

A REVISION OF THE RATS OF THE GENUS *LEPORILLUS*
AND THE
STATUS OF *HAPALOTIS PERSONATA* KREFFT.

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(Plates v-vi.)

While on a collecting expedition on behalf of the Trustees of the Australian Museum, at various stations on the Trans-Australian Railway, I secured several specimens of a stick-nest building rat. This series, in association with specimens already in the Museum collection, has proved of such interest that I present the following conclusions derived therefrom, together with figures of the cranial and other characters of the species of the genus. I am also able to supply notes upon the habits, and a photograph of the nest, of some of these interesting creatures.

During an examination of rats of the short-footed "jerboa" type, I had the cranium of the type of *Hapalotis personata* Krefft removed, and am now able to submit a note upon its status.

I wish to express my especial indebtedness to Professor F. Wood Jones, who generously supplied authentic specimens of *L. jonesi* so soon as he became aware that I was working upon the species of *Leporillus*. Also to Mr. Oldfield Thomas for his encouraging interest and valued notes received in correspondence, dealing with various species of Muridae. Of the Museum staff, I am indebted to Mr. A. R. McCulloch for his very willing help, and to Mr. J. R. Kinghorn, who most kindly prepared the figures, with the help of his assistant, Mr. H. O. Fletcher.

Genus *LEPORILLUS* *Thomas*.

Leporillus Thomas, Ann. Mag. Nat. Hist. (7) xvii, 1906, p. 83—
Orthotype *H. apicalis* Gould; *Id. loc. cit.* (8) iii, 1909, p. 372
(footnote), and (8) vi, 1910, p. 606 (footnote).

First and second upper molars each with two internal cusps; postero-internal cusps absent. Lower m^1 and m^2 each with a posterior concavity, in which a distinct median supplementary cusp is placed. Hind feet with the usual six pads. Ears long. Skull without supra-orbital ridges.

Affinities.—This genus resembles *Rattus* and *Notomys* in having the same number of molar cusps on m^1 and m^2 , but differs from the former in having much longer ears, and from the latter in having a short and broad hind foot with six interdigital pads, instead of a long and very slender foot with three to four pads.

Range.—West of the Lower Darling River in New South Wales; from Alice Springs to the Nullarbor Plains and Nuyts Archipelago in South Australia.

Key to the species.—

- A. Fur of middle of belly not pure white, slate coloured at base. Tail not tipped with white. Depth of muzzle, midway between henselion and palatal foramina, not longer than the upper molar row, which is 9-10.5 mm.
- a. Ear long, much longer than distance between rhinarium and posterior canthus of eye. Front edge of zygomatic plate straight and oblique. Foot slender, its width 6.0-6.6 in its length. Basal length of lower molar row 8.5 mm.
conditor.
- b. Ear short, slightly less than distance between rhinarium and posterior canthus of eye. Front edge of zygomatic plate more or less curved. Foot broad, its width 5.3-5.8 in its length. Basal length of lower molar row 9-9.7 mm.
jonesi.
- B. Fur of middle of belly pure white, white at base. Tail tipped with white. Front edge of zygomatic plate vertical. Depth of muzzle, midway between henselion and palatal foramina, longer than the upper molar row, which is 7.3 mm.
apicalis.

LEPORILLUS CONDITOR *Gould.*

(Plates v-vi.)

Mus conditor Gould, in Sturt's Exped. Centr. Austr., i, 1849, p. 120, pl. i; and ii, app. p. 7.

Hapalotis conditor Gould, Mamm. Austr. iii, 1863, pl. vi. *Id.* Krefft, Cat. Mamm. Coll. Austr. Mus., 1864, p. 65.

Conilurus conditor Ogilby, Cat. Austr. Mamm., 1892, p. 118. *Id.* Le Souef, Austr. Zoologist, iii, 1, 1922, p. 15, pl. i-ii.

External Characters.—Fur of back soft, fine, and moderately thick; an admixture of slate grey fur which is buffy towards, and light brown at tips, and longer blackish hairs which are not so thickly distributed as the short pile.

General colour of back light yellowish-brown, grizzled with blackish-brown; between the ears the yellowish-brown is clearer. Sides becoming greyish-buff. Fur of belly slate grey at base, with buffy-white tips the basal colour shows through the lighter tips, which are whiter on the throat and darkest between the forelimbs, where there is a buff patch. Inside of leg (outside in skin) washed with buff; outside of legs and either side of vent tinged with ochraceous-buff. There is a blackish-brown patch on the wrist, formed of light brown hairs with whitish tips, continued as a narrow bar of colour on the outer side of the hand as far as the base of the outer digit, whence it spreads

out into a dark patch on the metacarpals; extreme outer and the inner side of hand buff; digits darker owing to an intermingling of darker hairs. Feet (Pl. v, fig. 1b) with a patch of dark brown hairs on the outer base of the heels (inner in skin), which is continued in a light, thin line of shading along the outer edge of the metatarsals, and spreads out over the base of the outer digit; this shading is composed of dark grey hairs with dull white tips; rest of upper surface of feet buffy-white save for dark shading at the base of, and on digits. Ear dark brown on the outside, the anterior third of which is well covered with dark brown hairs with lighter tips; the rest of the outer surface is more lightly haired save for some long, light coloured hairs at the postero-external base; the upper half of the inside evenly covered with light brown hairs. Tail dark brown above, changing rather sharply to light buffy-brown on the sides and underneath, the colours being influenced by the scaling, which is dark above and light below; it is evenly covered with hairs, not concealing the scales, which are dark brown, generally with lighter tips above, and cream coloured on the sides and undersurface; the hairs do not become noticeably longer at the tip.

Ear (Pl. v, fig. 1a) large, its length much greater than the distance between the rhinarium and the posterior canthus of the eye, and reaching to about the middle of the distance between the posterior canthus of the eye and the base of the ear; it is longer than the distance between the heel tip and the most distal (3rd) interdigital pad (Pl. v, fig. 1b). Tail shorter than the head and body, its length 1.1 in that of the latter. Foot narrow, its width, opposite the distal end of the inner metatarsal pad, 7 mm.; its length from the heel tip to the end of the longest digit 42 mm.; the width is 6 in the length.

