African Journal of Agricultural Research Vol. 4 (1), pp. 085-091, February 2009
Available online at http://www.academicjournals.org/AJAR
ISSN 1991-637X © 2009 Academic Journals

Full Length Research Paper

Key for identification of the Hymenopteran parasitoids of the African citrus psylla *Trioza erytreae* Del Guercio (Hemiptera: Triozidae) in Cameroon

Joseph Lebel Tamesse

University of Yaounde I, Ecole Normale Supérieure, Laboratory of Zoology, P.O. Box 47 Yaounde, Cameroon.
E-mail: jltamesse@yahoo.fr.

Accepted 12 December, 2008

We studied the parasitic complex of the African citrus psylla, *Trioza erytreae* for the first time in the tropical zone of Africa, in Cameroon. This psyllid is the major pest of citrus in all high and humid land regions in Cameroon and is parasitized by numerous hymenopterans. Under natural conditions, we discovered that 17 different species of Hymenoptera laid their eggs on nymphs of *T. erytreae*. These parasitoids belong to the families Aphelinidae, Ceraphronidae, Encyrtidae, Eulophidae, and Figitidae. We provide an identification key for adults who can permit recognition and identification of all parasitoids of *T. erytreae*. New species are cited for the first time in this complex of parasitoids of this psyllid.

Key words: Citrus, ***Trioza erytreae***, hymenoptera, parasitoids, pest control, Cameroon.

INTRODUCTION

The citrus fruits constitute the first world fruit production; they offer a wide range of use. Some are required for decorative shrubs and generally for their fruits and their essential oils. The chemical composition of the juices of citrus cultivated in various producer countries indicates an abundance of ascorbic acid and of citric acid (Burke, 1967). Essential oils of citrus fruits are obtained after the treatments of the leaves, the fruits and the flowers (Huet, 1971). Essential oils of citrus nowadays offer many uses in nutrition and pharmaceutical industries. According to Huet (1971), the food flavourings scent the soft drinks, the syrups, the biscuits, the desserts, and in pharmacy, their role is to mask the unpleasant taste of drugs. The citrus fruits constitute an important vitamin source for a balanced food. The consumption of these fruits remains however very high in the developed countries (28 kg /personne/an), and very low in the other countries (14 Kg/personne/an) (Tamesse et al,, 1999). Biological control in citrus orchards may be useful in an integrated pest management approach combining other control strategies such as cross protection, tolerant and resistant rootstock and scions, limited pesticide use, and transgenic plants with resistance/tolerance to citrus diseases (Yokomi et al., 1993). Biological control of citrus psyllid could increase fruit production in Cameroon. Therefore it is very important to identify and to better know the natural enemies of the pest for an integrated pest management.

In Cameroon, ***Trioza erytreae*** is the major pest of citrus in all high land regions. ***T. erytreae*** constitutes a permanent pest of citrus production of the humid regions of the West and Adamaoua provinces as well as in forest zone in the South of the country (Tamesse et al., 1999). This psylla is responsible for numerous pit galls on the leaves of the host plants and transmits the bacterium ***Candidatus Liberobacter africanum***, responsible of the African citrus greening disease or huanglongbing (Garnier and Bové, 1997; Hocquellet et al., 1999). In the Yaounde region of Cameroon, Tamesse and Messi (2004) showed that the dynamics of the populations of ***T. erytreae*** in a citrus orchard were under the dependence of biotic factors (new leaves, predators and parasitoids), abiotic factors (temperature, relative humidity and maximum saturation deficit index) and other factors (enrichment of soil using nitrogenous manures).

In Cameroon, as in South Africa, the use of chemical pesticides against ***T. erytreae*** could not reduce the high level of the proliferation of the psyllid on citrus as well as the dissemination of greening disease throughout the country (Tamesse et al., 2002; Catling, 1969). The option of biological control remains the most promising alternative. According to Aubert and Quilici (1983), biological control against ***T. erytreae*** on Reunion Island permitted eradication of this important pest in the region. Different surveys showed that the pest is no longer present in the Reunion Island region since the introduction of primary parasitoid, ***Tamarixia dryi*** Waterston, from South Africa (Aubert and Quilici, 1983). In South Africa, Catling (1970) noted the presence many predators of ***T. erytreae*** who play an important role in the limitation of the populations of the psyllid under natural conditions. Several authors described different species of hymenopteran parasitoids from mummified citrus psylla in South Africa (Annecke, 1969; Catling, 1969; McDaniel and Moran, 1972; Waterston, 1922).

The first report on the hymenopteran parasitoids of Cameroon was published by Risbec (1955), however the author does not mention the presence of the parasitoids of ***T. erytreae***. This psyllid was present in Cameroon before 1960 as mentioned by Lavabre (1960). After his visit to the main citrus production areas in Cameroon, Aubert (1986) noted the absence of the primary parasitoids of ***T. erytreae*** and suggested the importation of these natural enemies of ***T. erytreae*** in the context of an integrated pest management program in citrus orchards and plantations in Cameroon.

