Estimation of losses in stored maize caused by *Corcyra cephalonica* Stainton in Southern Rajasthan and their eco-friendly management.

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ABSTRACT

Corcyra cephalonica Stainton is a notorious pest of stored cereals and cereal commodities in India as well as in other tropical and subtropical regions of the world. An experiment was conducted on extent of damage of *C. cephalonica* in maize under different storage structures during, 2010-2011, revealed that the maximum infested grain samples (61.53%) were recorded from grain stored in loose storage during June-July, 2011. Whereas, infested grain samples were not found from the grain stored in metal bin during November-December, 2010. The maximum weight loss (7.46%) was recorded in grain samples collected from loose storage in Udaipur district during June-July, 2011. No weight loss in grains were recorded in the samples collected from metal bin in Chittorgarh and Udaipur district during November-December 2010. In the quantitative and qualitative studies conducted in the selected districts observed that the maximum germination (78.00%) and protein content (8.60%) were recorded in the samples collected from metal bin in Chittorgarh district during November-December, 2010, while maximum carbohydrate content (72.00%) was recorded in maize samples collected from metal bin in Rajsamand district during November-December 2010. The minimum germination (62.00%) and carbohydrate content (66.50%) were recorded in maize samples collected from loose storage in Udaipur district; whereas, minimum protein content (6.70%) was recorded from loose storage in Chittorgarh district during June-July 2011. The studies conducted on efficacy of different grain protectants against *C. cephalonica* revealed that the highest larval mortality (82.20%), pupal mortality (10.00%) and minimum adult emergence (6.00%) were recorded in case of application neem leaf powder at 10g/kg seed, after 40 days of release. Application of wood ash at 15g/kg seed was found least effective.

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Key words: Quantitative, qualitative, survey, metal bin, loose storage.

INTRODUCTION

Maize (*Zea mays* L) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. It is cultivated on nearly 150 m ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices. In India, production of maize about 23 MT (IMS, 2014) mainly during *Kharif* season which covers 80 per cent area. There are about 200 species of insects and mites are found infesting maize grains, few of which are major or primary pests. Among these, *C. cephalonica* (Staint.) is a severe pest of stored cereals and cereal products in Europe, Asia, Africa, North America and other tropical and subtropical regions of the world. This moth is believed to be of eastern origin but has become a cosmopolitan species. Its larval stages cause serious damage to rice,

gram, sorghum, maize, groundnut, cotton seeds, peanuts, linseeds, raisins, nutmeg,currants, chocolates, army biscuits and milled products (Singh and Tiwari, 2014). The larvae cause damage to grain by feeding under silken webs. When infestation is high the entire stock of grain may converted into a webbed mass. Ultimately, a characteristic fowl odour is developed and the grain rendered unfit for human consumption. The pest causes quantitative and qualitative losses (Swaminathan, 1977; Scoot, 1991; Ambedkar, 2013).

The success achieved so far in making the stored grain free from insect pests has been largely on sole reliance of pesticides, but indiscriminate use of fumigants and other toxic chemicals caused serious problems like chronic and acute toxicity, development of insect resistance, pest resurgence, residue in food, hazards to human health and the environmental pollution. The use of plant products assumed significance as an important component of insect pest management because of their economic viability and eco-friendly nature. They hold promise as alternatives to chemical insecticides to reduce pesticide load in the environment. Contrary to the insecticides, they do not have mammalian toxicity, no health hazards, surface persistence last for long time, have no adverse effect on seed germination, cooking quality milling, less expensive and easily available. Increasing awareness of the hazards in use of chemical pesticides and several reported cases of food poisoning has created renewed interest in the use of plant products as grain protectants.

MATERIALS AND METHODS

Survey

Five villages were selected in Rajsamand, Chittorgarh and Udaipur districts of southern Rajasthan for the estimation of losses caused by *C. cephalonica*in different storage structures. Ten farmers were selected randomly from each village. The surveys were conducted during three seasons, November – December, 2010, January-February and June – July, 2011.The average rainfall, temperature and relative humidity of the selected districts were also recorded.

Table 1. Average annual rainfall, temperature and relative humidity in three districts of Southern Zone of Rajasthan.

