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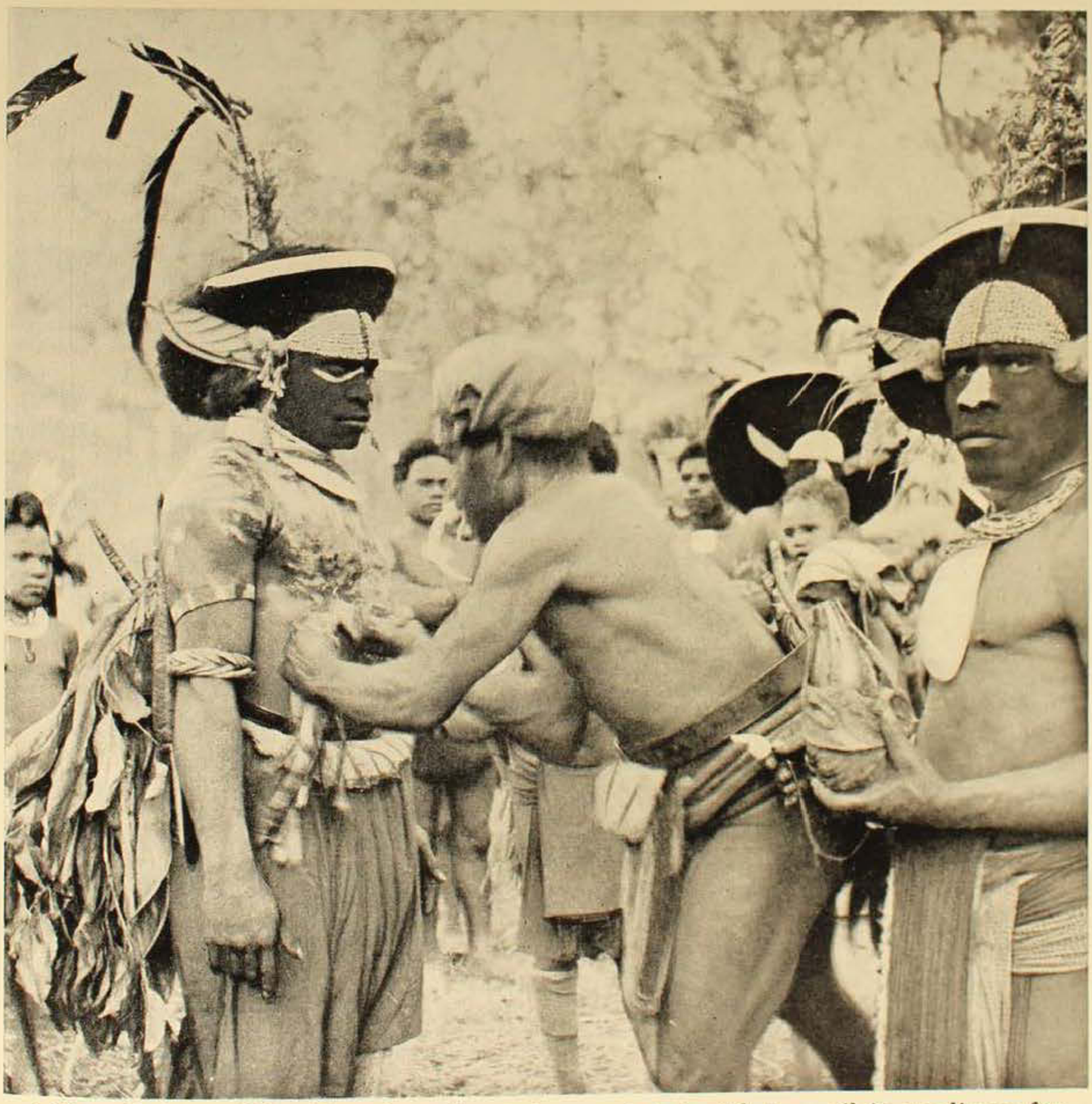

A New Guinea (Mae Enga) native being anointed with tree oil in readiness for a singsing. (Article Page 309.)

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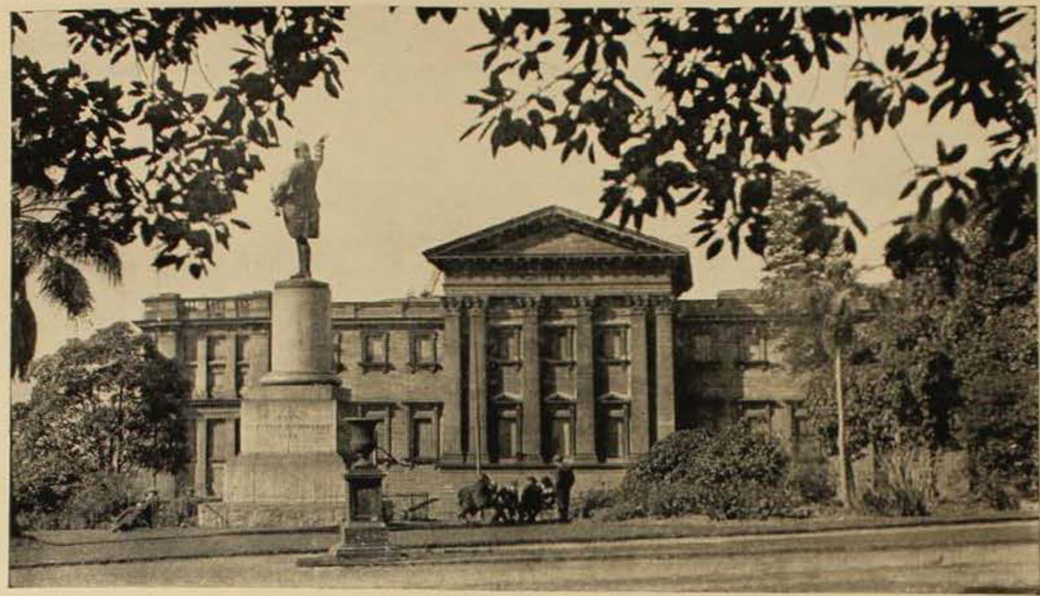

THE AUSTRALIAN MUSEUM MAGAZINE

● OUR FRONT COVER: M. J. Meggitt, author of the article on salt manufacture and trading in New Guinea (page 309) photographed this scene while studying native society in the Western Highlands of New Guinea. A singsing (the equivalent of an Australian Aboriginal corroboree) is about to take place and the participants are preparing themselves in traditional fashion. The man on the right holds a gourd from which the native in the centre has taken tree oil to anoint a third companion.

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VOL. XII, No. 10 JUNE 15, 1958

Salt Manufacture and Trading in the Western Highlands of New Guinea

By M. J. MEGGITT

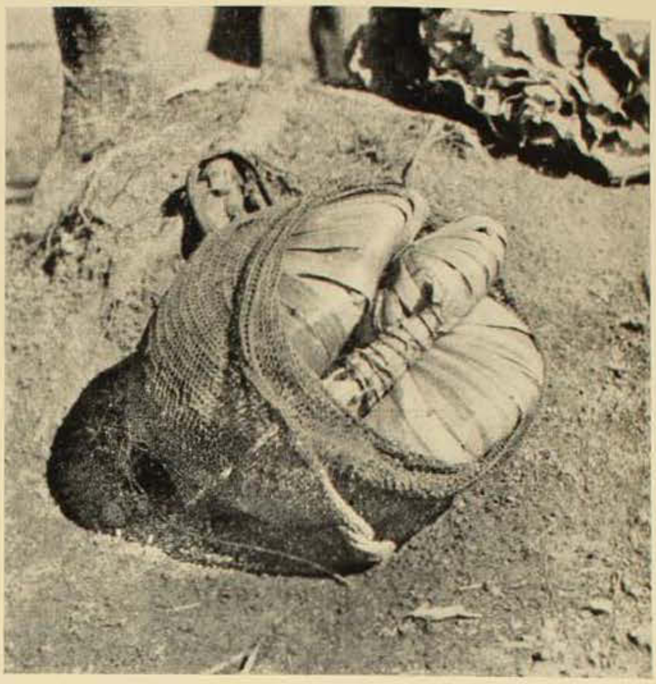
Department of Anthropology, University of Sydney

MOST New Guinea natives now, as in the past, depend on vegetables for their staple foods, especially on root vegetables such as taro, yams, cassava and sweet potatoes. Few native communities have access to reliable or extensive supplies of meat. Consequently their diet is deficient in sodium; in some way or other they must obtain salt to add to it.

In coastal areas, seawater can be evaporated to produce dry salt, or vegetable foods can be cooked in seawater. Dry sea salt may be traded some distance inland: but natives living far from the coast need alternative sources of salt. In some places elaborate techniques are used to extract salt from vegetation. For example, near Menyamya in the Eastern Highlands, natives burn wild sugar cane (*Saccharum spontaneum*) and filter water through the ashes. The water is evaporated on large clay ovens and the residual salt and other solids are made into blocks which can be stored or traded. This salt, however, contains potassium chloride, not sodium chloride, and probably has little nutritive value for the natives.

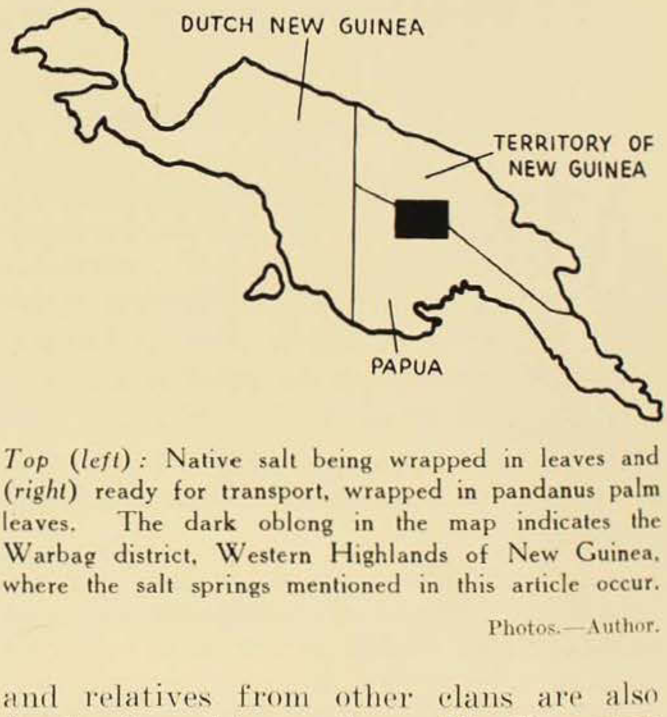
A common method of producing salt in both inland Dutch and Australian New Guinea involves soaking wood or leaves in salt springs, burning the material and collecting the ash, which contains sodium chloride. I was able to investigate this technique while carrying out anthropological fieldwork in 1955-7 among Enga-speaking natives of the Wabag district of the Western Highlands of the Territory of New Guinea, where there are a number of salt springs and where native salt production is on a fairly large scale. Native population in the Wabag district is comparatively dense, there being an estimated 100,000 Enga and other natives in the high mountain valleys. The salt springs, however, are not uniformly distributed geographically, so that a considerable trade in salt exists within the Enga area as well as with neighbouring peoples.

I visited several of the main salt-producing localities and found that the manufacturing techniques and forms of distribution are fairly constant. But the sorts of country in which springs occur vary somewhat and this in turn affects the size, number and forms of ownership of springs in a given locality.



At Liyonggo, about 14 miles west-south-west of Wabag administration station, two pools lie together on a rocky hillside. Each pool is about 100 to 150 square yards in area, and from 50 to 60 ins. deep, with a porous, rocky bottom through which salt water rises to a height of 40 to 50 ins. Men believe the pools were formed in ancestral times when a gigantic sow urinated there. Streams of its urine then ran underground to emerge in distant localities as other salt springs. Each pool is divided with rough palings into 80 to 90 more-or-less rectangular plots whose dimensions range from about 4 feet by 2 feet to about 6 feet square. Pieces of wood are steeped in these plots. Although one pool belongs to Konowe clan as a whole, and the other to Piyelyini clan, each plot is individually owned by a clansman or group of brothers who inherited it from their father. There are no other pools for miles around and, because of the rocky surroundings, these two pool areas cannot be extended. Each family therefore jealously guards its rights in the pools' salt production.

Kiowapere, on the other hand, is a set of three large and several smaller springs on a swampy, black soil plateau 7 or 8 miles south-east of Liyonggo. Each pool, which is from 40 to 60 inches deep, contains from 3 to about 35 small fenced-off plots. But these plots are used indifferently by all men of Kara clan as they need them, and relatives from other clans are also freely allowed to use them. If a Kara man wants a plot in a hurry and all the plots are in use, he can make a new spring simply by digging a small well in the surrounding black soil. As a result, the location of Kiowapere springs changes through the years.

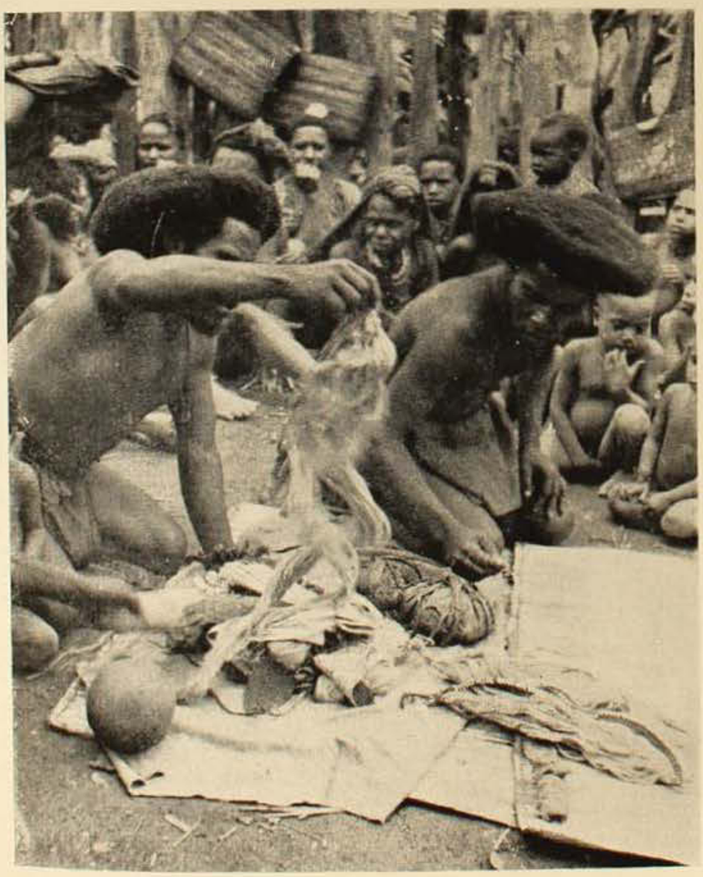


Top (left): Native salt being wrapped in leaves and (*right*) ready for transport, wrapped in pandanus palm leaves. The dark oblong in the map indicates the Warbag district, Western Highlands of New Guinea, where the salt springs mentioned in this article occur.

Photos.—Author.

The same is true of nearby Andepe spring, used by men of three clans comprising Irapuni phratry (tribal subdivision) and four clans of their brother phratry, Awaini. Several miles to the north-east and the north, in similarly swampy soil, lie the three Nakatini springs, made and used by clans of Yenaitini phratry, and the two Langku springs made by Pumaini clan. All these springs can be extended with little labour, so there is no problem of permanent individual ownership and inheritance of the component plots. Indeed, Pumaini men who live a long way from their springs allow men of two non-related but nearer clans to share with them the Langku salt output.