Tamesse et al**.** (2002) studied the parasitism of nymphs of ***T. erytreae*** and the biological diversity of parasitoids that parasitize the citrus psylla under natural conditions. These authors did not provide a key permitting recognition and identification these hymenopterans. From 1993 to 1998 we undertook a survey on the inventory of natural enemies of ***T. erytreae*** in a citrus orchard and in the forest zone. In the present work, we intend to produce a key for identification for all the species of hymenoptera that parasitize ***T. erytreae*** in Cameroon.

MATERIAL AND METHODS

Observations were made on emerged adult hymenopteran parasitoids from mummified larvae between 1993 and 1998. The mummies of ***T. erytreae*** were harvested from citrus plants in a citrus orchard of the experimental plantation of the Agronomic Research Institute for the Development at Nkolbisson (Yaounde) on the campus of the University of Yaounde I and the surrounding districts. Other observations have been made on ***Clausena anisata***, natural host plants of ***T. erytreae*** in the forest zone nearest the town of Yaounde.

In the laboratory, 4993 mummies of the psyllid were kept in the limp that served as an emergence capsule. From these mummies, 2962 adults of Hymenopteran were hatched. The hymenoptera thus emerged were sent to GL Prinsloo (ARC-Plant Protection Research Institute, Queenswood, Pretoria, South Africa) for the confirmation of the identification of parasitoids. Adults were identified using the keys of Prinsloo (1984, 1981) and Graham (1991); but the key provided here is original base on our observations.

The key for identification provided here is based on the observations made on the dead drying adult specimens. The wings, legs and antennae of different species were dissected under a stereomicroscope and slide-mounted to study certain microscopic or internal structures. The main characters described are those of the females. The numbering of antennal segments does not taken into account the radicle (the first small appendage by which the antenna is attached to the head). The terminologies used are from Prinsloo (1981, 1984), Graham (1991), Polaszek and Lasalle (1995) and Waterston (1922).

RESULTS

Biological diversity of the hymenopteran parasitoids of *T. erytreae*

Seventeen different hymenopteran species belonging to 5 families were recorded as parasitoids of the auxiliary fauna of ***T. erytreae*** in the region of Yaounde. Nine species were in the family Encyrtidae including: ***Cheiloneurus cyanonotus***, ***Psyllaephagus chiangamus***, ***Psyllaephagus pulvinatus***, ***Psyllaephagus secus***, ***Psyllaephagus*** sp.1, ***Psyllaephagus*** sp.2, ***Psyllaephagus*** sp.3, ***Psyllaephagus*** sp.4, ***Syrphophagus cassatus***; Four species were in the Eulophidae including: ***Tamarixia dryi***, ***Tamarixia*** sp, ***Tetrastichus*** sp.1, ***Tetrastichus*** sp.2,; the Aphelinid family included 3 species: ***Coccophagus pulvinariae***, ***Marietta javensis***, ***Physcus*** sp.; the Ceraphronid family included one species: ***Aphagnomus*** sp.; and the Figitid family included one species: ***Dilyta*** sp.

Key for identification

1. Forewing venation reduced (Figures 1a-i), antenna including at least 11 segments, non-terminal ovipositor 3, 4, 5…………………… ..Chalcidoidea

2. Forewing venation reduced with open cells (Figure 1j), antenna including more than 11 segments……….……………6…………………Cynipoidea.

3. Forewing hyaline or partly marked with dark zone; the sub–marginal vein of forewing is longer than the marginal vein, the post-marginal or the stigmal veins; the axillae of the thorax not distinctly separated from one of the other; the body is black, and the gaster is attached to the propodeum without forming a constriction at the base of the gaster; the tarsi of the legs have 5 segments (Figures 2.1, 2.3).....………………….……………….………... ..4. Median leg with a strong well-developed spur at the extremity of the tibia (Figure 2.1); the male antenna is often nine segmented with six funicle-segments and one segmented club (Figure 3); the female antenna is almost always long and slender and covered with long setae which stand away from the segments lending the antenna a hairy appearance. …………………………...... .Encyrtidae (7, 8, 16)

4. Forewing hyaline or marked with some dark zones; the forewing with an extreme long marginal vein which is several times longer than the short stigmal vein or post-marginal vein, the latter sometimes absent; male antenna carry short setae not presenting the appearance of hairs; antennae with 6 to 8 segments; The axillae of the thorax widely separated from each other on the midline of the thorax………………………….5………..………………… Aphelinidae (18, 19, 20).

