AN INVESTIGATION OF THE RAT PEST PROBLEM IN QUEENSLAND CANEFIELDS: 2. SPECIES AND GENERAL HABITS.

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SUMMARY.

1. *Eleven Murid species are recorded from northern and/or central Queensland canefields. Five are associated with damage to sugar cane.*

2. *Rattus conatus is the most important economic rat pest of cane, owing to its ability to sustain mass attacks. Melomys littoralis is second in importance: in some years when the greater proportion of the effect on cane is of a nuisance order only this is the species mainly responsible. The status of M. cervinipes as a pest of cane is indefinite, as its real distribution in years of heavy rat populations is not known. Rattus rattus and R. culmorum are of little direct economic importance.*

3. *The three indigenous Rattus species—R. conatus, R. culmorum and R. assimilis—are burrowing rats. R. conatus lives in damp, friable soil with a close and substantial ground cover. R. culmorum has been found in or near sugar districts only in sandy, grassy places amongst mangrove creeks and marine swamps. R. assimilis is confined to rain forest and adjacent localities. M. littoralis spends much of its time off the ground and builds nests in vegetation; it is often associated with R. conatus but is also found in "palm tree" swamps and in sparsely covered grass-shrub country. M. cervinipes has many characteristics similar to those of M. littoralis, but its native habitat is rain forest.*

INTRODUCTION.

The common collective name "rats" was used in all early references to damage by these pests in Queensland sugar-cane fields. In 1935 E. LeG. Troughton, of the Australian Museum, Sydney, tentatively identified three species, submitted by Gard as damaging cane in the Herbert River district, as *Rattus rattus* L., *Rattus culmorum* T. & D., and *Melomys littoralis* Lönn (Gard, 1935). During the succeeding four years these names were generally used in publications on various aspects, both medical and economic, of rat infestation of Queensland sugar-cane fields. During this period an ecological survey in a number of mill areas was undertaken by the Bureau of Sugar Experiment Stations, and it soon became apparent that the accepted identifications of some of the indigenous *Muridae* were not sufficiently well founded. It was observed that two species of naked- or file- tailed rats (*Melomys* spp.) damaged cane in Queensland; furthermore, a species of *Rattus* trapped in canefields in the Mackay

district in 1936 was found by Troughton (1939) to be the true *culmorum*. The species which had become so well known by that name for four years was then referred to Thomas's *conatus*.

Mr. Troughton has carried out a considerable amount of work on the nomenclature of Murid species inhabiting canefields and adjacent environments, and has identified the following which may be taken in those habitats in northern and/or central Queensland cane districts:—

Rattus rattus Linné (House rat);

Rattus conatus Thomas (Field rat or field ground rat);

Rattus culmorum Thomas and Dollman (Brown field rat or brown ground rat);

Rattus assimilis Gould (Scrub rat or scrub ground rat);

Melomys littoralis Lönnberg (Small khaki rat);

Melomys cervinipes Gould (Large khaki rat);

Hydromys chrysogaster reginae Thomas and Dollman (Water rat);

Xeromys myoides Thomas;

Uromys caudimaculatus Krefft;

Thetomys gracilicaudatus ultra Troughton;

Mus musculus Linné (House mouse).

Rattus norvegicus Erxlelen is, according to Pemberton (1925), the species most destructive to sugar cane in Hawaii. This rat is known to be present in some cities and towns in Queensland sugar-cane districts but it has never been trapped or recorded from canefields.

Common names from different sources have been included in the above list for those species of most concern in the rat problem in Queensland canefields. The names given for the two introduced species, *R. rattus* and *M. musculus*, are well known in this country, and are more suitable for use in cane districts than are the alternatives, black rat or ship's rat, and European mouse. Gard (1935) used "field rat" for the species then known as *R. culmorum* and since identified as *R. conatus;* this name is an apt one for sugar-cane areas, and an added colour designation is sufficient to separate the true *culmorum* from *conatus*. *R. assimilis* is the indigenous *Rattus* species found in rain forest ("scrub") and sometimes also in cane adjacent to it; hence the suggested name "scrub rat" for this species. The secondary name "ground rats" for the three burrowing *Rattus* species (*conatus, culmorum,* and *assimilis*) is sometimes useful. *Melomys littoralis* is known as "tree rat," "banana rat," "khaki rat," or "Melomys" in the Herbert River district; but following the more extensive trapping in other districts in recent years it is also necessary to consider *M. cervinipes* as a cane pest. The chief difference in appearance between these two *Melomys* species is size; their colour is distinctive, so the common names "small khaki rat" and "large khaki rat" should serve to identify them. The common water rat found throughout coastal Queensland is *H. c. reginae*.

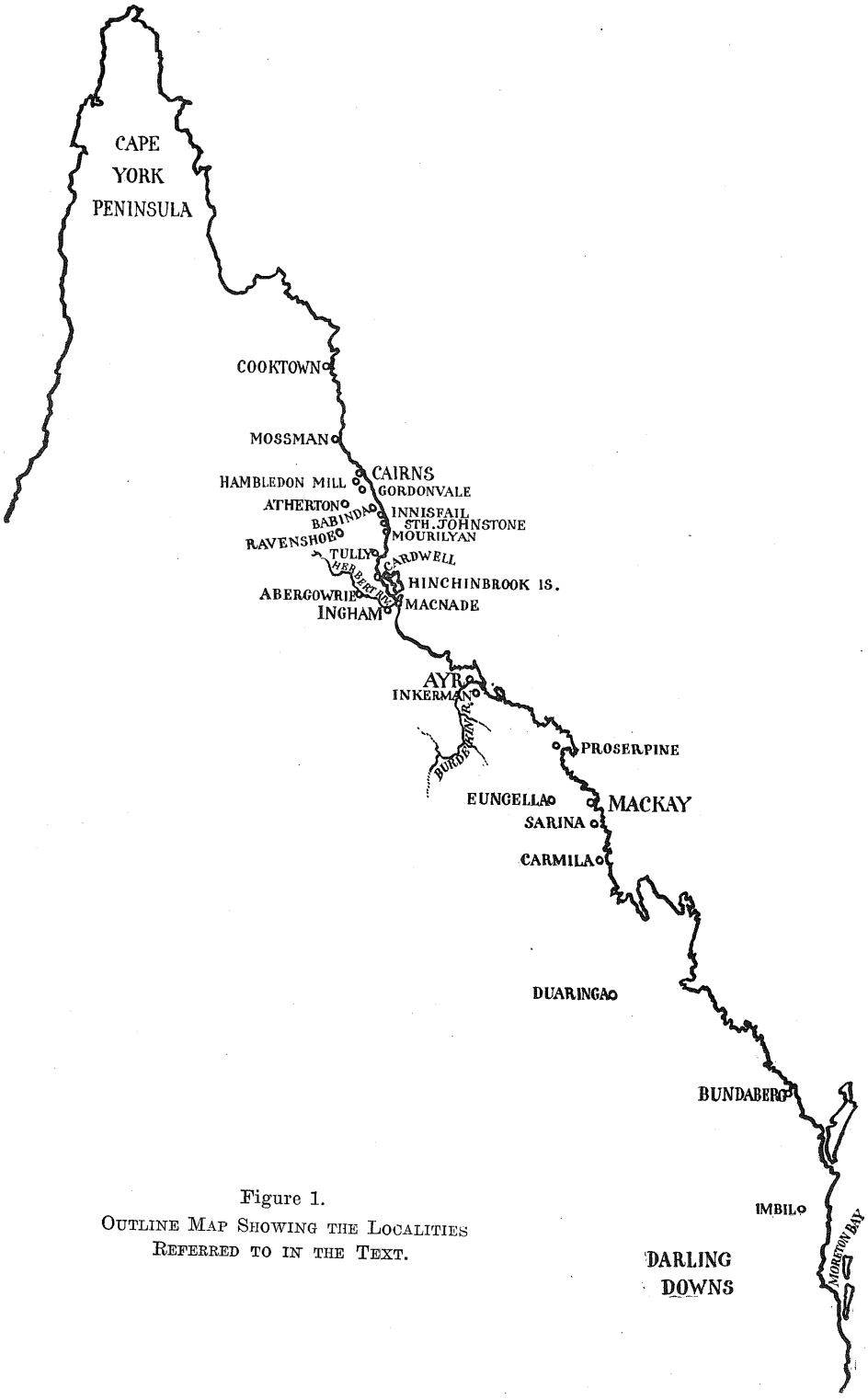

Figure 1.
OUTLINE MAP SHOWING THE LOCALITIES REFERRED TO IN THE TEXT.

Troughton (1941), in discussing *R. conatus,* remarks that "it is desirable to retain the specific distinction of the cane-fields *conatus* to simplify field investigations and the tabulation of research." Unfortunately for field workers, appreciations of this nature are only recent and in the past authors through force of circumstances have apparently concentrated on the detection of slight morphological differences, without due regard to the possible variation within a species. There is a voluminous descriptive literature on Australian *Muridae,* based chiefly on morphology, but with many species the specific differences and relationships are not clear or well established. Under such circumstances it is considered undesirable, at this juncture, to re-describe in detail (at a field station) any species associated with the rat pest problem of sugar cane; the checking with existing descriptions and the addition of further data should prove more useful. The listing of subspecies, as follows on subsequent pages, should be taken as merely formal. Outside the northern and central sugar areas, which extend from Mossman to Carmila (see Figure 1), only meagre information on the ecology and habits of the indigenous Murid species—with the exception of *R. assimilis*—is available. Without such data it would be unwise to accept completely records of distribution based on nomenclature derived from morphology alone.