Skull.—Comparatively light (Pl. v, figs. 1c-d). Muzzle long and narrow, its width at the level of the anterior end of the palatal foramina 1.5 in the depth, which is shorter than the upper molar row. Nasals long and slender, their breadth at the middle of their length 3.8 in their length. Interorbital region comparatively narrow, without very sharp angled edges and with the orbital surfaces of the frontals, from the preorbital processes to the fronto-parietal sutures, visible from above. Zygomatic plate narrow, its anterior edge straight but oblique, the base projecting forward and its upper angle gently rounded. Zygomatic arches expanded posteriorly, their breadth at the junction of the process of the squamosal with the jugal greater than the maximum breadth of the maxillary processes. Palatal foramina extending well beyond the level of the anterior roots of the molars, their length equal to that of a molar row. Palate narrow, its width between the second molars equal to that of one m^2 . Bullæ large, opaque, their depth, measured obliquely from the bony tubercle above the external meatus to the lowest point of the ventral surface, 10 mm. The postero-lateral edges of the interparietal forming a broad V, the well-defined apex overhanging the median keel and upper edges of the supraoccipital. Mandible moderately heavy.

Dentition.—Incisors slender and light, each 1 mm. in breadth. Antero-internal cusps of upper m^2 and m^3 (Pl. v, fig. 1e) directed obliquely forward, being situated opposite the divisions and filling the angles between the molars; the cusps press closely against the posterior laminae of m^1 and m^2 . Lower molar row (Pl. v, fig. 1f):—the first lamina of m^1 with a deep outer antero-lateral indentation, its inner cusp widely separated from that of the next lamina; all other laminae, except the hindmost, which is oval, are V shaped, owing to the marked pinching in at their middles and the strongly oblique postero-lateral direction of their inner and outer cusps. Between these cusps are well-marked re-entrant concavities; those behind the second lamina of m^1 and the first lamina of m^2 and m^3 show as deep pits when cleared of calculus, whereas in the concavities behind the posterior lamina of m^1 and m^2 there is placed a well-defined, rounded, median supplementary cusp. All the inner cusps are widely separated except those of m^3 .

Dimensions before Skinning.—Head and body 197 mm.; tail 178; hind foot 44; ear 43.

Skull Dimensions.—Greatest length 45.4; breadth of zygomatic arch at broadest part of zygomatic processes 20.4; breadth at junction of the jugal with the processes of the squamosals 21; nasals 17.5×4.5 ; interorbital breadth 5; palatilar length 21.5; palatal foramina 9.2×4 ; breadth of brain-case 17.6; depth of bulla 10; molar series, upper 9.3, lower 8.5.

Specimen described.—Adult female. Australian Museum Collection, No. M.3062. Collected 11th October, 1921, by E. Le G. Troughton and J. H. Wright. A series of dried and spirit specimens also examined.

Variation.—The general colour of four dried skins does not display marked variation beyond that the young specimens are slightly darker dorsally, the light brown tint becoming stronger in the older specimens. Two specimens have a short fur of varying length intermingled with the slate grey of the under fur; this is presumably a new growth, being so short in parts that only the lighter tips are showing above the skin, whereas in other parts the young fur shows a slate grey base, the light brown tips appearing half-way up the slaty base of the old fur and giving the appearance of rings of colour.

Comparative measurements of four spirit specimens exhibit a slight variation in the ear length; in two it is equal to the distance between the heel tip and the most distal pads, while in another it reaches from the former point to the middle of the longest digit. Measurements of eight fresh specimens show the tail to be from 10 to 20 mm. shorter than the head and body. Foot narrow, its width on a level with the distal end of the inner metatarsal pad from 6 to 6.6 in its length.

Comparative measurements of five crania show that the muzzles and nasals vary considerably in relative proportions with age. In four skulls from the same locality on the Trans-Australian Railway the muzzles of the young are relatively broader than those of adults, the muzzle width ranging from 1.2 to 1.5 in its depth; the width of the nasals of the smallest are 3.3 in their length, whereas they are 3.8 in the largest; in an adult from the Lower Darling these characters agree with the younger examples of my series rather than with the adults. The zygomatic plate is somewhat variable in shape, but the oblique anterior edge, with its projecting base, is maintained. Upper and lower molars of five skulls do not vary except for slight changes in general appearance due to wearing down in the older specimens; basal length of upper rows 9.9.3, lower rows 8.5.

Comparison with Allies.—The slender feet and large ears of this species resemble those of *apicalis*, but it is easily distinguishable from the latter by the structure of the cranium and teeth; it also has slaty basal belly fur and no tail tuft, as opposed to the entirely white belly fur and white tufted tail of *apicalis*. My specimens of *conditor* may be readily distinguished from *jonesi* by the markedly shorter ear and heavier foot, as well as by the stouter skull of the latter.

Identity.—*L. conditor* was first secured by Sturt in 1844 during one of his exploring expeditions on the banks of the Lower Darling, about 45 miles from Laidley's Pond. Since that time very few specimens seem to have been taken. Referring to the species in 1921, Mr. Oldfield Thomas wrote "there is no specimen of it in the British Museum," and in 1922 he recorded, on my authority, that there were no specimens in Sydney that could be recognised as *authentic* examples of Sturt's *conditor*. However, I have since found a single specimen in the old collection of the Australian Museum, which is entered as No. 86 in the Museum's earliest register, compiled by Secretary Palmer about the year 1877; the specimen may reasonably be considered identical with one presented to the Australian Museum by Krefft in 1861¹ as a "Building Rat, *Hapalotis conditor*," and subsequently listed by him in 1864; it is said to be from the Lower Murray, and, though considerably faded and with an imperfect skull, is apparently specifically identical with specimens recently collected by myself between Ooldea and Fisher in South Australia. I have no doubt, therefore, that the specimen described above is correctly identified as *L. conditor*.

Synonymy.—In his valuable "List of Australian and Austro-Pacific Muridæ," 1916, p. 37, Longman incorrectly relegated *conditor* to the synonymy of *Conilurus albipes* and overlooked Ogilby's reference to the former. Not only are these two specifically distinct, but *conditor* proves to be referable to the genus *Leporillus*, the members of which are distinguished by dental characters from the genus *Conilurus*, to which *albipes* belongs.

¹ Aust. Mus. 8th Ann. Rept., 1861 (1862), p. 3.

