aenea*: Smith, 1967: 2, figs 1, 2 (details of male terminalia).

**Material.** Rif: 1♂ (M033), Oued Mhannech, sweep net, 13.12.2013 (K. Kettani); 5♂ (M008, dissected), Oued Mhajrate, Malaise trap, 20.07–13.08.2016 (K. Kettani); 1♂ (M013), Oued Negro, sweep net, 7.04.2017 (K. Kettani); 14♂ (M034), Beach of Briyech, sweep net, 4.10.2017 (K. Kettani); 1♂ (M037), Zawya Merja souk, sweep net, 23.06.2019 (M. Nourti); 1♂ (M026), Adrou, sweep net, 25.06.2019 (K. Kettani); 1♂ (M043), Sefihat Telj, sweep net, 5.10.2019 (L. Zouhair); 1♂ (M027), Bni Bounsar, Malaise trap, 1.04–30.05. 2022 (K. Kettani); 1♂ (M024), Oued El maleh, sweep net, 6.05.2023 (H. Maamri); 1♂ (M051), sweep net, Beach of Dalia, 7.08.2023 (H. Maamri); 1♂ (M052), Beach of Cabo Negro I, sweep net, 10.11.2023 (H. Maamri); 2♂ (M053), Beach of Cabo Negro II, sweep net, 10.11.2023 (H. Maamri); 1♂ (M054), Beach of Dalia, sweep net, 23.01.2024 (H. Maamri).

Eastern Morocco: 1♂ (M007), Beach of Saidia, sweep net, 29.05.2022 (H. Maamri); 1♂ (M044), Titaouine valley, sweep net, 30.05.2022 (K. Menouar); 6♂ (M030), Beach Cap de l'eau, sweep net, 11.09.2022 (H. Maamri); 1♂ (M042), Oued Gafaït, sweep net, 12.07.2023 (L. Zouhair);

1♂, 1♀ (M055), Beach Cap de l'eau, sweep net, 19.07.2023 (H. Maamri); 1♂ (M056), Marchica lagoon, sweep net, 22.07.2023 (H. Maamri); 1♂ (M057), Beach of Sidi Boussaid, sweep net, 2.08.2023 (H. Maamri); 13♂ (M025), El Aïoun Sidi Mellouk, sweep net, 9.08.2023 (L. Zouhair).

Atlantic Plain: 1♂ (M040), Merja Zerka, sweep net, 15.06.2021 (L. Zouhair); 1♂ (M004), Réserve de Sidi Boughaba, sweep net, 15.06.2021 (L. Zouhair); 1♂ (M020), Ain Aouda, sweep net, 3.05.2023 (L. Zouhair); 5♂ (M019), Sidi Yahya Gharb, sweep net, 4.05.2023 (L. Zouhair).

Middle Atlas: 2♂ (M017), Lake of Ouiouane, sweep net, 9.06.2021 (K. Kettani); 1♂ (M038), Oued Sidi Rached, sweep net, 13.10.2023 (L. Zouhair).

High Atlas: 2♂ (M032), Tagadirt, sweep net, 24.03.2017 (K. Kettani); 1♂ (M036), Azib Tifni, sweep net, 2.07.2020 (Y. Fekrani); 1♂ (M049), Imlil, sweep net, 7.07.2021 (S. Fekrani); 2♂, 4♀ (M050), Cascade Imlil, sweep net, 7.07.2021 (S. Fekrani); 1♂ (M058), Oued Réghaya, sweep net, 27.05.2024 (L. Zouhair).

Anti-Atlas: 1♂ (M039), Tissint, sweep net, 30.12.2016 (K. Kettani); 1♂ (M060), Afra oasis, sweep net, 15.05.2024 (L. Zouhair); 4♂ (M059), Oued Agadir Wamsa, sweep net, 28.05.2024 (L. Zouhair).

**Extended diagnosis.** Male (Fig. 2). Small black species (body length: 2.3 mm; wing length: 2.2 mm). Antenna black, pedicel dark reddish brown. Postpedicel as long as wide, rather onion-shaped. Stylus 4 times as long as scape, pedicel and postpedicel combined. Ventral seta on pedicel slightly longer than postpedicel. Palpus black, with 1 long black apical seta. All coxae black; femora black, but apical fifth to quarter yellow. All tibiae from entirely yellow to darkened near middle, exceptionally entirely black. Tarsi yellow to somewhat brownish except tarsomeres 4 and 5 black. Hind tibia lacking strong anterodorsal setae; bearing in apical half a double row of diverging, fine, black ventral setae, which are longer than tibia width; with 3 short spine-like anterior setae at apex. Hind tibia with long pointed postero-apical tooth, which is about 1/3 of hind metatarsus length [Kovalev, 1969: 7, fig. 365]. Hind metatarsus with at least 3 strong spine-like setulae near middle ventrally. Anepisternum (mesopleuron) with a spot of silvery pubescence in the anterior dorsal corner. Mesoscutum with 4–5 pairs of strong dorsocentral setae. Mesoscutum covered with fine setulae, no distinct acrostichals. Apical portion of vein  $M_{1+2}$  straight.

Abdominal tergites: see Collin [1960] for characters.

Male terminalia (Figs 3–5) blackish. Right cercus fused through sclerotized bridge with much longer left cercus (Fig. 5). First lobe of rs1 broadened, with a small point in middle of apex, bearing long setae at left side (Fig. 4). Second lobe of rs2 with a few long setae. Ventral to the right surstylus is a large lobe protruding behind the surstylus visible as sharply pointed projections flanking the right surstylus (Fig. 4, a1, a2). Left surstylus 1 small, pointed, bearing only minute setulae. Left surstylus 2 longer than ls1, club-shaped, covered with short setulae (Fig. 3).

Female. Resembling male, except for the terminalia.

**Notes.** The colouration of the legs is quite variable and hence not a reliable character. The hind tibiae are characteristic by a combination of the absence of strong anterodorsal setae, the presence of a double row of fine long ventral setae in the apical half and a long pointed posterior apical spur. The enlarged black left cercus, fused through a bridge with the right cercus is also unique among the Palaearctic species.

**Distribution.** Azores Islands, Spain (Canary Islands), Portugal, France (mainland), Belgium, Germany, Switzerland, Austria, Italy (mainland, Sardinia), Malta,

Hungary, Bosnia and Herzegovina, Bulgaria, Greece (mainland, Crete, Dodecanisos), Ukraine, Russia (European part), Armenia, Azerbaijan, Cyprus, Middle East, North Africa, Egypt.

Published record, not found during the present study: High Atlas, Marrakech, Ouirgane [Shamshev et al., 2005]. This is the first record of *Crossopalpus aeneus* from the Rif, Eastern Morocco, Atlantic Plain, Middle Atlas and Anti-Atlas regions.

### *Crossopalpus atlanticus* Raffone, 2015 (Figs 6–10)

*Crossopalpus atlanticus* Raffone, 2015: 185 (figs 3, 4). Morocco: Mohammedia (Fedala).

**Material.** Rif: 2♂ (M031), Beach of Martil, sweep net, 18.07.2021 (M. Nourti).

Eastern Morocco: 1♂ (M006), Beach of Saidia, sweep net, 29.05.2022 (H. Maamri); 2♂ (M011), Estuaire Moulouya, Laisse de mer, sweep net, 29.05.2022 (H. Maamri); 1♂ (M029), Estuaire Moulouya, sweep net, 11.07.2022 (H. Maamri); 2♂ (M062), Estuaire Moulouya, Laisse de mer, sweep net, 20.05.2023 (H. Maamri); 1♂ (M061), Beach of Kariat Arekmane, sweep net, 25.05.2023 (H. Maamri).

Atlantic Plain: 1♂, 3♀ (M003), Réserve de Sidi Boughaba, sweep net, 15.06.2021 (L. Zouhair).

Previous record by Raffone [2015] not examined: Morocco, Atlantic plain, Mohammedia (Fedala) (zona litoriparia marina).

**Brief redescription.** Male (Fig. 6). Small black species (body length: 2.3 mm; wing length: 2.2 mm) with black legs, except for yellowish brown tarsi.

Postpedicel a little longer than deep. Apical ventral seta on pedicel, nearly 1.5 times as long as postpedicel. Anepisternum (mesopleuron) shiny. No distinct acrostichals apart from some long pubescence, 3 very long black dorsocentral setae, 2 long setae between anterior dorsocentral and notopleural depression, 1 short notopleural, a short supra-alar and a long postalar. A pair of long apical scutellar setae with a small seta at each side. Legs. Fore femur with a black dorsal seta on apical third, about as long as femur width, a long preapical anterior seta and pale ventral pubescence about half as long as femur width. Fore tibia on apical half covered with dense, pale, somewhat flattened anteroventral pubescence forming like a cushion (Fig. 7). Mid tibia with 1 very long black anterodorsal seta, twice as long as tibia width, at basal third. Hind tibia with 3 very long fine anterodorsal setae in addition to 2 very long posterodorsal setae; ventral pubescence yellowish, longer than tibia width. A long, pointed posterior yellow tooth-like projection, about third of hind metatarsus length. Hind metatarsus with long, pale, very dense ventral pubescence, lacking spine-like setulae.

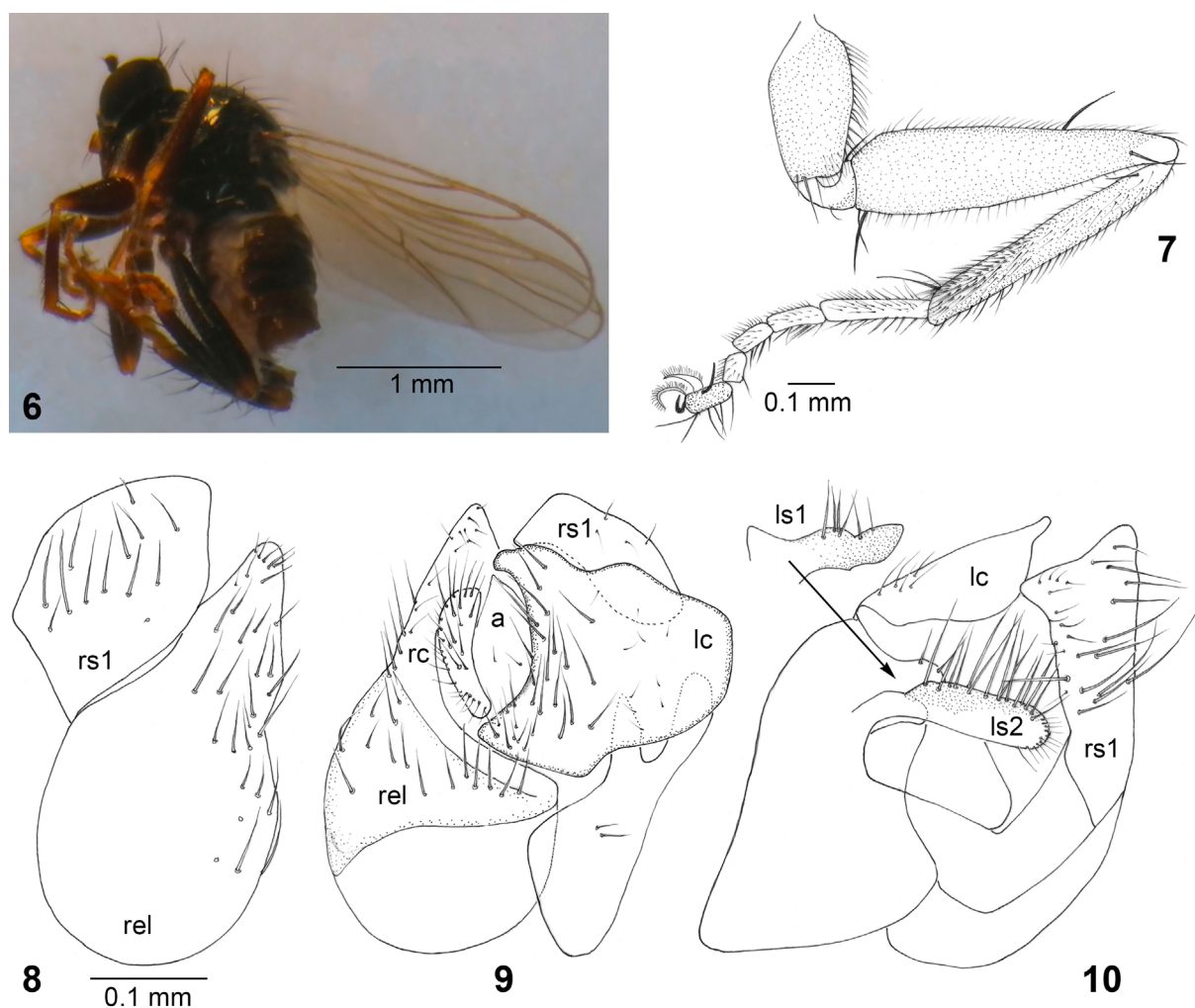
Wing yellowish brown, with pale brown veins. Vein  $M_{1+2}$  weakly undulate in basal half.