It has been found that, to be of material use, field observations on rats should have continuity and should cover a wide geographic range under different seasonal conditions. Authentic enlargement of the knowledge of distribution of canefield species would serve a useful purpose. Although the northern and central sugar-cane districts cover a large area, the climatic environment is substantially uniform throughout; observations on the same species elsewhere would serve both as a check on canefield rat work and as a help in improving the interpretation of data collected in these areas.

Animals other than rats and mice occasionally fill rat traps set in cane-fields and adjacent places; these include the brush or scrub turkey (*Alectura lathami* Gray), the Pheasant Coucal (*Centropus phasianinus* Latham), rails (*Rallidae*), the stone curlew (*Burhinus magnirostris* Latham), quails (*Turnicidae*), bandicoots (*Isoodon torosus* Ramsay and *Perameles nasuta* Geoffrey), several species of snakes (*Ophidia*), the blue tongue lizard (*Tiliqua scincoides* White), marsupial mice (*Phascogalinae*), and a native cat (*Satanellus hallucatus* Gould). The filling of traps by birds, other than the scrub turkey, is usually accidental.

Crop or stomach contents of some of these species were examined but results, naturally, depend to some extent on the season and environment. The crops of five out of six scrub turkeys trapped near cane were filled with cane fibre and that of the sixth with cane fibre and *Pentatomidae.* Ten bandicoots, when opened up during a dry November, yielded cane fibre; and the stomach of the only blue tongue lizard dissected contained *Sorghum* seeds and adult weevil borers (*Rhabdocnemis obscura* Boisd.).

TRAP BAITS, TRAPS, AND TRAPPING.

Gard (1936) estimated that 277,000 rats were trapped during control operations in the Macknade Mill district during 1934, and in the present work the author has been concerned, over a seven-year period, with the trapping and/or re-trapping of about 40,000 specimens in several mill districts. Whether trapping is undertaken as a direct measure aimed at economic control, as an aid in directing and checking control operations, or for purely research work, the types of traps to be used for the different purposes and the kinds of baits laid therein are of paramount importance.

Trap Baits.

Doty (1938) in discussing the uses of oils as attractants in rat baits in Hawaii confirms Gard's (1935) findings in Queensland that, of the various oils tried, raw linseed oil is the best for this purpose. Gard (*loc. cit.*) also states, "many farmers who were not successful in trapping previously, now use only paper and rag soaked in this oil for bait, and have no trouble in catching rats." The author, on Gard's suggestion at a later date, used small pieces of leather (approximately $\frac{3}{4}$ inch x $\frac{1}{2}$ inch for snap traps) as the trap bait base or carrier for oils.

Carefully controlled field-trapping experiments in different seasons have shown that there is no significant difference in the efficiencies of raw linseed oil, good quality maize oil, or wheat oil, when used on leather. However, linseed oil has two definite advantages: it is cheaper, and trappers usually prefer to work with it than with either of the other two.

Numerous experiments have compared the leather-linseed oil bait with others—such as whole maize, pumpkin seeds, shelled peanuts, coconut and coconut oil, raisins, dried fruits, fresh fruits (banana, apple, and papaw), fruit essences at different concentrations on neutral carriers or bases, bacon, fish (dried and fresh), meat (fresh and salted), bread, split peas, several other vegetable seeds, and cheese. For trapping all indigenous murine species under many different seasonal conditions the leather-linseed oil bait was found to be the most efficient. Where this failed the others did not improve the catch; where the others failed, the use of linseed oil on leather often gave results. This means that for most trapping purposes a standard bait is available and it is one which is convenient for use on a large scale under all field conditions.

For trapping the water rat (*H. chrysogaster*) fresh fish proved the most efficient bait, and the five specimens of the rare water rat (*Xeromys myoides*) taken were caught in "Bureau" traps containing a mixed bait of fresh fish and linseed oil on leather.

In common with experience elsewhere, it has been found difficult, at times, to trap the house rat in buildings without pre-baiting or undertaking other preliminaries; but this is not necessary to the same extent when trapping this species in the field.

Traps.

The essentials of a rat trap for use in the field are efficiency, simplicity and robustness of design, and ease and speed of manipulation. Live trappings for special purposes may be desired; otherwise the rats are caught and killed with the one action, and for this work the ordinary cheap, flat, "snap" or "break-back" trap (Plate 1) has been found most suitable. Before use in the field some

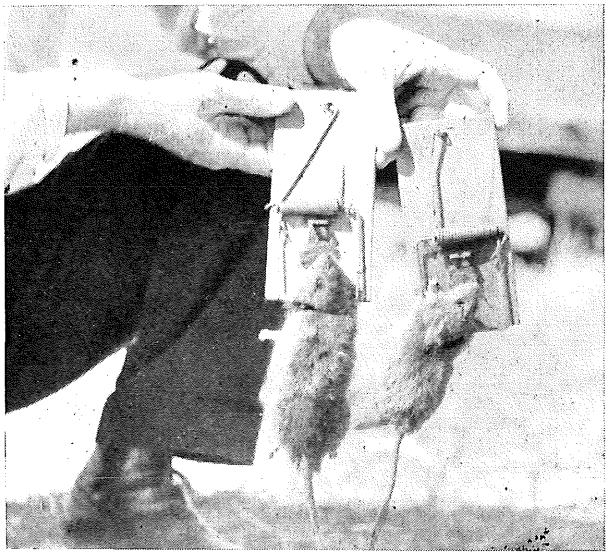

Plate 1.
"SNAP" OR "BREAK-BACK" TRAPS.

attention should be given to the staples, and when selecting from the numerous brands available only those with a long hook on the tongue (A in Figure 2) should be chosen. For trapping *Uromys caudimaculatus,* and in dealing with large moving populations of *Rattus* species when every trap must be accounted for, the traps should be wired to stakes. Some ingenious safety devices are

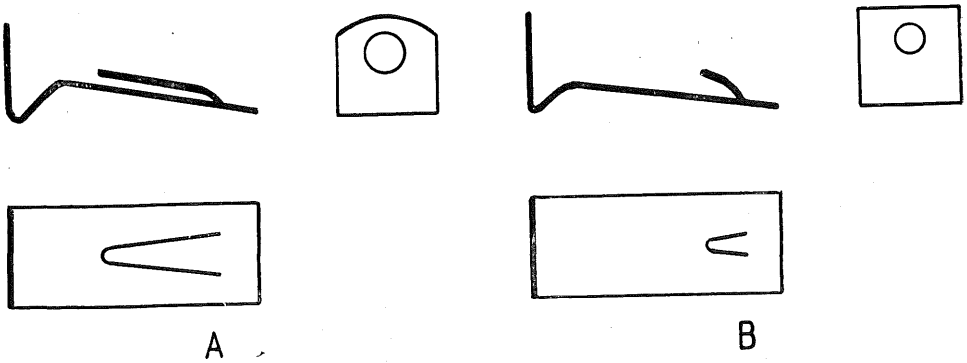

Figure 2.
TWO DIFFERENT TYPES OF TONGUE FOR "BREAK-BACK" TRAPS.

associated with break-back traps but these have been found impracticable for field use; not only do they decrease efficiency and speed of trapping but they have actually proved a danger. The ordinary trap, if firmly held by the back edge, is safe and easy to handle.

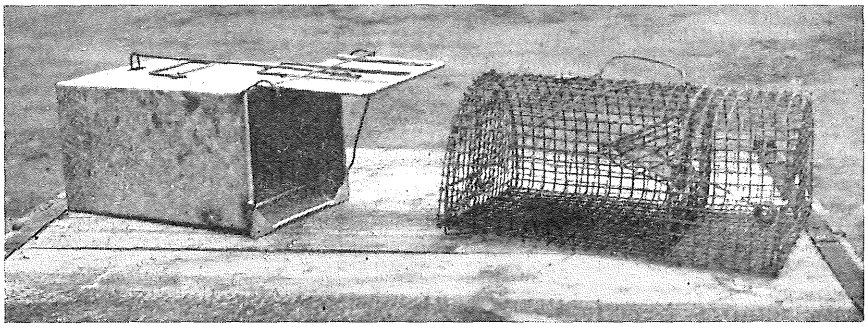

Plate 2.
A SET "BUREAU" TRAP (LEFT) AND A CAGE TRAP (RIGHT).

The cage trap (Plate 2, right), like several other types with automatic action, has little to commend it; it is comparatively inefficient and catches live rats only when large populations are encountered. Even if the idea of automatic traps were sound for practical purposes, their design is usually not sufficiently simple, nor their construction strong enough, for continuous field use.

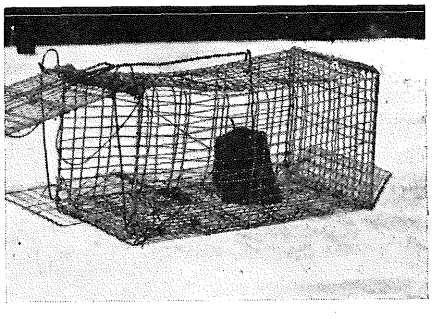

Plate 3.
A SET WIRE TRAP USED FOR WATER RATS.

The wire trap (Plate 3), provided it approximates closely to 8 inches x 7 inches x 14 inches, is best for trapping the water rat.

