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# Importance of the Scatophagidae family as efficient predators of blowflies (Insecta: Diptera)

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## Abstract

The biology of the larvae give Scathophagidae is very varied. Most live on dung, hence the family name. Some feed on plants (leaf miners, stem borers, or seed eaters), are aquatic predators, and are predators of other insect larvae in moist environments, such as piles of decaying vegetables, algae, or manure. Adults are predators of other insects. They are often found in flowers where they are usually stalking prey, not looking for pollen or nectar. Indeed, they are one of the most efficient predators of blowflies and for this reason they are considered beneficial insects. The objective of this literature review was to verify the importance of the Scatophagidae Family as efficient predators of blowflies (Insecta: Diptera). With emphasis on conceptual and taxonomic aspects was carried out in the years 1934 to 2021. Only complete articles published in scientific journals and expanded abstracts presented at national and international scientific events, Doctoral Thesis and Master's Dissertation were considered. Data were also obtained from platforms such as: Scielo Frontiers, Qeios, Pubmed, Biological Abstract, Publons, Dialnet, World, Wide Science, Springer, RefSeek, Microsoft Academic, Science.

**Keywords:** *Scathophaga stercoraria*; Predators; Manure; Decaying vegetables; Leaf miners

## 1. Introduction

A B

**Figure 1A** Specimen of Scathophagidae Family: Side view**. Figure 1B** Specimen of Scathophagidae Family Front view; (Source|: https://ecuador.inaturalist.org/photos/25416360)

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Scathophagidae is a small family of flies in the superfamily Muscoidea. The larvae of the most common species *Scathophaga stercoraria* (Linnaeus, 1758) Diptera: Scathophagidae) feed on manure as indicated by its scientific name, which gives its name to the family. There are about 500 species in the world in about 66 genera (Figures 1A, 1B, 2, 3, 4 and 5) [1,2].


**Figure 2** Habitus, lateral view. 1. *Cordilura rufipes* (Meigen, 1826) (dry specimen), 2. *Gimnomera montana* Ozerov et Krivosheina, 2013 (alcoholic specimen), 3. *Norellisoma spinimana* (Fallén, 1819) (alcoholic specimen), 4. *Parallelomma albipes* (Fallén, 1819); (Source: https://www.semanticscholar.org/paper/Dung-flies-fauna-(Diptera%3A-Scathophagidae)-in-East-Khaghaninia-Gharajedaghi/a412cd87c49913b0e4582b917a2d681b6429ba68)

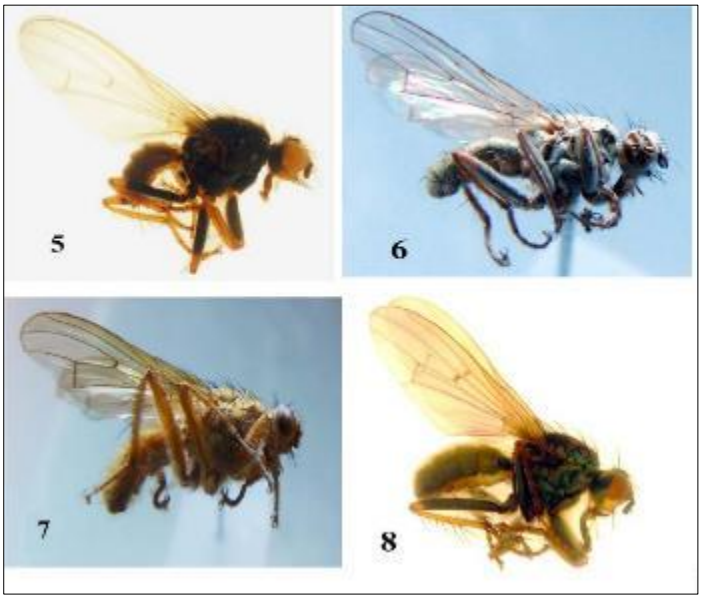


Figure 3 5-8 Habitus, lateral view. 1. *Scathophaga jezeki* (Šifner, 1981) (alcoholic specimen), 2. *Scathophaga kaszabi* (Šifner, 1975) (dry specimen), 3. *Scathophaga lutaria* (Fabricius, 1794) (dry specimen), 4. *Scathophaga stercoraria* (Linnaeus, 1758) (Fallén, 1819); (Source: https://www.semanticscholar.org/paper/Dung-flies-fauna-(Diptera%3A-Scathophagidae)-in-East-Khaghaninia-Gharajedaghi/a412cd87c49913b0e4582b917a2d681b6429ba68)

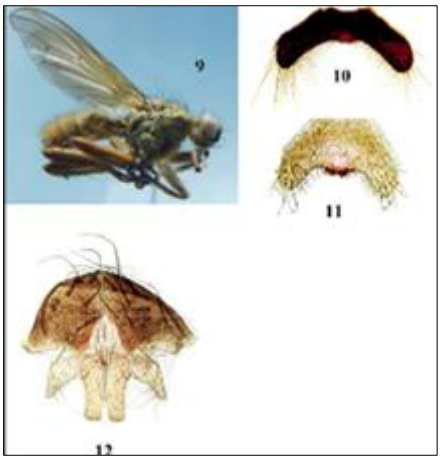


**Figure 4** 9-13 9. *Scathophaga taeniopa* (Rondani, 1867) (Habitus, lateral view, dry specimen). 10. *Scathophaga jezeki* (Šifner, 1981) (4th abdominal sternite)**,** 11. *Scathophaga kaszabi* (Šifner, 1975) (4th abdominal sternite), 12. *Scathophaga jezeki (*Šifner, 1981) (epandrium, dorsal view).


