

Diptera hosts of *Stylogaster* Macquart (Diptera, Conopidae) from Madagascar and South Africa

Márcia Souto Couri^{1,2} & Gabriel Pinto da Silva Barros^{1,3}

¹ Department of Entomology, Museu Nacional, Quinta da Boa Vista, 20940-040 Rio de Janeiro-RJ, Brazil. mcouri@terra.com.br

²CNPq fellow.

³CNPq/UFRJ scholarship.

ABSTRACT. Diptera hosts of *Stylogaster* Macquart (Diptera, Conopidae) from Madagascar and South Africa. The genus *Stylogaster* Macquart (Diptera, Conopidae) is represented by 14 species in the Afrotropical region, five of them endemic to Madagascar and two recorded from South Africa, one of them endemic. Fifteen specimens of Muscidae, 14 from Madagascar and one from South Africa, belonging to 10 species, impaled with *Stylogaster* eggs were examined. Among them, three new muscid host species were found. The dissected eggs were all similar, suggesting the presence of the same species in both localities, what is not recorded until now. The available data on the dipteran *Stylogaster* eggs hosts in Africa is summarized. Color photos of the material examined are presented.

KEYWORDS. Afrotropical region; dart-eggs; host; Muscidae; *Stylogaster*.

RESUMO. Dípteros hospedeiros de *Stylogaster* Macquart (Diptera, Conopidae) de Madagascar e África do Sul. O gênero *Stylogaster* Macquart (Diptera, Conopidae) é representado por 14 espécies na região Afrotropical, cinco delas endêmicas para Madagascar e duas assinaladas na África do Sul, uma delas endêmica. Quinze exemplares de Muscidae, 14 de Madagascar e um da África do Sul, pertencentes a 10 espécies, empalados com ovos de *Stylogaster* foram examinados. Entre eles, três novas espécies hospedeiras de muscidae foram encontradas. Os ovos dissecados eram todos similares, sugerindo a presença da mesma espécie nas duas localidades, o que ainda não está registrado. As informações disponíveis sobre hospedeiros dípteros de ovos de *Stylogaster* na África são resumidas. Fotos coloridas do material examinado são apresentadas.

PALAVRAS-CHAVE. Hospedeiro; Muscidae; ovos-dardo; Região Afrotropical; *Stylogaster*.

Stylogaster Macquart (Diptera) is a very peculiar Conopidae genus. Adults are slender, in shape, wings have a characteristic venation with a reduced anal cell, proboscis is long and thin and the females have an elongated ovipositor. This is the only genus of the Stylogastrinae subfamily and as its members are very different from the others congeners, it was treated as a separate family by some authors (Rohdendorf 1964; Smith & Van Someren 1985).

The genus is known from 92 species in the world, being predominantly Neotropic, where 69 species have been recorded. To the other regions, 14 species are known from the Afrotropics, five Australian, two Nearctic and two Oriental. No species has been described from the Palaearctic region.

The type-species of *Stylogaster*, *Conops stylatus* Fabricius, 1805, was the only species included in the original description of the genus (Lopes 1937). To the Afrotropical region, the first species described was *Ptychoproctus complexus* Bigot (= *S. complexa* Bigot) recorded from South Africa (Smith 1980).

The biology of *Stylogaster* is very interesting as its larvae are parasites of other insects mainly cockroaches and calyptate Diptera. The females are often seen hovering over marching columns of army ants (Hymenoptera, Dorylinae) and darting after their hosts that are trying to scape from the ants. Smith (1967) stated that the eggs are probably laid by a stabbing movement of the abdomen, with the ovipositor thrust forward between the legs. According to Kotbra (1997), the females, at the time of oviposition, fly on the hosts with the

eggs already positioned in the terminal chamber and with the ovipositor extended. After that the female fall on their hosts stabbing the cuticle with the posterior end. After penetrating the host cuticle, the egg is locked by its recurrent barbs and pulled free of the oviscapt as the *Stylogaster* female flies away. Stuckenberg (1963) wondered if the impaled insects are the final hosts or if they carry the eggs to their true hosts.

From the 14 species recorded to Afrotropical region, two are from South Africa, *S. complexa* (Bigot, 1859) and *S. nitens* Brunetti, 1925 (Smith 1980), the first one endemic, and five from Madagascar, all of them endemic, *S. camrasi* Stuckenberg, 1963; *S. malgachensis* Camras, 1962; *S. pauliani* Camras, 1962; *S. seguyi* Camras, 1962; *S. seyrigi* Séguy, 1932 (Smith 1980).

