PROCEEDINGS

OF THE

Royal Society of Victoria.

VOL. XXVIII. (New Series).

PARTS I. and II.

Edited under the Authority of the Council.

ISSUED NOVEMBER, 1915, and MARCH, 1916.

(*Containing Papers read before the Society during 1915*).

THE AUTHORS OF THE SEVERAL PAPERS ARE INDIVIDUALLY RESPONSIBLE FOR THE SOUNDNESS OF THE OPINIONS GIVEN AND FOR THE ACCURACY OF THE STATEMENTS MADE THEREIN.

MELBOURNE:

FORD & SON, PRINTERS, DRUMMOND STREET, CARLTON.

1916.

CONTENTS OF VOLUME XXVIII.

[Proc. Roy. Soc. Victoria 28 (N.S.), Part I., 1915.]

Art. I.—*Investigations into the Occurrence of Onchocerciasis in Cattle and Associated Animals in Countries other than Australia.*

By GEORGINA SWEET, D.Sc.

(With Plates I.-V.).

[Read 11th March, 1915].

During the tour upon the occasion of which these investigations were made, I was able to visit Java, the Straits Settlements, and Malay Federated States, Ceylon, India, Egypt, Europe, Great Britain, United States of America, Canada and the Hawaiian Islands. In addition, enquiries have been made from responsible officials regarding the other islands of Netherlands India, Burma, Siam, Annam, Southern China, and the Philippines, but very little information has been available in the latter cases. I wish to thank very sincerely those officials in so many places who have given me any assistance in their power, in many instances taking considerable trouble to do the necessary work.

In only two or three cases had we any previous knowledge of these "worm-nodules"; thus, one instance had been recorded (under the name of *Spiroptera reticulata*) of their occurrence near the shoulder of an Indian bullock in Malay (Daniels, 1904) (Gilruth and Sweet, 1912), while they had been found in cattle in Java by J. De Does (1904), and others (Railliet et Henry, 1910). As may be seen in detail in previous papers on onchocerciasis in Australian cattle, there is considerable historical evidence pointing to the importation of the parasitic worm causing these muscle-embedded nodules into Australia from Southern or South-Eastern Asia. It may have been brought in either in 1826-8 in buffaloes from Timor (Cleland and Johnston, 1910 (d)), or in 1824 or 1840 in cattle from Coepang in Timor (Gilruth and Sweet, 1911, p. 34), this latter seeming the more probable, inasmuch as the buffaloes found in considerable numbers in the Northern Territory, which are the descendants of buffalo imported in 1824 and 1826 from Timor and 1886 from India, are not known to harbour this parasite, although careful search was made for it, and for evidence from hunters and hide exporters, of its existence, while "all the cattle depastured on the same country are more or less affected" (Gilruth and Sweet, 1912, p. 23). On the other hand it was quite possible that it may have been introduced in Indian cattle about April, 1843 (Gilruth and Sweet, 1912, p. 24), inasmuch as the cross-bred descendants of the "Brahma" or Indian cattle in the Territory are more less infected.

As there were, however, no records as to its existence in India, it appeared a matter of some interest to find out somewhat more definitely the actual distribution of this parasite, and to determine the extent of its occurrence elsewhere, especially in countries more or less adjacent to Australia; likewise to collect any information which might throw light on the life-history.

Wherever possible I visited the Chief Veterinary Officer, both Government and Municipal, in each district entered, the Principal Medical Officer, where such was associated with the inspection of meat, Veterinary Schools where such existed, and often also the abattoirs, interviewing the Superintendent and his senior subordinates, and in many cases myself superintending the searching of carcases. Where I was unable myself to visit the district, a letter accompanied by a brief description of the condition under investigation, and a carefully drawn-up series of headings under which information was sought, was sent to the similar responsible officers, with a request that answers should be sent to me by a certain date. In several cases the officials of the various Governments concerned very courteously sent out these papers to their staffs, so giving the enquiry the aid of their authority and influence. Throughout much of the East the difficulties of such an investigation, owing to various conditions which are indicated later, are considerably greater than in countries where European customs and ideas prevail, so that the response has been somewhat disappointing in its extent, though much material and information promised have still to come to hand, so that I hope to be able to report further later on.

PART I.—GEOGRAPHICAL.

Before passing on, it is necessary, in order to avoid confusion, to indicate the types of bovines considered in the following pages:—

(1) *Bos taurus:* This term is used as including the well-known common tame ox of Europe and Northern Asia, and not in the restricted sense of Lydekker (1913, p. 12).

(2) *Bos indicus:* This term is used as indicating not necessarily a zoological species, but the common domesticated humped cattle of India, etc., often known to naturalists as the Zebu. This name does not appear in Lydekker's catalogue of Ungulate Mammals, a most remarkable omission in view of the fact that he quotes the names of other domesticated races of bovines in this which purports to be a complete catalogue of Ungulates. The humped Indian cattle are also called Brahman and sacred cattle, and are of several types of varying size and build, and useful in various ways, all having a very large sharply outlined hump on the withers, long ears, and a large loose dewlap and very full throttle. (See Fig. 1.) As to the origin of this form, we are not in a measure concerned, yet the question has the possibility of considerable interest in regard to the original host and place of origin of *Onchocerca gibsoni* and its allies. Two views have been held—one that of Blyth, that Africa was the original home of the ancestors of *Bos indicus;* the other, first suggested by Rutimeyer in 1878 and upheld by Lydekker, and the theory to which evidence strongly points as being correct, that the ancestor of the Zebu is to be found in the Indo-Malay group of cattle, which includes the Indian gaur (*Bos (Bibos) gaurus*), of which the Seladang of the Malay Peninsula is a variety (*Bos gaurus hubbacki*), and the Javan Bantin (*Bos (Bibos) banteng—Bos sondaicus*). As Lydekker states (1912, p. 153), since Rutimeyer's work, "the range of the Bantin (*Bos sondaicus*) has been found to extend into upper Burma, . . . and an examination of a large series of skulls and heads leads me to conclude that Rutimeyer was probably right in regarding this species—or possibly a nearly allied extinct type—as the ancestor of the Zebu." There are undoubtedly many hybrids of these two domesticated forms at least in Java, where also a certain admixture is stated to have taken place with the Bantin, and many of them are almost indistinguishable from the purer domestic breeds, so that at times possibly hybrids are included under one or other of the terms *Bos taurus*, and especially, *Bos indicus.*

(3) *Bos (bubalus) bubalis:* This is the recognised specific name of the Indian buffalo, water buffalo, Kerabau (in its various forms, e.g., Karibouw), or Arni, see Figure 2. This has thick, short limbs, and a massive neck, a dewlap being absent, its thick black skin carrying sparsely scattered, long, coarse black hair. The head, with its semicircularly curved horns, is carried well forward and low, so that the horns are more or less in the same plane with the neck. Rarely, a pinkish-skinned animal, with white hairs, may

be seen. As their name indicates, they are invariably to be found, when not working or feeding, wallowing in water-pools and covering themselves with mud.

The Malay Archipelago.

As already mentioned, the presence of "worm nodules" in the muscles of cattle in Java had already been noted and recorded by De Does and others, who have regarded them as being *Onchocerca gibsoni*.

While in Java, I had opportunities of conference with a number of Veterinary Surgeons, some of whom were able to throw a certain amount of light on the question, and, further, the authorities of the Government Veterinary School at Buitenzorg were good enough to undertake to make enquiries throughout the Dutch possessions in this archipelago in order to determine the range, hosts, and general conditions governing the occurrence of these nodules; so that it is hoped further information on these points may be forthcoming later.[1]

The nodules were first discovered by Mr. Hellemans in cattle in 1901 at Kediri (S.W. of Soerabaja), when a thorough meat inspection first began there, and have been constantly found there since, and in other parts of the valley of the River Brantas, such as Toelengagoeng, Blitar, and Pare, and at Rembang, Sloeke, and Madioen. Statistics given of their occurrence vary from 40 per cent. by earlier observers to 80 or even 90 per cent. of carcases later, an increase possibly due to greater familiarity with their existence and appearance. They are almost invariably found near the mid-line of the sternum, sometimes in considerable numbers, e.g., from 20 to occasionally 40 per carcase, and Hellemans reports having seen them rarely, in the stifle. Since the cattle are never killed until too old or weak to work, the nodules are unknown by post mortem examination except in 6, 7, or even up to 10 year-old animals, the worms being generally dead, and most of them caseous or much calcified, though it is stated by one observer that one may find a "very small *young* nodule beside the calcified ones."