Nests.—As noted by Sturt², the nest was first described by Mitchell³, but that explorer apparently did not keep a specimen of the animal which made it. He incorrectly ascribed it to *C. constructor* Ogilby, which species is synonymous with *C. albipes*⁴, but according to Gould⁵, this latter species does not build any such nest. It is therefore clear that Mitchell's description applies to the nest of *C. conditor*, as recognised by Sturt and Gould.

According to Mitchell's description of the nest in the region around the Lower Darling River, it consisted of a stack of small branches worked around and interlaced with a small bush, the whole resembling a pile for a signal fire. According to Sturt's description of nests in the same region, they were in the form of a compact cone like a beehive, and are so figured by him and by Gould⁶.

Nests found by myself in an area from five to twelve miles west from Ooldea, South Australia, were exactly as described by Mitchell and not as represented by Sturt and Gould. The discrepancy between the above authors' descriptions of the nests is doubtless accounted for by the fact that the structure varies in character according to the conditions of terrain and available material. As an instance of this, the nests which I found around Ooldea, built in the shallow depressions, or "dongholes," where there was ample vegetation, were about three feet high and firmly constructed around the base of a bush, whereas nests of the same species in the neighbourhood of Fisher, where dongholes and suitable bushes were not available, consisted of a comparatively flattened heap of sticks without definite cone-like shape or central support, and were placed over rabbit warrens in the open plain.

While stationed at Ooldea and Fisher on the Trans-Australian Railway, my assistant (J. H. Wright) and I had excellent opportunities for observing the nests and habitat of these interesting Murids. We tramped over three types of country within about fifty miles of Ooldea, situated on the edge of the vast Nullarbor Plain, where a remarkable contrast is shown between the mallee and stunted scrub growing on the sand waves eastward of Ooldea and the flat monotonous landscape which the train enters immediately west of the station and traverses for three hundred miles. There were no stick nests in the scrub around Ooldea, and, after walking a zig-zag course all one morning, we could not find a nest on the plain within several miles of the scrub; the railway gangers, who were most kind and gave every assistance,

² Sturt—Exped. Centr. Austr. i, 1849, p. 120.

³ Mitchell—In Ogilby, Trans. Linn. Soc. Lond. xviii, 1, 1838, p. 127-8, and Three Exped. Int. E. Austr. i, 1838, p. 305, and ii, p. 261-2.

⁴ *Vide* Gray, Ann. Mag. Nat. Hist. ii, 1839, p. 308.

⁵ Gould—Mamm. Austr. iii, 1863, pl. i.

⁶ Gould—loc. cit., pl. vi.

spoke of a nest about a mile from the station, but we could not find it, and it must have been an isolated one. This scarcity of nests close to the station may have been due to the aboriginals, who are not encouraged by the authorities to go farther west, and make a regular camp at Ooldea; food is generally scarce, and on the plain for several miles may be seen excavations where the natives have been digging out rabbits and bandicoots; the rats were doubtless eaten by the natives, who, according to observers, regard them as a delicacy; this would entail destruction of the nests, and account for their absence close in.

Scattered over the plain, for about twelve miles westward of Ooldea, are slight depressions which have the appearance of shallow lake beds, where the soil is softer and the monotonous blue bush gives place to thick rank grasses and stunted bush (Pl. vi, fig 1). These "oases," dongas or "dongholes," as they are called, watered only in times of heavy rain, must seem a veritable haven of refuge to the animals of the plains, which we found, to our relief, prone to congregate in them. The struggle for existence and accommodation must be very keen, and in one of the larger dongholes we saw striking proof of congestion, in a typical stick nest of *conditor* on the top of which was the nest of a Striped Brown Hawk, *Ieracidea berigora* V. & H. (Pl. vi, fig. 2). The rat's nest was of a typical shape, save that a neat depression at the apex of the cone housed the bird's three eggs; the association was a strange one, and it is difficult to surmise what pact or understanding reconciled these ill-matched householders. Bones littered about inside the rat's nest suggested a meat diet, and most rats are partial to eggs, while there are many records of the partiality of the Brown Hawks for small quadrupeds, such as marsupials and rats, as food.

The cone-like type of nest, such as found on the plain west of Ooldea, has been so well described by earlier writers that little remains to be written; one of the largest we observed was quite three and a half feet high, with a diameter of not less than five feet. All nests of this type examined had the grass nests within, and the "hole in the ground" underneath them described by Gould was of varying length, comparatively straight and did not descend to any depth; somewhat like a shallow rabbit burrow and not always entirely covered in, it may be used for food storage as suggested by Gould, as well as an additional hiding place. The nests are so firmly woven that we found dragging them apart a difficult and trying task in the heat and dust; the use of the trunk and limbs of a gnarled and stunted tree as a basis for the structure of interwoven sticks gives it an extraordinary strength, which is doubtless a protection from the dingoes, which travel over the plains in great numbers at certain seasons, as well as from the strong winds which prevail and would soon disperse a mere heap of light, dead sticks. A few nests were observed without any central support, though good ones were available, and these, though somewhat flattened, were more of the type described by Gould and very closely woven.

The first donghole searched contained one large nest which Wright proceeded to disturb, the writer waiting with gun poised. After several false alarms caused by rabbits rushing from the refuge, where they are seemingly quite at home, we caught our first glimpse of a living *conditor*, moving very rapidly. The rabbit-like appearance of this rat mentioned by various authors was heightened by its method of running; we had ample opportunity to observe that this was quite as in *Rattus*, and never jerboa-like as in *Notomys*. Having noted the rabbit warren to which the quarry had retreated, we burrowed after it with our hands and a small entrenching tool. On reaching the junction of two burrows, excitement became intense, and the rat, after several feints, sprang out with such velocity as to completely baffle its pursuers. This happened several times, but fortunately there is only a shallow layer of soft earth about two feet deep in the dongholes, under which is a hard stratum preventing the excavation of deep burrows, so that we eventually secured our largest specimen as it crouched in a burrow with several rabbits.

Some of the large dongholes contained as many as six nests, and, though one regretted destroying the results of so much industry, time was precious, and the holders so unwilling to leave their forts that it became necessary to realise Mitchell's simile of the "signal fire . . . used by the natives," by burning one of the nests to obtain a series of specimens. The rats, as they emerged, rose up firmly on their strong hind feet and surveyed the surroundings before darting to a rabbit burrow.

