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Thermometer-Bird or Mallee-Fowl (Lipoa ocellata).

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PART I.

HABITAT AND GEOGRAPHICAL DISTRIBUTION. — In those regions of Australia far from the haunts of white men, where there is very little surface water, and the soil is consequently clothed with stunted drought-resisting eucalypts such as *Eucalyptus incrassata*, *E. gracilis*, *E. oleosa*, *E. uncinata*, *E. behriana*, acacias such as *A. brachybotrya*, as well as other varieties, *Banksia ornata*, pines, and other dwarf vegetation, consisting of hakeas and grevilleas, dwells an ornithological enigma commonly known by its several vernacular names of Native Pheasant, Brush-Turkey, Lowan or Mallee-Hen, and by its well-chosen technical name of *Lipoa ocellata*, which literally means spotted-egg leaver. The Lipoa, which has an extensive range in southern Australia, was called by the aborigines of some of the western districts of the State of Victoria Low-an-ee, Louan, or Lowan, and it was from the latter of these that it has derived one of its vernacular names.* In the Wimmera River district, in western Victoria, a large tract of country, classified locally as a shire, has been named Lowan after the Lipoa, which bird is found within its confines. The bird's other vernacular name, and the one it is best known by, is Mallee-Hen. Mallee is an aboriginal name for thicket, and this native name is universally applied by settlers to areas of country clad with stunted eucalypts in certain districts of the States of New South Wales, Victoria, South Australia, and Western Australia. In these parts the Mallee extends for miles in one unbroken sea, as it were, and rippled like the waves of the ocean where the Mallee-clothed sand dunes rise in regular lines of uniform height from the surrounding level. Although the Mallee is the principal habitat of the Lipoa, yet these birds are sometimes found frequenting a mixed class of country. They prefer, however, the more arid southerly regions of Australia, partly on account of the type of vegetation which these dry areas support.

* For further historic records see "Nests and Eggs," by A. J. Campbell.

Being now essentially ground-frequenting birds, it is necessary that they should be protected by an open jungle through which they can readily run to avoid their enemies on the one hand, and on the other where they can search for food unhampered by a dense undergrowth. Nevertheless, the main reason why they frequent the Mallee is that this type of growth is essential for the successful incubation of their eggs, which they lay in their tumuli or mounds. The Mallee scrub is open, and its narrow, lanceolate leaves, set on the tops of this eucalypt's slender trunks, which usually branch out from the root in separate stems to a height of between 4 feet to 20 feet, averaging some 10 feet in height, allow the sun's rays to penetrate and warm the mound, thereby assisting the heat engendered by the fermenting vegetable material with which the Lipoa surrounds its eggs, the warmth of which is necessary to successfully hatch them out. Years ago, before the country was opened up, the Mallee-Hens existed within 35 miles to the west of the city of Melbourne, and ranged through southern Australia as far north in New South Wales as Wilcannia, lying between the 31st and 32nd deg. south latitude, to which position also they have been found to reach in South Australia, whilst they extend as far north as the tropical Murchison River district in Western Australia, which lies between the 26th and 28th parallels of latitude. Evidences of the existence of this bird have been found between Cue and Separation Well in the great North-West Desert of Western Australia. One of the reasons why they did not get so far north on the eastern side of the continent as on the western is due to the south-western half of Victoria being separated from the eastern half by a wide, dissected volcanic plain, forming a natural barrier, whilst the only available bridge leading from the western half to the eastern half of Victoria is the main Dividing Range ; but as this leads into country heavily timbered, and supporting a dense forest growth inimical to the incubation of their eggs, the birds' progress in that direction was also blocked. Although there are suitable habitats for these birds to the north of the main Dividing Range, especially along the River Murray, yet many plains intervene and prevent dispersal in that direction. Whilst the habitat of the Lipoa has such an extensive range in the Eyrean region, yet the areas frequented by it do not impinge on those inhabited by the other three Australian mound-builders forming the family of *Megapodiidæ*, and which exist in more humid zones situated in the Torresian region. If we seek for the main cause that restricts the Mallee-Fowl to its present southern habitats, of which the Mallee type of that country itself is the main stronghold, it will probably be found that originally this bird, when not so highly specialized, and when in its more primitive state of development, and not being so far removed from its reptilian ancestors as we find it to-day, frequented the sands of the shores