Male terminalia (Figs 8–10). The right cercus is digitiform and a little broader than in related species (Fig. 9). The left cercus is very large with long setae only on the right side (Fig. 9), apical border undulating (not forked). The right epandrial lamella has a pointed apex (Fig. 8) while the rs1 is unusually large (Fig. 8) and long (Fig. 10). Left surstylus 2 is unusually large with multiseriate long setae (Fig. 10) while ls1 is much shorter (Fig. 10) and hidden below ls2 (Fig. 10, inset).

**Notes.** Care should be taken with the variability in colour of legs since some specimens have quite yellowish tibiae that are darkened in others.

We did not have the occasion to study the type material of *C. atlanticus* nor specimen of the *C. pilipes* Loew, 1859 collected at Bahiret el Bihane (Tunisia) that Raffone [2015] used to compare his new species. Hence,





Figs 6–10. *Crossopalpus atlanticus*, male (Beach of Martil, M031), habitus and details of structure. 6 – habitus, lateral view; 7 – fore leg, anterior view; 8–10 – terminalia: 8 – right epandrial lamella with right surstylus, lateral view, 9 – epandrium, dorsal view, 10 – epandrium, ventral view. Abbreviations are given in “Material and methods”.

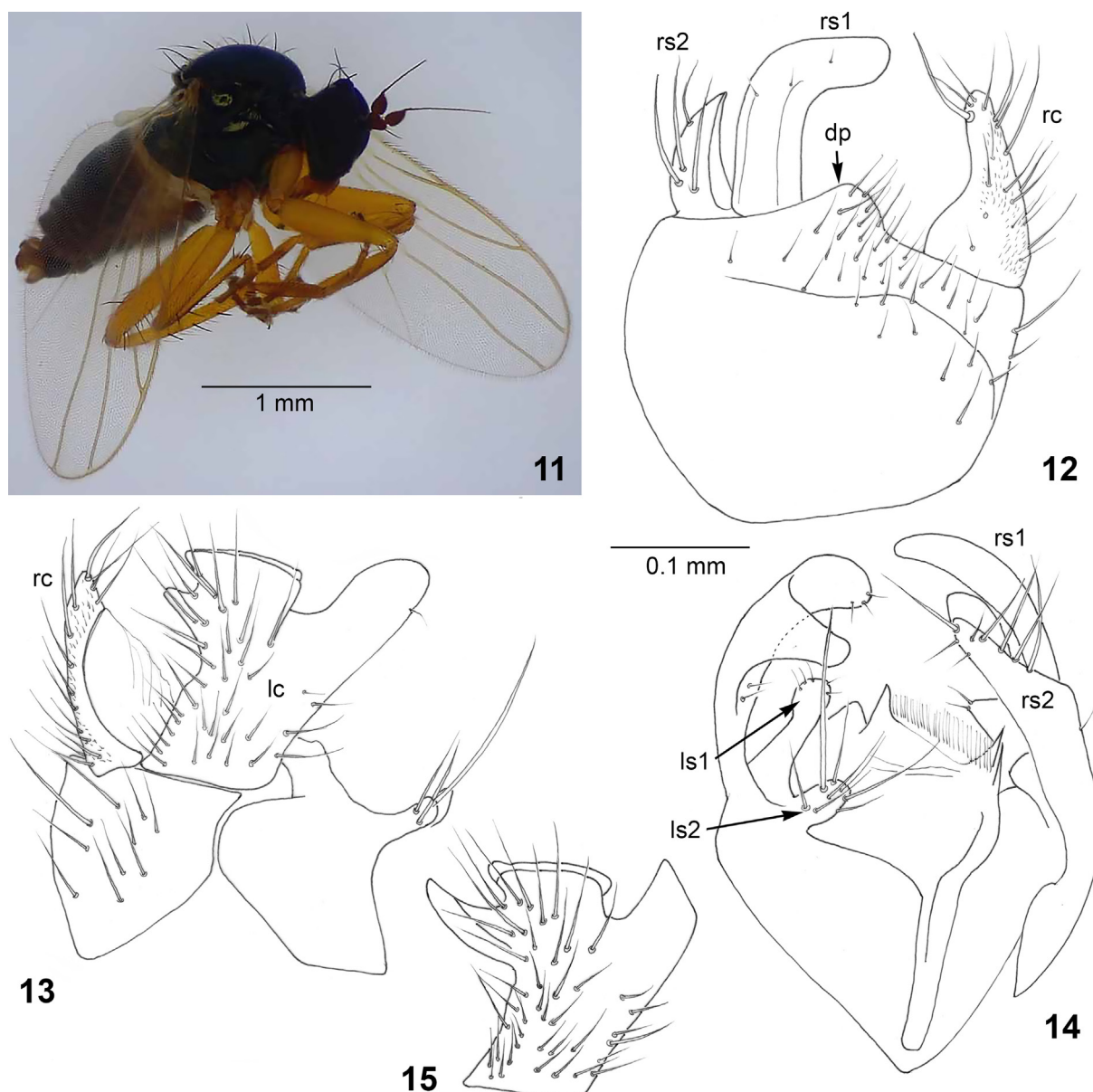
Рис. 6–10. *Crossopalpus atlanticus*, самец (Beach of Martil, M031), габитус и детали строения. 6 – габитус, вид сбоку; 7 – передняя нога, вид спереди; 8–10 – терминалии: 8 – правая эпандриальная пластинка с правым сурстилем, латерально, 9 – эпандрий, дорсально, 10 – эпандрий, вентрально. Расшифровка сокращений приведена в разделе «Material and methods».

we have to rely on his description alone [Raffone, 2015]. Unfortunately, comparison with the figures of Raffone [2015] was not possible since the different structures were not annotated and apart from the left cercus we were not able to identify the other structures. Nevertheless, we decided to attribute the name *C. atlanticus* to the ten males that we examined in the present study. This decision was based on the fact that we could compare the specimens of *C. atlanticus* from Morocco with specimens from Romania considered the true *C. pilipes* identified by Engel [1939]. They are undoubtedly closely related species as shown by the similar setation on the hind legs and the basic structure of the male terminalia. Both are the only *Crossopalpus* that have such a typical large left surstylus 2. Otherwise, there are many differences between the two species. The enlarged left cercus in *C. atlanticus* has the apical border undulating, lacking a deep median notch, whereas *C. pilipes* has a rather forked left cercus with a distinct median notch (Fig. 33) on the apical margin.

In *C. atlanticus* the right surstylus is slightly larger, with a different shape and lacking a prominent point on the right margin (Fig. 8) and the setation on the surstylus is rather long. In *C. pilipes* the right surstylus is smaller with a prominent point on the right margin (Fig. 32). The setation on the right surstylus is much shorter. The tip of the right epandrial lamella in *C. pilipes* is cap-like whereas it is straight in *C. atlanticus*.

Raffone [2015] indicated that the fore tibiae are apically surrounded by long yellow setation. We suppose that this unique character on the fore tibia indeed corresponds to the cushion-like, dense, pale pubescence in an anteroventral position on the apical half of the fore tibia. Such a dense cushion-like pubescence is not present on Romanian *C. pilipes*, however some dispersed pale pubescence is present on the latter species.

**Distribution.** Currently, this species is known only from Morocco. This is the first record of *Crossopalpus atlanticus* from the Rif and Eastern Moroccan regions.



Figs 11–15. *Crossopalpus dilutipes*, male (Amrah, M005), habitus and terminalia.

11 – habitus, lateral view; 12–15 – terminalia: 12 – right epandrial lamella and right cercus, lateral view, 13 – epandrium and cerci, dorsal view, 14 – epandrium, ventral view (hypandrium omitted), 15 – left cercus, dorsal view. Abbreviations are given in “Material and methods”.

Рис. 11–15. *Crossopalpus dilutipes*, самец (Амрах, М005), габитус и терминалии.

11 – габитус, вид сбоку; 12–15 – терминалии: 12 – правая эпандриальная пластинка и правый церк, латерально, 13 – эпандрий и церки, дорсально, 14 – эпандрий, вентрально (гипандрий не показан), 15 – левый церк, дорсально. Расшифровка сокращений приведена в разделе «Material and methods».

*Crossopalpus dilutipes* (Strobl, 1906)  
(Figs 11–15)

*Drapetis setiger dilutipes* Strobl, 1906: 312 (type locality: Andalusia, Algeciras).

*Crossopalpus dilutipes*: Chvála, 1981: 173 (redescription), fig. 28 (antenna, male terminalia).

**Material.** Rif. 1♂ (M005), Beach of Stehat, Malaise trap, 25.04–25.05.2015 (K. Kettani); 1♂ (M010), Amrah, sweep net, 15.05.2021 (K. Kettani).

Previous records not verified in the present study: Rif, Tétouan, M'Diq, Smir, lagoon/saltmarsh/Kabila beach, dunes [Ebejer et al., 2019]; Atlantic Plain, 9 km SE of Aïn Chouk, Lower Loukous marsh, 6 m [Ebejer et al., 2019].

**Brief redescription.** A species of the *setiger*-group with extensively yellowish legs in male including mid and hind coxae. Female with legs often more darkened. Antenna black. Postpedicel 1.5 times as long as wide, stylus about 3 times as long as postpedicel. Ventral seta on pedicel as long as postpedicel. Palpus brown, with a pale brown apical seta. Mesoscutum set with long acrostichals and dorsocentrals, lacking other fine pubescence. Mid tibia with a strong black anterodorsal seta on basal third. Hind femur with a strong anterodorsal seta on apical third. Hind tibia with 4 strong black anterodorsal setae, posterodorsally with a few long weak pale setulae on basal half, nearly as long as width of tibia; posterior apical spur absent. Wing with pale yellowish veins. Apical portion of  $M_1$  weakly undulating.

Male terminalia yellowish brown (Figs 12–14). The tip of the right surstylus 1 is cap-shaped like in other species of the *setiger*-group. Right surstylus 2 is pointed and bears some long setae (Figs 12, 14). The dorso-apical projection of the right epandrial lamella is quite short (Fig. 12), unlike other species of the *C. setiger*-group where it is higher and more pointed. The right cercus is much smaller than the left cercus and bears a strong subapical seta, the numerous other setae are long, but thin. The left cercus has a truncate apex with a rim (Figs 13, 15). The right side of the left cercus is set with long fine yellowish setae. This in contrast to *C. setiger* that bears stronger black setae.

Left surstylus 1 bears only short hairs, while ls2 bears a very long subapical seta, among shorter setae (Figs 13, 14).

**Notes.** The shape of the second right surstylus corresponds to the illustration in Chvála [1981: fig. 28b], but only a single seta is shown, while in our specimens there are four long setae. The short dorso-apical projection corresponds very well to the figure 28b in Chvála, as well as the left cercus with a truncate apex, bearing a rim. Unlike *C. flavitibia* sp. n. that is closely related to *C. dilutipes*, the apex of the left cercus is only slightly produced to the right side, while in *C. flavitibia* sp. n. as well as in *C. setiger*, the tip is distinctly produced to the right. This should not be confused by the large extension below the tip in these species (e.g. Fig. 40). The shape of the long projection to the left side is also identical to the illustration by Chvála [1981].

**Distribution.** Spain, Morocco, Tunisia.

*Crossopalpus flavipes* Grootaert et Zouhair, sp. n.  
(Figs 16–19)

**Material.** Holotype, ♂ (M015): Morocco, Rif, Amsemlil, sweep net, 17.02.2022 (L. Zouhair).

**Diagnosis.** A small black species (body length: 2.1 mm; wing length: 2.1 mm). Hind tibia lacking a posterior apical tooth. The new species appears to belong to the *aeneus*-group. A large sclerite is present at the inside of the right epandrial lamella that is probably homologous with the appendages present in *C. aeneus*.