Twelve miles westward of Ooldea the dongholes gradually disappear, and the landscape at Fisher, about forty miles farther on, is flat and fairly well covered with stunted bushes about knee-high. Here the frail bushes do not provide either adequate central support or sticks strong enough for the cone-like type of nests, which are therefore built over rabbit warrens, and in many cases had small stones placed among and on top of the sticks for added security. These nests looked like deserted crows' nests, having none of the orderly shape of those nearer Ooldea, and we might have doubted that they were occupied had we not occasionally surprised a rat sunning itself on top of one of them. The rats were very alert, and the nests, being placed at the confluence of several rabbit burrows in the centre of a warren, provided many avenues for escape; we tried to shoot specimens, but they always disappeared before coming within range of our light gun. To dig for specimens amongst the ramifying burrows was impossible, and as the rats were very wary of traps, we congratulated ourselves upon having secured a series from about Ooldea.

This species, unlike *L. apicalis* and *C. albipes*, which have been observed to live in hollow trees, appears to prefer entirely plain country, requiring the nest for protection.

Enemies.—Other enemies, doubtless more dreaded than the dingoes mentioned above, are the Barn or Delicate Owls, *Tyto alba*, which live in the limestone caves or "blowholes" which are scattered over the Nullarbor Plain. Though the openings of these blowholes are sometimes too small to allow a man to enter, they usually open out into a fair-sized chamber, from which small crannies are given off; their name is derived from the surprisingly strong wind which blows up from the crannies and out through the openings above; according to popular report the air at times is drawn strongly inward, the change in the direction of the draught being attributed to the action of the tides, some sixty miles away. We found owls roosting in several of the blowholes and collected a great many of their castings, the majority of which contained complete skulls of *conditor*, as well as those of a *Notomys* and a *Phascogale*.

In other areas, apart from the species' dislike of being disturbed by sheep and cattle, the penchant of the aboriginals for it as a food must have been a considerable factor in its extermination. Professor Sir Baldwin Spencer in a letter to Mr. E. R. Waite quoted the statement of a friend who forwarded specimens of *conditor*: "I let the boys (*i.e.*, blacks) have an hour's sport burning out some of them and chasing the inhabitants, which are regarded as a delicacy; there were four or five in each mound we tackled." Doubtless such depredations and the advance of settlement have driven the species to the more inaccessible desert country; on the vast Nullarbor Plain, where there is no stock and the natives are unable to exist, the species thrives in great numbers.

Habits.—Mr. A. S. Le Souef has noted the peculiar method *L. conditor* has adopted of carrying the young, which are firmly attached by their mouths to the nipples of the parent. There are several references to such an attachment amongst various genera of native Murinæ, doubtless the earliest being that of Gould⁷, who quotes, when writing of *Hapalotis albipes*, a note sent him by Sir George Grey during his Governorship of South Australia: "The specimen I send you, a female, had three young ones attached to its teats when it was caught. . . . While life remained in the mother they remained attached to her teats by their mouths, and grasped her body with their claws, thereby causing her to present the appearance of a marsupial minus the pouch. On pulling the young from off the teats of the dead mother, they seized hold of my glove with the mouth and held on so strongly that it was difficult to disengage them." Ogilby⁸ has commented upon this note.

Writing upon *Uromys cervinipes*, Lönnberg⁹, quoting Dr. Mjöberg's diary, writes of a female carrying four young ones "hanging attached at the nipples and dragging after her on the ground." After a ten minutes' chase the young ones had not let go their hold and did not do so until dropped into alcohol with the mother.

⁷ Gould—Mamm. Austr., 1863, pl. i.

⁸ Ogilby—Cat. Mamm. Austr., 1892, p. 114-5.

⁹ Lönnberg—Kungl. Sv. Vet. Akad. Handl. lii, 2, 1916, p. 4.

Describing *Uromys littoralis*, Lönnberg¹⁰ refers to further notes by Dr. Mjöberg and writes "the two young ones remained attached to the teats, although the mother ran hither and thither on the beach for awhile before she was caught, and the young were dragged along the ground. The young are hairy and . . . the mouth is open and appears quite normal. It is not obliterated at the sides as in the marsupials for retaining the maternal nipple. It is thus evident that the young animal in the present case has the faculty of holding on to the teat of the mother by means of their own muscular strength and with the aid of their jaws, lips and teeth. I think that it is especially the latter which are important . . . they are naturally enough, not worn to chisel-shaped edges at the ends, in which case they would wound the mother; on the contrary they are, especially those of the upper jaw, blunt. The upper incisors are also a little diverging with their bluntly rounded extreme ends, and by this, no doubt, the young animal gets a firmer grip. . . . a remarkable biological fact . . . but there is, of course, not the slightest trace of any marsupial affinity indicated by this."

Localities.—Lower Murray; Ooldea and Fisher on the Nullarbor Plain, Trans-Australian Railway, South Australia.

Distribution.—This species appears to have had a very wide range, as it occurred on the Lower Darling as well as at the above localities. This range is now greatly restricted, and Krefft, giving the habitat as "The plains of the interior," wrote in 1864: "This animal has become exceedingly rare, and is only found in localities where it is not disturbed by sheep or cattle. I do not think that it occurs south of the Murray, where, according to the aborigines, it was found in large numbers not many years ago."

LEPORILLUS APICALIS Gould.

(Plate v, fig. 3.)

Hapalotis apicalis Gould, Proc. Zool. Soc., 1851, p. 126, and Mamm. Austr. iii, 1863, pl. ii. *Id.* Krefft, Cat. Mamm. Coll. Austr. Mus., 1864, p. 64. *Id.* Spencer, Horn Exped. ii, 1896, p. 11.

Conilurus apicalis Ogilby, Cat. Austr. Mamm., 1892, p. 116. *Id.* Waite, Proc. Roy. Soc. Viet. x, 2, 1898, p. 115, pl. v, figs. 1a-e.

Leporillus apicalis Thomas, Ann. Mag. Nat. Hist. (7) xvii, 1906, p. 83, and *loc. cit.* (9) viii, 1921, p. 433 and pp. 618-620.