Districts	Rainfall (mm)		Temperature (^{0}C)		Relative humidity (%)	
	2010	2011	2010	2011	2010	2011
Rajsamand	840	759	32.90	32.10	70.23	77.82
Chittorgarh	793.82	859.90	32.76	31.62	70.35	78.12
Udaipur	875.30	952.20	32.50	31.50	71.40	78.40

Source: KVK Rajsamand, KVK Chittorgarh and Agromet Observatory, Instructional Farm, Rajasthan college of Agriculture, Udaipur.

A sample of 2 Kg of maize grains was collected from ten randomly selected farmers in each village. The samples were mixed thoroughly and then 500g grains were taken from each sample by dividing and sub dividing it. These samples were packed in polythene bags to avoid loss of moisture and were brought to the laboratory for analysis and further studies. The basic information on type of storage structures and varieties were also collected from each farmer. A sub sample of 100g was taken from the representative sample of 500g for further studies. The effect of insect pest infestation on different quantitative and qualitative

parameters were worked out in terms of mean loss in weight, germination (%), protein content and carbohydrate content in maize sample collected from different surveys.

Mean loss in weight: The per cent loss in weight was worked out with the help of following formula (Adams and Schulten, 1978).

$$\text{Per cent loss in weight} = \frac{(UNd) - (DNu)}{U\,(Nd + Nu)} \times 100$$

Where,

U = Weight of undamaged grains,

Nu = Number of undamaged grains,

D = Weight of damaged grains,

Nd = Number of damaged grains.

Germination test: A sample of 100 grains were taken from the representative samples. The samples were placed separately in moist germination paper covered with another sheet of the paper than rolled and kept in polythene bags to prevent moisture loss. There were three replications for each sample, complete randomized design. The observation on germination of seeds was recorded separately for each sample after 6 days. The effect on germination of maize worked out by following formula:

Mean germination loss (%) = No. of germinated seeds / No. of seeds kept for germination

Protein content: Nitrogen content of the grains was stored in different storage structure determined by micro Kjeldhal which was converted into protein content by multiplying with factor of 5.7 (AOAC, 1980).

Carbohydrate content: The amount of total soluble sugars was estimated using anthrone method. Principle of the method is anthrone reaction is the basis of a rapid and convenient method for the determination of hexoses, aldopentoses and hexuronic acids either free or present in polysaccharide. Carbohydrates are dehydrated by conc. H_2SO_4 to form furfural. Furfural condenses with anthrone to form a blue-green coloured complex which is measured colorimetrically at 630 nm. Following reagents were used during estimation of carbohydrate i. e. 80% ethanol, anthrone reagent and standard glucose One hundred milligram powdered sample were ground in pestle and mortar with 5 mL 80% ethanol. The homogenates were placed in sigma-centrifuge plastic tubes and then centrifuged at 10,000 rpm for 10 minutes. The supernatant solution was collected in tubes and used for estimation of soluble sugar. Then the volume was made up to 20 mL with 80% ethanol. From the above 20 mL solution 0.5 ml aliquots of sample were taken. The standards were also prepared by taking 0.2, 0.4, 0.6, 0.8 and 1 mL of the standard glucose solution. '0' served at blank. The volumes were made up to 2 mL in all the tubes including the sample tubes and the blank by adding distilled water. Then 4 ml anthrone reagent was added. After 8 minutes of heating in boiling water bath the samples were cooled and the green to dark green coloured solution was read at 630 nm against blank. The standard curve was drawn by plotting concentration of the standard on the X-axis versus absorbance on the Y-axis. Finally the amount of soluble sugars presented in the sample tube was calculated from the graph.

Ecofriendly management: For ecofriendly management of *C. cephalonica* following grain protectants were used viz., neem leaf powder at 10g/kg seeds, *Annona squamosa* seed powder at 10g/kg seeds, *Annona squamosa* leaf powder at 10g/kg seeds, diatomaceous earth at 15g/kg seeds, fly ash at15g/kg seeds and wood ash at 15g/kg seeds. Grain protectants were dried in shade and powdered in grinder than after passed through 60 mesh size sieves and mixed with 500g of maize grains were taken

in plastic containers for each treatment. Twenty five freshly hatched larvae of *C. cephalonica* were released in each jar. The mouth of containers was covered with muslin cloth and tightened with the help of rubber bands. Observations on larval mortality was recorded at 5 days interval; While, pupal mortality and adult emergence were recorded after pupal formation and adult emergence after completion of pupal period. The

mortality recorded was corrected as by Abbott's (1925) formula:

$$\text{Corrected mortality (\%)} = \frac{\text{Mortality in treatment} - \text{Mortality in control}}{100 - \text{Mortality in control}} \times 100$$