of the ancient inland lakes, or rather some vast inland sea, which, as the continent of Australia became uplifted, drained away in many directions in the shape of streams, which spread out and deposited their sandy scour in all directions as they rushed to lower levels. Thus it is that we find the sand distributed throughout the Mallee at the present day. The ancestors of the Lipoa of those ancient times gradually metamorphosed and adapted themselves to the altered conditions of their environment, and so we find them inhabiting sandy tracts of country, or places where the soil is loose and friable. This is a necessary concomitant in their breeding habits, as will be shown later on. We also find a counterpart of this peculiarity in the nesting habits of another genera of the *Megapodiidæ*. Unlike other birds, which incubate their eggs by sitting and brooding on them, the Lipoa builds no nest in which to brood, but instead forms a nesting mound in which the eggs are hatched out by heat, which the birds, with truly wonderful forethought, create artificially, assisted as well by the genial warmth of the sun, which the birds, in the choice of a site on which to build their mound, arrange to fall upon it.

MOUND, AND RISE OF MOUND-BUILDING HABIT.—How did the Lipoa become possessed of the intelligence which enables it to build such vast natural incubators with which to hatch out its eggs? Whence comes this bird's extraordinary knowledge of the chemistry of fermentation, and that heat artificially engendered thereby will incubate their eggs? How did these birds ascertain that by building a huge oven, as it were, of earth and sand, and by placing leaves, twigs, and other vegetable rubbish in its centre, and by covering it in when the material had been damped by rain and dew, a perfect hot-bed would be made whereby their eggs would be hatched out by the resultant heat? Why does the Lipoa regulate the heat of the mound? How did it know that it was necessary to do so? What part of the bird's organism acts as a thermometer, indicating and conveying to it the intelligence that the temperature of the interior of the mound is high enough to successfully incubate their eggs? When we remember that the heat supplied by nearly all the other species of birds for the incubation of their eggs is adventitious, depending principally on the warmth radiated by the parent's body, the temperature of which they do not regulate to any great extent, then the wonderful and complicated methods of forming a breeding-pit adopted by the Lipoa to hatch out its eggs arrests one's attention, and its mound-building habit is prominently brought before us as one of the greatest wonders to be found in the life-history of birds. All these complicated questions I hope to examine in this paper. When we search for the reason that induced the Lipoa to make a nesting mound to incubate its eggs, we must look to the past

and study the evolutionary processes that have, perhaps for centuries past, given rise to this elaborate and complicated system of incubation adopted by the Lipoa. We have evidences that birds have evolved from reptiles, that presumedly laid oblong or round white eggs, which they at first deposited haphazard in exposed positions on the surface of the ground. Being conspicuous objects on account of their colour, the eggs were readily preyed upon by enemies, until accidentally perhaps some reptile placed its eggs in a less conspicuous place than usual, and it so happened that it noticed that its eggs were not molested by their usual enemies. Then, having gained the knowledge of the value of protecting its eggs, it repeated the act of purposively hiding them, gaining greater skill and more precise methods each time, and so the habit of covering over or depositing its eggs under bark or stones, or shielding them by covering them over with *débris*, gradually developed. The covering-up process was thus handed down. As time went on, and as the families split up from the parent stock, they carried this habit with them, each adding some newer or more cunning, more complete or better considered innovation, rendered all the more necessary by the greater degree of skill acquired by their enemies, whose powers of keener observation were being evolved in the same ratio with them. Then those that added newer and more specialized methods of hiding their eggs survived, whilst those members of this branch that did not do so became extinct, or produced coloured eggs to secure some measure of protection—a question simply of the survival of the fittest, and the creation of the different species, aided by natural selection. We have a parallel case in the crocodiles of Australia, which creatures gradually found it necessary to bury their eggs, and afterwards to build mounds of mud to protect them, learning later on the value of placing vegetable material in the mound to generate more warmth to assist the solar heat in hatching their eggs, just as we find them doing in the tropical parts of Australia at the present time. Of recent years crocodiles have found it necessary to further protect their eggs from the depredations of wild pigs, aborigines, and other enemies, and I have often found the mother crocodile lying almost buried in a wallow, out of sight, alongside her egg-mound, as she kept guard. Then, continuing with the process of evolution from that branch of reptiles that evolved birds, from the study of which we find that our feathered friends are merely an extremely modified and aberrant reptilian type, or glorified reptiles—in other words, that the ancestors of birds were four-footed creatures which gradually metamorphosed into feathered bipeds, the fore legs becoming specialized, forming wings—then, when we take into consideration the fact that the contour of the eggs of the crocodile and the mound-