De Does reported to me having seen filarial larvae in blood-smears of infected animals, but admits that they may have been those of some filarial worm other than *Onchocerca gibsoni*, such as aortic filariae, etc. He has also seen larvae "not only in the tunnels

[1] See Addendum 2.

around the worm and in the connective tissue, but also *in a vein* in the wall of the same nodule. In this case, the larvae were quite probably those of *O. gibsoni*, but may have been carried by the knife into the vein space, in sections of a whole nodule, so that one cannot accept either statement as proof of the occurrence of the larvae of this worm in the bloodstream.

Hellemans was also able to find these nodules in Sumatra, when the more thorough meat inspection was instituted at Padang in 1904—but, strangely enough, after his experience of finding them in Java in the brisket almost entirely, here in Sumatra he was unable to find them in that location, detecting them in 25 per cent. of cows, and then in the stifle only.

Regarding *Bali*, nodules have also been seen in the brisket, and rarely on the flanks of cattle imported into Batavia from Bali, but no work has been done on the island itself.

In cattle imported into Soerabaja from Madura, nodules are so far unknown.

Nothing whatever is known of Lombok or Timor in this connection, and the infrequent communication rendered any attempt on my part to visit these islands impossible.

The term "cattle" used above undoubtedly includes *Bos taurus* from Europe, and Australia, and locally bred; and probably also pure-bred and hybrid *Bos indicus*. This term has been used here because of the difficulty of determining the absence of admixture even in so-called pure-bred cattle of either species; and it must be remembered that there is still some question as to the amount of interbreeding which may have taken place between those two domesticated races in Java, as authorities there are very conflicting on the point.

It was naturally a point of some interest to discover whether the nodules were present in the pure bred descendants to the humped cattle or Zebus (*Bos indicus*), which had been imported from India (Bengal), and also in any known hybrids with the ordinary cattle, (*Bos taurus*). I was informed that these nodules had not so far been seen in these pure-bred *Bos indicus*, nor in any of their hybrids, except as was stated by De Does, that he had seen them "in such hybrids in parts of West Java (where there are very few cattle), along the midline of the sternum, especially in animals of 2-3 years."[1]

Naturally also, the Bantin or native ox of Java (*Bos banteng*) forms a possible host for these worm-nodules, but I was unable to

1 But see Addendum 2.

obtain any evidence of their occurrence in this animal in either Java or Sumatra.

In the Karibouw, or water buffalo (*Bos bubalis*), worm-nests are well known to both Dr. Sohns and Mr. Hellemans. They occur at Kediri in Java, and also in Sumatra, always in the skin of the animal. Unfortunately I have not as yet been able to obtain any specimens suitable to determine whether the worm-nodules found in this constant position in the buffalo, belong to the same or a different species from *O. gibsoni*. Macroscopically no difference whatever has been seen in specimens from the two positions in *Bos taurus* and *Bos bubalis* in Java.

Inquiries were made with regard to the general conditions of those places from which the infected cattle come, and as to the animals found there which might possibly act as intermediate hosts, if such be necessary for the completion of the life history. In Java, Sumatra, and Bali all areas carrying infested cattle are similar in being low-lying and swampy, or flat, with much stationary water, and, as might be expected under those conditions, mosquitoes are very numerous. Biting flies do not seem to be especially frequent.

Although not immediately concerned with the object of the present investigation into forms found in the connective tissues, it is of interest to remember the existence of two kinds of filarial worms in the aortic walls of bovines in these regions, viz., *Onchocerca armillata*, Raill. et Henry, 1909, and *Elaeophora* (=*Filaria*) *poeli* (B. Vryburg, 1897). The former, which lies sinuously beneath the lining epithelium of the aorta of cattle (*Bos indicus*), has been recorded by Railliet and Henry (1903, and 1912, p. 117), from Sumatra (*vide infra* also). The latter, *E. poeli*, forms tumours in the walls of the aortae, containing the head of the female worm and one or more males, the remainder of the female worm floating about in the direction of the bloodflow. It has been recorded already by B. Vryburg (1897), and by Railliet and Henry (1912, p. 115), from the aorta of the Buffalo (*Bos bubalis*), and rarely of cattle (*Bos indicus*) from Sumatra, and it was quoted to me also from Java.

Pacific Islands.

As time did not permit me to visit the Philippine Islands, enquiries were made from the Bureau of Science at Manila, in reply to which the Director of the Bureau reported that "Onchocerciasis is not endemic in the Philippine Islands. It has been found in cattle shipped from Australia for slaughter in the Philippines, but no case has been reported in native cattle or carabaos."

Similar conditions appear to exist in the Hawaiian Islands which were visited.

Malay Peninsula.

As already known, worm-nodules were found by Mr. T. A. Ford in Malaya in 1904, and recorded under the name of *Spiroptera reticulata* by Dr. Daniels (1904, p. 17). These came from an aged specimen of *Bos indicus*. I visited a number of official Veterinary Surgeons in the Peninsula, and enquiries were made from others, but none so far seem to have been able to detect them elsewhere, though while this report was nearing completion, I received from Mr. Ford specimens from an old working Indian bullock, and from 17 small Siam bulls (from the west coast of Siam, about midway between Penang and Rangoon), the latter having been brought to Kuala Lumpur for slaughter. The nodules vary in number from 1-20. The fact that cattle are never killed unless incapable of work, naturally diminished the likelihood of the nodules being found, but it does not seem credible that they are so restricted in distribution in the Peninsula, especially in view of experiences elsewhere. Thus, at Penang inquiries were made, and finding that their existence had not been noted, I accompanied the Municipal Veterinary surgeon to the Abattoirs, where I interviewed his Chief Inspector, and made with them an examination of the carcases then in the houses. That they were well known to the Inspector, although he had not previously reported them, was quickly seen, as without any advice from myself he immediately cut in two inches to the side of the midline of the sternum of an Indian bullock, disclosing three nodules exactly similar to *O. gibsoni* in appearance and position. These were found to be mature, and contained living and actively motile larvae. The nodules were present to the number of 1-3 in nearly all the cattle killed that day, but none could be found in any of the buffalo then in. I was assured, however, by the Inspector, evidently a careful observer, that they are quite frequently found in Indian cattle (*Bos indicus*), and in more than 20 per cent. of the "native" brown Malay cattle. and in the small humped Siamese cattle, both of which appear to be varieties of *Bos indicus*—always in the brisket, but usually only up to three per animal, varying up to the size of a walnut. They are also found but comparatively rarely in the "native" buffalo or Karibouw (*Bos bubalis*). In the face of this evidence it seems credible that a more careful search will reveal the presence of these worm-nodules widely spread in the cattle and buffalo on the mainland.

It would have been of interest to find whether these nodules are present or not in the Seladang, or wild Malay gaur (*Bos gaurus hubbacki*), but, unfortunately, no evidence whatever was forthcoming.

The two bovine aortic worms previously referred to are also present, as I was able to see in Malaya and the regions to the North, as has been recorded already, though not always by name, by various authors, and first of all by Ford (1902); thus, *O. armillata* has also been recorded in bullocks, and rarely in buffaloes (less than 1 per cent.) by Tuck (1904, p. 30), from animals killed at the slaughter-house at Kuala Lumpur (F.M.S.). They are also described from cattle killed at Hué (Annam) by Bernard and Bauche (1912, p. 112) and Railliet and Henry (1912, p. 117), while *E. poeli* (under various names) has also been recorded by Von Linstow as *Filaria haemophila* (1904, p. 352), from buffalo, by Tuck (1904, p. 20), from buffalo and bullock (?) (p. 32) at Kuala Lumpur, by Ford (1907, p. 517) from buffalo (in 72 per cent. of carcases examined) at the abattoirs at Kuala Lumpur, and also in buffaloes in the country districts of Selangor, Negri Sembilan, and Pahang, by Bernard and Bauche (1912, p. 109) (83 per cent. of buffaloes and 1 per cent. of oxen being affected), and by Railliet and Henry (1903, p. 254; 1912, p. 115) from Hué (Annam).

India and Ceylon.

