

possible. The whole of the ester in this oil is saponified in the cold, by two hours' contact, using alcoholic potash, and the quantitative results are certain. The following results were obtained from two samples of the oil of this species: (1) Ester before acetylating, 63.7 per cent; after acetylating, 85.2 per cent. (2) Ester before acetylating, 71.68 per cent; after acetylating, 80.5 per cent. After distilling *in vacuo*, No. 2 gave 73.95 per cent of ester, and after acetylating, 82.2 per cent.

The well ascertained fact that the oil obtainable from the young growth of all eucalyptus species is the same in character as that obtained from mature trees is also borne out with the "suckers" from this tree, and fortunately the yield of oil is greater also, 0.23 per cent of oil being obtainable from "suckers." The oil from the young growth should be easily obtained, and in any quantity. There seems no reason, therefore, why this plant should not be cultivated for its oil, and when sufficiently grown it might be cut down by machinery. If sufficiently large stills were utilized the oil should be obtainable at a comparatively low price. The value of the oil of this species, containing 80 per cent ester, has been considered to be \$6 per pound, but it should be possible to produce it at a considerably cheaper rate. As it has been shown that the eucalyptus are very tenacious of life, destruction of the plants should not take place if the material were collected as suggested, and at the proper time of the year. Experiments should also be carried out to determine the most suitable time for collecting the material, so that a maximum yield of oil might also be obtained.

Another eucalyptus which may eventually be of considerable economic value as an oil yielding plant, is *E. Staigeriana*. Although it has not been possible, as yet, to carry out conclusive experiments with this tree, there is no reason to suppose but that this species will follow the rules always found to be constant with the members of this genus. The yield of oil from mature leaves is large, 2.5 per cent, and would be greater from the young growth. The oil of this species may eventually be used as a flavoring agent, and take the place of lemon oil for many purposes. The principal difference between this oil and lemon oil is that the predominant terpene of the oil of *E. Staigeriana* is *lævo*-limonene, while that of lemon oil is *dextro*-limonene.

The odor of the oil is very aromatic, reminding much of lemon oil, and has no resemblance to ordinary eucalyptus oil. The greater yield of citral over that of lemon oil is also worthy of notice, particularly if the manufacture of "terpeneless oils" is undertaken.

One wonders, perhaps, why Australia does not take advantage of the possibilities of these unique species of eucalyptus, by utilizing some waste places for their cultivation, and by modern commercial methods building up an industry with their products, and so utilizing some of the resources of the continent in new ways.

The oil from *Eucalyptus citriodora* consists principally of the aldehyde citronellal, and if the production of the oil is cheapened, it should have considerable value for scenting soap and other manufacturing purposes. The cost of collecting leaves from mature trees militates at present against cheap distillation, and as the yield of oil is not large (0.58 per cent) it is to the production from cultivated material that we must look for the successful exploitation of this species as an oil producing tree. The amount of aldehydes present in the oil—mostly citronellal—averages about 90 per cent.

This tree is a very good illustration of the comparative constancy of the products obtainable from particular species of eucalyptus, because no matter where the tree is grown its oil is practically constant in composition and character. Numerous illustrations of this fact have been accumulated from different species, as it was felt that this factor was of the greatest importance commercially. It is found that the constituents vary only slightly among themselves, so that when the results from any particular species have been accurately determined from undoubted material, it is known what material is obtainable from that particular species. One will not obtain a phellandrene oil from such species as *E. Smithii* or *E. globulus*, nor eucalyptol in quantity from such species as *E. dives* or *E. radiata*. Each has its own peculiarities, and if any particular constituent is required, then the species which contains that constituent in greatest abundance must be exploited.

