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Research Article

Diversity of Feed Storage Pest Beetle in Banten Province

Keanekaragaman Jenis Kumbang Hama pada Gudang Penyimpanan Bahan Pakan di Provinsi Banten

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ABSTRACT

Banten province is a growing industrial area, where many industrial items were prepared including animal feed whose raw materials are mostly imported from abroad. Therefore, monitoring feed storage is very important to ensure the existence of pest insects in storage warehouse and to prevent the entry of plant quarantine pest organism (OPTK) which may be carried by imported feed raw materials. The identification, diversity and evenness of pest beetle species in five feed storages in Banten province region have been done. Feed sampling was done using hand sampling method. Samples taken from the diagonal corner and center of storage, respectively as much as 250 grams four times within one-week interval. The results were that 13 species of pest beetles from seven families were intercepted. *Cryptolestes ferrugineus*, *Rhizoperta dominica*, and *Tribolium castaneum* pest beetles were the dominant insects attacking five storages. Specifically, the dominant pest beetles in each commodity were: *T. castaneum* on soybean meal (SBM); *C. ferrugineus* and *T. castaneum* on corn; *T. castaneum* and *R. dominica* on corn gluten meal (CGM); *T. castaneum* and *Sitophilus zeamais* on wheat; *T. castaneum* on soybeans; and *Oryzaephilus surinamensis* in sorghum. Environmental factors, the type and duration of stored commodities were found to be the factors supporting the existence of pest beetle species. The highest diversity of pest beetle varieties was found in warehouse A with a value of 1.552 which was considered as moderate diversity. The evenness index of pest beetle species showed that warehouses A and E were in unstable conditions. Meanwhile, the warehouses B, C, and D were in depressed conditions dominated by certain species of pest beetle.

Keywords: Banten Province, diversity, feed storage, pest beetle

INTISARI

Provinsi Banten merupakan daerah industri yang terus berkembang, termasuk industri pakan ternak yang bahan bakunya sebagian besar diimpor dari luar negeri. Oleh sebab itu, pengawasan terhadap gudang penyimpanan pakan sangat penting dilakukan untuk mengawasi keberadaan serangga hama pada gudang penyimpanan dan mencegah masuknya Organisme Pengganggu Tumbuhan Karantina (OPTK) yang mungkin terbawa bahan baku pakan yang diimpor. Identifikasi, keanekaragaman serta kemerataan jenis kumbang hama pada lima gudang penyimpanan pakan di wilayah Banten telah dilakukan. Pengambilan sampel bahan pakan menggunakan metode hand sampling. *Sampel diambil pada bagian sudut dan bagian tengah secara diagonal masing-masing sebanyak 250 gram sebanyak 4 kali dengan interval waktu 1 minggu sekali. Hasil penelitian diperoleh 13 jenis kumbang hama dari 7 famili. Kumbang hama jenis* Cryptolestes ferrugineus, Rhyzoperta dominica, *dan* Tribolium castaneum *merupakan serangga yang dominan menyerang kelima gudang penyimpanan. Jenis kumbang hama yang dominan pada masing-masing komoditas adalah* T. castaneum *pada* soybean meal *(SBM);* C. ferrugineus *dan* T. castaneum *pada komoditas jagung;* T. castaneum *dan* R. dominica *pada* corn gluten meal *(CGM);* T. castaneum *dan* Sitophilus zeamais *pada gandum;* T. castaneum *pada kedelai; dan* Oryzaephilus surinamensis *pada sorgum. Faktor lingkungan, jenis dan lama komoditas yang disimpan merupakan faktor pendukung keberadaan suatu jenis kumbang hama. Indeks keanekaragaman jenis kumbang hama tertinggi ditemukan pada gudang A dengan nilai 1,552 menggambarkan keanekaragaman tergolong sedang. Nilai indeks kemerataan jenis kumbang hama menunjukkan bahwa gudang A dan gudang E termasuk dalam kondisi labil; sedangkan gudang B, C, dan D termasuk dalam kondisi tertekan dengan didominasi oleh jenis kumbang hama tertentu.*

Kata kunci: gudang penyimpanan bahan pakan, keanekaragaman, kumbang hama, Provinsi Banten

INTRODUCTION

Indonesia imports several agricultural commodities including feed raw materials that enter through the province of Banten. The province of Banten is a growing industrial area, which develop a lot of industrial enterprises, including the animal feed industry. Livestock feed raw materials, such as corn and soybean meal, are mostly imported from abroad. The report of export and import of Banten province in 2015 is listed in the fifth category of fodder goods with the value of goods of US $ 554.3 million or 7.02% in the role of total import value (BPS, 2016).