building birds have similar characteristics, and are the same shape, the apices or ends being of uniform size or nearly so, as well as the shell of the eggs of both being brittle, whereas formerly in the earliest reptiles they were soft-shelled, then we have evidences of a common origin and the rise of a mound-building habit on reptilian lines. This is especially noticeable when we know that the young of both the mound-building birds and the crocodiles are able to take care of themselves immediately after birth. Further evidence of this contention is to be found in that the Lipoa knows the value of maintaining a correct temperature in the mound so that its eggs will hatch out successfully. All the bird's energies are centred in this object—the pleasure of brooding is foreign to their nature. Their only anxiety is to regulate the temperature of the egg-chamber, as will be shown later on, as well as to protect their eggs in some degree from the depredations of their natural enemies. It is also significant that the Lipoa forms its mound in or near the dried-up bed of an inland sea or river basin, in the waters of which they once probably existed in their reptilian form, afterwards gradually metamorphosing with the physiographic change of their habitat when the inland sea or river-bed changed into dry land and became in course of time clothed with its present stunted growth. It is suggestive, too, that a member of the Megapode family (*M. brazieri*), inhabiting Savo, an island in the Solomon Group, still retains a more primitive and reptilian method of incubating its eggs. This bird simply digs a hole in the sand of the sea-shore wherein to deposit its eggs. Doubtless owing to its isolation, and thereby the relatively smaller proportion of the enemies of its eggs, this species has not been compelled to develop a more specialized method of incubation. Probably before the land bridge which joined these islands to the continent of Australia became broken, all the members of the family of *Megapodiidæ* shared a common and a similar method of incubating their eggs to that of *M. brazieri*. Although the Lipoa, as before stated, frequents mixed country, the exception proves the rule, since it is in the areas covered with sandy wash or silt created by the action of water that we find them most numerous. A probable ancestor of the mound-builders was the fossil bird *Chosornis præteritus*.

CHOOSING A SITE FOR NESTING MOUND.—In choosing a site for its nesting mound the Lipoa, in its Mallee habitat, usually selects an open space in the scrub with a break or opening to the north or east, so as to admit the sun's rays, which have so important an influence on the incubation. Bushmen that have become lost, and who are acquainted with this fact, are enabled to note the points of the compass approximately when they happen on a mound in the scrub. On the opposite side of the mound the scrub is usually dense, and offers protection