All the springs mentioned are some miles from inhabited clan localities and clan owners cannot easily supervise or defend them. Men say that they would not steal wood soaking in another clansman's plot for this would lead to argument and blows, and quarrels *within* a clan are greatly deplored. In the past, hostile clans sometimes tried to seize these springs by force but rarely could they maintain their control over them in the face of the (presumably) rightful owners' counter-attacks. These springs are the greatest producers of salt per spring in Enga country, and provide a



Man distributing packets of native salt and other forms of wealth at a Mae Enga funerary distribution.

Photo.—Author.

widely-traded surplus. Other springs on the Lagaip and Porgera Rivers, and near Yalis on the lower Lai River, can barely supply the clans living near them.

Salt manufacture begins with the owner or user of a plot felling any of about six kinds of small, soft-wooded trees growing nearby. The wood is sun-dried and chopped into billets about 18 inches long. When thoroughly dry these are placed in a plot until it is filled. Heavy logs may be placed on this wood to keep it submerged; sometimes earth or cane grass (*Miscanthus* sp.) is heaped on the logs to prevent evaporation of water from the plot. It is then possible to walk over most plots without wetting one's feet. Preparation of plots may occur at any time of the year; heavy rain apparently does not appreciably reduce the high salinity of the water.

In most springs the wood soaks for two to three months, but at Andepe the water is so salty that a few weeks' steeping is sufficient. When this period has elapsed the wood is removed by women, who must immerse themselves in the icy water to clear the pool thoroughly. Men refuse to tackle this unpleasant task. Fresh wood, prepared beforehand, is at once placed in the newly-emptied plot. After some hours' draining the steeped wood is taken to sheds which clansmen have built beside the springs. These open-sided, lean-to sheds have thatched roofs and range in size from about 10 by 8 feet to about 30 by 15 feet. In each is a number of small, shallow depressions in the earth, used as fireplaces.

Men place a heap of quick-burning firewood in the middle of each pit to form a core, then carefully stack the salt-steeped wood in a circle around this core. They stoke the fire all night, and by dawn the salt wood is reduced to a heap of fine ash. The men carefully wrap this in large leaves (of breadfruit, cordyline, laportea, etc.), and bind the package with 30 to 40 feet of dry pandanus palm leaves joined together, to ensure that the package remains waterproof. The round, flat package, which now looks like a squash, weighs between about 2 and 12 pounds, and averages 5 or 6 pounds. The hot ash must be wrapped quickly, before it absorbs moisture from the atmosphere and deliquesces. For this reason men never make ash salt on rainy days. The whole process is repeated for several days until the wood from the plots selected is consumed. An average plot, about 5 by 4 feet, produces four to six large packets of ash salt weighing from 8 to 10 pounds each. This mixture appears to contain a remarkably high proportion of salt. A sample from Liyonggo, analysed by C.S.I.R.O. chemists at the request of Professor A. P. Elkin, contained 70 per cent. sodium chloride, plus significant amounts of potassium carbonate, magnesium, iron and phosphate. As they work, people constantly suck chips of the steeped wood, or certain pubescent leaves which they dip in the salty water. Indeed, nobody can pass a salt spring without sampling its water.

While a plot-owner and his family may make on each occasion enough salt to give them a surplus for particular exchange situations, a surplus is not often made specifically for trading. Instead, the owner prefers to wait for buyers to come to him. Laiap Enga from the east can obtain little salt from Walaiyeri clan's spring near Yalis, because most of its small surplus goes further east to Kyaka natives of the Baiyer River. If Laiap men need extra salt for their own consumption, or for use in ceremonial exchanges, they walk for two days across mountains to the upper Lai River springs to buy salt from Yandapu Enga. In the past they paid for it with shells and stone axe blades obtained from relatives and trading partners in the Mount Hagen area; nowadays they offer small pigs and yams. Southern Aruni and Kandep Enga also procure most of their salt from these Yandapu springs, carrying net bags, shells, pigs and gourds full of tree oil (for decorative use at singsings) for four or five days over the steep mountains to pay for it. They obtain the oil in trade from natives further south in the Lake Kutubu area. By judging seasonal demands of Mae and Yandapu Enga for tree oil and plumes, southern Enga middlemen can make handsome profits. Some weeks before the main ceremonial season opens among Mae and Yandapu, southern Enga visit Yandapu clans and make salt in exchange for pigs and axes. They carry this to Mendi peoples in Papua and convert it into tree oil, which they trade back to Mae and Yandapu for many more pigs and axes than they originally paid for the salt.

Ipili natives of the Porgera valley similarly exchange salt from Kumbirae spring on Aiyema Creek for tree oil and pigs brought to them by Huli and Duna men from Papua. But Kumbirae output is limited and, to meet the considerable Papuan demand, Ipili exchange hand-drums and plumes with Taro Enga clans for extra salt from the springs at Pipitaka on the Kera River and at Aukera on the Lagaip River. These Taro springs also provide a small amount of salt for southern Waka Enga and northern Maramuni Enga, who give tree oil, net bags and young cassowaries for it; but many Waka and Maramuni traders obtain salt from the Yandapu springs, which also supply all Mae and Yandapu domestic requirements.

These trading parties range from a couple of men to a whole clan or subclan, including wives and children—say 60 people in all. Usually they are at least a dozen strong so that they can defend themselves from attack and robbery while travelling. At the springs, however, visitors are guaranteed safe-conduct by their hosts.

The buyers ask the clan owning the spring if any members currently have wood steeping in the plots. Then they split up into family groups, each of which becomes the guest of a host family that has plots in readiness. Buyers know roughly how much salt the plots should produce, and agree on a price in terms of articles desired by the hosts, *e.g.*, two axes, three gourds of oil, two net bags and one pig for the use of six plots expected to yield 20 to 25 packets of salt. This price also pays for the food (sweet potatoes) the buyers will consume in the three or four days they are present. They hand over the payment, then camp by the spring while they burn the wood to produce salt ash. Sometimes a plot owner accepts full payment for a plot, knowing it is half empty. When the buyers discover this deception they demand the return of their payment, but, being visitors and in a minority, have little chance of recovering it. Few plot-owners, however, attempt such fraud because they know they will never be able to trade again with these people in the future.

If plot owners need extra oil, pigs, net bags, etc., on a particular occasion for a clan ritual, funerary distribution, or marriage payment, they may make a big supply of salt themselves and carry it to other areas to exchange. In these cases the price of the salt rises markedly, because the sellers expect extra compensation for their labour in making and transporting it. Two to four large packets may cost a pig, or one or two small packets a gourd of oil.

It may seem that these Enga devote a disproportionate amount of time and energy to the production and distribution of salt. When asked about this, they reply that salt manufacture and exchange are important to them for several reasons. First, salt is desired because it improves the flavour of food, especially of meat. Second, the ancestors originally made salt, so men to-day should continue to follow their example. Third—and very important—salt can be traded or distributed ceremonially, and so establish further friendly relationships with other natives. Through these relationships, men can enhance their social reputations and find opportunities to acquire more wives and pigs. And possession of many wives and pigs is the mark of the really important man in Enga society.

M. J. Meggitt, 33-year old lecturer in the Department of Anthropology, University of Sydney, did his first field work among the Walbiri Aborigines of Central Australia in 1953-55. He was then a Research Student of the Department. As a Research Fellow he went next to the Western Highlands of New Guinea to work among the Enga-speaking natives. Mrs. Meggitt accompanied her husband on both trips and investigated native women's life and activities.

Nature Quiz

Q.: What is the true identity of the coral builder, so often erroneously referred to as the "coral insect"?

A.: While the builders of corals are definitely animals they are not remotely like insects. The name "polyp" is the correct one to use. The nearest relatives of coral polyps are the sea anemones, common to every ocean shore. Sea anemones are really naked polyps for, unlike coral polyps, their flesh is neither enclosed nor supported by a skeleton of carbonate of lime.

A single coral polyp can be as small as a pin's head. Countless thousands of them may occur in the bulk of a delicate branching growth. In such an assemblage they form what is termed a colony and are linked, one with the other, by thread-like common flesh. Individual polyps occupy the innumerable pores (corallites) which pit the surface of a branching coral growth. In the massive, more closely knit forms of coral, the polyps are larger and the limits of the areas they occupy are often not readily discernible.

It is in the mushroom form of coral that one of the simplest types of coral polyp is found. In this case only a single polyp is housed in a mushroom-like limy skeleton, often of giant proportions; some kinds are as large as dinner plates.

Like sea anemones, coral polyps possess a crown of tentacles. These are armed with stinging or nettle cells sufficiently potent to paralyse the tiny floating prey they capture for food. A central mouth opening connects below with a stomach sac—the simplest known form of gastric cavity. The mouth also functions as the opening through which waste is expelled. It is truly remarkable that such a simple structure has the added capacity to extract carbonate of lime from sea water with which to build around and within itself the many and infinitely varied patterns of growth to be found on the numerous coral reefs of the tropics.

Aboriginal Cave Art

Mr. F. D. McCarthy, Curator of Anthropology at the Australian Museum, with the Museum's artist, Mr. J. Beeman, recently visited the Lake Conjola district to record aboriginal cave drawings. Among these drawings two styles or techniques of cave art were detected which are unrecorded anywhere else in Australia.

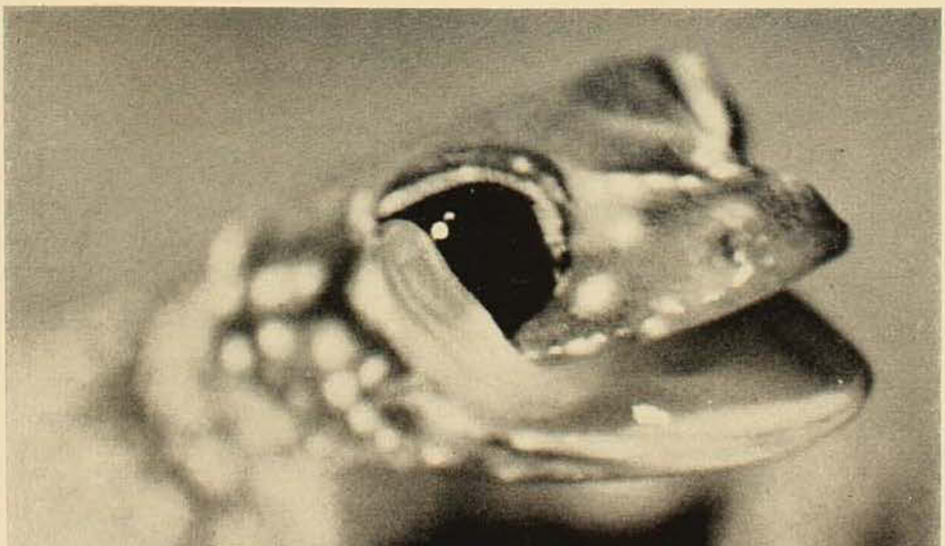
Adaptive Convergence in Australian Reptiles

By F. J. MITCHELL

Curator of Reptiles, South Australian Museum

THE natural phenomenon known as "adaptive convergence" is extremely widespread in the animal kingdom and many examples can be quoted. To illustrate we might consider two classic cases of convergence between unrelated mammals. The close superficial resemblance of the European Mole (order Insectivora) and the Australian Marsupial Mole (order Marsupiala) is obvious; likewise the True Porcupines (order Rodentia), the European Hedgehog (order Insectivora) and the Australian Echidna (order Monotremata) have many specialised features in common, despite their remote relationship.

Before the term can be properly understood it may be necessary to review our knowledge of the basic processes of evolution. Broadly speaking evolution is nature's way of selecting and maintaining individual traits of physique or vitality which prove advantageous in an animal's fight for life in the environment in which circumstances force it to live. It is a continuous process, simple in principle, but complex in mechanism, which enables genetically virile animals to re-adjust themselves over series of generations to a changing environment, or to adapt themselves to a new environment where natural competition for food and shelter is less severe. This modification has a guiding mechanism known as "natural selection", which gradually weeds out the weak and poorly adapted individuals from a population, thereby reducing the likelihood of a re-occurrence of their weak characteristics. Because of the positive nature of this guiding force it is not surprising that groups of unrelated animals competing among themselves or with other forms of life for living space and food under the same or similar environmental conditions, should evolve in parallel, individual body organs being modified in a similar manner.



The eyes of this gecko are mobile but each moves behind a protective transparent disc. "Tears" keep the discs moist and dust is removed by rapid use of the large fleshy tongue.

Photo.—Author.

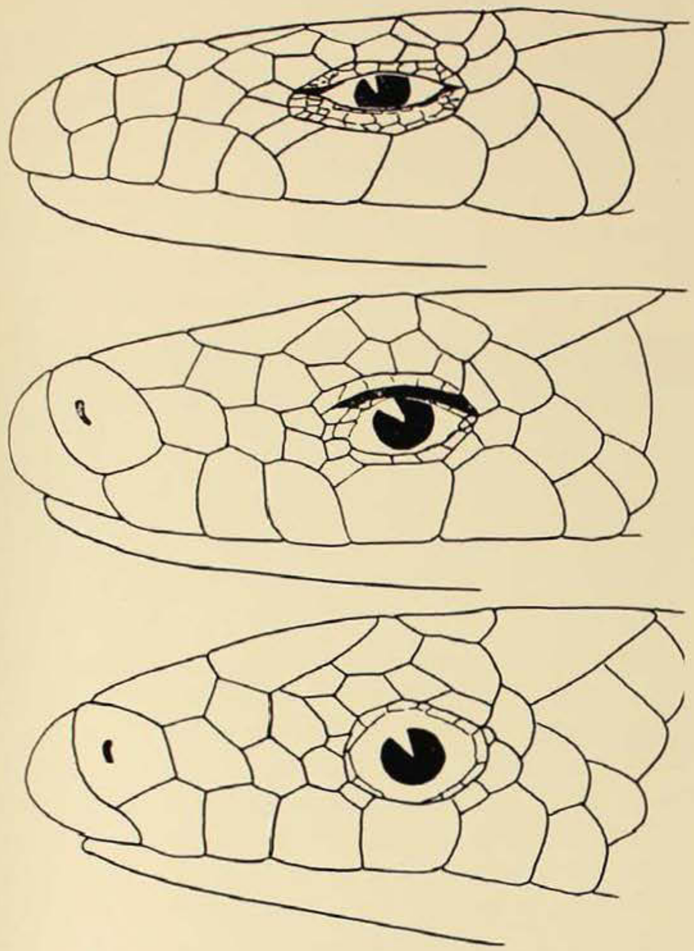


Fig. 1. Drawings illustrating the transition from a scaly mobile eyelid (*top*) to the fixed transparent disc (*bottom*).

Australia's reptiles provide us with some remarkable examples of convergence. Not only do we see the end products, but we also get an insight into the intermediary stages of the process.

It is the generally accepted opinion that the basic evolution of present day reptile groups took place in a humid tropical or subtropical environment, probably at a time when this type of climate occurred over a much larger part of the world's surface than it does today. Many of the main evolutionary trends therefore have been toward adaptions favouring life in the arid parts of the world. Cold-blooded animals, like the reptiles, although sun-loving animals, cannot withstand prolonged exposure to direct sunlight, and therefore it is essential that species living in desert areas with limited vegetation cover should be able to burrow underground, not only to escape overheating, but also to avoid the eyes of numerous predators. For this reason reptiles with a vermiform or wormlike shape, without the encumbrance of external limbs have several obvious advantages in a desert habitat.

