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PUPAL PARASITOIDS (HYMENOPTERA) OF THE HOUSE FLY (*MUSCA DOMESTICA*) AND OTHER MUSCOID FLIES (DIPTERA) ASSOCIATED WITH POULTRY AND LIVESTOCK MANURE IN SELECTED AREAS OF THE PHILIPPINES[1]

Leopoldo M. Rueda, Mateo B. Zipagan, Cecilia T. Hugo and Gliceria M. Arellano[2]

ABSTRACT

Eight species of parasitic Hymenoptera belonging to 3 families (Pteromalidae, Chalcididae and Diapriidae) were recovered from pupae of house fly (*Musca domestica* Linnaeus) and other filth flies in the manure of poultry, swine, carabao, beef and dairy cattle at selected areas of the Philippines. These parasitoids include *Pachycrepoideus vindemiae* (Rondani), *Spalangia endius* Walker, *S. cameroni* Perkins, *S. nigroaenea* Curtis, *Muscidifurax raptor* (Girault and Sanders), *Nasonia vitripennis* Walker, *Dirhinus himalayanus* (Westwood) and *Trichopria* sp. In Laguna, Luzon, *P. vindemiae* and *S. endius* were the most prevalent parasitoids in poultry and livestock facilities. House fly pupae exposed to parasitoids in confined poultry and swine facilities exhibited higher parasitism rates than in the pastures and the carabao, beef and dairy barns.

Key words: Hymenoptera, *Musca domestica*, fly pupal parasitoid, biological control.

INTRODUCTION

The common house fly, *Musca domestica* Linnaeus, and other muscoid flies are highly recognized as important human and animal health hazards. They cause severe annoyance to poultry and livestock animals as well as to human caretakers. Humans who are residing near or around poultry and livestock farms also are severely affected by these pesky flies. Furthermore, these flies are potential carriers of pathogenic microorganisms infecting both human and animals. In poultry, swine and other livestock production facilities, huge populations of house fly and other filth flies have direct and indirect inimical effects on the growth and production of poultry and livestock animals, which undoubtedly result to serious economic losses. For example, in North Carolina, U.S.A., the estimated annual loss (actual direct losses and control costs) due to house fly and other filth flies in poultry and swine reaches near \$8 million and \$10 million, respectively (Rutz, 1981). In the Philippines, reliable estimates of annual losses in poultry and livestock production due to filth flies are not available. The amount of losses, however, due to these pests are undoubtedly tremendous.

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[1]Received October 1991; accepted January 1992.

[2]Entomologist, 3600 Horton St., No. 202. Raleigh, North Carolina 27067 USA; and Research Assistants, Department of Entomology, U.P. Los Baños, College, 4031 Laguna.

Chemical pesticides, although often effective, are a significant production expense for poultry, swine and other livestock producers. Their use has many serious drawbacks, including destruction of natural enemies of the filth fly pests, excessive levels of unmonitored pesticide residues in eggs, meat and milk, environmental contamination, health hazards and development of pesticide resistance. It is, therefore, appropriate that an alternative or compatible measure for fly control be introduced and applied.

The use of biological control agents, specifically parasitic wasps (Hymenoptera), provides a promising tool to manage fly populations especially in poultry and livestock facilities (Axtell 1981, 1986). Knowledge of the identity and abundance of common parasitic hymenopterous species are necessary for planning effective fly management programs.

Although several species of filth flies (Cabrera and Rozeboom 1956; Cariaso and Rueda, 1984; Rueda 1985a, b) were reported, only few and scattered reports on their hymenopterous parasitoids in the Philippines are available. Rueda (1984), and Rueda and Axtell (1985a, b, c, 1987) indicated several species of Hymenoptera parasitic on pupae of muscoid flies based on their extensive review of the literature of the group and 4 of those parasitoids occurred in the Philippines. Baltazar (1966) noted 2 parasitic species on filth flies from the country. Arellano and Rueda (1988) and Rueda et al. (1986, 1990) listed additional species collected from poultry farms in Luzon, Philippines. This study was conducted to determine the species of Hymenoptera parasitic on muscoid pupae found in poultry and livestock facilities at selected areas of the Philippines. The relative abundance and parasitism rates of various parasitoid species that emerged from house fly pupae in poultry and livestock manure at Laguna, Luzon were indicated.