In the current free trade period, technical factors such as the presence of Plant Quarantine Pest Organisms (OPTK) on traded agricultural commodities can hinder competitiveness between countries. Therefore, the monitoring of feed storage warehouse is very important to monitor the existence of pest insects and OPTK which may be carried along with commodities or carrier media. This monitoring is important to prevent the entry of OPTK into the territory of the Republic of Indonesia which may result in losses in agriculture and trade. According to Haines (1991), the order Coleoptera is post-harvest pests are very damaging to the ingredients such as savings grains. Coleoptera order is the most common order found in sampling sites compared to Lepidoptera and Psocoptera orders. Beetle pest is one type of pest that is able to quickly reproduce and adapt to less supportive environment (Wagiman, 2014).

Detection and identification of warehouse insect are part of a sustainable pest control activity in a storage warehouse. Storage ecosystems with abundant feed sources and supported by environmental factors such as temperature and humidity, the absence of natural enemies, and organism resistance to insecticide applications result in insects becoming pests (Gullan & Cranston, 2010). According to Wagiman (2014), storage warehouse ecosystem is very vulnerable to pest population explosion if the management is not appropriate. Commodity damage can cause material loss, financial loss, and influence society.

Observations on feed storage are important in order to detect pest populations of pest beetles that may be carried off by feed ingredients. Observations on pest existence had been done using parameter of spreading pattern of pest beetle in storage area and comparing detection result by using hand sampling method to know the potential damage that caused by the pest.

This study aims to identify the type of pest beetle in feed storage and compare the diversity and evenness of pest beetle species in feed storage in Banten province.

MATERIALS AND METHODS

The research was conducted at the feed material commodity storage warehouses in Banten province. Observations were made on five feed storages: warehouse A in Cilegon city, warehouse B, C, and D in Serang district, and warehouse E in Tangerang district. The study was conducted from November 2016 to February 2017.

Research Procedure

The data were collected based on the sampling guidelines for plant products for health examination of pest pathways or OPTK of Agricultural Quarantine Agency. Samples of feed material were taken at the corner and the middle of an imaginary diagonal of the premises, each as much as 250 g, then were put in a jar and covered with gauze. Sampling was taken fourth times with an interval of one week. Each sample is labeled, then taken to the laboratory for observation once a week for one month. The items observed are the species and population of pest beetles.

Identification

The pest beetle is separated by host species and the location of the pest. Identification of pest beetle is done in Insect Laboratory, Agricultural Quarantine Office of Cilegon, Banten. Identification of pest beetle was done using references of Haines *et al*. (1991), Rees (2007), and Schnitzler *et al.* (2014).

Pest Beetle Diversity Index

The pest beetles found were then separated and the number and proportion of the individual species were calculated. To calculate the diversity index, the formula developed by Shannon and Wiever through the equation was used as follows:

$$H' = -\sum pi \ln pi$$

where: H': diversity index
pi : proportion of the individual species

And to calculate the species evenness index the following formula was used:

$$E' = \frac{H'}{\ln S}$$

where: E' : evenness index
S : number of species found

RESULTS AND DISCUSSION

Identification of Pest Beetles

Commodities contained in feed storage consisted of soybean meal (SBM), corn, corn gluten meal (CGM), wheat, soybean, and sorghum. The types of commodities that were almost spread out are SBM, corn and CGM; wheat is found only in warehouse A and warehouse C; soybeans are found only in storage D; while sorghum is found only in storage E. Identification results found 13 species of pest beetles from 7 families as shown in Table 1. Results of research by Darsilawati (2015) showed that insect pests in imported raw material warehouse found in the work area of Cilegon Agricultural Quarantine Office were *Tribolium castaneum*, *Cryptolestes ferrugineus*, *Sitophilus zeamais*, *Alphitobius diaperinus*, and *Oryzaephilus surinamensis*. This shows that the pest beetles found in the feed storage in Banten region had higher kinds of species.