In rat investigational work a live trap "unit" is often necessary. The trigger release action of these traps usually depends upon the animal touching either the bait or a false floor. Construction details depend upon the habits of the animals to be trapped and the conditions under which the traps are to be used. Chitty (1937) has described and figured the "Tring" trap used at Oxford for small mammals but, for Queensland canefield rat species, a false-floor trap was found to be more efficient; accordingly the "Bureau" trap

(Plates 2 (left) and 4 and Figure 3). was developed. This trap has not only given excellent results as a live trap unit, but it is more efficient than break-backs when collecting rats of many species in small and scattered populations.

Plate 4.
PLACING A SET "BUREAU" TRAP IN POSITION IN A CANEFIELD.

The "Bureau" trap is essentially an adaptation of a wire trap (as in Plate 3) of suitable size, actuated by a false floor. Opaque sides, bottom, and top provide the necessary amount of artificial cover when trapping murine species; an open-work trap is preferable for water rats. The frames of traps used in this investigation were made of 26-gauge galvanized sheet iron and in 1936 a completed trap cost 6s. 6d. Referring to Figure 3: the door lock (h) and the door lock guides (j) must be rigid and 12-gauge high tensile fence wire is suitable; the springs (d and f) are made of medium-gauge piano wire and they are not permanently secured to the frame but attached so that they may be replaced quickly if necessary; two pairs of small holes drilled at (e) and (e^1) for attaching the door spring (f) have given satisfaction. In Queensland canefields bandicoots are fairly common; individuals practically fill a Bureau trap and sometimes damage the springs, spares of which should always be carried by trappers. The edge of the false floor (b) should not be let in to

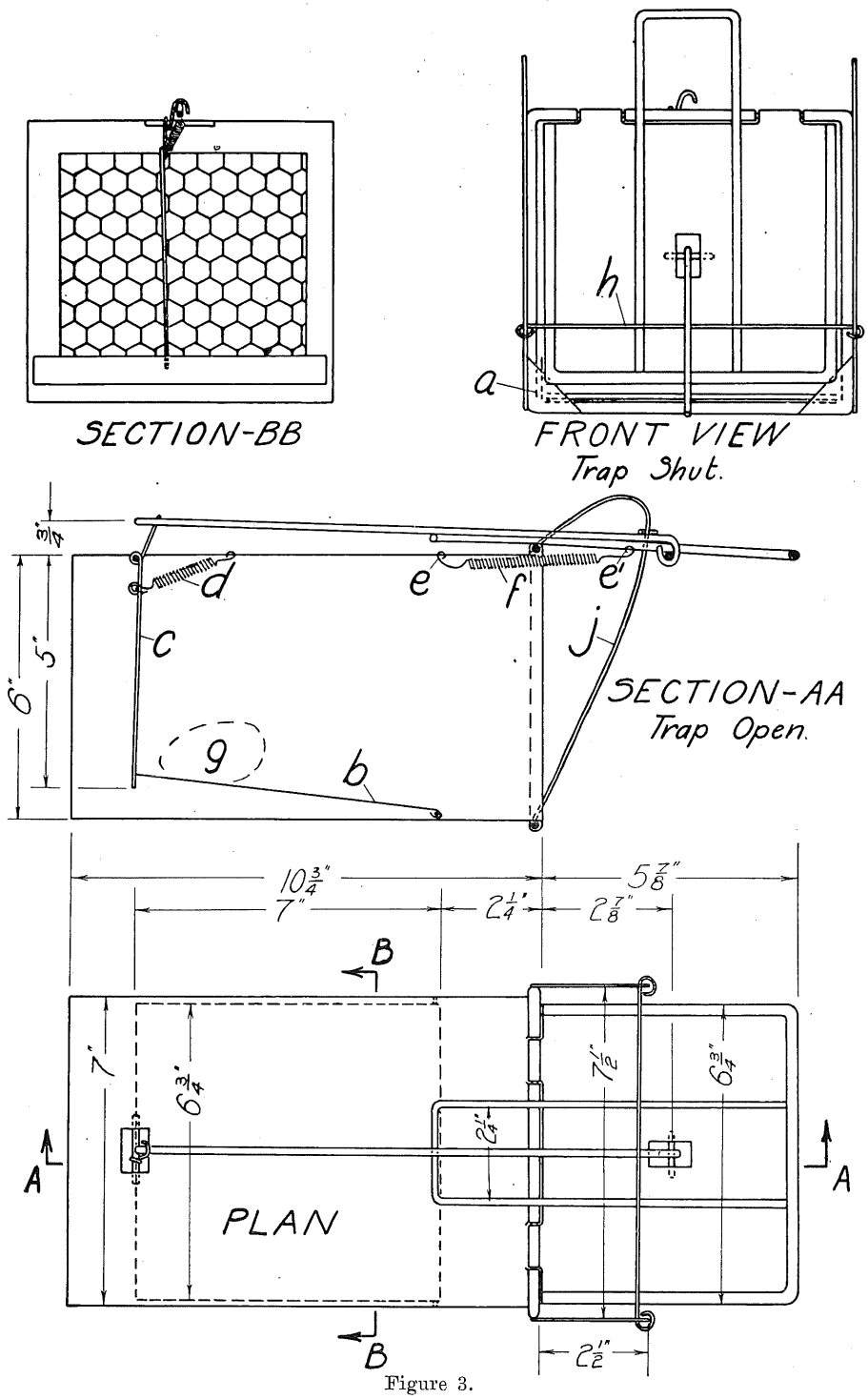

Figure 3.

PLAN OF BUREAU TRAP—(*a*) door stops; (*b*) false floor; (*c*) trigger; (*d*) trigger spring; (*e* and e^1) trigger spring contacts; (*f*) door spring; (*g*) bait; (*h*) door lock; (*j*) door lock guides.

a small cut on the trigger (c), as the point of contact of (b) and (c) is responsible for the fineness and flexibility of set; with smooth contact here it is possible to catch very young rats and mice. These traps were used constantly for four years, during which time only minor repairs were necessary, and the chief attention needed was periodical scraping of the false floors and boiling in water for hygienic reasons.

Trapping.

For mechanical reasons it is usually necessary in most environments to chip small patches of ground on which to place traps. This slight disturbance of the soil around and under traps increases efficiency and it has been found a profitable practice even on the bare floor of rain forests.

The wearing of gloves by trappers has no significant effect on catch. It slows down the work and has been practised by the author only as a prophylactic measure when working in swampy habitats.

Some "*conatus*" country is heavily infested by mosquitoes (*Culicidae*) and "sand-flies" (*Chironomidae*). Apparently these pests do not affect rats confined in live traps, but it is impracticable to work such localities without providing protection for the trappers. In this work protection was required for a six to seven hour period, including about four hours of bright, hot sunshine, since all "live" traps, and "dead" traps from which specimens were to be preserved, were cleared before sunrise, *i.e.*, during a time when sand-flies (the worse of the two pests) are very active, and the trap work was usually continued until mid-day. Several protective measures were tried but the only one to give any satisfaction over a number of years was to smear the torso (before putting on a shirt) and all exposed parts of the body with a mixture of equal parts of oil of lavender, citronella, and medicinal paraffin. The legs should be smeared also if not covered by long rubber boots; these were not used unless dew or rain had dampened the ground cover. When working close to the ground clothing is not a complete protection in areas of heavy sand-fly population and sufficient flies to cause inconvenience usually crawl under the clothing.

Preserving Specimens.

Specimens from "dead" traps should be cleared as early as possible and not later than sunrise. After taking the usual measurements, &c., it is essential that, under Queensland coastal conditions, the specimens be immediately gutted, washed, and placed in undiluted methylated spirits.

DESCRIPTIONS AND DISTRIBUTIONS.

Rattus rattus L. (Plate 5).

For present purposes a detailed technical description of this species is unnecessary. Hinton (1931), deliberately omitting mention of colour, briefly describes *R. rattus* thus:

> "Ears large, almost naked and translucent, reaching or covering the eyes when pressed forward. Tail slender, at least as long as, and often considerably longer than,

Plate 5.
Rattus rattus ($\frac{1}{2}$ natural size).