**Figure 5** 13. *Scathophaga kaszabi* (Šifner, 1975); (Source: https://www.semanticscholar.org/paper/Dung-flies-fauna-(Diptera%3A-Scathophagidae)-in-East-KhaghaniniaGharajedaghi/a412cd87c49913b0e4582b917a2d681b6429ba68)

### 1.1 Description

The flies of the family Scathophagidae are very small to medium in size, from 3 to 12 mm. The body is slender, especially that of males, with a generally elongated and cylindrical abdomen. Many flies in this family appear more robust due to their abundant hairiness. Body color ranges from yellow to black; some species are glossy, but none have a metallic sheen. Some have more than one color (Figure 6) [3,4].

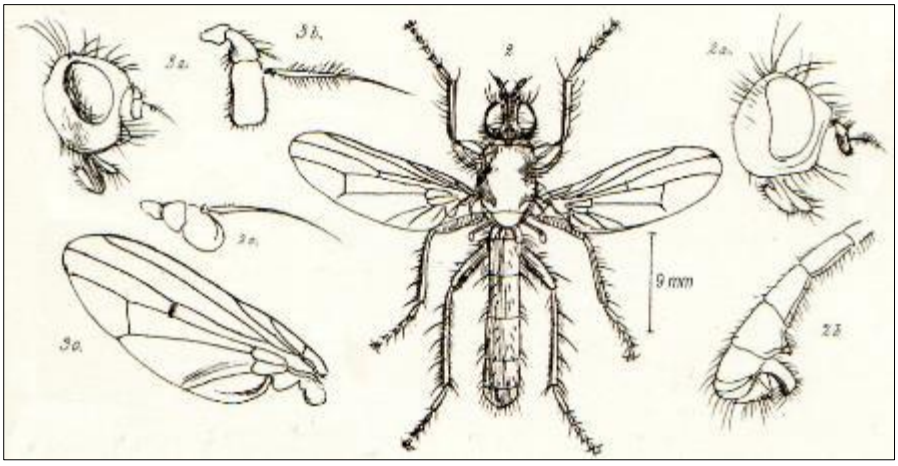


**Figure 6** *Scathophaga scybalaria* (Linnaeus, 1758) (Largest Dung-fly: B. Int. 405). *S. scybalaria* (detail: B. Int. 405). *S. scybalaria* (dissections: B. Ent. 405). *S. scybalaria*: B. Ent. 405, legend+text. *S. scybalaria*: B. Ent. 405, text cont. *Hydromyza livens* (Fabricius, 1794) (Water-lily *Cordylura* Fly: B. Int. 485). *H. livens*: B. Ent. 485, legend+text. *H. livens*: B. Ent. 485, text cont. *Coniosternum*, *Cordilura*, *Scathophaga* (from Walker). 2, *Cordilura pubera* (Linnaeus, 1758), male, with the head in side view (antennae removed, 2a), and a palp, (2b). 2c, an antenna of *Coniosternum obscurum* (Fallén, 1819). 3,

*Scathophaga stercoraria* (Linnaeus, 1758): head in side view (3a), male abdomen in side view (3b), and a wing (3c). From Walker (1853, Plate XIII), with approximate insect length (front of head to abdominal tip) indicated; (Source: https://www.delta-intkey.com/britin/dip/www/scathoph.htm)

The eyes are widely spaced in both sexes. The setae on the head, thorax and legs are well developed. The occiput is generally pale with long hairs. The awn can be glabrous or feathery. They lack frontal setae. The wings are generally transparent, but in some species they darken towards the tip or along the cross veins. The anal vein is long and usually reaches the margin of the wing (Figures 7A, 7B, 8, 9 and 10). [3,4,5].

A B

**Figure 7A** Arista long haired. Two humeral bristles. **Figure 7B** Arista short haired or virtually bare. One or no humeral bristles; (Source: https://scathophagidae.myspecies.info/files/scathophagid_key.pdf)

