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Titre francais : Le genre *Ctenophthalmus* Kolenati, 1856 (Insecte, Siphonaptera, Ctenophthalmidae) en Ethiopia : inventaire des taxa et description de deux nouvelles espèces.

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Abstract.

In this paper, two new flea species with illustrations are described, namely *Ctenophthalmus* (*Ethioctenophthalmus*) *leirsi* Beaucournu & Zewdneh **sp. n.** and *Ctenophthalmus* (*Ethioctenophthalmus*) *vanhoutteae* Beaucournu & Bereket **sp. n.** The first species is represented by both males and females while the other is only represented by a single female that does not match any of the previous descriptions of the Ethiopian flea fauna. In order to confirm the later species status a revision of the genus *Ctenophthalmus* in Ethiopia is discussed herein along with the *Ctenophthalmus* taxa and localities recorded so far in this country.

Keywords : [Afrotropical Region](#), Ethiopia , Fleas , Siphonaptera, Biodiversity

Résumé

Dans cet article, deux nouvelles espèces de puces sont décrites et accompagnées d'illustrations ; soit *Ctenophthalmus* (*Ethioctenophthalmus*) *leirsi* Beaucournu & Zewdneh **sp. n.** et *Ctenophthalmus* (*Ethioctenophthalmus*) *vanhoutteae* Beaucournu & Bereket **sp. n.** La première espèce est représentée par des mâles et des femelles tandis que la seconde est uniquement représentée par une unique femelle ne correspondant à aucune description connue de la faune des Siphonaptères éthiopiens. Afin de confirmer le statut d'espèce de cette dernière, nous la replaçons dans le cadre plus large d'une révision et discussion du statut des espèces connues du genre *Ctenophthalmus* décrites d'Ethiopie.

Mots clefs : [Afrotropical Region](#), Ethiopia , Fleas , Siphonaptera, Biodiversity

Introduction

The genus *Ctenophthalmus* Kolenati, 1856 contains 300 validated species. However, the [family Ctenophthalmidae](#) has been used as a catch all for a wide range of divergent taxa that almost certainly represent paraphyletic assemblages (Whiting et al. 2008, Zhu et al. 2015). The *Ctenophthalmus* spp. are distributed throughout the Holarctic (mainly [Palearctic](#)), Afrotropical and *pro parte* Oriental regions. A review of this genus was published by Smit (1963) and was later revised and updated by Hopkins and Rothschild (1966). In these documents, the genus *Ctenophthalmus* has been reported from a wide range of altitudes and habitats in association with their mammalian hosts, but is virtually absent in desert areas as their larvae suffer from hydric stress in dry conditions. However, several subspecies or so called “varieties” of a [palearctic](#) species *Ctenophthalmus (Ctenophthalmus) dolichus* Rothschild, 1913 are associated with Gerbillinae rodents in arid areas (Beaucournu & Lorvelec 2014). The *Ctenophthalmus* spp. were collected in Ethiopia from hosts caught from 1700m to 3500m above sea level. The description of two new species from the Ethiopian highlands is consistent with the poor number of systematic collections in Ethiopia and calls once more for a revision of the flea diversity [assigned to these taxa by combining morphological and ecological traits and molecular techniques](#).

Materials and methods

Mammal nomenclature follows [that of](#) Mammals of Africa (Kingdon et al. 2013), the IUCN Red List of threatened species (2016), and the most recent publications that are referred to in the text. Host DNA was extracted to confirm the host species identity using mitochondrial DNA cytochrome *b* based on L7 and H6 sequence primers comparisons (Montgelard et al. 2002). The sequences obtained were compared with GenBank sequences and the *AfricanRodentia* database (<http://projects.biodiversity.be/africanrodentia/>). [Flea mounting, and line drawings techniques as](#)

well as classical species description conventions (setae number, ctenidia teeth,...) are described in Beaucournu & Launay (1990). All the drawings are represented at a 200µm scale.

Results

Known *Ctenophthalmus* from Ethiopia

Siphonaptera, Ctenophthalmidae, *Ctenophthalmus Kolenati*, 1856

In Ethiopia, eight species or subspecies were known in the genus *Ctenophthalmus*, of which four were not scientifically described. Those unpublished data are presented here along with the description of the two new species collected recently by the Wolaita Sodo University research team (Ethiopia). The locality where the different taxa were found are geolocated on Figure 1.