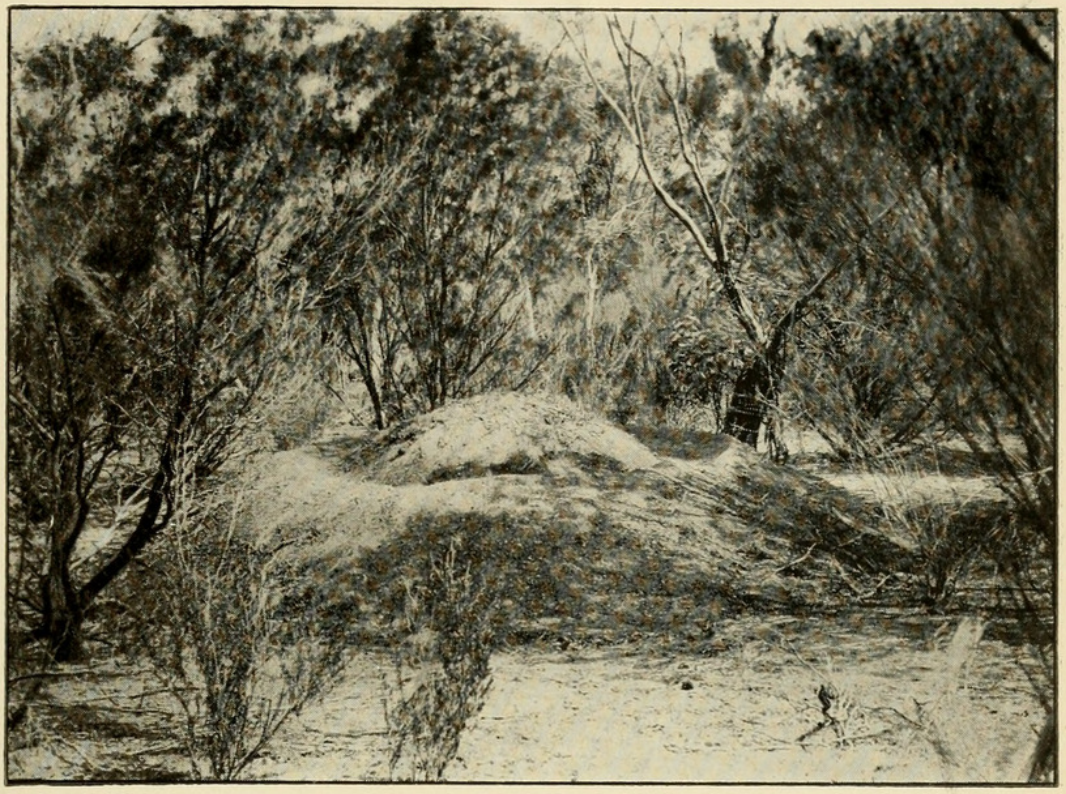
against the windy weather that blows from those quarters. As the outer covering of the mounds in Mallee country is composed chiefly of sand, this breakwind prevents the undue displacement of the superimposed material. The choosing of a site where the rays of the sun can fall upon the mound and warm it, as well as the selection of a place where the mound is protected by a breakwind, together with the circular style of architecture of the mound, which renders it less liable to damage by wind, emphasizes the truly marvellous knowledge of the laws of physics possessed by the Mallee-Hens. Although the mounds are constructed as a rule in these sites in the Mallee, yet I have examined a mound which had been built in the centre of a patch of scrub, the stems of which stuck up through the mound in all directions, whilst the leaves of the Mallee scrub overhead shielded the mound to a certain extent from the sun's rays. Within the egg-chamber of this mound, however, there was a greater supply of decomposing vegetable matter, to create greater heat. Mr. Charles M'Lennan, better known as "Mallee-Bird," who has had over 20 years' experience of the ways of the Lipoa, and who has greatly assisted me in my investigations of the life-history of these birds, informs me that he has found the Lowans utilizing the heaps of sand thrown out of a rabbit warren for building their mound, which they had erected in the centre of the burrows, thereby saving a large amount of toil, which represented a fortnight's work for the birds. In other districts, outside the Mallee area, which the Lipoa frequents, and which is closed with scrub, the birds choose sites in accordance with the above conditions as far as possible. Many mounds are found in the troughs between the sand-dunes in the Mallee or in depressions in these arid places, yet there are many exceptions to this rule. The theory that the mounds are placed in these depressions so as to get a greater supply of moisture to aid in the fermentative action does not apparently hold good. The mounds are placed in these sites for protection from the wind, as well as to obtain the advantage of the higher and more even temperature prevailing in these miniature valleys.

STRUCTURE AND MATERIAL OF MOUND.—The foundation of the mound of the Lipoa, which is the smallest structure of all the Australian mould-builders, is formed by first scratching out a circular depression in the ground about 2 feet wide and 1 foot deep. The sand or gravel is next scraped up and placed around this circular hollow, and so the outside wall of the nesting mound is formed. When completed the height of the mound ranges from 2 ft. 6 in. to 3 ft. 6 in., with a diameter at the base of between 12 feet and 18 feet. The size of the mounds varies from 110 cubic feet of material to 200 cubic feet. Only a pair of birds works at the same mound, and into the concavity, which now has the appearance of the crater of a miniature volcano,