Hitherto worm-nodules in the connective tissues have never been recorded from India or Ceylon, and, except in one instance, have been quite unknown there. Leiper states that Lingard has recorded Onchocerciasis in India—this refers, however, only to Aortic worms. The difficulties of the investigation are considerably greater than elsewhere for several reasons. The number of cattle killed is proportionately small, and they are even then, as in Java and Malay, almost invariably aged (e.g., 7-10 years is the usual age in many parts), and are only killed because they are no longer able to work. Also, the amount of meat consumed is proportionately less than in colder countries; and, further, in many places, it is almost entirely one section of the native population alone which uses the flesh of the local animals for food, the meat supply for the European residents being largely imported frozen. As a result of this, detailed meat inspection, even as we know it, is unknown, more especially in most parts of India. Although a form of meat inspection exists as elsewhere, the ordinary process was absolutely useless for my purpose, being conducted at the best chiefly by native veterinary officers watching for specific diseases, under the general supervision of a fully qualified European Veterinary officer who, however, has not only a very extensive area to control in this respect, but has also charge of all matters affecting the health of the animal population of the district, and has often to combat outbreaks of disease under considerable difficulties. In the ordinary abattoirs the animals are often killed between midnight and 1 a.m., and are taken away almost immediately for consumption, after cursory examination for certain diseases, so that the parts of the carcass concerned in this question are very rarely examined. This, added to the method of killing used, made any personal investigation neither easy nor pleasant. A somewhat similar condition as regards detailed inspection is normally found in the special abattoirs attached to meat drying Factories, which supply the trade to Burma more especially. In these, however, in some places more buffalo than bullocks are killed, and from these evidence was obtained, though no nodules could be found in the carcasses present at the time of my visit in one of these which I was able to visit personally.

The religious importance of the cow to the Hindu, to whom this animal is most sacred, gives rise to further difficulties in the way of such investigations—even in Serum Institutes and Research Laboratories, the animals appear to be less frequently killed than in many similar institutions elsewhere, while at the various Veterinary Schools and Hospitals, even if their native Hindu owners allow the animals to remain there to die, permission to make post-mortem examinations can very rarely be obtained. However, through the courtesy of the Department of Revenue and Agriculture of the Government of India, official circulars were sent to all Local Governments and Administrations, requesting that the resources of the Civil Veterinary Department should be enlisted in this question. Circulars were also sent to Sanitary Commissioners and to Health Officers, as these sometimes control the meat inspection, and I was able to visit personally a considerable number of Districts.

In Burma the Superintendent of the Civil Veterinary Department (Colonel G. H. Evans) reports that these worm-nodules "are pretty frequently present in oxen and buffaloes," but no details are forthcoming: in Assam, "they have not been observed"; similarly in Bengal. From Bihar and Orissa no information is available. In the Madras presidency, the Civil Veterinary Superintendent (Mr. Ware) was able to secure for me on two occasions specimens from

Indian bullocks—and I am informed by Mr. J. A. Valladares that he had found them in five bullocks at Madras previously to my visit.

In Ceylon, on my making enquiries, the Government Veterinary Surgeon, Mr. G. W. Sturgess, was able to obtain specimens from both *Bos indicus* and *Bos bubalis* killed in the local abattoirs, these nodules being evidently endemic in this Island. On examination of them in his laboratory, I found, although there were two or three living nodules from old cattle, most of them, large or small, were much caseated or calcified, or nearly absorbed.

Central Provinces and Berar.—I am indebted to Mr. J. A. Valladares, Deputy Veterinary Superintendent at Nagpur, for a number of specimens from four localities in this part of Central India, two being in the far North of the District, though in other localities in this district, where search was made, they were not obtainable. In each case they were found 1-3 in number, in the brisket and in old cattle. Once only were as many as eight nodules, all small in size, observed. In the four localities where careful observation was made and statistics were kept, only six animals were found affected out of a total of 1203 examined—though it is stated that in general "the existence of worm-nodules is fairly common in the Central Provinces."

United Provinces of Agra and Oudh.—The very careful investigations made, in response to my requests, at slaughter houses and meat drying factories, under the direction of Major J. D. E. Holmes, C.I.E., Imperial Bacteriologist, and of Mr. C. W. Wilson, 2nd Civil Veterinary Superintendent of these provinces (who most kindly set apart an officer especially for the purpose) have resulted in the finding of these worm-nodules in a great part of the area concerned from Bareilly and Shahjahanpur in the North to Jhansi and Lalitpur in the South, and from Aligarh and Agra in the West to Unao in the centre, and it is probable that they are even more widely distributed through this region than as yet discovered. I am informed by Mr. Wilson that these nodules have been known to exist here, although the fact had not previously been recorded. They are found both in *Bos indicus* and in *Bos bubalis*.[1] In cattle they occur the more usually about the base and side of the neck, but most commonly under the skin and in the intercostal spaces near the sternum, "between the 3rd and 13th ribs on the external oblique and pectoral muscles." In frequency affected cattle varied from 20 per cent. of the animals killed at the slaughter house and

1 See Addendum 1.

meat drying factories at Bareilly to about 2 per cent. in other districts. Most usually only 1, 2 or 3 are present in each host, but occasionally from 6-10, or even up to 15 and 20, are seen; the animals available for examination were sometimes as young as five or six years, but as usual here, mostly older, e.g., 17 to 20 years. The nodules were found in all ages, but were more numerous in the older animals; calcification was often considerable.

In buffaloes[1]—and they are found in these in all districts and at Agra more commonly than in cattle—the nodules are found "adherent to the skin, which becomes thin and hairless just over these nodules, so that the skin is cut when they are dissected out. The worm-nodules among buffaloes are more red than those among oxen, which are white ones." As in the case of cattle, they are generally attached to the right and left of the sternum at a distance of two or three inches, sometimes in "large numbers, especially in thinner animals," the size of the nodules varying from that of a pea to a pigeon egg. Again the animals in which they were found were 17 and 18 years old.

The localities whence the Indian cattle carrying these nodules were derived, agree in being normally very dry and hot ,e.g., "The climate of Jhansi, as might be expected from the rocky nature of the ground, the rapid drainage, the absence of high jungle, and the general depth of the water level, is characterised by exceeding dryness, and by heat considerably above the average of the province" —which is exactly the reverse of the more or less swampy conditions found wherever the nodules are known in Java, and might at first sight be considered to exclude the possibility of any necessity for the presence of water, either directly or indirectly, for the completion of the life history. But as we find that the soils in these parts of the United Provinces are either black cotton soils, which "in season of heavy rainfall rapidly become over-saturated," or else chiefly very good loamy soils, the conditions seem to be present which would allow of the occurrence of standing water in certain seasons at least—quite sufficient for the infection of cattle or buffalo, if such be associated in any way with the method of infection or transmission.

Before leaving this part of India, it is well to record the experience of Mr. S. H. Gaiger, at one time Parasitologist to the Imperial Bacteriological Laboratory, and now of Lahore. In the course of the post mortems conducted by him at the laboratory at Muktesar

1 See Addendum 1.

as well as elsewhere, in spite of the most detailed examination of all parts of the carcases, in the endeavour to find any new parasites, never once had he come across these nodules, or anything resembling them. The inference can only be that if these nodules be present at all in the hill cattle, which are chiefly used at the serum laboratory, they are very rare indeed, a deduction which is in harmony with Lingard's statement (1905, p 36-37) in connection with the occurrence of aortic worms in cattle, that he found only three animals infected out of 2000 autopsied.

Punjaub.—During my enquiries as regards this province, I found from Colonel Pease, Director of the Veterinary School at Lahore, and his staff, to whom I am indebted for their active interest, that worm-nodules had never been recognised in the Punjaub, and that they were very doubtful about their occurrence. In communications seven months later, Colonel Pease informed me that he had since found that the nodules are known to the butchers, but are very uncommon. After considerable difficulty he had managed to obtain two or three from the brisket of a five-year-old buffalo, and five from the brisket of a eight-year-old cow, the latter being the result of special examination of 120 cattle (=.83 per cent.).

Sind, Baluchistan and Rajputana.—The Acting Civil Veterinary Superintendent (Mr. E. S. Farbrother) of this area writes that he has " made investigations in Sind, but can find no evidence of the presence of worm-nodules in cattle in this part of India."

Bombay Presidency.—In spite of numerous enquiries in all directions which might possibly yield any results, I have been unable to hear of any instance of the occurrence of these nodules in this Presidency, either from Veterinary Surgeons (one of whom, Mr. Sowerby, of Bombay, has been watching carefully for cases since my visit, without result), Inspectors or Superintendents of Abattoirs.

I was not able to find any evidence of the occurrence of *Onchocerca fasciata* in camels in India, other than as already found by Mr. Leese in the Punjaub, and recorded by Railliet and Henry (1910, p. 248).

In India we find the aortic worms represented so far as I have yet been able to find, by *Onchocerca armillata* only. This has already been recorded by Lingard (1905, p. 27) from the aortae of cattle and buffalo—in 70 per cent. of " plains cattle," and in 15 per cent. of " hill cattle."

Egypt and the Sudan.