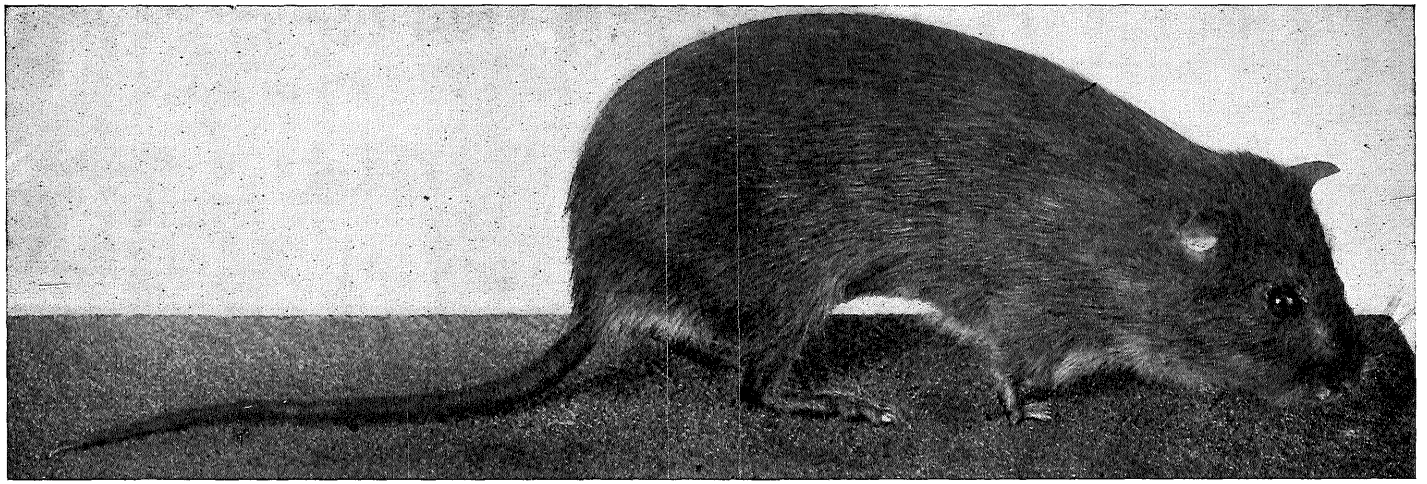

Plate 6.
Rattus conatus ($\frac{3}{4}$ natural size).

the combined length of the head and body. Pads of soles of feet relatively large. Fur soft, but usually intermixed in adults with many slender grooved bristles, which impart a somewhat harsh quality and bristling appearance to the coat as a whole. The females normally have ten mammae, two pairs on the chest, three pairs towards the groin; in some cases an additional pair, making twelve in all, is present upon the chest. Weight of adults rarely more than 8 oz. (227 grammes) usually less.''

Troughton (quoted by Gard, 1935) comments on *R. rattus* taken from canefields as follows:

''This species is at once distinguished by the combination of the extremely long tail, which, when pressed forward along the back, reached an inch or more beyond the nose-tip, and the coarse and sparse fur. The colour is very variable in any locality, leading to the use of the name *alexandrinus* at times for the light-bellied phase, but the name cannot be applied to the Australian animal; mention of colour in any event seems unimportant when so variable.''

Measurements of a typical male from canefields are:—Head-body, 193 mm.; tail, 218 mm.; foot, 36 mm.; ear, 25 mm.

In sugar districts both light and dark specimens are encountered; the lighter type varies considerably within itself, but the darker is quite distinctive. Occasionally the dark rat is predominant in a field and when traps yield numerous large, well-fed, well-coated specimens, the colour impression of the population is accentuated and results in requests from field workers for check identification.

This cosmopolitan species has been trapped by the author in canefields at Mossman, Hambledon, Gordonvale, South Johnstone, Mourilyan, and Tully (all during July, 1936); the Herbert River district (July, 1936, and September, 1939); and the Mackay district (1936 to 1941). Gard (1935) earlier reported its presence in canefields in the Herbert River district, and between 1936 and 1941 specimens were received from several of the northern cane areas. Incidentally, the only specimens received from a rat-damaged canefield in southern Queensland (Bundaberg, November, 1939) were of *R. rattus*. All specimens taken whilst trapping in rain forest near Tully Falls (Ravenshoe, N.Q.) during July, 1936, were of this species.

Rattus conatus Thomas (Plate 6).

The pertinent points in the type description (Thomas, 1923) are:

''Fur coarse and in old specimens heavily mixed with spinous hairs, a number of finer and longer white-edged piles on the posterior back; ordinary hairs 13-14 mm. in length, longer piles 35-37. General colour above grizzled buffy brown, but in older specimens the blackish spinous hairs are more numerous and dominate the colour, especially the posterior back. Under surface dull whitish, the bases of the hairs slaty. Hands and feet whitish. Tail shorter than head and body and rather well-covered with short hairs; black or brownish black throughout; under surface not lighter than the upper; about ten scales to the centimetre. Mammae 3-3, 12.

Skull, on the whole, different from the low skull of *assimilis* or that of the forms with greatly inflated bullae, such as *culmorum* and its allies. Supraorbital ridges well developed running in old specimens to the back of the parietals.

Anteorbital foramina widely open, the plate well projected forward. Palatal foramina narrow extending to the level of the first third of m^1. Bullae rather large.

Dimensions of the type (in the flesh): head and body, 170; tail, 143; hind foot, 29; ear, 22.

Skull: greatest length, 38; condylo-incisive length, 37·5; zygomatic breadth 20; nasals, 14·5; interorbital breadth, 4.7; palatilar length, 19; palatal foramina, 8; length of bullae, 7·8; upper molar row (crowns), 6·9 mm.''

The type specimen is evidently an old female, and from its head-body and tail measurements is as large as any of its species likely to be encountered in the field. A series of females of somewhat similar size taken from canefields agree with most of the above measurements, but particularly with those of the skull. They differ, however, in ear length which, in the type, exceeds that of normal large females by about 5 mm. The weights in grammes, and the head-body and tail lengths in millimetres, of six large females selected at random from a fresh field catch were as follows:—132, 168, 120; 161 (pregnant), 174, 125; 146 (pregnant), 168, 123; 162 (pregnant), 170, 130; 147 (pregnant), 172, 124; 128, 170, 123.

The largest male of this species taken in the field by the author weighed 207 g.; the largest of those of which full measurements were made weighed 173 g. and had a head-body length of 185 mm. and a tail length of 128 mm.

In the Mackay district, *i.e.*, in the southern part of the known range, the species is generally darker and none has been taken there with the whitish hands and feet characteristic of the northern specimens. In Mackay specimens these features are sufficiently dark to blend with the general body colour.

The type locality is in the vicinity of Cooktown, North Queensland. Since 1935 this rat has been taken, sometimes in large numbers, in all sugar mill areas from Mossman to the Herbert River district in northern Queensland, and from Proserpine to Mt. Christian (Mackay district) in the central cane districts. No authentic records of its presence in the intermediate Lower Burdekin district are available, and trapping in this area during July, 1936, did not yield this species. Numerous attempts by the author to find this rat on other than coastal lands have failed; habitats on the Atherton Tableland and in the Eungella district apparently suitable for the species were trapped whenever possible, but without result.

Rattus culmorum T. & D.

Extracts from the type description (Thomas and Dollman, 1909) of this species are:

''A coarse or spiny-haired fulvous rat with a whitish belly . . . Size about as in *Mus rattus* [= *Rattus rattus*] or rather smaller. Fur sparse and coarse, more or less mixed with flattened spines. General colour above brownish fulvous, varying considerably according to the degree of spinousness. Sides more buffy. Under surface whitish, often with a tinge of yellow. the hairs pale slaty basally on the belly, whitish throughout on throat and sometimes on the inguinal region. Ears rather short, practically naked. Upper surface of hands and feet white. Tail of

medium length . . . . its rings at base averaging about 10 to the cm., thinly haired; dull brownish; little lighter below. Mammae . . . . 2-3, 10.

Dimensions of the type (measured on the flesh): head and body, 150 mm.; tail, 135; hind foot, 29; ear, 17.

Skull: greatest length 35·5 mm.; basilar length, 30; greatest breadth, 19; length of nasals, 12·2; interorbital breadth, 4·8; palatilar length, 16·7; diastema, 9·7; palatal foramina, 7·5; greatest diameter of bullae, 9; length of upper molar series, 7·1.''

Dimensions of two adult females selected at random from catches in canefields were:

Head-body length.	Tail length.	Foot length.	Ear length.
mm.	mm.	mm.	mm.
145	122	28	16
125	117	27	15

The weights of the heaviest female and male caught by the author in the field were 112 g. and 124 g. respectively.

R. culmorum possesses comparatively large and protruding eyes. This very definite characteristic, which is apparently lost in preserved specimens, is helpful in both field and cage experiments with mixed *Rattus* populations.

This rat has been taken in Queensland canefields in one locality only—viz., Habana (Mackay). Thomas (1909) records it from Heath Island, Beach Mount, and Mt. Abbot—all in the Burdekin district—and recently Finlayson (1942) described and partly figured *R. culmorum cf. culmorum* from near Duaringa, Rockhampton district, Queensland. Troughton (1939) described a subspecies, *culmorum apex,* collected in 1913 at Skull Creek in the extreme north-west of Cape York Peninsula. Iredale and Troughton (1934) list three other subspecies, *c. youngi* Thomas from Moreton Island, South Queensland; *c. vallesius* Thomas from Duck Creek, Macquarie River, and Upper Darling (N.S.W. interior); and *c. austrinus* from Port Lincoln, South Australia.

Rattus assimilis Gould.

This more widely known species is described in ''The Wild Animals of Australasia'' (Le Souef *et al,* 1926) as:

''Fur long, soft, extremely thick on back; slate-coloured fur tipped with light brown; bases of longer hair greenish grey to length of fur, remainder either wholly black or tipped with light brown, producing pencilled effect. They are brightly irridescent in sunlight; sides lighter, merging into greyish-buff colour on under surface, which is produced by lighter slate colour of basal fur with its dull white tips. Feet covered with fine silvery-white hairs. Ears laid forward reach little beyond posterior margin of eye. Pinna thin, covered sparsely but evenly with light brown hairs externally, and with silvery to light brown hairs internally. Tail thinly covered with dark brown hairs, with lighter tips, which generally are longer than scales. Head and body, 180 mm.; tail, 160 mm.; hind foot, 37 mm.''