they scrape leaves, vegetable matter, brambles, bits of bark, and small branches, and heap it up in a circular fashion to a height of from 18 inches to 2 feet. The material is raked and swept up by the birds from every convenient direction around the mound, and is often brought a distance of 40 or 50 yards. The manner in which they sweep up this *débris* with their wings and breast, and also rake it, as it were, with their powerful legs, and the clean appearance which the ground afterwards presents, gives an impression that some gardener had been cleaning up the garden with a fine-toothed rake. The wings of the bird are much worn by this sweeping. The vegetable material in the centre of the now saucer-shaped mound is left for about four or five months uncovered, during which time it usually receives a good soaking by the winter rains, which causes decomposition to set up and change it into a regular hot-bed. That the Lipoa prepares the mound months ahead of the egg-laying period is a remarkable trait in this bird's character, evidencing the knowledge possessed by it of the seasonal changes as well as the physical requirements necessary to set in motion the fermentative action. Six to nine days before the hen commences to lay, the egg-chamber is formed in the centre of all this vegetable matter. A hole ranging from 14 inches to 20 inches in diameter and 18 inches to 2 feet in depth is scratched out by the female. The sides of the hole forming the egg-chamber are usually hard and well defined, consisting as they do of interlaced sticks matted together with leaves and twigs. This condition of the walls of the chamber has an important bearing on the future welfare of the eggs. In the first place, the foundation and inner walls of the mound being solid and laced together, so to speak, prevent the displacement of the whole mass, which would crush the eggs were it to start moving in any given direction, whilst the eggs would be liable to be broken if subjected to the compression of such an enormous weight of sand, which is of such an unstable nature, and out of which the Lipoa forms its mound, heaping it high above its eggs. The forming of the egg-chamber occupies the bird for about one and a half hours' duration. The vegetable *débris* broken out by the formation of the egg-chamber is placed back into the hole the same day, and, being mixed with sand, becomes more friable and loose. The mound is then heaped up into a pyramidal form, and after six to nine days have elapsed the female opens out the egg-chamber and deposits her egg. To construct a new mound and prepare it for the formation of the egg-chamber occupies the pair of Lowans from 25 to 33 days. The birds work at the building of the mound only early in the morning for about four hours, and again late in the afternoon for a short time. On moonlight nights Mr. M'Lennan has seen them working for a few hours. The energy displayed by these birds in making their mounds is truly marvellous, whilst the

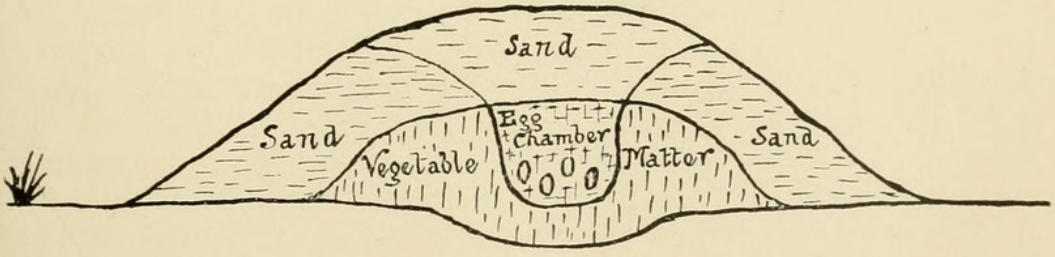
labour entailed in scraping and gathering together the enormous quantity of material which forms it is prodigious. But what is still more astonishing is the amount of labour which devolves upon the female bird every time she lays a fresh egg, since she has to scratch out the egg-chamber and refill it each time, and as she lays in ordinary seasons about 14 eggs, she has to reopen and refill it 14 times. This reopening and refilling, together with the necessity of repeatedly opening up and refilling the egg-chamber after the bird has ceased laying, so as to keep the material around the eggs loose, whereby sufficient oxygen can be supplied to the embryo in the egg, is a further cause of wonderment. The time occupied by the bird in cleaning out the egg-chamber and preparing it to receive the egg and refilling it again after depositing her egg, is from three-quarters of an hour to an hour. Occasionally the male assists the hen to open out the mound. About 9 o'clock a.m. the Mallee-Hen visits her mound, and between that hour and 10 a.m. she lays her egg. The same mound is not used every year by its original architects, since the Lipoa does not breed every season. In Victoria during the month of April and May the birds usually start to dig out the old mound or else construct a new one. The date of commencement varies according to the season and locality, but the governing factor is the rainfall, on which the Lipoa is dependent for the moisture to soak the vegetable material of the egg-chamber, as well as for the subsequent food supply. During periods of drought egg-laying is suspended, and although a season may have started propitiously, yet should a dry atmospheric condition manifest itself, the Lipoa leaves off depositing its eggs, influenced, no doubt, by the change wrought in the food supply as well as by the condition of the vegetable material of the egg-chamber, which, owing to the extreme dryness of the air, has become so devoid of moisture that it probably would not set up sufficient heat to incubate its eggs with any degree of certainty owing to the fermentation being arrested. During the greater part of the time of incubation the heat of the egg-chamber is many degrees greater than the surrounding amosphere, and ranges from 90 to 97 degrees Fahrenheit, whilst the external covering of sand on the mound often becomes so hot from the heat of the sun's rays that it is extremely painful for a person to recline on it. When starting to open up the mound to deposit its eggs the bird scratches out a channel all around the exterior of the summit of the mound about a foot from the top. (See illustration.) Over the outer edge of this the birds scrape the material resting on top of the egg-chamber, and when this has been removed the mound presents the appearance of a miniature volcano or funnel. Usually in dull or wet weather the birds cap the peak of the mound with sticks placed crosswise in a careless