South Africa is the most southern country of the African continent and has a territorial extension of 1.219.912 km². Three regions of this country are defined as “hotspots”: Cape Floristic Region, Succulent Karoo and Maputaland-Pondoland-Albany.

Madagascar is the biggest island of Africa, with 587 km² and has a very rich biodiversity. The island is one of the 34 areas in the world defined as “hotspot” and more than 80% of the species known to the island are not known in any other place of the world. Because of these singularities, Madagascar and South Africa had much interest directed toward them in recent years.

The first *Stylogaster* species recorded from the island,

was *S. seyrigi* described by Séguy (1932) based on one male and one female from d'Analalava Province. Camras (1962) studied the Conopidae from Madagascar and described three new species: *S. malgachensis* (based on one female), *S. pauliani* (based on males and females) and *S. seguyi* (based only on male).

Stuckenberg (1963) discussed the biology of the genus and summarized its geographical distribution: North America, South America, "Sub-saharan" Africa, Madagascar, parts of Asia, Philippines and Papua. Fifteen species were related to the African continent, 10 of them to Africa and 5 to Madagascar. *S. camrasi* was described in this paper based on males and females. The author also recorded *Stylogaster* eggs on some Muscidae species in South Africa: *Dichaetomyia serena* (Stein), *Dichaetomyia* sp. nov., *Dichaetomyia quadrata* (Wiedemann), *Dimorphia setulosa* (Stein), *Dimorphia tristis* (Wiedemann), and *Pyrellina marsya* (Walker) (as *P. chrysotelus* (Walker)).

Smith (1967) studied the biology of *Stylogaster* and discussed the oviposition of the species over calyptate Diptera from Africa and Madagascar. The taxonomy of the species of these regions was revised and an illustrated key to eggs and adults was given. Two new African species of *Stylogaster* were described and Calliphoridae and Muscidae hosts were recorded: *Bengalia depressa* (Walker), *Tricyclea* sp., *Hemigymnochaeta unicolor* (Bigot), *Hemigymnochaeta* sp., *Stomoxys ochrosoma* Speiser, *Stomoxys brunripes* Grunberg, *Stomoxys inornata* Roubard, *Stomoxys omega* Newstead, *Haematobosca praedatrix* Enderlein (as *Bdellia*), *Helina pervittata* Emden, *Phaonia abnormis* Stein and *Emmesomyia* sp. He also provided a key to the *Stylogaster* eggs of Ethiopia and Malagasy and illustrations of the eggs.

Kotrba (1997) studied the morphology of the female terminalia and eggs and related their to the oviposition behavior, contributing to the knowledge of the biology of genera.

More recently Couri & Pont (2006) studying a material collected by the "Madagascar Arthropod Biodiversity Project", developed by the "California Academy of Sciences (CAS, San Francisco, California), added seven new *Stylogaster* muscids hosts to the island: *Deltotus facetus* Séguy, *Deltotus viola* Zielke, *Dichaetomyia apicalis* (Zielke), *Dichaetomyia basilaris* (Zielke), *Dichaetomyia tristis* (Zielke), *Neomyia setulosa* (Zielke) and *Phaonia* sp. nov. The records for *Deltotus* Séguy and *Neomyia* Walker were the first for these genera.

In the present contribution, 15 specimens of Muscidae, 14 from Madagascar and one from South Africa, impaled with *Stylogaster* eggs were examined and the available data on the dipteran *Stylogaster* eggs hosts in Africa were summarized. All eggs were extracted aiming its morphologic study and identification. Colour photos of the material examined are presented.

MATERIAL AND METHODS

The material studied belongs to "California Academy of Sciences" (CAS, San Francisco, California, USA) and to

"Albany Museum" (South Africa) collections.

The material from CAS was collected using Malaise and pitfall traps, from December 2001 to November 2003, as part of the project "Terrestrial Arthropod Inventory of Madagascar". Albany Museum's material was collected using Malaise Trap, from May to October 2007.

The impaled pinned adults were kept in moist chamber for 24 hours, and the *Stylogaster* eggs were removed using entomological pins. The extracted eggs were macerated in a solution of 10% KOH for 24 hours. After their study (identification and illustration), they were stored in a microtube with glycerol, pinned with the specimen.