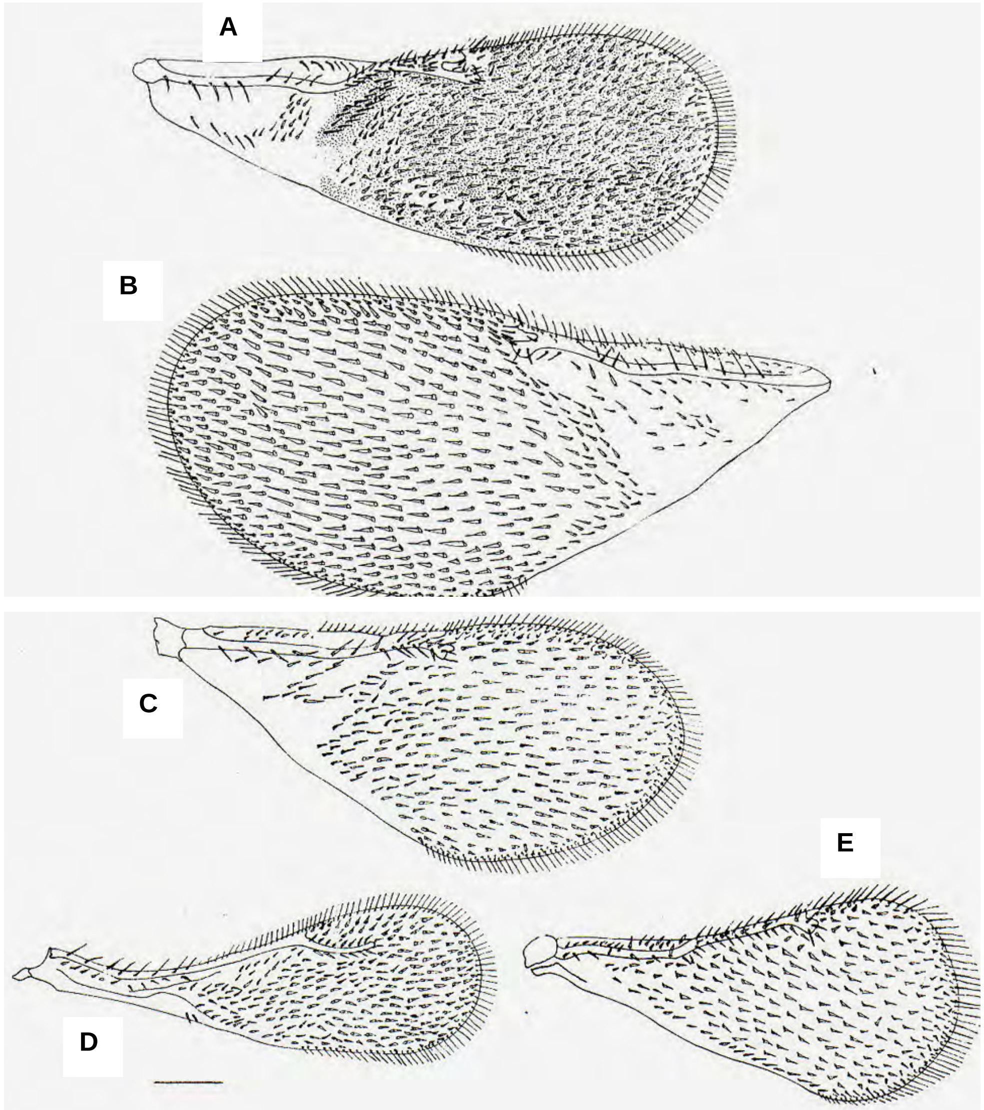

Figure 1. Forewing of Hymenopteran parasitoids of T.erytreaein Cameroon. A: Cheiloneuruscyanonotus, B: Psyllaephaguspulvinatus, C: Syrphophaguscassatus, D: Aphanogmussp. E: Coccophaguspulvinariae, scalebar: 0.1 mm

5. Forewing hyaline without any dark markings, the marginal vein is long (Figures 1b,c); the gaster is not broadly attached to the propodeum, but distinctly constricted at the junction with the latter; body generally black or first segments of the gaster with a more or less whitish patch; tarsi four segmented and the spur of the median leg is less developed (Figure 2.2); antenna with reduced number of segments; male antenna bearing long setae giving the appearance of long hair (Figure 4b, d, f, g)……………………..…..Eulophidae (21, 22, 23, 24, 25).

6. Antenna with 13 segments or more; body pale yellow to brown, only one visible gaster tergite……………………..…………………. .Figitidae (26)

7. Forewing less entirely marked with dark area (Figure 1a); apex of the scutellum with a semi-erect coarse bristles; antenna with scape expanded ventrally; the funicle six-segmented, the club three-segmented, hyperparasites (Figure 3j)…..***Cheiloneurus*** Westwood…… .***Cheiloneurus cyanonotus*** Waterston.