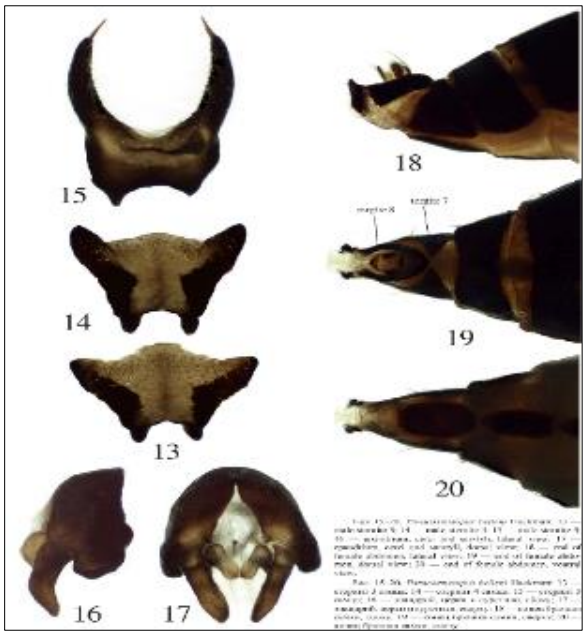


**Figure 8** 13 — male sternite 3; 14 — male sternite 4; 15 — male sternite 5; 16 — epandrium, cerci and surstyli, lateral view; 17 — epandrium, cerci and surstyli, dorsal view; 18 — end of female abdomen, lateral view; 19 — end of female abdomen, dorsal view; 20 — end of female abdomen, ventral view; (Source: https://www.semanticscholar.org/paper/A-review-of-species-of-the-genera-Bostrichopyga-and-Ozerov-Krivosheina/651e370e4bad902a77e84052f5e02a76d899ac17)

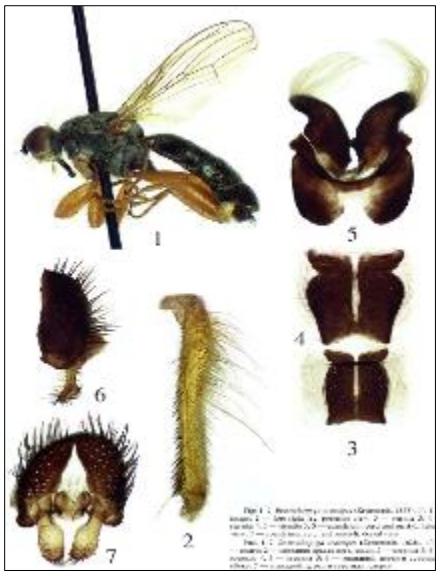


**Figure 9** 1 — imago; 2 — fore right leg, posterior view; 3 — sternite 3; 4 — sternite 4; 5 — sternite 5; 6 — epandrium, cerci and surstyli, lateral view; 7 — epandrium, cerci and surstyli, dorsal view; (Source: https://www.semanticscholar.org/paper/A-review-of-species-of-the-genera-Bostrichopyga-and-Ozerov-Krivosheina/651e370e4bad902a77e84052f5e02a76d899ac17)

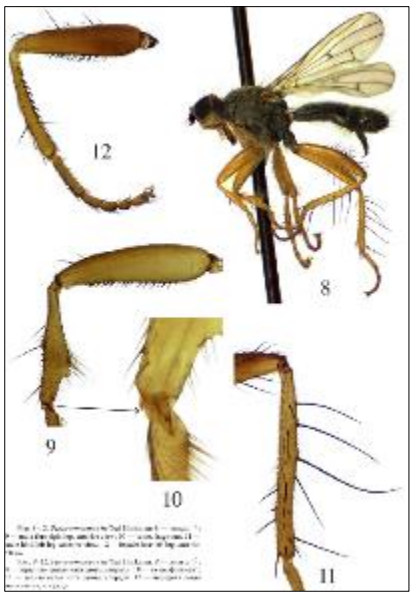


**Figure 10** 8 — imago, #; 9 — male fore right leg, anterior view; 10 — same, fragment; 11 — male hind left leg, anterior view; 12 — female fore left leg, anterior view; (Source: https://www.semanticscholar.org/paper/A-review-of-species-of-the-genera-Bostrichopyga-and-Ozerov-Krivosheina/651e370e4bad902a77e84052f5e02a76d899ac17)

These flies are sexually dimorphic, with the male showing more vibrant colors, namely oranges and yellows, than the female and also colored hair on the front legs [4,5].

### 1.2 Biology

Biology of the larvae is very varied. Most live on dung, hence the family name. Some feed on plants (leaf miners, stem borers, or seed eaters), are aquatic predators, and are predators of other insect larvae in moist environments The, such as piles of decaying vegetables, algae, or manure. Adults are predators of other insects. They are often found in flowers

where they are usually stalking prey, not looking for pollen or nectar. Indeed, they are one of the most efficient predators of blowflies and for this reason they are considered beneficial insects. One of the best known species is *S. stercoraria*. The males of these reddish-brown flies tend to congregate in cattle manure, where they are frequently seen at certain times of the year (Figure 11) [6,7].