***Ctenophthalmus engis* (Rothschild 1907)**

The species was described on two females from two localities in the country. The host was not properly identified and only mentioned as follows "Addis Abeba and Burka, Abyssinia, of a rat" by the collector and could thus be attributed to any Murid rodent. The flea specimen from Burka was later deposited in the British National History Museum and was designated as a lectotype by Smit & Wright (1978). On the other hand, the female flea specimen from Addis Abeba, was deposited in the National Museum of Natural History in Paris (MNHN) but its status as a paratype is not specified (Rothschild 1911).

Séguy (1945) pointed out that *Ctenophthalmus agyrtes* Heller, 1896 was collected from a nest in the upper Omo region of the Elgon, and added that the species is a widespread flea species common throughout Europe as a parasite of rodents and small insectivores. The location of the nest was mentioned as "Nest No. 8 *Camp III of the Elgon, st. 18, alt. 3500 m (5 I 33)* (= 5th January 1933). *Clearing on the slope of a valley in an area of arborescent heathers*". This collection did not take place in Ethiopia as the mentioning of "Omo" could mislead since the Mount Elgon is located on the border between Uganda and Kenya, and is about 400km of South Western Ethiopia and 500km,

at least, off the Omo Valley. This reference is also citing a non Afrotropical species which was unfortunately not found at the MNHN (C. Daugeron, *in litt.* 4.II. 2016) and undoubtedly refers to an erroneous identification and should be discarded from the Ethiopian collection.

***Ctenophthalmus allisoni* (Smit 1962)**

The species was described on a male holotype collected ±200km South of Addis Abeba, Colaris (7°0'N, 38°30'E), Sidamo province, in the Southern Nations, Nationalities, and People's Region (SNNPR), Ethiopia, on an African Grass Rat (*Arvicanthis niloticus zaphiri* Dollman 1911) caught in a native compound (23rd April 1959) and a female allotype collected from the same locality and host species, but caught under a tree on a rocky hill on 20th April 1959. *C. allisoni* was placed in the "*calceatus*" group by Smit (1963) and in the subgenus *Ethioctenophthalmus* by Hopkins & Rothschild (1966). No other station is known. These two species from Ethiopia, namely *Ctenophthalmus engis* and *C. allisoni*, are the only ones cited in Hopkins & Rothschild (1966). The authors noted about *C. engis* that the female paratype deposited in Paris (cited by Rothschild 1911) seemed not to be conspecific with the holotype, and this was later confirmed (Beaucournu & Guiguen 1991, Beaucournu & Morel 1992).

***C. evidens abyssinicus* (Beaucournu 1991)**

The species was described on older material held at the Museo di Genova (Italy), collected in 1885 by Dr. V. Ragazzi from 7 males and 3 females collected from *Arvicanthis abyssinicus* Rüppell, 1842 in Antoto (ca 9°15'N,38°50'E) - coordinates and names are both corrected on Figure 1 as Entoto, north of Addis Abeba (Semen Shewa), Ethiopia.

***Ctenophthalmus caecus* (Beaucournu & Morel 1992)**

This species is the latest *Ctenophthalmus* described from Ethiopia, from Dinsho locality (7°02'N-39°30' E) off *Stenocephalemys albocaudata* Frick, 1914. Although known, again by a single female, this species is characterized by an extreme reduction of the eye which rules out the possibility that this flea infest this murine rodent host, as a primary host. Indeed such a strong regression of the eye is typical of a subterranean mammalian host long term association and could well be the sympatric

Tachyoryctes macrocephalus Rüppel, 1842. Moreover, the labial palp and genal ctenidium of this species are well characterized, but in the absence of a male, assigning this specimen to a "species group" remains difficult.

***Ctenophthalmus* sp.**

Two undescribed species of *Ctenophthalmus*, examined by R. S. George and F.G.A.M. Smit, were recovered from a collection of Ashford and colleagues (1973) working on the epidemiology of leishmaniosis in Ethiopia in the Kutaber area. These were named *Ctenophthalmus* **sp. n. A** on *Praomys albipes* Rüppell 1842 and *Desmomys harringtoni* Thomas, 1902 (formerly *Pelomys harringtoni*) and *Ctenophthalmus* **sp. n. B** on *P. albipes*.