Table 1. Results of identification of pest beetle in feed storage in Banten province

No.	Famili	Species
1.	Bostrichidae	*Rhyzoperta dominica*
2.	Dermestidae	*Attagenus fasciatus*
3.		*Thorictodes heydeni*
4.	Dryophthoridae	*Sitophilus oryzae*
5.		*Sitophilus zeamais*
6.	Laemophloeidae	*Cryptolestes ferrugineus*
7.	Ptinidae	*Lasioderma serricorne*
8.	Silvanidae	*Oryzaephilus surinamensis*
9.	Tenebrionidae	*Alphitobius laevigatus*
10.		*Alphitobius diaperinus*
11.		*Latheticus oryzae*
12.		*Palorus subdepressus*
13.		*Tribolium castaneum*

The results of the identification and literature review are two species of pest beetles that have never been reported or had minimal information about their presence in Indonesia, i.e. *Attagenus fasciatus* and *Thorictodes heydeni*. In Indonesia, *A. fasciatus* has been reported from tobacco seed, in which the larvae were able to develop (Kalshoven, 1981). There was minimal information about their presence on other post-harvest products in other area in Indonesia. Pest beetle *T. heydeni* was reported found on broken grains, products from oily seeds, and nuts in tropical and subtropical Africa, Mediterranean, west and south Asia, Pacific islands, US and Mexico (Has not been reported in Indonesia) (Haines, 1991).

The Diversity of Pest Beetles Based on the Sampling Site

Distribution of pest beetle in feed storage in Banten province was shown Table 2. From 13 species of pest beetles found, there were three species of pest beetle that predominantly appear in five storages, i.e. *Cryptolestes ferrugineus*, *Rhyzoperta dominica*, and *Tribolium castaneum*.

In warehouse A there were SBM and corn commodities that were not always available but often they were stored for two to three months. The aeration of this warehouse was not managed properly by the warehouse manager, thus supporting the development of many types of pest beetles. On warehouse B there were SBM, corn and CGM commodities which were circulated quite fast. Humidity setting in the warehouse is noteworthy by regulating the ventilation of the warehouse, so the population of pest beetle species is not too high. In warehouse C there were SBM and maize commodities whose circulation is fast enough but always continuous, and there were also CGM and wheat commodities whose circulation were quite slow. Environmental conditions such as air ventilation arrangements are well arranged, but because the commodities stored in these warehouses are more diverse and always continuous and some of their commodities have been stored for more than three months, then it might lead to the abundance of pest beetle species and their populations become high. In warehouse D there were corn and soybean commodities stored for more than two to three months, and the aeration in the warehouse is not sufficiently good. This resulted in that a few species of pest beetles had survived and the population evolved was quite high. In the warehouse E there were SBM and CGM commodities with a fairly fast circulation, and corn and sorghum commodities with a fairly slow circulation. This factor supports the development of pest beetles. Temperature and humidity of storage warehouse in Indonesia ranged between 22−34^{o}C and humidity 52−99% which are enough to support the development of pest warehouse, while warehouse should have an ideal condition of room temperature 18^{o}C and humidity space 65% where at that condition insect and fungus life may not develop (Wagiman, 2014).

The highest number of pest beetle species was found in warehouse C as many as 12 species, while the lowest number of species in warehouse D was 6 types. The differences in population and diversity

Table 2. Distribution of pest beetle in five feed storage in Banten province

No.	Insect found	Storage				
		A	B	C	D	E
1.	*Alphitobius diaperinus*	-	✓	✓	-	✓
2.	*Alphitobius laevigatus*	✓	✓	✓	✓	-
3.	*Attagenus fasciatus*	✓	✓	✓	-	✓
4.	*Cryptolestes ferrugineus*	✓	✓	✓	✓	✓
5.	*Lasioderma serricorne*	✓	✓	✓	-	-
6.	*Latheticus oryzae*	✓	-	✓	-	-
7.	*Oryzaephilus surinamensis*	✓	-	✓	-	✓
8.	*Palorus subdepressus*	✓	✓	✓	-	-
9.	*Rhyzoperta dominica*	✓	✓	✓	✓	✓
10.	*Sitophilus oryzae*	✓	-	✓	-	-
11.	*Sitophilus zeamais*	-	-	✓	✓	✓
12.	*Thorictodes heydeni*	✓	-	-	✓	-
13.	*Tribolium castaneum*	✓	✓	✓	✓	✓
	Diversity	11	8	12	6	7

of pest beetle varieties in storage warehouses observed were influenced by many factors including temperature, humidity, commodity type and duration of storage. According to Rimbing (2015), the longer the storage periods of a material, the higher the population number of pests. The type of commodity of feed ingredients in warehouse A was less than warehouse C. Abundance of pest beetle type in warehouse A was quite high because the commodity was stored long enough. In warehouse C the number of pest beetle species is caused by the choice of commodities as the habitat of pest beetle more varied and always available although the storage is not long. The results of a research by Ilato *et al*. (2012) showed that the availability of suitable foods has an effect on the development and population of insect pests in storage warehouses. Mismatch of food can arise due to lack of required elemental content, low water content in food, hard material surfaces and material form (Ebeling, 2002).

