Tyroglyphid Mites in Stored Products in New Zealand.

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Summary.

1. An attempt is made to indicate the widespread occurrence of Tyroglyphid-mite infestations in stored products in this country.

2. An outline is given of the New Zealand conditions under which primary products susceptible to Tyroglyphid-mite attack, such as cheese, grain, seed, meal, etc., are handled and stored.

3. Alterations and developments in the methods of classification of the Tyroglyphid mites are traced from the beginning of the present century.

4. Ten cosmopolitan species of Tyroglyphids are recorded as stored-product pests in New Zealand.

5. Significant literature for each of these species is reviewed chronologically.

6. A key has been constructed, based on the modern classification of Zakhvatkin (1941), which includes diagnostic characters for the separation of the principal groups of Tyroglyphids and for the identification of species already recorded in New Zealand.

I. Introduction.

The Tyroglyphid mites are a group of great economic importance, a number of species being common pests of stored products in many different countries. A wide variety of foodstuffs and other substances is susceptible to attack, e.g., cheese, flour, grain, seeds, meals, bulbs, straw, and also wallpaper, furniture, etc. These mites are capable of subsisting on any fragments of organic debris in floor cracks, shelving, etc., are so readily spread by insect and human agencies, and have such wide tolerance to temperature that they are almost invariably to be found in small numbers wherever the above materials are stored. Such factors as the accumulation of debris, prolonged storage of material without cleaning or shifting, insufficient insulation against high temperatures and abnormally high humidity are important contributing factors to the development of serious infestations in stored products.

The Tyroglyphids have been the subject of extensive investigations in Europe, England, and America for many years. Published information up to 1944 on systematics, morphology, biology, ecology and control has been coordinated and summarized by Solomon (1943 and 1944). In the past this group has received little attention in New Zealand, and here published records are scanty. The following papers
constitute the total New Zealand literature on Tyroglyphid mites prior to the commencement of current studies:—

1. Cockayne (1912) recorded a Tyroglyphid species as a New Zealand household pest.

2. Cockayne and Waters (1916) recorded methods for the control of mites in bran and chaff. No specific identifications were given, but the mites were considered to belong to the genus Tyroglyphus.

3. In the New Zealand Dairyman, 20th February, 1918, an article on "Cheese Mites" was reproduced. This, however, did not refer to mite infection of cheese under New Zealand conditions but merely recapitulated the findings of N. B. Eales (1917a and b) in England.

4. Findlay (1921) discussed the medical aspect of cheese mites in New Zealand. Cases of skin irritation and also conjunctivitis had been reported amongst workers handling mite-infested cheese during the 1914–18 war. Findlay stated that the species responsible had been identified as Tyroglyphus longior.

In New Zealand the losses resulting from Tyroglyphid attack assumed great significance during the 1939–45 war period, when this country had to face the possibility of abnormal taxation of existing storage space owing to reduction and irregularity in the shipment of primary products. One of the products most endangered by such conditions was cheese. Cool storage space for cheese in this country was limited and priority had to be given to butter. Hence any accumulation of cheese due to shipping delays would have necessitated the use of temporary stores without temperature control. Under such conditions mite infestations caused serious losses in the 1914–18 war. Accordingly, in 1942 an investigation was undertaken by the Entomology Division, Plant Research Bureau, in association with the New Zealand Dairy Research Institute, to develop methods that could be applied immediately for the protection of cheese against mite attack in the event of temporary stores having to be utilized.

J. Muggeridge, Entomology Division, and R. M. Dolby, Dairy Research Institute, have covered the application of chemical and mechanical control measures against mites attacking cheese. They have published a preliminary paper (1943) on the use of dichlorofluoromethyl ether as an acaricide and a further and more detailed paper is being prepared. As a background to this work, the writer has been concerned particularly with fundamental studies on certain aspects of the biology and systematics of the mite species that are pests of cheese in this country. These studies have involved surveys of cheese factories and bulk cool stores, carried out to determine the incidence, relative abundance and distribution of the species concerned. Incidental to the cheese-mite surveys, some observations on the mite infestation of other stored products such as flour, grain, etc., have been made. Survey investigations have shown that mite infection, to a greater or less extent, is in all cases associated with both the production and storage of cheese throughout New Zealand, while it is an important factor in the deterioration of many other stored products.
The following outline of storage conditions in New Zealand in relation to mite contamination is based on general observations made during surveys carried out in 1942, 1943, and 1944. This is presented in association with a systematic account of the mite species recorded. Detailed systematic study has been found necessary to establish the identity and relationships of these economic species, in view of the confusion existing in the general classification of the Tyroglyphid mites, and the numerous variations in nomenclature occurring in the literature of the current century.

II. NEW ZEALAND STORAGE CONDITIONS ASSOCIATED WITH TYROGLYPHID INFESTATIONS.

Grain and Produce Stores.

There is no uniformity in the construction of wholesale or retail stores for grain and produce in this country. Walls are most generally wooden, although other building materials, such as concrete, are frequently used, while iron roofing is most common. Flooring may be of wood or concrete. Up to the present the writer has not seen any grain or produce store in which provision has been made for temperature control or air conditioning. Usually there is no special insulation against outside temperature fluctuations, so that temperatures may fall low in winter and become very high in summer. Many stores are so constructed that it would be difficult to seal them satisfactorily for fumigation. At present, when many of the old New Zealand stores have passed their period of usefulness and new stores are being erected, an excellent opportunity is offered to incorporate modern ideas for the safe and hygienic storage of grain and produce.

Tyroglyphid-mite infestations are most common in grain and general produce during the summer and early autumn. They develop particularly in material held in storage for long periods and neglected. Frequently mite infection has been observed in broken or half-used bags of grain, etc., which may have been spoiled by rats or mice or attacked by insect pests. Instead of being destroyed, these are often placed aside in a neglected corner where they become a constant source of infection for fresh material being brought into the store. Flour, bran, and pearl barley are products which have been found to be most readily attacked by Tyroglyphids. Infestations have also been recorded in wheat, unhusked barley, cruciferous seed, linseed, linseed meal, oatmeal, and different types of dairy meal.

If mite infestations in grain and produce are allowed to develop unchecked they are sometimes responsible for serious economic losses. Foodstuffs particularly, if badly contaminated by mites, become unusable and have to be destroyed. The chemical control of mites by fumigants, etc., is frequently necessary, but much can be done by efficient store management to reduce the risk of serious infestations. Material which is damaged or infested by insects should be destroyed or otherwise disposed of as soon as possible. It should not be retained as a source of infection. Floors should be kept clean and free from an accumulation of organic debris. Stored material should be turned frequently, and every effort should be made to ensure satisfactory ventilation in order to reduce humidity.
Cheese Factory Curing Rooms.

The present investigation has been concerned chiefly with the infestation of cheese by Tyroglyphid mites. It has been found that mite infection is general in factory curing rooms, where all cheese is held for at least two to three weeks after making.