It is well known that snakes have a wormlike form (not necessarily resulting from adaptation to arid conditions, but an undoubted advantage in such an environment), but it is not so well known that several families of lizards have independently reached a similar stage of specialization. Among Australian lizards the outstanding examples are the Legless Lizards (family Pygopodidae). These lizards have assumed an essentially snake-like appearance. The body and tail have become greatly elongated and the limbs have degenerated to a condition similar to that in the primitive snakes (Boas, Pythons etc.), where only remnants of the hind-limbs remain, these being visible externally as small spurs or, in the case of the lizards, small scaly flaps, one on each side of the anal opening. In members of the lizard genus *Aprasia*, the group most completely adapted for burrowing, evidence of the former existence of hind-limbs can only be found by the use of a powerful magnifying lens. Although the parallel development of the superficial appearance of these lizards and the snakes is practically complete, even to the extent of some rather disturbing mimicry of habits, they can be immediately separated on critical examination. The lizards possess external ear-openings and have long fragile tails, which, if complete, may measure several times the body length. Another often quoted, but not infallible means of separating the two reptiles is on body markings. In most snakes the colour pattern is transverse while the legless lizards usually have longitudinally disposed markings.

Evolution is an irreversible process always tending in vertebrates towards a simplification of the supporting bone structure. The gradual reduction in the number of bones in the limbs leading to their final disappearance is excellently illustrated by an examination of the limb structure of species in the Australian lizard genus *Rhodona*. Practically every combination of limb and digital structure can be found among the present day species, from primitive, well developed limbs with five digits on each, to a highly specialized condition similar to that in the Legless Lizards with no fore-limbs and only minute remnants of the hind-limbs remaining. Correlated with this degeneration is the gradual elongation of the body and tail and appropriate changes in the shape and position of various body organs together with the adoption of serpentine habits. In addition the shape of the head is often modified to assist in burrowing, the snout becoming streamlined and the lower jaw undershot as in a shark. The outer edge of the upper jaw often protrudes sharply over the lower jaw forming an effective scoop with which the lizard forces sand under and to the side of its body when burrowing.

Adaptation to fossorial life usually requires a reduction in size of the external openings about the head, such as the eyes, ears and nostrils, or alternatively, the development of some protective feature to preclude the entry of foreign matter. Snakes possess a specialised hearing mechanism which does not require any external openings. The snake-like lizards possess ear openings but these are greatly reduced in size. Similarly the nostrils are shaped to minimise the chance entry of foreign particles. The eye openings of some lizards with greatly reduced limbs are small and slit-like in shape, but the majority show strong convergent tendencies toward the specialized condition in snakes where the eyelids have disappeared and the eye is protected by a fixed transparent disc. Once again the remarkable Australian genus of Skinks, *Rhodona* gives us an insight into the stages of transition. Fig. 1 illustrates the evolution from completely mobile scaly eyelids to partially moveable eyelids with a transparent window in the lower lid to permit limited vision with the protective eyelids closed, to the ultimate fusion of the upper and lower lids and the enlargement of the transparent window to cover the whole of the eye as in the Snakes and the Legless Lizards.

The unblinking eye has also been independently developed by another family of lizards, the Gekkonidae (geckoes), a family well represented in Australia. The derivation of the "fixed" eyelid and the selective forces which guided its evolution in this case are not obvious from an examination of the present day anatomy and habits of these lizards. All have well developed pentadactyle limbs and few species are active burrowers. Most species have large and rather delicate eyes congenial with their nocturnal feeding habits. Their eyes differ from other "fixed" eyelid types in that they still possess an active lacrymal (tear producing) apparatus and this serves to lubricate the mobile eye which moves behind the transparent disc and also appears to keep the front face of the disc moist. This moist surface accumulates dust and has to be cleaned periodically by the rapid use of the large fleshy tongue.

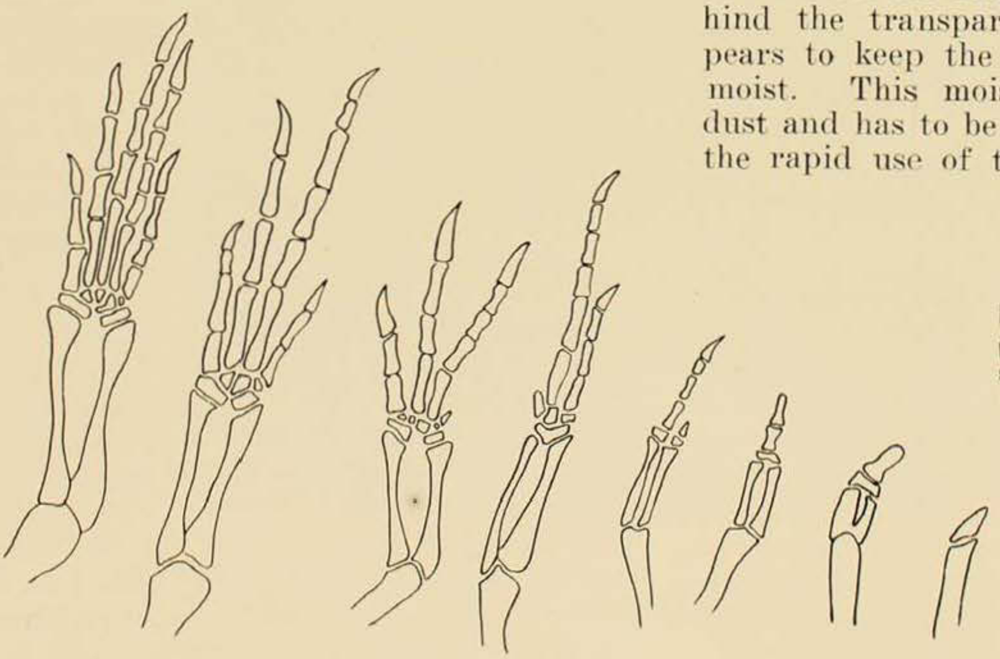


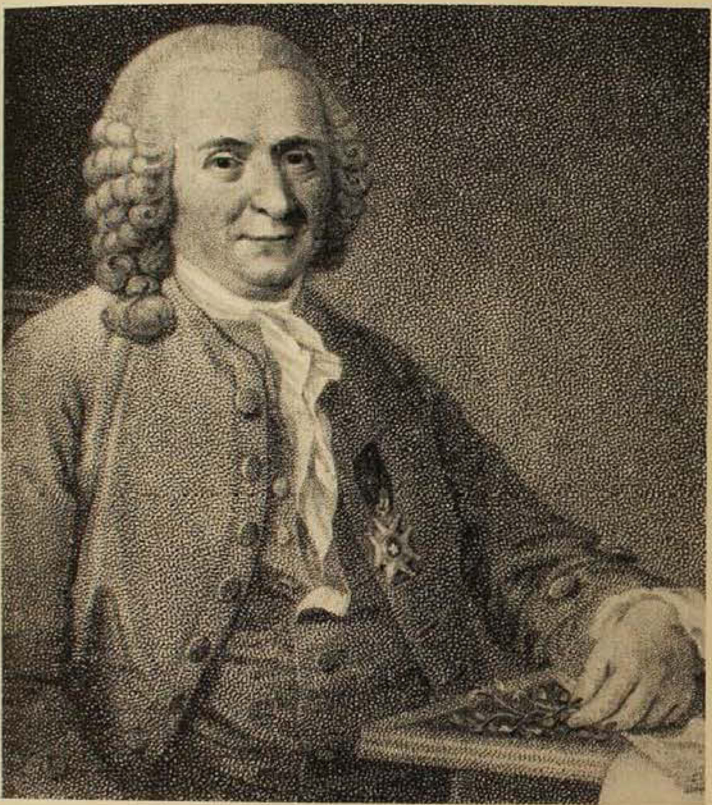
Fig. 2. Key stages in the degeneration of limb structure as shown by the dissection of various species in the lizard genus *Rhodona*.

To the casual observer the lizard only appears to be licking its lips, but high speed camera photographs reveal that the tongue is folded back around the labial edge and drawn along until its tip passes over the face of the eye. (See Page 314).

These are but a few examples of how nature has contrived to give more than one type of Australian lizard some of the adaptive advantages enjoyed by the snake, which is one of the most highly specialised animals living today.

Linnaeus and Zoology

By G. P. WHITLEY



Carl von Linne. An engraving from a portrait owned by Sir Joseph Banks.

From Pulteney's *A General View of the Writings of Linnaeus*, 2nd ed. 1805.

TWO Linnean anniversaries of importance fell within the years 1957 and 1958. Carl Linnaeus, the great Swedish naturalist, was born in May, 1707, two and half centuries ago; and the tenth edition of his *Systema Naturae*, which is the basis of the scientific naming of animals and still stands as a firm foundation, was published on January 1, 1758, two hundred years ago. Australia has an historical as well as a scientific interest in Linnaeus since one of his pupils, Daniel Solander, visited this continent with Captain Cook on his first voyage.

Carolus Linnaeus or Carl von Linné (1707-1778) was born in the south of Sweden. As a boy he was not a brilliant scholar but from an early age he was interested in botany and later extended his interests to zoology, mineralogy and medicine. In youth he suffered great poverty, wearing the cast-off clothes of others and patching begged shoes with bark or coarse paper. A Dr. Celsius took him into his home where he met another young naturalist, Peter Artedi, and the two devoted their leisure to natural history. In 1732 Linnaeus made his famous lone journey to Lappland. On horseback, or on foot, he traversed over 4,000 miles, suffered many hardships, collected new plants and on his return was pleased with his remuneration of about £10.

He fell in love with the daughter of a Dr. Moreus who insisted on a probationary period of three years before his decision should be given for or against the match.

"All the efforts of the naturalist were now turned to that of bettering his condition in life. Medicine was chosen as a profession, but for this a degree must be acquired, and he resolved to proceed to the university of Harderwick. He travelled by Hamburgh, through Holland, to the place of his destination; and at the former place, had nearly got into disagreeable embarassments, by pronouncing the famous Seven-headed Hydra to be deception, composed of weasels' jawbones, covered with serpents' skins. He found it necessary to leave the place, for in so great value was this serpent esteemed, that it had been pledged in security for a loan of ten thousand marks, a value which this discovery by no means enhanced. Upon his arrival at Harderwick, he was introduced to the professors, wrote and defended his thesis, and finally received his degree of M.D., with a diploma containing testimonials of his abilities, as flattering as those given upon his leaving school had been discouraging[1]".

Another of Linnaeus's friends and pupils was the entomologist Fabricius who, in his Anecdotes quoted by Jardine (*loc. cit.* pp. ii-vii) related that Linnaeus rose very early in summer, mostly at 4 o'clock. From 6 to 10 a.m. he lectured to his botanical pupils. He wandered in the garden and in the evening played the Swedish game of trissett with his spouse and pupils. On Sundays they "danced minuets or Polish". He liked his guests to be in high glee, and indeed very noisy; "had he not always found us so, he would have manifested his apprehensions lest we should not be sufficiently entertained." Fabricius also stated: "It sometimes appeared to me, as if his looks would penetrate through the very innermost recesses of the heart; his passions were strong & violent . . . suddenly roused to anger and boisterous; the sudden effervescence of this fiery passion subsided, however, almost at the very moment of its birth, and he immediately became all plain good nature again."

Linnaeus conducted summer excursions at the head of hundreds of students and "whenever some rare or remarkable plant, or some other natural curiosity was discovered, a signal was given by a horn or trumpet, upon which the whole corps joined their chief to hear his demonstration and remarks" (Jardine), whence Alfred Noyes' verse—

> "Flags flying, French horns blowing, kettle-drums throbbing,
> And Carl Linnaeus marching at their head . . . .
> And, afterwards, each with his own flower-fettered girl,
> They'd dance the rest of the summer night away."

In 1739 he began to acquire a good medical practice. In 1761 (antedated to 1757) he was ennobled as von Linné and classified the natural history collections of the Royal Family of Sweden. He brought order and concise description into the realms of zoology, botany and mineralogy. His work in the last-named field is quite outmoded nowadays, but botanists regard the foundation of their work as Linnaeus 1753, whilst zoologists accept the publication of the tenth edition of Linnaeus's *Systema Naturae* in 1758 as the starting point of the system of giving two scientific names (genus and species) to animals.

His first zoological publication was the *Methodus Avium Sveticarum* of 1731. Linnaeus' *Fauna Suecica*, published in 1746, is notable as being the first work especially devoted to the entire fauna of any country. In it 1,350 Swedish animals were mentioned.

The first edition of his *Systema Naturae*, of which a replica is in the library of the Linnean Society of New South Wales, published in 1735, was a folio of only 12 pages, but in 33 years this brochure grew to a work of some 2,400 pages. The first edition made mention of mainly Swedish animals, together with a few tropical ones added from literature.[2]

In his time fossils were regarded as "ambiguous stones" in the form of living things, rather than relics of earlier life. Palaeontology was not then a science. So Linnaeus classed fossils as stones (a fossil animal was a zoolithus; a plant, phytolithus; whilst the graptolithus was a stone adorned with markings resembling figures produced by painting.[3] He was, however, "modern" enough to regard corals and zoophytes as animals, not plants.

[1] Jardine, Naturalists' Library, 1843 edition, vol. xiv, p. 37.

[2] J. A. Allen, Ann. N. York Acad. Sci. xviii, 1908, pp. 12-13.

[3] MacGillivray, Lives of Eminent Zoologists, ed.2, 1834, p. 305.

Almost biblical in their straightforwardness and simplicity are the apposite names Linnaeus chose for his animals, such as *Canis familiaris*, the faithful dog.

Linnaeus was the first to separate "worms" from insects and to use the term Mammalia. He separated the whales from the fishes, but some of his combinations (*e.g.*, Rhinoceros amongst the rodents) may now seem odd to us. In birds, too, he associates one species of penguin with the tropic-bird and another penguin with the albatross—but he could not have had direct knowledge of any of those birds and probably followed Ray and other early authors. Since their migrations were not

CAROLI LINNÆI

EQUITIS DE STELLA POLARI,

ARCHIATRI REGII, MED. & BOTAN. PROFESS. UPSAL.; ACAD. UPSAL. HOLMENS. PETROPOL. BEROL. IMPER. LOND. MONSPEL. TOLOS. FLORENT. SOC.

SYSTEMA NATURÆ

PER

REGNA TRIA NATURÆ,

SECUNDUM

CLASSES, ORDINES, GENERA, SPECIES,

CUM

CHARACTERIBUS, DIFFERENTIIS, SYNONYMIS, LOCIS.

TOMUS I.

EDITIO DECIMA, REFORMATA.

Cum Privilegio S:æ R:æ M:tis Sveciæ.

HOLMIÆ.

IMPENSIS DIRECT. LAURENTII SALVII, 1758.

Two years ago the British Museum of Natural History printed a facsimile of the first volume of the 10th edition of Linnaeus's *Systema Naturæ* from a copy of that work in the general library of the Museum. The title page shown above is reproduced from the reprinted volume.

understood in his day, like other naturalists of the time he supposed swallows retired to the bottoms of lakes and rivers at the approach of winter, there to remain in a torpid state till summer came again.

In the tenth edition of Linnaeus there are, named and put in order, 6 classes, 312 genera and 4,380 species. In a later (1766) edition the number of species of animals was increased to 6,128. (In botany, more than 7,800 species were systematically discriminated).

How many species of animals are there in the world? Various estimates have been made from time to time and the number is still increasing. In 1830 the figure was put down as 71,598; in 1859, it was 129,370; 1881 suggested 211,553 and by the turn of the century 300,000 to 366,000. In 1911, Pratt estimated 522,400. The ancient Upanishads assigned 840,000 as the number, remarkably close to Storer's 1951 figure of over 900,000. The latest figures are approximately 1,500,000 different animal species and hundreds of new ones are still being discovered yearly, and all are named according to the system laid down by Linnaeus 200 years ago.

The effect of Linnaeus's *Sexual System of Plants* and of the *Systema Naturæ* upon the savants of his time was not altogether favourable.

