帯広畜産大学
Obihiro University of Agriculture and Veterinary Medicine

Roll of dung beetles and other insects in decomposing cow dung in grazing pastures

著者（英）	Kuramochi Katsuhisa
図書名	Global perspective on livestock waste management : the 2004 Obihiro Asia and the Pacific Seminar on Education for Rural Development (OASERD)
開始ページ	91
終了ページ	96
出版年月日	2004
URL	http://id.nii.ac.jp/1588/00003170/

Roll of dung beetles and other insects in decomposing cow dung in grazing pastures

Katsuhisa, Kuramochi
Associate Professor of Entomological Laboratory
Obihiro University of Agriculture and Veterinary Medicine

Introduction

It is well known that cow dung has contributed to several environmental problems in grazing pastures all over the world. For example, cow dung interferes with the growth of grazing grass; and many livestock pests such as biting flies reproduce in cow dung. It has been pointed out that rapid decomposition of cow dung is important to reduce its damage to grazing pastures. In nature, cow dung is usually first decomposed by insects (30%), second by fungus (40%) and third by small animals such as earthworms (30%) (Fig. 1). Insects inhabiting cow dung are the most effective decomposing organisms because of their feeding activity and movement in the cow dung which greatly assists in decreasing the initial high moisture content. Numerous species of insects are associated with cow dung, and the list of such insects in Tokachi is shown in Table 1. The insects that inhabit cow dung can be divided into 3 groups according to their eating habits: those that feed on cow dung, those that prey on other insects, and those that are parasitic of other insects. Most insects that feed on cow dung are dipterous or coleopterous insects. Coleopterous insects that feed on cow dung are called "dung beetles" and they belong to the family Scarabiedae.

Types of dung beetle

Dung beetles are divided into 3 types according to their feeding activity and reproductive process. The characteristics of the 3 types are illustrated in Figure 2. The first type is called "dwellers". Most species of this type are relatively small, less than 10mm in length as adults. They are the characteristic dung beetles of northern regions, though they are present in substantial numbers in sub-tropical regions as well. The entire egg, larval and pupal development of this type typically takes place in dung pats. Adults of this type - both female and male - make their nest in the soil just under the cow dung.

The second type is called "tunnelers". The small species of this type (less than 13 mm) make a shallow nest with numerous brood masses; they do not provide maternal care and probably live for only one season. In contrast, larger tunnelers make deep nests with fewer brood masses cared for by the female, and usually live for more than a year. The small species are present in northern or temperate zones, and the large species are present in semi-tropical or tropical regions.

The third type is called “rollers”. Adults of this type - both female and male - make nests in suitable places outside the dung. They make brood masses near the cow dung and roll them from the dung to their nests. They are present in only semi-tropical or tropical regions, especially in Africa.

The ability to decompose cow dung ranges from firstly “rollers”, secondarily “large tunnelers”, thirdly “small tunnelers” and finally “dwellers”. Many cows are kept in Europe, the U.S.A. or Australia; and all these areas are temperate regions. In these areas, only dwellers or small tunnelers exist natively, so the ability of dung beetles for decomposition of cow dung is insufficient. In these areas, many experiments for introducing rollers or large tunnelers from tropical or semi-tropical regions have been carried out. None of the experiments have succeeded in introducing rollers into any of the temperate areas; and only Australia has succeeded in introducing a few kinds of large tunnelers. Therefore, more effective utilization of native dung beetles, especially tunnelers, for decomposition of cow dung in the grazing pastures in temperate regions is needed.

Although the ability of dwellers for decomposition of cow dung is rather low, their activity inside the cow dung is very high and they make many small holes inside the cow dung. This phenomenon causes faster evaporation of moisture from cow dung and creates a suitable condition for fungus activity for the decomposition of cow dung. As a result, dwellers play a very important role in decomposing cow dung in grazing pastures.

