DISTRIBUTION OF BEETLES OF THE GENUS *TRIBOLIUM* (COLEOPTERA: TENEBRIONIDAE) IN STORED FOODSTUFFS IN QUEENSLAND.

By N. E. H. CALDWELL, M.Sc.Agr., and A. R. BRIMBLECOMBE, M.Sc., Entomologists, Science Branch, Division of Plant Industry.

During an investigation of stored foodstuff pests in Queensland in 1942 and 1943, two species of the genus *Tribolium*—*T. castaneum* Herbst., the rust red flour beetle, and *T. confusum* J. du V., the confused flour beetle—were commonly encountered. The distribution of these two insects differed to some extent from that in the southern States of Australia, where *T. castaneum* is the more important pest of wheat grain, while *T. confusum* alone occurs in flour mill machinery (Miller, 1944) and predominates in flour (Miller, 1946; Nicholson, 1942).

DISTRIBUTION IN QUEENSLAND.

Both species were present in wheat stored at Queensland flour mills, which are all situated in the southern part of the State, but *T. castaneum* far outnumbered *T. confusum* in the grain samples examined. As would be expected, *T. castaneum* was also more prevalent in the wheat cleaning machinery at the mills. Within the actual milling machinery *T. confusum* was the dominant species. It occurred commonly in the nine mills examined, sometimes in high populations, whereas *T. castaneum* was found only twice in milling machinery and then in very small numbers. Samples of spilled flour and sweepings from the flour storage section of mill premises contained the two species in approximately equal numbers.

Observations in southern Queensland in environments other than flour mill premises, though less extensive than in the north, indicated that both species were quite common in warehouses and depots containing cereals and cereal products. In storage sheds, commercial stores, and other places in tropical Queensland, however, *T. castaneum* was overwhelmingly the more numerous in a wide range of commodities, such as whole grains (wheat, maize, rice and barley), crushed and cracked grains, milled cereal products, nuts and nut meats. Large populations of this species were particularly common in the more finely milled cereal products, such as flour, bran and pollard. Although *T. confusum* was comparatively rare, fairly large populations were occasionally found in flour; of the other products examined, wheat, cracked maize, pollard and oatmeal were sometimes infested.

Interesting differences in the distribution of the two species in white flour from different sources were noted in northern Queensland. Data from a typical series of uniform samples of Queensland-milled flour and from all the samples of New South Wales flour examined are summarized in Table 1.

Table 1.

TRIBOLIUM INFESTATION OF WHITE FLOUR EXAMINED IN NORTHERN QUEENSLAND.

Origin of Flour.	Number of Samples.	T. castaneum.		T. confusum.	
		Number of Samples Infested.	Number of Adults.*	Number of Samples Infested.	Number of Adults.*
Queensland	38	36	1,803	10	65
New South Wales	13	5	59	8	304

* In the case of 6 of the Queensland and 6 of the N.S.W. samples only a portion of the population (about 50 adults) was sorted. The totals given are therefore only approximate.

As population density may be closely related to the period of storage and as the bulks from which the samples were drawn had been stored for varying lengths of time, the figures given in Table 1 for the adult population do not necessarily reflect the degree of initial infestation.

The distribution of the two species of *Tribolium* in foodstuffs in Queensland may be summarized as follows:—

(1) As a general pest of stored food products in Queensland *T. castaneum* is more common than *T. confusum*, especially in the tropical section.

(2) In Queensland, as in the southern States, *T. castaneum* is the dominant species of *Tribolium* in wheat grain.

(3) While in the southern States *T. confusum* is the more important species in both flour milling machinery and flour, in Queensland it is dominant only in the machinery, *T. castaneum* being by far the more prevalent pest of flour milled within the State.

Since *T. castaneum* is so seldom met with in flour mill machinery in Queensland it must be inferred that either the species will not thrive in such an environment or the grain stream is not an important source of the *Tribolium* populations in milling machinery.

The relative scarcity of *T. confusum* in flour stored in the north of the State indicates that contaminated mill machinery is not an important source of *Tribolium* infestation in bagged flour. Direct evidence on this point was provided by examination of 230 samples taken from the flour packers in a mill known to be heavily infested with *T. confusum*. These samples were examined when collected and again after incubation in the laboratory for a period long enough to allow immature stages to develop; not a single specimen of *T. confusum* was recovered.

That climatic factors do not prevent the establishment of the insect in flour and other cereal products in northern Queensland is shown by the thriving nature of the *T. confusum* infestations which do occur and the fact that rapidly-multiplying laboratory colonies have been maintained for many months in that area.

Since the predominating species of *Tribolium* in wheat is identical with that occurring in Queensland-gristed flour stored in the north, it appeared probable that in some way the infestation in the grain is responsible for that in the flour. It is considered that this takes place through the medium of the containers, namely, jute sacks. In Queensland new sacks are used for transporting wheat from farm to mill. Later, after having been passed through mechanical cleaners, they are filled with flour. An examination of recently-cleaned sacks at a Queensland mill showed that all insects, particularly those in the seams, were not removed by the process. These survivors may later infest the flour.

Evidence in support of this view was supplied by examination of flour samples taken from consignments immediately the sacks were filled at the mill and again on arrival at Townsville after a rail journey of several days duration. Results of this examination are given in Table 2.

Table 2.

TRIBOLIUM INFESTATION OF WHITE FLOUR BEFORE AND AFTER TRANSPORT IN CLEANED WHEAT SACKS.

—	Number of Consignments Sampled.	Total Number of Samples.*	T. castaneum.		T. confusum.	
			Number of Samples Infested.	Number of All Stages.	Number of Samples Infested.	Number of All Stages.
Brisbane	6	230	1	1	0	0
Townsville	4	126	20	130	3	6

* Size of samples—8 oz. from first consignment, 4 oz. from succeeding consignments.

After an initial examination the samples were incubated for a period sufficiently long for eggs and very small larvae to reach maturity before a second examination. Risk of contamination before or after the journey was minimized by despatching the flour by rail from Brisbane as soon as practicable after packing and by sampling before unloading at Townsville. It may be assumed that infestation would not be initiated in transit, as examination of numerous railway waggons over a lengthy period revealed no specimens of either species of *Tribolium*.

The presence of *T. confusum* in Queensland-milled flour at odd times may be due to an occasional carry-over of the pest in the sacks or to the accidental contamination of the bagged product from the population in the mill machinery.

The comparative abundance of *T. confusum* in New South Wales flour suggests differences in mill practice which increase the importance of this species.

It is concluded that the occurrence of *T. confusum* and *T. castaneum* in flour in Queensland is determined by the source of initial contamination rather than by the nature of the foodstuff or by climatic or other conditions.

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