**Description.** Male (Fig. 16). Head black, with long, black, diverging anterior ocellar setae and pair of equally long converging vertical setae. Frons grey dusted, wide. Face linear, eyes almost touching, with grey dusting, but clypeus shiny black. Gena broad, about 1/5 as wide as height of eye, densely set with long silvery microtrichia. Occiput grey dusted, with short pale brownish setulae. Antenna black, though postpedicel paler than pedicel. Postpedicel slightly longer than deep, about as long as pedicel. Stylus black, about 5 times as long as all antennal segments combined. Ventral apical seta on pedicel lost. Palpus black, almond shaped, set with dusky yellowish setulae and long black apical seta nearly as long as palpus.

Thorax with mesoscutum entirely shiny as well as pleura except small patch of silvery microtrichia on anepimeron (pteropleuron). Mesoscutum densely set with pale setulae; 1 long black fine notopleural seta, 1 black supra-alar and 1 prescutellar seta. Pair of long black scutellar setae with short seta laterally.

Legs entirely yellow, including coxae though hind coxae more dusky and apical tarsomere of all legs brownish. Fore coxa with yellowish setation. Fore femur swollen on basal half, with short yellowish ventral setae, hardly quarter as long as width of femur; at base with single brownish seta as long as width of femur; short anteroventral and anterior black preapical setae present as well as 2 posteroventral preapical setae. Fore tibia slightly shorter than fore femur, with pair of long black preapical setae, longer than width of tibia, posteroventral seta 2 times as long. Tarsomere 1

with setulae dorsally as well as ventrally, nearly as long as width of tarsomere. Mid coxa with long yellow anterior setae. Mid femur narrower than fore femur, with long black anteroventral preapical seta, without distinct ventral setae. Mid tibia without very long brown preapical setae. Hind femur longer than mid femur, with pair of black anterior or anteroventral black setae as long as width of femur. Hind tibia with black spine-like ventral seta nearly as long as width of tibia; without strong apical posterior spur, but with brown apical rim, indistinctly pointed; ventrally with dusky setulae about as long as width of tibia. Metatarsus with yellowish setulae only, lacking spines.

Wing with yellowish brown tinge. Veins brownish (Fig. 16). Veins  $R_{4+5}$  and  $M_{1+2}$  diverging in middle and converging after middle to end parallel in costa. Halter white. Squama whitish with long pale cilia.

Abdomen dark brown. Tergites dusted at base, set with short yellowish setulae. Sternites also set with short setulae. Terminalia (Figs 17–19) black, set with yellowish setae. Right cercus small and thin, with subapical seta as long as length of cercus. Left cercus very large, with rectangular projection above anus, not connected to right cercus; stripe of longer setae on right side of cercus; large left side of cercus darker, almost bare, with a few scattered minute hairs. Large sclerite present at inside of right epandrial lamella, spoon-shaped when viewed from side (Fig. 18), in later view protruding behind right epandrial lamella (Fig. 17). Left surstylus 1 small, with short setulae. Left surstylus 2 longer with a few very long setae (Fig. 19).

Female unknown.

**Derivatio nominis.** The species is named after the entirely yellow legs.

*Crossopalpus flavitibia* Grootaert et Zouhair, sp. n.  
(Figs 20–23)

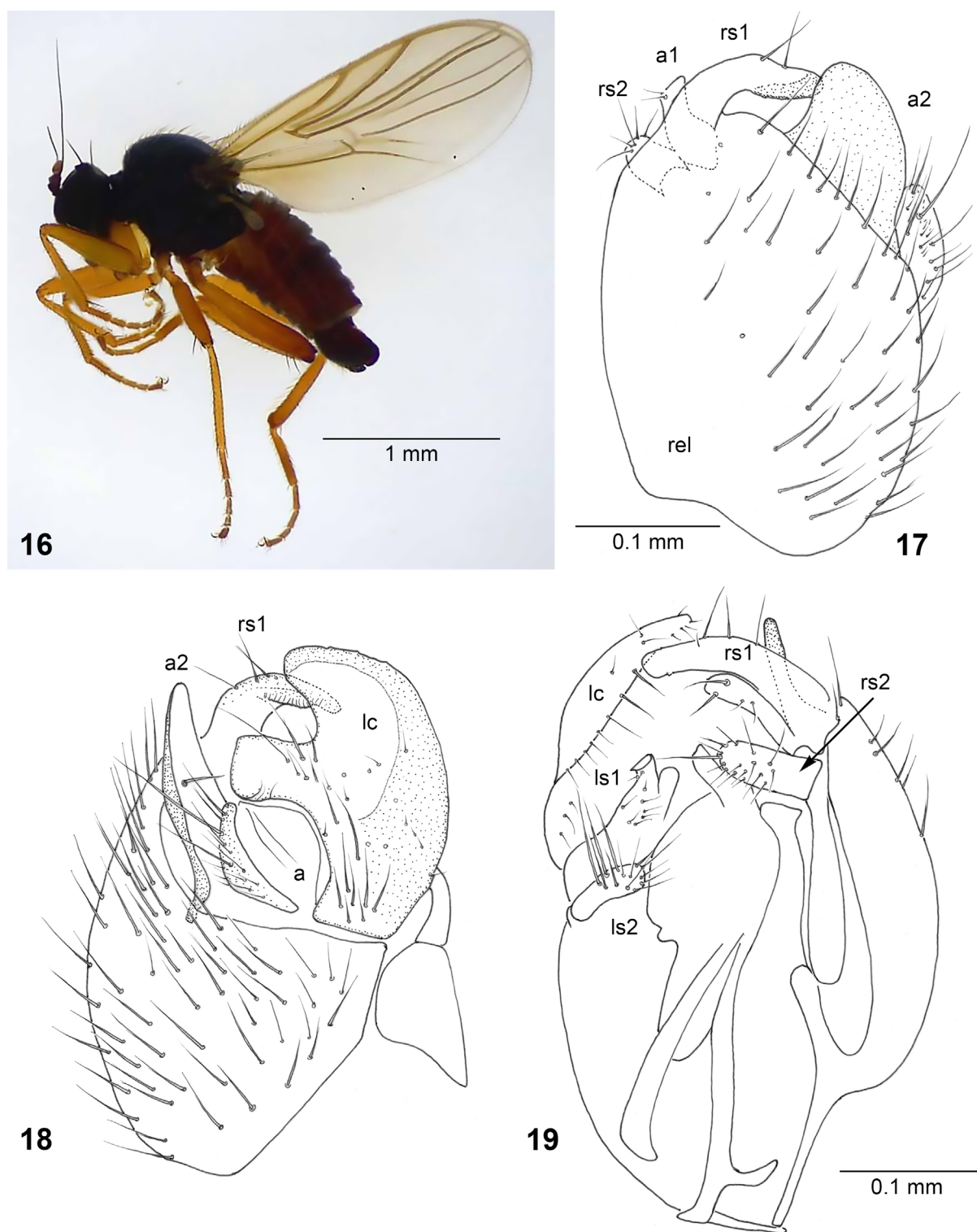
**Material.** Holotype, ♂ (M016): Morocco, Anti-Atlas, Boragua, sweep net, 2.12.2017 (Y. Fekrani). Paratype: 1 ♂ (M035), Morocco, High Atlas, Azib Tifni, sweep net, 2.07.2020 (Y. Fekrani).

**Diagnosis.** A small black species from the *setiger* species-group (body length: 2.7 mm; wing length: 2.3 mm). The dorso-apical projection of the right epandrial lamella in *C. dilutipes* is short and not pointed (Figs 12–14), which is a good genital character to distinguish the two species. In *C. flavitibia* sp. n. the dorso-apical projection is long, almost a third of the length of the right epandrial lamella and it is pointed (Figs 21, 22). The setation on the left cercus is much weaker than in *C. setiger*, which has strong black setae. The setation is yellowish in *C. flavitibia* sp. n. just like in *C. dilutipes*.

**Description.** Male (Fig. 20). Head black, with long black proclinate and lateroclininate ocellar setae. Vertical setae black, convergent, slightly longer than ocellars. Frons grey dusted, wide. Face narrow, as wide as 2 ommatidia combined, with grey dusting. Clypeus shiny black. Gena very broad, about a fourth to fifth as wide as height of eye, upper half densely set with long silvery microtrichia, lower half shiny black. Occiput grey dusted, set with short pale brownish setulae. Antenna black. Postpedicel small, 1.2 times as long as wide, slightly longer than pedicel. Ventral apical seta on pedicel black, longer than pedicel. Stylus black, nearly 4 times as long as all antennal segments combined. Palpus large, brownish black, set with pale setulae; a stronger black apical seta shorter than length of palpus. Proboscis brown.

Thorax with mesoscutum shiny black, only hind border with scutellum narrowly brownish microtrichose. A few yellowish setulae on anterior quarter and in postalar zone. Pleura shiny black. Scutellum shiny, postnotum grey dusted. Mesoscutum densely set with short pale setulae and very long black setae that probably correspond to acrostichals and dorsocentral setae. Pair of





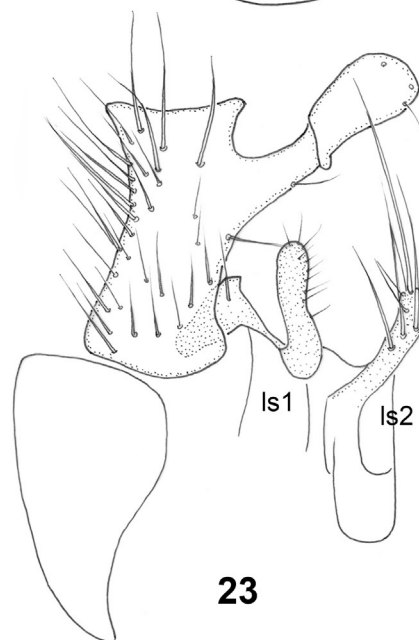
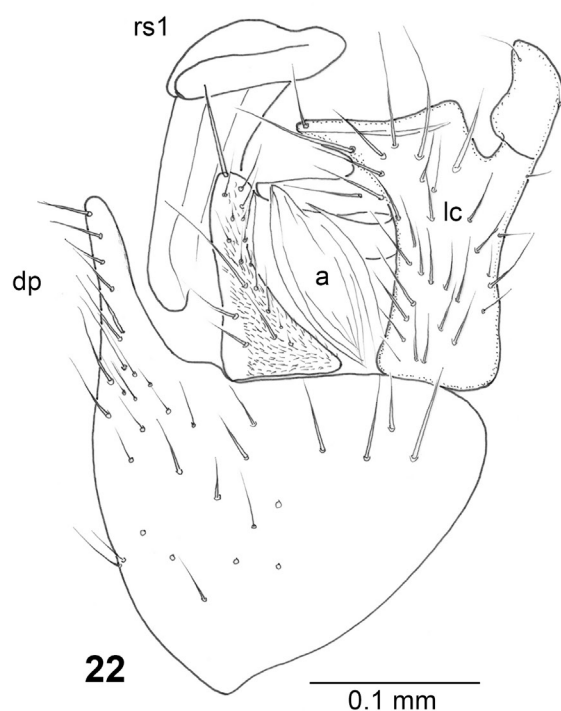
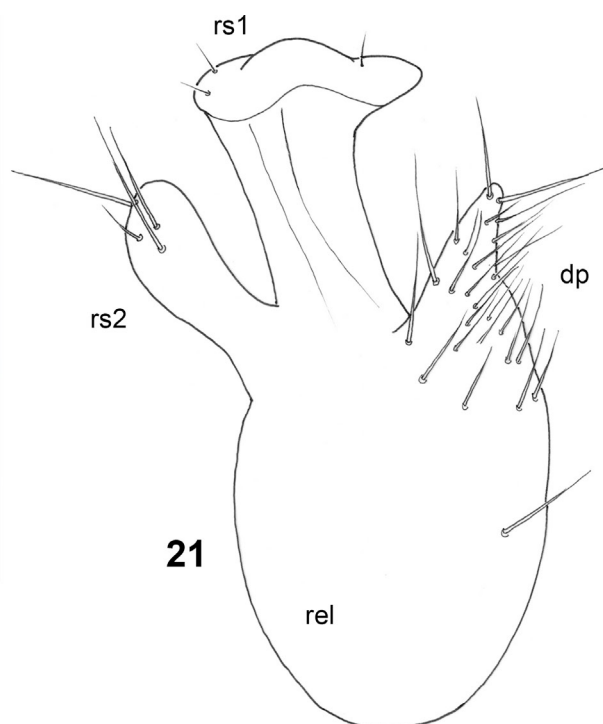
Figs 16–19. *Crossopalpus flavipes* sp. n., male, holotype (Amsemlil, M015), habitus and terminalia.

