Succession of the beetle assemblage in cow and horse dung on mountain pastures

A.M. Psarev
Tomsk State University, Tomsk, 634010, Russia

The assemblage of a dung, as well as any assemblage of alive organisms, is dynamical. One of exhibiting such dynamics is the series of changes of species composition imago coprobionts beetle, descending during changes, bound with age of a substratum. In the literature there are small data about such successions for beetle of some family from different area of worlds (Kessler, Balsbaugh, 1972; Koskela, 1972; Koskela, Hanski, 1977; Negrobov, 1999 et some al.), however, nature and rate of successions processes are determined by the regional factors. During some of years we studied a fauna and ecological distinctions of coprophilic insects of mountain pastures of a south-east and east of Kazakhstan and Gornyi Altai. One of problems of our researches was analysis of a course of a succession in assemblage of coprobionts beetle.

Coleoptera outnumber other coprobionts as regards to the variety of species, that is why it is rather difficult to trace the qualitative and quantitative changes during the succession within the bounds of this group. The reason is that the majority of them is too small, they can hardly be counted (Ptiliidae, some *Oxytelus, Atheta* from Staphylinidae), others can form local aggregations and then spread evenly out of the pasture (Aphodiinae), some are very mobile and they are able to leave the substratum several times during twenty-four hours (*Philonthus*), for some of the species relation with dung can be occasional etc. That is why we have chosen a number of dominant species of primary families for describing the successional processes of coprobionts Coleoptera and we did not take into account the number of small *Athetini,* Ptiliidae and occasional users of dung (Carabidae, some Staphylinidae and others). The general pattern of Coleoptera imago succession in cow and horse dung is shown in the fig.1.

Scarabaeidae population in cow dung grows evenly and reaches its peak during the first day, and the basic mass of species occupies the substratum during the first 3-6 hours. *Aphodius erraticus L., A. rufipes* L., *A. depressus* Kug., *A. rectus* Motsch., *Onthophagus gibbulus* Pall. and *O. nuchicornis* L. appear first. The number of these species becomes maximum during the first day. The number of some Aphodiinae (*A. foetens* F., *A. fimetarius* L.) is the biggest on the third or fourth day of dung existence. When the faeces become crusted over, dung beetles' flight activity is decreasing, by the end of first – the middle of the next twenty-four hours the development of Scarabaeidae complex is finished. Then some species leave the substratum, the others stay for longer time. According to the time of presence in dung it is possible to define species among Scarabaeidae, which can be found during 2 - 2.5 days (*Onthophagus spp.*); 3 - 4 days (*Aphodius erraticus, A. pusillus* Hbst., *A. haemorrhoidalis* L. and others) and those which inhabit it until almost total insiccation (*A. fimetarius*). During the substratum colonization we noticed that the number of species has a tendency for aggregation, observed during the first twenty-four hours (*A. erraticus, A. haemorrhoidalis, Onthophagus nuchicornis* and others) – the beetles are concentrating on separate loci, forming the groups of 8 - 15 insects. Coupling happens during this time, and then some beetles fly away, *Aphodius* distribution in the thickness of dung becomes almost even, examples of *Onthophagus* are breaking up under the dung.

Quantitative and qualitative changes of Hydrophylidae in the succession process are also clearly observed. There is a high population of these examples during the first twenty-four hours, then it decreases and in 4-5 days only single insects can be found. In the first stage the species most adapted to move in a flow medium are dominant: *Sphaeridium scarabaeoides* L. and *S. bipustulatum* F., then their number decreases rather abruptly, on the 3-4 day *Pachysternum haemorrhoum* Motsch., *Cryptopleurum minutum* F., *Cercyon spp.* predominate. The former are present in dung by day 1,5-2 (*Sphaeridium spp.*); others stay not less than 5 days.

Pertaining to species variety, Histeridae are poor in the cow's dung, they do not form clumps but they are constantly represented by the small number of examples. Usually the histerids complex is formed in 2 - 2,5 days, after the oviposition and appearance of first larvae of coprophilic flies. During this time it is common to observe *Hister sibiricus* Mars., *Margarinotus ventralis* Mars., *Atholus duodecimstriatus* Schrank, *A. bimaculatus* L. and others. Their number is fluctuating greatly - from 1-2 persons of *Pachylister inaequalis Ol.*, 3-4 persons of *Hister sibiricus*, *Margarinotus ventralis* up to 7-11 *Atholus duodecimstriatus*. In the drying out dung one can find *Abraeus globulus* Creutz..