Sir Hans Sloane and the German botanist Dillenius, whom Linnaeus met in England, were anything but cordial: at Oxford, "They looked upon him as a young innovator, who wished to overturn the old systems, only to exalt his own name upon a fleeting eminence." A Frenchman said: "He is a young enthusiast who confounds all, and whose only merit consists in having reduced botany to a state of anarchy." Another Frenchman complained to Voltaire that Linnaeus had associated Man with the pig and the horse. "He is a horse, himself", he shouted angrily, and Voltaire replied "Vous conviendrez que, si M. Linnaeus est un cheval, c'est le premier de tous les chevaux."

As Adam had named the animals, according to Genesis ii, 19, Linnaeus was regarded as impertinent for setting himself up as a second Adam. "The Deity has left none of his works imperfect. Animals are formed of different kinds, each kind having a figure and a temper peculiar to itself", stated Lord Kaimes (in 1774) and he remarked of Linnaeus's *System*, "It resembles the classing books in a Library by size, or by binding, without regard to the contents . . . . How whimsical is it to class together animals that nature hath widely separated, a man, for example, and a bat?"

Though his Lappland and botanical sketches are lively, Linnaeus was no great illustrator and constantly urged the employment of competent scientific draughtsmen, yet Archbishop Benzelius is responsible for the assertion that he knew more about painting than anybody else in Upsala.

The Linnean Society was established in England in 1790. Natural history became a fashionable recreation amongst the gentry and clergy and even the young ladies living in the country. With the nineteenth century, natural history societies were formed and the field was fruitful for the labours of Darwin, White of Selborne, Charles Waterton, the Rev. W. Kirby and a host of other naturalists.

Gradually the microscope and scalpel affected classification. Cell-structure may have been known to Linnaeus but the theory that all plants and animals were built up of cells was propounded later than his time. He used a lens, rather than a microscope, to augment his acute vision.

The Frenchman, Georges Cuvier, who had been a boy of eleven when the Tenth Edition of Linnaeus appeared, laid stress on the internal structure of animals. He was followed by schools of comparative anatomists (Agassiz, Muller, Owen, St. Hilaire). Later there developed the sciences of palaeontology, embryology, morphology and physiology; and the geneticists entered the field. Findings from these disciplines modified the Linnean classification, as did also the descriptions of hundreds of new species resulting from collections made in foreign lands. The "Indies" of Linnaeus had included both the East and West Indies indiscriminately but as new countries became explored their faunas were gradually revealed. The deeps of the sea, thought to have been lifeless, were dredged by the *Challenger* and other vessels and found to support an amazing variety of creatures. At the sea-surface, the plankton exhibited another animal cosmos, yet it was possible to fit all these newly found creatures into an expanded Linnean system of nomenclature. Once animals are properly classified, data on their life-histories can be associated with particular species and their ecology and bionomics studied with greater precision. Finally, the way opened up for experimental zoology to develop, with all its exciting possibilities.

In 1908 the Americans paid Linnaeus the delicate compliment of naming after him a bridge in Bronx Park, New York City, joining the botanical with the zoological gardens, and the British Museum recently issued a facsimile of the tenth edition of the *Systema Naturae*. In his native Sweden, the 250th anniversary of his birth was celebrated by the erection of a statute at Upsala, the striking of a medal, the issue of special postage stamps and telegraph forms bearing a coloured-representation of the plant *Linnaea borealis*, and the exhibition of Linnaeana.

Space will not permit any account of the influence of Linnaeus on later zoological workers, of the fate of the Linnaean collections and the apocryphal story that a Swedish man-o'-war chased an English brig to intercept the specimens on their way to England, or of Linnaeus's pupils and how they went to foreign lands, and how some, quite young men, left their bones in America, Arabia, Russia and Tartary.

Let us close with a quotation from a letter written by Linnaeus in October 1771 to Ellis, the Irishman who studied coral and zoophytes, in which Linnaeus refers his disciple to Cook's great voyage:

> All sublunary things are uncertain, nor ought any thing to be trusted to treacherous futurity. I therefore once more beg, nay I earnestly beseech you, to urge the publication of these new discoveries. I confess it to be my most ardent wish to see this done before I die. To whom can I urge my anxious wishes but to you, who are so devoted to me and to science?
>
> Remember me to the immortal Banks and Solander.

The Australian Prawn Industry*

By FRANK McNEILL

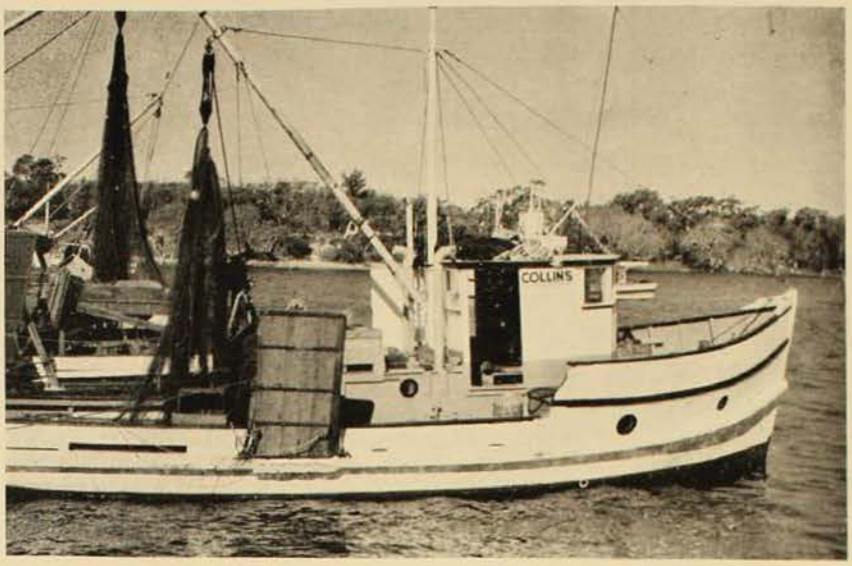


Photo.—E. C. Pope.

As recently as 1945 nobody could have guessed at Australia's prawn potential. About that time one or two progressive fishermen set out to explore offshore waters in the vicinity of Broken Bay, New South Wales. They were equipped with a small scale otter board trawl, and worked on a hunch that prawns could be netted in abundance over sandy parts of the shallow sea floor. Their initial success marked the beginning of a new and far reaching stage in the fishery of probably the most popular of our marine products.

The beginnings of the local prawn industry belong back in the early days of settlement. It was then that the sandy shallows of Botany Bay yielded the greatest abundance of prawns for the Sydney market. Here the fishery was started by experienced Welsh, English and Scottish migrants who laboured with hand-drawn seine nets. To this day their descendants occupy a semi-isolated suburban community known locally as "Fishing Town".

For over 130 years the pattern never changed, and along the New South Wales seaboard and elsewhere the quest for prawns spread to all inshore waters such as river estuaries and the numerous coastal lakes. Now, however, with the newly introduced offshore (sea) fishery, the industry has developed to unprecedented proportions. Numerous ocean grounds are being fished and explored along greater lengths of coastline than were previously exploited by the seine net fishermen. Here not only inshore types of prawns have been found in greater quantities, but other concentrations have been located of kinds which rarely, if ever, enter even the river estuaries.

Organised offshore prawn fishery has as yet been restricted to areas close to the coastline, mainly in proximity to river mouths and in depths not exceeding 25 fathoms. Included among these are the wide waters of Moreton Bay and Hervey Bay in Queensland, and Exmouth Gulf in West Australia.

There was sound reasoning behind the first operation of offshore prawning in New South Wales. Fishermen had observed that two well known local inshore species moved out to sea in mass migrations. This phenomenon periodically occurred on dark moonless nights during the summer season, and the so-called "runs" were particularly conspicuous in the narrow and shallow channels connecting coastal lakes to the sea. There was also the significance of the spasmodic presence of small catches of quite large prawns in the sea-drawn nets of trawlermen engaged in general fishing. This is why the offshore prawn fishery in Australia owes its existence to the resourcefulness of commercial fishermen. In the circumstances it is not surprising that the first ocean prawning

* See "Prawns and Prawning", Aust. Mus. Mag. viii (8), Aug. 1944, p. 262, and "The New Ocean Prawn Fishery", Aust. Mus. Mag. x (2), Mar. 1950, p. 37.

grounds were found close to already well established fishing centres. Quite naturally, the available port facilities and the proximity of a local market became decisive factors in the initial development. Then, too, there has been the expected reaction once the productivity of newly found grounds was established. More and more local fish trawlermen transferred to prawning while the boom lasted. Every increase in volume of catch attracted further trawlers to the new ground, a move which was made at the expense of more desirable exploratory work on home fishing grounds. Two of the earliest examples of this practice are the offshore prawn fisheries of Stockton Bight and Evans Head, New South Wales. Later a similar mass descent of prawn trawlermen was made on Hervey Bay, off the south Queensland coast. At first one or two local fishermen were supplying the nearby coastal market from an abundant prawn stock they had located. Later they consigned a trial lot to the market in Brisbane and, as a result, within a week there was a fleet of a dozen prawn trawlers operating in the Hervey Bay area. Before a year had passed the total of craft had increased to over fifty, all frantically exploring the newly found ground.

Irrespective of the credit which is due to local prawn fishermen, it is to be regretted that the offshore fishery has had such haphazard beginnings. Before it started, zoological research had established (1938) that at least one of the principal Australian prawns (King Prawn) consistently netted in inshore waters, migrated to the sea immediately before maturing and spawning, and never returned. The equally abundant School Prawn, also a frequenter of inshore waters of the eastern coast, was known by biologists to behave likewise, but its migratory habit had not been conclusively established by research. If this knowledge had then prompted a government-sponsored survey of the possibilities of an offshore prawn fishery, the results would no doubt have given the industry benefits far beyond the stage of its present success.

Perhaps a bigger population and better facilities for distribution are needed in Australia before an overall investigation

A co-operative fishermen's plant and cool store. After cooking, prawns are placed in wire baskets and immersed in water to cool.

From "Fisheries Newsletter".

is considered worthwhile along comparable lines to those sponsored for a similar purpose in the United States. In that better populated country a full-scale government research project on the huge shrimp industry proved to be more than justified. A fact not generally known is that the so-called American shrimps are closely related to the Australian prawns since both belong to the same family of the Crustacea (Penaeidae). As this is the case it is natural to expect that their habits would be similiar. Before any research work on migratory behaviour in the Australian region had been published, it had been shown by research to occur with several American species of shrimp. As in Australia the initial American fishery had been carried on for generations in shallow inlets comparable to our coastal lakes and in estuaries along the coasts of Florida and Louisiana, in the Gulf of Mexico.

The initial results of shrimp investigation in America led to the development of a fishery in offshore waters. Hence the year 1938 was a busy one for the Bureau of Fisheries (now the Fish and Wildlife Survey) observers, who explored 1,200 miles of the sea floor of the Gulf of Mexico with trawl nets.

The great concentrations of shrimp they discovered soon enabled a new industry worth millions of dollars to be established, with profitable employment for several hundred men. In addition, the country's annual shrimp production was soon increased by about 50,000,000 lb. This figure is only about one-fifth of the total American production which extends offshore to the Atlantic Ocean, around the tip of the Florida peninsula, and to Pacific waters in the Gulf of California.

The American offshore fishery yields generally much larger shrimps than the ones previously netted inshore—so large that they have come to be known as "jumbos." To some degree, the success of their offshore fishery has been matched on the limited number of Australian grounds so far exploited, but it is doubtful whether the local prawns are so consistently large. Despite the general assumption by New South Wales fishermen that commercial prawn stocks are confined generally to known grounds adjacent to their home ports, it is an established fact that, in so far as New South Wales is concerned, a constant larger run of individuals (jumbos) is obtainable in deeper water farther out to sea. The first evidence of this fact came from occasional small catches of giant King Prawns in the large mesh otter board nets of the steam fish trawlers. Only quite recently the whole question of the future development of offshore prawning in New South Wales waters has been investigated on a scientific level. It is the first exhaustive study yet undertaken in Australia and all credit is due to the State Fisheries administration and its staff biologist, Dr. A. A. Racek. The results of this investigation are now published and hence available for the help and guidance of prawn fishermen in this State.

It is easy to understand why fishermen find the present offshore grounds, close to the coast, to be the most convenient. They need, however, to be encouraged and assisted to explore and exploit new grounds along all convenient and promising sections of our seaboard, and particularly to extend their activities into wider and deeper waters. Any work in greater depths will undoubtedly be harder, the equipment more costly and the time factor involved, greater. However, without such expansion of effort, combined with exploratory initiative, much of the present offshore prawn fishery will remain inefficient and extremely unreliable. Several of the offshore grounds along the New South Wales coast have already, from time to time, been overfished, with periods of a year or more elapsing before the prawn stocks were again re-established. At the moment it seems as if unbalanced fishing intensity of this sort will continue to have resulting harmful effects.

By comparision with the work done in New South Wales, other officially sponsored prawn fisheries surveys made in Australian waters can be classed only as preliminary. The fisheries authority in Queensland has organised test hauls along the coastline as far north as Townsville, but mainly in enclosed (inshore) waters; only in a few cases have nets been cast from

Notes on Prawns Illustrated Opposite

Fig. 1. KING PRAWN (*Penaeus plebejus*). Light-brown body, yellow legs, blue tail with reddish fringe; side of abdomen often with short vertical blue bands. Grows to 11½ in. One of the principal N.S.W. and Queensland commercial species, ranging north to about Bowen. Mainly a night swimmer, inhabiting estuaries and lakes during growing stages and migrating to the sea before fully mature. The other very similar species with grooved head region (West Australian King Prawn, *P. latisulcatus*) grows to 9 in. It is fished commercially both in the estuaries and in offshore waters along the west coast, and has lately been located in marketable quantities in South Australian offshore waters; only rare examples have been netted along the eastern coastline.

Fig. 2. SCHOOL PRAWN (*Metapenaeus macleayi*). Body translucent, with olive-green or brownish-red spots; tip of tail purplish-blue. No upper teeth towards slightly upturned tip of head spine. Grows to 6 in. One of the principal N.S.W. and Queensland commercial species. Mainly active during daylight hours. Occurs only over a limited range from eastern Victoria, where it is sometimes abundant, to southern Queensland. Life-history similar to King Prawn.

Fig. 3. GREEN TAIL or Greasy-back Prawn (*Metapenaeus mastersii*). Body semi-transparent, speckled with dark-brown; tip of tail greenish. Irregular minutely hairy patches present, giving a "greasy" effect. Grows to 5 in.; average commercial size 3 in. Common in many estuaries and coastal lakes of N.S.W. and Queensland. Active mostly during dawn and dusk. Distributed along the eastern Australian coast from temperate to tropical regions. Normally matures and spawns without recourse to migration seawards. A closely related and similar sized inshore species is the West Australian Green Tail (*M. dalli*), fished commercially in the Swan, Murray and other west coast rivers. Yet another, stouter bodied commercial relative, the Offshore Greasy Back (*M. incisipes*), carries irregular hairy patches, and grows to over 6 in. It is, however, very distinctly coloured, and rarely leaves the sea even to enter the mouths of estuaries. It is at times fished commercially in northern N.S.W. and Queensland waters and ranges along the tropical north coast to North-west Australia.

Fig. 4. BANANA or White Prawn (*Penaeus merguiensis*). Body a semi-transparent cream, minutely speckled with blue; tail yellow, tipped with greenish blue. Sometimes the body takes on a pink to reddish hue. Grows to 9 in. A commercial species fished abundantly in southern Queensland and West Australian offshore waters. Spends some of its young stages in river estuaries (inshore). Apparently plentiful offshore along the coast of the northern half of Australia; rarely in northern N.S.W. waters.