So far, worm-nodules in bovines have only been recorded for Africa, as present in parts of Algeria and Tunis, by Professor Neumann, who has described *Onchocerca gutturosa*, Neumann, 1910 (1910, p. 270) from the region of the cervical ligament in the neck of cattle killed at Constantine and at Tunis. I was informed by Mr. F. E. Mason, Government Veterinary Pathologist, Cairo, that worm-nodules are present in the subcutaneous connective tissue of any part of the body, but especially along the sides of the neck in the Egyptian Belady or village cattle. These animals, which are prevalent as far south as Wady Halfa, have a more gently curving, dome-shaped hump, somewhat more forwardly placed than in the case of the Sudanese cattle. Specimens from these are under promise to me; in the meantime I am unable to say whether they are similar to *Onchocerca gutturosa*, or to the Indian form, or even a different species from either of these. *O. gutturosa*, as described by Professor Neumann, forms flattened nodules up to the size of the palm of the hand, situated in connective tissue on the inner face of the cervical ligament, in the region of the 2nd or 3rd dorsal vertebrae. These worm-containing nodules are very similar to those of *O. gibsoni*, though differing in location, and formed by another species of worm.

The Sudanese cattle have a more backwardly placed hump, shaped more like that of *Bos indicus*, of India, and are more prevalent south of Wady Halfa. So far as I have been able to obtain any evidence, either at the time of my visit or since from the Director of the Veterinary Laboratory at Khartoum, the nodules are unknown in these Sudanese cattle, and also in the buffalo of these countries.

Mr. Mason also informed me that the subcutaneous worm-nodules of camels in Egypt, recorded by himself as " present in subcutaneous positions, and similar to those found by Cleland in camels in Western Australia," but recorded nevertheless under the name *O. gibsoni* (1912, p. 97), while found chiefly along the side of the neck, are also found over the quarters, then on the head, and sometimes in the subcutaneous connective tissue of any part of the body. As no specimens have yet come to hand, I am unable to state whether or not these are caused by *O. fasciata*. He has also recorded the presence of " mature filarial worms, presumably *Filaria evansi*, in the blood-vessels of the lungs, testicle, and in the vas deferens of camels " in Egypt (1906, p. 120, and 1911, p. 329).

Europe.

Investigations were continued in Italy, Austria, Switzerland, Germany, Denmark, France, and Great Britain, but all enquiries from those under whose notice the existence of worm-nodules, such as *O. gibsoni* must have come, did they occur, were met with negative replies. The genus *Onchocerca* is, however, represented in every department of France by a species (*O. bovis*, Railliet et Henry, 1912) (see Piettre, 1912, p. 509), which is found in as many as 95 per cent. of cases inspected at Les Halles Centrales in Paris. Here M. Piettre, their discoverer, who is in charge of the Veterinary Laboratory, enabled me to see several examples of this infection. These are, however, as already described by M. Piettre (Oct., 1912, p. 537, etc.), much more like *O. reticulata* of the horse in their manner of occurrence, no nodular formation taking place. As recorded and shown to me by him, *O. bovis* occurs almost exclusively in the region of the femoro-tibial articulation in the thickness of the internal and external articular ligaments, and in the tendons, generally nearer the tibial than the femoral surfaces. Two to five worms, males or females, or both, lie coiled in and out of the fibres, in the thickness of the ligaments and tendons, causing their degeneration, though free parasites may be found between the synovial membrane and the tendons. I have, therefore, not been able to find any evidence of the indigenous existence of these worm-nodules in Europe.

United States of America.

In a country of such extent as this, having a great range of latitude and of climate, many of the Southern States occupied in cattle-raising being similar in latitude to districts in the Eastern Hemisphere where these nodules are found, it is credible that one should find some form of worm-nodule similar to those found in the latter hemisphere.

Moreover, considerable interest attached to enquiries here on account of the importation of "Brahman cattle" into South Carolina in 1849 (Mohler and Thompson, 1911, p. 84), into Southern Texas about the year 1880 (loc. cit., p. 81), and again in 1906 (loc. cit., p. 82-3), some at least being derived from districts in which worm-nodules are now known to exist.

The chances of discovery of anything of this kind here are very considerable, in view of the admirable work of the Federal Bureau of Animal Industry at Washington, D.C.—the Zoological division of which pays special attention to the parasites of domesticated animals—the widespread system of meat inspection by properly qualified Veterinary officers, and the numerous Agricultural Experimental stations throughout the States.

Hitherto, a species *Filaria lienalis* (possibly to be referred to the genus *Onchocerca*) has been described by Dr. Stiles in 1892 from the capsule of the spleen of cattle in U.S.A., but nothing comparable in position and nodule structure with *O. gibsoni* has ever been recorded from that country, nor in my visits to the Bureau of Animal Industry, or the State Veterinary Schools of Pennsylvania, Ohio, or the Agricultural Experiment Station of Illinois, was I able to hear of anything further. To test their possible existence in the most probable district, the Chief of the Bureau of Animal Industry (Dr. Melvin) and the Chief of the Zoological Division (Dr. B. H. Ransom) kindly undertook to have investigations made to determine definitely whether or not these worm-nodules exist in the descendants of the imported animals referred to above, and whether it has spread at all to the local breeds. As they have not so far, however, been recognised by the Veterinary Inspectors of this country, one may well assume that they are not present there.[1]

I was, unfortunately, unable to visit South America, and no definite information is yet forthcoming therefrom. However, a careful investigation has been very recently made into the cattle industry in South America by two independent and eminently qualified officials—Dr. Melvin (1914, p. 347) from the United States and Mr. Dunlop Young (Chief Meat Inspector, London) from England (1914, p. 522). Neither of these observers have any evidence of the existence of worm-nodules in South America, and such must surely have come under their notice, especially under that of Mr. Young, who has been familiar officially with their occurrence in Australian cattle. One may, therefore, conclude that so far they are absent from South America.

It is, however, interesting to note that in 1906 (Gunn, p. 31) 200 young Ongole cattle were taken from the Madras Presidency, where these nodules are now known, to Brazil, so that it will be well to follow the effects of this importation in this respect.

PART II.—SYSTEMATIC.

The question of the specific identification of the nematode causing the worm-nodules found in Indian cattle has been a matter of considerable difficulty in some respects—chiefly in view of the

1 See end of Addendum 2.

marked range of variation in size in certain structures. The almost certain derivation of the Australian *Onchocerca gibsoni* from cattle imported from India or Malaysia, coupled with Dr. Leiper's identification (1911, p. 10) of the parasite found by Ford in the Malay States in 1904 as *O. gibsoni*, and the assertions of the same identity in the case of the Javan parasite by other workers, made one naturally expect to find the Indian species the same also. The absolute similarity of the position and manner of occurrence of the nodules in the body of the host and of their macroscopic structure still further strengthened this expectation. However, during the microscopic examination of one or two nodules as a matter of routine identification, I was impressed by the variation shown by them in some details of structure outside the range previously recorded for *O. gibsoni*, and accordingly dissected more nodules. From these I obtained five females (four complete in essential parts) and six complete males.

Onchocerca gibsoni has been already described by Dr. Gilruth and myself in detail in a Bulletin issued by the Commonwealth of Australia, as well as by Drs. Cleland, Johnston, Leiper and Breinl (see Bibliography). After careful measurements and comparisons with this and other forms, I have been forced to the conclusion that the form found in cattle in India is to be regarded as a different species, which I have called *O. indica*, and a specific description of which is hereafter given; nevertheless I have no doubt whatever as to the origin of these forms from one another, or else of both from a common ancestral form. In view of this it is doubly disappointing to me not to have yet received other material from Javan and Egyptian cattle and buffaloes, and also from Malaysian and Indian buffaloes[1] as this (especially that from Javan cattle) would probably throw further light on the question. Nevertheless it seems desirable to publish what I can up to date, and add to it later on. I have a certain amount of material from some of these hosts and localities, but, as previously stated, it was in such a condition as to be useless for this purpose. While this report was being completed I had the gratification of receiving specimens from Mr. Ford from an Indian bullock in Malaysia, and from Siam cattle, which will be referred to later.[2] The nodules found in cattle (*Bos indicus*) in India resemble exactly in macroscopic appearance and position in the body those of *O. gibsoni* found in cattle (*Bos taurus*) in Aus-

1 See Addendum 1, *re O. indica* in *Bos bubalis*.

2 See Addendum 1, *re O. indica* in *Bos bubalis*.

tralia.[1] They are more frequently flattened like a broad bean in the former than in the latter, much as in *O. gutturosa*, due naturally to compression between the muscles and between them and the skin. I have not seen any so large as those sometimes found in *O. gibsoni*, nor any with anything approaching the great thickness of fibrous tissue, such as occasionally occurs in the latter. A thickness of 5 mm. of fibrous capsule is abnormally great in *O. indica* in cattle, 2 to 3 mm. being the more common. A larger proportion of nodules of *O. indica* seen by me are calcified or caseated, due undoubtedly to the fact that practically only aged cattle are killed in the country whence these come. The whole tissue of the nodule is often permeated with larvae, even in cases where mature worms show no larvae in the genital tubes; also larvae (.12 to .16 mm. long) are to be found on the periphery of the nodule, and sometimes thickly in the loose connective tissue on the surface of the nodule.