MATERIALS AND METHODS

A. Mass rearing of the fly host

House fly (*M. domestica*) and blow fly (*Chrysomyia megacephala* (Fabricius) were reared in the laboratory following the techniques used by Arellano and Rueda (1988). Adult house flies collected from poultry and livestock production facilities were transferred into a wire-screened oviposition cages (46 x 46 x 46 cm.) They were provided with oviposition medium (tissue paper soaked in evaporated milk) in plastic cups. The eggs then were transferred in a 2-liter plastic tray with larval medium (mixture of broiler feed mash, 100 g; rice bran, 100 g; evaporated milk, 10 ml; sugar, 10 g; and water, 150 ml). The larvae were allowed to develop and pupate. Upon pupation, the pupae were separated from the medium. Blow fly was reared in a similar manner as the house fly except blood meal was provided the adult blow flies to produce viable eggs.

B. Survey and identification of parasitic Hymenoptera

An extensive survey and collection of parasitic wasps (Hymenoptera) was conducted in selected towns of Laguna and other provinces where poultry, swine and other livestock production facilities were located. The following techniques were used in collecting the parasites of house fly and other muscoid flies: a) Pupal bag technique - This consists of laboratory-reared house fly pupae enclosed in a 14-meshed wire screen bag, and then inserted in poultry or livestock manure, for a one-week exposure to the parasites. After the exposure, the pupal bags (with 30 house fly pupae/bag) were retrieved. The pupae were placed in respective vials (5 cm in height, 2 cm in diameter) for parasite development and emergence. b) Collection of naturally occurring fly pupae - This involves collection of a one-liter dry manure of poultry or livestock. The sampled manure was placed in a 4-liter bucket (half-filled with water), and then constantly stirred using a wooden rod for about 5 minutes. The pupae which floated were retrieved, placed on a pan lined with tissue paper and allowed to air-dry for 2-3 hours. They were subsequently placed in respective vials (size as above) for parasitoid development and emergence. The pupal bag technique was used only in Laguna and nearby areas.

C. Relative abundance and parasitism rates

Hymenopterous parasitoids of fly pupae from various production facilities (i.e., poultry caged-layer, broiler, swine, carabao, beef and dairy barns and pastures) in Laguna were monitored weekly using pupal bag technique (as described above), and collection of naturally occurring muscoid fly pupae.

RESULTS AND DISCUSSION

A. Survey and Identification of Hymenopterous Parasites

Eight species of parasitoids, under 3 families were recovered from naturally occurring pupae and sentinel pupae of the house fly in the manure of poultry, swine, carabao, beef and dairy cattle. These include *Pachycrepoideus vindemiae* (Rondani), *Spalangia endius* (Walker), *S. cameroni* Perkins, *S. nigroaenea* Curtis, *Muscidifurax raptor* (Girault and Sanders), *Nasonia vitripennis* (Rondani) (Family Pteromalidae); *Dirhinus himalayanus* (Westwood) (Family Chalcididae); *Trichopria* sp. (Family Diapriidae). These 8 species were commonly found in Laguna and Batangas during various months of the survey. Parasitoid species collected in other provinces of the country are listed in Table 1.

B. Relative abundance and parasitism rates

During the 3 years (1985-1987) of the survey of hymenopterous parasitoids attacking pupae of house fly in poultry and livestock manure in different farms at Laguna, about 8 species of parasitoids were recovered (Table 2).

In caged-layer poultry farms, the following 7 species were collected: *P. vindemiae, M. raptor, S. endius, S. cameroni, S. nigroaenea, D. himalayanus,* and *Trichopria* sp. *P. vindemiae* was the most abundant species, followed by *S. endius* and *S. cameroni.* Among the parasitoid species recovered, only *P. vindemiae* and *S. endius* occurred throughout the sampling months (May to October) having peaks of abundance during October and July, respectively. Parasitism rates in sentinel and naturally occurring house fly pupae averaged 12.3 and 48.4%, respectively, during the 3-year period. In naturally occurring pupae of the blowfly, *C. megacephala,* however, parasitism rates averaged 46.8 in 1986.