Fig. 5. COMMON TIGER PRAWN (*Penaeus esculentus*). Abdomen carries light-brown and mid-brown bands, with the spaces between a buff to yellow colour; head spine with red and brown bands; tail red, tipped with yellow, and with fringes of dark red. Grows to 9 in. Often fished commercially in offshore waters of southern Queensland. Ranges around the coast from N.S.W. to North-west Australia. The other related banded Australian species is the Black or Giant Tiger (*P. monodon*) which grows to over 12 in. Colour of body ranges from buff to vivid blue, with grey crossbands on abdomen; tail and bases of abdominal appendages blue. Though of rare occurrence in northern N.S.W. and Queensland offshore waters, it is of commercial importance in Indian and Indonesian seas; very likely to be later found plentiful in north Australian tropical waters.

protected sea beaches behind the Great Barrier Reef. The results provided little more information than to enable the identification and particulars of the occurrence of species. A very recent (1957) and more ambitious long-term investigation of the same State's prawn resources has been commenced by the Commonwealth Government Division of Fisheries (Department of Primary Industry). The crew of its chartered vessel, M. V. *Challenge*, has already had a measure of success in not only being the first to locate the night-swimming Humpback Prawn in possible commercial quantities around the coral isles of the Capricorn Group, east of Gladstone, but also by collecting the first known specimens in Australian seas. This species, *Penaeopsis* (*Metapenaeopsis*) *lamellatus*, was originally described from Japanese waters. Further to the south, in Tin Can Bay at the end of Great Sandy Strait, the *Challenge* had earlier investigated the extent of concentrations of large King and Tiger Prawns which had only recently been discovered by a Moreton Bay fishermen.

In West Australia the Government Fisheries authority has also become interested in the State's potential prawn resources. The M. V. *Lancelin* has been operating there during recent years, exploring both inshore and offshore waters, with useful results. Some technical assistance in the project was given to the State authorities by the local branch of the Commonwealth

Fig. 1. King Prawn.

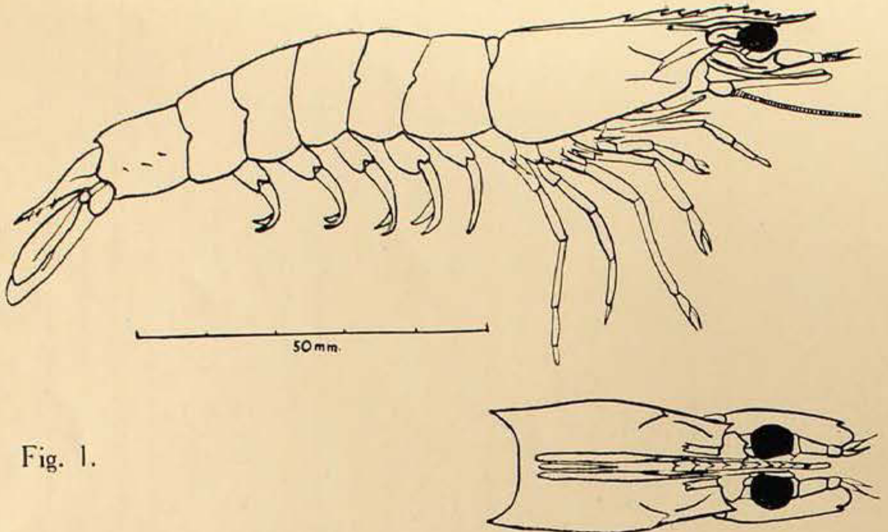
Fig. 2. School Prawn.

Fig. 3. Green Tail Prawn

Fig. 4. Banana or White Prawn

Fig. 5. Common Tiger Prawn.

Drawings by W. Dall in "Fisheries Newsletter."



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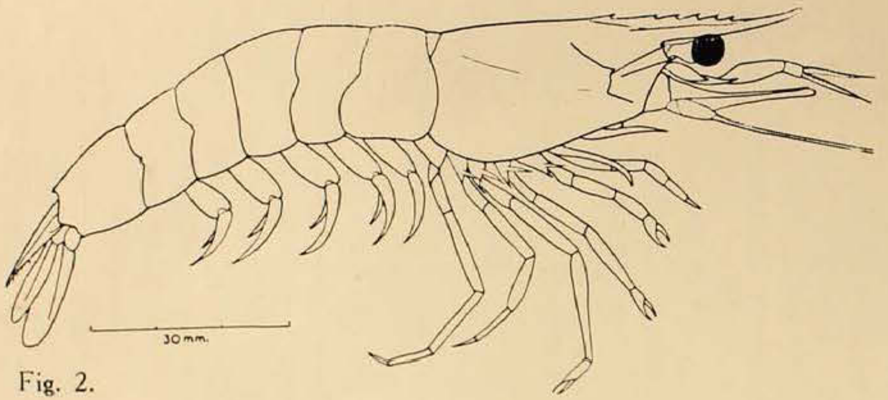

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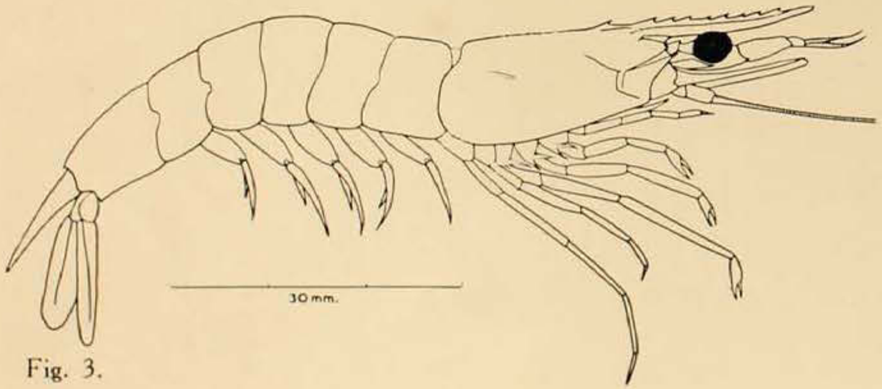

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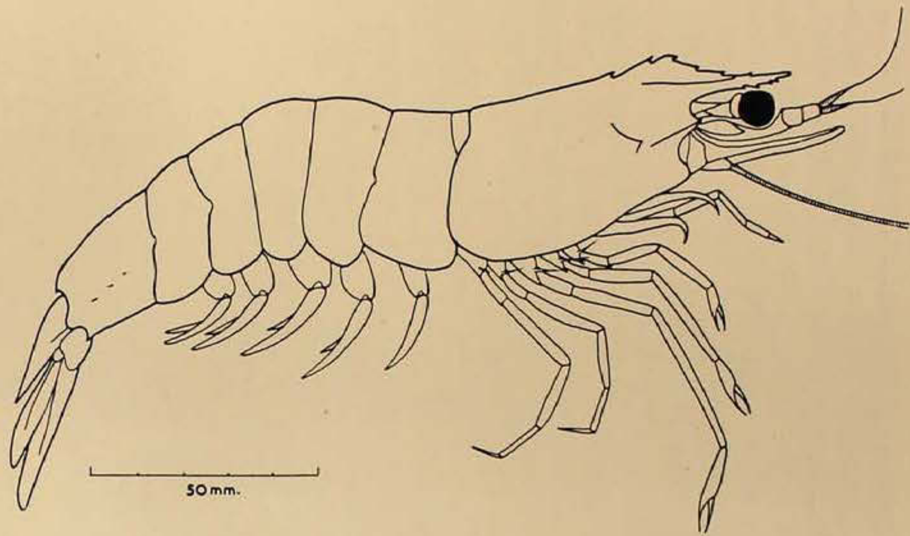

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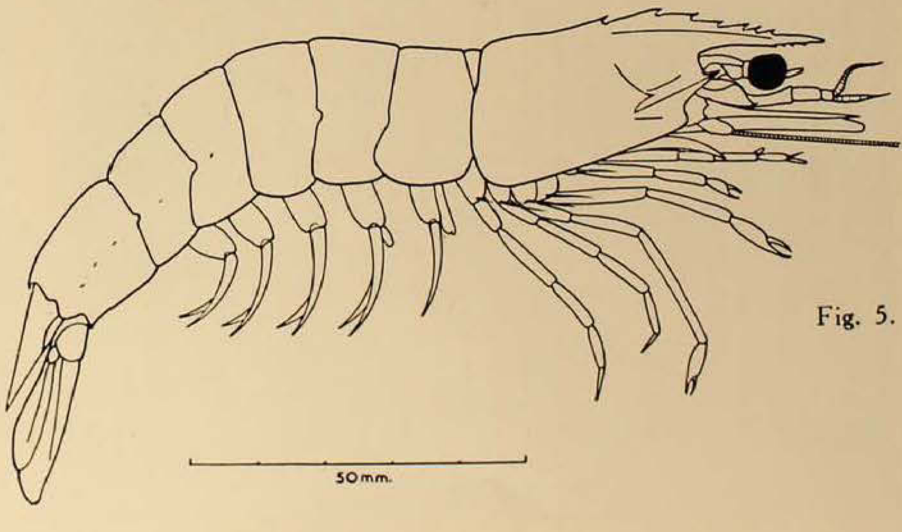


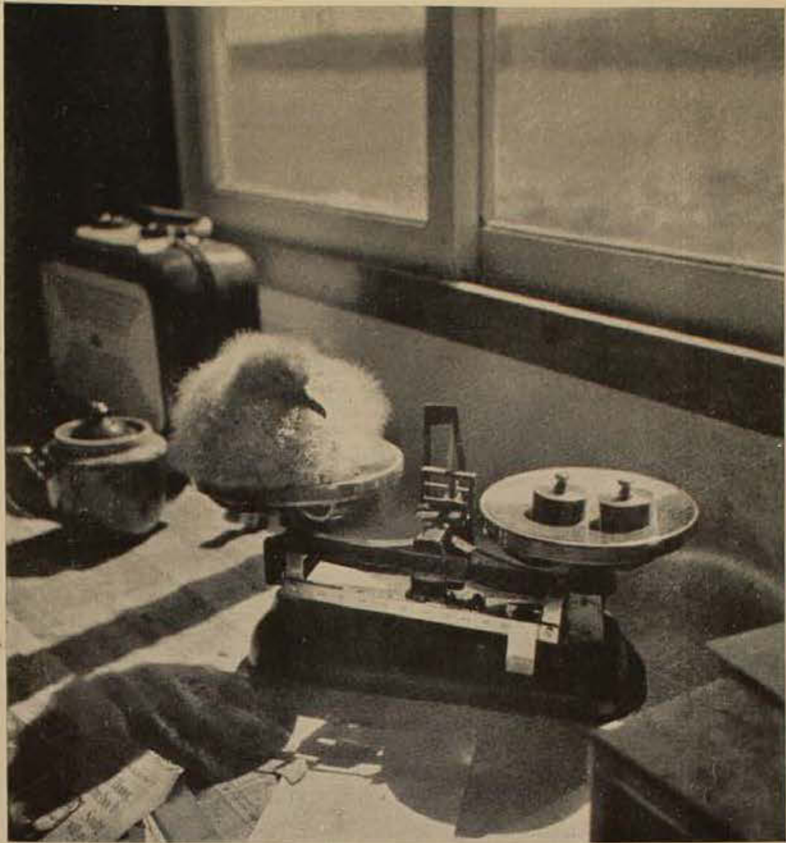
Fig. 5.

Scientific and Industrial Research Organisation's Division of Fisheries and Oceanography. The same body also co-operated in making available for a short term the specialist services of Mr. W. Dall, from the Division's headquarters in Sydney, who prepared a report on the identity and relative abundance of species netted.

Although there are promising early signs of a considerable Australian offshore prawn fishery, it needs to be remembered that production—a mere 7,000,000 lb.—is so far meagre compared with that of the United States and that approximately five-sevenths of it comes from New South Wales waters. Nevertheless, the production is already sufficient on the east coast alone to provide for the beginnings of a potential lucrative export trade to the U.S.A. One particular large species which has been abundantly netted offshore has proved most attractive to American buyers, who are anxious to supplement the great though inadequate supply which is available from their own waters.

The comparatively small Australian production figures might fail to impress an economist, but to a zoologist the future of our prawn industry is extremely encouraging. This is because the latter is aware that about thirty species of the commercial prawn family are known to occur in Australian coastal waters, excluding New Guinea, and that at least six of these are of present commercial importance. Furthermore a few more of the balance may well prove of value in the future and in this part of the world there is a concentration of prawn populations in the great faunal region of which Australian waters form an integral part. This region extends to the seas of India and to southern Japanese waters through the crowded islands of the East Indies. It far exceeds the scope of the Central American shrimp faunal area and along the North Australian coast at least it is commercially unexplored. Available reports and the evidence of actual specimens suggest that great offshore stocks abound along the whole of the tropical coastline. One particular species of persistent occurrence from the warmer north-eastern waters right across to the west coast, is the large Banana Prawn, and there are hopeful signs that one day this will be the principal commercial species of northern parts. One need only consider the potential prawn resources of the wide, shallow and sandy-floored waters of the Gulf of Carpentaria to obtain some idea of the hopeful picture for the future. However, it will depend on facilities, including the use of modern cold storage, that can only eventuate as a result of a larger and better distributed population, to unlock any untouched riches of our northern waters.

In considering the future of Australia's prawn industry, it has to be accepted that much exploratory investigation, including a study of the behaviour of local prawns is still needed. Only by these means can enough facts be established on which regulations can be based so that the industry can be certain of producing abundant and regular supplies. As already mentioned earlier the behaviour of those species which form the mainstay of the New South Wales fishery has already been closely studied and the information obtained made available in printed reports. Similar work has yet to be done on the prawn stocks of other Australian waters. Now that knowledge of prawn behaviour is available for the comparatively highly productive New South Wales waters, it is highly desirable that stricter controls be enforced. At present the custom of netting prawns in the river estuaries and the coastal lakes continues; even set purse nets are used across the outlet channels connecting lakes with the sea. It is obvious that the industry must eventually cease to be profitable if it is exploited at both ends. The offshore prawn stocks of New South Wales are predominantly King and School Prawns, both of which are ocean spawners; the inshore waters are merely nurturing grounds. It is to be regretted that both of these species are now being netted at sea (offshore) in close proximity to the inshore waters they have left. It is certain that many of those thus captured will have barely matured and have had little opportunity to spawn. After reaching maturity these seagoers live for a year or more and spawn several times as they grow larger and move farther out from the coast.



Weighing a fledgling mutton-bird at Fisher Island.

Photo.—V. N. Serventy.