In the large group of Staphylinidae, connected with the cow dung succession processes have more complicated development then the same procedure of other Coleoptera. Their qualitative and quantitative presence in dung of different ages is defined by the specificity of the species trophism – there are coprophagous, predators, saprobes and myxophages among them. Specific composition of coprobionts Staphylinidae is formed

by the second day but the peak of population is noticed by the 4 - 5 day, the number of insects of different species changing during succession. During the first hour both coprophagous (*Oxytelus piceus* L., *Platystethus cornutus* Grav., *P. arenarius* Four. and others), and predators (*Ontholestes murinus* L., *O. tesselatus* Fourc., sometimes *Philonthus*) appear. Predators hunting for flies' imago during nutrition oviposition eat their eggs, taking them out of the substratum. As dung is getting dry and crusted over, the number of predators is increasing. This is the time of intensive hunting of *Ontholestes spp.*, which is specialized in flies' imago hunting on the substratum. *Philonthus* (*Ph. agilis* Grav., *Ph. cruentatus* Gmel., *Ph. marginatus* Stroem. and others) attack the flies as well. In 2 -2,5 days *Ontholestes spp.* leave the substratum and *Philonthus spp.* mainly eat larvae of other coprobionts. The number of the majority of predators is gradually increasing by the 3 - 4 day, then their number decreases and by the 5th to 7th day there are mainly species of middle and big size (*Philontus cruentatus, Ph. sanquinolentus* Grav., *Ph. rectangulus* Sharp., Ph. splendens F., *Ph. nitidus* F., *Emus hirtus* L. – more rare and others) in the dung because the flies larvae grow up by that time and become inaccessible for small predators. By about the 3-4 day the number of *Aleochara spp.* reaches its peak, their larvae are ectoparasites of flies' pupa.