16 – habitus, lateral view; 17–19 – terminalia: 17 – right epandrial lamella, lateral view, 18 – same, dorsal view, 19 – epandrium, ventral view (hypandrium omitted). Abbreviations are given in “Material and methods”.

Рис. 16–19. *Crossopalpus flavipes* sp. n., самец, голотип (Амсемли, М015), габитус и терминалии.

16 – габитус, вид сбоку; 17–19 – терминалии: 17 – правая эпандриальная пластинка, латерально, 18 – то же, дорсально, 19 – эпандрий, вентрально (гипандрий не показан). Расшифровка сокращений приведена в разделе «Material and methods».





Figs 20–23. *Crossopalpus flavitibia* sp. n., male, holotype (Boragua, M016), habitus and terminalia.

20 – habitus, lateral view; 21–23 – terminalia: 21 – right epandrial lamella, lateral view, 22 – epandrium with cerci, dorsal view, 23 – left cercus and left surstyli, ventro-lateral view (hypandrium omitted). Abbreviations are given in “Material and methods”.

Рис. 20–23. *Crossopalpus flavitibia* sp. n., самец, голотип (Boragua, M016), габитус и терминалии.

20 – габитус, вид сбоку; 21–23 – терминалии: 21 – правая эпандриальная пластинка, латерально, 22 – эпандрий с церками, дорсально, 23 – левый церк и левые сурстили, вентро-латерально (гипандрий не показан). Расшифровка сокращений приведена в разделе «Material and methods».

long black scutellar setae with shorter fine paler lateral seta at half as long as apical scutellars.

Legs with all coxae black. All femora black with apical quarter of fore femur, apical fifth of mid and hind femora yellowish. All tibiae yellow with dusky patches. All tarsomeres yellow except darkened apical tarsomere of all legs. Fore coxa with yellowish setation. Fore femur slightly swollen in basal 2/3, with short yellowish ventral pubescence; fine black ventral seta at base, longer

than width of femur. A long anterior black preapical seta longer than femur is wide, anterodorsally with row of at least 4 long black setae. Fore tibia shorter than fore femur with long black anterodorsal seta on basal third and pair of long black preapical setae. Mid femur narrower than fore femur, with long black anterior preapical seta, without distinct ventral setae. Mid tibia with long black anterodorsal seta on basal third and a pair of black preapical setae. Hind femur longer than mid femur, with row of

4 black anteroventral setae nearly as long as width of femur. Hind tibia with 5 black anterodorsal setae as long as width of tibia, on swollen apex of tibia with 2 short black preapical spine-like setae. Posterior spur short, indistinct, represented by apical swelling of tibia, produced in small point. Hind tibia ventrally densely set with row of dusky setulae about as long as width of tibia; without apical spur. Metatarsus with row of short black setae (not spine-like), nearly as long as width of metatarsus.

Wing clear, veins pale brownish (Fig. 20). Veins  $R_{4+5}$  and  $M_{1+2}$  diverging from middle onward toward wing margin. Halter white. Squama whitish with long pale cilia.

Abdomen. Shiny black tergites sparsely set with short yellowish setulae. Terminalia (Figs 21–23) yellowish brown, with yellow setation. Dorso-apical projection of right epandrial lamella long and pointed (Figs 21, 22), about one third of total height of right epandrial lamella (excluding surstylus). Right cercus with strong apical seta, further with fine setae. Left cercus with truncate tip, with apical rim produced towards right. Below apical border with large projection running behind anus and hence hidden on Fig. 22; very long ribbon-like projection at left side of left cercus, with median fold, visible as line on Fig. 23. Right surstylus large with cap-like folded apex, apparently not separated from right epandrial lamella. Right surstylus 2 bears some long apical and subapical setae (Fig. 21). Left surstyli finger-like; ls1 with minute setae, ls2 bearing very long setae, with apical seta longer than surstylus.

Female unknown.

**Derivatio nominis.** The name *flavitibia* alludes to the yellow tibiae.

*Crossopalpus nigriteloides* Grootaert et Zouhair, **sp. n.**  
(Figs 24–27)

**Material.** Holotype, ♂ (M014): Morocco, Rif, Tourbière Amsemlil, sweep net, 23.04.2017 (K. Kettani). Paratypes: 1♂ (M045), same label as holotype; 1♂ (M063), Moulay Staëil, sweep net, 23.06.2024 (L. Zouhair).

**Diagnosis.** A small black species (body length: 1.8 mm; wing length: 1.3 mm). This small species is very similar to *C. nigritelus*. The main differences are in the male terminalia. The shape of the left cercus is much different, it is forked with a very deep notch in the apical margin, for about half the length of the left cercus. This notch is very shallow in *C. nigritelus*. The right lobe of left cercus is wide, with a pointed tip while the left lobe of left cercus is long, finger-like (Fig. 26), unlike *C. nigritelus* that has a rounded apical margin of the right side of the left cercus (Fig. 30). Right surstylus 1 is very wide, bent over the epandrium in *C. nigritelus* and rs2 is large (Fig. 31). In *C. nigriteloides* **sp. n.** rs1 is narrow, not hood-shaped at all while rs2 is slender (Fig. 27).

**Description.** Male (Fig. 24). Frons wide above, narrowed towards antennae, grey dusted. Occiput grey dusted. Eyes almost touching on face, nearly of one ommatidium width. Clypeus shiny. Antenna black, postpedicel less darkened than pedicel. Stylus black, about 4 times as long as all antennal segments together. Long black ventral apical seta on pedicel, longer than postpedicel. Postpedicel 1.2 times as long as wide, only slightly longer than pedicel. Palpus black, grey dusted, with black apical seta slightly shorter than palpus.

Mesoscutum polished. Anepisternum (mesopleuron) shiny, with some pruinosity but not microtrichose. One black notopleural and 1 postalar seta. Pair of not very long scutellars.

Legs entirely black including all coxae, femora and tibiae; knees slightly paler. Metatarsi of all legs black, while other tarsomeres are brownish. Fore femur with inconspicuous ventral pubescence. Fore tibia with a pair of black apical setae, longer than

depth of tibia. Fore metatarsus with a few black spine-like ventral setulae. Mid femur with long black anterior preapical seta, ventrally with short pubescence only. Mid tibia with pair of black apical setae, longer than depth of tibia. Hind femur much thickened on apical half, with a row of 3 black long anteroventral setae in apical third. Hind tibia with short brownish ventral pubescence, with long black preapical anteroventral seta, long pointed yellowish brown posterior spur, about 1/3 as long as metatarsus. Hind metatarsus with a few longer brownish ventral setulae near base, otherwise setulae short, not spine-like.

Wing clear, veins pale brownish (blackish when wing dry). Veins  $R_{4+5}$  and  $M_{1+2}$  not undulating, only weakly diverging towards end, parallel near wing margin (Fig. 24). Vein Cu with only basal half brown, apical half whitish. Squama small, whitish, with long white cilia. Haltere pale brownish (not black, note haltere becomes darker when specimen is dried).

Abdomen. Tergites shiny black, set with short pale pubescence. Terminalia (Figs 25–27). Right cercus narrow in dorsal view, set with long fine setae (Fig. 26). Left cercus large with broadly forked apex; right fork broad; left fork long, finger-like (Fig. 26). Right surstylus long (Figs 25, 27), bearing only short setulae. Right surstylus 2 very short (Fig. 27). Left surstylus 1 much longer than unusual short ls2. Left surstylus 2 much shorter than usual, bearing only a few setae (Fig. 27).

Female unknown.

**Derivatio nominis.** The name *nigriteloides* alludes to its resemblance with *C. nigritelus*.

*Crossopalpus nigritelus* (Zetterstedt, 1842)  
(Figs 28–31)

*Tachydromia nigritelus* Zetterstedt, 1842: 298 (type locality: Sweden, Gotland).

*Drapetis nervosa* Loew, 1859: 37 (type locality: Germany).

*Tachydromia parvicornis* Zetterstedt, 1859: 4992 (type locality: Southern Sweden, Scania).

*Drapetis aterrima* Curtis: Lundbeck, 1910: 254; Frey, 1913: 68; Engel, 1939: 111. Misidentifications.

*Crossopalpus nigritelus*: Collin, 1961: 46, fig. 20.

*Crossopalpus nigritelus*: Chvála, 1975: 271, figs 10, 19, 29, 614, 625–627, 777.

**Material.** Rif : 2♂ (M041), Maison forestière, Malaise trap, 7.06–17.07.2014 (K. Kettani); 1♂ (M028), Maison forestière, sweep net, 28.04.2019 (K. Kettani).

Middle Atlas: 1♂ (M047), La Maison de la Cédraie, sweep net, 29.05.2021 (S. Fekrani).

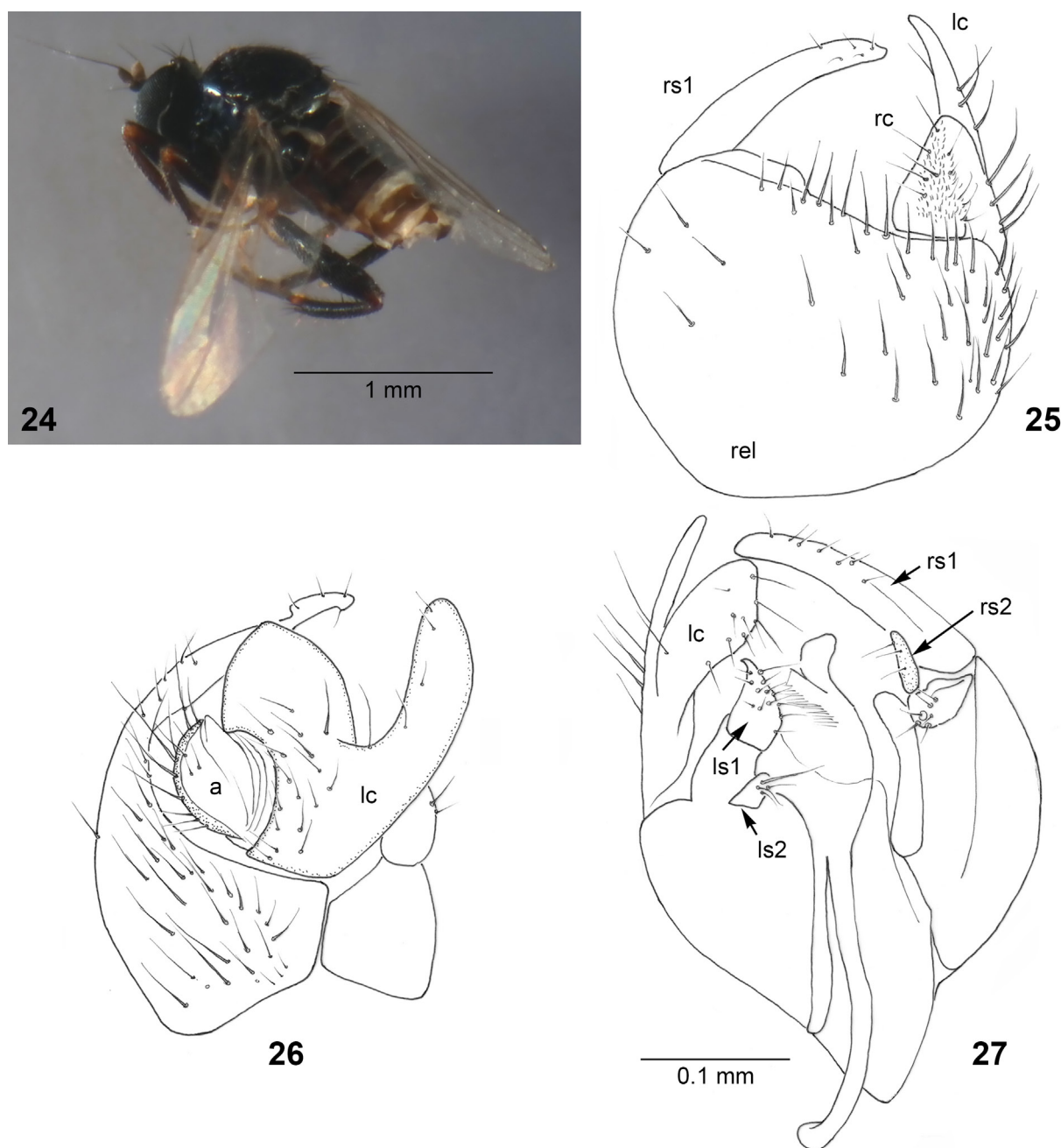
High Atlas: 1♂ (M012), Source Titaouine, sweep net, 24.05.2021 (K. Menouar).