Beaucournu & Guiguen (1991) published an annotated list of the Siphonaptera of Ethiopia, where three undescribed *Ctenophthalmus* are listed, as well as two congeneric taxa, each represented by a single female, only designated *sp. nova* 1 and *sp. nova* 2, and therefore not "described" officially.

The *sp. nova* 1 is the female deposited at MNHN as the *Ctenophthalmus engis* Rothschild, 1907 collected from Addis Abeba. The *sp. nova* 2 is an isolated female collected from *Crocidura baileyi* Osgood, 1936, 2km West of Ambagu (Gojam), alt. 3500 m (10°44'N,37°58'E), Ethiopia, by Dr. M. Largen (Senckenberg Institute, Frankfurt am Main, Germany – n°SMF Si.30.1989 .I) but in the absence of the corresponding male, a name could not be attributed to the later.

Recently, two species belonging to the genus *Ctenophthalmus* were collected by the research team of Wolaita Sodo University, Ethiopia. The first species was represented by males and females while the second was only represented by a single female that did not match any of the species previously reported from this country. The two new species are described and named in the present work.

***Ctenophthalmus* (*Ethioctenophthalmus*) *leirsi* Beaucournu and Zewdneh, sp. n.**

Type Material. Holotype ♂ ; allotype ♀, [three ♂ paratypes and one ♀ paratype](#), **Ethiopia:** Maraka District [7°03'N-along 37°09'E], 2325m elev., Dawro Zone, SNNPR. Holotype on *Lophuromys* (*Lophuromys*) *chrysopus* Osgood, 1836 (Rodentia, Muridae) No ETH 2208, September 2015; allotype and [one ♂ paratypes collected on the same individual host; one ♀ paratype on *Stenocephalemys albipes* Rüppell, 1842](#), ETH No. 2174 (Rodentia, Muridae), [same locality as holotype](#) but collected in August 2015; one ♂ paratype on *L. chrysopus*, No. ETH 2269, [same station and locality](#) as holotype, but collected in October 2015; one ♂ paratype on *L. chrysopus*, N° ETH 2457, [same station and locality](#) as holotype, but collected in March 2016.

The *L. chrysopus* were trapped outside a rundown mud plastered wooden house. The house was surrounded by bamboo (*Arundinaria alpina* K.Schum.), Ethiopian banana ([Ensete ventricosum Cheesman](#)), coffee (*Coffea arabica* L.), avocado (*Persea americana* Mill.) and *Vernonia theophrastifolia* Oliv.&Hiern.

Type location: [Holotype, allotype and two paratypes](#) are deposited in the collections of Jean-Claude Beaucournu, Laboratory of Medical Parasitology, Faculty of Medicine of Rennes, France. These collections will later be deposited in the collections of the Entomology Laboratory of the Natural History Museum of Paris, France (MNHN).

Description. Head (Fig. 2). [Head capsule narrower in its pre-antennal portion in the male than in the female](#); 1st pre-antennal row of setae with five plus one small seta at the base; 2nd row of three strong setae. Eye fairly pigmented, oblong, showing a [postero-ventral sinus](#). Occipital rows of 3, 4, 5 setae in holotype, and 4, 4, 5 in ~~one~~ [paratypes](#) and in the allotype. [Occipital groove slightly saddle-backed](#) in males. First tooth of the genal [ctenidia](#) separated by a [diastema of the second](#) (narrow but visible on Fig. 2). Labial palp [reaching 2/3](#) of the coxa I. **Thorax.** Prothorax: the [ctenidia](#) is significantly longer than the prothorax and has 16 teeth and is preceded by five long setae. Mesothorax: main row of five long setae, preceded by numerous small setae distributed as