The connective tissue trabeculae, which form the walls of the network of tunnels, in which the worm lies, resemble exactly in nearly every case those of *O. gibsoni*, but in two instances (see fig. 4) one was surprised to find within the dense fibrous capsule, which was 1.5 and 2 mm. respectively in thickness, the worm lying quite freely in the interior, with only one or two delicate connective tissue strands 2 to 3 mm. long, in place of the intricate fairly substantial network otherwise present. Evidently either an inexplicable inhibition of fibroblasts had taken place in the interior during the development of the nodule, or probably, some unusual degenerating factor had been at work, since in one case, the internal structure of the anterior part of the body of the female was almost undecipherable, while that of the male was also affected.

The simple relationship found in *O. gibsoni* between the heads of the male and the female does not so frequently obtain here. There is always, however, a certain close association (see figure 3), and intertwining of these and of the tail of the male, which are generally to be found on one of the flattened surfaces, the body of the male sometimes coiling about in close proximity at several points to the other flattened side.

In reference to the numbers of males and females associated together in each nodule, it is interesting to note that although Breinl (p. 9) has noted the occurrence of two males with one female in the case of *O. gibsoni*, no one else has hitherto observed this condition, while in *O. indica*, of the four females obtained entire,

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1 See Addendum 1, *re O. indica* in *Bos bubalis*.

two nodules had one male, and the two other nodules each had two males. In the other nodules dissected no male was found at all.

In structure, the worm very closely resembles *O. gibsoni*, to which it has undoubtedly close affinity, and in view of the detailed descriptions of that worm already published (and referred to above) it is unnecessary to repeat here a minute general description. I have therefore contented myself with a statement of the specific characteristics of the Indian worm, and a careful comparison with other allied forms as indicative of the reasons for the establishment of a new species. Incidentally, light is thrown on one or two points of general interest as regards the specific diagnosis of Nematodes.

The characteristics of this worm may be summarised as follows (cf. Tables 1, 2, 3, and Figures 5, 6, 7, 8, 9), the variations being discussed in detail later.

Onchocerca indica, n. sp.

Male.—3.38 to 9.3 cm. long (average 5.69 mm.); diameter of central portion of body, .175 to .220 mm. (average, .198 mm.), tapering to each extremity. Anterior end straight and without interruption, posterior end often spirally coiled, having a cloacal swelling on which the cloaca opens, behind which the tip of the tail is generally bent sharply towards the ventral surface, forming a hook. Cuticle, .003 to .004 mm. thick in the central region of the body, where also it has regular rounded transverse ridges, the depressions between which are .005 to .006 mm. apart at the maximum, these ridges becoming smaller and less conspicuous as they approach the two ends, where they are absent; finer striae were not detected Mouth terminal with three slightly marked lips and three papillae (not always easily seen) close behind the level of the opening. Oesophagus long, from over .847 to 1.22 mm. (average, over 1.051 mm.), thick-walled, .031 to .039 mm. (average, .036 mm.), and generally with a well-defined bulb (or "cardia"), .062 to .069 (average, .064) mm. long, and .047 to .060 (average, .053) mm. wide, at the junction of the oesophagus, with the typical thin-walled, straight intestine. Nerve ring surrounds oesophagus usually at .188 mm., though sometimes at .172 mm. (average, .182 mm.) from the anterior end, and where seen the excretory pore appeared to be situated at .219 to .282 (average, .250) mm. from the anterior end Cloacal opening at .062 to .086 (average, .07) mm. in front of the tip of the tail, the diameter of the body at the level of the opening being .042 to .062 (average, .053) mm. Anal papillae somewhat variable, generally eight or nine pairs in number, but sometimes asymmetrical, their range being as follows:—*Right*—preanal 1, par- (or ad-) anal 4 (or rarely 3), postanal 1, precaudal 1, caudal 1 to 2. *Left*—preanal 1, paranal 3 to 4, postanal 1, precaudal 1, caudal 1 to 2. Two unequal spicules of characteristic shape, the longer .207 to .274 (average, .257) mm. long, and .009 to .012 (average, .011) mm. in diameter at middle of length, curved in harmony with the body curve, the proximal termination being enlarged and funnel-shaped, and the distal termination pointed or rarely slightly bifid. Midway the median channel of the distal portion of the long spicule opens obliquely forwards and outwards to its surface. Short spicule .08 to .094 (average, .087) mm. long, enlarged proximally and flattened somewhat in the greater part of its length, being .006 to .012 (average, .007) mm. in its less diameter, and .012 mm. in its greater diameter, its distal termination having a shoe-shaped enlargement for the guidance of the long spicule. On one occasion the short spicule was missing, and no evidence could be seen of its having previously been present.

Female.—May reach at least 100 cm. in length; diameter of central portion of body .38 to .63 (average, .47) mm., tapering at each extremity, both ends being straight and uninterrupted. Cuticle .02 to .024 mm. thick in the central region, and thickened for greater part of the length of the body into prominent wavy ridges, which may be as much as .138 mm. apart; generally in one continuous spiral, with occasional gaps at one or other side, and also occasionally a double spiral may be found; no network is present, and the spiral ridges are gradually lost anteriorly and posteriorly; no fine transverse striae could be seen. Mouth terminal, with three very small lips and three papillae, but no separation of the head from the body, and no cervical swelling. Oesophagus long, 1.1 to 1.44 (average, 1.23) mm., and equally thick walled with that of the male, .031 to .034 (average, .032) mm. in diameter. Bulb (or cardia) more frequently indefinite than in the male, but when present is .062 mm. long, and .045 to .055 (average, .050) mm. in diameter. Nerve ring at .188 mm. from the anterior end; excretory pore not seen. Anus at .125 to .232 (average, .187) mm. from the posterior end. Vulva in mid-ventral line, generally on a slight swelling, at .55 to .75 (average, .63) mm. from anterior end, leading internally into a thick-walled sometimes twisted vagina. Segmented ovum .026 x .017 mm., eggs containing fully developed larvae .0251 to .0329 mm. long, and .0172 to .0251 mm. wide; larvae just free from egg, which has a very thin shell, .12 to .196 mm. long, and .0021 to .0024 mm. in diameter; all stages up to free embryos being found in the genital tubes of the female larva, with very bluntly truncated head, and gradually tapering to a very long fine point posteriorly, no sheath being observed. (Larvae were insufficiently well preserved to allow of accurate observation of histological structure, being also easily broken in making smears.)

In a previous paper on *O. gibsoni* (Gilruth and Sweet, 1911) the very considerable amount of variation in important structures was pointed out, as had also been done by myself on two or three previous occasions (e.g, see Sweet, 1910, p. 243 et seq., and p. 247 et seq.) when describing new species, which, so far as I am aware, have not yet been recorded from elsewhere, and which are undoubtedly and most naturally closely allied to analogous forms in the same host in "older" countries. It would seem that the transference in these latter cases of the domesticated host from its older habitat to a new environment in Australia has fairly quickly influenced the structure of some of the contained parasites to an unexpected degree. On the other hand, although in most cases the older workers gave no indication of any variability in measurements given, it is probable that a considerable amount of variation exists even in well-known species elsewhere. In view of this it is of interest while considering the value of measurements in specific diagnoses to compare work summarised in a paper by Fracker (1914, p. 22), in which he seeks "to ascertain the extent to which the proportions of the worm (*Oxyurias vermicularis*) were constant, and the parts which undergo the greatest variation," considering especially the use of the formula suggested by Cobb in 1890, and since invariably used by him. Fracker concludes that while "an individual should never be identified on the basis of the formula alone, or of the proportions alone," "the proportionate size of the organs in the Nematoda is an important factor in their identification, and should be stated in any description of a new species." With these conclusions, in so far as they emphasise the necessity for a statement of measurements, most workers in the group of Nematodes will agree, in view of the paucity of marked specific characters. Curiously, however, in the case of the two species of Onchocerca which I have studied in this special connection, measurements proportionate to the length of the body even of the male, such as are emphasised by Fracker, are useless for the purpose of specific diagnosis, such measurements having no relation to one another, while within a stated range, there is a marked similarity in certain absolute measurements, quite irrespective of the length of the animal, and such variations as do occur, are independent of the size of the worm. All measurements given in the paper on *Onchocerca gibsoni* previously quoted (Gilruth and Sweet, 1911), and those given here for *Onchocerca indica*, have been made under identical conditions—the specimens being cleared in carbolised absolute alcohol, just before measurements were made with a standardized screw micrometer eyepiece—so that in comparison of these two sets of figures all extraneous influences are eliminated, except any differences which might be due to a different preserving fluid. Since, however, the action of the above clearing fluid freshly applied in the way indicated is to "plim" the body of the worm into its apparently normal condition as when living, I think this may be ignored, and we may regard the figures given as strictly comparable. Reference is made to figures given by other workers as indicated, since although perhaps not strictly comparable with the two sets given by myself (on account of the slightly varying amount of swelling or contraction caused in certain parts by different clearing reagents), they may at least be taken to indicate that variations in excess of those present in the worms examined by me, were encountered by these workers, so must be taken into account in separating two species so closely allied as the two under consideration.