**Figure 11** The duration of the *Acanthocnema* predator life stages was: egg 2.9 ± 0.8 (mean ± SD) days, larva 15.6 ± 10.2 days, pupa 80.3 ± 24.9 days and adult 7.2 ± 4.8 days. The short duration of the *Acanthocnema* egg stage (1–7 days) compared to that of its prey *Neophylax rickeri* Milne,1935 (Trichoptera: Uenoidae) (2–4 weeks) raises the probability that the undeveloped eggs of *N. rickeri* would be available to the young predators upon hatching. Egg consumption of *N. rickeri* eggs by *Acanthocnema* averaged 262.6 eggs per larval period; (Source: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2427.2008.02060.x)

A

B

**Figure12A** Golden dung flies, *Scathophaga stercoraria* (Linnaeus, 1758), male guarding female while she lays eggs. **Figure 12B** lender, strongly to weakly setulose and sometimes densely hairy flies, usually black, gray, brown, or yellow, sometimes strikingly bicolored, usually subshining but sometimes densely gray to yellow pruinose. Wings usually hyaline, but sometimes with clouded crossveins, spots, or transverse bands. Male abdomen often enlarged apically. Length 3-11 mm; (Source: https://www.alamy.com/stock-photo-golden-dung-flies-scathophaga-stercoraria-male-guarding-female-while-35092085.html)

The matings for reproduction are made in the feces to which both males and females are attracted. Like other insects this species undergoes a metamorphosis. Other names: Yellow dung fly, Golden dung fly (GB); *Scatophage* du fumier (F). [6,7].

Females are small and have limited precopulatory choice. Copulation lasts 20–50 minutes, after which the male attempts to guard the female from other males. Both males and females often mate with multiple partners. Reproductive success depends on a variety of factors, including sperm competition, nutrition, and environmental temperature (Figures 12A and 12B) [6,7].This is where adult females lay their eggs, providing their larvae with enough food for them to grow. Despite their eating habits being strange to us, this species plays a very important role in the environment as it is responsible for decomposing these feces that would otherwise be a focus of diseases and therefore harmful to public health. On the other hand, they are part of the diet of other species, namely birds [6,7].

Larvae and pupae. The larvae terrestrial; phytophagous (including some leaf miners), or saprophagous, or coprophagous, or predatory, or parasitic; acephalic. The pupae enclosed within a puparium (Figures 13, 14A, 14B and 14C).

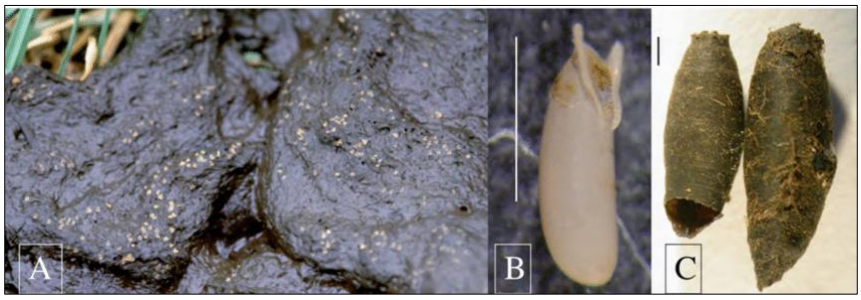


**Figure 13** (A) *Scathophaga stercoraria* (Linnaeus, 1758) eggs in a dung pat; (B) close-up of one egg, with the yellowish plastron and the respiratory horns clearly visible; and (C) two pupae (the left one is open after the emergence of an adult). Scale bars are 1 mm; (Source: Photos by Peter Jann, Stephanie Bauerfeind and Marlen Wildenhues. High quality figures are available online)


**Figure 14A** Larva and pupae of Scathophagidae; (Source: https://bugtracks.wordpress.com/tag/scathophagidae/)

**B**

**C**

**Figure 14** B Larva of Scathophagidae. **Figure 14C** Eggs of Scathophagidae; (Source: https://www.discoverlife.org/mp/20q?search=Scathophagidae&guide=Groups_Insecta&flags=col4:&res=240)

### 1.3 Food

The adults mainly prey on smaller insects—mostly other Diptera. They can also consume nectar and dung as additional sources of energy (Figures 15, 16 and 17).

**Figure 15** Common yellow dung-fly or Golden dung-fly; (Source: https://theresagreen.me/tag/golden-dung-fly/)


**Figure 16** Common yellow dung-fly or Golden dung-fly; (Source: https://www.ipmimages.org/browse/taxthumb.cfm?fam=861)


**Figure 17** Dung flies *Parallelomma* sp.; (Source: Gyorgy Csoka)

### 1.4 Geographical distribution

Most species are found in the Palearctic and Nearctic regions. The family is confined almost entirely to the Northern Hemisphere, with only five species in the Southern Hemisphere. Two of them are species of *Scathophaga* that are also present in the northern hemisphere; they have possibly been accidentally introduced to Brazil and South Africa with domestic herds. The most diverse fauna is found in the far east of Russia [6,7].

### 1.5 Taxonomy

Subfamilies: Scathophaginae and Delininae (Figures 18, 19, 20 and 21).