several irregular rows; presence of two pseudosetae with one located on top of the segment, and one at the mid-height. Metathorax: main row of six setae preceded by two irregular rows. Metepimeron with six setae; spiracle tapered but practically as long as high. **Legs.** Distotarsomere III with four pairs of plantar bristles (one pair between the setae of the first pair); dorsal margin of tibia III with seven notches (2, 2, 2, 2, 2, 2, 4). Longer *seta* on the second tarsal segment of leg III, exceeding apex of segment IV. **Unmodified abdominal segments. Tergites.** T-I with five large main setae preceded by two irregular rows in males, seven large setae in the female; presence of a spinelet; T-II-IV with eight main setae which bottom is below the spiracle in males, seven in the female; presence of a spinelet; T-V, seven main setae in males, five in the female; no spinelet; T-VI, six main setae in males, four in the female; no spinelet; T-VII: three antesensorial bristles in male of approximate ratio (top to bottom): 0.5 / 1 / 0.7, in the female, 0.5 / 1 / 0.85; presence of small setae anterior to spiracle VIII (Fig. 3), six in males, two in females. **Sternites.** Males S-II: one ventral and distal seta; S-III-VII, five ventral and distal setae, the three most posterior setae longer and thicker; S-VIII (Fig.3) showing 6-9 setae according to the specimen (six in the holotype), ventral margin with a clear indentation; female, S-II: one ventral *seta*; S-III-VI, 5-9 setae of which the 3rd and 4th distal, are thicker. **Modified Abdominal Segments, Male.** Segment IX (Fig. 4). Tergite: *Area fusoria* present; *processus basimeris* stocky, with 4 long setae at its apex and one on its postero-ventral margin, above the acetabular *seta*. *Processus basimeris dorsalis*: beyond the insertion of long apical setae, 2 contiguous small pigmented tubercles, followed by an overlaid oblique lobe representing the *processus basimeris ventralis*, lightly pigmented, terminating at the insertion of the acetabular seta. *Processus telomeris* with angular apex down and backwards, barely wider at the top than in the ventral part that is translucent. **Sternite.** Proximal arm of S-IX longer than distal arm ; apex of distal arm expanded, obliquely rounded with two fine setae at apex and patch of fine setae about midway on lateral surface. Phallosome (Fig. 5): dorso-apical sclerite with thin end and apodeme narrow (see Hopkins & Rothschild, 1966). **Modified Abdominal Segments, Female and spermathecal ductus** (Fig. 6). Caudal margin of S-VII with undulating broad lobe subtended by

subventral deep sinus.. Lateral margin of S-VII with five large setae in the allotype, only four in the paratype; there is, as in most African species, nor ~~uneiform~~ hook-shaped (unciform) sclerotization, nor *littea* (pigmented strip)(see Peus, 1976; Beaucournu & Morel, 1992); apex of S-VIII broadly truncated with brush of fine, short setae-. **Spermatheca.** *Bulga* slightly conical, *hilla* almost as long as the *bulga*, strongly curved, relatively thick. *Ductus bursae* is only visible, rather short, sub linear and strongly pushed back by an ovoid glandular formation (not shown) at its base.

Length (slide mounted specimens). Males, 1.9- 2.5 mm (holotype : 2mm), females, 2.3-2.5 mm (allotype : 2.3mm).

Etymology. The species is named in honor of Pr. Dr. Herwig Leirs, renowned mammalogist and Belgian promoter of the Research Team at Wolaita Sodo University, Ethiopia.

Remarks. *Ctenophthalmus leirsi* **sp. n.** belongs to the subgenus *Ethioctenophthalmus*. The allocation to a "species group" *sensu* Smit (1963), is clearly guided by the presence of the *area fusoria* and especially the morphology of the phallosome that evokes those of the group "*evidens*". It also reminds of those of the group "*eumeces*" (except that of *C. flagellatus* Smit, 1964 that is a clearly aberrant taxon in this complex) and other taxa of this group such as *-C. evidens derocki* Laudoit & Beaucournu, 2009. *C. gilliesi* Hubbard, 1963, that was briefly described, was placed in the group "*eumeces*" by Hopkins & Rothschild (1966), and drawn by Smith (*in* Hopkins and Rothschild, *op. cit.*, fig. 395). However, while the telomere and basimere show a certain similarity with the new species, the phallosome is unclear for it is hidden by the contours of segments VI, VII, VIII and IX. We thus present here an original drawing of the apex of *C. gilliesi* (Fig. 7) which is close to, but still different from that of *C. leirsi* **sp. n.** *C. gilliesi* is known from Tanzania (~~Tanganyika ex~~) in Njombe (1830 m) on *Mastomys natalensis victoriae* Matschie, 1911 as the host type, but paratypes were collected on *Mus (Leggada) bellus indutus* Thomas, 1910 (synonym *Mus minutoides*), *Lophuromys flavopunctatus* and *Crocidura hirta velutina* Peters, 1852. *Lophuromys*