RESULTS AND DISCUSSIONS

Three quantitative survey were conducted on the *C. cephalonica* pest of stored maize during November-December 2010, February-March and June-July, 2011, from different storage structures in Rajsamand, Chittorgarh and Udaipur district of Southern Zone of Rajasthan. Among different surveys the maximum infested grain samples i.e. 8 out of 13 samples (61.53%) were recorded from loose storage during June-July, 2011. Whereas, the minimum infested grain samples i.e. 0.0 out of 19 samples (0.0%) were recorded from metal bin during November-December, 2010 (Table 2). Earlier, Lal and vaidya (2001), Shankar Dass (1977) and Agrawal *et al*. (1981) reported metal bin was found most effective with merely 1.96 per cent infestation. Lal *et al.* (2001) who reported that the maximum losses in stored maize was occurred during rainy season (12.24%) followed by summer (9.85%) and winter season (3.62). They also observed that the local storage structures, like gunny bags and bamboo bins resulted in significantly higher weight losses (11.51and 8.87%) compared to improved structures, like drums and metal bins (7.34 and 6.57%), respectively.

During different surveys quantitative and qualitative losses (weight loss, mean germination per cent, protein content and carbohydrate content) were also observed. The maximum weight loss (7.46%) was recorded from loose storage in Udaipur district during June-July, 2011, and no weight loss was recorded from metal bin in Chittorgarh and Udaipur district during November-December 2010 (Table 3).

Earlier, Gahlawat *et al*. (1993), Malik *et al*. (1994) and Singh and Yadav (1995) reported that grain stored in metal bin carried minimum infestation and resulted in minimum weight loss as compared to traditional storage structure. The maximum germination (78.00%) was recorded in Chittorgarh district during November-December, 2010, Whereas, minimum germination i.e. 62.00 per cent was recorded from loose storage in Udaipur district during June- July, 2011 (Table 3). Earlier, Singh and Yadav (1995) who reported maximum germination 96.00 per cent was recorded in wheat stored in metal bin and minimum 89.00 per cent in room. Similarly, Dhaliwal (1971) recorded 85.00 per cent germination of grains stored in metal bin and 77.00 per cent germination in loose stored wheat. Maximum protein content (8.60%) was recorded from metal bin in Chittorgarh district during November- December, 2010, while, minimum (6.70%) was recorded from loose storage in Chittorgarh district during June-July, 2011 (Table 4). Shankar Dass (1977) who reported a direct correlation between the decrease in protein content and the level of infestation. The maximum and minimum carbohydrate content 72.00 and 66.50 per cent were recorded from metal bin and loose storage in Rajsamand district during November-December, 2010, and June – July, 2011, respectively, (Table 4). Singh *et al*. (1992) who reported that grain stored in traditional store viz., gunny bag and kucchi kothi had higher level of free fatty acid and alcoholic acidity because of higher insect infestation. All the grain protectants were found superior over the control. The larval mortality increased with the increment in the days of release. The maximum larval mortality was 82.21 observed at 40 days after release with neem leaf powder at 10g/kg of seed treatment which was significantly higher to rest of the treatments.

Table 2. Survey of storage structures with respect to infestation of *C. cephalonica in maize* during, 2010- 2011.