The eucalyptol bearing species are the most numerous, as this constituent occurs, in either small or large amounts, in the oils from most eucalypts. It is even found in small quantity in the oil from *E. dives*, it occurs in the pinene oils, and also in the phellandrene oils, as in *E. risdoni* and in *E. amygdalina*, etc. Provided a sufficient amount of eucalyptol is present—the minimum might well be fixed at 55 per cent—the presence of a small amount of phellandrene in

oils for pharmaceutical purposes should not be condemned any more than pinene. It is true that the oils richest in eucalyptol are not obtained from the phellandrene bearing plants, but it must not be forgotten that we do not even now know which is the most efficacious medicinal constituent in eucalyptus oils. In the preparation of eucalyptol oils for pharmaceutical purposes commercial requirements will settle the matter of species, and the price of the article will eventually find its natural level. The two factors to be considered are percentage of eucalyptol and yield of oil. The increased cost of collecting leaves from large trees, over that of the shrubby forms or Mallees, practically puts the large trees out of the running; so that if it is desired to utilize these species, they will have to be cultivated, to place them on an equal footing with the shrubby forms.

A consideration worthy of notice when dealing with the distillation of the eucalyptol oils for pharmaceutical purposes, is the duration of time necessary to distill the leaves, so that the best results may be obtained, both in amount of oil distilled and in the quality of the product. An investigation was undertaken to decide this point, and it was found that with *E. amygdalina* 89 per cent of the total oil distilling came over during the first 2 hours, 7 per cent during the third hour, and 4 per cent during the fourth hour. Practically the whole of the eucalyptol came over during the first two hours, the less volatile constituents as the sesquiterpene, aromadendral, etc., distilled far more slowly. It is thus possible to leave the greater portion of these products in the still, securing a superior eucalyptol oil by so doing. Practically the same results are obtainable with other eucalyptol bearing species.

These high boiling constituents have some value, however, in raising the specific gravity of the oil, but it is doubtful whether economy of fuel, time, and labor is not better served by stopping the distillation after two or two and one-half hours. Of course this method is not applicable to the perfumery oils, as with these it is necessary to obtain all the available oil from the leaves.

It may be well here to refer to the method of eucalyptol determination. The phosphoric acid method for the determination of eucalyptol in eucalyptus oils was discovered by L. R. Scammell, of Adelaide, South Australia, in 1892, and the method was utilized for the commercial manufacture of eucalyptol. In 1894 the method was patented in England, France, Germany, and America, as well as in the Australian Colonies, as a commercial process for the production of eucalyptol. It has now been supplanted by the freezing process, but it still remains the most useful method for the quantitative determination of eucalyptol in essential oils, though it is not a perfect method for general practice, as so much depends on the mode of manipulation and on the analyst. If a method could be devised which would minimize these errors of manipulation, it would be a most welcome acquisition.

When the cake formed by the combination of eucalyptol with phosphoric acid has been prepared in a perfectly dry condition, it can be weighed for the determination of the percentage amount of eucalyptol, or if preferred decomposed by hot water and the eucalyptol measured, or it may be prepared in petroleum ether as recommended in the American Pharmacopœia, although the dry method is preferable.

Taking varying amounts of the solid cake, prepared with the greatest care and decomposing with hot water, the mean of six determinations gave weights of eucalyptol corresponding to a mean value of 59.47 per cent (59.34 to 59.57) and the weights of the phosphoric acid which had entered into combination, determined by titration and other methods, represented an acid containing 89.28 per cent H_3PO_4 . The phosphoric acid used in the determination contained 89.4 per cent H_3PO_4 . One might expect, too, that the water separating from the H_3PO_4 in the formation of the eucalyptol phosphate, if such separation took place, would prevent satisfactory quantitative results being obtained. Experiments were made with more dilute phosphoric acid, but the results were not at all satisfactory.

Although several organic acids have been determined in eucalyptus oils, yet, they all appear to be in a state of combination as esters, with the exception of a portion of the acetic acid. Efforts were made to determine whether the lower members of the aliphatic monohydric alcohols were present in any particular eucalyptus oil, and if so which of them. The investigation was made on half a gallon of the water which first distilled when the oil of *E. amygdalina* was rectified. The results showed that methyl, ethyl, isobutyl, and amyl alcohols were present, and in somewhat considerable amount. It was thus possible to chemically prove the presence of all of them in the oil of this species. It is not to be supposed, however, that they all occur together in the oils of all the species, although they may be present even in traces.