chrysopus belongs to the same complex as *L. flavopunctatus* (Verheyen et al. 2007, Lavrenchenko et al. 2007). The hosts of *C. evidens* ssp. (Group "evidens") are also close by, and appear again, especially on *Lophuromys* ssp. (Beaucournu & Laudisoit, 2013).

***Ctenophthalmus (Ethioctenophthalmus) vanhouttee* Beaucournu & Bereket sp. n.**

Type material. Holotype ♀, **Ethiopia:** Maraka District [7°03'N -37°09'E], 2325 m elev., Dawro Zone, SNNPR. Holotype on [Rattus rattus \(L., 1758\)](#), ETH 2135 collected in June 2015.

The habitat of this host is the same as the habitat reported for *Lophuromys* hosting the new species, *C. leirsi* sp. n.. *Rattus rattus* is certainly not the primary host which should be considered to be amongst sympatric sylvatic Muridae such as *Lophuromys* spp., *Praomys* spp. or *Pelomys* spp.

Type location : Holotype is deposited in the collections of Jean-Claude Beaucournu, Laboratory of Medical Parasitology, Faculty of Medicine of Rennes, France, and these collections will later be deposited in the collections of the Entomology Laboratory at the Museum of Natural History in Paris (MNHN).

Description. Head. Head capsule without special character: first pre-antennal row of five setae, 2nd row of three setae. Eye fairly pigmented, oblong, [without notch. Occipital rows of three, four, and five setae in this specimen.](#) First tooth of the genal ctenidia separated [by a slight diastema of the second tooth.](#) Labial palp reaching 2/3 of coxa I. **Thorax.** Prothorax: the ctenidia is significantly longer than the prothorax and has 16 spines, preceded by five long setae. Mesothorax: main row of five long setae, preceded by numerous small setae on several irregular rows; presence of three pseudosetae of which one is situated on top of the segment, the others halfway. Metathorax: main row of six setae preceded by two irregular rows. Metepimeron with six setae; spiracle tapered but practically as long as high. **Legs.** [Distotarsomere III with four pairs of plantar bristles \(with an additional pair between the setae of the first pair\);](#) dorsal margin of tibia III with seven notches (2, 2, 2, 2, 2 and 3). Longer tarsal *seta* on segment II of leg III, not reaching the apex of segment III.

Unmodified abdominal segments.Tergites. The spiracles are less tapered and that of T-VI is rounded at its end. T-I with five large setae preceded by two irregular rows; presence of spinelet; T-II-IV with seven main setae whose bottom is under the spiracle; presence of a spinelet on each of these segments except the II where there are two; T-V, six main setae, no spinelet; T-VI, four main setae; no spinelet; T-VII: three antesensilial setae of approximate ratio from top to bottom 0.5 / 1 / 0.85; absence of small setae anterior to the stigma of T-VIII. Sternites: S-II: 1 ventral *seta*; S- III-VI, 5-9 setae of which the 3rd to 4th distal are thicker. **Modified Abdominal Segments and spermathecal ductus, Female.** S-VII (Fig. 8) has quite an exceptional shape for an

Ethioctenophthalmus with a very large dorsal lobe- [in comparison with its ventral part, showing at 3/4 of its length an obtuse angle, anterior to a marked sinus; presence of hook-shaped sclerotization](#) or *lacuna*, overlooking a *littea*, [a and-pigmented arstripea](#), with lightly marked contours.

Spermatheca bulga gently tapered, [juncture with hilla clearly](#) narrower (Fig. 9); *hilla* large, bent at right angle, thick wall, showing the insertion point of the ~~motor~~ muscles of the *hilla* but without *papilla*; the *ductus bursae* [shows two unusual convolutions](#); it is pushed back, as in *C. leirsi* n. sp., by an annex glandular ovoid structure, located at its base. The nature and the exact origin of this structure are not known and would require histological studies.