Districts	Villages	Infestation of *Corcyra* during November- December				Infestation of *Corcyra* during February-March				Infestation of *Corcyra* during June-July			
		Gunny bags	Metal bin	Kucchi kothi	Loose storage	Gunny bags	Metal bin	Kucchi kothi	Loose storage	Gunny bags	Metal bin	Kucchi kothi	Loose storage
Rajsamand	**Jitawas**	6 (1)	0	2	2	3 (1)	3	3	1 (1)	2 (1)	5 (2)	3 (1)	0
	Badarda	3	2	2 (1)	3	2	4	1	3 (1)	1 (1)	4 (1)	4	1 (1)
	Bhana	2	2	3	3 (1)	2	3	4 (1)	1	2 (2)	3	5 (1)	0
	Kanusa	4	1	3	2	3 (1)	2	3	2 (2)	3 (1)	4	2 (1)	1
	Gawar	4	0	1	5	4	2	2	2 (1)	2 (1)	4 (1)	2	2 (2)
Chittorgarh	**Soniana**	4	1	2	3 (1)	2	3 (1)	3 (1)	2 (1)	2 (1)	2	6 (3)	0
	Morvan	4	2	1	3 (1)	4 (1)	2	4(1)	0	3	4 (1)	3	0
	Budhpura	2	2	1	5 (1)	3	2	3	2 (2)	2 (1)	3	4 (1)	1 (1)
	Arni	4	1	2	3	3	4 (1)	2	1	3 (1)	2	5 (2)	0
	Bansi	5 (1)	1	1	3	4 (1)	2	3 (1)	1	2	6 (2)	2	0
Udaipur	**Bamnia**	3	1	4 (1)	2	2	4 (1)	2	2 (1)	1 (1)	2	5 (2)	2 (1)
	Changeri	2	2	1	5 (1)	3	3	2 (1)	2	3 (2)	3	2 (1)	2
	Ladani	3	1	2	4	2 (1)	4	2	2 (1)	2 (1)	3 (1)	3	2 (1)
	Gadawat	5 (1)	2	1	2	4 (2)	4	1	1 (1)	3 (2)	3 (1)	3 (1)	1 (1)
	Boria	3	1	3	3	3 (1)	2	3 (1)	2	3 (1)	2	4 (1)	1 (1)
Total		**54 (3)**	**19(0.0)**	**29 (2)**	**48 (5)**	**44 (8)**	**44 (3)**	**38 (6)**	**24 (11)**	**34 (16)**	**50 (9)**	**53 (14)**	**13 (8)**
Per cent		**5.56**	**0.00**	**6.90**	**10.42**	**18.18**	**6.81**	**15.79**	**45.83**	**47.06**	**18.00**	**26.42**	**61.53**

Figure in parenthesis shows the number of samples infested by *C. cephalonica*

Table 3. Effect of seasons on weight loss and mean germination per cent in stored maize grain during different surveys in three districts of Southern Rajasthan during 2010-2011.

Districts	Storage structures	Weight loss (%)			Mean germination (%)		
		Surveys			Surveys		
		Nov. Dec.	**Feb.-March**	**June-July**	**Nov. Dec.**	**Feb.-March**	**June-July**
Rajsamand	Gunny bags	0.50	0.90	3.06	74.00	69.00	67.00
	Metal bin	0.20	0.40	0.42	77.00	74.00	72.00
	Kucchi kothi	0.40	0.50	1.92	75.00	70.00	69.00
	Loose storage	0.60	1.40	5.40	71.00	68.00	66.00
	Mean	0.43	0.80	2.70	74.25	70.25	68.50
Chittorgarh	Gunny bags	0.40	1.00	2.04	72.00	70.00	66.00
	Metal bin	0.00	0.30	0.40	78.00	75.00	73.00
	Kucchi kothi	0.00	0.40	1.04	73.00	71.00	70.00
	Loose storage	0.50	1.10	5.30	68.00	68.00	67.00
	Mean	0.23	0.70	2.20	72.75	71.00	69.00
Udaipur	Gunny bags	0.35	1.00	4.42	70.00	68.00	66.00
	Metal bin	0.00	0.40	0.48	78.00	74.00	72.00
	Kucchi kothi	0.20	0.90	1.82	71.00	70.00	67.00
	Loose storage	0.45	1.30	7.46	68.00	67.00	62.00
Mean		0.25	0.90	3.55	71.75	68.25	66.75
S.Em.±		**0.035**	**0.046**	**0.066**	**1.495**	**1.109**	**0.781**
CD (P=0.05)		**0.102**	**0.133**	**0.194**	**4.363**	**3.236**	**2.278**

Table 4. Effect of seasons on mean protein content and carbohydrate content of maize grain stored in different storage structures in three districts of Southern Rajasthan during 2010-2011.

