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Coleoptera Associated with Undisturbed Cow Pats in Pastures in Southeastern Brazil

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Coleoptera Associados a Massas Fecais de Bovinos em Pastagens no Sudeste Brasileiro

RESUMO - Coleoptera associados a fezes de gado bovino excretadas no pasto apresentam grande diversidade e abundância, e várias espécies são de importância veterinária por serem inimigos naturais de insetos-praga que se criam nesse tipo de substrato. Para se fazer um levantamento da abundância e diversidade dos Coleoptera associados a fezes bovinas no pasto, quatro massas fecais inteiras e 5 cm do solo imediatamente abaixo delas foram coletados semanalmente na maioria das vezes, de abril de 1992 a abril de 1994. As coletas foram feitas numa fazenda localizada nas proximidades da cidade de São Carlos, região central do estado de São Paulo. Os besouros foram extraídos das fezes com funis de Berlese, e também mantendo as fezes em recipientes cobertos com organza por 30 a 40 dias, coletando os besouros que emergissem. O total de 24.332 espécimes pertencentes a 13 famílias de besouros, e pelo menos 66 espécies foram identificadas. As famílias mais abundantes foram Aphodiidae, Staphylinidae and Scarabaeidae. Em geral, os besouros foram mais abundantes durante o período quente e úmido, de outubro a março, com algumas exceções. A importância dos besouros, tanto como inimigos naturais da mosca-dos-chifres como agentes da decomposição de massas fecais de bovinos é discutida.

PALAVRAS-CHAVE: Fezes bovinas, besouro coprófago, diversidade, controle biológico, Brasil

ABSTRACT - Coleoptera associated to undisturbed cattle droppings in pastures present great diversity and abundance. Several species are of primary veterinary importance for they may act as natural enemies of pest insects that breed in this habitat. To survey the diversity and abundance of Coleoptera associated to undisturbed cattle droppings, four undisturbed cattle dung pats naturally dropped in pastures and 5 cm of the soil immediately beneath them were collected almost all weekly from april 1992 to april 1994 in a farm located in the vicinity of São Carlos, State of São Paulo, Southeastern Brazil. Beetles were collected from the pats both using Berlese funnels and by allowing the beetles to emerge for 30 to 40 days. A total of 24,332 specimens belonging to 13 beetle families and at least 66 species were identified. The most abundant and diverse families were Aphodiidae, Staphylinidae and Scarabaeidae. In general, the Coleoptera were more abundant in the warmer and wet period, from October to March, with a few exceptions. The importance of the beetles, both as horn fly natural enemies and as cattle dung decaying agents, is discussed.

KEY WORDS: Cattle dung, dung beetle, diversity, biological control

Cattle dung pats naturally dropped in pastures are normally colonized by a diversified arthropod community which has been studied in detail in several places (Merrit & Anderson 1977, Cervenka & Moon 1991), especially in countries where dung incorporation into the soil is problematic (Macqueen & Beirne 1975, Ridsdill-Smith 1981, Summerlin *et al*. 1990). The coprophagous fauna is composed mainly by Diptera and Scarabaeidae (Coleoptera), which are considered the most important agents promoting dung pat decay (Laurence 1955, Anderson *et al*. 1984, Cervenka & Moon 1991). Several studies have been done to determine the role of dung beetles in recycling the dung and to assess the possibility of using them as decomposing agents in the dung decaying process and in the control of dung breeding arthropod pests, mainly Diptera (Ridsdill-Smith 1981, Anderson *et al*. 1984, Roth *et al.* 1988). The introduction of the horn fly, *Haematobia irritans* (L.) (Diptera: Muscidae) into Northern Brazil was reported in the early 80's (Valério & Guimarães 1982). Its introduction and rapid dispersion to almost the entire country stimulated investigations on the arthropod community of undisturbed cattle dung in pastures in Brazil (Flechtmann *et al*. 1995a, Guimarães & Mendes 1998, Mendes & Linhares 2002). This paper presents data on diversity and abundance of cattle dung beetles collected during a two-year period in

the vicinity of the city of São Carlos, State of São Paulo, Southeastern Brazil.