The measurements of a medium-sized female selected at random from an *assimilis* population in and near canefields were:—Head-body, 150 mm.; tail, 130 mm.; foot, 34 mm.; ear, 17 mm.

Brazenor (1936) when describing an average Victorian specimen found the tail uniformly brown, but most *assimilis* taken by the author in Queensland coastal areas have had distinctly cream-coloured tail scales. Topotypes (Atherton Tableland, 1936) of *assimilis coracius* Thomas were found to have much darker tails than the coastal specimens.

The tympanic bullae are convenient internal characters for separating the three indigenous *Rattus* species associated with cane in central and northern Queensland. With *assimilis* exhibiting the smallest and *culmorum* the largest, these structures show a graded increase in size of tympanic bullae from species to species (see Plate 7).

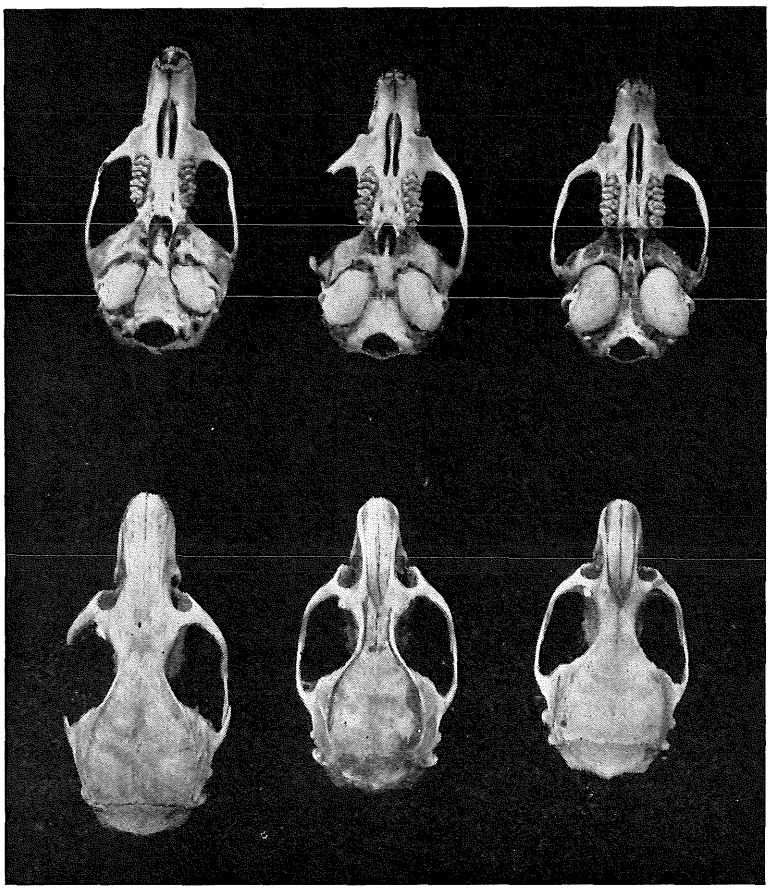

Plate 7.

VENTRAL AND DORSAL ASPECTS OF THE SKULLS OF (from left to right) *Rattus assimilis*, *R. conatus*, and *R. culmorum*.—Note the graded increase, from species to species, in the inflation of the tympanic bullae.

Plate 8.
Melomys littoralis (¾ natural size).

This species has been taken by the author in or near canefields at Abergowrie (July, 1936); Gordonvale (July, 1936); and South Johnstone (September, 1939); and a number of specimens from Mourilyan canefields (Mr. E. H. Fox) were received during 1938-39. Iredale and Troughton (1934), Derrick *et al* (1940) and Troughton (1941) indicate that the range of this species is coastal and mountainous regions of eastern Australia.

Melomys littoralis Lönnberg
(Plate 8).

Lönnberg (in Lönnberg and Mjoberg, 1916) in his type description of this species states:—

> "This rat is probably related to *M. cervinipes* of which it may be a dwarfed littoral race. It differs, however, very plainly in being much smaller and slenderer in every respect. . . . .
>
> "The general colour is on the sides most similar to Ridgway's 'drab,' somewhat suffused with buffish, on the back darker, more brown by means of the blackish-brown tips of the hairs. On the flanks the colour of the lateral parts pass gradually into the light buff of the lower side. . . . . The throat is yellowish-white. The feet are scantily covered with whitish hairs. Tail wholly dark. The fur is soft and dense, about 11 mm. long; basally it is slate grey on the upper side, plumbeous grey on the lower side. The scales of the tail rather small so that 18-19 rings may be counted to the centimetre.
>
> "Head and body (skin) about 90 mm.; tail a little longer, about 112 mm. Hind foot dry (s.u.), 26 mm., c.u. 27·8 mm. Greatest length of skull 30·2 mm.; condylo-incisive length, 28; zygomatic breadth, 15; nasals, 10·5; interorbital breadth, 4·7; mastoid breadth, 11·9; palatal length to include incisors, 13·5; palatal foramina, 4·8; upper molar series, 6·1."

Measurements of three *littoralis* specimens taken at random for head-body, tail, and hind foot were as follows:—Female, 114 mm., 117 mm., 24 mm.; male, 115 mm., 131 mm., 24 mm.; male, 122 mm., 127 mm., 27 mm. The skull

measurements of the last-mentioned were:—Greatest length, 30 mm.; condylo-incisive length, 27·4 mm.; zygomatic breadth, 15·1 mm.; nasals, 10·2 mm.; interorbital breadth, 4·1 mm.; palatilar length, 13·2 mm.; breadth of brain case, 13 mm.; palatal foramina, 4·9 mm.; upper molar series, 5·7 mm. Adult weights usually range from 30 g. to 50 g., but the male of two specimens somewhat darker than usual, and taken in a swamp, weighed 60 g.

In 1935 Troughton (*loc. cit.*) remarked that "this . . . . species of coastal north Queensland has hitherto been known only from the original female and young collected near . . . . Russell River [Babinda Mill area] . . . . and the subspecies from Hinchinbrook Island, *M. littoralis insulae,* described by Troughton and Le Souef in 1929." Since then, *littoralis* has been found to be widely distributed in all sugar-cane areas north of, and including, the Mackay district.

Melomys cervinipes Gould.

Gould's original description of *cervinipes* is not available to the author, but the Director of the Australian Museum has supplied the following extract and notes:

> "Distinguishing characters are: its short, soft adpressed, furry coat, destitute of any lengthened hairs along the back and sides of the body . . . . the nearly uniform rufous colouring of its upper surface . . . . and its slender hairless reticulate tail. Head, all the upper surface and flanks sandy brown, the base of the fur being dark slaty-grey; tarsi and feet fawn colour; undersurface variable buffy white and grey, the base of the fur being grey, and the extremity buffy white; tail purplish flesh colour. In some, the buffy white (of the belly) predominates and becomes conspicuous on the throat and breast. In young animals the upper surface is bluish grey and the under surface greyish white. Dimensions were not originally given by Gould."

In "The Wild Animals of Australasia" (Le Souef *et al,* 1926) the dimensions of *cervinipes* are given as:—Head and body, 150 mm.; tail, 145 mm.; hind foot, 32 mm.

Corresponding measurements of three adult specimens selected at random from canefield catches were:—Male, 127 mm., 142 mm., 28 mm.; females, 118 mm., 140 mm., 27 mm.; male, 140 mm., 153 mm., 28 mm. The skull measurements of the last-mentioned were:—Greatest length, 35·3 mm.; condylo-incisive length, 32·2 mm.; zygomatic breadth, 18·7 mm.; nasals, 11·5 mm.; interorbital breadth, 5·3 mm.; palatilar length, 15·5 mm.; breath of brain case, 14·2 mm.; palatal foramina, 6 mm.; upper molar series, 6·5 mm. Adult weights usually range from 40 g. to 60 g.; the largest male taken in the field weighed 73 g., and a male in captivity reached 95 g.

The tail scale count was found to be of little use in separating the two *Melomys* species taken in canefields and both have three hairs per tail scale. The dorsal muzzle line of *cervinipes* exhibits a slight hump, which gives living specimens of the species a facial expression quite distinct from that of *littoralis.* In addition to the blue-grey colour of the young cited above, the comparatively large feet of young *cervinipes* can be used to advantage as a distinguishing

feature; a *littoralis* of similar body size is of lighter build and reddish-khaki. In many instances habitat differences (see pages 73-76) help in separating these species in the field.

The type locality of *cervinipes* is Stradbroke Island, Moreton Bay, South Queensland, and its range is given (Troughton and Le Souef, 1929) as New South Wales and South Queensland. *M. c. eboreus* Thomas is described from Ravenshoe, North Queensland, and *M. c. pallidus* Troughton and Le Souef from Hinchinbrook Island, North Queensland.

The distribution of this species in cane districts is not fully known; it is suspected that, in suitable seasons, its occurrence is wider than records indicate.

Difficulties with the identification of *Melomys* species in canefields followed the collection of field data over a number of years. These difficulties were initiated during 1934-36 as, early in this period, *littoralis* had been identified as associated with damage to sugar cane in the Herbert River district where, prior to 1935, most of the detailed observations on cane pest rats had been carried out. With the widening interest in the subject (McDougall, 1944) the identifications from the one district were used in others where, in some instances, different ecological conditions occurred. Also, during the period 1933-36 large or diminishing rat populations, abnormally dispersed, were encountered, and these contained a large percentage of immature animals. This undoubtedly created difficulties in separating poorly known species of a difficult genus, since, to field workers, size is a useful specific characteristic. In later years, when rat populations became stabilized and more normal, the separation of *littoralis* and *cervinipes* was easier. During 1939, after separating the species, samples of *Melomys* catches of earlier years were checked and in a number of instances the rats from canefields in different mill areas were found to be *cervinipes* and not *littoralis* as previously identified.