Previous record, not seen during this study: Rif, Chefchaouen, Oued Laou, saltmarsh [Ebejer et al., 2019]; Issaguen, scrub, rocky slope, cedar forest, 1620 m a.s.l. [Ebejer et al., 2019].

**Diagnosis.** Postpedicel nearly 2 times as long as wide. Stylus long, about 5 times as long as postpedicel. Ventral seta on pedicel longer, about 2 times as long as postpedicel. Mesoscutum with only short brownish setulae besides the usual stronger setae at the sides. Anepisternum (mesopleura) entirely shiny black, no patches of microtrichia present.

Legs with all coxae and femora black, tibiae brown to black. All tarsomeres yellowish brown, hind basitarsus brown as well as apical tarsomere. Hind tibia with an anterior apical row of 4 setae, slightly longer than tibia as wide. No strong anterodorsal setae present. Hind tibia with a strong yellow pointed posterior spur.

Halter dusky (not white). Wing veins brown. Apical portion of vein  $M_{1+2}$  weakly undulating.



Figs 24–27. *Crossopalpus nigritelloides* sp. n., male, holotype (Tourbière Amsemlil, M014), habitus and terminalia. 24 – habitus, lateral view; 25–27 – terminalia: 25 – right epandrial lamella with surstyli, latero-dorsal view, 26 – epandrium with cerci, dorsal view, 27 – epandrium with left cercus, ventral view (hypandrium omitted). Abbreviations are given in “Material and methods”.

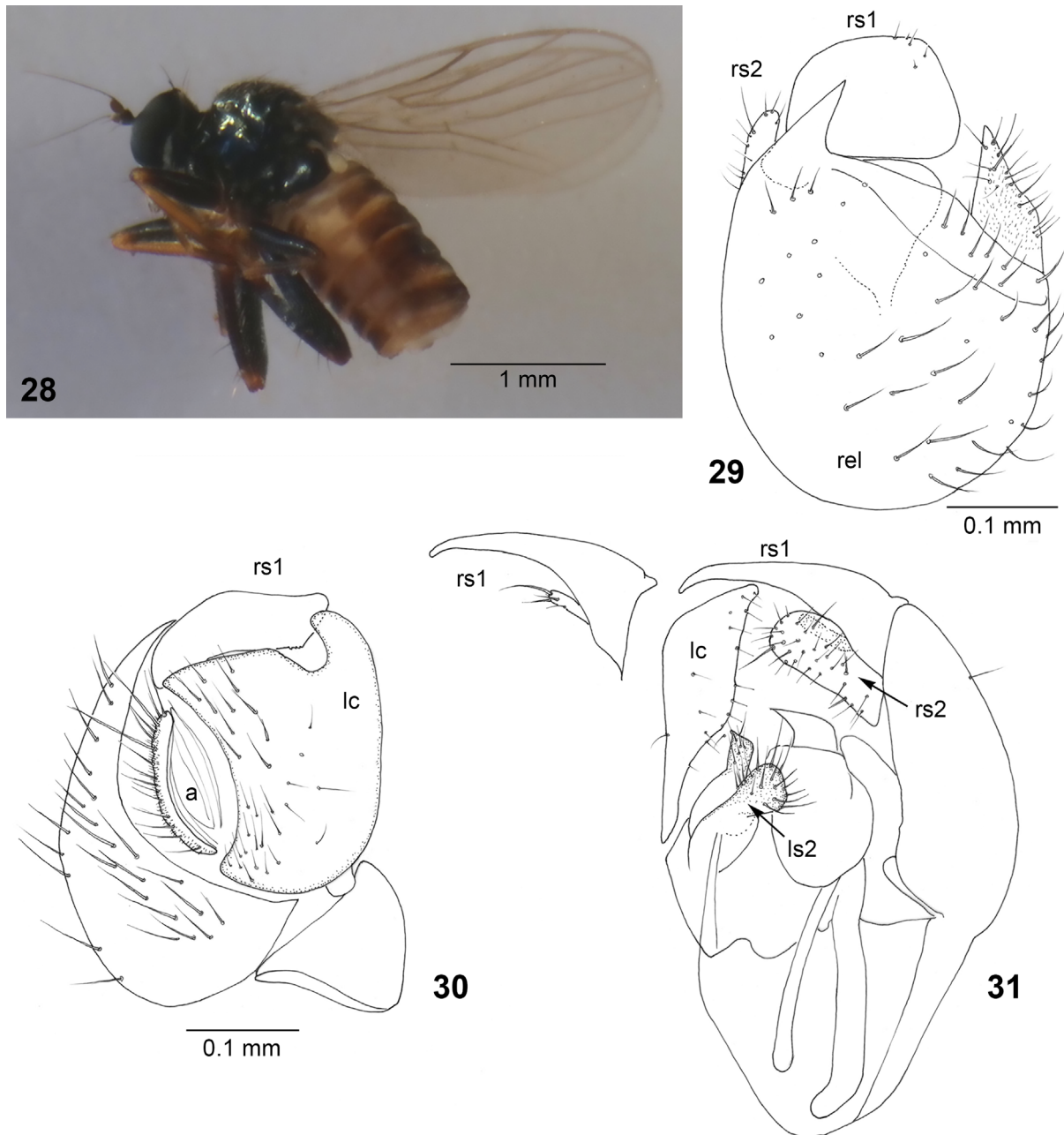
Рис. 24–27. *Crossopalpus nigritelloides* sp. n., самец, голотип (Tourbière Amsemlil, M014), габитус и терминалии.

24 – имаго, общий вид; 25–27 – терминалии: 25 – правая эпандриальная пластинка с сурстилиями, латеро-дорсально, 26 – эпандрий с церками, дорсально, 27 – эпандрий с левым церком, вентрально (гипандрий не показан). Расшифровка сокращений приведена в разделе «Material and methods».

Male terminalia (Figs 29–31) black, somewhat globular broader than tip of abdomen. Right cercus narrow with a few long fine setae on the right side. Left cercus enlarged with apical margin produced into a right and a left point (Fig. 30). The left cercus is longer than in other European specimens. Right surstylus 1 large hood-shaped bent over the tip of the epandrium (Figs 29, 30). Right surstylus 2 rectangular (Fig. 31) covering the presence of a smaller papilla-like projection at the base

of rs1 (Fig. 31, inset). Both left surstyli are rather small with not very long setae (Fig. 31).

**Notes.** The illustrations given by Chvála [1975: figs 625–627] are confusing since microtrichia were added to the anus which are not present in most *Crossopalpus*, at least in dorsal view so far as known. Hence the size of the right cercus is way too large [Chvála, 1975: fig. 626]. The left cercus, confusedly called left dorsal appendage [Chvála, 1975: fig. 627], is presented with a pointed tip at



Figs 28–31. *Crossopalpus nigritellus*, male, habitus (Maison forestière, M028) and terminalia (Source Titaouine, M012).

28 – habitus, lateral view; 29–31 – terminalia: 29 – right epandrial lamella, lateral view, 30 – epandrium and cerci, dorsal view, 31 – epandrium and cerci, ventral view (hypandrium omitted). Abbreviations are given in “Material and methods”.

Рис. 28–31. *Crossopalpus nigritellus*, самец, габитус (Maison forestière, M028) и терминалии (Source Titaouine, M012).

28 – габитус, вид сбоку; 29–31 – терминалии: 29 – правая эпандриальная пластинка, латерально, 30 – эпандрий и церки, дорсально, 31 – эпандрий и церки, с детализированием небольшого выступа под вершиной правого сурстиля, вентрально (гипандрий не показан). Расшифровка сокращений приведена в разделе «Material and methods».

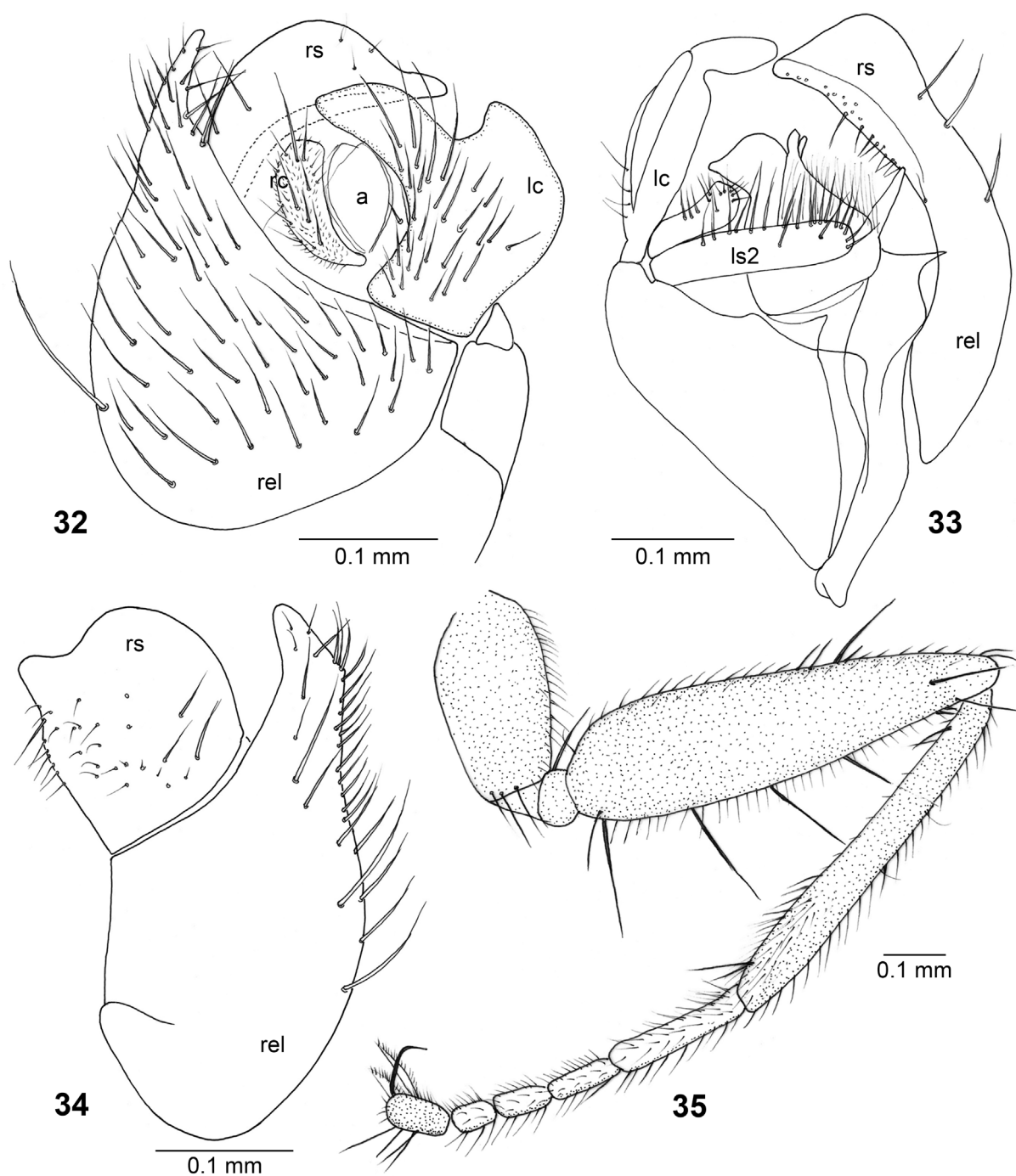
both lobes of the cercus, while the tips are rounded in the specimens we observed so far.