Both ethyl and amyl alcohols and formic acid had previously been detected in a eucalyptus oil. It seems thus conclusive that the presence of the known alde-

hydes and acids in these oils is traceable to the prior presence of the corresponding alcohols.

The presence of esters in eucalyptus oils is often large, and one or other of these appear to be present in all eucalyptus oils, from traces up to 77 per cent. In some of these oils a valeric acid ester occurs; the oil of *E. saligna* was found to be the best in which to determine its presence. The amyl ester of eudesmic acid occurs in small amount in the oil of this species, but valeric acid is also found existing as an ester, and was separated in sufficient quantity to chemically determine its identity. No other alcohol than amyl alcohol could be detected in the oil of this species. It may be mentioned that those oils in which this valeric acid ester occurs contain most markedly the corresponding aldehyde.

Other constituents worthy of mention which are found occurring in eucalyptus oils are—eudesmol, the stearoptene; aromadendral, the aromatic aldehyde; piperitone, the aromatic ketone; and the sesquiterpene. Eudesmol has been found in a considerable number of eucalyptus oils, and one species, previously undescribed, was named by R. T. Baker, *E. camphora*, from the presence of this stearoptene in the oil. This is not the only eucalyptus that has been so honored. The "Sydney peppermint," *E. piperita*, derives both its vernacular name and its scientific name from the presence of piperitone in its oil, although this constituent was not known until recently. It is the presence of this ketone that causes the name "Peppermint" to be applied to a large group of these trees. It is not perhaps generally known that eucalyptus oil was one of the first Australian products exported to England, and a quart of the oil distilled from the leaves of the "Sydney peppermint" was sent to a Mr. Wilson in 1788, soon after the first settlement in New South Wales was formed. Dr. White mentions that he found this oil most efficacious in dealing with some of the ailments of the convicts at that time.

Aromadendral is a frequent constituent in eucalyptus oils, being found in all the members of the large group of trees known as "boxes," as well as in allied species; and is found mostly in those species in which phellandrene is absent. It is to the presence of aromadendral, therefore, that the *lævo*rotation of the "box" oils is due.

In some species *dextro*-rotatory, and in others *lævo*-rotatory, pinene occurs in such abundance that the oils are practically turpentine oils, so that it is hardly possible to detect sophistication with ordinary turpentine. It is thus necessary to insist on standards which will insure the quality of the product required, but any general standard cannot meet all requirements, nor determine the value of eucalyptus oils for all purposes. For pharmaceutical oils the specific gravity should be 0.91 at 15 deg. C. (59 deg. F.) or 0.905 at 22 deg. C. (71.6 deg. F.) but the figure can be readily calculated from any ordinary temperature, because it has been determined that these oils alter their specific gravity 0.00075 for every ordinary degree of temperature Centigrade.

There is no more interesting chemical group of substances in the eucalypts than the astringent exudations, or kinos. Many of the species exude kino freely, but these differ very greatly in chemical constitution. Whatever is eventually done with eucalyptus exudations commercially, it must be recognized that it is just as imperative for the product of a particular species or groups to be kept distinct, as it is in the preparation of the various oils. The two main uses to which these exudations may eventually be put, is in the tanning industry and for pharmaceutical purposes, principally for the preparation of tinctures.

(To be continued.)

BIRDS THAT KILL SNAKES.*

By W. G. FITZGERALD.

"Of what use are snakes?" is a question often asked by the student of Nature. They do not gratify the esthetic sense, as other useless creatures do, but are loathsome and pernicious, and altogether a mistake. Surely they are one of Nature's abortions or failures? Every other created thing views them with horror—men and monkeys, beasts of prey, and reptiles, and birds. Not to mention the owls, kites, carrion crows, and ravens, which all have a bitter antipathy to the ophidian race and kill them whenever found. Even though they may not always devour the mangled remains, there are hosts of birds who gain their livelihood by assiduously seeking poisonous serpents.