Color photos were made using Syncroscopy Auto-Montage with Leica MZ16 optical microscope.

RESULTS AND DISCUSSION

Fifteen host muscid specimens, belonging to 10 different species were found and the *Stylogaster* eggs were identified.

Regarding the material from CAS, only the collection codes are given, as the material is fully listed in Couri & Pont (2006).

Stylogaster muscid hosts

1. *Deltotus facetus* Séguy, 1935

Material examined: CAS: CASENT 3010583 (Fig. 1); CASENT 3009402 (Fig. 2); CASENT 3009764. Albany Museum: MADAGASCAR: Fianarantsoa Province: Ranomafana National Park; 21°15.613'S 47°25.117'E, Malaise trap; 15-17.i.2007, A.H. Kirk-Spriggs. 1 male.

2. *Deltotus viola* Zielke, 1972

Material examined: CAS: MADAGASCAR: CASENT 3010581; CASENT 3010584

3. *Dichaetomyia apicalis* (Zielke, 1972)

Material examined: CAS: MADAGASCAR: CASENT 3010318

Dichaetomyia basilaris (Zielke, 1972)

Material examined: CAS: MADAGASCAR: CASENT 3009843

5. *Dichaetomyia tristis* (Zielke, 1972)

Material examined: CAS: MADAGASCAR: CASENT 3009365 (Fig. 3); CASENT 3010857.

6. *Dichaetomyia* (*Panaga*) sp.

Material examined: Albany Museum: SOUTH AFRICA: Eastern Cape Province: Amathole Mnts., Hogsback: 32°35.873'S 26°57.546'E, Malaise Trap, 20-21.v. 2007, A.H. Kirk-Spriggs. 1 male. (Fig. 4) NEW HOST RECORD.

7. *Helina carpieae* Couri, Pont & Penny, 2006

Material examined: Albany Museum: MADAGASCAR: Fianarantsoa Province: Ranomafana National Park; 21°15.613'S 47°25.117'E, Malaise trap; 15-17.i.2007, A.H. Kirk-Spriggs. 1 female. NEW HOST RECORD.



Figs. 1–7. 1, *Deltotus facetus* Séguy, 1935; scutum and abdomen; 2, *Deltotus facetus* Séguy, 1935; head and scutum; 3, *Dichaetomyia tristis* (Zielke, 1972); head and scutum; 4, *Dichaetomyia* (*Panaga*) sp.; head and scutum; 5, *Helina grisella* Couri, Pont & Penny, 2006; head and scutum; 6, *Stylogaster* sp. egg, lateral view; 7, *Stylogaster* sp. egg, ventral view.

8. *Helina grisella* Couri, Pont & Penny, 2006

Material examined: MADAGASCAR: Fianarantsoa Province: Ranomafana National Park; 21°15.613'S 47°25.117'E, Malaise trap; 15-17.i.2007, A.H. Kirk-Spriggs. 1 female. (Fig. 5) NEW HOST RECORD.

9. *Neomyia setulosa* (Zielke, 1972)

Material examined: CAS: MADAGASCAR: CASENT 3009084.

10. *Phaonia plurivittata* Couri, Pont & Penny, 2006

Material examined: CAS: (as *Phaonia* sp. nov. in Couri & Pont (2006): MADAGASCAR: CASENT 3009762.

Eggs

Stylogaster eggs are yellow, elongated and have a very characteristic pointed black tip with one or two pairs of

Table I. Records of *Stylogaster* diptera hosts in Africa.