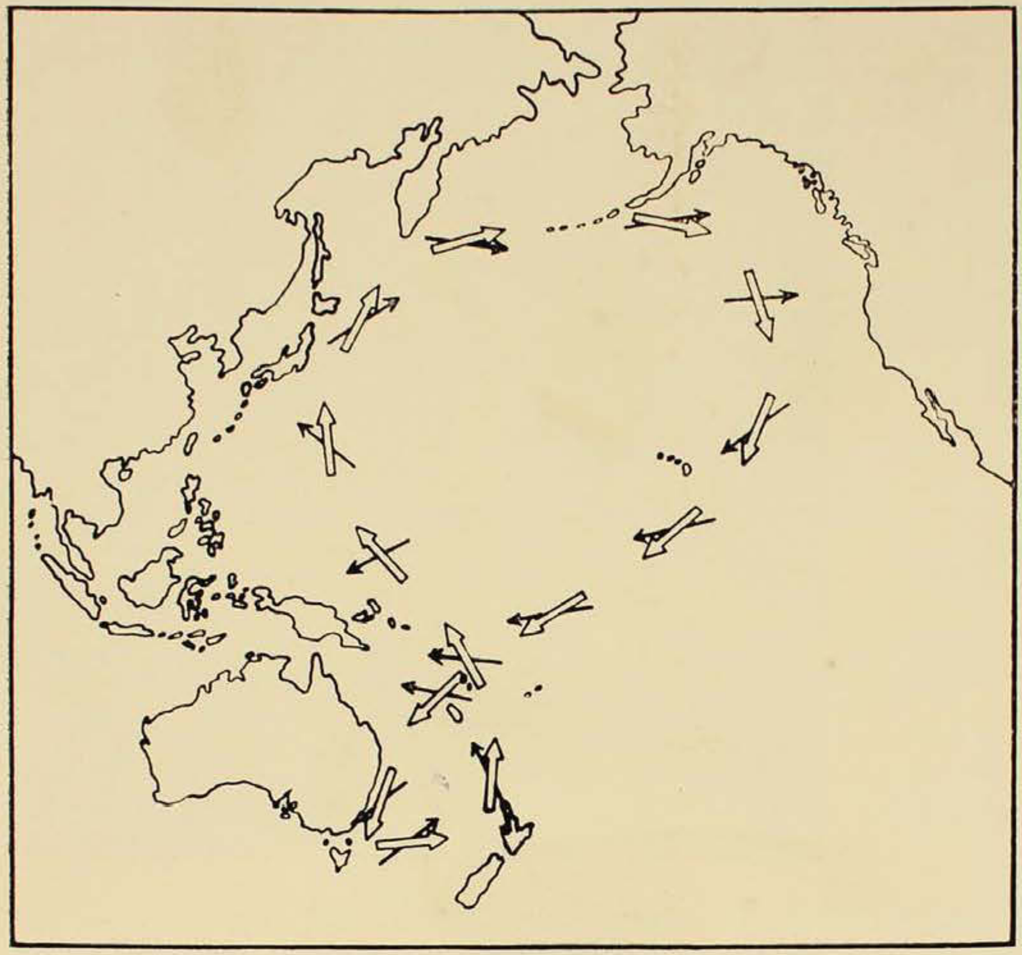
Recent Studies on the Tasmanian Mutton-Bird

By D. L. SERVENTY
Principal Research Officer, C.S.I.R.O. Wildlife Survey Section, Western Australia.

HISTORICAL INTRODUCTION

POSSIBLY few Australian birds can lay as wide a claim to the interest of Australian readers as the Tasmanian Mutton-bird, *Puffinus tenuirostris* (Temminck), known to ornithologists under the book-names of Short-tailed or Slender-billed Shearwater, to the Tasmanian Aborigines as "Yolla" and to the white seafarers of Bass Strait as the "Yowler". Historically it enters the record earlier than white settlement of this country; sociologically it has importance as the only example of commercial wildfowling successfully surviving in Australia and in being the mainstay of that interesting community, the Cape Barren Islanders; scientifically, it amazes naturalists through the astonishing regularity of its breeding timetable, its widespread migration and its uncannily accurate homing each year to its exact nesting site. And it occurs in such abundance that it could quite well be Australia's most numerous bird.

Though it did not receive a valid scientific name until the Dutch ornithologist, Coenraad Jacob Temminck, described it in 1835, it had been referred to, described and illustrated by many voyagers and naturalists very much earlier. Possibly the first reference to it is an obscure Russian publication by the geographer Krashaninnikov who recorded a seabird which might have been this in the Kuriles in 1755. It must have come under the notice of all of the navigators in the Aleutians area for we now know that it is one of the commonest petrels of those seas in the northern summer. The first scientific record of it was made during Captain Cook's Third Expedition, when William Ellis, an artist on the *Discovery*, included a study of the bird in a series of paintings of natural history subjects made during the voyage. Unfortunately it was never published but the folio is preserved at the British Museum (Natural History) and when I was in London in 1955 I took a kodachrome photograph of it, which is reproduced here, the first portrait of our Mutton-bird. Ellis painted his picture in August, 1778, in Lat. 70° N., "in the Arctic Ocean, between Asia and America", the birds being found among ice floes.



The migratory path of the Tasmanian Mutton-bird in the Pacific Ocean. The white, open arrows represent the general course of the birds' flight and the black arrows the prevailing wind directions at the particular time and place.

Del. G. M. Storr.

Another early relic of the mutton-bird which I was able to examine abroad was the earliest surviving skin of a scientifically taken specimen. This was in the University Zoological Museum, Berlin, where Professor Erwin Stresemann showed me a specimen collected by the German naturalist, Carl Heinrich Merck, who accompanied Captain Joseph Billings' expedition between Okhotsk and Alaska between 1787 and 1791. Dr. Merck collected several specimens which passed through the hands of Peter Paul Pallas, distinguished for his early zoological surveys of the Russian Empire, but unfortunately they were incorrectly referred to other species such as *Procellaria aequinoctialis*.

All these records refer to birds encountered during their exodus migration from Australia. No really important observations were made in their "home grounds" until after the coming of the First Fleet in 1788.

It was Matthew Flinders who first put the mutton-bird on the Australian map. He described the abundance of "sooty shear-waters" and his report on the sealing potentialities of the Bass Strait islands drew the first white visitors to them. Many intermarried with the native Tasmanians, their descendants are there today, and the "sooty shearwater" from the beginning played an important part in their economy. When and why the bird acquired its name of "mutton-bird", which it shares with other petrels in Australia and New Zealand, is not certainly known. The earliest use of the name "mutton-bird" which I can trace is on a plate in the "Watling Drawings" at the British Museum. On one of them, of the Norfolk Island Petrel, there is an annotation, "Norfolk Island Petrel or the Mutton Bird in full feather". This note was probably written by Surgeon-General John White who was in New South Wales between 1788 and 1794.

EARLIER INVESTIGATIONS

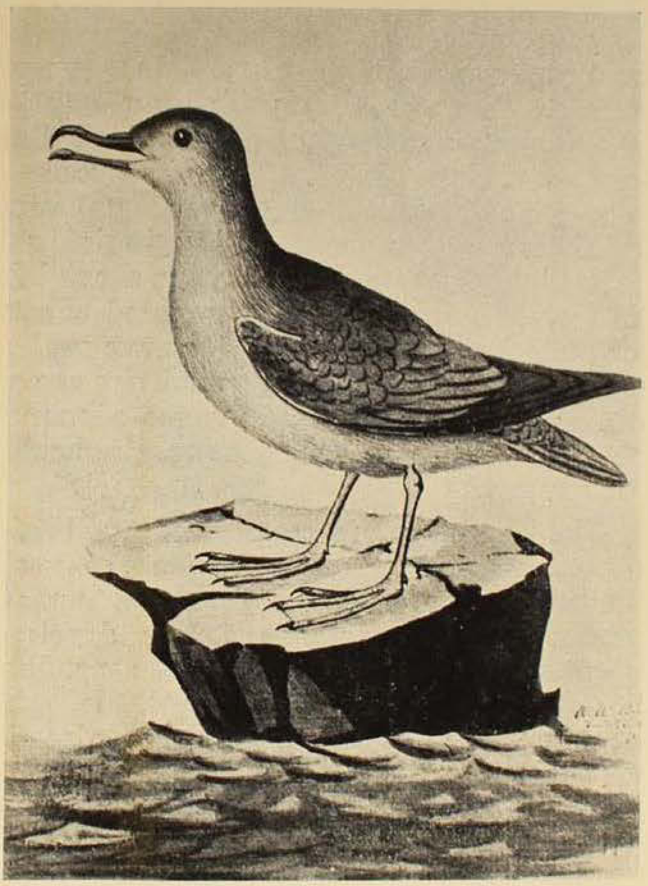
The exploitation of *the* mutton-bird in the Tasmanian region from the late 18th century until the present day naturally

Mr. D. L. McIntosh, C.S.I.R.O. Wildlife Survey Section, with an adult mutton-bird at Fisher Island.

Photo.—V. N. Serventy.

led to great interest in the life history of the bird and a considerable literature has accumulated. So compelling is the interest in many phases of the bird's nesting cycle that visitors to the islands, laymen as well as naturalists, have been unable to resist an urge "to write a paper on the subject". Outstanding amongst these was Dr. H. H. Montgomery, a former Bishop of Tasmania, and father of the distinguished Field-Marshal of the late war. Montgomery visited the Furneaux Group in the course of his episcopal duties, and like everyone else soon fell under the spell of the mutton-bird. He delved into the study more energetically than most visitors and his papers in *Ibis* (1898) and the *Papers and Proceedings of the Royal Society of Tasmania* (1891, 1896) will be always valuable references. He maintained his interest in the group long after he returned to England and his last published contribution (in 1920) is of interest in that he held to his old belief, even at that late date, that the birds migrated south to Antarctic waters. The writings of journalists and other authors on the birds, in newspapers and magazines, are legion.

So when in 1947 the C.S.I.R.O. and the Tasmanian Fauna Protection Board began an investigation into the mutton-bird there was already much published information available on the subject, but it was difficult to evaluate its reliability. Accordingly a comprehensive study on a small "manageable" population was begun. A small island off Lady Barron (the well-known



The earliest portrait made of the Tasmanian Mutton-bird. Reproduction of a coloured painting by William Ellis, made during Captain Cook's Third Expedition, August 1778.

Reproduced by courtesy of the Trustees of the British Museum (N.H.).

mutton-birding centre on the southern shore of Flinders Island) was chosen as the base for investigations. This was Fisher Island, named after Police Sergeant George A. Fisher, who, whilst he was the district police officer, behaved according to pattern and, falling under the fascination of the bird, began investigations by using the marking technique on the fledglings. Fisher, however, did not remain long enough at his station to reap any harvest from his well-planned efforts. The following facts on the life history of this bird have emerged from the field and laboratory work we have carried out.

Landfall to Egglaying

Puffinus tenuirostris is a very long-lived creature and for a bird of its size has an unusually lengthy period of sexual immaturity. Female birds begin to breed at 5 to 7 years of age and males at 7 to 8 years. Immature birds do not make a landfall, once they leave their natal islands as fledglings, until they are 3 to 4 years of age. This has been a pitfall not only to the earlier investigators of the bird but also to workers on petrel species overseas who have depended on conventional aluminium leg-rings for marking individual birds. Aluminium rings have a short life in sea-water owing to the combined effects of corrosion and abrasion. We soon realised that some more durable metal was essential and it was only after the use of monel metal rings was adopted that results began to appear.

The sexually mature, breeding birds return from their migration to the nesting islands in the last week of September, and by then gametogenesis, or development of the gametes (or reproductive cells), is well advanced. In the male bunched spermatozoa have already developed in the seminiferous tubules, while in the female the oocytes, though small, have begun their steep seasonal increase in size. Burrows are actively scratched out and vocal performances enliven the rookeries at night. Though egg-laying does not begin until the third week in November a striking behavioural change occurs at the beginning of November. The birds vacate the islands entirely and do not return again until the onset of egg-laying.

This exodus is correlated with the attainment of the peak of gametogenesis in the male, and the shedding of sperms. It seems that the exodus follows immediately on fertilisation and the birds leave for the open sea whilst the single very large egg matures (it weighs about 85 gm. and is about 16 per cent. of the female body weight). Though this pre-egglaying exodus was known in the Tasmanian mutton-bird from very early times it was not detected in other petrels until comparatively lately. Recent studies on the European Fulmar (*Fulmarus glacialis*) and other petrels suggest that it may be a general phenomenon in petrels, with some modifications imposed by local environmental stresses. That it was more readily perceived in our bird is due, undoubtedly, to its short telescoped egg-laying season, thus ensuring that most individuals are in phase with each other. In species like the Fulmar and the Manx Shearwater (*Puffinus puffinus*), which are the ones that have been most studied abroad, the egg-laying is protracted in time and in consequence individuals in a colony are strung out in various phases of the gonad (reproductive organ) cycle, thus blurring the behaviour pattern when the species is observed in the mass and not studied as individuals.

Egg-laying with our bird starts about November 20/22 and ends about November 30 to December 2. The calendar is invariable from year to year and from rookery to rookery, though these are spread through eleven degrees of latitude—from near Ceduna, in South Australia to southern Tasmania—adjacent to seas which differ widely in temperature, chemistry and currents. Year to year variations in the local sea conditions, or the weather, have no influence on the breeding calendar, which is the same now as when the earliest observers wrote their accounts over a hundred years ago. Naturally this exciting constancy has challenged biologists for an explanation, but its full solution has yet to be found. A preliminary experiment in Perth in 1957 has demonstrated the existence of a 12 months internal cycle. However this must be geared to the annual calendar by some external regulator. Such a constancy as we know exists can only be produced by some astronomical factor and the one which immediately suggests itself is the seasonal change in the hours of daylight. How it functions in the case of the mutton-bird is not known at present, but we are reasonably sure that the stimulus which sparked off the coming breeding cycle must have activated the birds before they reached Australia.

Incubation and Fledging

When the birds return to their nesting islands for the egg-laying the male gonad is in a remarkable condition. It has dwindled drastically in size and the seminiferous tubules in which the sperms are produced are in a state of fatty metamorphosis (i.e., contain break-down products of a fatty nature). No other avian species shows a more rapid testis collapse, though this may be characteristic of the petrel group. Further fertilizations are impossible in the same season and hence it is physically out of the question for a second egg to be produced if the first is lost. When the egg is laid the female departs to sea to recuperate from her ordeal. The male remains to take the first incubation shift. This lasts usually between 12 and 14 days, during which time he remains continuously in the burrow, without receiving any food. The female takes the second shift, of 10 to 13 days, and the regime of alternating duty continues until hatching. This usually occurs during the female's second shift, between January 10 and 23. The total incubation period is between 52 and 55 days.

The newly hatched chick is tended continuously by the parents for rarely longer than two days and is then left alone by day. Both parents share in the feeding, which takes place at intervals and the young bird may have to undergo lengthy fasts of several days between Gargantuan banquets of krill (mostly the Euphausid crustacean, *Nyctiphanes australis*). The growth rate is rapid and the fledgling may come to exceed the weight of large adults in little more than a month after hatching, though this weight is not usually attained until early March. As the young bird becomes fully fledged the meals are smaller and when the fledglings receive their last meal, some time during April, the parents cease their visits to the island. This is the so-called "desertion period" or "starvation period" and may last about a fortnight. The youngsters emerge from the burrows at night, vigorously exercise their wings and at length make their own departure from the natal islands. This exodus of the fledglings usually occurs from the third week in April to the first week in May. The islands and neighbouring seas will see them and their parents, no more until the following spring.

Migration

The nature of this migration has long been a matter of speculation. We have seen that Montgomery retained a belief in an Antarctic wandering. Some ornithologists were loath to believe that the birds in the northern Pacific could be of the same breeding stock as the Australian birds, and typical of this school of thought were the late Gregory Mathews and Tom Iredale. The first ornithologist to suggest that the north Pacific birds were Australian birds on migration was A. J. Campbell. Though a mass of circumstantial evidence was built up in support of the idea (cf. Serventy, 1953), it was only in 1955 that the first positive proof was obtained by a banding record. Since then three additional banded birds from Australia have been recovered in the Aleutians and the Bering Sea.

The route followed on migration appears to be largely conditioned by the direction and strength of the prevailing winds. In the map on page 328 the generalised course of the migratory circuit (based on reliable sight observations and specimens collected by expeditions) is shown by the open arrows. The black arrows represent the direction of the prevailing winds *at the time the birds are traversing the particular sector*. It will be seen that by flying a round-about "figure of eight" course over the Pacific the birds are wind-assisted. The only place where they meet with any strong wind resistance is on the southward leg of the route when returning to Australia in the spring. Here they have to battle against the strong South-east Trades which blow all the year round across the Pacific. Wherever they cross this belt the birds must encounter strong winds.