Behavior of tunnelers

Fig. 3 shows the tunnel and brood mass making process of *Caccobius jessoensis* in the laboratory, which is the most popular species of tunnelers in Hokkaido, Japan. After the female and male cooperate in burrowing perpendicularly in the soil under the cow dung for about 15 cm, the male returns back to the cow dung and brings a piece of cow dung to the end of the tunnel. The female receives the piece of cow dung from the male and fixes the cow dung with her saliva for making a brood mass for rearing her larva. After handing over the piece of cow dung to the female, the male returns to the cow dung and brings another piece of cow dung to her. This behavior - of both the male and female - is repeated several times. After the brood mass grows to approximately 2.2 cm in length and 1.1cm in diameter, the female oviposits an egg inside the brood mass. After ovipositing, the female burrows through the soil horizontally for a few centimeters, and begins to make a brood mass again. At this time, the male continues to bring pieces of cow dung to her. After the female makes 4 or 5 brood masses, both the female and male return to the cow dung and repeat the above process again. It takes about a day for making a brood mass. The female makes about 20 brood masses in total. It takes about 7 days for the eggs to hatch, about 25 days for larval development, and about 10 days for pupal development of this species. Newly emerged adults enter diapuse in winter before copulation and oviposition. They emerge from diapuse in early March of the following year.

Effect of dung condition on insect development

1) Moisture content of dung

Table 2 shows the effect of moisture content of cow dung on larval development of the horn fly under laboratory conditions. From eighty to eighty-five percent moisture content of cow dung is suitable for larval development. Table 3 shows the effect of moisture content on the ovipositional behavior of a horn fly adult. From eighty-four to eighty-seven percent moisture content of the cow dung is suitable for adult horn fly oviposition. These results indicate that around 85 percent of moisture content is suitable for the whole life cycle of the horn fly. Similar results were obtained for other kinds of insects inhabiting cow dung.

2) Veterinary drugs

Many kinds of veterinary drugs have been used for a long time to help cows recover from various diseases. Recently, the use of veterinary drugs for controlling internal or external parasites, such as ivermectin or moxidectine, has increased using the topical application method. It is well known that internal parasites, such as the nematode parasite in the digestive organs of cows, trigger serious problems, and this phenomenon causes growth retardation of young cows and an inhibitory effect on the reproductive ability of adult female cows. It is widely known that external parasites, such as the stable fly, horn fly, face fly, mosquito or heamatophagous tick, bring much stress to cows and act as vectors for many kinds of microbiological infectious diseases. Therefore, the application of these drugs to cows brings much benefit for increasing the production of meat or milk. Many of these drugs are non-metabolized drugs, and excreted with the dung. These drugs in the cow dung influence the insects inhabiting cow dung. Table 4 shows the emerging rate of the horn fly of which larvae were reared on dung excreted from a cow after a topical with ivermectin was applied. Residue ivermectin in the cow dung had an inhibitory effect on larval development of the horn fly, and this effect continued more than 4 weeks. Similar results were obtained for other kinds of flies inhabiting cow dung, especially large species. Since many kinds of cow pest flies emerge from cow dung - such as the horn fly, stable fly, house fly, or face fly - ivermectin is effective for the control of these insect pests.

Table 5 shows the effect of ivermectin in cow dung on the development of larvae, pupae and adult *Onthophagous gazelle*, which is one of the most popular dung beetles (type of tunneler) in the world and was introduced successfully to Australia. Ivermectin had an inhibitory effect on this beetle in all developmental stages. Table 6 shows the effect of ivermectin on the adult activity of three species of *Onthopagous*. Table 7 summarizes the effect of ivermectin in cow dung on the reproductive ability of insects. From these results, the effect of ivermectin in cow dung varied among the species inhabiting cow dung. Ivermectin is suitable for the control of cow pests in cow dung. From another point of view, this drug sometimes has an inhibitory effect on insects which decompose cow dung in grazing pastures.