Ask the Australian colonist which of the many queer birds that adorn his primitive forests he holds in most reverence, and he will instantly name the "laughing jackass," as he calls the giant kingfisher (*Dacelo gigantea*). Its note does certainly resemble a donkey's bray. The dacelo lives almost entirely on poisonous reptiles, in which the island continent is inconveniently rich. And he varies the diet only by lizards—especially venomous ones; also frogs and toads, cicades, and tree leeches. He never catches fish after the man-

* From American Homes and Gardens. Published by Munn & Co.

* Eucalyptus species do not sucker in the strict sense of the term, and the word is here used with that understanding to denote adventitious shoots.

ner of his American or European kindred. I have seen one of these singular birds catch a deadly snake.

It was a hot day in the Blue Mountains of New South Wales, and I had been tramping through almost shadeless bush for some hours. At last, reaching a big mimosa, I sat in its shadow on a fallen tree trunk; for it is almost the only one of the Australian trees that does not turn the edge of its leaves to the sun; this accounts for the curious shadelessness of the antipodean bush. Suddenly I beheld a big dace in one of the gum trees opposite. He was sitting motionless, as I had seen his American namesake over pond or trout stream.

He startled me with an abrupt dash to the ground not far from where I sat, and a few seconds later flew back to his perch with something wriggling in his big fierce-looking bill. It was a carpet snake that had been basking in the hot sunshine just beyond the shelter of the mimosa clump. The dace had seized the reptile by the neck and held it in a vise-like grip, despite its violent struggles and writhings. And now and then the angry bird would bang its prey's head against the hard bough of the gum tree until he had reduced the evil-looking deadly thing to mere harmless pulp. Then only did he relax his hold, to toss the dead snake, limp and lifeless like a strip of hide, high into the air.

Very cleverly did the bird catch it by the tail, and proceed to engulf it in its capacious maw. The coiled-up remains of the reptile formed a projecting mass on the bird's breast that was fully visible from where I sat. So far the jackass had been too busy capturing and preparing the snake to notice me, though I sat within ten yards of him. His banquet done, however, he caught sight of me, ruffled up his feathers fiercely, and with an eerie shriek compounded of laugh, groan, and bray, flew off noisily to digest his capture.

As the intestinal tract of the dace is short, digestion is not a lengthy process. Consequently he eats often, and from dawn to dusk is industriously after snakes, being on that account first favorite of the woods with squatter and bushman, who protect the bird from every pot hunter.

The Australian magpie or singing crow is also a serpent killer, as is the native crane and several others. This crow, handsome, lively, and clever, is known from Sydney to Fremantle for his black and white coat and startling diet of centipedes, scorpions, and poisonous snakes. He, too, first kills his prey, throws it into the air with a song of triumph and then disposes of it at leisure.

The "native companion," as the Australian crane is called, is no mean antagonist of the ophidian race, of which it destroys hundreds of thousands. Its method of killing is peculiar, for it stamps on the reptile with the full force of its leg, retracted up to the body and then propelled downward like a piston rod with all the bird's strength on foe and prey. And to make assurance doubly sure the crane strikes a quick succession of blows that crushes the last vestige of life out of the mangled reptile, which is then swallowed with no more ado.

I fear the natural history books of one's childhood are very far astray when dealing with another snake-eater, the secretary bird of South Africa (*Sepentarius reptilivorus*). More than once I have seen this curious creature—half vulture and half falcon, with a suggestion of the crane—tackling a big snake just as the native companion of Australia does; that is to say, never touching it with beak or wing, but always stamping on the squirming folds with its powerful legs, disabling the reptile at the first blow and finally dislocating all the vertebrae.

Should the snake show fight, the secretary bird seems to tighten all its feathers about it, hopping briskly here and there, with all the "foot-work" of the veteran pugilist, so as to avoid the desperate onslaught. Such contests can only end one way, and the crushed serpent is soon reposing harmlessly in its living tomb. Another Australian bird, known as Jardine's harrier, is a serpent killer of great ability, especially endowed by Nature with legs of great length mailed with strong yellow scales, quite impervious to ophidian teeth. It also kills and eats frogs, newts, lizards, and other reptiles.