PLATE VI.



Lipoa's Egg-Mound
(Showing first operation of opening by bird).

FROM A PHOTO. BY A. H. E. MATTINGLEY.



Section of Lipoa's Egg-Mound.

litter, evidently to turn aside the water, which would percolate to the egg-chamber and interfere with the proper rate and progress of the fermentation, whilst the sticks would help materially to detract from the prominence of the sharp cone, and so make detection more difficult, as well as preventing the loose sand from being scattered by the wind. (See illustration.) Thus sticks on the mound are nearly always a sign that the birds have started to lay. On warm and sunny days the apex of the mound is removed and a concave opening made, so that the warmth of the sun's rays may penetrate and assist in the incubation.

Descriptions of New or Rare Australian Birds' Eggs.

By D. Le Souëf, C.M.Z.S., &c., Melbourne.

Ninox peninsularis (Cape York Owl).

(Mathews, Handl. Bds. of Austr., No. 290.)

This fine bird seems to be principally found in the Cape York district. A set of two eggs was found on 4th January, 1907, in a hollow of a eucalyptus tree, the egg being deposited on the decomposed wood at the bottom, mixed with the small bone remains of birds and small mammals, probably mice. The hollow had evidently been used for some time. The eggs are the usual round type of Owls', and are glossy, smooth, and measure—(*a*) 1.82 x 1.48, (*b*) 1.81 x 1.56 inches. The locality was not far from Somerset, Cape York, Northern Australia.

Ægotheles rufa (Rufous Owlet Nightjar).

(Mathews, Handl. Bds. of Austr., No. 380.)

A clutch of three of the eggs of this bird was found in a hollow of a eucalyptus tree near Derby on 15th November, 1906. They are pure white, with a roughened surface, and are indistinguishable from those of *Ægotheles novæ-hollandiæ*. They measure—(*a*) 1.12 x .90, (*b*) 1.11 x .87, (*c*) 1.14 x .88 inches.

Collyriocincla woodwardi (Woodward Shrike-Thrush).

(Mathews, Handl. Bds. of Austr., No. 641.)