Conclusions

There are many kinds of insects associated with cow dung excreted in grazing pastures. Among these insects, flies and beetles are most important for decomposition of cow dung. The ability to decompose cow dong is higher in beetles, especially among rollers and tunnelers. In temperature regions where many cows are kept for animal production, it is a hard environment for all but two types of dung beetles. So, programs to introduce two types of dung beetles from tropical areas failed all over the world except Australia. It is important that a suitable environment for traditional dung beetles be maintained, especially concerning the quality of cow dung. When we use veterinary drugs, we must consider the effect of drugs on the insects inhabiting cow dung.

Explanation of figures

Fig. 1. Process of decomposition of cow dung in the grazing pasture by insects, fungi and small animals such as earthworms

Fig. 2. Three types of dung beetles associated with cow dung In the grazing pasture

Fig. 3. Process of making tunnels and brood masses in the case of *Caccobius jessoensis* in the laboratory

Table 1. List of the insects occuring from the cow dung in the pasture at Tokachi District

Order	Family	No. of Species	No of Individuals
Coleoptera			
(Beetles)	Scarabaeidae	11	１００－５００
	Hydorohylidae	4	１００－５００
	Histeridae	2	＞１０
	Stephylinidae	19	１０－１００
	Carabidae	8	＞１０
Diptera			
(Flies)	Sepsidae	7	＜５００
	Muscidae	8	１００－５００
	Scatophagidae	1	１００－５００
	Sarcophgidae	1	＞１０
	Sphaerociredae	13	１００－５００
	Chironomidae	7	１００－５００
	Dolichopodidae	3	１０－１００
	Cecidomyiidae	19	＜５００
Hymenopteta			
(Wasps)	Pteromalidae	3	１０－１００
	Branconidae	10	＜５００
Total	14	116	＜ 3000

Table 2. Effect of moisture content in cow dun on the developmento of horn fly larvae.

Moisture content in cow dung (%)	No.of eggs observed	Hatching rate of eggs (%)	Pupation rate of larvae(%)	Mean wt. of pupae (mg)	Emergence rate of pupae (%)
90	100	96	36	5.37	20
85	100	95	93	6.08	91
80	100	96	93	6.14	91
75	100	93	91	4.13	83
70	100	91	0	n.d.	n.d.

Table 3. Number of the eggs oviposited by the flies on several moisture contento of cow dung in the pasture

Moisture content in cow dung (%)	No. of the flies oviposited	Av. No. of the eggs oviposited/a dung
more than 90	18	0.2
87-90	79	12.8
84-87	58	14.1
less than 84	6	4.3

Table 4. Mean numbers of adult horn flies reared from 50 eggs deposited on 100g of dung from cattle treated with ivermectin pour-on

Wk. post-treatment	Untreated steer	Treated steer #1		Treated steer #2	
	Mean	Mean	Reduction	Mean	Reduction
0	38.6	36.4		39.6	
1	27.8	0	100	0	100
2	28	0	100	0	100
3	25.2	0	100	0	100
4	23.6	0.2	99	1	96
5	33	15.4	53	20.6	38
6	34.6	17.4	50	34	2

Fincher (1996)

Table 5. Effect of ivermectin on immature *Ontophagous gazella* developed 28 days in brood masses from buckets each containing four females and four male adult beetles

No. of brood masses with	Ivermectin containing pats Days aftaer treatment			Controls
	2	7	17	
Larvae	0	1	26	47
Prepupae	0	0	18	21
Pupae	0	0	128	40
No chamber	4	1	0	0
Chamber without live larvae	174	92	5	2