8. Forewing hyaline (Figure 1b); head and body entirely brown to black; scutellum without a tuft of bristles; legs usually marked with darker zones which characterise different species, as well as the shape and the colouration of antennal segments; primary parasitoids …………………………………..***Psyllaephagus*** Ashmead

9. Foreleg with coxa and femur entirely pale; antenna with black radicle, scape brown at base, pedicel dark, and the remainder of the antenna pale brown (Figure 3k-l) ...***Psyllaephagus pulvinatus*** Waterston

10. Median and hind legs with coxa entirely black, re-

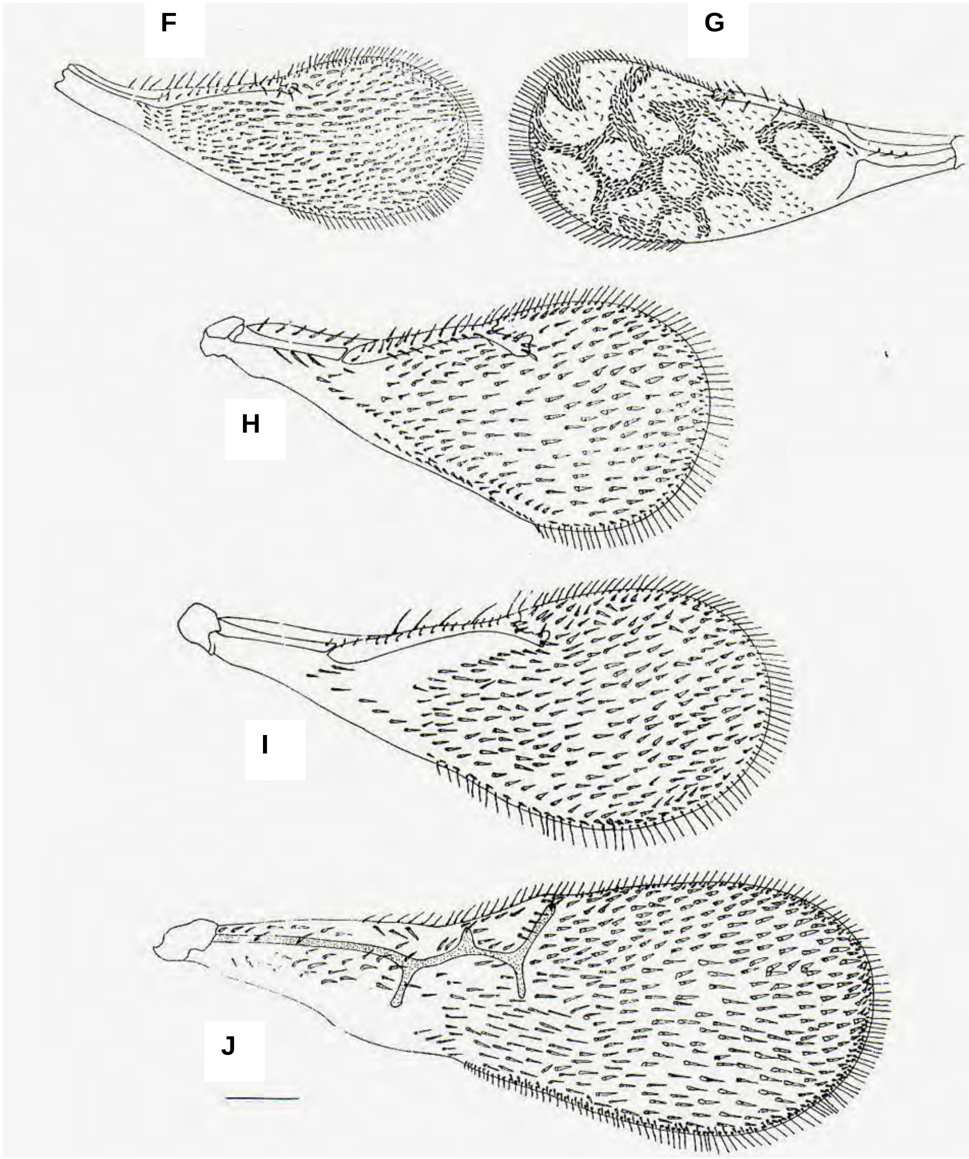

Figure 1. Forewing of Hymenopteran parasitoids of T.erytreaein Cameroon. F: Physcussp., G: Mariettajavensis, H: Tamarixiadryi, I: Tetrastichussp1., J: Dilytasp., scalebar: 0.1 mm.

mainder of the leg segments pale yellow; antenna with black radicle, scape partially dark, pedicel darker on its distal end, the remainder of the antenna pale yellow (Figure 3c, d) ………………..……..…....***Psyllaephagus chiangamus*** Prinsloo

11. Coxa of all legs black, femur of all legs with dark markings; antenna with black radicle, scape pale, pedicel partially dark, club darker than the other segments of the funicle usually pale yellow (Figure 3e) ………………..***Psyllaephagus secus*** Prinsloo. 12. Coxa of all legs black, femur of hind leg darker or black; antenna with black radicle, scape brown, proximal portion of pedicel black, club darker than the other segments of funicle usually pale yellow (Figure 1h…………………… i) ***Psyllaephagus*** sp1.