External Characters.—In the Australian Museum Collection are three dried and mounted specimens, which, though old and somewhat faded, agree well with Gould's descriptions and figure, and are quite as described by Waite. The general colour of the back is well represented in Gould's figure; it is lighter and not so grizzled as in *conditor*,

¹⁰ Lönnberg—*loc. cit.*, p. 6.

owing to the darker hairs being lighter and not so numerous as in the latter species. The fur of the under surface from the chin to the vent is entirely white from base to tip. Hands white with a median brown oblique mark separating the white from the greyish-brown of the upper limb. Feet white, showing signs of the "dark" marking described by Waite; the marks are light brown and irregularly placed, the most consistent being a faint line running down the outer side of the metatarsals; the faint markings do not restrict the generally white colour of the foot to any definite pattern. Ears: outside covered with light brown hairs which are longer and darker on the anterior third; upper half of inside covered with light yellowish-brown hairs. Tail with basal three-fourths of upper surface brown, the colour narrowing to a thin line and fading out towards the apical fourth, around which the hairs are considerably lengthened, forming a pencil of white; entire under surface lighter.

Ear long; in two dried specimens the length is greater than the distance between the rhinarium and the posterior canthus of the eye and equal to the distance between the heel tip and the fourth interdigital pad. Tail, according to Waite's measurements, considerably longer than the head and body. Foot long and slender.

Skull.—Comparatively light and elongate; its upper profile comparatively straight and not much bowed in the nasal region. Muzzle deep, its width above the anterior end of the palatal foramina 1.6 in the depth, which is longer than the upper molar row. Breadth of the nasals at the middle of their length, 3.8 in the length. Interorbital region broad, with sharp angled edges and with very little of the orbital surface of the frontals visible from above. Front edge of zygomatic plate straight and vertical, its upper angle gently rounded. Zygomatic arches expanded posteriorly; according to Waite's figures their breadth at about the junction of the process of the squamosal with the jugal is considerably more than the maximum breadth of the maxillary processes. Palatal foramina comparatively long, reaching the level of the anterior roots of m^1 . Palate broad, its width between the second molars greater than the width of m^2 . Bullæ missing. Mandible light.

Dimensions (of three dried and mounted specimens).—Ear 28-29 mm.; hind foot 41-43 mm.

Skull Dimensions.—Nasals 14.5×3.8 ; interorbital breadth, 5.2; palatilar length 19; palatal foramina 8.5×3.5 ; molar series, upper 7.3, lower 7.5.

Specimens described.—The above description is based on three old and considerably damaged specimens, which are evidently identical with those catalogued by Krefft in 1864, and do not display any noticeable variation. Associated with them is a label inscribed "The White-tipped Tree Rat, *Hapalotis apicalis*."

Dentition.—Incisors rather slender. Upper molars with their general arrangement as in *conditor* (Pl. v, fig. 1e), but distinctly smaller. Lower molars (Pl. v, fig. 3):—first lamina of m^1 without a strong outer antero-lateral indentation, its inner cusp not so widely separated from the next as in *conditor*; the other laminae much as in *conditor* but simpler, their inner and outer cusps not so obliquely placed and the concavities are therefore not so large; there are the same pits behind the second lamina of m^1 and the first of m^2 and m^3 ; the last is small owing to the thickness of the centre of the lamina; the well-defined, median supplementary cusp behind the posterior lamina of m^1 and m^2 is also present; inner cusps of molar row not as widely separated as in *conditor*.

Comparison with Allies.—Form lighter and teeth smaller than in *conditor* and *jonesi*. The upper surface of the foot is white with only faint suggestions of the dark markings which are present in a greater or lesser degree in *jonesi* and *conditor*. It is readily distinguished from the two latter by its entirely white belly fur, white tail tuft, whiter feet, smaller teeth and generally more delicate form and skull. The skulls of *apicalis* available to me are incomplete, but, according to Waite's figures, the zygomatic arches are wider posteriorly than anteriorly.

The White-tipped Tail.—In a recent paper, Thomas¹¹ discusses the type of *L. apicalis* Gould, which he states has now an imperfect tail. He further says that Gould "wrongly" described the tail as being white-tipped, and refers to a second specimen from Gould's collection in support of this contention. Gould's descriptions of the species in 1851 and 1863 state definitely that the "apical fourth" of the tail was "thinly clothed with white hairs"; he also mentioned, in comparison with the heavy brush of *C. albipes*, that the tail was "nearly destitute of the long brushy hairs towards the tip," and that he had but a single specimen with those characters. Krefft, who saw numerous living specimens, describing the tail of *apicalis* in 1864, wrote: "It has been stated that the tail of this animal is nearly destitute of the long brushy hairs towards the tip. . . . This, however, is not the rule, but the exception only, though specimens kept in captivity soon lose the long hairs, and frequently their tails also, if kept in company with other rodents." Though Krefft omits colour in his description, the tails were evidently white since he calls the species "The White-tipped *Hapalotis*." Waite in 1898 described several specimens of *apicalis* from Central Australia and specially noted that Gould's figure was an excellent representation of the animal; he also described a pencil of white hairs at the tip of the tail and suggested that it was probable that the tail of Gould's single example "had been somewhat denuded of hair."

¹¹ Thomas—Ann. Mag. Nat. Hist. (9) viii, 1921, p. 619.

Of three specimens in the Australian Museum only one is complete enough to show the white portion of the tail; though its extreme tip is missing, it has a definite tuft of lengthened white hairs extending around and along the end for about an inch. The tails of the other two are not sufficiently complete to show the tuft. In consideration of the foregoing I cannot accept Thomas' suggestion that the type of *apicalis* was originally other than as described by Gould.

Identification of the Holotype.—Despite the fact that Gould wrote in 1863, twelve years after his original description was published, that he possessed "a single example only of this species," Thomas¹² has referred to two specimens from Gould's collection in the British Museum, one of which he selects as the lectotype of *L. apicalis* (B.M. No. 53. 10. 22. 15). Two months later, however, Thomas¹³ definitely states that Gould "seems only to have done his describing from one of them (B.M. No. 53. 10. 22. 14), the worst of the two, young and with an imperfect tail." It is therefore obvious that this latter specimen must be accepted as the holotype of the species.

Habits.—"Nocturnal and gregarious" according to Kreffft, who also wrote: "I have frequently taken from eight to ten out of a hollow tree, and tamed them so that they kept about the camp, mounting the supper table at tea time for their share of sugar and damper."

Writing of the "hut-like mounds of dry sticks" constructed by *conditor*, frequently observed by him on the Murray Plains, Kreffft noted that "they are either uninhabited or occupied by *Hapalotis apicalis*, a species always at war with the larger, and apparently stronger, but not so numerous *Hapalotis conditor*."