Districts	Storage structures	Protein content (%)			Carbohydrate content (%)		
		Surveys			Surveys		
		Nov.-Dec.	Feb.-March	June-July	Nov.-Dec.	Feb.-March	June-July
Rajsamand	Gunny bags	7.50	7.10	7.00	68.50	67.80	66.60
	Metal bin	8.10	7.80	7.50	72.00	70.00	70.00
	Kucchi kothi	7.90	7.40	7.30	70.50	69.00	68.50
	Loose storage	7.40	6.90	6.80	68.00	67.20	66.50
	Mean	7.73	7.30	7.15	69.75	68.50	67.90
Chittorgarh	Gunny bags	8.10	6.85	6.80	68.00	67.80	67.40
	Metal bin	8.60	7.50	7.40	71.40	69.80	69.60
	Kucchi kothi	8.20	7.00	6.90	68.50	67.80	67.50
	Loose storage	8.10	6.80	6.70	68.20	67.70	67.40
	Mean	8.25	7.04	6.95	69.03	68.28	67.98
Udaipur	Gunny bags	7.80	7.00	6.75	69.00	67.50	67.00
	Metal bin	8.10	7.30	7.25	70.80	69.50	69.30
	Kucchi kothi	7.90	7.00	6.85	69.10	68.00	67.16
	Loose storage	7.60	6.90	6.80	68.30	67.00	66.50
Mean		7.85	7.05	6.91	69.30	68.00	67.49
S.Em.±		**0.188**	**0.184**	**0.143**	**0.586**	**0.423**	**0.465**
C.D. (P=0.05)		**0.549**	**0.537**	**0.418**	**1.710**	**1.235**	**1.357**

Table 5. Relative efficacy of different grain protectants against *Corcyra cephalonica*Stainton.

Treatments	Dose (g/kg.)	Per cent larval mortality at								Pupal mortality (%)	Adult emergence (%)
		5 DAR	10 DAR	15 DAR	20 DAR	25 DAR	30 DAR	35 DAR	40 DAR		
Neem leaf powder	10	49.33	55.13	77.77	77.77	79.46	82.21	82.21	82.21	10.00	6.00
Annona squamosa seed powder	10	44.00	46.57	76.30	76.30	76.32	76.35	76.35	76.35	8.00	13.33
Annona squamosa leaf powder	10	38.67	42.46	66.66	66.66	69.18	70.37	70.37	70.37	6.00	20.67
Diatomaceous earth	15	46.00	49.66	76.30	76.30	77.40	77.78	77.78	77.78	8.00	12.00
Fly ash	15	45.32	48.29	73.33	73.33	74.34	74.81	74.81	74.81	7.00	15.67
Wood ash	15	21.33	21.92	50.45	50.45	51.11	55.55	55.55	55.55	6.67	33.33
Control		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	90.00 (71.57)
S.Em. ±		0.586	0.826	1.078	1.070	1.102	1.149	1.148	1.148	0.520	1.589
C.D. (P=0.05)		1.779	2.505	3.269	3.246	3.343	3.485	3.482	3.482	1.576	4.822

DAR- Days after release

The least larval mortality was recorded in wood ash at 15g /kg seed was 51.11 per cent. Maximum pupal mortality of 10.00 per cent was recorded in neem leaf powder at10g / kg of seed and minimum was 6.00 per cent with custard leaf powder at 10g/ kg seed. The minimum adult emergence i.e. 6.00 per cent was observed with neem leaf powder at 10g/ kg seed and maximum was 33.33 per cent with wood ash at 15g/kg seed. Earlier, Arya and Tiwari (2013) reported that neem leaf powder, jatropha seed powder, mustard oil, cow dung powder, cow dung ash powder and cow urine @ 2% were found superior with less adult emergence, seed damage and weight loss with higher adult mortality, seed germination, vigour index and significance of viability in comparison to other treatments and untreated control. Pathak and Tiwari (2010a) reported that 100 per cent mortality at 3.50% dose level of neem leaf. Veeranki and Reddy (2004) reported that custard apple seed powder, neem leaf, seed kernel powder and inert dusts (attapulgite and palygorskite) as effective treatment. Pathak and Tiwari (2010) observed larvicidal and pupicidal effects of neem seed extract at 0.11% a.i. (Table 5).