**Figure 18** Subfamily Scathophaginae (Scathophagidae); (Source: https://scathophagidae.myspecies.info/taxonomy/term/74/media?page=1)

**Figure 19** Close-up of the sides of the thorax of Scathophaginae showing the hairs on the pteropleuron; (Source: https://scathophagidae.myspecies.info/taxonomy/term/74/media?page=1)

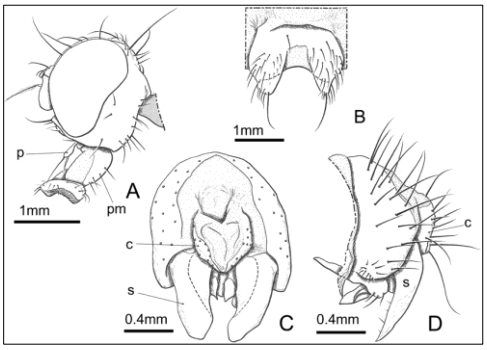


**Figure 20** Morphology of Delininae: (A) Male head in left lateral view; (B) male 5th abdominal sternum in ventral view; (C) male genitalia in posterior view; (D) male genitalia in left lateral view. c, cercus; p, palpus; pm, postmentum; s, surstylus; (Source: https://www.researchgate.net/figure/Morphology-of-Parallelomma-vittatum-Meigen-1826-from- Cephalanthera-falcata-A-Male_fig2_330413240)

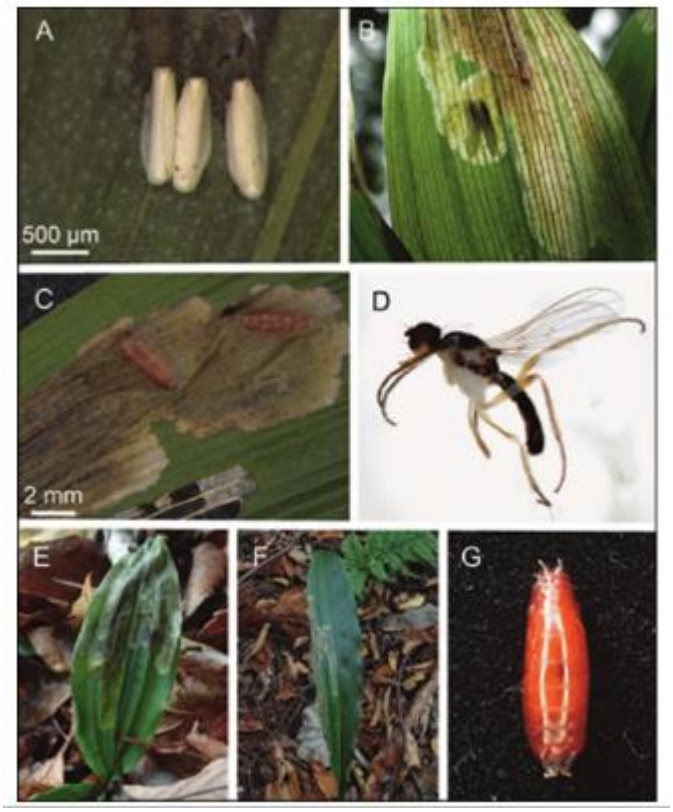


**Figure 21** Egg in a Delininae leaf; (D) the newly emerged Delininae adult from leaf; (E) blotch mine by two larvae of probable Delininae leaf; (F) blotch mine by two larvae of probable Delininae leaf; (G) puparium of probable Delininae obtained from the blotch mine in a Delininae leaf; (https://www.researchgate.net/figure/A-Clutch-of-Parallelomma-vittatum-Meigen-1826-eggs-that-have-recently-hatched-and_fig1_330413)

### 1.6 British representation: Genera

*Anthocnema, Ceratinostoma, Chaetosa, Cleigastra, Conisternum,*
*Cordilura, Cosmetopus, Delina, Ernoneura, Gimnomera, Gonatherus, Hydromyza, Leptopa, Megaphthalma, Microprosopa, Nanna, Norellia, Norellisoma, Parallelomma, Pogonota Scathophaga, Spaziphora* and *Trichopalpus* (Figure 22A) [8].