13. Coxa of all legs entirely pale yellow or whitish; antenna with radicle and scape pale yellow, pedicel dark and the remaining antenna pale yellow (Figure 3b)……... ...***Psyllaephagus*** sp2.

14. Coxa of fore leg pale yellow or whitish, mid and hind coxae black; mid and hind femur whitish but distal end of hind femur marked with darker zone; tibia of median leg marked with a black point on the proximal end; antennal radicle black, scape extended and darker basally, pedicel black and remaining antennal segments pale yellow.. . ..***Psyllaephagus*** sp3.

15. Coxa of foreleg entirely black, femur of fore and midlegs marked with a darker zone; hindleg entirely pale or whitish; antenna with black radicle, scape partially darker, remainder of the antenna pale yellow ………………..

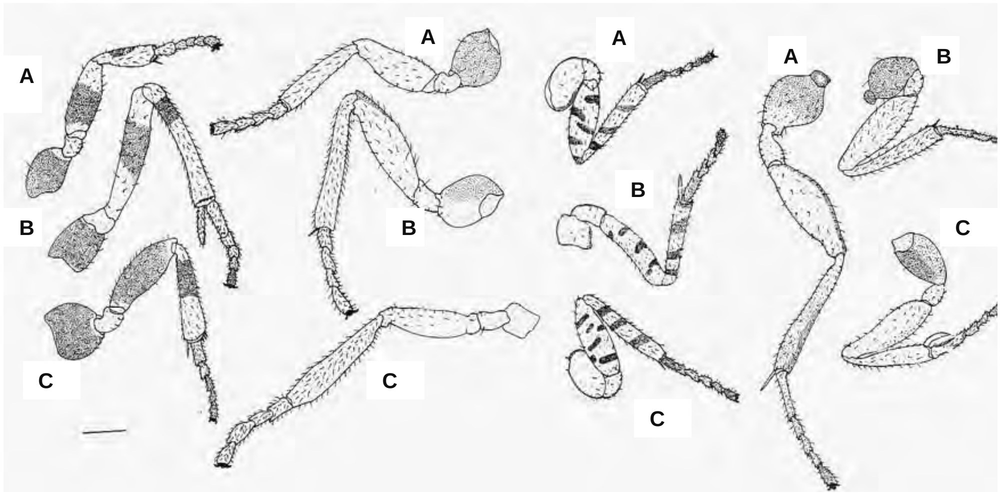

Figure 2. Legs of hymenopteran parasitoids of ***T. erytreaein*** Cameroon.1: ***Syrphophagus cassatus***, 2: Tamarixiadryi, 3: Mariettajavensis, 4: Dilytasp., A: fore leg, B: midleg, C: hindleg, scalebar: 0.1 mm.