In broiler poultry facilities, about 7 parasite species (i.e., *P. vindemiae, S. endius, S. cameroni, S. nigroaenea, N. vitripennis, D. himalayanus,* and

Trichopria sp.) were collected. *P. vindemiae* was the dominant species, followed by *S. endius*. *P. vindemiae* was the only species present almost throughout the sampling months (May to October), with peaks of abundance during June and September. Parasitism rates in sentinel and naturally occurring house fly pupae averaged 9.6 and 36.4%, respectively, occurring during the 3-year period.

In swine barns, 8 species of parasitoids (same species as in cage-layer poultry facilities plus *N. vitripennis*) were recovered. *P. vindemiae*, the most abundant species, occurred throughout the duration of the sampling period (May to October). *S. endius*, the second abundant species, was recovered also from May to October. Parasitism rates in sentinel and naturally occurring house fly pupae averaged 2.7 and 25.2%, respectively, during the 3-year period.

In carabao barn, about 4 species of parasitoids (i.e., *P. vindemiae, S. endius, S. cameroni* and *N. vitripennis*) were recovered. *P. vindemiae*, was the dominant species, followed by *S. endius*. Both species occurred throughout the sampling period (May to October). Parasitism rates in sentinel house fly pupae averaged 3.5% during the 3-year period.

In beef cattle barn, 4 species of parasitoids (same species as those in carabao barn) were recovered. *S. endius* was the most abundant species, followed by *P. vindemiae*. Both species occurred throughout the sampling period (May to October). Parasitism rates in sentinel house fly pupae averaged 0.5% during the 2-year (1985-86) period.

In dairy cattle barn, 4 species of parasitoids (i.e., *P. vindemiae, S. endius, N. vitripennis, Trichopria* sp.) were collected. *P. vindemiae* was the dominant species, followed by *S. endius*. Both species occurred throughout the sampling period (May to October). Parasitism rates in sentinel house fly pupae averaged 0.6% during the 2-year (1985-86) period.

In the open pasture areas for beef and dairy cattle, 7 species (same species as those in cage-layer poultry facilities, except *D. himalayanus* being replaced by *N. vitripennis*) were recovered in 1986. *P. vindemiae* was the most abundant species, followed by *S. endius*. Parasitism rates in sentinel house fly pupae averaged 0.8%, with the peak of parasitoid abundance during the month of August.

Comparing different production facilities as collection sites, caged-layer poultry farms had the greatest number of individual parasitoids of fly pupae recovered and the highest parasitism rates, followed by the broiler poultry and swine farms. Dairy and beef cattle barns had the lowest population densities of the hymenopterous parasitoids and the lowest parasitism rates in house fly and blowfly pupae. Among the parasitoids, *P. vindemiae* was the most abundant species recovered from all production facilities, except beef cattle barn, surveyed. This species has a great potential as a biological control agent against house fly populations (Pickens 1981, Pickens and Miller 1978). *S. endius* was the second abundant species in all production facilities, except in beef cattle barn where it was the dominant species. This species, other *Spalangia* species and *M. raptor* are also promising biological control agents.

Numerous reports (Axtell 1981, Rutz and Axtell 1979, Morgan et al., 1975, Legner and Dietrick 1974) indicated the effectiveness of these parasitoid species in lowering the population densities of the filth flies in poultry production facilities. *D. himalayanus* and *Trichopria* sp. were recovered in most facilities surveyed but at low levels of parasitism rates. The presence of these 2 species, together with other parasitoid species, might contribute to the overall reduction effects on fly population densities.

SUMMARY AND CONCLUSIONS

Eight species of hymenopterous parasitoids (i.e., *P. vindemiae*, *S. endius*, *S. cameroni*, *S. nigroaenea*, *M. raptor*, *N. vitripennis*, *D. himalayanus* and *Trichopria* sp.), under 3 families were recovered from naturally occurring pupae and sentinel pupae of house fly in the manure of poultry, swine, beef and dairy cattle and carabao. They were also recovered from naturally occurring pupae of blow fly and other muscoid flies. They were present not only in Laguna and Batangas, but also in various parts of the Philippines.