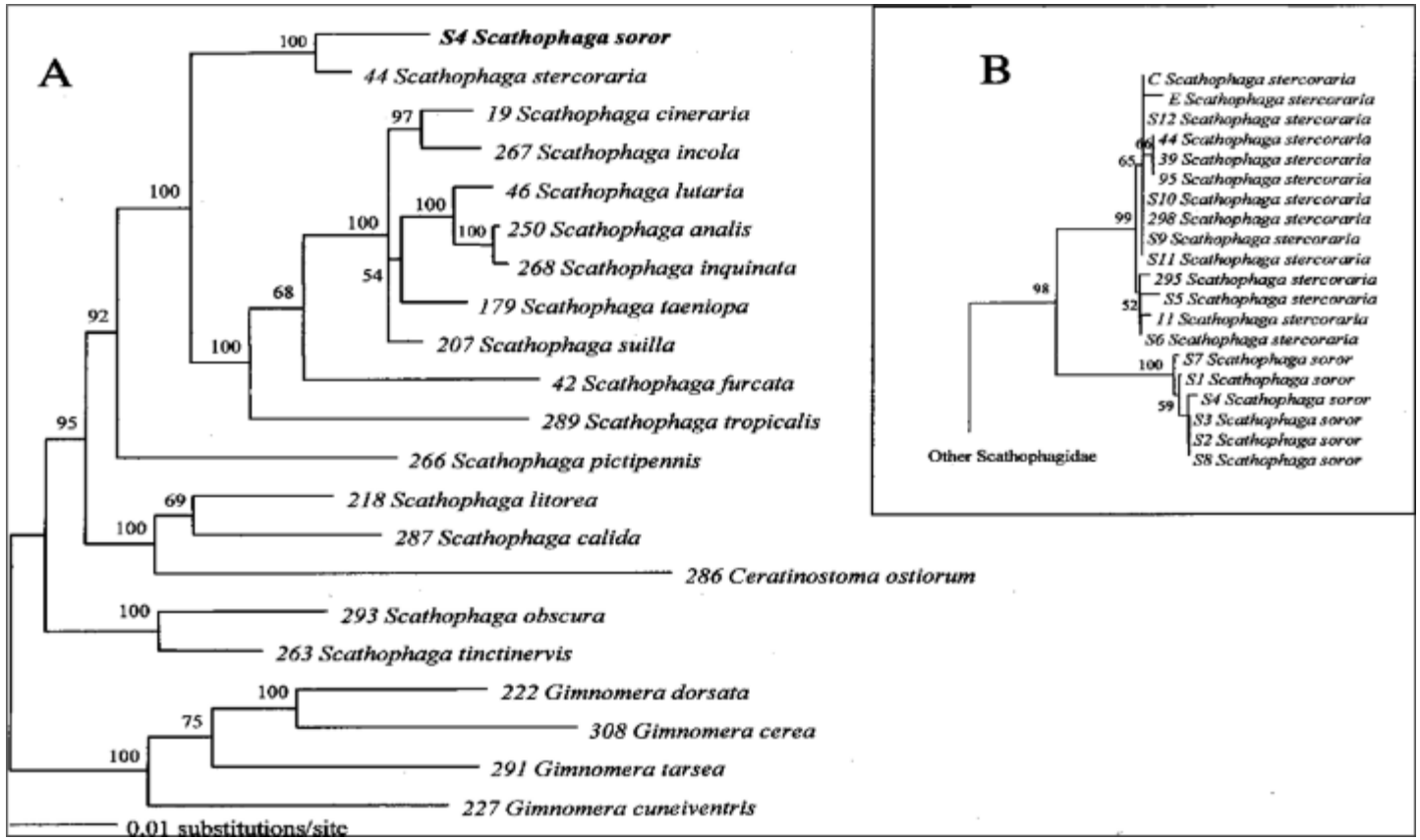


**Figure 22A** A. Phylogenetic relationships derived from 18'002 Bayesian trees based on combined COI, 12S rDNA, 16S rDNA, and ITS2 sequences as established between 21 Scathophagidae species. The tree is a 50% majority rule consensus tree; values of posterior probabilities over 50% are indicated above branches (branches with probabilities less than 50% are collapsed). Scathophaga soror is evidenced in bold. B. Excerpt from a gene tree (Neighbour Joining, Kimura 2 parameters, COI gene) illustrating the sister group relationship between the monophyletic S. stercoraria and S. soror clades. Bootstrap values (for 1000 pseudo-replicates) are indicated above branches; (Source: https://www.semanticscholar.org/paper/Systematic-ambiguity-in-the-well-established-model-Bernasconi-Berger/752924d5c5b0ad790b172fd807551fbab0c5886d)

*Objective*

The objective of this literature review was to verify the importance of the Scatophagidae Family as efficient predators of blowflies (Insecta: Diptera).

## 2. Methods

The method used to prepare this mini review was Marchiori 2021 methodology [9].

## 3. Studies conducted and selected

### 3.1 Study 1

Dung fly *Scathophaga stercoraria* (Linnaeus, 1758) (Figures 22B and 22C).

**B** **C**

**Figure 22**B and **Figure 22C**: Specimens of *Scathophaga stercoraria* (Linnaeus, 1758); (Source: https://www.semanticscholar.org/paper/Systematic-ambiguity-in-the-well-established-model-Bernasconi-Berger/752924d5c5b0ad790b172fd807551fbab0c5886d)

His species of flies belongs to the Diptera order and the Scathophagidae family and is found in Portugal. As the common name implies, this species, while in its larval stage, is often found in the feces of large animals such as cows, sheep and horses (coprophagy) (Figure 23).

**Figure 23** Larva of *Scathophaga stercoraria* (Linnaeus, 1758); (Source: https://www.commanster.eu/Commanster/Insects/Flies/WFlies/Scathophaga.stercoraria.html)

This is where adult females lay their eggs, providing their larvae with enough food for them to grow. Despite their eating habits being strange to us, this species plays a very important role in the environment as it is responsible for decomposing these feces that would otherwise be a focus of diseases and therefore harmful to public health. On the other hand, they are part of the diet of other species, namely birds.

These flies are sexually dimorphic, with the male showing more vibrant colors, namely oranges and yellows, than the female (photo on the side) and also colored hair on the front legs (photo above). When they are adults they are carnivores feeding on other smaller arthropods, supplementing their diet with nectar and faeces (Figure 24).