Reference to Tables 4 and 5 included herein will facilitate such comparison. As will be seen (Table 4), the range in length of mature *male* worms is considerably greater than in *O. gibsoni*, *O. gutturosa*, or *O. bovis*, the other forms of this genus occurring in the connective tissues of cattle, the average length also being greater than in those species. Further, the worm is markedly stouter than any others, the specimens of *O. indica* exceeding in average diameter the stoutest of *O. gibsoni*, both anteriorly and in the middle part of the body. The stoutness, however, bears no relation to the length of the worm, as will be seen on glancing at Bii, and Dii, and E in Table 1. In spite of this, the variation in position of the nerve ring from the anterior extremity is exactly the same as found by ourselves and Cleland and Johnston in *O. gibsoni*, though greater than that recorded by Breinl, and less than by Leiper. Rather unexpectedly, moreover, in the two longest specimens of *O. indica*, I find that it is slightly further forward than in the others, though one would naturally have thought to find the reverse. The oesophagus of the male again always exceeds in length the highest range given for *O. gibsoni* by all workers, except Breinl, and, as a rule, that found in *O. gutturosa* or *O. bovis*, while in diameter it greatly exceeds that of other forms (with the same exception), being often twice the thickness in those forms. The oesophageal bulb or "cardia" also is unusually conspicuous, occupying on an average the terminal .064 mm. of the oesophagus. In specimens of *O. gibsoni* examined by me, it was not seen, though from Leiper's and Breinl's descriptions of the occasional thickness of the posterior end of the oesophagus, something of the sort was evidently present in some of their specimens, this probably accounting for this exception in regard to the thickness of the oesophagus mentioned above. A glance at the averages of length and diameter of the oesophagus of *O. indica* and *O. gibsoni* will show the extent to which that in the former exceeds that in the latter. The Cloacal opening is also often further from the posterior end than in specimens of *O. gibsoni* examined by me, though the range in *O. indica* corresponds approximately with that given by other workers for *O. gibsoni*. The spicules show a certain amount of variation from other forms, most marked, however, in the case of the long spicule. This in general exceeds that of any of the other forms, the range of which it overlaps, except the greatest length of *O. gutturosa*, while its lowest range only slightly overlaps the highest range of *O. gibsoni* (Breinl)[1] and of *O. bovis*. Further, the average length of the long spicule of *O. indica* is considerably greater than the greatest length given by any one for *O. gibsoni*; though the range of thickness of the long spicule in *O. indica* is included within the total range found in *O. gibsoni*. Not only does the long spicule most nearly approximate that of *O. gutturosa* in range of length, but also in the fact that the long spicule of *O. indica* sometimes appears bifid as in *O. gutturosa*. The range in length and diameter of the short spicule agrees approximately with the total ranges found by others and myself in *O. gibsoni*, though the average, both of length and diameter of the short spicule, is greater than the average of all forms of *O. gibsoni* described. The anal papillae also show considerable variation, as was pointed out by us to occur, though to a less extent in *O. gibsoni*. The highest number of papillae described by any observer (with the exception mentioned immediately) for the latter species, was seven pairs—one preanal, three ad- (or par-) anal, one post-anal, one precaudal, and

1 If the figures given by Dr. Breinl for his male specimens of *Onchocerca gibsoni* be analysed, it will be seen that the three individuals in which the length of the long spicule overlaps the lower end of the range found in *O. indica* do not show the concurrent characteristics found in *O. indica*, except that in one case (No. 19), a length of oesophagus (1.074 mm.) which is unique and extraordinary for *O. gibsoni*, is found in a worm having a length of .210 mm. for the long spicule. Apart from this one worm there does not appear to be any regularity of variation in *O. gibsoni*, in the features referred to, as characteristic of *O. indica*. A study of these tables will emphasize the extreme and irregular variability of Australian specimens of *O. gibsoni*.

one caudal (the latter three being grouped together in those descriptions as three post-anal). In one specimen seen by Breinl, and one side of one specimen from our material, an additional papilla was present anterior to the usual preanal ones, making eight in those two isolated cases. The exact way in which these occur in the six male specimens of *O. indica* referred to is shown in Table 2 and Figure 9, where it will be seen that, with the exception of one side in one case, the smallest number of papillae is eight on each side, while nine are present nearly as often as eight; and, also, the arrangement is different from that of *O. gibsoni*, the additional papillae being adanal and caudal in position, not preanal. It is also interesting to note the occasional occurrence of only three adanal papillae, as is characteristic of *O. gibsoni*, though in two out of these three occurrences the number of postanal (four) characteristic of *O. indica* are certainly present; in the other case I could not be positive on the point. Transverse ridges are present at a distance of .005 to .006 mm. apart, cf. .0045 to .0060 mm. in *O. gibsoni* (.045 mm. given by Leiper must surely be a printer's error for .0045), and .005 to .006 mm. in *O. bovis*, and contrast Neumann's measurements for *O. gutturosa*.

In the case of the *female* worms (see Table 5) the length and thickness of *O. indica* falls within the range found in *O. gibsoni*, with the exception of the tail, which is markedly thinner; the average thickness is, however, distinctly less in *O. indica* (except in the middle of the body, while the average diameter of the tail of *O. indica* female is less than the minimum given for the tail of *O. gibsoni* female. The position of the nerve ring is constantly the same as in the highest range given for *O. gibsoni*. The length of the oesophagus in the four females of *O. indica*, in which it was measurable, always exceeds that of *O. gibsoni*, with the exception of two instances quoted by Breinl. In thickness it is fairly constant in *O. indica*, and within the range found in *O. gibsoni*. The average length and thickness is much greater in *O. indica* than in *O. gibsoni*. The position of the vulva and that of the anus varies much less than in *O. gibsoni*, and like each of the other species of Onchocerca, they fall within the range found in *O. gibsoni*, though their average positions are much nearer the tip of the head and tail respectively than in that species. The egg, when segmentation is complete, is similar in size to that of *O. gibsoni*. Eggs containing fully developed larvae are smaller than those of other species, and the larva when just freed from the egg shell is distinctly shorter, .12 to .196 mm. being the length in *O. indica*, this range overlapping that of *O. gutturosa* only. In diameter it is often only half that found in other forms. The cuticle in the female *O. indica* is distinctly thinner than in *O. gutturosa*, but twice at least as thick as in *O. gibsoni*. Moreover, the ridges of the cuticle so characteristic of the female *Onchocerca* are further apart in the middle of the body than in *O. gibsoni*, and are often much more prominent.

Comparative measurements in some of these cases may possibly be regarded as misleading, and further observations may render the range in size much nearer, still the greater number and different arrangement of the anal papillae, and the greater length of the long spicule, the generally thicker head of the male and thinner head and tail of the female, and the usually longer oesophagus in both male and female seem to call for the separation of the new species, which it will be seen is in some respects intermediate between *O. gibsoni* and *O. gutturosa*.

This being established, one expected to find, even more than a possible geographical delimitation of the species, a definite relation to the special host; and in examining the material which so recently arrived from an old Indian bullock (*Bos indicus*) from the Malay States, and from Siam humped cattle (*Bos indicus*) freshly imported into Kuala Lumpur (F.M.S.) for slaughter, I certainly expected to find that these nodules, especially in the former case, were *O. indica*, and in the latter either that, or quite possibly a form intermediate between it and *O. gibsoni*, and perhaps rendering the separation of the former from the latter untenable. To my surprise, the nodules from all of these contained worms belonging without any doubt whatever to *O. gibsoni*, the measurements, etc., of those parts mentioned above on which the separation is based being almost invariably those of average specimens of *O. gibsoni*, or even nearer the limit of the range in *O. gibsoni*, away from that which approaches the range of *O. indica*.[1] This fact corroborates some years after, and on varied material from *Bos indicus* from Siam as well as Indian bullock (*Bos indicus*) long domiciled and possibly bred in Malaya, the identification by Leiper of Ford's original material, also from an old Indian Zebu in Malaya. Johnston (1911, p. 223) quite obviously misinterprets Leiper in stating that he identified "aortic worms" in Malayan buffaloes recorded by Ford, 1902 (not 1903) as *Onchocerca gibsoni*. Leiper's identification (1911, p. 10) was of the material referred to by Daniels (1904, p. 17) as coming from "near the shoulder in bullock beef." For purposes of comparison I

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[1] See Addendum 1.

append in Tables 6 and 8, the measurements made of the worms found in these Siamese and Malayan nodules. One nodule from the Indian bullock was particularly interesting, as it was found to contain two females, 4 iv. and 4 v., and three male worms, 4 i., 4 ii. and 4 iii. No. 3 was also from the same animal, Nos. 1 and 2 being from the Siamese bulls. Also, in Table 7 and Figure 10, I have shown the number and arrangement of the anal papillae, which are emphatically not those of *O. indica*, and which vary considerably among themselves. It is interesting to note in Fig. 10 (3, left side) one solitary and unilateral example of four adanal papillae (cf. the usual four adanal papillae of *O. indica*), though even here the total number of papillae is only seven on that side.