As indicated in the description of the male terminalia, the left cercus is longer in the specimens we studied here. The shape of the left cercus is also slightly different. The median excavation on the apical border is more shallow, while it is much deeper in European specimens. Genetic distance of these forms is unknown.

**Distribution.** Britain Isles, Danish mainland, the Netherlands, Belgium, France (mainland), Spain (mainland), Germany, Switzerland, Czech Republic, Austria, Slovakia, Sweden, Finland, Estonia, Lithuania, Poland, Slovenia, Greece (mainland, Crete), Ukraine, Russia (northeast and centre of the European part).

This is the first record of *Crossopalpus nigritellus* from the Middle and High Atlas.





Figs 32–35. *Crossopalpus pilipes*, male (Romania, Sacalin Island (leg. A. Pintilioaie)), details of structure.

32–34 – terminalia: 32 – epandrium, dorsal view, 33 – epandrium, ventral view (hypandrium omitted), 34 – right epandrial lamella with right surstylus, lateral view; 35 – fore leg, anterior view. Abbreviations are given in "Material and methods".

Рис. 32–35. *Crossopalpus pilipes*, самец (Румыния, остров Сакалин (leg. A. Pintilioaie)), детали строения.

32–34 – терминалии: 32 – эпандрий, дорсально, 33 – эпандрий, вентрально (гипандрий не показан), 34 – правая эпандриальная пластинка с правым сурстилем, латерально; 35 – передняя нога, вид спереди. Расшифровка сокращений приведена в разделе «Material and methods».

*Crossopalpus pilipes* (Loew, 1859)  
(Figs 32–35)

*Drapetis pilipes* Loew, 1859: 36 (type locality: Sicily).

*Drapetis* (*Crossopalpus*) *pilipes*: Engel, 1956: 117 (diagnosis), fig. 68 (Engel [1956] transferred this species to *Crossopalpus*, but indicated it as *Drapetis* in figure capture).

**Diagnosis.** *Crossopalpus pilipes* has the fore femur with more than one (2–3) dorsal setae and 4 long ventral setae. The related species *C. atlanticus* has the fore femur with only 1 dorsal seta and a single ventral seta at its base. The fore tibia is apically set with less dense pubescence (Fig. 35) than in *C. atlanticus*. Male terminalia (Figs 32–35): left cercus with a deep notch on the apical border.

**Notes.** Raffone [2015: figs 1, 2] illustrated the terminalia of a male recorded at Bahiret el Bibane, Tunisia. Due to the lack of annotations on the figures from Raffone [2015], we do not find resemblances with the specimen from Romania we used for comparison. A revision of the type material is needed to clearly distinguish between both *C. atlanticus* and *C. pilipes*.

**Distribution.** Spain, France, Italy, Romania, Bulgaria, Greece, Tunisia and Egypt.

*Crossopalpus pilipes* is to our knowledge not yet reported from Morocco although it is expected to occur here since it is a Mediterranean coastal species that is reported from nearby countries (Spain, Tunisia).

*Crossopalpus setiger* (Loew, 1859)  
(Figs 36–40)

*Drapetis setigera* Loew, 1859: 39 (type locality: Germany).

*Crossopalpus setiger*: Chvála, 1975: 268 (redescription), figs 616, 617, 619–621, 775; Kovalev, 1976: 782, figs 3, 4 (male terminalia).

**Material.** Rif: 1♂ (M022), Tourbière Amsemlil, sweep net, 7.02.2017 (K. Kettani); 1♂, 1♀ (M009), Tourbière Amsemlil, sweep net, 23.04.2017 (K. Kettani); 7♂, 8♀ (M001 ♂ dissected, M002) Oued Amsemlil, sweep net, 1.07.2019 (K. Kettani); 1♂, 9♀ (M052), Bni M'hamed, sweep net, 10.05.2021 (L. Zouhair).

Middle Atlas: 1♂ (M046), Lake of Zerrouka, sweep net, 13.10.2023 (L. Zouhair).

Anti-Atlas: 1♂ (M021), Dades valley, sweep net, 28.09.2022 (S. Fekrani); 2♂ (M064), Fint oasis, sweep net, 14.05.2024 (L. Zouhair).

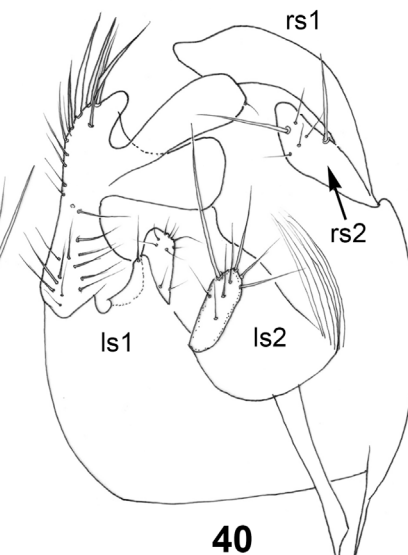
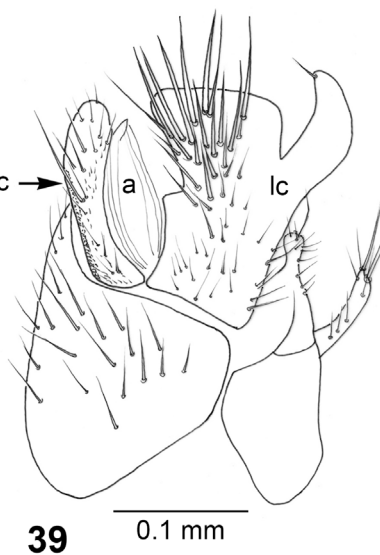
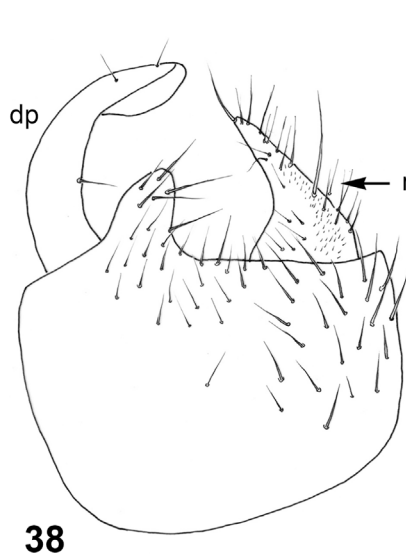
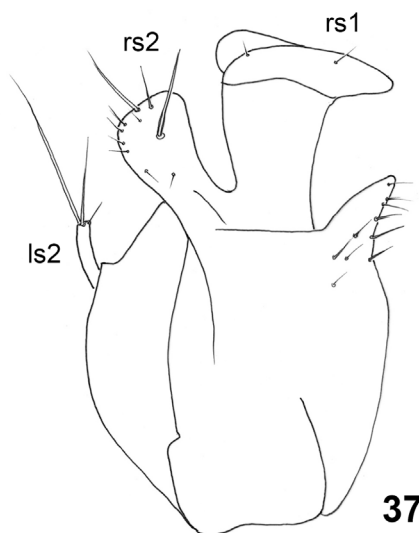


Fig. 36–40. *Crossopalpus setiger*, male (Oued Amsemlil, M001), habitus and terminalia.

36 – habitus, lateral view; 37–40 – terminalia: 37 – right surstylus and left surstylus, right lateral view, 38 – right epandrial lamella and right cercus, lateral view, 39 – epandrium and cerci, dorsal view, 40 – epandrium, ventral view (hypandrium omitted). Abbreviations are given in “Material and methods”.

Рис. 36–40. *Crossopalpus setiger*, самец (Oued Amsemlil, M001), габитус и терминалии.

36 – габитус, вид сбоку; 37–40 – терминалии: 37 – правый сурстиль и левый сурстиль, латерально справа; 38 – правая эпандриальная пластинка и правый церк, латерально; 39 – эпандрий и церки, дорсально; 40 – эпандрий, вентрально (гипандрий не показан). Расшифровка сокращений приведена в разделе «Material and methods».

Previous record not re-examined: Rif, Smir lagoon [Ebejer et al., 2019].

**Brief redescription.** A shiny black species with black legs (Fig. 36). Postpedicel 1.5 times as long as wide. Black ventral apical seta on pedicel shorter than postpedicel. Mesoscutum with long black setae mixed with small brownish hairs. Mid tibia with a long black anterodorsal seta on basal quarter. Hind tibia with 5 black anterodorsal setae and lacking a posterior apical tooth.

Male terminalia black (Figs 37–40). Right surstylus 1 has the apex bent hood-like over the apex of the epandrium (Fig. 38). At the base of rs1 is a lobe considered as rs2 with truncate tip and bearing 2 apical setae. The apical margin of the right epandrial lamella bears a short triangular projection, the dorso-apical projection (Fig. 38, dp). The right cercus is digitiform in dorsal view and with a strong subapical seta (Fig. 38). The left cercus is black and has 3 lobes, the apical lobe is large with a broad truncate apical margin (Fig. 39), which lacks a rim as in *C. dilutipes* and *C. flavitibia* sp. n. At the right side is a large keel-like lobe hidden under the anus (Fig. 39), but visible in a ventral view on the epandrium (Fig. 40). At the left side is a ribbon-like lobe directed upward, with small apical setulae (Fig. 39), in ventral view the apex of the epandrium is truncate (Fig. 40). The setae on the right side of the left cercus, especially on the apical half, are strong and black while in related species these setae are yellowish and appear less strong. Left surstylus 1 is short (Fig. 40), with short setulae, while ls2 is digitiform and bears a very long apical seta (Figs 37, 39, 40).

**Notes.** The male terminalia of the specimens from Belgium, the Netherlands, Greece and Romania have been compared to the specimens from Morocco and the resemblance is great (Grootaert, unpublished) so that we consider it now indeed as a single species with a very wide distribution.

In all the specimens we studied, the anus lacks microtrichia in dorsal view, in contrast to the illustration in Chvála [1975: fig. 620], where microtrichia were erroneously added to the anus.

**Distribution.** Very wide distribution in North Africa and Europe: Britain Isles, Danish mainland, the Netherlands, Belgium, France (mainland), Spanish mainland, Germany, Czech Republic, Sweden, Finland, Estonia, Lithuania, Italy (mainland, Sardinia), Bulgaria, Greece (mainland, Dodekanisos), Russia (northeast and centre of the European part).

Here in Morocco it is up to now only found in mountains and it is newly recorded from the Middle Atlas and Anti-Atlas.

In Europe it is more of a lowland species that occurs along both saline and freshwater marshland habitats. However, in Greece it was found in mountain forests [Grootaert, Beuk, 2024].



Fig. 41. *Crossopalpus undulans* sp. n., male, holotype (Oued Taâounia, M023), habitus.

Рис. 41. *Crossopalpus undulans* sp. n., самец, голотип (Оued Taâounia, M023), рабиту.

*Crossopalpus undulans* Grootaert et Zouhair, sp. n.  
(Figs 41–44)

**Material.** Holotype, ♂ (M023): Morocco, Rif, Oued Taâounia, sweep net, 29.06.2008 (K. Kettani). Paratype: 1♂ (M048), Morocco, High Atlas, Oued Ahansal, sweep net, 10.07.2021 (Y. Fekrani).

**Diagnosis.** A small black species (body length: 2.5 mm; wing length: 3 mm). Hind tibia lacking a posterior apical tooth. In the key of Chvála [1975], the new species will lead to *C. curvinervis* (Zetterstedt, 1842). However, the male terminalia of the new species are entirely different from *C. curvinervis* as illustrated by Chvála [1975: figs 631–633] mainly by the apical margin of the left cercus which is sharply pointed to the right side. In the new species the right side of the left cercus has a broadly rounded tip. The terminalia in *C. curvinervis* are very wide, while in the new species they are much narrower.

**Description.** Male (Fig. 41). Head black with long black diverging ocellar and vertical setae. Frons grey dusted, wide. Upper half of gena under eye, densely dusted while lower half shiny black. Face narrow, as wide as half width of scape, with grey dusting. Clypeus shiny black. Gena broad, about 1/6 as wide as height of eye, densely set with long silvery microtrichia. Occiput grey dusted, set with short pale brownish setulae. Antenna pale brownish. Postpedicel small, hardly longer than pedicel. Ventral apical seta on pedicel black, slightly longer than pedicel. Stylus black, nearly 4 times as long as basal antennal segments combined. Palpus large, pale brownish, set with white setulae; strong apical seta lacking. Proboscis brown.