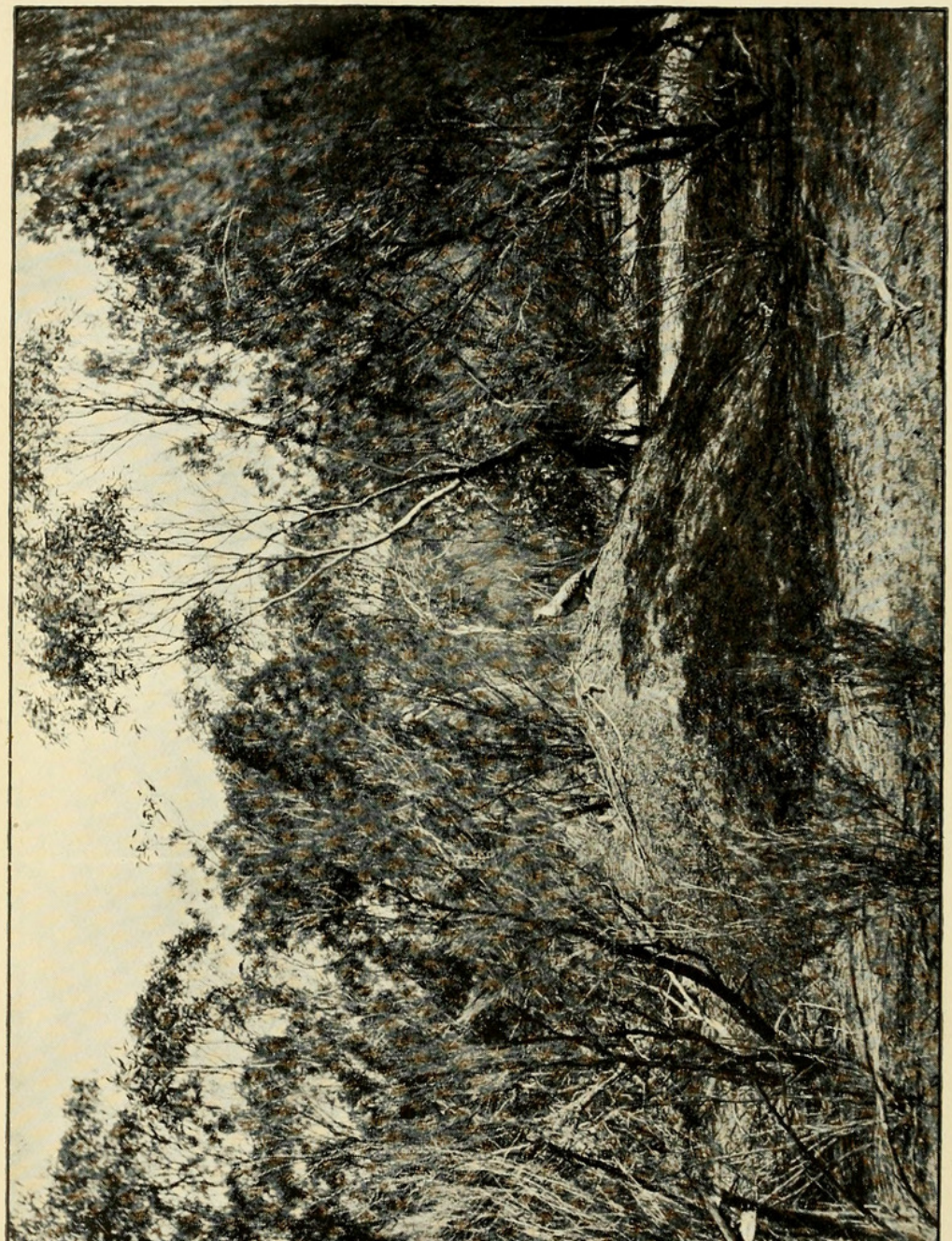
A clutch of three eggs of this bird was found near Port Darwin, 22nd January, 1907. They are white, well freckled with small markings of umber, the markings being most plentiful at the larger end; but, as in the other members of this family, there is much variation in the markings of different clutches. They measure—(*a*) 1.02 x .78, (*b*) 1.04 x .76, (*c*) 1.03 x .77 inches. The nest, composed of light twigs and leaves, was built in an open cavity in the trunk of a dead tree.

Pinarolestes boweri (Bower Shrike-Thrush).

(Mathews, Handl. Bds. of Austr., No. 645.)

The eggs of this species are a very pale cream colour, irregularly blotched with dark reddish-brown markings, more plentiful on the

PLATE V.



Lipoa on Egg-Mound.

FROM A PHOTO. BY A. H. E. MATTINGLEY.