The harrier, besides the pied crow and the laughing jackass, is of great value to Australia, which contains so many varieties of deadly snakes. It seeks for them on the wing, hawking at no great distance from the ground over the hot and stony places frequented by them. With a sudden sweep the reptile is grasped by the neck with one powerful foot, and then the harrier soars high into the air and kills its reptile prey by dropping it on rocks or hard sun-baked earth from great altitudes.

The Indian adjutants and cranes of all kinds, Manchurian and Dutch, are also snake hunters. Indeed, in India the adjutant is treated with as much consideration as the sacred monkeys of Hanuman, and woe betide the inexperienced tourist or visitor who tries to shoot one of these curious birds.

Then there is the burrowing owl of the South American pampas, who preys upon young rattlesnakes, fol-

lowing the creatures into their own holes. These birds also are respected, and with cause. For there is no greater foe to all warm-blooded mammals than the poisonous snake; and any bird with cleverness and courage enough to kill one and dine off it afterward, well deserves our gratitude and protection.

SCIENCE NOTES.

Prof. Rudolf Emmerich, Professor of Hygiene in the University of Munich, announces the discovery of a cure for diphtheria, effective even in the most dangerous cases. He calls the serum "pyocyanase," producing it from the assimilation of the pyocyanase bacilli developed in liquid cultures. The preparation is sprayed into the patient's throat, completely destroying the diphtheria bacilli.

The use of artificial graphite is on the increase. The quantity manufactured in 1906 amounted to 5,074,757 pounds, valued at \$337,204, which is the largest quantity produced in any year since its first introduction in 1897. Of the total output 2,766,000 pounds were ground to a fine powder and this product was valued at \$94,578. A process has recently been developed for treating artificial graphite with tannin. The resulting deflocculated graphite is claimed to be adapted especially for use in lubrication, with either water or oil as a vehicle.

In a paper read before the Academy of Sciences on Prof. Bordas's discoveries, based on the observation of the late Prof. Curie that glass acted upon by radium acquires a magnificent azure tint, it was stated that Prof. Bordas placed a small quantity of corundum in contact with radium for a period of a month. At the end of the time, he found that uncolored corundum acquired the yellow of the topaz, blue corundum became an emerald green color, while violet corundum took a sapphire blue. Corundum is an oxide of aluminum, and when colored is known as sapphire, Oriental ruby, Oriental topaz, and Oriental amethyst, according to the tint. The granular variety of corundum is known as emery. Upon returning the colored samples to the jeweler from whom he bought them, the former gave the value of the altered specimens as \$9 a carat. Upon repeating the experiment with various shades of the mineral, one that became ruby colored was appraised by the jeweler at from \$100 to \$160 a carat. The altered substance was not affected either by heat or by electricity.

Through the generosity of Mr. Emerson McMillin a fine collection of heads and horns of native animals has been brought to the United States. The collection was formed by Mr. A. S. Reed, an Englishman. During the years when big moose and caribou were abundant on the Kenai Peninsula, and in other accessible districts of Alaska, Mr. Reed, then residing in Victoria, made many hunting trips to the best game districts of Alaska and British Columbia. He spent several winters in the far Northwest, sometimes with the Indians, in order to hunt moose and caribou when they were in their finest condition as to antler, and to hunt the big brown bears when their pelage was at its best; in fact, Mr. Reed had his pick of the big game at the time when it was most plentiful, and the finest specimens taken by him were preserved. His collection, which includes heads and antlers of Alaskan moose, caribou, bear, sheep, and walrus, can never be duplicated. There is a moose head the antlers having a spread of 76 inches; a caribou head and a Kadiak bear skin said to be the finest specimen in the world; and other exceptional specimens. The collection was for sale for \$10,000; when the owner heard that it was wanted for public display in New York he generously cut the price in half. The trophies are at present stored in the zoological park, and on the completion of the administration building there in 1908 will be displayed in it.