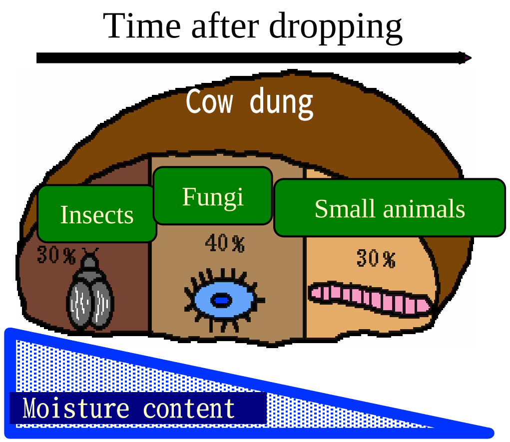
Sommer and Nielsen (1992)

Table 6 Effect of avermectin on total catches of three species of dung beetles in dung-baited pitfall traps set at two localities in Australia

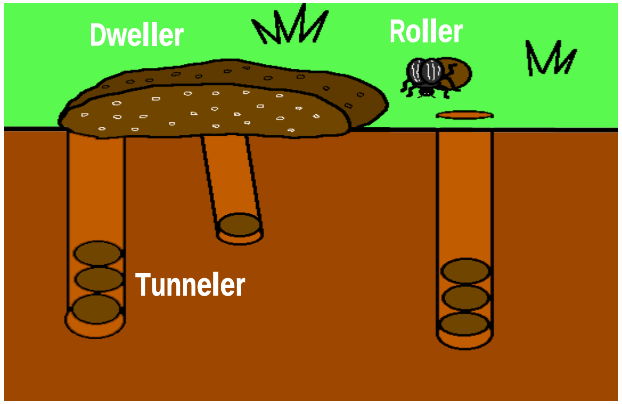
Dung collection (days after treatment)	Area	*Ontophagous australis*		*Ontophagous pexatus*		*Ontophagous pentacanthus*	
		treated	untreated	treated	untreated	treated	untreated
3	A	2069	1061	10	1	0	0
25	A	1021	560	7	4	0	0
35	A	195	200	10	2	0	0
3	B	718	305	267	195	11	2
25	B	730	369	3330	2381	3	1
35	B	278	293	970	800	2	1
Totals		5011	2788	4594	3383	16	4

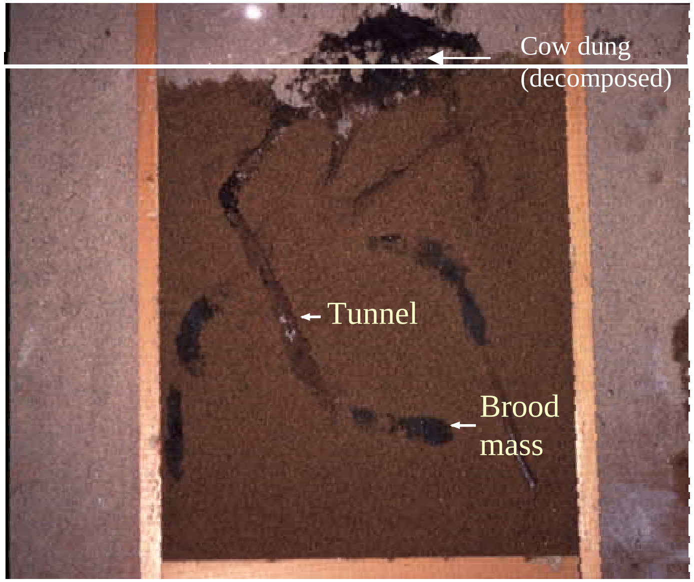
Table 7　Days required for recovery of reproductive ability from the starting day reared withthe dung pats containing ivermectin

Name of the species	Average days required for recovery of reproductive ability
Flies	
Horn flies	54
Nemyia cornicina	25
Face flies	14
Stable flies	14
Beetles	
Ontophagous gazzela	19
Copris hispanus	16
Dung beetles in Hokkaido	12
Euoniricdellus fulvus	10



Time after dropping
Cow dung
Insects
Fungi
Small animals
30%
40%
30%
Moisture content


Dweller
Roller
Tunneler


Cow dung
(decomposed)
Tunnel
Brood
mass