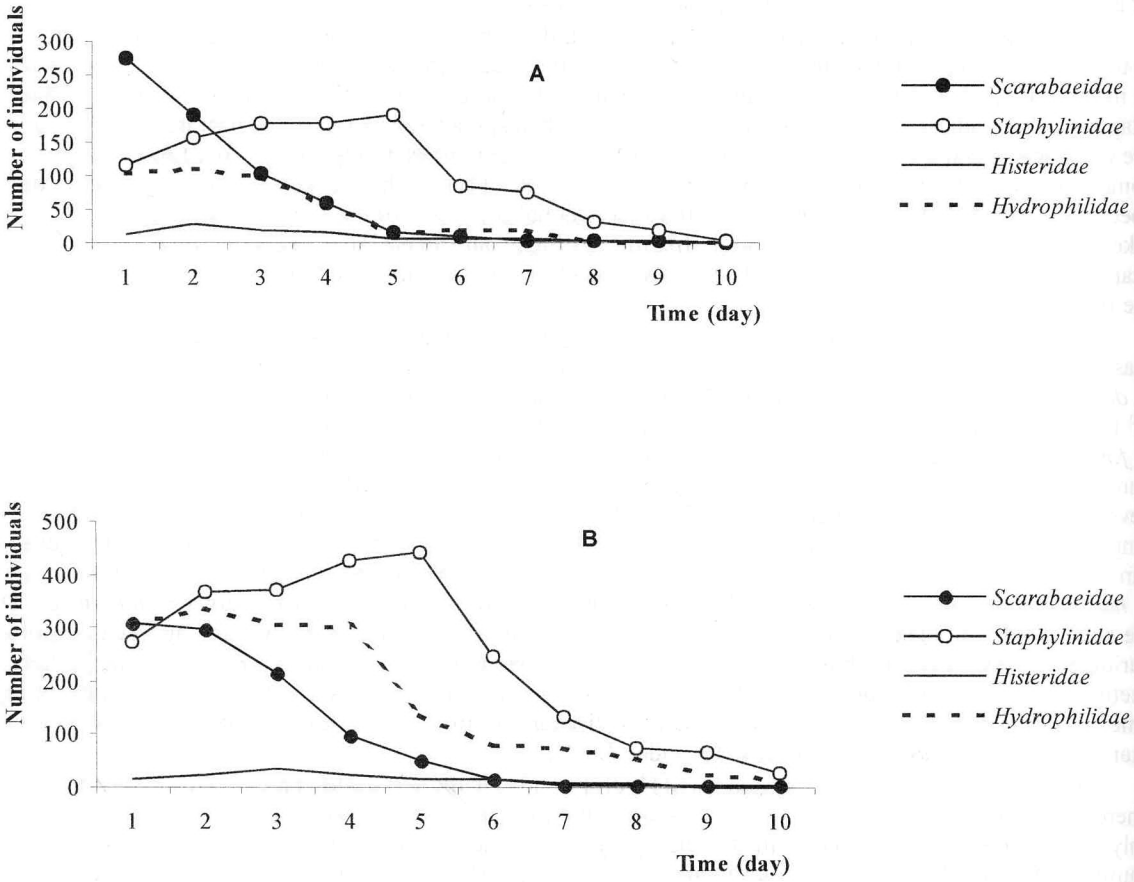

Fig 1. Changes in the mean number of individuals coprophilous beetle during the succession: A - cow dropping, B - horse dropping.

In the table 1 the data about the number of the most common Coleoptera species in the cow dung during the different stages of succession is given. Horse dung differs from cow dung in consistency it has a pronounced fragmentation, a quaggy structure, and it is highly moist for a long time. Those microbiotopical peculiarities affect not only the species composition of Coleoptera, but also the duration of the succession process.

The dynamics of Scarabaeidae settling in the horse dung resembles the common course of changes, which take place with this Coleoptera group in the cow dung. The greatest number of examples is noticed during the first day of succession, though high number of leaf-horned beetles remains the same the next day.

Table 1. Number of some coprophilous beetle in the cow dung at different stages of a succession

Coleoptera	Time of existence a dung (day)									
	1	2	3	4	5	6	7	8	9	10
Histeridae										
Abraeus globulus Creutz.		5	6	8	4	4	6	2		
Hister sibiricus Mars	7	7	4	3	2	3				
Atholus bimaculatus L.	2	2	1							
A. duodecimstriatus Schrank	1	8	7	2						
Margarinotus ventralis Mars.	3	5	1	2	1					
Hydrophylidae										
Sphaeridium scarabaeoides L.	31	15	8	3						
S. bipustulatum F.	13	12	5	2	1					
S. lunatum F.	10	13	11	12	2					
Cercyon spp.	6	29	31	15	5	7	12	8	6	5
Pachysternum haemorrhoum Motsch.	24	21	23	12	3	5				
Cryptopleurum minutum F.	12	18	18	15	6	8	6	3	4	2
Scarabaeidae										
Aphodius erraticus L.	61	27	22	15	1					
A. foetens F.	2	21	36	18	5	3	1			
A. rectus Motsch.	20	17	1	1						
A. rufipes L.	40	42	15	2						
A. fimetarius L.	1	8	12	8	5	5	3	2	3	1
Onthophagus gibbulus Pall.	23	8	3							
O. fracticornis L.	83	56	10	16	4					
Staphylinidae										
Platystethus cornutus Grav.	10	8	14	18	22	21	10	12	8	4
Pl. arenarius Geoffr.	5	11	11	8	10	3	5			
Aploderus caelatus Grav.	12	2	2	4		3				
Oxytelus piceus L.	12	18	22	18	16	4	3			
O. nitidulus Grav.	4	6	18	40	54	4	24	12	8	
Ontholestes murinus L.	5	2	2							
O. tesselatus Four.	3	1	1							
Emus hirtus L.	1	1	1	2	1		1			
Philonthus marginatus Stroem.	12	13	6	2	3	2				
Ph. splendens F.	6	8	5	2	4	5	3			
Ph. nitidus F.		3	5	5	1	2				
Ph. rectangulus Sharp.	1	3	5	3	4	2	2			
Ph. varians Payk.	4	8	12	4	8	5				
Ph. politus L.	2	4		4	2					
Ph. albipes Grav.	6	21	22	18	14	15	4			
Ph. sanquinolentus Grav.	2	2	7	2	6	2	2			
Ph. cruentatus Gmel.	25	17	27	10	14	8	17	6	3	
Ph. agilis Grav	6	4	4	16	13	2	1			
Ph. spinipes Sharp.		4	6	2		1				
Tachinus rufipes Deg.			2	4	4	1	2	1		
Aleochara intricata Mnnh.	1	8	4	16	14	2				
Atheta spp.		+	+	+	+	+	+	+	+	+
Ptiliidae	+	+	+	+	+	+	+	+	+	+
Acrotrichis sp.	+	+	+	+	+	+	+	+	+	+

Note: "+" the presence of small-sized species is indicated, the number which was not taken into account

Table 2. Number of some coprophilous beetle in the horse dung at different stages of a succession