Materials and Methods

The studies were done at Fazenda Canchim (21.30° S; 47° W), a farm belonging to Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) in São Carlos, São Paulo State. The experimental sites were pastures of *Brachiaria decumbens* Saft. and *Andropogon gayanus* Kunth. From April 1993 to April 1994 ten undisturbed cattle dung pats naturally dropped and 5 cm of the soil immediately beneath them were collected almost all weekly, making a total of 83 samples (830 pats) collected in the two-year period.

The samples were placed in individual plastic containers and taken to the Laboratório de Entomologia, Universidade Estadual de Campinas, located approximately 150 km Southeast of São Carlos. A quarter of each of four dung pats, adding to the equivalent of one dung pat, and a 5 cm layer of its associated soil were transferred to Berlese funnels equipped with 40W light bulb where they were kept for five to seven days or until the funnel content was dry. The remaining three quarters of the four dung pats were kept individually in plastic containers covered with organza at room temperature. The other six pats were used to collect dung flies, and the results were presented elsewhere (Mendes & Linhares 2002). The containers were checked daily for insect emergence.

After 30 to 40 days the extraction of the remaining Coleoptera and other arthropods within the pats was done by dissolving the pats in water and collecting the floating arthropods. All collected arthropods were kept in 70% alcohol. Coleoptera were identified with the help of specialists and identification keys, and by comparison with material deposited at the Museu de Zoologia, Universidade de São Paulo (MZUSP). The collected species or genera were classified into trophic groups as proposed by Valiela (1974) and Cervenka & Moon (1991). Pearson correlation coefficient was used to test for correlations of abundance among families, using the SAS® PROC CORR procedure (SAS, Inc 1987). Faunal indexes such as: Frequency, constancy, abundance and diversity of beetles collected during the drier and cooler, and warmer and humid periods were presented, as well (Silveira Neto *et al*. 1976).

Results and Discussion

The 24,332 collected Coleoptera belonged to 13 families and to at least to 66 species (Table 1). The most abundant and diverse families were Aphodiidae, Staphylinidae and Scarabaeidae. Nearly all Staphylinidae were identified at least to genus, and half of the species were separated into morphs. Differently from what happened during the warmer and humid period, all the non-identified species, although sparsely, were present during the cooler and drier year period. These data influenced the diversity index obtained for this period (Table 2).

Although the morphospecies comprised approximately half of the species, they represented only 3% of the collected specimens (Table 1). It is important to point out that almost all Aphodiidae and about 40% of the small Coleoptera were obtained from the four quarters of four dung pats (the equivalent of one dung pat) that were placed in the Berlese funnels. The Aphodiidae was the most abundant family representing 48.11% of the extracted Coleoptera (Table 1). The endocoprids *Nialaphodius nigrita* Fabricius and *Labarrus lividus* (Olivier) represented 88.28% of the family and 42.38% of all Coleoptera. Among the Scarabaeidae, *Dichotomius bos* (Blanchard) was the most frequent and constant species. This and other paracoprid species present natural nocturnal and twilight activity (Koller *et al*. 1999, 2002; Aidar *et al.* 2000). Because of this and due to the fact that dung pats were collected during the morning period, the paracoprids and telecoprids frequency and constancy may have been underestimated when compared to those of endocoprids that remain in the dung pat. Oliveira *et al.* (1996), who used Pitfall traps baited with dairy cattle dung near to stable in the same locality, presented data that support this assumption. *Ontophagus buculus* Mannerhein was the most frequent and constant species of the genus (Tables 1 and 2). Because it is absent or dispersed in other Brazilian localities, this beetle is not included among the important dung burying species (Flechtmann *et al.* 1995a, Marchiori *et al*. 2001). The Staphylinidae represented 30.4% of the Coleoptera and was the most diverse family in number of species (Table 1). *Oxytelus* spp. represented 59.95% of this family. The Histerids represented 3.9% of the Coleoptera, and *Hister curvatus* Erichson and *Euspilotus* spp. represented 99.3% of the 953 collected individuals (Table 1).