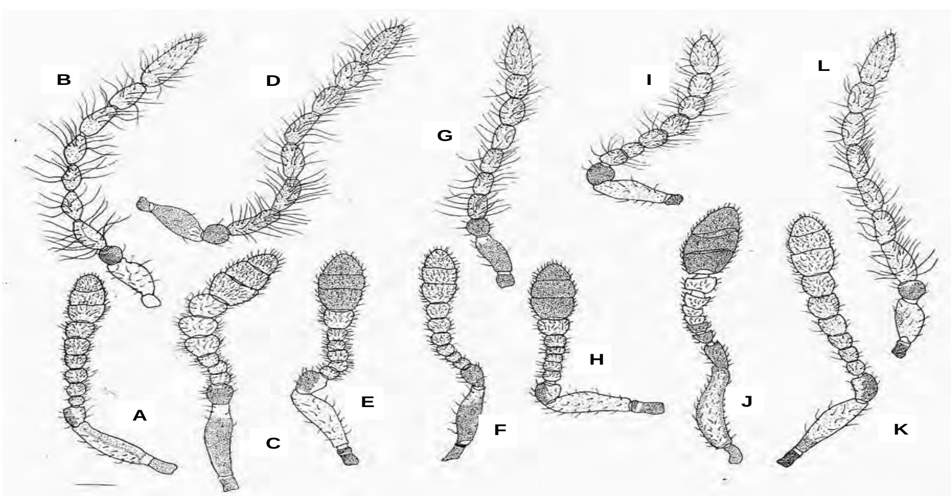

Figure 3. Antenae of hymenopteran parasitoids of ***T. erytreaein*** Cameroon. A: ***Psyllaephagus sp***. 2 female, B: ***Psyllaephagus sp***. 2 male, C: ***Psyllaephagus chiangamus*** female, D: ***Psyllaephagus chiangamus*** male, E: ***Psyllaephagus secus*** female, F: ***Syrphophagu scassatus*** female, G. ***Syrphophagus cassatus*** male, H. ***Psyllaephagus sp***.1 female, I. ***Psyllaephagus sp***.1 male, J: ***Cheiloneurus cyanototus*** female, K: ***Psyllaephagus pulvinatus*** female, L: ***Psyllaephagus pulvinatus*** male, scalebar: 0.1 mm.

Psyllaephagus sp4.

16. Coxa of all legs black, femur and tibia of all legs carrying black zones (Figure 2.1); antenna with black radicle, scape black except its distal end, pedicel black and the remaining segment of antenna pale yellow, funicle six-segmented (Figures 3f-g)……………… ***Syrphophagus*** Ashmead…...…………***Syrphophagus cassatus*** Annecke

17. Coxa, femur and tibia of all legs carrying darker or black zones; tarsi five-segmented; body shiny black with a yellow gaster that is brown basally; antenna with black radicle, scape cylindrical and brown, dark or black with other segments of antenna pale yellow; funicle five-segmented; club three-segmented (Figure 4k); Forewing with post - marginal vein well- developed; no distinct sub - marginal vein (Figure 1d)…………… ….Ceraphronoidea …...Ceraphronidae………***Aphanogmus***……….Thomsom ….. ***Aphanogmus*** sp.

18. Body black, jugal cone and face yellow; forewing hyaline (Figure 1e); antenna with 8 segments (Figure 4h); coxa of mid and hindlegs black, tibia and femur of all legs whitish or yellow……….…..***Coccophagus Westwood…… Coccophagus pulvinariae*** Compere.

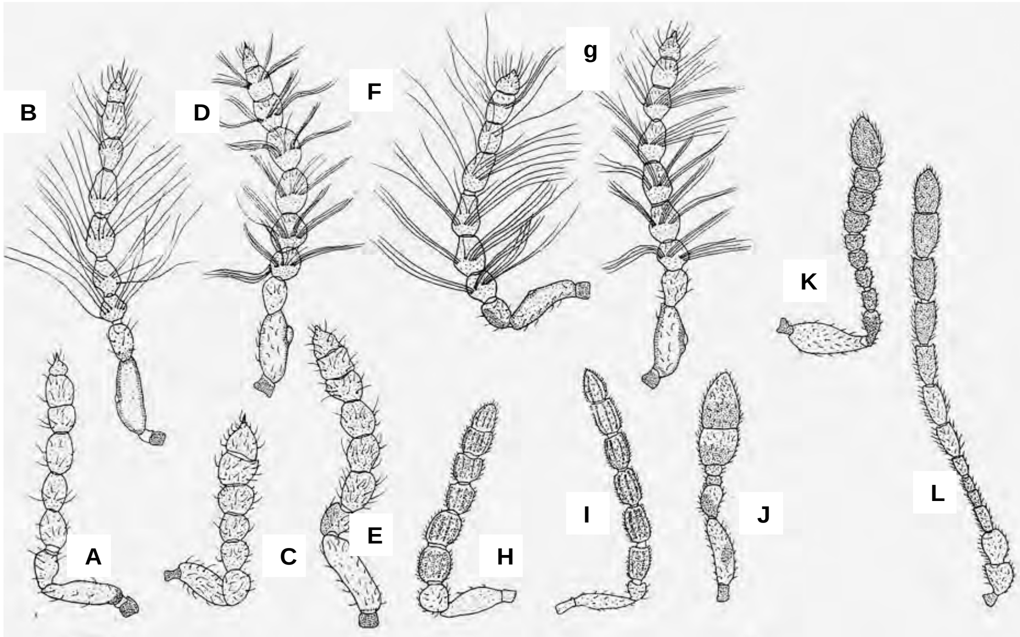

Figure 4. Antenae of hymenopteran parasitoids of ***T. erytreaein*** Cameroon. A: ***Tamarixia sp***. female, B: ***Tamarixia sp***. male, C: ***Tetrastichus sp***. 1 female, D.***Tetrastichus sp***.1 male, E: ***Tamarixia dryi*** female, F: ***Tamarixia dryi*** male, G: ***Tetrastichus sp***.2. male, H: ***Coccophagus pulvinariae*** female, I: ***Physcus sp***. female, J: ***Marietta javensis*** female, K: ***Aphanogmus sp***. female, L: ***Dilyta sp***.female, scalebar: 0.1 mm.