Coleoptera	Time of existence a dung (day)									
	1	2	3	4	5	6	7	8	9	10
Histeridae										
Abraeus globulus Creutz.	4	4	8	14	12	15	9	6	1	1
Hister sibiricus Mars	4	5	8	3	2	2				
Atholus bimaculatus L.	1	1	1							
A. duodecimstriatus Schrank	1	7	7	2						
Margarinotus ventralis Mars.	6	5	12	4	1					
Hydrophylidae										
Sphaeridium scarabaeoides L.	59	46	15	18	6	12	8	6		
S. bipustulatum F.	65	57	16	23	12	12	6	3		
S. lunatum F.	12	5	10							
Cercyon spp.	115	125	132	160	53	25	32	27	12	12
Pachysternum haemorrhoum Motsch.	35	65	68	34	22	13	12	3	5	2
Cryptopleurum minutum F.	17	38	62	64	43	18	18	16	6	5
Scarabaeidae										
Aphodius erraticus L.	16	24	14	8	3	6				
A. foetens F.	2	8	6	7	3	1	1	2	1	2
A. rectus Motsch.	72	76	68	25	10	2				
A. rufipes L.	34	24	8	8	6	1	2			
A. fimetarius L.	6	18	18	15	11	5	2	1	2	1
A. fossor L.	5	6	6	4	3					
A. carinatus Derm.	14	16	15	15	6	2				
A. immundus Kr.	7	7	8	6	3					
A. sabulicola Thoms.	4	7	6	3	1					
Onthophagus gibbulus Pall.	12	10	8	2						
O. fracticornis L.	124	85	53	6	6					
Geotrupes baicalicus Rtt.	8	11	3							
Staphylinidae										
Pl. arenarius Geoffr.	31	96	164	120	56	84	36	42	45	18
Aploderus caelatus Grav.										
O. nitidulus Grav.	48	53	72	64	60	43	38	12	14	5
Ontholestes murinus L.	6	5	4	2						
O. tesselatus Fourc.	3	4	3							
Emus hirtus L.	3	4	2	3	1					
Philonthus marginatus Stroem.	10	14	14	12	15	5				
Ph. splendens F.	5	6	5	6	2	1	1	1	1	1
Ph. nitidus F.	3	4	5	4	1	1	1	1	1	1
Ph. rectangulus Sharp	4	8	6	8	4	4	3	2	1	1
Ph. varians Payk.	32	26	38	21	12	5	8			
Ph. politus L.	5	6	8	3	5	6	3	1		
Ph. albipes Grav.	18	16	20	12	5	8	5			
Ph. sanquinolentus Grav.	7	5	8	4	5	5	1			
Ph. cruentatus Gmel.	39	42	45	26	16	14	18	9	3	
Ph. agilis Grav	14	17	21	15	12	9	8	2		
Ph. spinipes Sharp	2	5	6	4	2	1				
Tachinus rufipes Deg.			8	6	3		6	2		
Aleochara intricata Mnnh.	1	8	4	12	16	3				
A. bilineata Gyll.	3	3	9	21	8	10	3	1		
A. bipustulata L.	1	6	5	10	14	6	2			
Atheta spp.		+	+	+	+	+	+	+	+	+
Ptiliidae										
Acrotrichis sp.	+	+	+	+	+	+	+	+	+	+