The majority of New Zealand curing rooms are constructed on a somewhat similar plan. The room is rectangular in shape, dimensions ranging from 30 to 40 ft. in width by 50 to 100 ft. in length. The walls may be concrete or wooden, with or without insulation. Slatted windows or ventilators are inserted in outside walls, although in some cases they are few in number. Double windows may be used for increased insulation. Floors are generally of concrete. Cheeses are placed on tiers of wooden shelves built at right angles to the outside walls. Wooden uprights run from floor to ceiling, with cross supports on which rest the movable shelves (see Fig. 2). One end of the curing room is left free from shelving, and here cheeses are weighed and erated prior to leaving the factory.

In only a few cases have curing rooms been built in this country with plant installed for the complete control of temperature and humidity. In these cases the temperature is generally held at 50°–55° F., although as low as 45° F. may be used for curing, with relative humidities of 80–85 per cent. Some older curing rooms have no insulation and no temperature or humidity control. Here daily temperature fluctuations may cover a range of 8°–10° F., with correspondingly wide variations in humidity. Seasonal temperatures may vary from a mean 45°–50° F. in winter to 65°–70° F. in summer. The majority of New Zealand factories, however, have been constructed with a view to maintaining reasonably uniform temperatures and humidities in the curing rooms. Walls are generally well insulated, and a steam-pipe heating system provides for the raising of winter temperatures. Adjustment of ventilators facilitates the reduction of summer temperatures and of the high humidities produced by evaporation from new cheeses. Fans may be utilized for air circulation. Fig. 1 shows the

![Graph](image-url)

**Fig. 1.**—Mean weekly maximum, mean and minimum temperature, and relative humidity in a South Island cheese factory curing room, March-November, 1944.
temperature and humidity conditions in a South Island curing room of the latter type. Daily temperature variations are of only 2°–4° F., while the winter and summer range of means rises from 50° to 60° F.

In New Zealand only small quantities of fancy types of cheese are made for local sale, but the demand for these is negligible. Throughout the country the manufacture of Cheddar cheese is concentrated on both for export and local sale, so that the question of the susceptibility of different types of cheese to mite attack does not arise. This is in contrast to conditions in England, where many cheese types are produced. Here, for example, Cranfield, Roebuck and Stafford (1934) have stated that Stilton and Wensleydale cheeses are more susceptible than Cheddars and Cheshire cheeses, while Eales (1917a) noted that Stiltons are the cheeses most affected by mite attack.

Only 80 lb. cheeses are produced for export. During the cheese-making season, from August to April or May, each day’s export cheeses are brought to the curing room shelves, where they are held for from two to three weeks. They are turned daily to ensure uniform evaporation, a practice which must incidentally be of some value as a deterrent against the establishment of mite colonies. At the end of the initial curing period cheeses are crated (see Fig. 3) and dispatched from the factory to the cool store. Examination of the shelves on which export cheeses are held at the factory has shown them to be covered by actively breeding mites, so that it is inevitable that some at least are carried forward to the cool store.

At least a portion of the output of many factories is sold on the local market. Either medium (45 lb.) or loaf (10 lb.) cheeses are made, and are matured in the curing room, generally for from three to four months. In the past few years processed cheese has become increasingly popular, and large quantities have been utilized for the Armed Forces. A proportion of well-matured cheese is required for the processed product, and this has to be held for from six to nine months. It is stored either in factory curing rooms or in curing rooms attached to processing plants. Cheese for local sale and for processing always becomes mite-infested to a greater or less extent.

Each season in the majority of factories a certain number of cheeses have to be rejected for export, either on account of injury or inferior quality resulting from starter failure in the vats. It is the practice to place reject cheeses aside in one corner of the curing room, where in some cases they may be left undisturbed for twelve months or more. They are retained in the factories and allowed to mature in order to be disposed of on the local market or sold to the suppliers. Such cheeses invariably become heavily infested with mitas (see Figs. 4 and 5).

For about two months in the winter, between cheese-making seasons, no export cheeses are held in curing rooms. As much local-sell cheese as possible is also disposed of, to enable curing rooms to receive their annual cleaning. In most cases all shelves are removed, scraped and scrubbed with caustic. Shelves may also be dusted with sulphur before new cheeses are placed on them. For many years sulphur has been either burnt in curing rooms or dusted on shelves to combat the development of mould. It has been considered to be of
value against mite infection, but there is little evidence to substantiate this.

In the large number of New Zealand cheese factories examined during the present investigation mite infestations have always been found to be present in some section of the curing room. This has been so at all seasons of the year, including the period immediately following the annual cleaning. From observations made during the present investigation and confirmed by overseas publications on the biology of Tyroglyphid mites, it is apparent that cheese is cured in this country under conditions highly favourable to the propagation of constant mite infection. The following points in particular have been noted as being conducive to the development of infestations:

1. Lighting in curing rooms is dim, a factor which Eales (1917) has shown favours the increase of Tyroglyphid mites.

2. Cracks in wooden shelving and in the supporting uprights invariably harbour mites and many of these cannot be removed by present cleaning methods.

3. Temperature and humidity conditions are ideal. Indeed, Dustan (1937b) stated "The experience of cheese-men both in Canada and the United States, and tests made by the writer, show that to cheese stored at 32° to 35° F. there is practically no noticeable damage done by the mites. This is because they are dormant or nearly dormant at these temperatures. From 35° to 40° F. there is some development but it is slow and usually cheese can be stored at these temperatures for several months with comparative safety. Above 40° the mites become more active and injurious and at 50° to 60° F. they are very active and do great damage." As noted earlier, cheese is generally cured in New Zealand at temperatures between 50° and 60° F. or higher, even when temperature control apparatus is installed.

4. The holding of reject cheese for long periods in curing rooms is probably the most important single factor responsible for constant mite infection.

It is obvious that Tyroglyphid infestations on both export and locally-sold cheese originate in the factory. There is little hope of eliminating or even reducing infection until more stringent control measures are introduced in the curing room. The practice of storing reject cheese for long periods should be discontinued, and the annual cleaning should be more drastic. In particular, the curing room should be fumigated when it is empty, and the supporting framework, in addition to shelving, should be scrubbed with strong disinfectant.

Bulk Cool Stores.

Crated export cheeses are transported directly from the factories to bulk cool stores to await shipment overseas. Cool stores have been expressly constructed for the storage of primary produce at low temperatures. Walls are heavily insulated, and buildings are divided into a series of compartments for different types of produce. Modern plant for complete temperature control is installed throughout. A constant check is kept on the storage temperature of each compartment, so that any divergences may be adjusted immediately. Cheese is held in cool storage at temperatures between 40° and 50° F., 45° F. being the average temperature maintained.
Crated cheese is piled in cool-store compartments and may be left undisturbed for lengthy periods, depending on available shipping space. Little evidence has been obtained of any marked increase in mite infection on export cheese in cool storage. Mite infestations, however, have been recorded where consignments have been held for an extended period, e.g., up to one year. The species complex involved in these infestations has been found to be different from that recorded in factory curing rooms. In the latter, Tyrophagus casei and Tyrophagus longior are responsible for damage to cheese, whereas in cool stores Tyrophagus fariniae, Glycyphagus domesticus, G. destructor and, in a minor degree, Tyrophagus longior are involved. It is probable that these further species are secondary on the mould which commonly develops under cool-store conditions.