Localities.—The specimens are labelled as having been obtained on the Lower Murray and Lower Darling Rivers.

Distribution.—Gould's holotype was "procured by Mr. Strange in South Australia." Two specimens were secured at Alice Springs, Central Australia, by Messrs. Gillen and Field, who presented them to Professor Sir Baldwin Spencer. The species once inhabited the "Plains of the Murray and Darling" according to Kreffft.

LEPORILLUS JONESI *Thomas*.

(Plate v, figs. 2a-2f.)

Leporillus jonesi Thomas, Ann. Mag. Nat. Hist. (9) viii, 1921, p. 618.

External Characters.—Fur rather thin and poor, not so thick as that of *conditor* or *apicalis*; slate coloured basally both above and below. The general colour of the back, sides and under surface much

¹² Thomas—loc. cit., p. 433.

¹³ Thomas—loc. cit., p. 620.

as in *conditor* but darker. On the hands the brown colour-marking is darker and covers much more of them than in *conditor*. The light colour-mark on the surface of the foot (Pl. v, fig. 2b) is more clearly defined and the brown shading is heavier and darker than in *conditor*. Outsides of ears dark brown; upper third of insides covered with yellowish-brown hairs. Tail blackish-brown above, brownish-white below, the colours darker than in *conditor*.

Ear short (Pl. v, fig. 2a), its length slightly less than the distance between the rhinarium and the posterior canthus of the eye; not longer than the distance between the heel tip and the distal end of the first interdigital pad. Tail considerably shorter than the head and body in a spirit specimen; the tail, in two specimens, ends so obtusely as to appear imperfect, but after careful examination, and the removal of the caudal vertebræ, there seems no doubt that they are complete. The tail is more heavily haired than in *conditor*, the scales being almost concealed; the hairs are decidedly longer towards the end, some long ones extending about 14 mm. beyond the tip. Foot broad, its width opposite the distal end of the inner metatarsal pad 9 mm. (Pl. v, fig. 2b); its length from the heel tip to the end of the longest digit 48 mm.; the width 5.3 in the length.

Skull (Pl. v, figs. 2c-d).—Stout and very heavy in the nasofrontal region, the latter accentuated by the considerable thickening of the nasal processes of the premaxillæ; width of the muzzle, at the level of the anterior end of the palatal foramina, 1.2 in the depth, which is shorter than the molar row. Nasals broad and strong, their breadth at the middle of their length, 3.3 in the length. Interorbital region broad, with comparatively sharp angled edges, and with only a small posterior portion of the orbital surfaces of the frontals visible from above. Zygomatic plate broad, its anterior edge curved, concave below, its upper angle projecting forward and broadly rounded. Zygomatic arches expanded anteriorly, the maximum breadth of the maxillary processes greater than the breadth of the arches at the junctions of the processes of the squamosals with the jugals. Palatal foramina short and just reaching the level of the anterior roots of the molars; their length less than that of an upper molar row. Bullæ medium in size, noticeably smaller than those of *conditor* in skulls of the same size, their centres semi-transparent; their depth, measured obliquely from the bony tubercle above the external meatus to the lowest point of the ventral surface, 9 mm. Mandible heavy.

Dentition.—Incisors heavier than in *conditor*, but rather slender for the heavy skull; each more than 1 mm. broad.

The variation displayed by the worn and unworn molars of two specimens is so striking that I have described both conditions, and figured the worn rows of *jonesi* for comparison with the unworn ones of *conditor*, which are typical of the genus.

Comparatively unworn molars of an adult female much as in *conditor* (Pl. v, figs. 1e-f), but somewhat heavier. Upper molars:—antero-internal cusps of m^2 and m^3 situated opposite the divisions and filling the angles between the molars; the cusps pressing closely against the posterior lamina of m^1 and m^2 . Lower molars:—first lamina of m^1 with an indentation anteriorly; all other laminae except the last strongly pinched in at their middles, their inner and outer cusps oblique; posterior lamina of m^1 and m^2 with a well-marked posterior concavity in which is placed a very distinct, rounded median supplementary cusp.

The very worn molars of an aged male, upon which the general description is based, differ markedly from the unworn molars in the following features. Upper molars (Pl. v, fig. 2e) heavier and more rounded; antero-internal cusps of m^2 and m^3 not directed obliquely forward or situated opposite the divisions between the molars, and the cusps not touching the posterior lamina of m^1 and m^2 . Lower molars (Pl. v, fig. 2f), heavy and rounded, the laminae not, or scarcely pinched in at their middles and without the oblique set of the inner and outer cusps. The posterior lamina of m^1 and m^2 are not pinched in at all, and are without any trace of concavities or median supplementary cusps behind, the posterior edges of the laminae being convex and closely opposed to the laminae of the succeeding teeth.

Variation.—In a female spirit specimen, 10 mm. shorter than the male described, the ear and tail are of the same length and the foot somewhat lighter, its width being 5.8 in its length, as opposed to 5.3 in the male. In the two spirit specimens the tail is from 30 to 42 mm. shorter than the head and body. The skull of the female is somewhat lighter than that of the male, but heavier than *conditor* in skulls of the same size. Zygomatic arches of the female as wide at the maximum breadth of the maxillary processes as at the junction of the squamosals with the jugals; they are not expanded anteriorly as in the male described. Palatal foramina of the female 1.2 mm. longer than those of the male in skulls of almost equal size. Basal length of upper molar rows 9.5 to 10.5, lower 9.2 to 9.7.

The variation between the molars of the aged male and the adult female is remarkable. In the former the lower molars are so worn that there is not the slightest trace of concavities or median cusps behind m^1 and m^2 ; they are worn down below the level of the median cusps so that the latter are completely effaced. In the female the concavities and cusps are present in the unworn state. This would seem to indicate that unless a series is available, the presence or absence of such cusps is a character which should be accepted with great reserve.

Dimensions (of spirit specimen).—Head and body 206 mm.; tail 164; hind foot 48; ear, from outer base to tip, 29.

Skull Dimensions.—Greatest length 45.4; breadth of zygomatic arch, at broadest part of zygomatic processes of maxillæ, 23.2; the breadth, at the junction of the jugal with the processes of the squamosals 22; nasals 16.7×5 ; interorbital breadth 5.5; palatilar length 22; palatal foramina 8×3.8 ; breadth of brain-case 17.8; depth of bulla 9; molar series, upper 10.5, lower 9.7.