The Diversity of Pest Beetles by Commodity Type

The average population of pest beetles on each commodity in five sampling sites is shown in Table 3. In SBM commodity, *T. castaneum* is the most dominant species with the highest population averages found in warehouse A with 43.50 individuals. In corn commodity, *C. ferrugineus* and *T. castaneum* is the most dominant species with the highest average population of 200.60 individuals and 51.20 individuals, respectively in warehouse D. In CGM commodities, *T. castaneum* and *R. dominica* pest beetles are the most dominant species with the highest average population of 147.40 individuals and 0.20 individuals in warehouses C. On wheat commodity, *T. castaneum* and *Sitophilus oryzae* is the dominant species with the highest population average of 35.20 and 34.20 individuals, respectively in warehouse C. On soybean commodity, the most dominant pest beetle is *T. castaneum* with an average population of 8.40 individuals in warehouse D. While on the sorghum commodity, the most dominant pest beetle is *Oryzaephilus surinamensis* with the average population of 49.00 individuals in warehouse E.

The pest beetles were founded in the six types of commodities observed, i.e. *T. castaneum* and *C. ferrugineus*. The red flour beetle, *T. castaneum*, is a cosmopolitan stored product insect that can infest raw grains, mills and processing plants, and finished food product (Rees, 2004). It is a major pest of flour mills in the United States, which have relied on fumigation of structures with methyl bromide as the primary management strategy (Campbell *et al*., 2010a, b). Pest beetle *T. castaneum* was found as dominant species of pest beetle in five commodities, expect on sorghum. According to Rimbing (2015), the dominant species of post-harvest pests that attack the grains are *S. zeamais*, *Tribolium* sp., and *Carpopilus* sp.. The spread of other post-harvest pests such as *C. ferrugineus* emerged after the pest of *S. zeamais* in corn kernels, whereas in intact corn it was difficult to find the population of *C. ferrugineus*. According to Haines (1991), the existence of *Sitophilus* sp. can increase feed availability for *T. castaneum* because of *Sitophilus* sp. is a primary pest, which is due to their attack, the grains of rice

Table 3. The average population of pest beetle associated with feed commodities in the storage warehouse in Banten province

No.	Insect found	SBM				Corn				CGM			Wheat		Soybean	Sorghum
		A	B	C	E	B	C	D	E	B	C	E	A	C	D	E
1.	*Alphitobius laevigatus*	30.00	0.20	0.20	-	-	-	0.20	-	-	0.20	-	1.20	0.75	-	-
2.	*Alphitobius diaperinus*	-	-	4.20	2.40	-	-	-	4.00	0.20	0.40	-	-	6.80	-	-
3.	*Attagenus fasciatus*	0.50	0.20	0.80	-	-	-	-	-	-	0.80	0.20	-	0.60	-	-
4.	*Cryptolestes ferrugineus*	2.50	0.20	0.20	-	0.60	19.80	200.60	4.20	0.25	1.20	-	-	1.40	0.80	5.20
5.	*Lasioderma serricorne*	0.50	0.20	1.20	-	0.40	-	-	-	1.20	1.20	-	-	0.20	-	-
6.	*Latheticus oryzae*	0.50	-	2.00	-	-	-	-	-	-	0.60	-	0.40	0.80	-	-
7.	*Oryzaephilus surinamensis*	2.00	-	-	-	-	-	-	58.80	-	-	-	0.50	0.40	-	49.00
8.	*Palorus subdepressus*	4.00	-	0.40	-	-	-	-	-	0.20	1.00	-	-	0.20	-	-
9.	*Rhyzoperta dominica*	1.50	0.40	-	-	-	0.20	0.40	2.60	0.20	0.20	0.20	0.40	3.40	-	2.00
10.	*Sitophilus oryzae*	2.50	-	-	-	-	-	-	-	-	0.40	-	2.20	34.20	-	-
11.	*Sitophilus zeamais*	-	-	-	-	-	2.40	1.00	10.80	-	-	-	-	-	0.60	23.20
12.	*Thorictodes heydeni*	8.50	-	-	-	-	-	-	-	-	-	-	2.40	-	0.25	-
13.	*Tribolium castaneum*	43.50	1.80	22.20	2.00	2.40	4.00	51.20	7.40	22.80	147.40	3.00	7.40	35.20	8.40	10.60
	Diversity	11	6	8	2	3	4	5	6	6	10	3	7	11	4	5
		12				8				10			12			