Mite infection is not a problem on export cheese held in cool stores. It is probable, however, that some mites are carried from the factories, and cool-store treatment is not sufficiently drastic to kill them. Development is merely retarded, so that, though damage remains negligible in stores, the infection is sufficient to give rise to major infestations under favourable temperatures.

III. Classification of the Tyroglyphid Mites.*

The classification of this group of mites has been in considerable confusion during the present century. Michael (1901, 1903) published a detailed account of the British species in which he regarded all species as belonging to the single family Tyroglyphididae. This he divided into three subfamilies (see Table 1), clearly separated by the structure of the ambulaera and mandibles.

Table I.—Classification of the family Tyroglyphidae according to Michael, 1901. Tyroglyphidae

<table>
<thead>
<tr>
<th>Tyroglyphinae</th>
<th>Lentungulinae</th>
<th>Histiostominae</th>
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<tbody>
<tr>
<td>Histogastr</td>
<td>Lentungula</td>
<td>Histiostoma</td>
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<tr>
<td>Acerobius</td>
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<tr>
<td>Tyroglyphus</td>
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<td>Rhizoglyphus</td>
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<td>Saprogluphus</td>
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<td>Fusacarus</td>
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<td>Chortoglyphus</td>
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<td>Glycyphagus</td>
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<td>Hericia</td>
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<tr>
<td>Carpglyphus</td>
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<tr>
<td>Trichotarsus</td>
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<tr>
<td>Maeria</td>
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</table>

In Michael's classification all the genera of the now widely-known stored-product mites fell in the single subfamily Tyroglyphinae. Michael's descriptions and observations have continued to stand as the basis for modern studies of the Tyroglyphids, although, with more extensive knowledge of the group, his method of classification has had to be superseded.

In 1906 Oudemans divided a large section of the Acarina broadly into three groups as follows: Diacrotricha (with 2 vertical hairs), Monacrotricha (with 1 median vertical hair) and Anacrotricha (with-

* Subsequent to going to press, a discussion of this subject has been published in a paper by H. H. J. Neshitt (see Canad. J. Res., 23, 139-188).
Table II.—Classification of Group Diacrotricha according to Vitzthum, 1929.

**Diacrotricha**

- **Caelenshrinidae**
  - *Caenethra*
- **Anoetidae**
  - *Anoetus*
- **Dermoglyphidae**
  - *Lentuchuanidae*
    - *Lentuchuanida*
  - *Falculigeridae*
    - *Syringobriidae*
- **Ensliniellidae**
  - *Ensliniella*
- **Tyroglyphidae**
  - *Hystognates*
    - *Tyroglyphus (Aeurobius Mich.)
  - *Caloglyphus*
- **Rhizophgyidae**
  - *Rhizophyus Schevnea*
- **Winterschmidtidae**
  - *Winterschmidtia*
- **Nanacridae**
  - *Nanacris*
- **Chortoglyphidae**
  - *Pusacris*
  - *Chortoglyphus*
- **Carpoglyphidae**
  - *Carpoglyphus*
  - *Calozola*
  - *Faucellinia*
  - *P. ocrea*

**Not generally included in Tyroglyphidae (s.l.)**
out vertical hairs). It should be noted that Oudemans only regarded as vertical hairs those placed immediately behind the gnathosoma (Fig. 6), towards, or on, the mid-dorsal line of the propodosoma (see \( v_1 \) in Fig. 8 and \( v_1 \) in Fig. 9).

Under this method of subdivision, the major portion of the Group Diacrotrecha was made up by the family Tyroglyphidae of Michael, but with the addition of mite species parasitic on insects, on and in the skin and fur of mammals and the feathers of birds. Oudemans placed the latter in the families Canestriniidae, Listrophoridae, Acaridae, Analgesidae, Dermoglyphidae, Falculigeridae and Syringobiidae. These differ so markedly from the Tyroglyphidae (s.l.) both in structure and habits, that their inclusion in the same group did little towards producing a natural system of classification of the Acarina. Oudemans, however, recorded and described many new species and groups of species allied to the earlier known family Tyroglyphidae. Unfortunately, in doing so, he created an excessively large number of new families. Nevertheless, his work stands at the present time as perhaps the most extensive current contribution to knowledge of the group. Many of the families he created were separated on characters which do not appear sufficiently distinctive to warrant their being given this status. However, later work has demonstrated that Oudemans’ families can be incorporated satisfactorily in the classification of the Tyroglyphids in groups of lower status.

Oudemans’ subdivisions were followed by Vitzthum (1929) and a number of other workers, and resulted in the development of a highly complex system of classification. (See Table II.)

Recently Zakhvatkin (1941) has published a complete revision of the Tyroglyphid mites, which he has placed in the single superfamily Tyroglyphoidea. This he has divided into three families, namely Tyroglyphidae, Saproglyphidae and Glycyphagidae (see Table III). Genera of Oudemans’ families Tyroglyphidae, Tyrophagidae and Rhizoglyphidae have been placed together in the family Tyroglyphidae, grouped in related subfamilies and tribes. The family Saproglyphidae has been extended to include genera from Oudemans’ Winterschmidtiiidae, Ensliniellidae, Nanacaridae, etc. Oudemans’ families Carpoglyphidae, Chortoglyphidae, etc., have been reduced to subfamilies of Glycyphagidae, while parasitic mites of the families Canestriniidae, Dermoglyphidae, Falculigeridae, Syringobiidae, Analgesidae, Acaridae, Listrophoridae, have been excluded from the Tyroglyphoidea.

Solomon (1943) says of Zakhvatkin’s revision: “This outstanding work at last fulfills the need for a unified and complete system for the classification and identification of the known species.” Zakhvatkin’s system has been followed herein.

IV. Tyroglyphid Species Recorded in New Zealand.

The following Tyroglyphid species, which have been recorded from a number of stored products in New Zealand during the present investigation, have been listed according to Zakhvatkin’s classification. The nomenclature of these cosmopolitan species has undergone a number of changes, due largely to the insufficiency of early descriptions. Therefore, a chronological review of relevant systematic
TABLE III.—Classification of Tyroglyphoid Mites according to Zakhvatkin, 1941.

TYROGLYPHOIDEA

TYROGLYPHIDAE

HIZOGLYPHIDAE
Caloglyphus
Acatylopus
Heteroglyphus
Rhizoglyphus
Hislopaster
Scheibes
Monieriella
Thyroaglyphus
Lueckerbeaer g.n.
Robinisca g.n.
Treuenburs g.n.
Schulzea g.n.

SAPHROGLYPHIDAE
Potopipedium
Saprophagus
Winterischmittia
Calcina
Enstintella
Neaucaeus
Vidu

GLYCYPHAGIDAE

CHORTOGYPHIDAE
Chortoglyphus
Blomiad

GLYCYPHAGINAE
Glycophagus
Comelacarus

AEROGLYPHIDAE
Aeroglyphus g.n.