Specimen described.—An adult male in the Australian Museum collection No. M.3061, presented by Professor F. Wood Jones. The description of the unworn molars is based upon a skull, No. S.1600 also kindly presented by him. A female spirit specimen, lent by Professor Wood Jones, was also examined.

Comparison with Allies.—Form and teeth heavier and the ear smaller than in the other members of the genus. Foot much larger than in *conditor* and with the light mark more clearly defined. In adult skulls of the same length that of *jonesi* is noticeably heavier, but the bullæ are smaller and the palatal foramina are shorter than in *conditor*; the palatal foramina of the former are also shorter than those of a much smaller skull of *apicalis*. The zygomatic arches of *jonesi* are as broad or broader anteriorly, whereas they are broader posteriorly in all my specimens of *conditor* and, according to Waite's figures, in *apicalis*.

Habits.—Professor Wood Jones, to whom the discovery of this species is due, kindly forwarded me some notes upon its habits, but, it being his intention to write upon the species at an early date, I quote but briefly such of the information as is of especial importance in relation to the habits of the other species. The "rats build nests" of sticks which are "often over penguins' holes. Many rats live under and between great granite boulders. Make no burrows of their own."

Localities.—Franklin Island, Nuyts Archipelago, South Australia.

RATTUS RATTUS *Linnaeus*.

Hapalotis arboricola (Macleay) Krefft, in Gould's Mamm. Austr. i, 1863, p. xxxv.

Hapalotis personata Krefft, Proc. Zool. Soc., 1867, p. 318.

Mus novae zelandiae Buller, Trans. N.Z. Inst. iii, 1871, p. 1, pl. i. *Id.* Hutton, *loc. cit.* xi, 1879, p. 344.

Mus griseocaeruleus Higgins and Petterd, Proc. Roy. Soc., Tasm., 1882 (1883), p. 173, fig. 2-2a, and 1883 (1884), p. 197. *Id.* Longman, Mem. Qld. Mus. v, 1916, p. 34.

Mus variabilis Higgins and Petterd, Proc. Roy. Soc., Tasm., 1882 (1883), p. 174, fig. 3-3a. *Id.* McCulloch, Rec. Austr. Mus. vi, 4, 1907, p. 312.

Mus tamarensis Higgins and Petterd, Proc. Roy. Soc. Tasm., 1883 (1884), p. 185. *Id.* Longman, Mem. Qld. Mus. v, 1916, p. 34.

Mus (Hapalotis) tompsoni Ramsay, Proc. Linn. Soc. N.S. Wales, vi, 4, 1882, p. 763, figs 1-3. *Id.* McCulloch, Rec. Austr. Mus. vi, 4, 1907, p. 312.

Conilurus personatus Ogilby, Cat. Austr. Mamm., 1892, p. 118.

Mus rattus rufescens Collet, Proc. Zool. Soc., 1897, p. 323.

Mus arboricola Waite, Proc. Zool. Soc., 1897, p. 857-860 (with note by Thomas).

At the time Krefft described *Hapalotis personata* it was apparently not realised that *R. rattus* was established in Australia. The first authentic record of its occurrence was probably the published description of *H. arboricola* Macleay in 1863, though the identity of that species with *rattus* was not determined until 1897. It is surprising that writers, dealing with rats taken in localities and conditions typical of those affected by *rattus*, should have described so many synonyms of the species and even allocated them to different genera. While the status of these synonyms remained in doubt they formed a considerable obstacle to any work on allied species; it is therefore with satisfaction that I definitely relegate another of these doubtful species to its correct place in the Australasian synonymy assembled above.

H. personata Krefft, has not been recognised since it was first described, and, though Mr. Oldfield Thomas' remarkable knowledge of the Murinæ enabled him to suggest that it "probably belongs to *Mus*,"¹⁴ its affinities and status have remained unknown. The type and two other mounted specimens are in the collection of the Australian Museum, and an examination of their crania and external characters proves *personata* to be synonymous with *rattus*.

In describing *personata*, Krefft, evidently referring to the complete laminae and also the cusps as "tubercles," wrote: "In the upper jaw the first tooth has three tubercles of almost equal size, the second also three (the inner one very small), and the third two (the inner less than half the size of the outer one)." In the absence of a specimen this might suggest that the teeth were of the *Mesembriomys* type, but the posterior lamina of m^1 and m^2 do not extend across to form a third postero-internal cusp to these teeth. The "second tooth" has two laminae, the "inner tubercle" of Krefft being the antero-internal cusp of m^2 ; the tooth was regarded by the author as having three tubercles. In the lower molar row, the author's fourth and third tubercles of m^1 and m^2 respectively, are the median supplementary cusps which are typical of these teeth in *rattus*, with which species the dentition agrees in every essential.

¹⁴ Thomas—Ann. Mag. Nat. Hist. (7), xvii, 1906, p. 84.

The body and tail measurements given by Krefft agree approximately with those of the mounted specimens, from which they were doubtless taken; the head and body of these specimens are considerably stretched, which evidently accounts for Krefft's statement that they are longer than the tail. The specimens are old and their fur very much thinned, so that the dark mark from the nose to the eye described by Krefft is not discernible; it is possible that it was part of the dark colouring of the upper surface, the edge of the lighter colour of the under surface running just below the eye in the mounted specimens.

In deciding the affinities of this long lost species, the interesting fact has emerged that *rattus* had established itself at Cape York, apparently in the bush, as early as 1867.

The type of *personata* is registered no. 75, and two other specimens nos. 76-7, in Secretary Palmer's register of the early Australian Museum collection.

I have included *R. rattus rufescens* Collett in the above synonymy as the measurements quoted by him are typical of Australian specimens of *rattus*. I have collected specimens of the blackish-gray and others of the *rufescens* type of colouration within a few yards of each other; they were of similar length, the head and body of each being about 7 ins. long.

Habits and distribution.—Since the first records of its appearance in Australia, this ubiquitous old world species has spread amazingly, reaching the remoter parts of the country and periodically occurring as plagues and doing grievous damage. It has also been associated with two serious outbreaks of bubonic plague. The writer has trapped it in the bush at Eyre's Peninsula, and between Albany and Denmark in south Western Australia. In the latter locality, where *Rattus fuscipes* was once plentiful, my traps were recently repeatedly filled with *R. rattus*.

