

## Survival over the winter of *Rhyzopertha dominica* F. (Coleoptera: Bostrichidae) in Hot Spots Caused by Improper Grain Storage Technology: the First Record in the Czech Republic\*

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### Abstract

STEJSKAL V., ZUSKA J., WERNER P., KUČEROVÁ Z. (1999): Survival over the winter of *Rhyzopertha dominica* F. (Coleoptera: Bostrichidae) in hot spots caused by improper grain storage technology: the first record in the Czech Republic. Pl. Protect. Sci., 35: 23–25.

The survival of dense populations of *Rhyzopertha dominica* in stored grain hot spots in the Czech Republic during winter months was documented for the first time. Improper storage of grain causes subsurface hot zones, which seem to provide conditions for pest overwintering and become the source of subsequent cross infestations.

**Key words:** *Rhyzopertha dominica* F. (Coleoptera: Bostrichidae); stored grain technology; low and high temperature; geographical range extension

*Rhyzopertha dominica* (Fabricius 1792), which used to be listed as a quarantine species in the Czech Republic, is one of the most dangerous primary stored-product pests. It has been spreading all over the world by international trade during the last decades. The first record of the occurrence of *R. dominica* in former Czechoslovakia was published by ČERNÝ (1958). He found this beetle in wheat imported from Australia in 1957. Since then, *R. dominica* has been occasionally imported with grain and rice (BARTOŠ & VERNER 1979; STEJSKAL & KUČEROVÁ 1993). As the species is of tropical and subtropical origin it was believed to cause only temporary infestations that sometimes developed from infested imports but inevitably ended during the harsh local winter.

The present study was initiated by the discovery of a grain store heavily infested with *R. dominica* in Central Bohemia in autumn 1995. A later inspection in spring confirmed the existence of an extremely dense population of *R. dominica* at that location. We recognized that such an infestation was of primary importance: The opinion expressed earlier by BARTOŠ and VERNER (1979) that *R. dominica* populations would be unable to overwinter in the Czech Republic has been maintained up to the present, although several observations within the last decade hinted that *R. dominica* may indeed be able to survive local winters.

The aim of this article is to record the first documented survival over the winter of *R. dominica* in the Czech Republic, and show that this species could be a serious pest even in the temperate climatic zone.

### MATERIAL AND METHODS

Our data are not a result of a special study of survival over the winter of *R. dominica*, but rather a by-product of an extensive faunistic research of grain stores in the Czech Republic supported by the Czech Ministry of Agriculture (WERNER *et al.* 1997). The presence of *R. dominica* was detected in wheat stored in large district elevators (concrete vertical silos holding 900 metric tons each, with active aeration) in Central Bohemia. Four bins were sampled on September 25, 1995, and again on April 24, 1996, approximately 14 days after minimum night temperatures exceeded 0 °C. In both cases wheat samples totalling 2.5 kg were taken from 10 points in each bin from the subsurface layers, and by means of a metal conical sampler (STEJSKAL 1996). Another 2.5 kg sample was taken from the outlet of each bin using a stream cup sampler (only in 1996). All samples were sieved and adult beetles counted. According to the information provided by the storekeeper and, independently, by the owner of the elevator, no grain imports had been received during these critical months.

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## RESULTS AND DISCUSSION

The abundance of *R. dominica* in wheat in autumn 1995 and spring 1996 is shown in Table 1. These data confirm the ability of *R. dominica* to produce and maintain continuous, local populations that survive the winter. The ambient winter temperatures (Fig. 1) did not allow any re-infestation and re-colonisation of silo bins from external sources. Instead, the extraordinarily high subsurface grain temperatures (hot spots) found in the infested silos (Table 1) provided an optimal microclimate for pest development, although outdoor temperatures were low enough to avoid infestation of a properly cooled silo. In the infested bins other pests were also present, predominantly Coleoptera: *Sitophilus granarius*, *Oryzaephilus surinamensis*, *Tribolium castaneum*, *Alphitobius diaperinus*, *Latridius minutus*, and *Ahasverus advena*. The multi-species infestation may have had a synergetic effect on the winter population of *R. dominica*.

Problems with high infestations of grain with *R. dominica* were also reported recently as a new phenomenon in Canada (FIELDS *et al.* 1993). The authors proposed three hypotheses to explain the origin of massive infestations by *R. dominica*: (1) introduction of the pest from outside the area, (2) wind transport from other regions, (3) pest establishment in the grain stock, and successful survival over the winter (either as a result of increased cold-resistance, or by utilising high grain temperature). It is known that huge volumes of grain can retain a high temperature throughout winter, and pest organisms can by respiration even further increase grain temperature considerably. Although aeration systems are frequently installed to cool stored grain, they are lacking in many facilities while in others they are inadequate or operated inefficiently (BURRELL & HAVERS 1970).