CETEGYPHIDAE
Ctenoglyphus
Nycteroglyphus g.n.
Diamonoglyphus g.n.

LABIOGRAPHIDAE
Xenacanthus g.n.
Labidophorus
Gobius g.n.
Xenoryctes g.n.
Oxytactenus g.n.
Talpacaru g.n.
Pomacurus g.n.
Myracerus g.n.

CARPOGLYPHIDAE
Henderson
Carposidus
Heraclea

CHAETODACTYLIDAE
Neumastia
Chaetodactylus
Horastia
Tolonta
Neoherastia g.n.
Ceroaphagus
Ceroaphagus g.n.
Nenniellonius g.n.
literature of the present century has been included for each species. Literature for the previous two centuries has been covered by Michael (1901–03), and his findings have been summarized for earlier-described species.

Fam. TYROGLYPHIDAE.
Subfam. TYROGLYPHINAE.
Tribe TYROGLYPHINI

1. *Tyroglyphus farinae* (L.). (Figs. 10, 11.)

**Historical.**

1903. Michael, on pp. 71–79, described this species under the name *Aleurobius farinae* Koch. He referred the genus *Aleurobius* to Canestrini 1888, and considered that the distinction of the genus from *Tyrophagus* Latreille 1796 was sufficient to justify its retention. Michael considered that the descriptions of *Acarus farinae* by Linnaeus, 1758, and by de Geer, 1778, were not sufficient for specific identification, and that the species could not be said to be defined until 1841, when it was described by Koch.

1906. Rainbow referred to the species in Australia under the name *Aleurobius farinae*, which he ascribed to de Geer.

1918. Newstead and Duvall described the species as *Aleurobius farinae* de Geer, and this was repeated by Newstead and Morris in 1920.

1924. Oudemans, on p. 249, used the generic name *Tyroglyphus*, which he referred back to Latreille 1795. He divided this genus into six subgenera, of which one was the subgenus *Tyroglyphus* Latr. 1795, type *farinae* Linnaeus 1758. Later, on pp. 305–7, four of these subgenera, including the subgenus *Tyroglyphus* Latr., were raised to generic rank.

1929. Vitzthum, p. 73, followed Oudemans in referring to the species under the name *Tyroglyphus farinae* Linnaeus.

1936. Jary adhered to Michael’s designation of the species as *Aleurobius farinae* Koch.

1936. Zakhvatkin reverted to the generic name *Tyroglyphus*, but ascribed the species to de Geer.

1941. In his revision of the Tyroglyphoidea, Zakhvatkin followed Oudemans, Vitzthum, etc., in referring the species *Tyroglyphus farinae* back to Linnaeus 1758.

**New Zealand Distribution and Habitat.**

Recent records of *Tyroglyphus farinae* (L.) in New Zealand have been obtained from a number of localities extending from Auckland to Dunedin, and the species appears to be generally distributed throughout the country. Stored products attacked include cruciferous seed, cheese in cool storage, processed cheese at room temperature, vells, ergot, linen flax seed, pearl barley, unhusked barley, flour, dairy meal, linseed meal, bran, Vimax, Oatina, wheat.

Tribe TYROPHAGINI.

2. *Tyrolichus casei* (Ouds.). (Figs. 12, 13.)

**Historical.**

1903. Michael, pp. 117–123, described the species under the name *Tyroglyphus siro* (Linnaeus). He considered that the species was defined by Gervais 1844, who for the first time separated *T. siro* from *T. longior* (see later) and also kept it apart from
Acarus farinae. Michael stated that T. siro could be separated from T. longior by its shorter, unpunctated body hairs, the presence of two or more spines at the distal end of the tarsus, its shorter legs, especially tarsi, and by the fact that its movements were much more sluggish than those of T. longior.

1910. Oudemans, on p. 74, proposed the specific name casei for siro, while still including the species in the genus Tyroglyphus.

1920. Newstead and Morris pointed out that the characters given by Michael for the separation of siro from T. longior did not seem to be entirely satisfactory. They stated: "In specimens of T. siro from the collections of the Liverpool University, identified by Michael, some, at least, of the body hairs are punctated like those of T. longior. Both species also have spines at the distal end of the tarsi, and such spines are shown by Canestrini (1888) to be present in T. longior. Among a number of specimens of T. longior from the collection of A. Berlese, some have the typically long tarsus, others a relatively short one as in T. siro."

1924. In his subdivisions of the genus Tyroglyphus, Oudemans proposed the new subgenus Tyrolichus for the type casei Oudem. 1910. Later in the same year he revised the subdivisions of this section of the Tyroglyphids, raising Tyrolichus to generic status. The following characters, which Oudemans used for the separation of this genus from Tyrophagus, in which he placed the species longior, were more satisfactory than those of earlier workers:

<table>
<thead>
<tr>
<th>Tyrolichus</th>
<th>Tyrophagus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propodosoma. (Fig. 6) with transverse row of 4 hairs almost equal in length.</td>
<td>Inner pair of transverse row longer.</td>
</tr>
<tr>
<td>Hysterosoma (Fig. 6) with 1 pair of short bristles, moreover with longer hairs.</td>
<td>Hysterosoma with 2 pairs of short bristles, moreover with longer hairs.</td>
</tr>
<tr>
<td>Tarsi dorsistally with little spine, ventriderstally with 3-5 spines.</td>
<td>Tarsi dorsistally without spine, ventriderstally with 3-5 spines.</td>
</tr>
</tbody>
</table>

Oudemans did not define those pairs of dorsal hairs on the hysterosoma in each genus which are represented by short bristles, but it is obvious that the single pair in Tyrolichus is d₁ of Zakhvatkin, and the two pairs in Tyrophagus are d₁, and l₁ (see Fig. 8).

1929. Vitzthum referred to the species as Tyrolichus casei (Ouds.) and followed Oudemans in the diagnostic characters which he used.

1937b. Jary reverted to the name Tyroglyphus siro L. (Gerv.) as used by Michael, and did not refer to Oudemans' and Vitzthum's work on the species. Nevertheless, he cleared the confusion which had arisen in the separation of the species from Tyrophagus (Tyroglyphus) longior. Jary's conclusions on the significance of Michael's characters were as follows:

Pectination of Hairs: The presence or absence of pectination is only of importance on hairs at the posterior end of the body,
these being sparsely and minutely pectinate in *T. longior* but not pectinate in *T. siro*.

**Spines on Tarsi:** This character is probably of little value. Spines are certainly present in *T. siro*, but can also be found in *T. longior*, though they are less well defined.

**Length of Tarsi:** Although Michael is correct in his comparison of the lengths of the tarsi in the two species, this by itself is not a sufficiently definite character for diagnosis.

Jary pointed out that the development of the body hair VI (la of Zakhvatkin, see Fig. 8) is the most important character for separation of the two species. He stated "In *T. longior* this hair is short, fine and not very conspicuous, whereas in *T. siro* it is developed to approximately the same length as the other long posterior hair" (f hairs). He suggested that, for diagnostic purposes, it is sufficient to note the length of hair VI, using other characters (such as those of Michael) only for confirmation.