**Figure 24** *Scathophaga stercoraria* (Linnaeus, 1758) (Scathophagidae) - (female imago); (Source: https://commons.wikimedia.org/wiki/File:Scathophaga_stercoraria_(Scathophagidae)_-_(female_imago),_Nijmegen,_the_Netherlands_-_3.jpg)

The matings for reproduction are made in the feces to which both males and females are attracted. Like other insects this species undergoes a metamorphosis. Other names: Yellow dung fly, Golden dung fly (GB); *Scatophage* du fumier (F) (Figure 25) [10,11].

**Figure 25** Yellow dung fly *Scathophaga stercoraria* (Linnaeus, 1758) (Scathophagidae) in bovine feces; (Source: http://abugblog.blogspot.com/2015/07/yellow-dung-fly.html)

## 3.2 Study 2

### *3.2.1 Family Scathophagidae*

All the adults of this family are predaceous, feeding on a wide diversity of small to medium-sized soft-bodied insects. The larvae of many species, mainly *Scathophaga* and related genera, live in the dung of mammals or in decaying vegetative debris such as banks of seaweed. These larvae are generally predaceous, attacking and draining other larvae, including those of other Diptera (Figures 26, 27, 28, 29, 30A, 30B and 31) [12].

### *3.2.2 Scathophagidae predators of Simuliidae*

*Scathophaga stercoraria* (Linnaeus, 1758): Predator–prey–stages: Adults on adults of *Simulium equinum* (Linnaeus, 1758) [12].

**Figure 26** *Scathophaga stercoraria* (Linnaeus, 1758); (Source: https://commons.wikimedia.org/wiki/File:Scathophaga_stercoraria_(Scathophagidae)_-_(female_imago),_Nijmegen,_the_Netherlands_-_2.jpg)

*Scathophaga scybalaria* (Linnaeus, 1758): Predator–prey–stages: Adults on adults of *Scathophaga. equinum* (Linnaeus, 1758) and *Simulium aureum* Fries, 1824 (¼ a member of *S. aureum* species complex) [12].

**Figure 27** *Scathophaga scybalaria* (Linnaeus, 1758); (Source: https://www.discoverlife.org/mp/20p?see=I_MWS122112&res=640)

*Scathophaga suilla* Fabricius, 1794: Predator–prey–stages: Adults on adults of *S. equinum* [12].

**Figure 28** *Scathophaga suilla* Fabricius, 1794; (Source: https://scathophagidae.myspecies.info/scathophagid-checklist/scathophaga-suilla)

*Spaziphora hydromyzina* (Fallén, 1819): Predator–prey–stages: Larvae on larvae and pupae of *Prosimulium hirtipes* (Fries, 1824) (¼ a member of the *P. hirtipes* species group) [12].

**Figure 29** *Spaziphora hydromyzina* (Fallén, 1819); (Source: https://en.wikipedia.org/wiki/Spaziphora_hydromyzina)

### 3.3 Recorded numbers of species of Dipteran predators of Simuliidae, by family and zoogeographical region

Scathophagidae: Palaearctic /Afrotropical Oriental/ Australasian & Oceanean/ Nearctic/ Neotropical /World total Number 400004.

**A**

**B**

**Figure 30A** *Simulium equinum* (Linnaeus 1758). **Figure 30B** *Simulium aureum* Fries, 1824; (Source: https://www.commanster.eu/Commanster/Insects/Flies/SpFlies/Simulium.aureum.html)

**Figure 31** A *Prosimulium hirtipes* (Fries, 1824); (Source: https://v3.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxid=111792)

## 3.4 Study 3

### *3.4.1* *Scathophaga suilla* (Fabricius, 1794)

This is generally a small species and the ground color of the lower front part of the thorax (humeri to front coxae extending on to the mesopleuron and sternopleuron) and the lower part of the occiput tend to be pale yellow. The antennae, palps and proboscis all have a pale ground color and the abdomen (which usually has a darker ground colour) has thick bands of yellow-brown dusting. These factors, together with the entirely yellow legs, all give an overall pale impression. The wing has both cross-veins infuscated. Wing length: ♂ 5.1 - 6.0 - 7.4 mm (17); ♀ 5.5 - 6.2 - 7.2 mm (Figures 31B and 31C) [13.14,15].

**B**

**C**

**Figure 31** B *Scathophaga suilla* (Fabricius, 1794) Side view; **Figure 31C** *Scathophaga suilla* (Fabricius, 1794) Dorsal/side view; (Source: https://scathophagidae.myspecies.info/scathophagid-checklist/scathophaga-suilla#ref1)

## 3.5 Study 4

### 3.5.1 *Scathophaga scybalaria* (Linnaeus, 1758)

A very large, orange-yellow, furry species ('teddy-bear fly') in which the attractive males are covered in long golden fur, have a strong yellowish tinge to the wings and long yellow legs. However, smaller duller individuals also occur which are less readily distinguished from *S. stercoraria*. Large specimens of *S. lutaria* seem particularly liable to be mistaken for this species, probably because the membranous strip above the hind coxae is darkened and not at all obvious in some cases. The male claspers are distinctive being rather pale and narrow, darkening towards the tip which is bifid whereas most other *Scathophaga* have simple, stout, black claspers. Wing length: ♂ 10.2 - 11.0 - 11.9 mm (8); ♀ 9.0 - 9.6 - 10.2 mm (6) (Figure 32) [16].