The meteorological data from the collecting period showed a drier and cooler period from April to September and a warmer and more humid period from October to March. In these periods the mean temperature varied respectively from 17°C to 22°C and from 22°C to 26°C. The monthly rainfall averages were 56 mm and 166 mm, varying from 0 to 120 mm and from 80 mm to 270 mm, respectively (details in Mendes & Linhares 2002).

In general, the Coleoptera were more frequent and abundant in the warmer period (Figs. 1a-f, Table 2). The exceptions were *Cryptobium* spp., *N. nigrita*, *Phylonthus flavolimbatus* Erichson and *Cercyon* spp that presented similar frequency and constancy in both year periods, and *Dibelonetes hybridus* Erichson that was more frequent and constant in the cooler period (Figs. 1a,c; Table 2). The species *L. lividus*, *D. bos*, *Oxytelus* sp.2 and *H. curvatus* were markedly more abundant in the warmer period (Figs. 1a,b,d,e; Table 2). The correlation analysis did not evidence a significant correlation among the Coleoptera families and between them and the Diptera families. However, significant positive correlations were verified between Scarabaeidae and Muscidae (+0.30; $P < 0.006$), Hydrophilidae and Scarabaeidae (+0.41; $P < 0.0001$), and Staphylinidae and Scarabaeidae (+30; $P < 0.006$).

Apparently, *N. nigrita*, *L. lividus* and *Ataenius* spp. were the main dung tunneling and airing beetles during both years (Table 2). This could facilitate the dung colonization by predators and parasites of Diptera (Bornemissza 1976). Direct observations at the pastures indicate that *Dychotomius* spp., especially *D. bos*, were efficient dung burying agents during the warmer and humid season. Indirect evidence of *Dychotomius* presence beneath the dung was registered by the findings of dung partially covered by the soil extracted

Table 1. Diversity and abundance of Coleoptera from dung pats naturally dropped at Fazenda Canchim pastures in São Carlos, SP, from April 1992 to April 1994.

Species	Troffic group	Total	%
Aphodiidae			
Ataenius aequalis Harold	SC	591	4.41
Ataenius spp. (3 species)	SC	776	5.80
Euparia sp.	LC	1	0.01
Labarrus lividus (Olivier)	SC	5,855	43.66
Nialaphodius nigrita Fabricius	SC	4,457	33.20
Total		11,680	100
Scarabaeidae			
Agamopus viridis Boucomont	LC	25	0.10
Cantidium sp.	LC	1	0.00
Dichotomius bos (Blanchard)	LC	427	3.18
Dichotomius crinicollis (Germar)	LC	6	0.04
Dichotomius nisus (Olivier)	LC	8	0.06
Dichotomius glaucus (Harold)	LC	2	0.01
Dichotomius semianeus (Germar)	LC	2	0.01
Isocopris inhiata (Germar)		5	0.03
Ontherus appendiculatus (Mannerhein)		24	0.18
Onthophagus buculus Mannerhein		1,155	8.60
Onthophagus hirculus Mannerhein		1	0.00
Onthophagus rubrescens Blanchard		1	0.00
Onthophagus sp.		1	0.00
Pedaridium brasiliense Ferreira & Galileo		32	0.23
Sulcophanaeus menelas (Laporte)		1	0.00
Trichillum adjunctum Martinez		1	0.00
Trichillum externepunctatum Borre		38	0.28
Total		1,780	100.00
Staphylinidae			
Aleochara spp. (2 spp.)	PP	80	0.20
Aleocharinae sp. 1	PP	718	9.70
Aleocharinae sp. 2	PP	319	4.40
Cryptobium spp. (4 spp.)	PS	529	7.20
Dibelonetes hybridus Erichson	PS	240	3.20
Eulissus calybaeus Mannerhein.	PS	39	0.60
Heterothops spp. (3 spp.)	PS	285	3.90
Oxytelus spp. (4 spp.?)	CS	4436	60.00
Phylonthus flavolimbatus Erichson	PS	474	6.40
Phylonthus sp.	PS	10	0.20
Vatesus sp.	PS	67	0.90

Continue

Table 1. Continuation.