M. cervinipes has been trapped in canefields at Mt. Jukes, Sarina, Cattle Creek, Habana, and Macquarie Creek (all in the Mackay district) from 1936 to 1940; South Johnstone (August, 1939); Mossman (July, 1936); and Gordonvale (July, 1936). Mr. E. H. Fox supplied specimens from the Mourilyan Mill area during 1938 and 1939.

During the winter months of 1936-38 *cervinipes* was trapped at Eungella and Mt. Dalrymple, both places situated in mountainous country, about 45 miles west of Mackay.

When investigating rat damage to reforestation projects at Imbil, South Queensland, Mr. R. H. Doggrell submitted, in 1936, a collection including this species as well as *R. assimilis* Gould and *R. lutreolus imbil* (identified and described by Troughton, 1937).

Hydromys chrysogaster reginae T. & D.

Le Souef *et al* (1926) records this species as being:

"General colour dark greyish, slightly darker along dorsal line; under surface white tinged with buff; tail black, white terminally. Head and body, 336 mm.; tail, 320 mm.; hind foot, 66 mm.; ear, 19 mm."

The numerous geographic races of this water rat have a wide range over eastern Australia. *H. c. reginae* (type locality, Inkerman) is present in all central and northern sugar-cane districts. A water rat taken by the author at Ravenshoe (Atherton Tableland, 1936) has been identified by Mr. Troughton as the topotypical *Hydromys longmani* Thomas.

Xeromys myoides Thomas.

"External appearance very like ordinary rat. Fur very short.. General colour above dark slaty grey; under surface white. Ears short and rounded; laid forward they do not reach to within 3 or 4 mm. of posterior canthus of eye. Hands and feet very thinly haired; white. Palms and soles naked, former with five, latter with six, pads; last hind-pad elongate. Tail slender, scaly, covered with fine white hairs. Head and body, 110 mm.; tail, 154 mm.; hind foot, 40 mm.; ear, 20 mm."

(From "The Wild Animals of Australasia," Le Souef *et al*, 1926.)

Dimensions of specimens taken by us do not agree with those given above; measurements of these specimens were:—Female: Head-body, 120 mm.; tail, 87 mm.; hind foot, 23 mm.; ear, 10 mm. Male: 129 mm.; 86 mm.; 25 mm.; and 10 m.m.

This rare water rat has been reported from the Mackay district only, and the specimens were trapped with *H. chrysogaster*, *M. littoralis*, and *R. conatus* in a "reed" swamp close to canefields about 12 miles from Mackay.

Uromys caudimaculatus Krefft.

This large mosaic-tailed rat is briefly described in "The Wild Animals of Australasia," under the name *U. macropus*, as follows:—

"Fur moderately soft, but longer hairs rather bristly. General colour above greyish brown, tinged with reddish, some coarse black-tipped hairs intermixed; under surface white. Whiskers very long, stiff, black. Feet white. Tail black on basal part, white or pale yellow on apical half. Head and body, 363 mm.; tail, 360 mm."

A somewhat smaller specimen (female) taken by the author measured:—Head-body, 260 mm.; tail, 330 mm.; foot, 61 mm.; ear, 27 mm. This species was trapped in large numbers at Abergowrie (Herbert River district) during June, 1936, and in the same month at Gordonvale. It is apparently a coastal species, with Cardwell as the known mainland southern limit of its range. The type locality is recorded (Iredale and Troughton, 1934) as Cape York, North Queensland, and Sawers (1938) lists a specimen from the Cairns district.

Thetomys gracilicaudatus ultra Troughton.

Troughton (1939) describes this subspecies as:

"General coloration above speckled yellowish-brown, composed of the clay and dark mummy brown tipping, the light tips becoming paler on the head, rump, and

sides where an ochraceous-buffy wash is indicated. Basal fur about deep neutral grey, contrasting with the yellowish-brown tipping of the back . . . . Dimensions of of holotype: . . . . head and body 110; tail 105; pes 26; ear 16 mm.''

The largest male of this species taken in the field by the author weighed 66 g. As in all known indigenous mice there are no pectoral mammae, the formula being 0-2, 4. This species has been trapped only in a few localities near Habana (Mackay district). *T. gracilicaudatus* Gould has been reported (Iredale and Troughton, 1934; Troughton, 1939) only from South Queensland (type locality—Oak Creek, Darling Downs).

Mus musculus Linné.

This imported mouse may be easily distinguished from the native species by the notched wearing surface of the upper incisors and the presence of ten mammae (3-2 = 10). Brazenor (1936) gives the dimensions as:—''Head and body, 74 mm.; tail, 82 mm.; hind foot, 17·5 mm.; and ear, 11·5 mm.'' The general colour is variable from dusky grey to yellowish brown; those taken in canefields often have the hair tips bleached, whilst specimens from houses, rubbish dumps, and thick protective ground cover (*e.g.*, a heavy stand of *Mimosa pudica*) are darker.

Gard (1935) reported the presence of mice in the Herbert River canefields, and the author has trapped *M. musculus* in canefields at Tully (July, 1936), at Gordonvale (July, 1936), and in the Mackay district (1936-40).

GENERAL HABITS AND STATUS OF SPECIES AS PESTS IN CANE FIELDS.

Rattus rattus L.

Pemberton (1925) and Gard (1935) have reported the house rat as nesting in trees. Cilento (1936) illustrates rat nests in trees in the Herbert River district, and although in the accompanying text no attempt is made to distinguish the nesting habits of various species, it is obvious that these nests are those of *R. rattus*. Poorly constructed nests of this species—in the form of shallow depressions in the soil and lined with grass, cane trash, or other bedding—may be found at the bases of cane stools and clumps of Guinea grass (*Panicum maximum* Jacq.). The wide variation in the quality of the nests of this species in the field is paralleled in and around buildings.

Gard (1935) considers this rat of small economic importance in Herbert River canefields, attacking cane only close to buildings. The author has trapped it in widely-separated canefields and sometimes in large numbers, but the damage to cane caused by it is usually insignificant and mostly of slight nuisance quality. On occasions heavier rat damage in house rat infested fields has been noticed, but trapping and other signs have indicated that one of the native rats—usually the small khaki rat—is the responsible agent. Conditions in the Te Kowai-Racecourse (Mackay) area during 1936 can be quoted as an example. During

the winter it was difficult to trap other murine species around the lagoons because house rats filled the traps. There were numerous complaints about rats in buildings; a fernery was attacked, and biscuits and other groceries had to be protected. Large house rat populations were encountered in canefields and, when a quarter of an acre of Guinea grass was burnt off, 227 house rats were counted leaving the fired area. A few patches of cane were attacked by rats, but in all instances either the field rat or the small khaki rat was present.

The bite of the house rat in cane is usually distinctive and is more uneven and ragged than those inflicted by the native species.

In all sugar-cane districts it has been observed that, at times, rats enter dwellings and other buildings from the fields. This usually happens towards the end of harvesting, and often the cane immediately adjacent to the entered buildings has not suffered from rat attacks. The house rat is the only *Rattus* species known to enter buildings from canefields and other vegetation and is, therefore, the only rat frequently associated with both houses and canefields.

The house rat seldom attacks stored sugar, *i.e.*, sugar stacked in bags. However, in poorly constructed and secluded stacks some damage has been noticed, but it was evident that the rats desired the bag shreds for bedding and nesting material rather than the sugar for food.

Rattus conatus Thomas.

Plate 9.
OPENINGS OF *R. conatus* BURROWS IN AN IRRIGATION BANK, TE KOWAI, MACKAY.

This rat is a burrower (Plate 9), and one of the simplest forms of a colony is a single well-established nesting burrow consisting, primarily, of a tunnel two to four inches in diameter and sloping from ground level to a nest

chamber. The nest is fairly compact, rounded, about six inches in diameter, and made of dry grass and/or cane trash or other similar plant material. From the main tunnel and/or the nest chamber there may be subsidiary tunnels of varying length, diameter, destination, and degree of branching. Many of these are blind, but at least one is carried to the surface to make another colony burrow opening. There are no main entrances or exits from a colony, and any opening may be used for either purpose. Some of the subsidiary tunnels are as long as 20 feet on ground plan, and they turn and twist, sometimes break soil surface here and there, connect with each other, and often do not exceed one inch in diameter. It is impracticable to dig out these burrows in most soils without first inserting a flexible stick in each successive straight portion; otherwise they may be lost. A similar system may be found without the nest, and the expanded tunnel or chamber is then used as the chief living chamber. Other burrows may not have progressed as far as the excavation of a chamber, and these, called "travelling" burrows, are used by the rat or rats for a short time before moving elsewhere. Bandicoots, when searching for grubs or other food, often dig holes superficially resembling rat burrows, but probing with a stout stick will show that only rat burrows, if advanced at all, have turnings. A network of runways or pads, with those from the burrow openings in use as main stems, are associated with a colony. Often the main runways are easily seen, particularly in soft, wet, or sandy soils, and when a number of active rats are in residence. Sometimes loose dirt is noticeable at burrow openings, but mounds cannot be associated with this species. Tunnels to a depth of three feet have been traced, but usually most of the burrow system is within 15 inches of the ground surface.