**Figure 32** *Scathophaga scybalaria* (Linnaeus, 1758); (Source: Cors Bodeilio, Anglesey on11/07/2014)

### 3.6 Study 5

*3.6.1 Spaziphora hydromyzina* (Fallén, 1819)

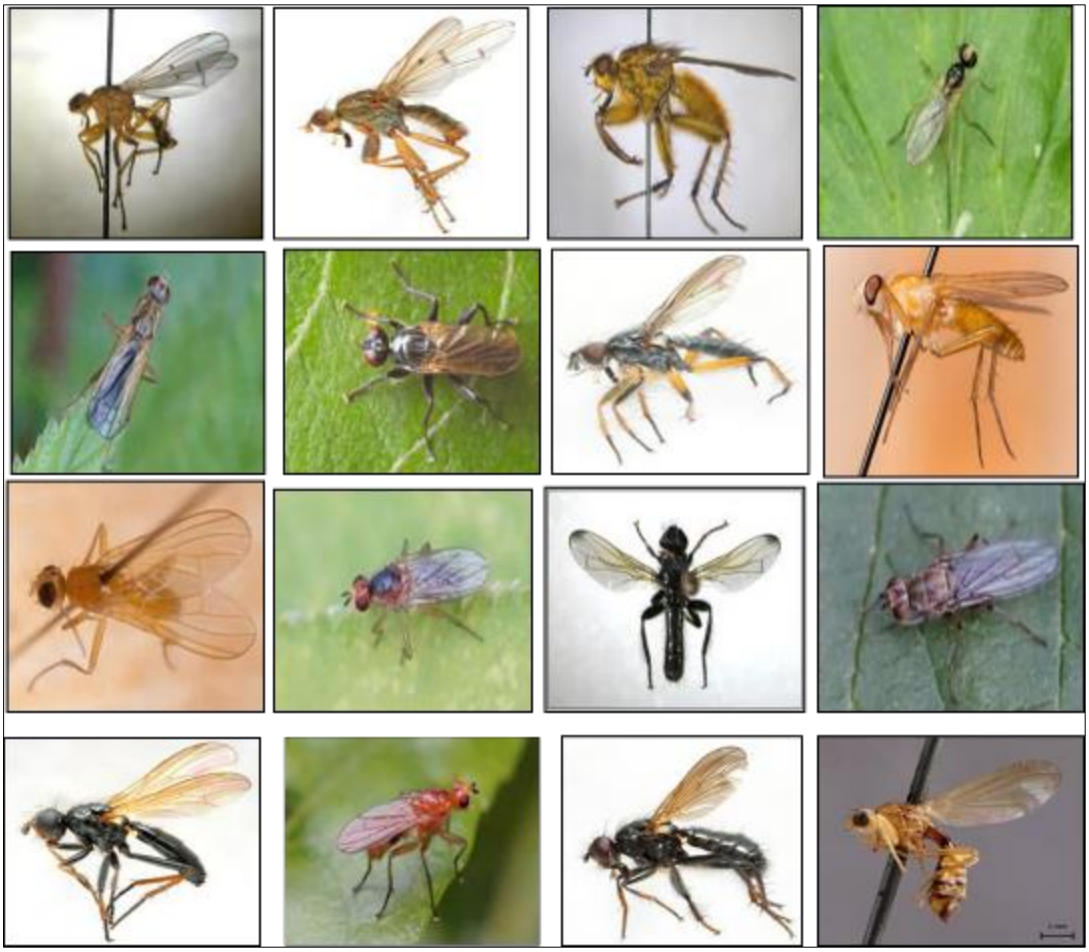

**Figure 33** *Specimens of Scathophagidae; (*Source: https://scathophagidae.myspecies.info/scathophagid-checklist/spaziphora-hydromyzina)

In the field this fly appears quite dark, long and thin and with a conspicuously yellow face. The legs are reddish and normally have dark rings on all femora, but the degree of darkening of the legs is very variable and Collin (1958)[1] reports entirely pale-legged specimens. The thorax and abdomen are densely grey dusted with broad brownish stripes along the line of the dorsocentrals. Front half of the frons and the sides of the face reddish yellow, face and jowls pale yellowish dusted. Proboscis black. Palps pale, large, flattened and spoon shaped. Wing length: ♂ 5.7 - 7.4 - 8.6 mm (23); ♀ 5.4 - 6.0 - 6.8 mm (17) (Figure 33) [17].

## 4. Conclusion

This is where adult females (Scatophagidae) lay their eggs, providing their larvae with enough food for them to grow. Despite their eating habits being strange to us, this species plays a very important role in the environment as it is responsible for decomposing these feces that would otherwise be a focus of diseases and therefore harmful to public health. On the other hand, they are part of the diet of other species, namely birds.

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