Probably it is the exhaustion which some of them suffer in breaking through this wind barrier that may be a contributing factor in the mortalities that occur in some years along the east Australian coast during the spring migration. If the surface food of small fish and plankton should be temporarily absent, just when they most need it, then the hard-pressed birds may be in severe straits. The weaker ones will perish from hunger. It has been established, from the recoveries of ringed birds and the timing of the mortalities (usually during late October through to early January) that the victims are principally first-year birds, inexperienced youngsters which are less able than their elders to avoid the various hazards of oceanic life. It is the first-year, and some second-year birds too, which are the ones that become enmeshed in fishing nets in the north Pacific and so provide us with most of the recoveries there of our ringed birds.

These youthful first and second-year birds share in the general migration of the more mature birds, though some individuals among them may continue to spend the southern summer in the north. Such behaviour is not unusual with other trans-equatorial migrants, such as the waders. However even though they may migrate south with the breeding birds the first and second-year individuals do not come ashore but remain at sea. It is only when they reach three years of age that they effect a landfall, and then only comparatively briefly, between hatching time in January and the third week in March. The fourth-year birds show a similar behaviour but more appear to come ashore at this age than at three years, and some individuals even put in an appearance earlier in the season, namely from mid-December onwards. When they are five years and older the birds appear to come ashore with the breeding adults, though many remain unmated.

Young birds return to the islands on which they were raised, and will attempt to nest there themselves. Several birds hatched on Fisher Island are now established breeders there, but we have not yet determined to what degree inter-island dispersal exists. Once a bird begins to breed on a particular site it tends to return to the same spot each season with remarkable fidelity. Often it remains mated with the same partner. On Fisher Island there are several examples of birds which have bred together each year since observations first began in 1947.

Several Australian ornithologists, including members of the staff of the Australian Museum, have participated in the field work at Fisher Island and assisted in the gathering of the facts which made up the foregoing account. Other readers of this Magazine may assist in this project in the future by observations, as the opportunity offers, of the migratory movements of these birds around the coastline of south-eastern Australia, and by the inspection for leg-rings on birds washed up ashore. If possible exact counts should be kept of the number of all such birds encountered so that when ringed individuals are eventually found among them statistical computations may be attempted on various population problems. The author would be glad to enter into correspondence with any reader who may wish to carry out local observations on the species.

Marine Crayfish

For most of the year, the waters of the New South Wales central coast can be correctly termed temperate. There is, however, a period during the warmest season, between January and March, when the temperature of the ocean lapping our beaches rises as high as 76°F. The cause is found in eddies from the warm tropical current which swings close inshore, bringing with it a vagrant fauna from northern seas. In this connection there are many notable records of fish and crustacean species. The latest to be recognised is a colourful tropical marine crayfish, *Panulirus ornatus*. An example of the species, not previously recognised from New South Wales, was captured in a prawn trawl in Port Jackson in February this year, and presented to the Australian Museum by Dr. A. Racek, biologist to the State Fisheries.

A 4 ft. long worm responding to an unpleasant stimulus (a few drops of methylated spirit) by emitting jets of fluid through its dorsal pores. It contracted and writhed violently while squirting.
Photo.—E. C. Pope.

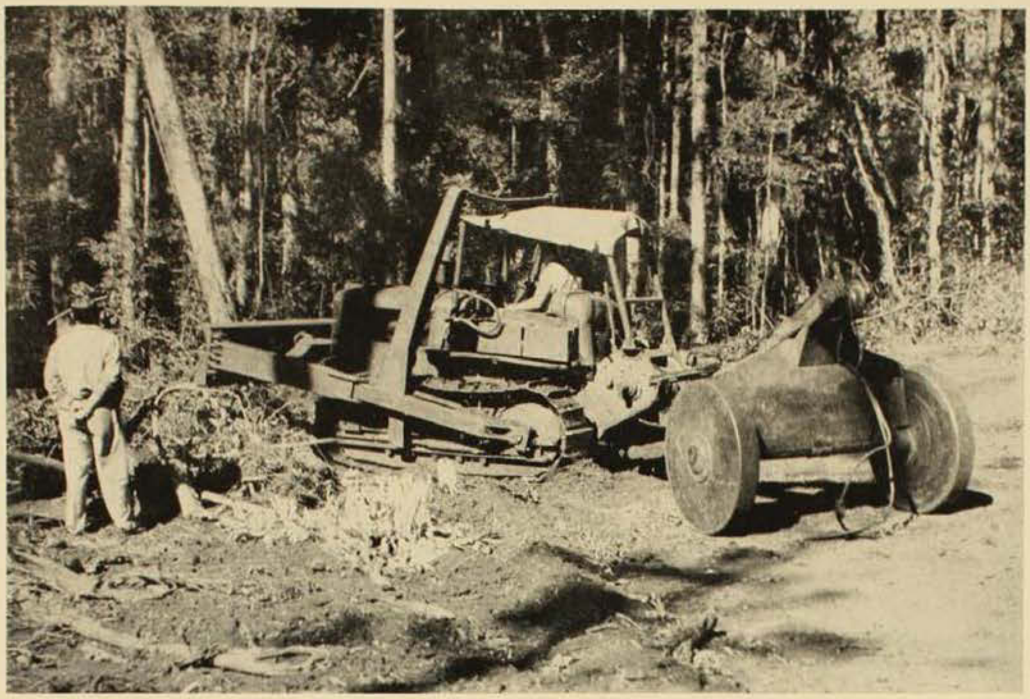
Giant Earthworms

By ELIZABETH C. POPE

UNTIL 1939 the presence of giant earthworms in northern New South Wales was unknown; only Gippsland, Victoria, could boast of quantities of the world's largest land worms. In that year, however, in State Forests near Kyogle, some giant worms were noticed by forestry workers who were making new roadways. When bulldozers were brought into the rain forest to push over trees and stumps, many broken pieces about 6 ins. long and 1 in. diameter, of what looked like huge earthworms, were seen in the moist red soil beneath the roots.

These notes on the first discovery of the giant Kyogle worms have kindly been supplied to the author by Mr. W. T. Jones, who at that time was working for the State Forestry Commission but who is now with C.S.I.R.O. in Brisbane. He recounted how, as work progressed at Cox's Road in the Toonumbar State Forest and the roadway penetrated deeper and deeper into the rain forest, the worms found were larger and more plentiful. "As with most things of this nature," he said, "they became so common that their novelty soon wore off and they were temporarily forgotten."

Some years later, in the late 1940's, a fragmented worm reached the Australian Museum by a roundabout route as a result of a radio quiz session and caused a great deal of interest on account of its size. However, nothing could be done at that time to arrange an expedition to collect and preserve complete giant worms or to observe their occurrence in the field. An opportunity to do so came in May, 1957, and with the help of local State Forestry officers—Messrs. P. Dalton, G. Ruttley and R. Ellis—and especially through the kind offices of Mr. R. Titmarsh, Manager of the timber mill at Grevillea which was carrying on logging operations in the area, a most successful trip was made.



By using a bulldozer (left) to push over shallow rooted trees giant earthworms are collected much more readily than by digging with a spade and following the burrows.

Once a tree is down (below) earthworms are almost sure to be found in the tangled mass of roots and red soil. They retreat very smartly into the ground and must be seized quickly.

Photos.—E. C. Pope.

FIVE KINDS

In all, five distinctly different kinds of worm were taken of which only one resembled the common or garden, introduced species in size and appearance. Of the remaining four (all suspected of being native species) one was of the giant kind (the reason for the expedition) and forty-four whole specimens of these were successfully pickled for the Museum's collection. A second, salmon-pink, species was dubbed "the spaghetti worm" on account of its long, attenuated body, no thicker than that of a normal earthworm but over 1 ft. in length. Another species was striped alternately in cream and black cross bands (like a football jersey) and only one specimen of this sort was seen in spite of tons of soil being overturned. Finally, there was a second very large species which differed from the giants in possessing a better developed clitellum (thickened breeding ring) and in being somewhat shorter in length.

A haul as rich as this in the extremely difficult terrain could only have been accomplished with the aid of bulldozers which were able to turn over large quantities of soil and knock down many trees in a few hours. Weeks of digging with spades could not have accomplished nearly as much, for many worms burrow in and out between tree roots and when disturbed can dig and move away quickly enough to evade capture.

In 1952 David Fleay[1] described what are obviously the same kind of large worms at West Burleigh in Queensland and mentioned that they also occur in the Lamington National Park, Gympie, and Brisbane areas. In his notes to us Mr. Jones mentioned that giant worms also occurred in the basalt soils of the Atherton Tablelands and his statements have been confirmed by other forestry workers. It is thus apparent that the northern giant worms have a

[1] "Talking of Animals," 1956. Jacaranda Press, Brisbane, p. 6.

wider distribution than the giant *Megascolides australis* worms of Gippsland, which, according to Miss Hope Macpherson of the National Museum of Victoria, "are often reported as occurring in the Bass River Valley but more correctly come from the hillsides of the watershed of the Bass River and the southern slopes of the Strzelecki ranges".

Anatomy

Even in the largest specimens of the Kyogle worms the body has the characteristic, somewhat iridescent "skin" of the regular earthworm, marked at intervals by clearly defined grooves into segments. The segments are more easily seen when the worm is opened up and it is then also clear that secondary ringing occurs on the skin that has nothing to do with internal arrangement of the organs. When the live worm is "stroked the wrong way", *i.e.*, from behind forwards, tiny bristles or setae are felt. These are arranged in eight longitudinal rows two pairs on either side of the midline, in the lower half of the body.

Some of the internal structures of the giant worms are interesting. There are, for instance, two large, distinct gizzards which lie in segments 6 and 7 and this feature at once distinguishes these worms from *Megascolides australis* which, according to Baldwin Spencer, has only one. In many other features, however, there is a close resemblance between the two kinds of worm. The girth of the body gradually increases behind the front four segments of the body to reach its maximum in segment 10 or 11 and from this point it decreases again gradually till just in front of the darkened clitellum. Here it reaches a size which remains uniform throughout the remainder of the long body, except for the final few segments where it again increases slightly in girth. The dividing internal walls (septa) between one segment of the body and the next in the wider sections of the worm are greatly reinforced by strong tissues and obviously act like bulkheads to strengthen and keep rigid these parts of the worm during anchoring or burrowing operations.

A cylindrical worm cast and portion of the burrow in which it was found.

Photo.—H. Hughes.

Locomotion

The method of locomotion is interesting since the setae are used but little during progress through the soil. First the tail end is seen to swell up and anchor itself in the burrow by means of the thickened, reinforced segments. Then the front end relaxes its grip on the burrow and extends forward as far as possible. The girth of the front "swollen" area of the body is increased till it is plugged firmly in the burrow and grips well. Then the tail end is relaxed and the body drawn towards the front end—to take a new hold on the burrow walls and allow the operation to be repeated. Progress by this method is surprisingly fast and so long as one end of the worm remains buried in the ground the animal can retreat very quickly from a would-be capturer. Once removed from its burrow its movements become very sluggish.

When the bulldozer cut a section along a bank of soil, inch-wide worm burrows could be seen extending vertically from 3 to 5 ft. down. This was in May, just after the close of the wet season. According to Mr. Jones and to other foresters, the worms emerge from their burrows during very wet periods and move around among the surface litter and it is at this time that they are pounced upon by their predators. Fleay has reported similar behaviour in the Queensland worms.

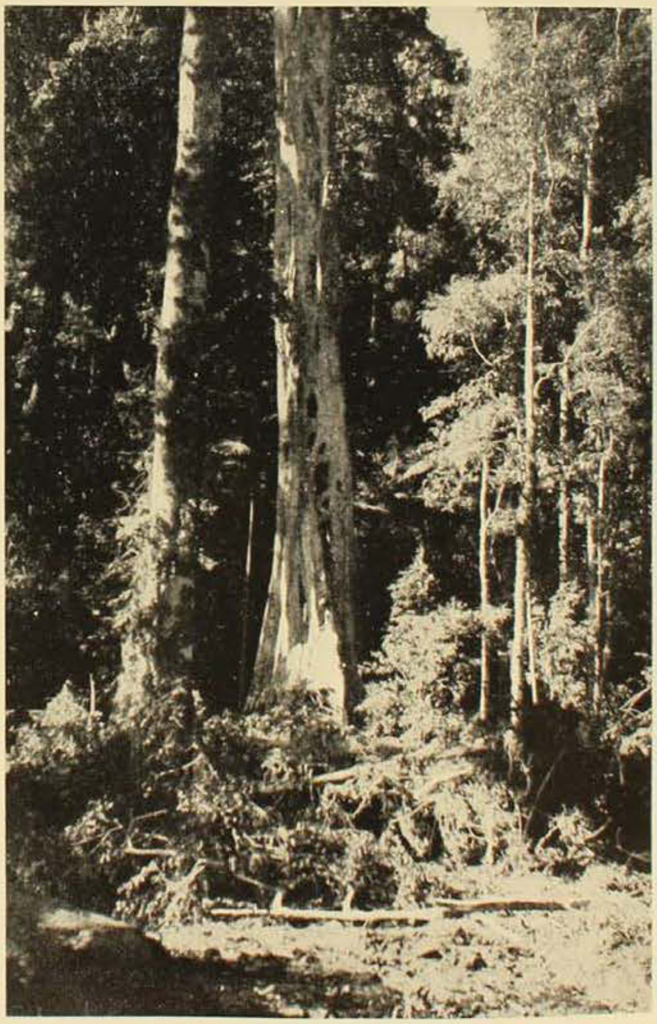
Habitat

The worms of the Kyogle district are found not in valleys but up on high ridges that are densely clothed with broadleaf rain forest which, north of the Richmond River, grows extremely thickly. Flooded Gums, Red and Yellow Carrabeens, Booyongs, Hoop Pines, figs of several species and Pigeonberry Ash trees were some of the species we learned to recognise in the thick tangle; every now and then a magnificent giant Blue Gum would stand out. Lawyer vines and hooked creepers trailed from the trees which were covered with growths of staghorns, mosses, ferns and orchids; amidst this tangle of growth it was difficult to move except on cut tracks or logging roads.

The soil was a rich-looking red basaltic type which even in this dry season, seemed very moist to the touch. The atmosphere was dank and cold in the intense shade of the forest and the forest floor had a thick carpet of leaf mould—an environment well-suited to earthworms and animals with similar habitat requirements. It is therefore, not surprising to find worms of such size, variety and abundance in these surroundings. For every one of the forty or so giant worms we took whole and alive, at least ten must have been rejected because of injury due to bulldozing or some other mischance, not to mention those that "turned on a spraying match" and disappeared into the soil before we could seize them.

A great number of worms were seen when shallow-rooted trees like the Red Carrabeens (*Geissois benthami*) were knocked over by the 'dozer—their burrows tunnelling in and out among the tangled mat of roots. In such situations worms could escape more often than not, for it was impossible to chop through roots fast enough to keep up with their progress and even if a worm were grabbed and held by one end it would break in two rather than release its underground hold, and their strength was remarkable. As a final resort when disturbed they would squirt out numerous fine jets of fluid from a line of pores all along the centres of their backs and it was most difficult to maintain a grip on their slippery bodies. Their ability to squirt was however, not as great as that of the Squirter Worms from the brush forests round Sydney that have already been described in an earlier article.[2] Whereas the Squirter can produce a spray at greater pressure and "shoot" up to 4 ft. in the air, the giant worms can squirt fluid for

[2] Australian Museum Magazine XI (12), p. 384.



A typical habitat of the giant worms, Toonumbar State Forest, near Kyogle, N.S.W. A variety of trees, epiphytic ferns and creepers, palms and a Strangler Fig with a clump of small Carrabeen trees, to the right, are seen on the edge of a clearing.