The Canadian authors were unable to verify or reject any of those hypotheses. Yet our data leave little doubt

that under certain circumstances *R. dominica* is able to overwinter in the Czech Republic, indicating the validity of the last-mentioned hypothesis. As we did not take any measurements of physiological parameters of the population observed, we cannot exclude the existence of some level of cold-tolerance and its impact on survival over the winter abilities. However, an exceptionally high level of cold-tolerance of *R. dominica* is improbable (FIELDS & WHITE 1997).

The mathematical models by SINGH and THORPE (1993) showed that moisture and temperature were lowest at the bottom of a grain bulk, whereas they were highest below the surface of the grain mass. Fungal and/or arthropod activity in these warm and humid grain layers frequently resulted in the development of high temperature zones known as hot spots (SINHA 1961). We suggest that hot spots are the main cause, and the basic ecological resource, for the survival over the winter of *R. dominica* in the Czech Republic and elsewhere in the temperate climatic zone. Our explanation is supported by the presence of hot spots with dense and thriving populations of *R. dominica* in the subsurface vapour-condensation layers of the grain mass, whereas the adult beetles collected within the cool bottom zone of the silo bins were dead (Table 1). The ecology of hot spots was extensively studied by Canadian scientists (SINHA 1961; SINHA & WALLACE 1966), but the fact that hot spots provide an ecological opportunity for tropical and subtropical species to increase their geographical ranges was obviously never suggested in the literature.

During the consequent faunistic research, further occurrences of *R. dominica* in various grain stores in the Czech Republic were documented (e.g. in 1996 *R. dominica* was present in 14.1% of the 64 grain stores tested), which confirmed the preliminary results and the conclusion of this report.

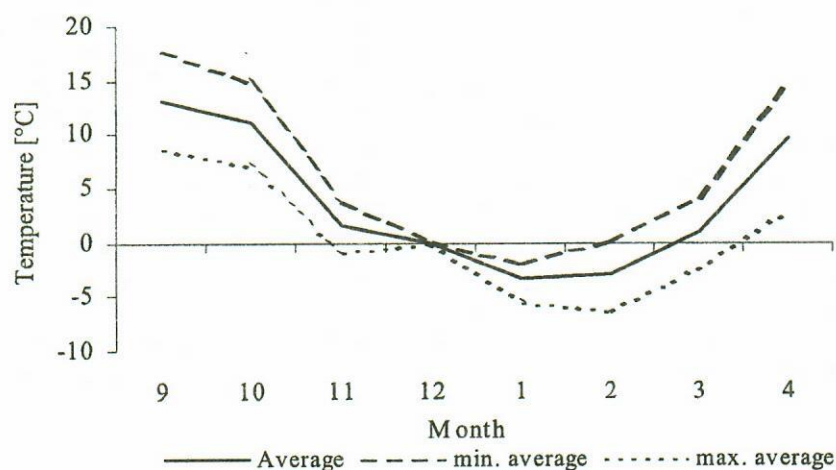


Fig. 1 Temperatures during winter 1995/96 in Central Bohemia



Table 1. Density of *Rhyzopertha dominica* (D – No. of live/dead adults per 2.5 kg sample) and wheat temperature ( $T_{\min-\max}$  [°C]) in infested silos

Year	Sampling site	Bin No.1		Bin No.2		Bin No. 3		Bin No.4	
		D	T	D	T	D	T	D	T
1995	Surface	0/0	16–20	156/32	25–38	28/2	18–36	0/0	16–24
	Bottom	–	–	–	–	–	–	–	–
1996	Surface	105/7	8–38	896/265	39–45	2/130	16–28	0/0	5–20
	Bottom	0/0	4–6	0/41	4–8	0/1	4–8	0/2	4–5

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## Souhrn

STEJSKAL V., ZUSKA J., WERNER P., KUČEROVÁ Z. (1999): První nález přežívání a množení korovníka obilního, *Rhyzopertha dominica* F. (Coleoptera: Bostrichidae), v zimním období v České republice jako důsledek nevhodné technologie skladování obilnin. Pl. Protect. Sci., **35**: 23–25.

Poprvé bylo v České republice zjištěno a zdokumentováno přežívání přemnožených populací korovníka obilního (*Rhyzopertha dominica*) během zimního období v ohniscích záhřevu ve skladovaném obilí. V mnoha případech nedokonalá technologie skladování obilí umožňuje vznik ohnisek záhřevu v podpovrchových vrstvách obilí a pravděpodobně tak vytváří vhodné podmínky k přezimování tohoto teplomilného druhu. Tato ohniska se pak stávají zdrojem dalších infestací. Byl zhodnocen ekologický význam ohnisek záhřevu v obilí jako potenciálního mechanismu pro rozšíření tropických škůdců do mírnějších pásem.

**Klíčová slova:** *Rhyzopertha dominica* F. (Coleoptera: Bostrichidae); technologie skladování obilí; vysoké a nízké teploty; geografické rozšíření

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