1941. Zakhvatkin described the species as *Tyrolichus casei* (Ouds.), using certain of the diagnostic characters described by Oudemans, Jary, etc.

**New Zealand Distribution and Habitat.**

This species is second only to *Tyrophagus longior* in its importance as a pest of cheese in New Zealand. It has been recorded from cheese in factory curing rooms throughout the country, and in a number of cases has been found to be the sole species responsible for very severe infestations. *Tyrolichus casei* has not been recorded in pest proportions from any stored product except cheese. In only one instance a few specimens were recovered from ealf meal infested principally by *Tyroglyphus farinae*.

3. *Tyrolichus* sp. ? lini (Ouds.). (Figs. 14, 15.)

**Historical.**

1924. On p. 307, Oudemans included the new genus *Tyroborus*, type *Tyroborus lini* n.sp., in his key to the genera of Tyrophagidae. The following is a translation of Oudemans' description of *T. lini*, given on p. 325:

"*Tyroborus lini* nov. sp. Mas. Length 365 μ, width 180 μ, thus sturdily built. Dividing line at ½ of its length. Hairs smooth, except the distal half of the vertical hairs, of the cervical hairs, and of the outside pair of the propodosomatal transverse row. Cervical hairs are not covered with such dense hair as in the case of *Tyrolichus* and *Tyrophagus*; further, they are stiffer, straighter. Pseudostigmatic organs are noticeably large, and beautifully feather-shaped. The shield is greater in length than width, nearly pentagonal; its front edge passes through the basal rings of the vertical hairs; its rear edge (2 edges of the pentagon) is wave-shaped; the rear vertex just reaches the transverse row. The mandibles, seen from above, are curved, so that they bulge outward in the middle, and are longer than the maxillae. The tarsi are shorter than the preceding two segments taken together. Tarsus IV has one sucker in the middle of the proximal half, and one in the middle of the distal half. Ventral—
Maxillae median and more deeply incised in \( \omega \)-shape than the above-mentioned genera. Tarsi distally with 3 spines. In old linseed; I found only one \( \delta \).

1929. Vitzthum referred to the species as *Tyroborus lini* Oud., using Oudemans' key characters for the identification of the genus.

1941. Zakharovkin redescribed the species *T. lini* (Oud.) on p. 98 in the Russian section of his revision, placing it in the genus *Tyrolichus*. He included diagnostic characters for the species on p. 418 of the summary in French.

I have found only European references to this species, and the New Zealand material cannot be referred to it with certainty.

On comparison with Oudemans' original description, the New Zealand species has been found to agree in all but the structure of the pseudostigmatic organ in the males. In New Zealand specimens examined, this hair has been small and difficult to distinguish.

**New Zealand Distribution and Habitat.**

This species has been recorded on only one occasion, in the Nelson District, when it was recovered in large numbers from old linseed earlier infested by *Tyroglyphus farinae*.

4. *Tyrophagus longior* (Gerv.). (Figs. 16, 17.)

**Historical.**

1903. Michael, on pp. 123–131, gave a description of this species under the name of *Tyroglyphus longior* Gerv.

1912. Cockayne recorded *Tyroglyphus longior* as a household pest in Dunedin. The specific identification may be open to some doubt, as the author stated, "It is difficult for anyone except a specialist in the Acarina to name these minute animals specifically with any degree of accuracy, but the Dunedin specimens appear to answer to the description of *Tyroglyphus longior*.''

1916. Cockayne and Waters outlined methods of control against a Tyroglyphid species which they called "The Chaff-Mite", and which they considered to be *Tyroglyphus longior*. The species was recorded in Wellington in enormous numbers from stored bran and chaff, and to a lesser extent from hay and oats. N.B.—From the materials attacked it appears possible that the species *Tyroglyphus farinae* may have been at least partially responsible for the infestation.

1921. Findlay referred to *Tyroglyphus longior* as causing cheese mite itch and conjunctivitis amongst store workers in New Zealand during the 1914–18 war.

1924. Oudemans proposed the new subgenus *Tyrophagus*, type *Acarus putrescentiae* Schr. 1781, as a subdivision of the genus *Tyroglyphus*. Under this subgenus he included the species *dimidiatus* Herm. 1804, for which he stated *longior* Gerv. 1844 to be a synonym. Later Oudemans treated *Tyrophagus* as a genus of the new family Tyrophagidae.

1929. Vitzthum referred to the species as *Tyrophagus dimidiatius* Herm., listing the typical form and three other varieties according to the habitat.

1936. Zakharovkin used the generic name *Tyrophagus*, but adopted the specific name *putrescentiae* Schrank, considering both *Tyro-
glyphus longior Gerv. and Tyrophagus dimidiatus Herm. to be synonyms.

1937. Jary and Stapley reverted to the earlier generic name of Tyro-
glyphus, describing the species as T. dimidiatus Herm. (longior
Gerv.).

1937a. In Jary’s note on the variety castellani (Hirst) of T. longior,
found originally in copra fibre, he elaborated the characters by
which it could be distinguished from the typical T. longior.

1940. Zakhvatkin concluded that the species Tyrophagus putrescentiae
Schr. was unrecognisable and changed the specific name back to
longior Gerv. He considered that T. dimidiatus Herm. was
referred to species of the group of T. numerosus Oudem.

1941. In his revision of the Tyroglyphoidea Zakhvatkin redescribed
the species on p. 109, listing it as Tyrophagus longior (Gerv.).

Morphological Note.

It has been observed that, while in New Zealand specimens of the
arrangement of hairs at the caudal end of the body agrees with that
described by Jary (1937a) for the typical T. longior, at the same time
the comparative elongation of the dorsal hairs, d1 and d2 (Zakhvat-
kin’s terminology), associated with the variety castellani is apparent.
Zakhvatkin uses the comparative lengths of d1 and d2 as a
character separating T. longior from other species of the genus Tyro-
phagus. According to his key, the New Zealand species is not longior,
but all his separation characters are so indistinct that the generally
accepted specific name of longior has been retained.

New Zealand Distribution and Habitat.

This species is the most common cheese pest recorded in New
Zealand. It has been found on cheese throughout the country, serious
infestations having been observed as early as one month after making.
T. longior causes the greatest damage to cheese held at normal atmos-
pheric temperatures either in factory curing rooms or stores. It has,
however, been recorded also from cheese in cool storage. The species
attacks many different substances in addition to cheese, having been
obtained in this country from stored wool, dead insects, fungal cul-
tures and food substances such as tomato relish and cake. Instances
of skin itch amongst workers handling stored wool infested by T.
longior have occurred during 1945.

Subfam. RHIZOGLYPHINAE.

5. Rhizoglyphus echinopus (F. and R.). (Figs. 18, 19.)

Note: Although it may not be regarded as primarily a stored-
product pest, R. echinopus, the bulb mite, has been included in this
record as being one of the best-known Tyroglyphid species in New
Zealand.