Species	Troffic group	Total	%
Other species (10 spp.)		220	3.00
Total		7.399	100.00
Histeridae			
Hister curvatus Er.		247	26.00
Euspilotus spp. (3 spp.)		699	73.30
Sp. 1		7	0.70
Total		953	100.00
Hydrophilidae			
Cercyon variegatus Sharp		931	37.40
Cercyon spp. (2 spp.)		189	7.60
Sp. 1		1368	55.00
Total		2488	100.00
Elateridae			
Conoderus sp.		1	11.10
Heteroderes sp.		1	11.10
Other species (4 morphs)		7	77.80
Total (Elateridae)		9	100.00
Carabidae			
Scarites sp.		1	11.10
Other species (2 morphs)		8	88.90
Total		9	100.00
Curculionidae			
Spermogolus sp.		1	
Anobiidae		44	
Leiodidae		8	
Chrysomelidae		6	
Trogidae		2	
Scydmaenidae		3	
Total Coleoptera		24,332	100.00

LC = large coprophagous; SC = small coprophagous; PS = predatory Staphylinidae, PP = predators and parasites, CS = coprophagous Staphylinidae; PH = predatory Histeridae

by *Dychotomius* while tunneling (Alves & Nakano 1977). It is also important to point out that other paracoprids such as *Digithontophagus gazella* (F.) and *Onthophagus* spp. have been pointed as more prolific and productive as dung burying beetles than *Dychotomius* spp. (Hunter *et al*. 1991, Walsh *et al*. 1997, Miranda *et al*. 1998).

The majority of the collected Staphylinidae belong to *Oxytelus* spp. Species of *Oxytelus* are considered coprophagous (Hanski 1987). Therefore, more than half of the collected individuals belonging to this group should not be considered efficient controllers of pest Diptera. Nevertheless, *Chryptobium* spp., *Heterothops* spp., and *Phylonthus* spp. are predators of Diptera eggs and larvae, while *Aleochara* spp. are parasites as immatures and predators as adults (Harris & Blume 1986, Hanski 1987). Some species of *Phylonthus*, including *P. flavolimbatus*, are efficient predators of *Haematobia irritans* (L.) (Harris & Oliver 1979, Hunter *et al*. 1989). Among the Histeridae, species of *Hister* and *Euspilotus* are also cited as predators of immature Diptera, including *H. irritans*, in Australia and North America (Summerlin *et al.* 1982, Harris & Blume 1986).

The absence of correlation between some groups and the positive correlation detected between some Diptera and other groups indicate that there is enough food for the flies

Table 2. Faunal indexes of Coleoptera from dung pats naturally dropped at Fazenda Canchim pastures in São Carlos SP, according to two periods of the year.

Species	Cooler and drier period			Warmer and humid period		
	F	C	A	F	C	A
Aphodiidae						
Ataenius aequalis	3.5250	56.41	C	1.7926	84.10	C
Ataenius spp.	2.5738	56.41	C	3.5658	88.64	C
Euparia sp.	-	-	-	0.0064	2.27	D
Labarrus pseudolividus	18.2072	100	VA	27.4616	93.18	VA
Nialaphodius nigrita	14.8724	92.31	VA	20.3169	97.73	VA
Total	39.1784	-	-	53.1433	-	-
Scarabaeidae						
Agamopus viridis	0.1678	20.51	D	0.0549	15.91	D
Cantidium sp.	0.0111	2.56	D	-	-	-
Dichotomius bos	1.0966	48.71	C	2.1369	54.54	C
Dichotomius crinicollis	0.0671	15.38	D	-	-	-
Dichotomius nisus	0.0559	12.82	D	0.0194	6.82	D
Dichotomius glaucus	-	-	-	0.0129	4.54	D
Dichotomius semianeus	-	-	-	0.0129	4.54	D
Isocopris inhiata	0.0223	5.13	D	0.0194	4.54	D
Ontherus apendiculatus	0.0671	2.56	D	0.1169	15.91	D
Onthophagus buculus	5.5617	84.61	C	4.2738	90.91	C
Onthophagus hirculus	0.0111	2.56	D	0.0	0.0	-
Onthophagus rubrescens	-	-	-	0.0064	2.27	D
Onthophagus sp.	-	-	-	0.0064	2.27	D
Pedaridium brasiliense	0.1007	7.69	D	0.1493	18.18	D
Sulcophanaeus menelas	0.0111	2.56	D	0.0	0.0	-
Trichillum adjunctum	0.0	0.0	-	0.0064	2.27	D
Trichillum externepunctatum	0.0335	5.13	D	0.2273	25.00	D
Total	7.206	-	-	7.0429	-	-
Staphylinidae						
Aleochara spp.	0.4923	43.59	D	0.2338	38.64	D
Aleocharinae sp. 1	4.4874	82.05	C	2.0589	68.18	C
Aleocharinae sp. 2	1.8464	64.10	C	1.0002	43.18	C
Cryptobium spp. (3 spp.)	2.4507	69.23	C	2.0135	70.45	C
Dibelonetes hybridus	1.7569	64.10	C	0.5391	34.09	D
Eulissus calybaeus	0.1342	20.51	D	0.1753	34.09	D
Heterothops spp.	1.1974	51.28	C	1.1561	75.00	C
Oxytelus spp. (4 spp.)	22.1239	94.87	VA	15.9716	95.45	VA
Phylonthus flavolimbatus	2.2157	71.79	C	1.7926	79.54	C
Phylonthus sp.	0.0783	15.38	D	0.0194	4.54	D