Thorax with mesoscutum shiny black, with posterior border grey microtrichose. Anepisternum (mesopleuron), anepimeron (pteropleuron) and anepimeron (hypopleuron) entirely microtrichose, only katepisternum (sternopleuron) shiny black. Mesoscutum uniformly and densely with short pale setulae. No distinct acrostichal or dorsocentral rows. Three short fine pale setae about as long as postpedicel in dorsocentral position. One fine black notopleural and 1 short black post- and supra-alar setae present. Pair of long black scutellar setae with short lateral seta.

Legs entirely reddish yellow with brown maculation especially on mid tibiae and anteriorly on hind femora. Hind coxae and trochanters brownish. All tarsomeres reddish yellow including apical tarsomeres. Fore coxa with yellowish setation. Fore femur swollen on basal 2/3, with minute yellowish ventral pubescence. Short anterior, black preapical seta present and very short preapical posteroventral seta. Fore tibia shorter than fore femur with pair of long black preapical setae; posteroventral seta longer than width of tibia, anteroventral paler and shorter. Mid coxa set shiny black anteriorly, with long pale anterior setae. Mid femur narrower than fore femur, with long black anterior preapical seta, no distinct ventral setae. Mid tibia with pair of not very long brown preapical setae. Hind coxa brown anteriorly, darker posteriorly. Hind femur longer than mid femur, thickened at middle with short black anterior seta as long as width of femur. Hind tibia lacking posterior apical spur, ventrally with dusky setulae about as long as width of tibia. Metatarsus with yellowish setulae only, lacking spines.

Wing clear, veins pale brownish (Fig. 41). Vein  $R_{4+5}$  with anterior bend on apical half, diverging in middle and converging after middle to end parallel to  $M_{1+2}$  in costa.  $M_{1+2}$  strongly bent upward near middle. Halter white. Squama whitish with long pale cilia.

Abdomen dark brown. Tergites dusted at base, set with short yellowish setulae. Sternites also with short setulae.

Terminalia black (Figs 42–44): right epandrial lamella with a large dorso-apical projection considered as the rs1 fused with the epandrium. At right side is large lobe, also fused to the epandrium and considered to be the right surstylus 2. At the inside of the epandrium is a large plate behind the dorso-apical projection



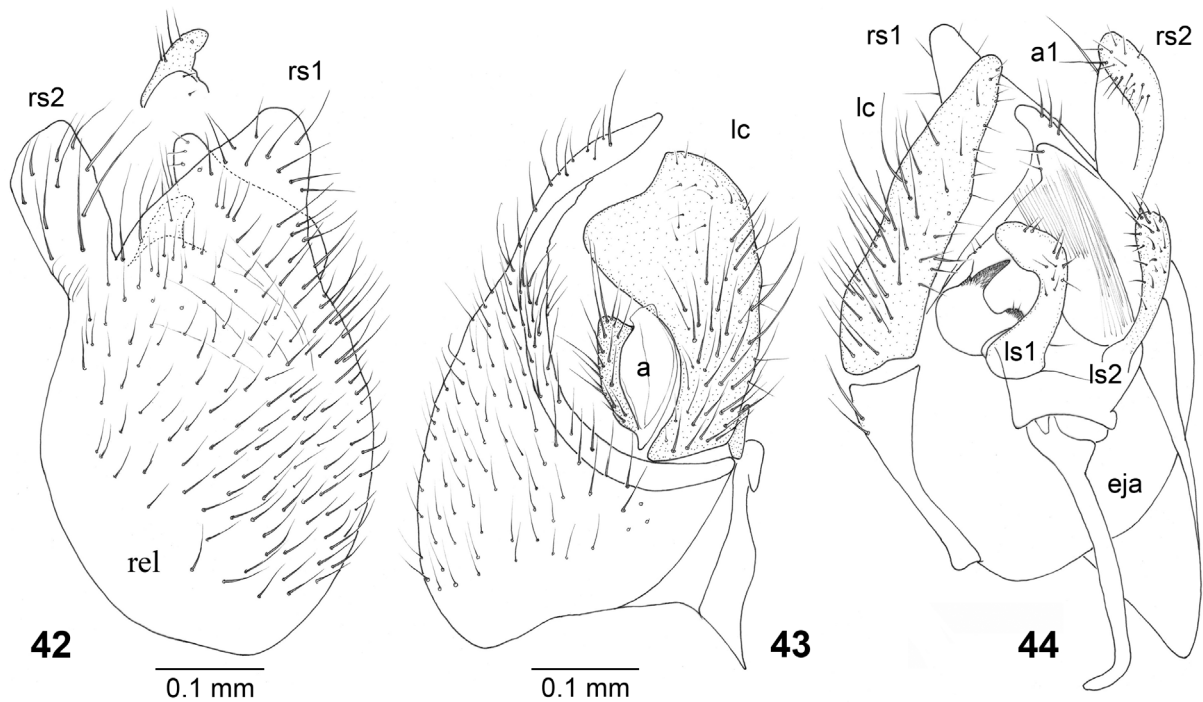


Fig. 42–44. *Crossopalpus undulans* sp. n., male, holotype (Oued Taâounia, M023), terminalia.

42 – right epandrial lamella, lateral view; 43 – epandrium and cerci, dorsal view; 44 – epandrium, ventral view (hypandrium omitted). Abbreviations are given in "Material and methods".

Рис. 42–44. *Crossopalpus undulans* sp. n., самец, голотип (Oued Taâounia, M023), терминалии.

42 – правая эпандриальная пластинка, латерально; 43 – эпандрий и церки, дорсально; 44 – эпандрий, вентрально (гипандрий не показан). Расшифровка сокращений приведена в разделе «Material and methods».

(Figs 42, 44), but indistinct in dorsal view of the epandrium (Fig. 43). Right cercus short with truncate tip, bearing long setae. Left cercus very large, somewhat club-shaped, with shallow apical notch. Right side of apex lacks setation; middle and left side of left cercus bearing dense setation. Left surstylus 1 and ls2 quite long, finger-like, both set with short setulae only.

Female unknown.

**Derivatio nominis.** The name *undulans* refers to the undulation of vein  $M_{1+2}$ .

#### Key to male *Crossopalpus* from Morocco (modified from Chvála [1975])

1. Hind tibia with at least 2 distinct anterodorsal setae besides usual preapical setae. Mesonotum with long erect black setae mixed with short pruinulent setae covering mesonotum ..... 2
- Hind tibia without anterodorsal setae except preapical setae. Mesonotum with only short setae, without distinct long erect setae except at lateral margins ..... 6
2. Hind tibia with 2 to 3 very long posterodorsal setae (in addition to the row of anterodorsal setae), about 3 times as long as width of tibia. Hind tibia with a preapical posterior yellow spur, about one third length of metatarsus ..... 3
- Hind tibia without long posterodorsal setae and long posterior spur, at most with small rounded projection ..... 4
3. Fore femur with 4 long ventral setae. Fore tibia with sparse pale pubescence anteroventrally (Fig. 39). Mediterranean region and North Africa ..... *C. pilipes*

- Fore femur with a single ventral seta at base. Fore tibia densely pubescent anteroventrally pale. Morocco ..... *C. atlanticus*
- 4. Hind tibia black or dark brown on basal quarter. Left cercus with strong black setae on right lobe ..... *C. setiger*
- Hind tibia yellow. Left cercus with fine yellow setae on right lobe ..... 5
- 5. Palpus yellow. Legs extensively yellow, including all coxae, in male (in female, femora sometimes brown to black). Dorsal projection on upper margin of right epandrial lamella present, short, not pointed (Fig. 12). Spain, North Africa ..... *C. dilutipes*
- Palpus black. Legs with black femora. Dorso-apical projection on right epandrial lamella long and pointed (Fig. 21). Morocco ..... *C. flavitibia* sp. n.
- 6. Anepisternum (mesopleuron) entirely shiny black. Hind tibia with more or less distinct apical tooth ..... 10
- Anepisternum (mesopleuron) with spots of light pubescence or entire upper margin pubescent. Hind tibia with large distinct apical tooth (*C. aeneus*) or without apical tooth (*C. flavipes* and *C. undulans*) ... 11
- 10. Larger species (body 2.4 mm). Left cercus with notch on apical margin (Fig. 30). Apical segment of vein  $M_{1+2}$  slightly undulating but not curved upwards until extreme tip ..... *C. nigrtellus*
- Smaller species (body 1.8 mm). Left cercus deeply indented apically (Fig. 26). Apical segment of vein  $M_{1+2}$  straight ..... *Crossopalpus nigrtellus* sp. n.



11. Palpus and legs mainly black ..... *C. aeneus*  
– Palpus and legs reddish yellow ..... 12  
12. Apical section of vein  $M_{1+2}$  with strong median wave  
(Fig. 41) ..... *C. undulans* **sp. n.**  
– Apical section of vein  $M_{1+2}$  almost straight (Fig. 20) .....  
..... *C. flavipes* **sp. n.**

Discussion

Table 2 provides an overview of the species studied in the present work. As can be seen, only 144 specimens were collected. This rather low number is likely due to the collecting technique. *Crossopalpus* is mainly active on the ground and sometimes lives hidden under debris and fallen leaves [Chvála, 1975] and hence not easily collected by sweep net. Coloured pan traps and sometimes Malaise traps are more efficient in collecting larger numbers [Grootaert, Beuk, 2024]. As can be seen further in Table 2, 118 males and only 26 females have been collected. We suppose this discrepancy in sex ratio is due to different activity patterns, where females are less easily observed and collected. Although only 144 specimens were collected, they belong to nine species, four species being new to science. One of the new species is a singleton, two species are doubletons while the other one is tripleton. These low numbers suggest that several more species are present. *Crossopalpus pilipes*, a species with a wide distribution around the Mediterranean coast, is one of them.

Species groups

The morphological differences between some species are striking so that species groups, clusters or species complexes can be seen. In his overview of the Scandinavian fauna, Chvála [1975] did not see the necessity yet to group the species. Indeed, the northern fauna is rather limited in species. However, Collin [1960] already recognized the *Crossopalpus aenescens*-group that includes four species. Smith [1967] provided a key and illustrations of the male terminalia to these species and he used both the term complex and species group for them. His illustrations of the male terminalia were limited to only the two lobes

of the right surstylus that are named in the present study rs1 and rs2 (Fig. 4). The major parts of the male terminalia were not illustrated and hence it was difficult to compare the structures with the more complete illustrations given by Chvála [1975], especially because the complicated structure was not annotated as mentioned previously in the introduction.

In the present study we recognize five species-groups not only based on the observations of the Moroccan fauna but consolidated with other Palaearctic regions.

***Crossopalpus aenescens*-group.** This species group is characterised by the hind tibia having a strong posterior spur on, but lacking strong anterodorsal setae instead. Appendages (lobes) are present on the apex of the right epandrial lamella tentatively recognized as surstyli (rs1 and rs2). The left cercus is longer than the right cercus and the cerci are connected by a broad bridge.

The *Crossopalpus aenescens*-group is represented here by *C. aeneus* only. *Crossopalpus aenescens* (Wiedemann, 1830) (known from Namibia, Botswana, Zimbabwe, South Africa and Madagascar [Cumming, Sinclair, 2014]), *C. subaenescens* Collin, 1960 (known from Egypt, Palestine and Arabia) and *C. hirsutipes* Collin, 1960 (from South India) were already assigned to this group, while *C. complicans* Grootaert et Van de Velde, 2019 is another species described from the Cabo Verde Islands that belongs to this group.

***Crossopalpus pilipes*-group.** This group is characterised by the hind tibiae having a strong posterior spur and bearing at least three pairs of long dorsal setae. There are no appendages or lobes on the inside of the tip of the right epandrial lamella. Right surstylus is represented by a single large lobe, tentatively annotated as rs1. The right cercus is finger-like and separated from the enlarged left cercus that has an apical excavation. Left surstylus ls2 is much larger than the left surstylus ls1 and it is densely set with long setae on the entire right side (Figs 10, 33).