Several years ago *rattus* was accidentally introduced to Lord Howe Island, where its variability in colour caused residents to believe that more than one species was represented. On the island many of the rats have adopted the same mode of life as attributed to "*arboricola*," building nests in vines and tree spouts, and eating fruit, vegetables, and molluscs; one of the nests was in a spout about sixteen feet from the ground, the opening of which was filled with layers of fresh leaves, the nest apparently communicating with the hollow centre of the tree. The rats, having increased with characteristic rapidity, now overrun the island and seriously menace the local seeding industry; they climb to, and travel with ease, amongst the close growing palm tops, eating an amazing quantity of the valuable *Kentia* Palm seeds. They also eat the eggs and young of insectivorous birds, which they have so nearly exterminated that the insect fauna has greatly increased. The rats also eat household stores, corn, potatoes,

fruits, and the roots of rare and interesting plants. As noted of "*arboricola*," they are very partial to snails, and the gnawed shells of *Placostylus bivaricosus* may be seen all over the island and taken from the nests of rats. The living snails, which were once very plentiful, are now quite scarce, possibly because they supply moisture as well as food for the rats in dry seasons.

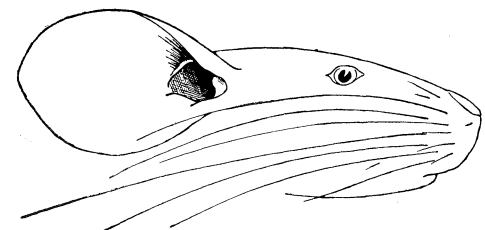
Boulenger¹⁵ has noted that *R. Rattus* and *norvegicus* are now often found living in harmony together, and I recently received specimens of both species taken from the same house at Neutral Bay, Sydney.

¹⁵ Boulenger—Proc. Zool. Soc., 1919 (1920), p. 244.

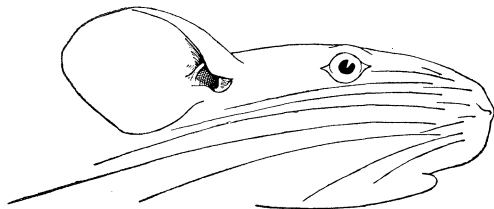
EXPLANATION OF PLATE V.

- Fig. 1. *Leporillus conditor* Gould.
„ 2. *Leporillus jonesii* Thomas.
„ 3. *Leporillus apicalis* Gould. Lower molar row.
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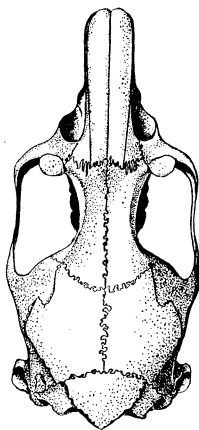
- a. Outline of head.
b. Upper and lower surface of foot.
c. Skull from above.
d. Skull, profile.
e. Upper molar row.
f. Lower molar row.



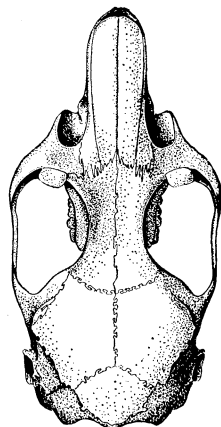
1a



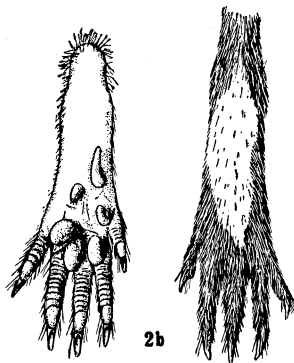
2a



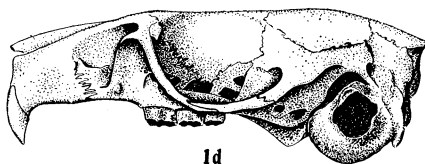
1c



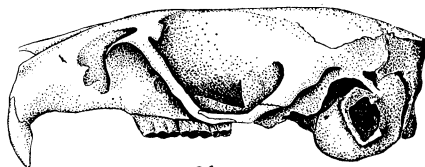
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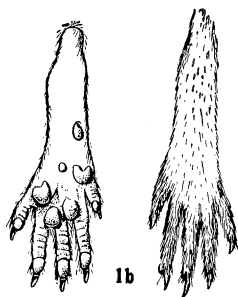
2b



1d



2d



1b



1e



2e



2f



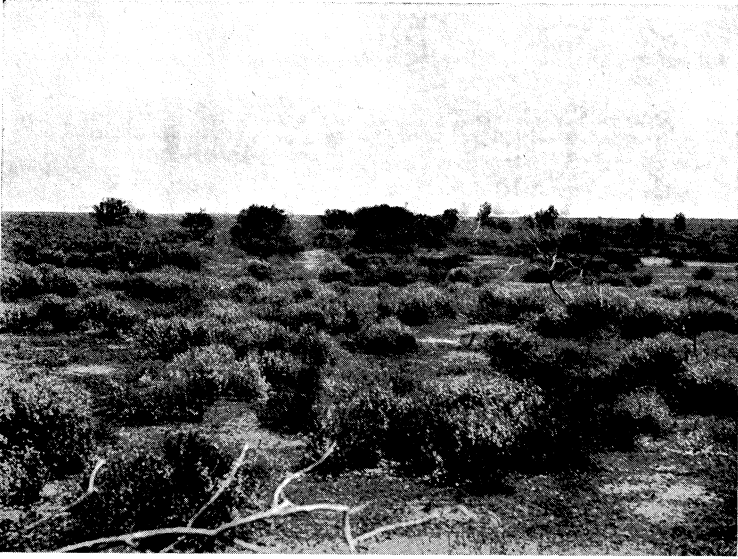
1f



3

EXPLANATION OF PLATE VI.

- Fig. 1. Dongas, or "dongholes," on the Nullarbor Plain. These shallow depressions in the plain are practically "oases" where the vegetation is heavier, and where the animal life congregates.
- „ 2. Stick nest built by the indigenous rodent, *Leporillus conditor* Gould, with the eggs of a Striped Brown Hawk (*Ieracidea berigora* V. and H.) in a depression on its summit.



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