19. Body yellow and black, dorsal view of the gaster black and ventral view entirely yellow; scutellum, metanotum, propodeum and mesonotum yellow; forewing hyaline (Figure 1f); antenna brown or dark, 8-segmented (Figure 4i). Coxa and other antennal segments entirely whitish or pale yellow…..…………***Physcus Howard*** …..…………………***Physcus*** sp.

20. Head and body yellowish to greenish; forewing marked by darker lines and circular zones (Figure 1j); antenna carrying dark and light strips; antenna 6-segmented (Figure 4j); legs and body marked by the dark lines (Figure 2.3)…***Marietta*** Motschulsky…***Marietta javensis*** Howard

21. Body black; gaster of the female with an expanded whitish zone on the first 5 segments; this zone is less widespread for the male (at least 3 segments of the gaster); antenna 8-segmented, scape whitish and remaining segments of antenna brown or dark, setae of male antenna very long giving appearance of long hair (Figure 4b-4f)…… ……… .22, 23……..………***Tamarixia*** Graham

22. Coxa of foreleg black; other leg segments entirely whitish (Figure 2.2) …………………...***Tamarixia dryi*** Waterston

23.Coxa and femur of all legs entirely black ………..…………..……***Tamarixia*** sp.

24. Coxa and femur of all legs extensively black, remaining segments of legs whitish; body black; male antenna with the long setae, funicule and club each 3-segmented, scape and pedicel yellowish, number of segments for female antenna 7 (Figure 4c)........***Tetrastichus*** Haliday……………………………………***Tetrastichus*** sp.1

25. Coxa and femur of all legs black; body black with a whitish zone not spreading on more of 3 gaster tergites; male antenna with less long setae than those recovered on the ***Tamarixia*** species, antenna 8-segmented brown to dark (Figure 4d, g)…………………… .***Tetrastichus*** sp2.

26. Coxa of hindlegs black, remainder of the all legs yellowish brown (Figure 2.4); body pale yellow or brown; antenna 13-segmented, the first two antennal segments are short and cylindrical; the remaining seven are longer than the others; and the last four segments are generally darker than the others (Figure 4l)…………………… ***Dilyta*** Förster……………………..***Dilyta*** sp.

DISCUSSION

The parasitism of the citrus psylla in Cameroon is different from the situation noted in Reunion Island where Catling (1973) noted the absence of the parasitoids on citrus fruits attacked by the African citrus psylla, ***Trioza erytreae***. The biological diversity of the parasitoid complex of this psyllid is comparable to the one described in South Africa by McDaniel and Moran (1972). These authors described 2 species of primary parasitoids and 13 species of hyperparasitoids. In Cameroon, as in South Africa, the main primary parasitoids are ***Psyllaephagus pulvinatus*** and ***Tamarixia dryi***; the main secondary parasitoid is ***Syrphophagus cassatus***. These hyperparasitoids have a limited effect on the populations of the primary parasitoids. However the population of secondary parasitoids is naturally controlled by tertiary parasitoids such as ***Cheiloneurus cyanonotus*** as recognized by McDaniel and Moran (1972) in South Africa. Our observations complete those of Aubert (1986) and permit to affirm that it will not be necessary to import the primary parasitoids of ***T. erytreae*** in Cameroon. In South Africa, the works of McDaniel and Moran (1972) permitted to note that the predominance of the hyperparasitoids compromises the odds of success of the biological control program against ***T. erytreae***. The reduction of the strengths of the secondary parasitoids is imperative to the success of the biological control programs against this psyllid. Additionally, it would be interesting to increase the odds of development of the tertiary parasitoids such as ***Tetrastichus*** species and ***Cheiloneurus cyanonotus***.

Conclusion

The African citrus psyllid, ***Trioza erytreae***, is parasitized by a diversify auxiliary fauna which included 17 species. There are primary, secondary and tertiary hymenopteran parasitoids. The predominant species are ***Syrphophagus cassatus*** (secondary parasitoid), ***Psyllaephagus pulvinatus*** (primary parasitoid), ***Tamarixia*** sp. (primary parasitoid), and ***Tamarixia dryi*** (primary parasitoid). Several species such as ***Dilyta*** sp. (Figitidae) and ***Aphanogmus*** sp. (Ceraphronidae) are cited here for the first time in the parasitoid complex of ***T. erytreae***. The presence in Cameroon of an important fauna of parasitoids of the citrus psylla is a serious asset in the perspective of the biological control against this important citrus pest. It would be necessary to complete this survey by studying the taxonomy of the unknown or nondescribed species of hymenopteran parasitoids of ***T. erytreae*** in Cameroon. This related work will permit to fulfil the biodiversity of these important insect for the integrated pest management program.

REFERENCES

Annecke DP (1969). Records and descriptions of African Encyrtidae-5 (Hymenoptera: Chalcidoidea), J. Entomol. Soc. S. Afr. 32: 443-459.