Continue

Table 2. Continuation.

Species	Cooler and drier period			Warmer and humid period		
	F	C	A	F	C	A
Vatesus sp.	0.1342	20.51	D	0.3572	15.91	D
Other species (10 spp)	1.8017		-	0.2663		D
Total	38.7197	-	-	25.5845	-	-
Histeridae						
Hister curvatus	0.3021	43.59	D	1.4289	70.45	C
Euspilotus spp. (3 spp.)	2.2269	82.05	C	3.2475	93.18	C
Sp. 1	0.0223	2.56	D	0.0324	9.09	D
Total Histeridae	2.5514	-	-	4.7090	-	-
Hydrophilidae						
Cercyon variegatus	4.4196	87.18	C	3.5398	90.90	C
Cercyon spp. (2 spp.)	1.2869	41.02	C	0.4806	38.64	D
Sp. 1	6.4458	66.67	C	5.1441	56.82	C
Total	12.0523	-	-	9.1647	-	-
Elateridae						
Conoderus sp.	0.0111	2.56	D	-	-	-
Heteroderes sp.	0.0111	2.56	D	-	-	-
Other species	0.0447	10.25	D	0.0194	6.82	D
Total	0.0671	-	-	0.0194	-	-
Carabidae						
Scarites sp.	0.0111	2.56	D	-	-	-
Other species (3 spp.)	-	-	-	0.0519	18.18	D
Total	0.0111		-	0.0519		D
Curculionidae						
Spermogolus sp.	0.0111	2.56	D	-	-	-
Anobiidae Sp1	0.1790	23.53	D	0.1818	25.0	D
Leiodidae	0.0223	5.13	D	0.0389	13.64	D
Chrysomelidae	-	-	-	0.0389	11.36	D
Trogidae	-	-	-	0.0129	4.54	D
Scydmaenidae	-	-	-	0.0194	4.54	D
Total Coleoptera	100.0	-	-	100.0	-	-
Diversity index	$\alpha = 6.9248$			$\alpha = 6.4303$		

Cooler and drier period = from April to September; warmer and humid period = from October to March; F = frequency; C = constancy; A = abundance; C* = common; D = disperse; VA = very abundant; α = Diversity index

and their competitors, and that the predation suffered by them would not significantly interfere with their emergence. The construction of tunnels by the tunneling Coleoptera would facilitate the locomotion of the fly larvae in the dung pats. In addition, it should be taken into consideration that the dung pats were kept in the laboratory after their collection at the pastures and, a considerable number of Coleoptera was taken daily from the dung. Therefore, it would be necessary to make a more controlled and/or specific experiment to check for interactions between the insect guilds in dung pats in the pastures. Finally, the results show a diverse and abundant Coleoptera community in cattle dung pats at pastures, and several collected species are important dung burying agents and can be considered as potential horn fly natural enemies.