Historical.

1903. Michael, pp. 84–96, described the species as Rhizoglyphus
echinopus, and attributed it to Fumouze and Robin 1868, who
placed it in the genus Tyroglyphus. In his synonymy Michael
recorded the name Acarus hyacinthi Boisduval 1867, but stated
"This is practically a nomen nudum, and cannot be followed;
it is only the habitat which makes it probable that it may be the
present species." He listed the generic name as being changed
from *Tyroglyphus* to *Rhizoglyphus* by Murray in 1877 and to *Coepophagus* by Méglin in 1880. The latter genus has received little recognition in more recent literature. Michael mentioned several specific names as synonyms of *echinopus*, the best-known of these being *spinitarsus* Can. 1888. Michael considered *R. echinopus* to be a most destructive pest of bulbs. From his observations he concluded that, while the species will live on decaying bulbs, it shows a preference for sound ones.

1906. Banks considered the American species to be identical with the *R. echinopus* of Michael, but referred it to *Rhizoglyphus hyacinthi* Boisd. He repeated this in 1907.

1911. Windle investigated the question of whether the bulb mite, which he called *Rhizoglyphus hyacinthi* Boisd., causes direct injury to bulbs or is secondary. He concluded that it is a primary cause of injury.

1928. Hodson published an economic paper designating the species as *Rhizoglyphus echinopus* Fumouze and Robin. He stated "Under the names of *R. echinopus*, *R. spinitarsus* and *R. hyacinthi*, the mite has been reported from nearly every portion of the world." Hodson’s investigations were designed to elucidate the economic status of the mite. His summary included the statement: "The foregoing observations and experimental work clearly indicate that the bulb mite, *Rhizoglyphus echinopus*, is not a primary pest of the narcissus. At the same time there is every indication that the mite does bring about the destruction of bulbs originally damaged by other organisms or by mechanical means, which would normally recover from their original injuries."

1941. Womersley, on p. 465, noted the occurrence of the species in Australia and recorded receiving material from Auckland, New Zealand in 1938.


**New Zealand Distribution and Habitat.**

*R. echinopus* has been recorded on bulbs in this country for many years, although it has not been possible to trace the earliest record. On a number of occasions the species has been taken from bulbs imported from Europe and is mentioned in Entomology Division correspondence as far back as 1930 from a number of different localities. During the current investigation specimens have been obtained from tulip and narcissus bulbs, gladiolus corms, and from decayed stems of Californian thistle.

6. *Thyreophagus entomophagus* (Lab.). (Figs. 20, 21.)

**Historical.**

1903. Michael, on pp. 55–66, outlined the synonymy and described the species as *Histiogaster entomophagus*, referring back to the original record of *Acarus entomophagus* by Laboulbène in *Ann. Soc. Ent. France*, 1852. The generic changes listed included the adoption of the generic names *Tyroglyphus* by Laboulbène and Robin 1862, *Montiesiella* by Berlese 1897, and *Histiogaster* by Krammer in 1899.
1906. Rainbow, on p. 180, recorded the species attacking entomological collections in Australia. He used the name *Tyroglyphus entomophagus* Labouéb., giving the date 1862.

1920. Newstead and Morris described and figured the species under the name *Histiogaster entomophagus* Laboulbéne, stating that it was an important pest of stored flour and mixed farinaceous foodstuffs.

1936. Zakhvatkin included the species as a pest of grain and flour in his key to the granary mites, referring it to the genus *Monieziella*.

1940. Zakhvatkin referred *Monieziella entomophaga* Lab. to the allied genus *Thyreophagus*, of which he stated it to be the type.

1941. Womersley recorded *Thyreophagus entomophagus* (Lab.) from flour in Australia. He listed the genus *Thyreophagus* as being described by Rondani in *Bull. Soc. ent. Ital.*, vi, 1874, p. 67. This thus predates both *Monieziella* and *Histiogaster*. In his synonymy of the species *T. entomophagus*, Womersley recorded *Thyreophagus entomophagus* Rondani; *Bull. Soc. ent. France*, v, 1874, p. 67. No description has been found in this publication, and it appears probable that the reference has been cited in error for the *Bull. Soc. ent. Ital.* as recorded under the genus. Womersley also listed *Tyroglyphus entomophagus* Laboulbéne et Robin; *Ann. Soc. ent. France*, ser. 4, ii, 1868, pp. 317–338, pl. x. The description cited is to be found in this publication for the year 1862, not 1868.

1941. Zakhvatkin redescribed and figured the species on p. 209 of his revision of the Tyroglyphoidea, diagnostic characters being included in the key, on pp. 423–424.

**New Zealand Distribution and Habitat.**

Heavy infestations of this species have been recorded from flour originally infested by *T. farinae*, and from ergot.

**Fam. GLYCYPHAGIDAE.**

**Subfam. CHORTOGLYPHINAE.**

7. *Chortoglyphus arcuratus* (Tr.). (Figs. 22, 23.)

**Historical.**

1903. Michael described *Chortoglyphus arcuratus* Troupeau on pp. 3–7. In his synonymy he recorded *Tyroglyphus arcuratus* Troupeau 1879 and *Chortoglyphus nudus* Berlese 1894. Michael mentioned the presence of pectinated hairs on the two front pairs of legs, figured by Troupeau but not by Berlese, and of several pairs of minute hairs on the dorsal surface, not figured by either Troupeau or Berlese. However, there seems little doubt that Michael’s was identical with these earlier-described species.

1920. Newstead and Morris, on p. 22, gave a brief description of the species, recording it from flour.

1941. Zakhvatkin redescribed and figured *C. arcuratus* (Tr.) on p. 286, key characters being enumerated on p. 450.

**New Zealand Distribution and Habitat.**

Only one record of *C. arcuratus* has so far been obtained. In this case a heavy infestation of the species had developed in red clover seed held in store in Nelson.
Subfam. GLYCYPHAGINAE.

8. Glycyphagus (s.str.) domesticus (de Geer). (Figs. 24, 25.)

Historical.

1901. Michael described this species on pp. 238–245 as Glycyphagus domesticus de Geer, referring back to the mite originally described as Acarus domesticus by de Geer in 1778. Michael stated ‘There can be but little doubt that by many ancient and even some modern writers the specific name domesticus has been used in error when the creature really spoken of was T. siro, T. longior, or G. spinipes.’


1912. Cockayne referred to G. domesticus as being frequent in New Zealand in timber injured by wood-borer.

1934. Hora recorded details of the biology of G. domesticus in relation to temperature and humidity.

1936b. Zakhvatkin created the new subgenus Oudemansium for the type Glycyphagus domesticus de Geer.

1938. T. E. and A. M. Hughes described in detail the internal anatomy and post-embryonic development of the species.

1941. In his revision Zakhvatkin did not retain the subgenus Oudemansium, but used the subgenus Glycyphagus s.str. for the species G. domesticus (de Geer). He redescribed and figured it on p. 302, including diagnostic characters in the key on p. 453.