Different confined poultry and livestock production facilities, as well as open pasture areas, exhibited various species composition, abundance and parasitism rates. This study provided a partial information on the kind of hymenopterous parasitoids attacking pupae of house fly and other filth flies in poultry and livestock production facilities in selected areas of the country. These parasitoid species have their specific potentials as biological control agents. Further studies, however, on aspects of their behavior and bio-ecology are necessary before they could be integrated in a fly pest management program in any of the poutlry and livestock production facilities.

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Table 1. Hymenopterous parasitoids of filth fly pupae collected from different production systems in various areas of the Philippines.

Type of farm/ Place collected	Date collected	Parasitoid species (Total collected)	Host species (Total pupae collected)	Parasitism, %
Poultry caged-layer Baguio City	May 5, 1985	*P. vindemiae* (10) *S. endius* (5) *S. cameroni* (6)	*M. domestica* (30)	70.0
Poultry broiler Tiaong, Quezon	July 25, 1985	*P. vindemiae* (21) *S. endius* (10) *S. cameroni* (3) *D. himalayanus* (2)	*M. domestica* (61)	59.0
Poultry cage-layer Tanauan, Batangas	Aug. 5, 1985	*S. endius* (5) *P. vindemiae* (20) *S. cameroni* (3) *D. himalayanus* (4)	*M. domestica* (67)	48.0
		S. endius (4)	*Fannia* sp. (10)	40.0
		S. endius (6) *P. vindemiae* (4)	*Orthellia indica* (21)	48.0
Poultry cage-layer CSU-Alt, Fiat Cagayan	Oct. 26, 1985	*P. vindemiae* (8) *S. endius* (10) *S. cameroni* (1)	*M. domestica* (97)	19.6
Poultry cage-layer ISU, Echague, Isabela	Oct. 27, 1985	*P. vindemiae* (15) *S. endius* (6) *D. himalayanus* (3) *N. vitripennis* (4)	*M. domestica* (139)	20.1

Type of farm/ Place collected	Date collected	Parasitoid species (Total collected)	Host species (Total pupae collected)	Parasitism, %
Poultry caged-layer NVSIT, Bayombong, Nueva Viscaya	Oct. 29, 1985	*P. vindemiae* (32) *S. endius* (10) *S. cameroni* (4) *D. himalayanus* (3)	*M. domestica* (246)	19.9
		S. endius (17) *D. himalayanus* (1)	*C. megacephala* (123)	24.4
Poultry caged-layer Baao, Camarines Sur	Apr. 5, 1986	*P. vindemiae* (20) *S. endius* (7) *D. himalayanus* (1) *S. nigroaenea* (1)	*M. domestica* (87)	33.0
Poultry caged-layer San Jose, Iloilo	May 8, 1986	*P. vindemiae* (4) *D. himalayanus* (2)	*M. domestica* (107)	5.6
		S. endius (15)	*C. megacephala* (38)	39.5
Poultry caged-layer VISCA, Baybay Leyte	May 29, 1986	*P. vindemiae* (4) *S. nigroaenea* (2) *S. cameroni* (4)	*M. domestica* (26)	38.5
Poultry cage-layer SEARSOLIN, Xavier Univ. Cagayan de Oro	May 27, 1986	*P. vindemiae* (1)	*C. megacephala* (3)	33.3
		S. cameroni (2) *S. nigroaenea* (1) *S. endius* (3)	*M. domestica* (30)	20.0
Poultry broiler Mamburao, Mindoro Occidental	Nov. 25, 1986	*P. vindemiae* (20) *S. endius* (15) *S. cameroni* (3)	*M. domestica* (75)	50.7

Type of farm/ Place collected	Date collected	Parasitoid species (Total collected)	Host species (Total pupae collected)	Parasitism, %
Poultry caged-layer PNAC, Palawan	Feb. 20, 1987	*P. vindemiae* (18) *S. endius* (3)	*M. domestica* (42)	50.0
Poultry caged-layer CSCST, Cebu City	May 30, 1987	*P. vindemiae* (1) *S. endius* (1) *S. cameroni* (1)	*M. domestica* (29)	10.3

Table 2. Relative abundance of parasitic Hymenoptera that emerged from sentinel and naturally occurring house fly pupae exposed in poultry and livestock manure in different farms at Laguna (May- October, 1985-1987).