CONCLUSIONS.

It is evident then that we have in India itself a different species of nodule-forming worm from that present in the same host species in Siam and Malaya, and in *Bos taurus* in Java and Australia. The exact geographical limitation of *O. indica*, I am unable to state further, and it is more than possible, as hinted before, that with additional material from Burma and Bengal, or elsewhere, one may find a complete mergence of the one species into the other in view of the remarkable extent of variation in each, but especially in *O. gibsoni*, and of the already known overlapping in some measurements. Still there is the most definite and constant means of separation in the association of a shorter long spicule, with a smaller number and different arrangement of anal papillae in *O. gibsoni*.

It would appear that *O. indica* is the true species of the Peninsula of India, and *O. gibsoni* as seen in these Siamese and Malayan cattle that of the Malay Peninsula, and immediately adjacent countries. Further, either (1) the *O. gibsoni* seen in Australian cattle and that of the Malayan and Siamese cattle are undergoing a process of modification parallel with one another, from *O. indica*, or (2) *O. indica* has arisen from the Malayan *O. gibsoni*; or (3), and most probably, both *O. indica* and the Malayan *O. gibsoni* have arisen together from the original form, and from this Malayan form either directly or indirectly the Australian form (introduced at least 70 years ago) has continued to be modified, its variability being quite remarkable. Although the greater length of the large spicule of *O. indica* is fairly constant, and its shorter length in the Malayan *O. gibsoni* is likewise fairly constant, the anal papillae certainly show some slight indication of a not very distant common ancestry, and there is no doubt in my mind that the host animal of the original Asiatic nodule-worm will yet be found in the Indo-Malayan gaur or wild ox (*Bos* (*Bibos*) *gaurus*), or its variety, the Seladang, or the nearly allied species, the Javan Bantin.

It is to be noted further that in the regions where these nodules occur in Australia, the number of animals affected is much greater than in similar parts of India and apparently of Malaya. This greater frequency in *Bos taurus* is undoubtedly due to its having less resistance to the development of the parasite than has *Bos indicus*, which is at least more closely allied to the presumptive original host. As to Java, I have been unable to obtain definite information as to the relative frequency of the nodules in introduced or locally bred *Bos taurus* or *Bos indicus*.[1] One is justified in the light of the evidence in expecting to find in Javan nodules characteristics closely similar to those of the Australian form, though whether they have been introduced into Java from Malaya or from India, is as yet unknown, though one would judge the former to be the more probable. It is, of course, quite probable if the Indo-Malayan gaur were the original source of infection that also the Seladang of Malaya was and is likewise infected, and that this was the immediate source of the infection of the Malayan cattle. Whether the Javan Bantin was also infected, either originally or secondarily, or whether the infection came there from the Malay Seladang or from Malay cattle, we cannot yet tell.

The greater variability of the Australian form is only analogous to what I have pointed out previously (vide supra), that the tendency is when parasites are introduced into this continent, even in their normal European (or other) domesticated host, for considerable variation to take place at times resulting in the formation of what appears to be a distinct and new species.

It is greatly to be regretted that material is not yet forthcoming from the Malay Archipelago for close comparison with these forms, as it would appear from the above that the entrance of the nodule-worm into Australia cannot be credited to the introduction of Indian cattle into the Northern Territory, but rather to that of cattle from further East, and so quite probably from Timor—as previously emphasised—sometime between 1824 and 1840. It is to hoped that information and material from Timor may soon be forthcoming, in which one may expect to find a link between the Malayan and the Australian *O. gibsoni*.

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1 See Addendum 2.

The contention of Dr. Gilruth and myself (1912, p. 24) that the buffalo was probably not the means of introduction—since the buffalo hunters of the Northern Territory (who used the brisket for food and the skins for export) have never seen these nodules—is strongly supported by the fact that both in Java and in India, whence buffalo have been imported into Australia, although nodules are present, they are found closely attached to the skin, a fact which was unknown to us at that time.[1]

The intermediate character of *O. indica* in some respects between *O. gibsoni* and *O. gutturosa* suggests the possible origin of the latter form from *O. indica* at some earlier period in some way not yet known.

No definite evidence is forthcoming from any source as to the life-history of these forms.

SUMMARY.

1. Worm-nodules in the connective tissues, caused by species of Onchocerca are now known to exist in cattle and associated animals as follow :—

Place.	Host Animal.	Previous record.	Present record.[2] 40-90°,
Java	Bos taurus	O. gibsoni (De Does, etc.)	O. gibsoni (?)
,,	Bos indicus	—	O. sp. (?)
,,	Hybrids of above	—	O. gibsoni (?) (subcutaneously)
,,	Bos bubalis	—	O. sp. (?) (subcutaneously)
,,	Bos banteng	—	—[3]
Sumatra	Bos taurus	—	O. gibsoni (?)
,,	Bos indicus	—	O. sp. (?)
,,	Bos bubalis	—	O. sp. (?) (subcutaneously)
,,	Bos banteng	—	—
Bali	Bos taurus	—	O. gibsoni (?)
Madura	—	—	—
Lombok	—	—	—
Timor	—	—	—
Poeloe Laoet	Bos indicus	—	O. sp. (?)
Philippine Is.	Bos indicus (?)	—	—
,, ,,	Bos bubalis	—	—

1 See Addendum 1.

2 The mark (?) in this column indicates that, although I have now evidence of the existence of the nodules as indicated, either the material available is useless for exact specific determination, or else material for this purpose is not yet in hand.

3 The mark — indicates that such nodules are as yet unknown in these cases.

Place.	Host Animal.	Previous record.	Present record. 40–90%
Hawaiian Is.	Bos taurus	—	—
" "	Bos bubalis	—	—
Singapore	Bos indicus	—	—
"	Bos bubalis	—	—
Kuala Lumpur	Bos indicus	O. gibsoni (Daniels, Ford, Leiper)	O. gibsoni
" "	Bos bubalis	—	O. sp. (?)
Penang	Bos indicus	—	O. gibsoni
"	Bos bubalis	—	O. sp. (?)
Malaya	Bos taurus hubbacki	—	—
Siam	Bos indicus	—	O. gibsoni
Burma	Bos indicus	—	O. sp. (?)
"	Bos bubalis	—	O. sp. (?)
Assam	—	—	—
Bengal	—	—	—
Bihar and Orissa	—	—	—
Ceylon	Bos indicus	—	O. indica n.sp. (?)
"	Bos bubalis	—	O. indica n.sp. (?)
Madras	Bos indicus	—	O. indica n.sp.
"	Bos bubalis	—	—
Central Provinces and Berar	Bos indicus (.5%)	—	O. indica n.sp.
Central Provinces and Berar	Bos bubalis	—	O. indica n.sp. (?) (subcutaneously)
United Provinces of Agra and Oudh	Bos indicus (2–20%)	—	O. indica n.sp.
United Provinces of Agra and Oudh	Bos bubalis	—	O. indica n.sp. (?) (subcutaneously)[1]
Punjaub	Bos indicus	—	O. indica n.sp.
"	Bos bubalis	—	O. indica n.sp. (?)
"	Camelus bactrianus	O. fasciata (Leese, Railliet)	—
Sind, Baluchistan and Rajputana	Bos indicus	—	—
Sind, Baluchistan and Rajputana	Bos bubalis	—	—
Bombay Presidency	Bos indicus	—	—
" "	Bos bubalis	—	—
Egypt	Bos indicus (?)	—	O. sp. (?)
"	Bos bubalis	—	—
"	Camelus dromedarius	O. fasciata (?) (Mason)	—
Sudan	Bos indicus (?)	—	—
"	Bos bubalis	—	—

[1] See Addendum 1.