New Zealand Distribution and Habitat.

This species has been recorded repeatedly from cheese in cool storage in several parts of the North Island. A few specimens have also been obtained from cheese held at normal temperatures. The association of G. domesticus with cheese may be secondary, the species living on the mould which so commonly develops under cool store conditions. G. domesticus has been recorded from pearl barley on several occasions, while the most serious infestation so far observed was on vells in cool storage. It is of interest to note that a number of cases of dermatitis have been reported in New Zealand amongst workers handling vells infested by G. domesticus.

9. Glycyphagus (Lepidoglyphus) destructor (Schr.) Ouds. (Figs. 26, 27.)

Note: There has been considerable confusion in establishing the identity of this species from early descriptions. The name listed above follows Zakhvatkin and a number of Russian workers, but, as has been pointed out by Solomon (1943), the species is still generally known as G. cadaverum Schr. in Britain.

Historical.

1901. On pp. 245–250, under the name Glycyphagus spinipes Koch, Michael described a species similar to the one concerned except for the presence of a setose scale on the genual of the third leg of the female.

1904a. Oudemans, on p. 102, referred to the species Glycyphagus cadaverum (Schrank) as being the one commonly known as G. spinipes. He stated that this lacked the scale on genual 3 of Michael's spinipes. Oudemans suggested Glycyphagus
Fig. 2.—Factory curing room. Ends of successive tiers of cheese shelves.

Fig. 3.—Medium cheeses crated ready for dispatch from the factory.

[To face page 202]
Fig. 4.—Cheeses from slow vats, heavily mite infested after having been held in the curing room for 1 year 9 months.

Fig. 5.—Upper surface of one of the cheeses in Fig. 4, showing mite injury.
Fig. 6.—Subdivisions of the body in the Acarina (after Vitzthum). A, gnathosoma; B, propodosoma; C, metapodosoma; D, opisthosoma; A + B, proterosoma; C + D, hysterosoma; B + C, podosoma; A + B + C, prosoma; B + C + D, idiosoma.

Fig. 7.—Segments of the leg in the Acarina.

Fig. 8.—Arrangement of dorsal body hairs in the Tyroglyphidae (after Zakharvatkin). a, an, anal hairs; d₁, d₂, d₃, first, second, third, fourth pairs of dorsal hairs; e, h, h₁, exterior and interior humeral hairs; l₁, l₂, l₃, anterior and posterior lateral hairs; p₁, postanal hairs; s₁, s₁₁₁, exterior and interior posterior hairs; s₁, s₁₁, exterior and interior seaparial hairs; e, v, v₁, exterior and interior vertical hairs.

Fig. 9.—Arrangement of dorsal body hairs in the Glycyphagidae (after Zakharvatkin). h, humeral hairs; l₁, l₂, l₃, first, second, third pairs of lateral hairs; v₁, v₁₁, anterior and posterior vertical hairs.
Fig. 10.—*Tyroglyphus farinae*, female dorsal.  Fig. 11.—*Tyroglyphus farinae*, male ventral.
Fig. 12.—*Tyrolichus casei*, female dorsal.

Fig. 13.—*Tyrolichus casei*, male ventral.
Fig. 14.—Tyrolichus sp. ? lini, female dorsal.
Fig. 15.—Tyrolichus sp. ? lini, male ventral.
Fig. 16.—*Tyrophagus longior*, female dorsal.

Fig. 17.—*Tyrophagus longior*, male ventral.
Fig. 18.—*Rhizoglyphus echinopus*, female dorsal.
Fig. 19.—*Rhizoglyphus echinopus*, male ventral.
Fig. 20.—Thyrampus entomophagus, female dorsal.

Fig. 21.—Thyrampus entomophagus, male ventral.

Fig. 22.—Chortaliphus arcuatus, female dorsal.

Fig. 23.—Chortaliphus arcuatus, male ventral.
Fig. 24.—*Glycyphagus* (s. str.) *domesticus*, female dorsal.

Fig. 25.—*Glycyphagus domesticus*, male ventral.
Fig. 26.—*Glycyphagus* (*Lepidoglyphus*) *destructor*, female dorsal.

Fig. 27.—*Glycyphagus* (*Lepidoglyphus*) *destructor*, male ventral.
Fig. 28.—Gohieria fusca, female dorsal.
Fig. 29.—Gohieria fusca, male ventral.
michaeli nov. nom. for the *G. spinipes* of Michael, which he considered an entirely different form from the continental one.

1913. Oudemans corrected his earlier use of the name *Glycyphagus cadaverum* (Schrank). He stated that he had wrongly identified *G. cadaverum* as being the same as *G. destructor* (Schrank), whereas *cadaverum* (Schrank) was identical with *privatus*, a species recorded by Oudemans in 1904. This correction, which has been generally ignored by British acarologists, entailed the substitution of the specific name *destructor* (Schrank)—not *cadaverum*—for *spinipes* Koch.

In this paper Oudemans divided the genus *Glycyphagus* into a number of groups, of which the most important were:

1. The *Domesticus*-group, containing *G. domesticus*, *ornatus* and *cadaverum* Schrank (≡ *privatus* Oudm.).
2. The *Destructor*-group, containing *G. destructor*, *pilosus* Oudm. (≡ *setosus* Oudm., non Koch), *michaeli*, *fustifer* and *burchanensis*.

1918. Newstead and Duvall referred to the species as *Glycyphagus cadaverum* Schrank, this identification being based on Oudemans’ findings of 1904.

1920. Newstead and Morris illustrated the species which they called *G. cadaverum*. Its morphological characters agree with the present New Zealand species.

1929. Vitzthum, on p. 77, described the species under the name *Glycyphagus cadaverum* Schrank, recording *spinipes* Koch as a synonym.

1936b. Zakhvatkin erected the new genus *Lepidoglyphus* for the species *G. destructor* Schr., which he stated = *spinipes* Koch, thus recognising Oudemans’ correction of the species from *cadaverum* to *destructor*.

1940. Zakhvatkin reduced *Lepidoglyphus* to the status of a subgenus of *Glycyphagus*.

1941. In his revision, on pp. 451–452 of the key, Zakhvatkin divided the genus *Glycyphagus* into two subgenera, *Lepidoglyphus* and *Glycyphagus* s.str. The subgenus *Lepidoglyphus* included those species comprising the *Destructor*-group of Oudemans, while the subgenus *Glycyphagus* s.str. corresponded to the *Domesticus*-group. Zakhvatkin redescribed and figured *Glycyphagus* (Lepidoglyphus) *destructor* (Schr.) Ouds. on p. 296. Diagnostic characters for the species were included on p. 452 of the key in French.

*New Zealand Distribution and Habitat.*

This species has frequently been found in association with *G. domesticus*, although generally in smaller numbers. It has been recorded from barley, rice, cheese in cool storage and vells.

Subfam. LABIDOPHORINAE.

10. *Gohieria fusca* (Ouds.). (Figs. 28, 29.)