Length. Holotype 2.7 mm.

Etymology. The authors are pleased to dedicate this species to a dear colleague, Natalie Van Houtte, University of Antwerp, Belgium, who has supervised the researchers of the Wolaita Sodo and performed numerous molecular identification of mammalian hosts from Africa, harbouring a series of flea species described during the last decade.

Remarks. Although based on a single female specimen, this taxon is easily identifiable on the genital characters. None of the known Afrotropical *Ctenophthalmus* - including those where the male is unknown - shows the characters mentioned here. However, examining the pattern of the

uniform sclerotizations of *Ctenophthalmus* sp. A (in Beaucournu & Guiguen 1991, Fig. 2 -4) (false paratype of *C. engis*) mentioned as the outline of the sternum VII, *C. leirsi* **sp. n.** is somewhat similar but the other characters do not coincide. *Ctenophthalmus* sp. B (in Beaucournu & Guiguen 1991; Figure 5 -7), shows a *littea* but no sclerotization; and sternite VII, the *ductus bursae* and *spermatheca* do not have the same structure.

Discussion

The compilation of the bibliographic data on the *Ctenophthalmus* genus in Ethiopia provides a final inventory (including the current paper results) of six species described (*engis*, *allisoni*, *evidens abyssinicus*, *caecus*, *leirsi* and *vanhoutteae*) and 4 other new suspected species but not described in the absence of male and / or sufficiently distinctive characters (n sp A, n sp B in Ashford et al. 1973; sp nova 1 and sp nova 2 in Beaucournu & Guiguen 1991).

In addition to the species mentioned above, the household compound where hosts of the two new flea species were trapped, were fenced and covered with natural bush and several evergreen grass. This might have provided shelter and food provisions for both *Rattus rattus* and the sympatric sylvatic rodents such as *Lophuromys* spp. Moreover, human induced land use changes (e.g. for agriculture) in the area may have been responsible for the movement of sylvatic rodents to human settlement as observed elsewhere (Singleton et al. 1999) ; hence mediating ectoparasites host switching and potentially vector borne pathogens. Many rodent tracks and runways were noted near the rundown house where trapping was carried out suggesting rodent migration from the nearby crop fields and shrubs to the household compound and *vice versa*.

The scarcity of the *Ctenophthalmus* in the recent collection, in opposite trend to the abundance of *Xenopsylla* (paper in preparation), given their sensitivity to hydric stress could on the one hand be attributed to sub-optimal environmental conditions in the months preceding the capture campaigns and on the other hand to a trapping bias towards domestic and peridomestic species.

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Figure list

Figure 1. Map of Ethiopia with historical and recent rodent sampling and *Ctenophthalmus* collection ; locations refers to the eight taxa cited in the text.

Figure 2-9 (scale: 200µm)

Figure 2. *Ctenophthalmus (E.) leirsi* sp. nova – Holotype ♂, anterior part of the cephalic capsule (d : diastema).

Figure 3. *Ctenophthalmus (E.) leirsi* sp. nova – Holotype ♂, segment VIII, stigmata of T-VIII and S-VIII.

Figure 4. *Ctenophthalmus (E.) leirsi* sp. nova – Holotype ♂, segment IX.

Figure 5. *Ctenophthalmus (E.) leirsi* sp. nova – Holotype ♂, phallosome.

Figure 6. *Ctenophthalmus (E.) leirsi* sp. nova – Allotype ♀, sternites VII et VIII, spermatheca and *ductus bursae*.

Figure 7. *Ctenophthalmus (E.) gilliesi* Hubbard, 1963 – Holotype ♂, apex of the phallosome.

Figure 8. *Ctenophthalmus (E.) vanhoutteae* sp. nova - Holotype ♀, sternites VII (featuring the *lacuna* and *littea*) and sternite VIII, outline of the spermatheca.

Figure 9. *Ctenophthalmus (E.) vanhoutteae* sp. nova – Holotype ♀, spermatheca, beginning of the *ductus spermathecae*, *ductus bursae* and auxilliary gland.