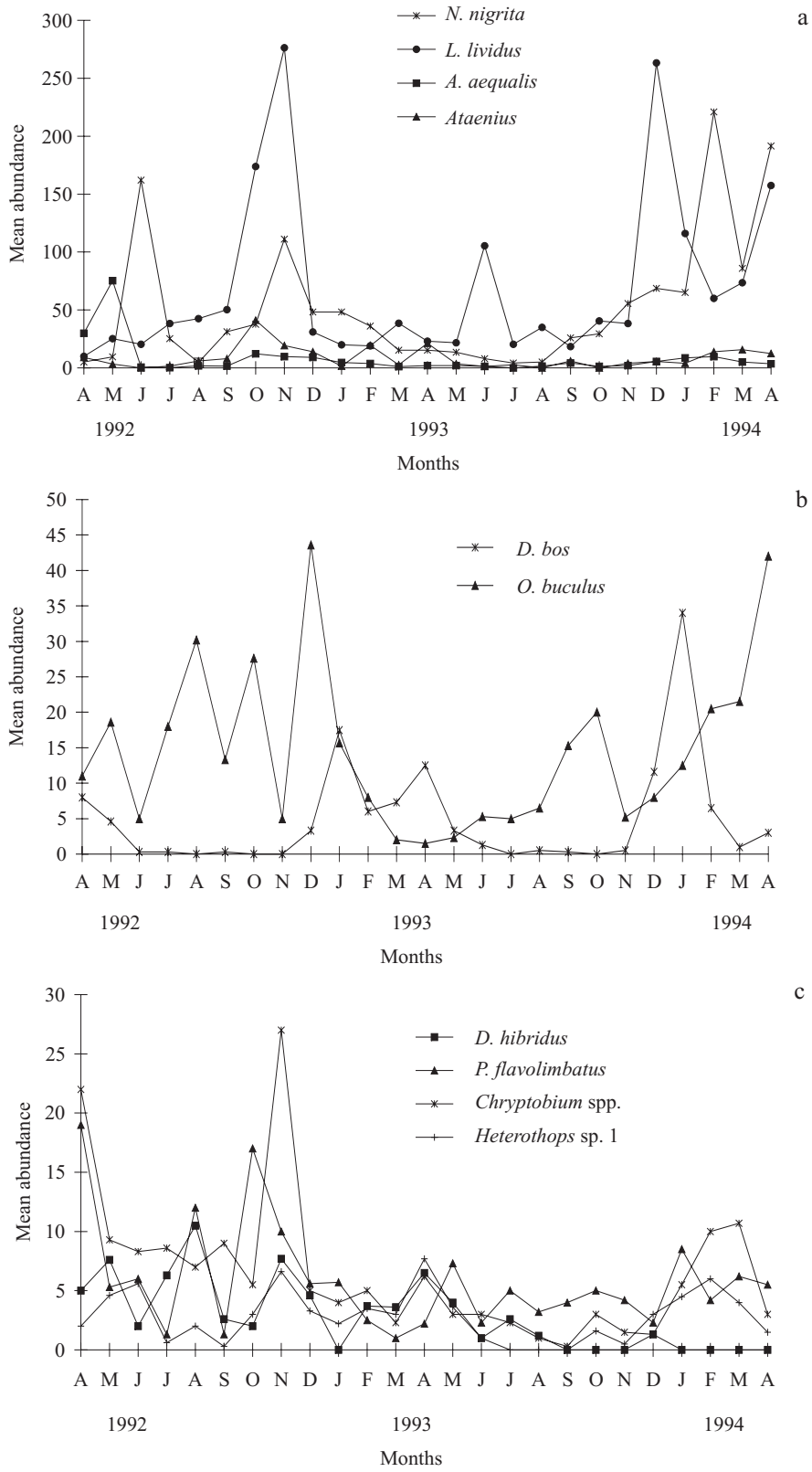

Fig. 1a-f . Annual variation of cattle dung Coleoptera extracted from cattle manure collected at Fazenda Canchim pastures in São Carlos, State of São Paulo from April 1992 to April 1994. Values are the mean of two to four samples collected each month. (continue)