Although this group superficially resembles the *aenescens*-group, there are major differences as can be seen in the diagnosis. Following species are included: *C. pilipes*, *C. atlanticus* and *C. salensis* Grootaert et Van de Velde, 2019 (Cabo Verde).

***Crossopalpus nigritellus*-group.** This group is characterised by the hind tibiae having a strong posterior spur, but lacking strong anterodorsal or dorsal setae. There are no distinct appendages or lobes present at the inside of the tip of the right epandrial lamella. The right cercus is slender and broadly separated from the large left cercus. The left surstyli are short, with short setae.

In this group we recognize *C. nigritellus* and *C. nigriteloides* **sp. n.**, but for the moment we are hesitant to include other species.

***Crossopalpus setiger*-group.** This group is characterised by the hind tibiae lacking a posterior spur and having 3–6 strong anterodorsal setae. The right surstylus rs1 is hood-like bent over the cerci. Right surstylus rs2 is long, generally strap-like. The right epandrial lamella has a more or less prominent dorso-apical projection (absent in other groups). The right cercus is well separated from the left cercus. The apex of the left cercus is truncate (sometimes with a rim) and a long, strap-like, left lobe present.

Table 2. Overview of the Moroccan species and studied specimens of *Crossopalpus*.

Таблица 2. Марокканские виды *Crossopalpus* и количество изученных экземпляров.

Species Вид	Males Самцы	Females Самки	Total Всего
<i>Crossopalpus aeneus</i> Walker, 1871	80	5	85
<i>Crossopalpus atlanticus</i> Raffone, 2015	10	3	13
<i>Crossopalpus dilutipes</i> Strobl, 1906	2		2
<i>Crossopalpus flavipes</i> <b>sp. n.</b>	1		1
<i>Crossopalpus flavitibia</i> <b>sp. n.</b>	2		2
<i>Crossopalpus nigriteloides</i> <b>sp. n.</b>	3		3
<i>Crossopalpus nigritellus</i> Zetterstedt, 1842	4		4
<i>Crossopalpus setiger</i> Loew, 1859	14	18	32
<i>Crossopalpus undulans</i> <b>sp. n.</b>	2		2
Total number / Общее количество	118	26	144

In addition, an inner lobe is present. The left surstyli are small and the left surstylus 2 generally bears one or more long apical setae.

This group includes *C. setiger*, *C. dilutipes* and *C. flavitibia* **sp. n.** all known from Morocco. Other species belonging to this group are *C. chvalai* Kovalev, 1976 (Hungary, Greece and Russia) as well as *C. giordanii* Raffone, 1983 (Volano, Italy), *C. demartini* Raffone, 1984 (Sicily; maybe a junior synonym of *C. dilutipes* and *C. bonomettoi* Raffone, 1984 (Sardegna, Italy)). Species *C. giordanii*, *C. demartini*, *C. bonomettoi* need a revision of their specific status.

**Crossopalpus flavipes-group.** This group is characterised by the hind tibiae lacking a posterior spur as well as distinct anterodorsal setae. The right epandrial lamella has a very large inner lobe (a2) and a small papilla-like projection at the right side (a1). The right surstylus rs2 is small. The right cercus is not connected to the left cercus. The left cercus bears a large rectangular projection to the right side, however this could be a specific character only for *C. undulans* **sp. n.**

Apart from *C. flavipes* **sp. n.**, we tentatively include *C. undulans* **sp. n.** to this group or cluster. Currently, it is not clear which other Palaearctic species can be associated to these species. *Crossopalpus minimus* (Meigen, 1838) and *C. humilis* have more or less similar though distinctly different male terminalia. Moreover, both species have a small posterior spur on the hind tibiae. Maybe all belong to the *nigritellus*-group after all and an analysis of multiple genes could help to elucidate the phylogeny of the species-groups and the genus.

## Habitat preference

Based on its diverse climatic, orographic and geomorphological characteristics, the Moroccan territory can be divided into seven natural biogeographical zones: the Rif, the Eastern Morocco, the Atlantic Plain, the Middle Atlas, the High Atlas, the Anti-Atlas, and the Sahara [Beaudet, 1967; Thauvin, 1971; Combe, Monition, 1971; Benabid, 1982, 1985; Mokhtari et al., 2013]. Extensive collecting expeditions conducted for over a decade across these biogeographic zones, covering a broad range of habitats and targeting different seasons of the year, have resulted in the compilation of a large collection of hybotid flies, including the specimens of *Crossopalpus* under study here. During these excursions, *Crossopalpus* was associated in most cases with the edges of wetlands like oueds (intermittent and permanent watercourses), valleys, peat bogs, lakes, lagoons, waterfalls, springs and oasis including seashore areas in sandy dunes, estuaries, rocky shores or caves and rarely associated with strictly terrestrial habitats such as forests and agricultural fields, or open vegetated habitats (grasslands).

Some species can inhabit different biotopes, both at edges of aquatic habitats as well as exclusively terrestrial habitats, like *C. aeneus* which occupies most of the mentioned habitats and constitutes the most commonly found species in Morocco (Fig. 45), occurring in all Moroccan regions and in most prospected sites. This species was previously recorded by Shamshev et al. [2005] in the

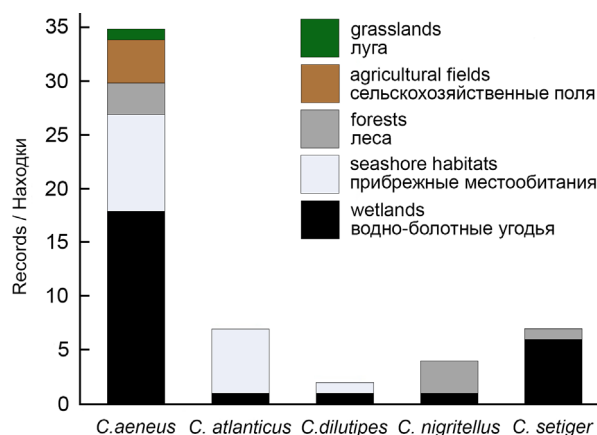


Fig. 45. Distribution of Moroccan *Crossopalpus* species among the investigated types of habitats.

Рис. 45. Распределение марокканских видов рода *Crossopalpus* в различных типах исследованных местообитаний.

country, but no habitat information was given. According to Chvála and Kovalev [1989] and Yang et al. [2007], *C. aeneus* is recorded in all North African countries (except Mauritania where the genus has not yet been reported), but unfortunately there are no ecological data available in these references to compare with our findings. Ventura et al. [2015] recorded *C. aeneus* in Algeria, found on the banks of an oued, a lake and a sebkha. This latter habitat is a kind of salt lake that occurs in the Sahara, occupying the bottom of a depression. It is important to highlight that this kind of biotope was also mentioned by Grootaert and Van De Velde [2019] as an habitat of *Crossopalpus* spp. from Cabo Verde. In fact, there are many sebkhas in Moroccan Sahara, but unfortunately, this part of the country has received little attention during field excursions, leading us to believe that several other *Crossopalpus* species will be found when collecting is stepped up.

*Crossopalpus atlanticus* can be considered as a littoral species (Fig. 45). It prefers sandy dunes, rocky shores or edges of estuaries, or aquatic habitats close to the beach. Raffone [2015] recorded it for the first time on the beach of Mohammedia (previously named Fedala) in the Atlantic Plain. In our study, we found this species along the Mediterranean coast at Martil beach in the Western Rif, and at Saidia beach, beach of Kariat Arekmane and the Moulouya estuary in Eastern Morocco, as well as on the shores of Sidi Boughaba lake, 800 m away from Mehdiya beach on the Atlantic coast.

*Crossopalpus dilutipes* was collected in the sandy dunes of Stehat beach along the Mediterranean coast and on the edge of a peat bog (Amrah). It was previously reported by Ebejer et al. [2019] from the sandy dunes of Kabila beach and the shores of the Smir lagoon on the Mediterranean coastline, as well as in the saltmarsh on the Atlantic coast. We can suggest that this species prefers to inhabit edges of aquatic habitats including coastal marine habitats (Fig. 45), in particular sandy dunes, salty wetlands and lagoons. In North Africa, *C. dilutipes* has also been reported in Tunisia [Chvála, Kovalev, 1989; Yang et al., 2007], but no data on its habitat has been provided.

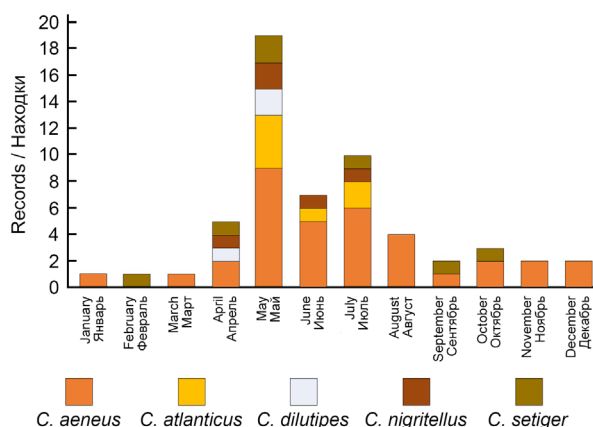


Fig. 46. Seasonal pattern of Moroccan *Crossopalpus* species based on records number.

Рис. 46. Сезонная динамика марокканских видов рода *Crossopalpus* на основе количества находок.

*Crossopalpus nigritellus* was caught mainly in forests, but also at the edges of aquatic habitats (Fig. 45). We found it twice in a fir forest (*Abies marocana*) at high altitude in the Rif region in 2014 and 2019 at the same locality, as well as in a cedar forest (*Cedrus atlantica*) in the Middle Atlas, also at high altitude. Ebejer et al. [2019] also reported it in a cedar forest in the Rif. However, it can also inhabit the edges of aquatic habitats since it has been spotted at the edge of a spring in the High Atlas, and around a salt marsh in the Rif by Ebejer et al. [2019]. In North Africa, *C. nigritellus* has so far only been reported from Morocco.

*Crossopalpus setiger* seems to prefer mostly wetlands (Fig. 45), according to the collecting sites where it has been captured at the edges of oueds, peat bogs, lakes, valleys and oasis. Ebejer et al. [2019] also recorded it from a lagoon on the Mediterranean coast, but we found it as well in a forest at 1330 m in the Rif region. In North Africa, like *C. nigritellus*, *C. setiger* is currently only reported from Morocco.

As regards to the newly described species, some statements can be made about their ecological preferences, although further material is needed to support our findings, especially for species with a single record as *Crossopalpus flavipes* sp. n. which was captured from a forest. *Crossopalpus nigritelloides* sp. n. was captured from a forest and the edge of a peat bog. *Crossopalpus flavitibia* sp. n. was recorded in the same habitat (agricultural fields) following its records in the High Atlas (2017) and Anti-Atlas (2020). The same applies to *C. undulans* sp. n. which was found at the edge of an oued in the Rif (Oued Taâounia) in 2008, and in another oued (Oued Ahansal) in the High Atlas in 2021.

## Phenology

According on our results, the flight period of *Crossopalpus* does not seem to be well defined since the genus was observed at different seasons of the year and seems to be inherent to each species specifically (Fig. 46). *Crossopalpus aeneus* which represents the most common species in the country, occurred in all four seasons,

suggesting its ability to adapt to different climatic conditions. The same can be said for *C. setiger*, which appeared in spring (April, May), summer (July), winter (February) and autumn (September and October). *Crossopalpus atlanticus* was previously collected by Raffone [2015] in summer in June, and we reported recently this species in the same season (June, July), but also in spring (May). *Crossopalpus dilutipes* seems to occur in spring, since we only collected it in April and May and was previously reported by Ebejer et al. [2019] in the same months. *Crossopalpus nigritellus* emerged mainly in spring (April, May) and the beginning of summer (June), but it appeared later in autumn (October).

As for the new described species, a clearly defined flight period could not be proven either, particularly for species that only have one record, like *C. flavipes* sp. n. reported in February. *Crossopalpus nigritelloides* sp. n. was captured in spring (April) and summer (June). *Crossopalpus undulans* sp. n. appears to occur only in summer, since it has been captured twice in June (2008) and July (2021), but *C. flavitibia* sp. n. was collected in winter (December) and in summer (July), revealing its adaptation to extremely wide-ranging climatic conditions.

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