Parasitoid species	Relative abundance, %					
	Sentinel pupae			Naturally occurring pupae		
	1985	1986	1987	1985	1986	1987
Poultry caged-layer (n-2)						
P. vindemiae	82.0	76.3	71.7	76.9	41.9	37.3
M. raptor		1.0				
S. endius	17.0	19.8	14.6	70.8	21.0	27.4
S. cameroni	0.8	1.9	6.1		6.3	6.7
S. nigroaenea		0.2				
N. vitripennis					6.8	8.0
D. himalayanus	0.2	0.8		2.3	8.3	1.3
Trichopria sp.			7.6		15.6	24.0
Total parasitoids collected (n)	1562	979	1055	78	205	75
Total pupae collected intact (n)	13941	5793	12128	112	446	189
Parasitized pupae (%)	11.2	16.9	8.7	69.6	45.8	31.2
Poultry broiler (n=3)						
P. vindemiae	77.7	41.3	69.9	71.9	45.6	33.3
S.endius	21.9	21.3	18.0	27.1	38.6	18.5
S. cameroni		20.0	9.9			
N. vitripennis	0.4		1.0		1.7	5.5
D. himalayanus		0.7	0.3			
Trichopria sp.		16.7	0.4	1.0	14.0	42.6
Total parasitoids collected (n)	1130	531	1031	115	57	54
Total pupae collected intact (n)	14725	3663	15871	383	105	62
Parasitized pupae (%)	7.7	14.5	6.5	30.0	54.3	54.8
Swine barn (n=4)						
P. vindemiae	19.2	52.0	81.8	46.0	41.5	42.9
S. endius	80.2	39.9	12.1	54.0	58.5	57.1
S. cameroni		3.0	3.0			
S. nigroaenea		0.3	3.0			
M. raptor	0.2					
N. vitripennis	0.2	0.7				
D. himalayanus		4.0				
Trichopria sp.	0.2					
Total parasitoids collected (n)	495	296	33	35	53	21
Total pupae collected intact (n)	17189	12035	1129	26	204	156
Parasitized pupae %	2.9	2.4	2.9	36.2	25.9	13.4

Parasitoid species	Relative abundance, %					
	Sentinel pupae			Naturally occurring pupae		
	1985	1986	1987	1985	1986	1987
Carabao barn (n = 1)						
P. vindemiae	62.0	37.9	72.7			
S. endius	37.0	56.9	27.3			
S. cameroni	5.2					
N. vitripennis	1.0					
Total Parasitoids collected (n)	100	58	11			
Total pupae collected intact (n)	5967	3808	150			
Parasitized pupae (%)	1.7	1.5	7.3			
Beef cattle barn (n = 1)						
P. vindemiae	7.7	28.6				
S. endius	92.3	38.1				
S. cameroni	28.6					
N. vitripennis	4.7					
Total parasitoids collected (n)	13	21				
Total pupae collected intact (n)	4271	3220				
Parasitized pupae (%)	0.3	0.6				
Dairy cattle barn (n = 1)						
P. vindemiae	64.3	41.7				
S. endius	35.7	25.0				
N. vitripennis	29.2					
Trichopria sp		4.1				
Total parasitoids collected (n)	28	24				
Total pupae collected intact (n)	5282	3661				
Parasitized pupae (%)	0.5	0.6				

[1] Relative abundance means are based on the total number of parasitoids collected during the 6-month period of each year (1985-1987) from sentinel or naturally occurring pupae which were recovered intact in each of the different poultry and livestock production systems (30 pupae per bag. 15 bags per farm per week).

[2] Total number of sentinel or naturally occurring house fly pupae recovered intact.

[3] Percentage of sentinel or naturally occurring house fly pupae recovered intact from which the parasites emerged. Parasitism means were calculated from the total number of parasites recovered and the total number of sentinel or naturally occurring pupae recovered intact during the 6-month period (May-October, 1985-87).