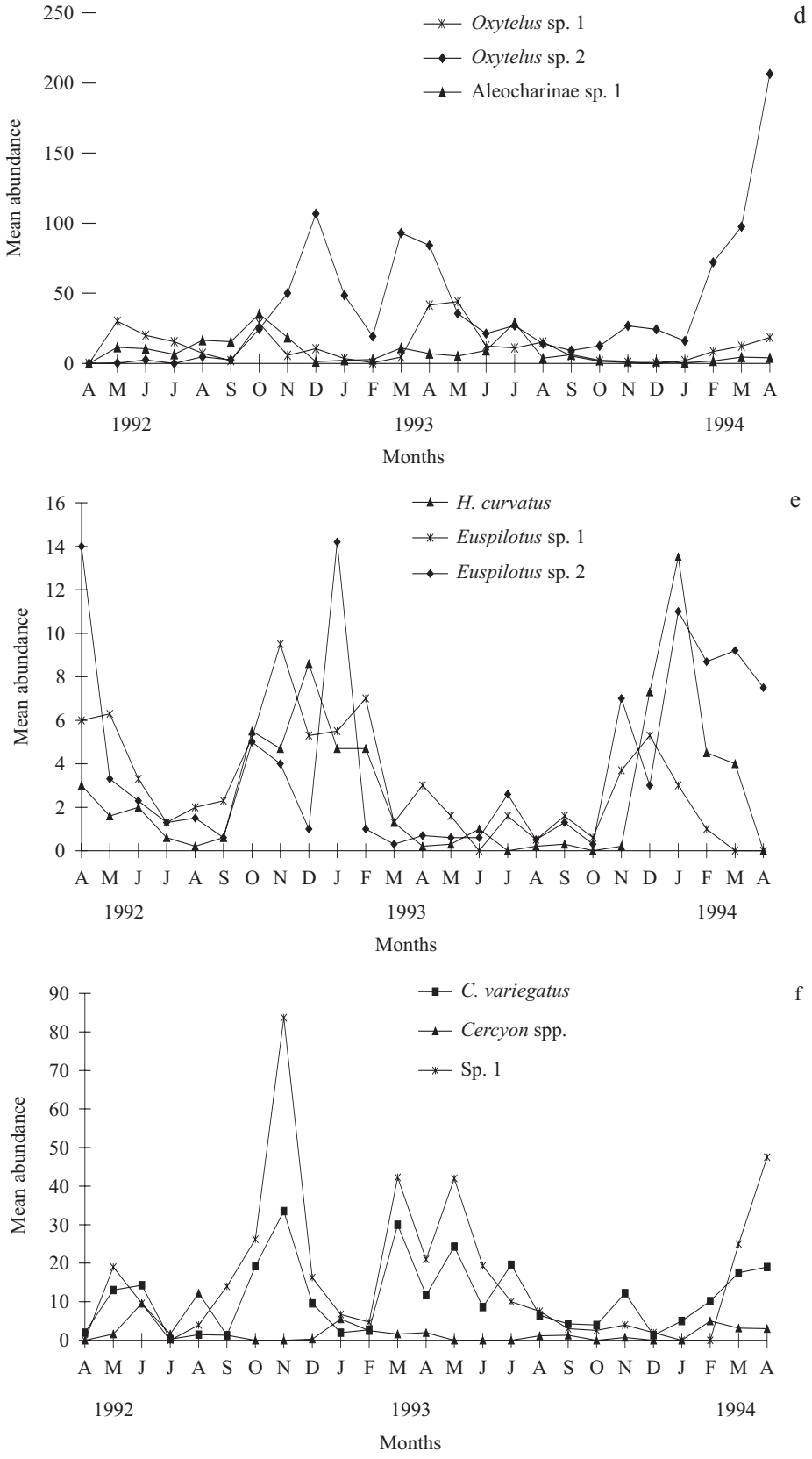

Fig. 1a-f . Continuation.

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