REFERENCES

Abbott, W.S. 1925. A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology*, **18**: 265-267.

Adams, J.M. and Schulten, G.G.M. 1978. Loss caused by insects, mites and micro-organisms in post harvest grain loss assessment methods. *American Association of Cereal Chemists, Saint Paul, Minnesota*, U.S.A., 193 **PP**.

Agrawal, R.K., Singh, K.N. and Srivastava, A.K. 1981. Studies on the assessment of storage losses in wheat due to stored grain insect pest in U.P. *Bulletin of Grain Technology*, **19**: 198-200.

Ambedkar, B. 2013. Effect of Extracts of Argemone Mexicana leaves on the Development of *Corcyra Cephalonica*

(Stainton) for the Protection of the Stored Grains. *Indian Journal of Applied Research*, **4**: 20-22.

Anonymous. 2014. Indian Maize Summit, **PP.** 7-11.

AOAC, 1980.Official method of analysis, 18th Edition. Association of official Agricultural chemists, Washington, DC.

Arya, M. and Tiwari, R. 2013. Efficacy of plant and animal origin bioproducts against lesser grain borer, rhyzopertha dominica (fab.) in stored wheat. *International Journal of Recent Scientific Research*, **4**: 649 – 653.

Dass, S. 1977. Survey of insect pest in rural storage structures of Haryana and estimation quantitative and qualitative losses caused by them. Ph.D. thesis submitted to HAU, Hisar.

Dhaliwal, G.S. 1971. Incidence of storage pest in rural areas. *Indian Journal of Entomology*, **39**: 114-116.

Gahalawat, K., Singhal, S. and Singhal, S.K. 1993. Estimation of losses in food grains in different storage structures in rural households of Haryana. *Bulletin of Grain Technology*, **31**: 107-111.

Khan, M.I. and Thakare, H.S. 1997. Effect of selected plant products and entomopathogenic bacteria on development and control of rice moth, *Corcyra cephalonica* Stainton. *Integrated Pest Management in Agriculture* (eds) G.M. Bharad, R.S. Bonde, S.A. Nimbalkar and S.V. Sarode, 291-303 **PP**.

Lal, R. and Vaidya, D.N. 2001. Weight loss in maize grains due to insect infestation in different storage structures. *Insect environment*, **7**: 37-39.

Malik, Y.P., Singh, S.V. and Pandey, N.D. 1994. Assessment of losses under various storage practices in western Uttarpradesh. *Indian Journal of Entomology*, **1**: 21-27.

Pathak, C.S and. Tiwari, S.K. 2010b.Toxicity of neem seed (*Azadirachtaindica* A. Juss, Meliaceae) extract against immature stages of rice-moth, *Corcyra cephalonica* (Staint.) (Lepidoptera: Pyralidae). *Journal of Applied Bioscience*, **36**: 173-177.

Scott, H.G. (1991). Nutrition changes caused by pests in food. In Ecology and Management of Food Industry Pests (J. R. Gorham, ed.), **PP**. 463–467.

Singh, A. and Tiwari, S.K. 2014. Biological Activity of Fenoxycarb, a Juvenile Hormone Analogue on Rice Moth, *Corcyra cephalonica* Staint. (Lepidoptera: Pyralidae). *World Applied Sciences Journal*, **31**: 376-382.

Singh, Dharam. andYadav, T.D. 1995. Studies on the incidence of insect pests, practices and losses in stored wheat in Haryana. *Indian Journal of Entomology*, **57**: 107-115.

Singh, G., Thapar, V.K., Singh, J., Sehgal, V.K. and Paul, S. 1992. Biochemical losses due to insect infestation of stored wheat grains in relation to different kinds of storage structures. *Bulletin of Grain Technology*, **30**: 108-112.

Swaminathan, M. (1977). Effect of insect infestation on weight loss, hygienic condition, acceptability and nutritive value of food grains. *Indian Journal of Nutritional Diet*, **14**: 205–216.

Veeranki, S. and Reddy, K. D. 2004. Evaluation of various products of grain protectants against rice moth in maize. *Journal of Research, ANGRAU*, **32**: 24-33.

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