Photo.—E. C. Pope.

only a foot or two. Such squirting behaviour may prove a defence against Kookaburras which, according to foresters, prey on them during their perambulations above ground in wet weather. However, it seems more probable that the true function of the fluid is the lubrication of burrows during locomotion. The fluid seems harmless in its effects on human skin.

Odour

There is a peculiar, somewhat sickly aromatic smell associated with the giant worms which remains even after they have been preserved in alcohol for several months. Gippsland worms are reputed to have a smell somewhat akin to creosote and, according to Professor McCoy, who first wrote about them, this made them unpalatable to chickens. The evidence of predation by Kookaburras on the northern species, however, would seem to point to the fact that whatever causes their peculiar smell it does not ruin their palatability. A great deal of fibrous, woody material which had not been greatly broken down by digestive processes or the grinding of the two very muscular gizzards was found among the "soil" in the hinder part of the giant worm's gut. It, therefore, is possible that the peculiar smell may result from the quantity of essential oils passed through the body in consequence of the intake of roots and of leaves (if, indeed, leaves do form part of the diet).

No signs of castings were seen in May although a special search was made for them, but Mr. Jones informed us that at certain times cone-shaped casts can be seen on the forest floor. If accident causes a break in the walls, cast material is also used to plug burrows or to reduce water loss in the "dry". One such cast and a portion of the burrow in which it was found are illustrated.

Colour

The colour of the live worms is partly determined by the red earth contained in the digestive canal. The outer wall of the body is a rich olive green, but when the red earth shows through the effect is for the worm to appear grey except for segments 14 to 18 which form the clitellum and are a dark purply brown on the dorsal surface. The clitellar region does not normally differ in girth from the general body size but it may do so in the breeding season. No egg cocoons were seen at Kyogle and no information has yet been obtained as to breeding times or habits. David Fleay mentions that the worms from West Burleigh produce egg cocoons similar to those of the Gippsland worm.

Soil Aeration?

When a few damaged worms were left for a time in a dish the body-fluid that oozed from the tissues was red (the colour typical of haemoglobin). Unfortunately, chemical tests have not been carried out on the fluid but, since the sub-soils of our northern rain-forests are generally badly aerated (owing to the high humus content of the surface soil and the consequent consumption of oxygen by the humus), the supposition that the red colour is due to a red respiratory pigment is a plausible one. W. D. Francis[3] who has given an excellent general account of Australian jungle and its environment, attributes the development in the trees of buttressed stems and shallow root systems (which were characteristic in areas where the worms flourished) to the lack of oxygen in the sub-soil. The numerous, winding and interlacing worm-tunnels may thus play an important part in aerating the sub-soil in the rain-forests of Kyogle and instead of being a mere curiosity the worms may well prove to play an important role in the ecology of the rain-forests.

Whatever may be the environmental conditions limiting their distribution, the giant worms seem to be found only in association with rain-forests, for even the area in Gippsland, Victoria, where the largest ones now live, was formerly clothed by a wet or high forest, Blue Gum-Mountain Ash association. The known distribution of the large worms is discontinuous and is associated with certain of the rain-forests. These are characterised by dense vegetation, a great diversity of plant species, high rainfall (60 in. per annum in most places) and soils of a basaltic or granitic origin.

[3] "Australian Rain-Forest Trees," 1929. Government Printer, Brisbane, Queensland, pp. 1-9.

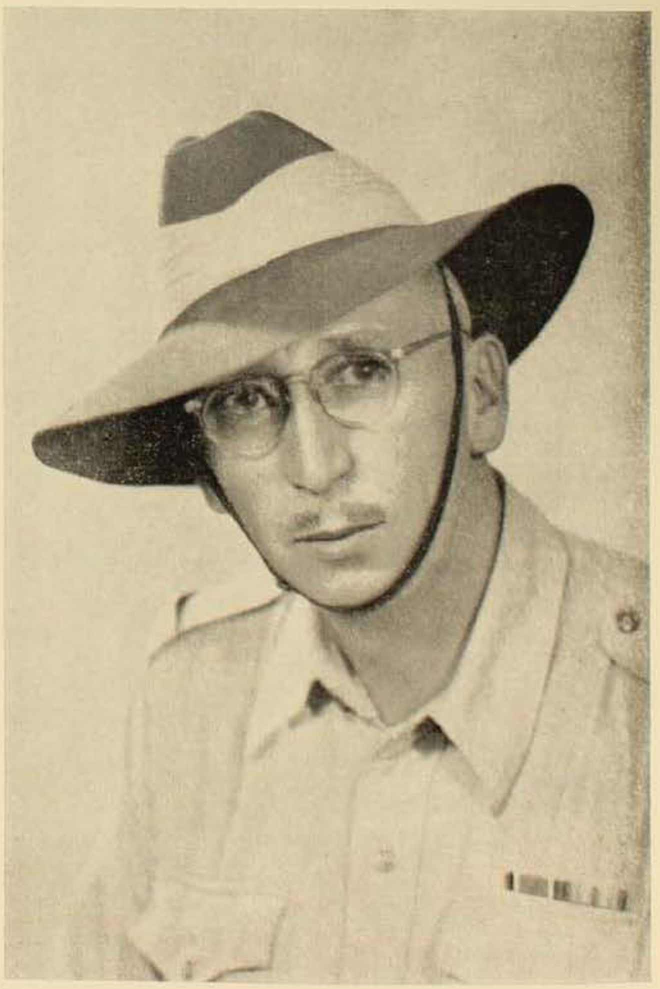
Even in May, in the dense shade of the forest of northern New South Wales the coolness of the humid atmosphere was surprising.

SURVIVAL

At the present time the worms are flourishing and plentiful in the primitive untouched rain-forest, but the effect of the opening up of the jungle for timber cutting may prove unfavourable for them. However, it is possible that under present forestry management, the jungle habitat will remain sufficiently stable to permit their survival. It is true that worms lack the appeal of Koalas and the scientific interest of the Platypus and marsupials, but if people will travel to see the so-called tame eels of New Zealand then they might be induced to take an interest in earthworms as big as snakes—especially if exhibited amid the scenic grandeurs of Mount Lindsay and the Macpherson Ranges.

It will be noted that a scientific name has not been ascribed to the giant worm from Kyogle. This is because it does not conform to the detailed descriptions of any of the known genera of the Australian earthworms. Fleay placed the giant worms in the genus *Digaster*. Even though the Kyogle worms are not exactly like authentic specimens of *Digaster* housed in the Australian Museum collections, for the time being they may be considered as belonging to this genus.

Retirement of Mr. Ellis Troughton



The Curator of Mammals and Skeletons at the Australian Museum, Mr. Ellis le Geyt Troughton, F.R.Z.S., C.M.Z.S., retired on 29th April, after more than fifty years service at the Museum.

Mr. Troughton joined the Museum staff as a scientific cadet in January, 1908, at the age of 15. He studied zoology at Sydney Technical College and at the University, and was trained in museum work by curators in the ethnological and zoological departments of the Museum.

In World War I he saw active service with the A.I.F. as a stretcher-bearer with the 4th Field Ambulance in France. During leave from the Army he studied collections at the British Museum and on returning to Sydney he was given the task of organising a Department of Mammals and Skeletons, thus becoming the first full-time Curator of Mammals in any Australian museum, a position which he held for 38 years.

Mr. Troughton organised, or accompanied, a number of field expeditions and has collected in every State of the Commonwealth and in New Guinea and the Santa Cruz Group.

Investigations which he has undertaken of economic significance have included a study of cane-field mammals acting as reservoirs of Weil's Disease in Queensland and of the mammal-reservoirs of the mite-borne scrub typhus.

During the last World War, Mr. Troughton was seconded to the Scientific Liaison Bureau, with commissioned rank, for field service with the Tropical Scientific Section of the A.I.F. in the Territories of Papua and New Guinea and Dutch New Guinea, including the islands of Biak and Morotai.

In the course of three tours abroad, on long service leave, he visited the major museums of the United Kingdom, the Continent and the United States to study exhibition methods and their collections of Australian mammals.

His well-known book *Furred Animals of Australia*, published by Angus and Robertson, Sydney, in 1941, which provided the first complete popular guide to these mammals, has run to several editions, including an American one. It is used for university instruction in the United States and the Commonwealth Government has distributed 1,000 copies in Colombo Plan countries.

Other scientific and popular writings comprise 114 titles in the *Records* and *Memoirs* of the Australian Museum, and other State museums, the *Proceedings of the Zoological Society of London*, the *Journal of the American Society of Mammalogists* and in the Proceedings of various Australian scientific societies. He has written no less than 50 articles for the Australian Museum Magazine.

At the Auckland meeting of the Australian and New Zealand Association for the Advancement of Science (1937), Mr. Troughton was elected Hon. Secretary of the Biological Survey of Australia Committee of A.N.Z.A.A.S. and at the Perth meeting in 1947 this Committee sponsored the Recommendation to the Commonwealth Government which paved the way for the establishment of the Wildlife Survey Section of the C.S.I.R.O.

Mr. Troughton took part in the initial scientific reconnaissance of the Mount Kosciusko National Park and submitted a report on the mammal fauna of the Park to the State Park Trust. As part of his numerous and varied activities he has served terms as President of the Linnean Society of N.S.W. and of the Royal Zoological Society, and as representative of local scientific societies has served on the N.S.W. State Fauna Protection Panel continuously since its inception in 1949.

"Troughtie", as he is affectionately known to his many friends, is a good mixer and his recitations at parties and smokos will long be remembered. He has performed in repertory theatre plays with distinction. A keen theatre and ballet "fan", his memories of the stage cover the times from H. B. Irving and Adeline Genee to the present day.

He has ever been a champion of the underdog and in the past agitated for better salaries for the younger members of the staff. At the time when he joined the Museum his salary was 10/- a week!

We wish him a long and enjoyable retirement.

G.P.W.

Book Reviews

ZOOGEOGRAPHY: THE GEOGRAPHICAL DISTRIBUTION OF ANIMALS. By Philip J. Darlington Jr. pp. xi, 675, 80 figures, John Wiley & Sons, Inc. New York.

Price 15 dollars.

In the preface this book is described as "an attempt to amass facts, put the facts together, and discover or rediscover the principles of geographical distribution of animals over the world." It is concerned solely with land and fresh-water vertebrates and seeks in particular to answer the following four questions: What is the main pattern of animal distribution? How has the pattern been formed? Why has the pattern been formed and what does animal distribution tell about ancient lands and climates?

The greater part of the book consists of the presentation of information relating to the distribution of terrestrial vertebrates and in assembling these the author has undoubtedly performed a valuable service to biological science; it is quite certain that his book will have wide use as a source of reference. As well as chapters on the distribution of the various groups of vertebrates there are others on Faunal Regions, Island Patterns, Evolution of Geographical Patterns, the Past in the light of Zoogeography and the Principles of Zoogeography. All these are clearly and simply written and stimulate interest, though some will possibly provoke controversy.

In the reviewer's opinion, the author, when considering the significance of animal distribution, has sometimes placed too much weight on the absence of groups from a region and not always enough on the facts of their presence. Although he suggests that the story of animal distribution as told by vertebrates is different from those of plants and insects he nevertheless provides evidence which suggests that they are in fact in many ways identical. Dr. Darlington is clearly of the opinion that the hypothesis of Continental Drift is unnecessary in order to explain animal distribution, but he acknowledges that there may have been a connection between southern South America and Australia before the Tertiary; yet having done this he then proceeds to give possible reasons for the distribution of insects in the southern continents which completely ignore the possibility of Drift!

This criticism is however of little moment, since the book is not concerned with insects and makes mention of them only in passing. In the preface Dr. Darlington acknowledges that he has been lucky in many ways. Readers of *Zoogeography* will agree that they too are lucky in having the benefit of the author's wide interests and prolonged and deep thought made available to them in a readable form, on a subject of such great interest.

J. W. E.

A RECLASSIFICATION OF THE ORDER ODONATA. By F. C. Fraser. Sydney (Royal Zoological Society of New South Wales. November, 1957), pp. 133, figs. 62, 1 pl. frontispiece. Price 12/6d.

This work on a new classification of the dragonflies represents a revision of an earlier series of papers* which appeared in three parts in the *Australian Zoologist*, Vol. 9, Nos. 2, 3, 4. 1938-1940.

In the preface to the present work the author points out: "During the nineteen years which have elapsed since the first part of the Tillyard and Fraser Classification appeared. considerable advances have been made in the study and interpretation of the venation of the Odonate wing; the result has been to modify some of the views which we held on the taxonomy of the Order."

In this revision the dragonflies are dealt with on a world basis, the author tracing the development of the venation of their wings from fossil records to the forms of the present day. The relationships of dragonflies to allied Orders are discussed before he deals with the Classification, which, as the title suggests, is the main object of the work.

In dealing with the actual classification of the Order, the author defines the various subdivisions (*viz.* suborders, families, subfamilies, and genera, both fossil and recent) in dichotomous keys, many of these division headings being proposed as new.

The work is primarily for the advanced student in entomology; the amateur entomologist who wishes to identify his specimens specifically will find that the Classification stops at the generic headings, and therefore would to him be of limited use. The author, and the Royal Zoological Society of New South Wales, are to be congratulated upon the production of a work of considerable merit; one which should prove to be of inestimable value to entomologists in Australia and abroad. The publication itself has been printed by E. J. Miller & Co., Erskineville, Sydney, for the Society, and reflects credit upon printers and publishers alike.

It is hoped that in the near future Colonel Fraser will be able to prepare for the Royal Zoological Society of New South Wales a similar work dealing exclusively with the Australian *species* of Odonata, for this continent is rich in interesting and beautiful forms of dragonflies.

A.M.

* A Reclassification of the Order *Odonata*, based on some new interpretations of the venation of the dragonfly wing. By the late R. J. Tillyard and F. C. Fraser.

Notes and News

Death of Professor Shellshear

Professor J. L. Shellshear, Honorary Archaeologist to the Australian Museum, died in March.

Professor Shellshear came to Sydney many years ago upon his retirement from the Chair of Anatomy, University of Hong Kong. His enthusiasm had been stimulated by the wonderful discoveries of ancient man in Peking, and by the intensely interesting results, particularly from Australia's point of view, of excavations carried out by the French in Indo-China, the British in Malaya, and the Dutch in Indonesia, particularly in Sumatra. Because of his interest in archaeological matters, on arrival in Sydney he associated himself with the Australian Museum, and for some years carried out reconnaissances with me to locate and examine prehistoric deposits in the Hawkesbury area. He tried, also, to bring about a greater awareness of the value of Aboriginal relics and prehistoric sites, and the need for their investigation by trained people.

I am personally extremely grateful to the late Professor Shellshear for the encouragement he gave me in my archaeological studies here, and for making it possible for me to visit Indonesia and Malaya, and to attend the third Congress of the Prehistorians of the Far East, an experience of inestimable value to me in all my subsequent work.

Professor Shellshear's main research was on the development of the brain. One of his major contributions to knowledge is a monograph on the brain of the Chinese and the Australian Aborigines, published by the Royal Society of London. He was a Research Professor of the Anatomy Department of the University of Sydney and had resumed work on the brain just prior to his death.

F. D. McCarthy.

Curator of Mammals Appointed

Mr. B. J. Marlow has been appointed Curator of Mammals at the Australian Museum, following the retirement of Mr. Ellis Troughton. Mr. Marlow was educated in England and during the War was a wireless operator in R.A.F. Bomber Command. Afterwards he graduated B.Sc., with honours, at University College, London, and went to Northern Rhodesia as biologist to the Government's Game Department. In 1954 he joined the Wild Life Survey Section of the C.S.I.R.O., as a research officer, and while there completed a survey of the status of marsupials in New South Wales.