Aubert B (1986). Problems occurred on Cameroonian citrus production. Visit report from 10/11 to 25/11 1985, IRA Cameroon, CIRAD-IRFA, Montpellier, France. p. 25

Aubert B, Quilici S (1983). New biological balance observed in the Reunion Island on the populations of psyllids after the introduction and the establishment of hymenoptera chalcidoids. Fruits 38 (11): 771-776.

Burke JH (1967). The commercial citrus regions of the world. In: Citrus Industry. Tome I, (Reuter W, Webber HJ, Batchelor LD ed.), California. pp. 40-189.

Catling HD (1969). The bionomics of the South African citrus psylla, ***Trioza erytreae*** (Del Guercio) (Homoptera: Triozidae). 2. The influence of parasites and notes on the species involved. J. Entomol. Soc. S. Afr. 32 (1): 209-223.

Catling HD (1970). The bionomics of the South African citrus psylla, ***Trioza erytreae*** (Del Guercio) (Homoptera: Triozidae). 4. The influence of predators. J. Entomol. Soc. S. Afr. 33 (2): 341-348.

Catling HD (1973). Result of a survey for psyllid vectors of citrus greening disease in Réunion**.** FAO Plant Protect. B. 21: 78-82.

Garnier M, Bové JM (1997). Recent developments in vascular-restricted, walled bacteria of citrus: ***Xylella fastidiosa*** and ***Liberobacters***, proteobacterial plant pathogens. Fruits**.** 52(6): 361-369.

Graham MWR (1991). A reclassification of European Tetrastichinae (Hymenoptera: Eulophidae): Revision of the remaining genera. Mem. Am. Entomol. Inst. 49: 1-322.

Hocquellet P, Toorawa P, Bové JM, Garnier M (1999). Detection and identification of the two ***Candidatus*** Liberobacter species associated with citrus huanglongbing by PCR amplification of ribosomal protein genes of the β operon. Mol. Cell. Probe. 13: 373-379.

Huet R (1971). Les huiles essentielles d'agrumes. In : Les agrumes, G.P. Maisonneuve et Larose ed. Paris 5ème p. 455-475.

Lavabre E (1960). Presence in Cameroon of the citrus psylla, ***Trioza (Spanioza) erytheae*** Del G. J. Agric. Trop. Bot. Appl. Jan.-Feb. 1-2-3): 132-134.

McDaniel JR, Moran VC (1972). The parasitoid complex of the citrus psylla ***Trioza erytreae*** (Del Guercio) (Homoptera: Psyllidae). Entomophaga 17: 297-317.

Polaszek A, Lasalle J (1995). The hyperparasitoids (Hymenoptera Ceraphronidae, Encyrtidae, Eulophidae, Eurytomidae) of cereal stem borers (Lepidoptera Noctuidae, Pyralidae) in Africa. Afr. Entomol. 3(2): 131-146.

Prinsloo GL (1981). On the encyrtid parasites (Hymenoptera: Chalcidoidea) associated with psyllids (Hemiptera: Psylloidea) in South Africa. J. Entomol. Soc. S. Afr. 44(2): 199-244.

Prinsloo GL (1984). An illustrated guide to the parasitic wasps associated with citrus pests in the Republic of South Africa. Sci. Bull. Dep. Agric. Repub. S. Afr. 1-117.

Risbec J (1955). Hymenopteran parasitoids from Cameroon. Bull. Inst. Fr. Afr. N., 17-A(1): 191-266.

Tamesse JL, Messi J, Nguyen TX, Quilici S (1999). Incidence of ***Trioza erytreae*** Del Guercio, citrus psylla in the main ecoclimatic zones of Cameroon. Fruits 54(5): 311-321.

Tamesse JL, Messi J, Silatsa Soufo E, Kambou J, Tiagho AB, Ondoua Ndongo A, Dzokou VJ (2002). The parasitoid complex of ***Trioza erytreae*** (Del Guercio) (Homoptera Triozidae), citrus psylla in Cameroon. Fruits 57(1): 19-28.

Tamesse JL, Messi J (2004). Factors influencing the dynamic of the population of ***Trioza erytreae*** (Homoptera: Triozidae), the African citrus psylla, in Cameroon. Intern. J. Trop. Insect Sci. 24(3): 213-227.

Waterston J (1922). On the Chalcidoid parasites of psyllids (Hemiptera, Homoptera), B. Entomol. Res. 13: 41-58.

Yokomi RK, Tang YQ, Nong L and Kok-Yokomi ML (1993). Potential mitigation of the threat of the brown citrus aphid, ***Toxoptera citricida*** (Kirkaldy), by integrated pest management. Proc. Florida State Hortic. Soc. 106: 81-85.