An advance upon the single nest or living-chamber colony is the multiple one extending over larger areas and consisting of the three types of burrow, either in use or abandoned. As an example, it may be noted that at Abergowrie, during July, 1936, 1,051 burrow openings (in use) were counted in an area 19 yards by 142½ yards and, in addition, openings apparently not in use were estimated at 2,300. A continuation of this narrow strip for another 80 yards yielded a further 216 openings in use, but in the lower country for about 200 yards around only a few scattered openings, at the rate of five to the acre, were to be found. Taking this field as a whole the burrow distribution is typical of any infested area arbitrarily defined and without due recognition of the natural habitat of the species.

In a colony area the runways and tunnels from each unit system may intermingle; sometimes undermining is appreciable, and when crossing rat-infested sandy country, either on foot or on horseback, sinking underfoot may be experienced. In canefields there is a tendency for much of the tunnelling to follow the cane lines, with the nests under, and burrow openings at the bases of, stools. This is particularly noticeable in well-hilled cane in damp fields; in uncultivated lands burrow openings are often found near clumps of grass, stumps, fence posts, and large stones.

Whilst young are nest-bound all males and females without young are kept away as far as possible, and they are forced to live and sleep in parts of

the colony not in immediate contact with the nest. During non-breeding periods an isolated single living-chamber (which may be an old nest) burrow system may harbour a number of rats; one dug out contained 23 specimens.

The desirable natural living conditions for *R. conatus* are a damp friable soil capable of, and actually providing, close and substantial ground cover, often termed harbourage. As pointed out by Gard (1935) the presence of water near the burrows is not essential. In dormitory cages where dry food is provided these rats drink from drip water bottles, but a colony of *conatus* lived for three years in a field cage on forest soil, where the only water available was that provided either by rainfall or by light hosing sufficient to keep Guinea grass ground cover flourishing. In the field large numbers of these rats may be found during dry periods some miles away from free water.

This species has not been taken by the author in rain forest, although many attempts, using both line and grid trapping, have been made. Some grids and trap lines have been placed partly in cane or grass and partly in rain forest and where, apart from the ground cover, environmental conditions were similar, but the field rat was taken only in the cane or grass. Also, parallel trap lines, some set in rain forest and others set through ground cover adjacent to the forest edge, have never yielded this species in the forest lines. Similarly, vegetation such as lantana (*Lantana camara* L.) in a pure stand is not sufficiently close to the ground to harbour *conatus*. A complete list of cover species is merely that of plants of suitable growth in any district and growing in the particular soil conditions favoured by the field rat. Some of the more common are: blady grass (*Imperata cylindrica var. Koenigii*, R. & S.), Para grass or giant couch (*Brachiaria purpurascens* Raddi), sensitive plant (*Mimosa pudica* L.), Guinea grass (*Panicum maximum* Jacq.), native and cultivated sorghums (*Sorghum* spp.), green manure or cover crops (*Vigna spp.*), sugar-cane (*Saccharum* spp.), goat weed (*Ageratum conyzoides* L.), and red Natal grass (*Rhynchelytrum repens* C. E. Hubbard). Despite occasional instances of cannibalism the diet of the field rat is essentially vegetarian, and consists of the stem tissues and seeds, where possible, of the harbourage. Often the cover is not a pure stand of any one species but includes other plants which, by themselves, would not provide suitable ground cover, but which do provide food and are sometimes attacked before or in preference to the main or obvious cover species. As an example it is recorded that small tufts of couch grass (*Cynodon dactylon* Pers.) growing near or amongst taller cover are often eaten first. Similarly Gard (1935) reports the seeds of the noogoora burr (*Xanthium pungens* Wallr.) to be eaten by the field rat.

Sugar cane is often considered an accidental addition to the diet, and this is equally true of any other plant attacked by this rat. Cover plants are part of the desired environment, and the part providing food, but so far as *conatus* population distribution is concerned, field evidence has not demonstrated preference for any particular food plant sufficient to override the conjunctive factor of soil environmental conditions. As an example, the lower slopes of a gap in the Habana district contained a number of seepages, some virtually

permanent and others intermittent, and were planted to cane and other crops. Over a period of three years an area on these slopes, approximately 15 chains wide by three miles long, was under observation and trapping. The field rat was definitely associated with these seepages irrespective of their cover crops. One seepage covered a small part of a field of cane, and rats were present only in this small part; another partially occupied an area planted to cowpea, a third to a portion of a saccharine sorghum plot, and a fourth occurred in blady grass, but only the seepage areas yielded rats. For two years another of these wet spots (a small part of a large field) was covered successively by grass, Poona pea, and then sugar cane, but under these different covers rats were invariably trapped in numbers only in the damp portion of the field.

Compared with the house rat, the field rat is clumsy and when ploughed out it attempts, with a hopping gait, to escape. On ploughed ground it is easily caught or killed with a stick, but if released in its undisturbed natural habitat it quickly disappears by trotting or creeping and by taking every advantage of cover. Being a poor climber it feeds from the ground or other substantial foundation, and in canefields the stalks, if not sprawling or lodged, are first felled by attack on the lower internodes; bites on higher internodes are effected later. Occasionally young rats may climb up leaning stalks to feed, but usually the attack on cane by a pure *conatus* population is indicated by the presence of burrows and of bites capable only of being inflicted from the ground.

Small food is masticated and swallowed direct, but large pieces, such as splinters of cane or maize seeds, are held with the front feet and quickly nibbled away while the animal sits on its haunches after the style of a squirrel. This species may feed gregariously, but if a quantity of food is moveable it may be taken away for a meal in solitude. Like some other species of rats it may return to the same food supply each night, but the creating of its own accord of a definite feeding place is not so highly developed as in, for example, some house rats and water rats. Unlike some of the field rats in rice fields in India (Wagle, 1927) and other rodents, *conatus* does not store food in its burrows, and any material taken there is for nest-building purposes. The same habit is characteristic of the house rat, although it is easier to demonstrate with the latter species. On several occasions the packeted, thallous sulphate-treated, wheat baits used in canefields were laid in buildings; the rat population was apparently reduced, and the bait "take" was good. Later many of the baits were found in nests as bedding, and in some of these nests, kept under discreet observation, families were reared and dispersed.

Sick field rats and a few individuals of large congested populations have been noticed above ground in the day time during cloudy and dull weather, and once, during a sunny day, a hawk was seen to dive and pick up a rat from a known field rat colony area. Normal out-of-burrow activities, however, are nocturnal; and at night, in canefields being attacked by this pest, gnawing and cracking of cane and the squeaking of the rats can be heard. In dormitory cages there is a noticeable increase in activity late in the afternoon.

Mating, playing, searching for food, and feeding are carried on by rats of this species intermittently during waking hours; they urinate indiscriminately and without assuming any particular posture, and urine and faecal pellets are to be found even amongst their food. The home ranges of rats in bulk have an appreciable odour, and canefields occupied by large populations soon assume a distinctive stench, which is accentuated by damp conditions.

The field rat, *per capita,* is not so severe a destructive agent of sugar cane as are the *Melomys* species. However, in some seasons large populations attack canefields, affecting extensive areas in suitable environmental conditions, and then true economic damage is comparatively high; this is due simply to mass attack. In other seasons the area of cane attacked is often negligible, and most of the damage is of the nuisance type only. The ability of this species to sustain mass attacks places it first in importance as an economic rat pest of cane. Further, Sawers (1938), in discussing the leptospirosis problem in Australia, considers *R. conatus,* then incorrectly called *R. culmorum,* the main reservoir of infection in Queensland canefields.

Rattus culmorum T. & D.

This species is a burrower which builds a distinct ridge of soil around the main burrow openings, whilst those formed by *conatus* in the same soil type are more often level with the surroundings. In principle the simple burrow system is similar to that of the field rat, but tunnelling is not so extensive, and in canefields there is not the tendency to nest under stools that is shown by *conatus.*

During a visit to the Lower Burdekin district an attempt was made to inspect the type localities of this species, but it was found that Beach Mount and Heath Island could not be approached from the landward side; evidently the original specimens from these localities were taken from the grassy, sandy places amongst mangrove creeks and marine swamps. In the Habana section of the Mackay district cane growing in a similar situation, *i.e.,* in sandy soil with a constantly high water table (and in this case also amongst mangrove creeks and marine swamps), was attacked by field rats and small khaki rats during 1935 and 1936. During 1937 *R. culmorum* appeared in numbers, and in 1938 it became the predominant species, but in succeeding years all rats disappeared from these particular fields. Whilst trapping *conatus* in damp localities in the more typical forest country on the same farm, the owner remarked that on the sandy soil a brown rat which had been observed in previous years was also present. The check-up resulted, as above, in the finding of *culmorum,* and over a number of years of trapping on this and adjacent farms only an occasional brown field rat was taken at a distance (sometimes as far as two miles) from its habitat. These strays, as with other species when trap lines were taken through unlikely rat country, were usually old males.

Apparently *culmorum* can damage cane near or in its own environment, which, however, is limited as far as cane land is concerned. This smaller *Rattus*

species is, *per capita,* less severe on cane than *conatus,* but its method of attack is the same, *i.e.,* primarily from the ground.

Rattus assimilis Gould.