Hosts	Sex	Locality	Site of eggs	Number of eggs	Reference
MUSCIDAE					
<i>Deltotus facetus</i> Séguy	♂	Madagascar, Province Fianarantsoa	Mesonotum	1	Present paper
<i>Deltotus facetus</i> Séguy	♂	Madagascar, Province Fianarantsoa	Scutellum	1	Couri & Pont 2006
<i>Deltotus facetus</i> Séguy	♂	Madagascar, Province Fianarantsoa	Mesonotum	1	Couri & Pont 2006
<i>Deltotus facetus</i> Séguy	♀	Madagascar, Province Fianarantsoa	Tergite 5, Mesonotum	2	Couri & Pont 2006
<i>Deltotus viola</i> Zielke	♀	Madagascar, Province Fianarantsoa	Postpronotum, Eye	2	Couri & Pont 2006
<i>Deltotus viola</i> Zielke	♀	Madagascar, Province Fianarantsoa	Notopleuron, Tergites 1+2, 3	3	Couri & Pont 2006
<i>Dichaetomyia (Panaga) sp.</i>	♂	South Africa, Amathole Mnts., Hogsback	Eye	1	Present paper
<i>Dichaetomyia apicalis</i> (Zielke)	♀	Madagascar, Province Fianarantsoa	Eye	1	Couri & Pont 2006
<i>Dichaetomyia basilaris</i> (Zielke)	♂	Madagascar, Province Fianarantsoa	Tergite 3	1	Couri & Pont 2006
<i>Dichaetomyia tristis</i> (Zielke)	♀	Madagascar, Province Toliara	Mesonotum	1	Couri & Pont 2006
<i>Dichaetomyia tristis</i> (Zielke)	♂	Madagascar, Province Fianarantsoa	Mesonotum	1	Couri & Pont 2006
<i>Dichaetomyia serena</i> (Stein)	♀	South Africa, Champagne Castle, Natal	Notopleuron	1	Stuckenberg 1963
<i>Dichaetomyia serena</i> (Stein)	♀	South Africa, Ngome Forest, Natal	Eye	1	Stuckenberg 1963
<i>Dichaetomyia quadrata</i> (Wied.)	♀	Mozambique, Gorongosa Mountain	Eye	1	Stuckenberg 1963
<i>Dichaetomyia sp. nov.</i>	♀	South Africa, Kirstenbosch	Wing	1	Stuckenberg 1963
<i>Dichaetomyia sp. nov.</i>	♀	South Africa, Kirstenbosch	Katepisternum, Spiracle prothoracic	2	Stuckenberg 1963
<i>Dichaetomyia sp. nov.</i>	♀	South Africa, Plettenberg Bay	Tergite 4, Scutellum, Spiracle prothoracic	4	Stuckenberg 1963
<i>Dimorphia setulosa</i> (Stein)	♀	South Africa, Knysna	Mesopleuron	1	Stuckenberg 1963
<i>Dimorphia setulosa</i> (Stein)	♀	South Africa, Knysna	Mesonotum	1	Stuckenberg 1963
<i>Dimorphia setulosa</i> (Stein)	♀	South Africa, Knysna	Anepimeron, Notopleuron, Mesonotum	4	Stuckenberg 1963
<i>Dimorphia setulosa</i> (Stein)	♀	South Africa, Storms River	Tergite 4	2	Stuckenberg 1963
<i>Dimorphia setulosa</i> (Stein)	♀	South Africa, Kirstenbosch	Mesonotum, Mesopleuron	1	Stuckenberg 1963
<i>Dimorphia tristis</i> (Stein)	♀	South Africa, Knysna	Tergite 1+2	1	Stuckenberg 1963
<i>Dimorphia tristis</i> (Stein)	♀	South Africa, Knysna	Katepisternum	1	Stuckenberg 1963
<i>Dimorphia tristis</i> (Stein)	♀	South Africa, Knysna	Metanotum	1	Stuckenberg 1963
<i>Dimorphia tristis</i> (Stein)	♀	South Africa, Knysna	Katepisternum	1	Stuckenberg 1963
<i>Dimorphia tristis</i> (Stein)	♀	South Africa, Knysna	Tergite 1+2	1	Stuckenberg 1963
<i>Dimorphia tristis</i> (Stein)	♀	South Africa, Knysna	Abdomen	1	Stuckenberg 1963
<i>Dimorphia tristis</i> (Stein)	♀	South Africa, Eshowe, Natal	Anepisternum	1	Stuckenberg 1963
<i>Emmesomyia sp.</i>	♀	Nigeria, Mambilla Plateau	Antenna	1	Smith 1969
<i>Emmesomyia sp.</i>	♀	Nigeria, Mambilla Plateau	Meron	1	Smith 1969
<i>Haematobosca praedatrix</i> Enderlein	♀	Uganda, Toro Mwenge	Sternite 4	1	Smith 1969
<i>Haematobosca praedatrix</i> Enderlein	♂	Uganda, Toro, Kibale Forest	Postpronotum	1	Smith 1969
<i>Haematobosca praedatrix</i> Enderlein	♀	Uganda, Toro, Kibale Forest	Notopleuron	1	Smith 1969
<i>Haematobosca praedatrix</i> Enderlein	♂	Uganda, Toro, Muzizi River	Notum	1	Smith 1969
<i>Helina carpiae</i> Couri <i>et al.</i>	♀	Madagascar, Province Fianarantsoa	Mesonotum	1	Present paper
<i>Helina grisella</i> Couri <i>et al.</i>	♀	Madagascar, Province Fianarantsoa	Anepisternum	1	Present paper
<i>Helina pervittata</i> Emden	♀	Kenya, Chyulu Hills	Wing, base	1	Smith 1969
<i>Helina pervittata</i> Emden	♀	Kenya, Chyulu Hills	Neck	1	Smith 1969
<i>Helina pervittata</i> Emden	♀	Kenya, Chyulu Hills	Notum	2	Smith 1969
<i>Helina pervittata</i> Emden	♀	Kenya, Chyulu Hills	Notopleuron	4	Smith 1969
<i>Helina pervittata</i> Emden	♀	Kenya, Chyulu Hills	Anepisternum	1	Smith 1969
<i>Neomyia setulosa</i> (Zielke)	♀	Madagascar, Provincia Antsiranana	Mesonotum, notopleuron	2	Couri & Pont 2006
<i>Phaonia abnormis</i> Stein	♂	Nigeria, Mambilla Plateau	Sternite 3	1	Smith 1969
<i>Phaonia plurivittata</i> Couri	♂	Madagascar, Province Fianarantsoa	Eye	1	Couri & Pont 2006
<i>Pyrellina chrysotelus</i> (Walker)	♀	South Africa, Knysna	Eye	1	Stuckenberg 1963
<i>Stomoxys ochrosoma</i> Speiser	♀	Kenya, Ngong	Notum	1	Smith 1969