Remark: SBM = Soybean meal, CGM = Corn gluten meal

crushed into a groom favored by *T. castaneum*. Therefore, the dominance of *C. ferrugineus* occurred because of the initial attack of *Sitophilus* sp. and *T. castaneum*. While the dominance of *T. castaneum* increased due to the presence of *Sitophilus* sp. on the same commodity. *R. dominica* is a post-harvest pest that has an important economic impact status that can be found even in factories that have implemented modern systems (Rees, 2007). According to Wagiman (1999), association of *Sitophilus* sp. and *T. castaneum* significantly reduced population and population growth rates of *Sitophilus* sp. It is suspected to interfere competition so that growth is hampered.

Diversity Index and Evenness Index of Pest Beetle Species

Species diversity of pest beetle is the number of pest species found in feed storage warehouse in Banten province. The diversity of species of pest beetle will affect the commodity damage of feed ingredients in the warehouse. In this study, to determine the diversity of species of pest beetle, the data were taken from the total number of species and total individual pest beetle obtained by hand sampling method. The diversity index and the evenness index of pest beetle species in the five feed storage warehouses can be seen in Table 4.

The diversity index (H') describes the stability of a community. The high diversity of pest beetle types affects the commodity damage. A community with $H' < 1.5$ score indicates that species diversity is low, if $1.5 < H' \leq 3.5$ that indicates diversity is moderate, and if the value of $H' > 3.5$ indicates diversity is high. Table 4 shows that the highest diversity of pest beetle varieties is found in warehouse A with a value of 1.552 which indicated that the diversity of pest beetles in warehouse A is moderate. The diversity of pest beetle species in warehouse A was higher than in other warehouses, which shows that there is potential damage to the commodities in the warehouse.

The evenness index (E') describes the stability of a community. The higher value of E' indicates the type of pest beetle in the community that is increasingly spreading. According to Krebs (2009), three environmental community criteria are based on evenness index, i.e. when $E' < 0.50$ the community is in a depressed condition, if $0.50 < E' \leq 0.75$ then the community is in unstable condition, whereas $0.75 < E' \leq 1.00$ then the community is in stable condition. The smaller the value of E' or near zero, the more uneven spread of organism within the community, meaning it is dominated by a certain type, and instead the greater value of E' or near one, the organism in the community will spread evenly. Table 4 shows the value of the evenness index of pest beetle type in feed storage warehouse in Banten province. Warehouses A and E were in unstable condition. The warehouses B, C, and D were in depressed condition which was dominated by certain species of pest beetle.

CONCLUSION

The pest beetles found in Banten province on the feed storage are 13 species from 7 families. Pest beetles of *Cryptolestes ferrugineus*, *Rhyzoperta dominica*, and *Tribolium castaneum* are the dominant insects attacking the five storage warehouses. The most important results of the identification and references review are the findings of two species of pest beetles that have never been reported or had minimal information about their presence in Indonesia. Those insects are *Attagenus fasciatus* and *Thorictodes heydeni*. The dominant pest beetle species in each commodity of feed ingredients, among others are *T. castaneum* on SBM; *C. ferrugineus* and *T. castaneum* on corn; *T. castaneum* and *R. dominica* on CGM; *T. castaneum* and *S. zeamais* on wheat; *T. castaneum* on soybeans; and *O. surinamensis* in sorghum. Temperature, humidity, type, and duration of commodity storage are the factors supporting the existence of a species of pest beetle. The highest diversity of

Table 4. Diversity and evenness index of pest beetle species in feed storage warehouse in Banten province

	Warehouse				
	A	B	C	D	E
Total individual (N)	244	236	1474	1267	478
Total species (S)	11	8	12	6	7
Diversity index (H')	1.552	0.917	1.100	0.546	1.245
Evenness index (E')	0.647	0.441	0.443	0.305	0.640

pest beetle varieties found in warehouse A with a value of 1.552 depicts diversity as moderate. The diversity of pest beetle species in warehouse A is higher than in other warehouses, showing the potential of greater damage to the commodities in the warehouses. From the index of evenness of pest beetle species, warehouses A and E are considered in unstable conditions. The warehouses B, C, and D were considered in a depressed condition with dominance by certain species of pest beetle.

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