At the recent Congress of the French Association for the Advancement of Science, Prof. A. Henry demonstrated a process of using slaked lime to produce a high vacuum. Hydrated lime—Ca (OH)₂—as is well known, can be dissociated into anhydrous lime—CaO—and water. The tensions measured after two hours' heating will vary between 2.4 millimeters at 85 deg. C. and 20 millimeters at 145 deg. C. The vapor given off by the heated hydrate is used to expel the low-pressure air left in a receiver by an ordinary air or water pump. The receiver is connected on the one hand with a glass bulb containing about 30 grammes of slaked lime, and on the other by a vapor-absorbing tube with an ordinary air pump. The vacuum maintained by the air pump being about 1 centimeter, the temperature of the lime is raised to about 150 deg. C. by an alcohol lamp, when water vapor will be given off; after about four minutes' heating the receiver should be sealed on the side turned toward the air pump. The lime will soon absorb the water vapor left in the receiver, and the vacuum will become high enough to allow cathode rays to be produced. This is shown by providing the receiver with two electrodes, when a discharge from an induction coil will give a radiation susceptible of deflection

under the action of a magnet. This tube, while connected to the lime bulb, can be used to show the variable aspect of discharges according to variations in tension by simply heating the bulb slightly with the alcohol lamp, when the various phenomena, including those of Geissler tubes, will be produced successively within about two minutes; by allowing the bulb to cool at the contact of the air, the same phenomena will be reproduced in inverse succession within less than five minutes. Long glass tubes, such as are used in connection with Tesla experiments, have been likewise treated according to the above process. All these experiments have been made with marble lime, while hydrated baryta under similar conditions also produces a vacuum giving off cathode rays. This cheap and quick process may prove highly valuable not only for the laboratory, but even for industrial purposes.

ENGINEERING NOTES.

The production of pig iron in Belgium during the eight months ending with August last comprised 732,470 tons of Bessemer and basic, 151,030 tons of forge pig, and 67,140 tons of foundry pig, a total of 950,640 tons, which contrasts with only 937,490 tons in the corresponding period of 1906.

It is stated that the Imperial Steel Works, near Shimonoseki, Japan, are about to submit their Siemens mild steel to a series of tests before Lloyds' surveyor at Nagasaki. The object is to have their name added to the list of approved firms which make steel to be used in the construction of ship and boiler materials for vessels classed at Lloyds. At the present time most of the structural steel used in shipbuilding in Japan comes from Great Britain.

A new automatic continuous ore-feeding reverberatory furnace consists of a fire-box and a hearth-chamber, whose angular side walls converge and meet in a point at the front end of the hearth. At this point, and on a level with the floor of the hearth, is provided a tap-hole or matte through the front wall of the furnace; at the back end of the hearth, and a little above the floor level, are placed tap-holes for the slag, on both sides of the fire-box. In the side walls of the furnace are placed a number of ore shoots terminating close to the floor of the hearth, and arranged so as to deliver ore continuously at both sides of the front end of the furnace as fast as the ore melts on the hearth of the latter.

It has been found that for maximum efficiency in a steam turbine it is requisite that the thickness of the elementary streams should, in the successive stages of progress through a multiple-effect turbine, vary approximately with the radius of curvature of the absolute path of the stream; so that with a radius of curvature of the absolute path of the stream becoming greater, the thickness may be increased by the employment of fewer vanes, or for a continuous thickness of stream by a constant space-interval or pitch of vanes, then a uniform radius of curvature of absolute path should be maintained by the use of vanes of diminishing radius of curvature. This action has been geometrically demonstrated, and a diagrammatic illustration given of the forms of stator and rotor vanes adopted.

In a recent issue of the *Revue Scientifique* Dr. C. Fery gives an illustrated account of the new methods of determining high temperatures in industrial operations. For temperatures up to 700 deg. C. he recommends a thermo-electric couple of iron-constantan, from that to 1,300 deg. C. one of platinum and its alloys, in each case in combination with a self-registering arrangement. Where the thermo-couple would be injured if brought into direct contact with the source of heat, he advocates the use of his own pyrometer, in which the radiation from the source is concentrated by a concave mirror on to the thermo-junction. For sources of small dimensions at temperatures above 900 deg. C., optical pyrometers, e. g., Wanner's, are the most useful.

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