Table I. Cont.

Hosts	Sex	Locality	Site of eggs	Number of eggs	Reference
<i>Stomoxys brunnipes</i> Grunberg	♀	Uganda, Toro	Anepisternum	1	Smith 1969
<i>Stomoxys brunnipes</i> Grunberg	♀	Uganda, Ankole Oryobu	Eye	1	Smith 1969
<i>Stomoxys brunnipes</i> Grunberg	♀	Uganda, Ankole Oryobu	Leg	1	Smith 1969
<i>Stomoxys brunnipes</i> Grunberg	♀	Uganda, Ankole Oryobu	Eye	1	Smith 1969
<i>Stomoxys brunnipes</i> Grunberg	♀	Uganda, Ankole Oryobu	Propleuron	1	Smith 1969
<i>Stomoxys brunnipes</i> Grunberg	♀	Uganda, Ankole Oryobu	Eye	1	Smith 1969
<i>Stomoxys brunnipes</i> Grunberg	♀	Uganda, Ankole Oryobu	Anepisternum	1	Smith 1969
<i>Stomoxys brunnipes</i> Grunberg	♀	Uganda, Ankole Oryobu	Eye	1	Smith 1969
<i>Stomoxys inornata</i> Roubard	♀	Uganda, Toro Mwenge	Anepisternum	1	Smith 1969
<i>Stomoxys inornata</i> Roubard	♀	Uganda, Toro Mwenge	Postpronotum	1	Smith 1969
<i>Stomoxys inornata</i> Roubard	♀	Uganda, Toro Mwenge	Prosternum	1	Smith 1969
<i>Stomoxys inornata</i> Roubard	♀	Uganda, Toro Mwenge	Eye	1	Smith 1969
<i>Stomoxys inornata</i> Roubard	♀	Uganda, Toro Mwenge	Katepisternum	1	Smith 1969
<i>Stomoxys inornata</i> Roubard	♀	Uganda, Kigezi	Postpronotum	1	Smith 1969
<i>Stomoxys omega</i> Newstead	♀	Uganda, Ankole Oryobu	Tergite 5	1	Smith 1969
<i>Stomoxys omega</i> Newstead	♀	Uganda, Ankole Oryobu	Propleuron	1	Smith 1969
CALLIPHORIDAE					
<i>Bengalia depressa</i> (Walker)	♂	Rhodesia, Chirinda Forest	Eye	1	Smith 1969
<i>Bengalia depressa</i> (Walker)	♂	Kenya, Nlairag Nigare	Notum	1	Smith 1969
<i>Tricyclea</i> sp.	♂	Uganda, Kampala	Notum	1	Smith 1969
<i>Tricyclea</i> sp.	♂	Uganda, Bulemwezi	Tergite 5	1	Smith 1969
<i>Tricyclea</i> sp.	♂	Uganda, Bulemwezi	Tergite 5	1	Smith 1969
<i>Hemigymnochaeta unicolor</i> (Bigot)	♂	Nigeria, Zaria, Samuru	Notum	1	Smith 1969
<i>Hemigymnochaeta</i> sp.	♂	Sierra Leone, Batkany	Tergite 3	1	Smith 1969
<i>Hemigymnochaeta</i> sp.	♂	Cameroon, Kumba	Eye	1	Smith 1969
LAUXANIIDAE					
Lauxaniidae sp.	♂	Madagascar, Forest in Madagascar	Ptilinal suture	1	Stuckenberg 1963
TACHINIDAE					
<i>Androeuryps ecitonis</i> (Townsend)		No data	No data	No data	Stuckenberg 1963
<i>Calodexia agilis</i> Curran		No data	No data	No data	Stuckenberg 1963
SYRPHIDAE					
<i>Asarkina hullei</i> (Munro)	♂	Mozambique, Tumbine Mountain, Forest	Between sternites 4 and 5	1	Stuckenberg 1963