Brazenor (1936) in discussing *assimilis* remarks:

> "This . . . . rat is an inconspicuous completely nocturnal animal. It prefers a habitat in thick scrub and makes its burrows under overhanging branches of bushes, under logs, or at the base of thick grass clumps. As a rule the burrows are not deep; they slope gently down to an enlarged chamber in which is a nest of grass . . . . This rat leaves no noticeable tracks, for its runs seldom extend far from the mouth of its burrow and have not a well-used appearance."

With due allowance for cover differences, this species has living habits somewhat similar to the field rat. *R. assimilis* has been taken by the author only in rain forest and adjacent canefields and, compared with the populations of other rats in cane, it is encountered in small numbers only and seldom more than 50 yards from its native habitat. When *assimilis* has been found in cane *M. cervinipes* has also been present, but in numerous fields the only scrub rat which could be trapped was *cervinipes.* On several occasions, with converging environments, the field rat, the scrub rat, and the large and small khaki rats have been present in fields at the same time.

In a personal communication received during 1937 Mr. Brazenor described damage inflicted by indigenous rat species on pine tree reforestation in the midst of virgin scrub in Victoria. Both *R. assimilis* and *R. lutreolus* were involved, and it is of interest to note that the same two species were included (see p. 65) in a collection of rats associated (at least to the extent of having been trapped near at hand) with damage to forestry projects in South Queensland during 1936. In this instance Mr. Doggrell noticed an *assimilis* specimen in cleared country about 200 yards from standing scrub.

Although cane fibre usually predominates in the stomach contents of those *assimilis* specimens taken in canefields, it is considered that this rat is of little economic importance as a pest in cane. The species should be recognised, however, in the interpretation of ecological data; for it is evident that in the past the group *R. assimilis-M. cervinipes* has sometimes been considered as *R. conatus-M. littoralis,* chiefly on the false assumption that *cervinipes* and *littoralis* are conspecific.

Melomys littoralis Lönn.

This agile rat spends much of its time off the ground and builds somewhat spherical nests of grass, cane trash, or other dead leaves (Plates 10 and 11). As stated by Gard (1935), each nest has two openings, and varies up to eight inches in diameter. Troughton and Le Souef (1929), in discussing *M. l. insulae,* remark that "The specimens were taken only adjacent to some high grass, known as 'blady grass,' about 3-4 feet high, in which they built nests fairly well up amongst the stems; the nests were circular, about 5 in. in diameter, and of similar size to a blue wren's nest." In cane or tall grass the nests are usually

one to three feet from the ground, but some have been found as high as six feet. Irrespective of cover (which may be Pandanus, other palms and shrubs, as well as sugar cane and grasses), every effort is made by these rats to conceal their nests. Gard (1935) reports that "the tree rat nests above ground as a rule .... although in several instances it has been found in burrows beneath the ground."

Plate 10.

Melomys littoralis NEST IN PANDANUS.
(Photograph from K. R. Gard.)

Plate 11.

Melomys littoralis NEST IN SUGAR CANE.
(Photograph from K. R. Gard.)

Lönnberg (1916) in dealing with the type specimen (a female with two young taken under a board on a beach), notes that "the two young remained attached to the teats although the mother ran hither and thither on the beach for a while before she was caught. . . ." It is usual for these rats to leave their nests when an intruder touches, or in many instances merely approaches, them; and, if the young are being suckled, they remain attached to the teats. A mother carrying as many as four young of a total weight larger than her own may be seen struggling amongst cane foliage or along the ground, but if small young are being carried movement is rapid. Her object is to get away from disturbance as quickly as possible, and sometimes, under such circumstances, the haven may be a hole in the ground, a ground-rat burrow, or shelter under a log, but these situations are not used for nesting purposes. This vacating of nests makes it difficult to study nesting habits in the field. The presence of abandoned young is positive evidence that the nest is in use, otherwise this fact has to be decided on appearance and internal evidence such as temperature and cleanliness. No more than one adult has been seen leaving any nest. In captivity, each breeding female invariably constructed her rounded nest with the wood wool provided in all cages. With the sexes segregated there is still a tendency for each female to

make a nest for herself, but in some instances up to four have occupied one nest for months at a time. In cages males will use nests built and abandoned by females, but generally they use the wood wool merely as cover; in the field, males have not been seen emerging from, and have not been trapped in, nests being used by breeding females. The resting places or sleeping quarters of males in breeding cages may assume the appearance of a crudely built nest, but this is due to constant use rather than to any attempt at building.

In many instances *littoralis* and *conatus* are associated both in canefields and other environments, and the ground cover necessary for the field rat is often suitable for the small khaki rat; sugar cane and blady grass are typical examples. However, soil condition, a limiting factor in *conatus* dispersal, does not concern *littoralis* other than indirectly through its effect on plant life, and this latter species may be found in comparatively large numbers in "palm tree" swamps, which are fairly common in northern cane districts, and country supporting a mixture, sometimes sparse, of grasses and shrubs. These covers supply suitable hiding places for nests, some protection for the rats themselves, and allow greater freedom of movement than is desired, say, by *conatus,* or is possible in some types of close ground cover inhabited by the ground rat.

M. littoralis is more of a wanderer than any of the native *Rattus* species associated with canefields, but it has never been taken by the author in rain forest. When breeding these rats may be found up to 60 yards from their nests and, at other times, either complete or partial changes of range may be frequent; these may be sudden following interference or local disturbance. Damage to sugar cane by this rat is often patchy, and when investigating quite fresh rat bites it may be found that the rat or rats responsible have moved elsewhere or, at least, have not returned to feed at or near the same place. Rats of this species will enter houses and other human habitations near their native habitats, but such trespass is mostly casual and in keeping with the general habits. *M. littoralis* is a vegetarian and its habits allow it a diet more varied than that of the field ground rat. In addition to plant tissues such as sugar cane and the soft barks of shrubs, &c. it eats berries and other native fruits, guavas (*Psidium guajava* L.), and sometimes the cultivated banana (*Musa* spp.); stomach contents are generally more liquid than those of the *Rattus* species. In canefields, their neat bites, surrounded by typical teeth marks in all but very soft varieties are found up the stalks; but this does not mean that *littoralis* climbs an erect stalk, clings on, and eats. Usually a slanting or crossing stalk or trash serves as a platform during feeding, and this is well illustrated in some fields of mixed varieties. For example, in two fields, one of Q.2 and H.Q.426 and the other of Q.2 and varieties with similar rind hardness, all except Q.2, the only erect self-trashing variety present, had been attacked by this pest. On another occasion three pieces of trash well up the stalks in a Q.2 field had failed to fall and above each was a *littoralis* bite.

As a pest of cane this species is, on present knowledge, second in importance to the field rat. Often it attacks cane six to eight weeks earlier than *conatus*,

and in some years it is responsible for most of the rat attacks on cane in many Queensland cane districts, when the greater proportion of the effect is of a nuisance order only. This rat is itself capable of causing, and does cause, economic damage to cane, but its chief role is in conjunction with *conatus;* it may be responsible for converting nuisance damage into economic losses or for unduly aggravating the position in fields where losses were already appreciable.

Melomys cervinipes Gould.

Little is known of the nesting habits of this species, and reports of its building in such likely places as vines, stumps, and trees have not been confirmed. In captivity it does not build rounded nests similar to those of the small khaki rat, but is content with a poorly made bed and wood wool as cover; it should be pointed out, however, that this rat has not been bred in captivity. It has many characteristics similar to those of *littoralis*—such as varied diet, agility, wandering, leaving teeth marks around its bites in cane, and attacking cane well up the stalks—but damage inflicted by it is much more severe than that of the smaller rat.

The native habitat of *cervinipes* is rain forest, where it has been trapped over extensive areas; and, although it damages cane adjacent to scrub only, occasional specimens have been taken in cane up to 200 yards from the edge of the scrub.

The status of this species as a pest of cane is at present indefinite, as its true distribution in cane areas in years of heavy rat population is not known. In normal years its activities are confined to occasional infestations, these often resulting in some of the worst rat damage seen in canefields.

Other Species.

None of the species mentioned below damages sugar cane:

H. chrysogaster may be found in canefields close to water, and particularly in fields in rough country broken by creeks or other running water. This rat seldom interferes with traps or baits used against other species, but it can be a serious pest of poultry on farms where unsuitably protected fowlhouses are located near watercourses, swamps, or lagoons. Of *U. caudimaculatus,* Longman (1916) quotes as follows: "Collett notes that it is said to be not uncommon in hollow trees in the plains, but Krefft stated that the animal frequented rocks more than trees, so that its habitat seems to be variable." The author has trapped this species only in rain forest (sometimes in numbers and in varying stages of growth) and in cane adjacent to it, but its presence in the crop is rare and apparently accidental.

Thetomys gracilicaudatus ultra has never been taken in large numbers, although over a number of years occasional specimens have been regularly recorded. Most of these have come from the drier patches amongst or near *conatus* populations.

Mus musculus has often been taken in numbers in the field during early summer and occasionally at other times. This species may be found in burrows in well-cultivated young plant cane, but its full field dispersal is not known, as the snap traps used for the rats and the methods of using them were not suitable for the taking of this mouse. In farm buildings the house mouse is frequently present in its usual pest role, but no plagues, as occurring in other parts of Australia, and which have been discussed by Murnane (1934), Winterbottom (1920), and many others in topical references, have been reported from Queensland sugar districts.

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