Note: The original description of the species by Oudemans is not at present available in New Zealand, but specimens taken here have been found to agree with the species described and figured by Newstead and Morris (1920), except that the plumose hair figured by
them on the ventral surface of coxae I and II in the male is lacking. Newstead and Morris stated that their material did not show the strongly serrated lateral margins in the female as figured by Oudemans. In New Zealand specimens there is considerable variation
in the degree of serration and in some specimens it is strongly marked. The striated appearance of the leg segments in females of the present material is a conspicuous character which has not been noted by Newstead and Morris. Striations are most marked on legs I and II, where they are transverse or diagonal on the femora and longitudinal on the genuals and tibiae. (See Fig. 28.)

Historical.
1902. Oudemans published the original description of the species under the name *Glycyphagus fuscus*.
1928. Oudemans proposed the new genus *Ferminia*, with *Glycyphagus fuscus* as the genotype.
1936a. Zakhvatkin included the species in his key to the granary mites under the name *Ferminia (Glycyphagus) fuscus* Oudm.
1939. Oudemans proposed the new generic name *Gohieria* for *Ferminia*, which he had found to be preoccupied.
1940. Zakhvatkin substituted the genus *Gohieria* Oudm. 1939 for *Ferminia* Oudm. 1928.
1941. Zakhvatkin revised the genus *Gohieria* on p. 342, redescribing and figuring *G. fusca* on p. 344. Diagnostic characters for the species were included in the keys on pp. 456–457.

New Zealand Distribution and Habitat.
Although the species has been recorded on a number of occasions from flour, and from grain and meal sweepings, no heavy infestations have been found. It has occurred generally in association with *Tyroglyphus farinace*.

V. KEY FOR SPECIES SEPARATION.
(For terms used, see Figs. 6, 7, 8, 9.)
Tyroglyphids already found in New Zealand could be most easily separated by an artificial key confined to them alone, but it is hoped that the following will be of greater use, allowing as it does for the inclusion of species which may be recorded here in the future. This key is based directly on a translation of the summary in French of Zakhvatkin’s revision of the Tyroglyphoidea, 1941, and his original phraseology has been adhered to wherever possible. In it separation characters for families, subfamilies and tribes have been combined with generic and specific characters for the species at present known to occur in New Zealand.

1. With one interior and one exterior pair of vertical hairs; with no more than two pairs of lateral hairs (Fig. 8)
   Fam. TYROGLYPHIDAE
   2

   – With one anterior and one posterior pair of vertical hairs; with three or more pairs of lateral hairs (Fig. 9)
   Fam. GLYCYPHAGIDAE
   7

2. Exterior vertical hairs (*v*) finely plumose, placed antero-laterally between leg I and the gnathosoma;
interior scapular (ac i), interior humeral (h i), first dorsal (d i), second dorsal (d s), third dorsal (d t) and anterior lateral (l a) hairs all well developed;
clawst rather small, pretarsi well developed, covering at least half the claw

- Exterior vertical hairs minute and smooth, placed antero-dorsally, or absent;
- se i, h i, d i, d s (and sometimes also d t and l a) hairs greatly reduced or absent;
clawst stout, pretarsi little developed, covering only the base of the claw

3. Sexual dimorphism very pronounced—in the s, legs I are enlarged and the femur is armed underneath with a strong, conical spine, while in the q the legs are of normal structure;

- interior apical hair of genuals I extremely long, 6–10 times as long as the exterior
- Tribe Tyroglyphini

Posterior margin of the body bearing only two pairs of rather long hairs

- (se i and p a);
- all the other hairs of the hysterosoma are short except the exterior humerals (h e)...

- Tyroglyphus farinae (L.)

- Secondary sexual characters scarcely defined—legs I normally formed in the two sexes;

- interior apical hair of genuals I of moderate length, not more than three times as long as the exterior
- Tribe Tyrophagini

Posterior margin of the body bearing more than two pairs of long hairs

4. Tip of the tarsi with three ventral spines;
tarsal copulatory suckers of the s placed in the proximal half of tarsi IV

- Tyrophagus longior (Gerv.)

- Tip of the tarsi with a conical spine dorsally and five ventral spines;
tarsal copulatory suckers of the s placed almost at the same distance from the base and the tip of tarsi IV

5. L-a represented by long hairs of similar dimensions to the humerals

- Tyrolichus casei (Ouds.)

- L a represented by microchaetae of the same length as d

- Tyrolichus lini (Ouds.)

6. se i, h i, d i, d s, and d t, represented by microchaetae;
a thick, conical spine immediately in front of the olfactory club;
legs stout, armed with a number of strong spines;
species of large size

- Rhizoglyphus echinopus (F. and R.)

- se i, h i, d i, d s, absent, also d t and l a;
- no spine in front of the olfactory club;
- legs slender, without spines;
species of small size

- Thyrophagus entomophagus (Lab.)

7. Gnathosoma very strongly developed, largely concealed by a hood-like production of the propodosoma

- Sub-fam. Chortoglyphini

- All the hairs of the dorsal surface of the idiosoma short, smooth, scarcely visible;
hairs of tibiae and genuals I and II pectinate, one of the ventrals of the tarsi in the form of a spine;

- s armed with anal and tarsal copulatory suckers, with the genital aperture displaced forwards between the bases of legs I

- Chortoglyphus arcuatus (Tr.)

- Gnathosoma of normal dimensions, not concealed by a production of the propodosoma.

- Hairs of the dorsal surface of the idiosoma more strongly developed;
pectinate hairs not only on tibiae and genuals I and II, but also at least on tibiae III and IV;

- no ventral spine on the tarsi;

- s without anal and tarsal copulatory suckers, and with the genital aperture placed normally between the bases of legs III and IV
8. Cuticle smooth, strongly pigmented, brownish; tarsi III and IV of the ♂ obliquely truncate at the tip; ♀ without a protruding copulatory tube

Sub-fam. LARIDOPHORINAE

Hairs of the dorsal surface simple, none more than 10–15% of the length of the idiosoma; in the ♂ epimera I are united directly to the chitinous ring surrounding the genital aperture ... ... Gohieria fusca (Ouds.)

Cuticle finely granular, colourless; tarsi III and IV of the ♂ not obliquely truncate at the tip; ♀ with a posterior protruding copulatory tube

Sub-fam. GLYCYPHAGINAE

Hairs of the dorsal surface plumose, at least 30% of the length of the idiosoma, the majority considerably longer; in the ♂ epimera I remote from the genital aperture ... ... 9

9. Tarsi concealed by a pilose sheath; crista metoptica (rudimentary propodosomal shield) absent; ventral hairs of femora 1 smooth, setiform; d₁ placed normally, well before d₂ and at the same level as l₁ ... ... ... Glycyphagus (Lepidoglyphus) destructor (Schrk.) Ouds.

Tarsi without pilose sheath, but with several barbate hairs; crista metoptica present; ventral hairs of femora 1 plumose; d₁ displaced backwards between, and at the same level as d₂, and much further back than l₁ ... ... Glycyphagus (s.str.) domesticus (de G.)

REFERENCES.