projecting barb-like spines. At the pointed apex, some eggs have a extrusible sac-like structure very varied in shape and length among the different species (Stuckenberg 1963). According to Rettenmeyer (1961) this sac is everted after the deposition of the egg and may serve to hold the egg in the host and perhaps absorb nutrients. Stuckenberg (1963) suggested that in the African species *S. parva* Camras “an ancillary function of the bladder is to erect the spines, thereby greatly increasing their efficiency as barbs for retaining the eggs in the host’s body”. The chorion is finely reticulated, and this pattern also helps the identification of the species.

Smith (1967) used these characters in the key for identification of the eggs (number of lateral barbs, head symmetrical or assymetrical, length of the eversible sac, sculpture of the egg’s surface, among others).

Morphology and identification of the dissected eggs

Description (Figs. 6 and 7): (all dissected eggs are morphologically similar). Yellow, elongated, head

symmetrical, pointed apex with two pairs of lateral barbs close together, eversible sac short and surface of the egg sculptured only close to the head.

In Smith (1967)’ key they run to *S. nitens* Brunetti, but the key lacks *S. complexa* and *S. seguyi*, both endemic, respectively to South Africa and Madagascar, as these eggs are not known. Concerning *S. nitens* (recorded to South Africa but not to Madagascar), the eggs figured by Smith (1967) are a little different from the eggs of *S. parva* Camras figured by Stuckenberg (1963), although these two species are synonyms. Comparison with these illustrations show some differences with the eggs herein studied, as straight head (and not curved as in *S. nitens* (Fig. 14 of Smith 1967) and the lateral barbs are close together and not separate showed in Figs 2–7 of *S. parva* (Stuckenberg 1963).

The Madagascan species of *Stylogaster* which egg is morphologically closer to the present species, is *S. camrasi*, but in this species the eversible sac is very long and the lateral barbs very separated (as long as entire egg) and the egg has its whole surface sculptured.

Figures 16 and 17 of Smith (1967) show an identical egg with the one herein presented, but it is referred in text as an “unknown *Stylogaster* sp. ex. *Dichaetomyia* sp.” Under the discussion of *S. camrasi* and *S. seguyi* the author suggested that this can be the egg of *S. seguyi* and that this species is closely related to *S. camrasi* and *S. nitens*.

It is interesting to register that all eggs herein examined, both from Madagascar and South Africa, are identical, suggesting the occurrence of the same species in both localities, what is not recorded until now (see catalogue Smith 1980).

Seventy three records of *Stylogaster* diptera hosts in African continent were found in literature. They belonged to the following families: Muscidae, Calliphoridae, Lauxaniidae, Tachinidae and Syrphidae, each of them respectively with 24, 4, 1, 2 and 1 host species. Table 1 summarizes the available information. The predominant sex carrying *Stylogaster* eggs in all records is female, totalizing 53 records, 72.6% of the total. All records for *Stomoxys*, *Helina* and *Dimorphia* are only of females, while in all Calliphoridae species only males were recorded.

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