These are *Aphodius rectus, A. sabulicola* Thoms., *A. erraticus, Onthophagus gibbulus, O. fracticornis, O. laticornis* Gebl., *O. marginalis* Gebl., *O. nuchicornis, Geotrupes baicalicus* Reitt. and some others which appear first. By the second day the specific composition is formed completely. The most common species for this substratum besides the above enumerated are *A. immundus* Kr. , *A. vittatus* Say., *A. fossor* L., *A. carinatus* Germ., *A. pusillus* and some others. It should be mentioned that during the colonization of the horse dung Aphodiinae do not have such predominance in population as they do in the cow dung. Moreover, it is noticed, that Scarabaeinae and Geotrupinae are prevailing sometimes. So in the horse dung which was 1,5 days old in the area of the settlement Tcherga (Central Altai) 11 examples of *G. baicalicus*, 142 *Onthophagus spp.* (*O. gibbulus, O. fracticornis, O. laticornis, O. nuchicornis*), 67 *Aphodius spp.* (*A. erraticus, A. rectus, A. rufipes, A. haemorrhoidalis* and others) had been found 05.08.1997. In the probe from the cow dung of the same age, which was taken nearby (about 15 m. from the first one) 121 example of *Aphodius spp.* (*A. erraticus, A rufipes* and others) and 36 *Onthophagus spp.* (*O. gibbulus, O. nuchicornis*) were found. However, in the majority of cases the number of Aphodiinae is slightly exceeding the quantity of *Scarabaeinae* in the horse dung. Aggregation of *Aphodius spp.* is expressed in the beginning of their colonization in the horse dung to a greater extent in comparison with the cow dung. The number of *A. rectus* in some conglomerates of substratum of 0,5 decimetre^3 can reach up to 23 examples. The majority of Scarabaeidae species stay in dung during 4-5 days, however their number gradually decreases by the third day. In the dung of 6-7 days age one can observe *Aphodius foetens, A. fimetarius*; and *A. rectus, A immundus* are found more seldom. According to the time of connection with the substratum in the horse dung as well as in the cow dung it is possible to define species among *Scarabaeidae*, which can be found during 2 - 2,5 days (*Onthophagus spp., Geotrupes baicalicus, Aphodius fossor, A. depressus, A. erraticus*); 4 - 5 days (almost all the *Aphodius - A. rectus, A. immundus, A. ater* Deg., *A. haemorrhoidalis* and others) and those which inhabit it until almost total I nsiccation (*A. fimetarius, A. subterraneus* L.).

The specific composition of Hydrophylidae in the horse dung is different from the one in the cow dung by the greater variety of *Cercyon* species. The biggest number of *Sphaeridium spp.* is noticed during 1,5 - 2 days. In some probes of the 24 hours' dung, the quantity of *Sphaeridium bipustulatum* examples reached up to 170; of *S. scarabaeoides* – up to 79; of *S. lunatum* F. – up to 12. By the end of the first to the beginning of the next twenty-four hours an intensive flight of small Hydrophylidae (*Pachysternum haemorrhoum, Cryptopleurum minutum, Cercyon spp.*) commences, their number remaining high for up to approximately 4-5 days, then gradually decreasing. Not numerous *Cercyon spp.* are met also in the old dung of eight-ten days' existence.

Histeridae are present in the horse dung since the first hours of its existence until almost total insiccation, their number is noticeably smaller than other Coleoptera quantity. *Hister, Margarinotus, Saprinus, Atholus* are commonly met species, the peak of their population is seen in 2,5 - 3 days when the eggs and larvae of coprobiontic insects are represented more abundantly. *Abraeus globulus* Creutz., more seldom *Saprinus spernax* Marsh., *Margarinotus ventralis* can be found in the drying dung.

Staphylinidae are more numerous in the horse than in the cow dung. The curve, describing the general succession development has the smooth pattern and the high number of different trophic groups of Staphylinidae is being preserved for a long time (fig.1, B).

Specific composition of Staphylinidae is completed by the second day of the dung existence, but the peak of their numerosity is marked by the 5th day (up to 120 ex/dm^2), mainly due to the small coprophages - *Oxytelus spp., Platystethus spp.* The majority of Staphylinidae species (*Ontholestes murinus, O. tesselatus, Emus hirtus, Philontus cruentatus, Ph. sanquinolentus, Ph. rectangulus, Ph. splendens, Ph. nitidus* and others) and time of their appearance in the substratum concur with the same species in the cow dung. The dynamics of the particular species number is defined by the physical peculiarities of the substratum and it is more spread out chronologically. The table 2 contains data on the number of Coleoptera commonly living in the horse dung on the different stages of its existence.

Thus, the succession of coprobionts beetle is an example of a representative destructive succession, bound with decomposing of a substratum. The changes of number and species composition of different groups beetle are depend of trophics specialization of species and micribiotopical conditions in a dung. The common number of beetle in substratum reaches a maximum for the second day, her sluggish drop follows hereinafter . At the early stage of a succession dominate coprophagous, the number of predators is max for days. The general course of a succession in the cow and horse dung is similar. As a whole on mountain pastures course of a succession is more long-standing, than on steppe flat pastures.

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Резюме

Псарев А. М. **Сукцессии в сообществе жесткокрылых коровьего и конского помета на горных пастбищах**

Изменения в видовом составе имаго копробионтных являются примером типичной деструктивной сукцессии и связаны с трофической специализацией видов и изменениями, проходящими в субстрате. Для копрофагов (Scarabaeidae, Hydrophylidae, части стафилинид) максимум численности наблюдается на вторые сутки. Численность Histeridae, хищных Staphylinidae медленно нарастает к 4-5 суткам. Общий ход сукцессии в коровь