Place.	Host Animal.	Previous record.	Present record. 40-90°.
Algeria and Tunis -	Bos taurus (?) -	O. gutturosa (Neumann) -	—
Italy -	Bos taurus -	— -	—
Austria -	,, ,, -	— -	—
Germany -	,, ,, -	— -	—
Denmark -	,, ,, -	— -	—
Switzerland -	,, ,, -	— -	—
France -	,, ,, -	O. bovis (Piettre) not nodule forming -	O. bovis
Great Britain -	,, ,, -	— -	—
United States of America -	,, ,, -	O. (?) lienalis (Stiles) in capsule of spleen -	—
United States of America -	Bos indicus and hybrids -	— -	—
South America -	Bos taurus -	— -	—
,, -	Bos indicus and hybrids -	— -	—

2. Allied parasitic worms are present as previously known in the main aortae of cattle and buffalo, as follow :—

Place.	Host animals.	Parasite.
Java -	Bos indicus (rarely) -	Elaeophora poeli
,, -	Bos bubalis -	,, ,,
Sumatra -	Bos indicus -	Onchocerca armillata
,, -	Bos indicus (rarely) -	E. poeli
,, -	Bos bubalis -	,, ,,
,, -	Bos bubalis (rarely) -	O. armillata
Malay States -	Bos indicus -	,, ,,
,, ,, -	Bos indicus (rarely) -	E. poeli
,, ,, -	Bos bubalis -	,, ,,
,, ,, -	Bos bubalis (rarely) -	O. armillata
Annam -	Bos indicus -	,, ,,
,, -	Bos indicus (rarely) -	E. poeli
,, -	Bos bubalis -	,, ,,
,, -	Bos bubalis (rarely) -	O. armillata
India -	Bos indicus -	,, ,,
,, -	Bos indicus (rarely) -	,, ,,

3. The new species herein described from cattle in India,[1] while overlapping in some respects the allied species *O. gibsoni* and *O. gutturosa*, differs from those, in the association in the male worm of a certain range of length of the larger spicule intermediate between those two species with a greater number of differently arranged anal papillae than is found in either of them, and from

1 And see Addendum 1, *re* its presence in buffalo in India.

O. gibsoni further in the thicker head of the male, the thinner head and tail of the female, and the generally longer oesophagus in both.

4. The limitations of these species appear to be geographical rather than otherwise:—thus, *O. gutturosa* is characteristic of Northern Africa, presumably in *Bos taurus*; *O. indica* is found in *Bos indicus*[1] in the peninsula of India, and *O. gibsoni* in *Bos indicus* in the Malay Peninsula, and as a very variable form in *Bos taurus* in Australia, and most probably the Malay Archipelago. The occurrence of such nodule-forming worms is probably much wider than is at present suspected.

5. The evidence supports the theory that worm-nodules were introduced probably by cattle from the Malay Archipelago, and not by cattle from India, and therefore almost certainly they came in the cattle brought from Coepang in Timor in 1824 or 1840.

6. The Buffalo cannot be implicated so far.

7. The original parasite and its original host are probably to be sought for in the Indo-Malayan gaur or wild ox (*Bos (Bibos) gaurus*), from which also *O. gutturosa* may be derived indirectly through *O. indica*.

8. No evidence is forthcoming as to the life-history, from any source.

In conclusion, I wish to express my thanks to Professor Baldwin Spencer and to Professor H. A. Woodruff for permission to use their laboratories in this University for the purpose of this research, and to them and to Dr. T. S. Hall and Mr. H. R. Seddon, for their kind interest and ready help.

ADDENDUM 1.

Since the foregoing report was presented, I have received a further supply of nodules (a) from cattle (*Bos indicus*) from Southern Siam, sent by Mr. S. L. Symonds from Serembam, F.M.S., and (b) from 3 Indian buffaloes (*Bos bubalis*) from Mr. C. W. Wilson, from Aligarh, United Provinces, India.

(a) These are typical nodules of *O. gibsoni*, with the characteristic dense fibrous capsule much thicker than in *O. indica*. In one nodule no male could be found, although the female contained fully developed eggs and larvae. Caseation was considerably advanced in parts of this nodule, and neither the head nor the tail of the female could be found. In the second nodule there was much

[1] And see Addendum 1, *re* its presence in buffalo in India.

extravasation of blood into the worm-tunnels, and the anterior end of the female and most of the male were caseated. In the third nodule there was also much extravasation into the worm-tunnels, and caseation of nodule and worms, but the heads of both male and female, and the tail of the male, were obtained, and served but to confirm the observations made in the body of this report on nodules from Siam, provided by Mr. T. A. Ford, these worms being certainly *O. gibsoni*.

One or two peculiarities in this specimen are specially noteworthy, the remarkable distance (1.24 mm.) of the opening of the vulva from the anterior end, even for *O. gibsoni*, in which it is often so much greater than in *O. indica* (cf. Leiper's description of 1.23 mm.). Also in the male, are found a remarkably short, thin oesophagus (length .314 mm., and diameter .0094 mm.), and a very short "long" spicule (.138 mm.), which are quite unique even for *O. gibsoni*. These features, with the abnormally thin head and body of the male, emphasise the statement made in connection with the previous material of *O. gibsoni* from Siam, that where any special variations from the average measurements of *O. gibsoni* exist therein, those variations are in an opposite direction to those measurements which are characteristic of *O. indica*. A similar statement is true here of the anal papillae, which are as follow:

R., preanal 0, adanal 2, postanal 1, caudal 2;
L., preanal 0, adanal 2, postanal 1, caudal 2,

making a total of five on each side—again a smaller number than is usually found in *O. gibsoni*.

(b) The nodules from the buffalo differ somewhat in external appearance from those found in cattle, the capsule of free nodules being at times much thicker than in *Bos indicus*, and the fibrous tissue much less compacted in the outer part of the capsule than in either *Bos taurus* or *Bos indicus*, though at the same time it is very tough and resistant to cutting or tearing. At other times, a continuous capsule wall is absent, only a trifling amount of fibrous tissue being present, and then forming long independent strands. A quantity of muscular tissue, more or less degenerated, surrounds the nodule in place of the ordinary capsule. Very frequently the nodule is closely united with the skin (see Fig. 12). There may be then also no true capsule wall, the nodule (=worm-area only) lying in the subcutaneous muscular tissue. There is present a very small amount of white fibrous tissue forming long bundles emerging irregularly from the worm-area and mingling with the fibrous tissue of the subdermal layers. The trabeculae forming the walls of the worm-tunnels have a considerable quantity of fibrous tissue. These nodules are inseparable except by cutting from the skin, as contrasted with the smooth surfaced compact capsule of *O. gibsoni* in either *Bos taurus* or *Bos indicus*, or of *O. indica* in *Bos indicus*. This firm attachment to the skin in the buffalo is attributed by Mr. Wilson "to the density of the subcutal structures in that animal." He also states that "the 'nests' show more tendency to calcify quickly in the buffalo than in cattle," but that he has "failed to notice any variation in colour" such as was mentioned by one observer. The hairlessness of the skin over the nodule, noted by the same observer, is apparent slightly, in one of the specimens, but I cannot detect any thinning of the skin in that position. These nodules were taken from the vicinity of the sternum in three buffaloes, 8, 11 and 12 years old respectively, considerable caseation being present in several, e.g., in II., in which the head and tail of the female were not found, and III., in which the head of the male is missing. (See Tables 9, 10 and 11.) Nodule II. had two males with the one female, while one male only was present in each of the others. Commencing caseation also accounts for some uncertainty in regard to the anal papillae in the males II. 1 and II. 2, while the tail of the male III. was much distorted, the long spicule having torn through the postanal tissues.

Reference to the tables (9, 10, and 11) herewith added, and their comparison with those previously given will be found to establish the conclusion that these nodules in *Bos bubalis* in India are caused by the same species of worm as causes those in *Bos indicus* in India, viz., *O. indica*. In the male the thicker anterior end, the longer thicker oesophagus, the slightly more anterior cloacal opening, the thick and longer large spicule characteristic of *O. indica* are all present, while in I., and as far as can be seen in II. I and II. 2, the anal papillae are such as are found in that species. In the female, the thinner anterior end characteristic of *O. indica* is found, with a fairly long oesophagus, and also a more posteriorly placed anus, but the other features are not so characteristic, though still such as are found in other specimens of *O. indica*.

It will be seen that this further material entirely confirms the conclusions arrived at in the body of this Report (1) that the nodule worm of India is a new species different from that of Australia, (2) that the nodule worm of Siam or Malaya is similar to that of Australia, (3) that the Indian buffalo has not been the carrier of this parasite into Australia, and (4) that Malaya or the Malay Archipelago has been the source of the infection of Australian cattle.

ADDENDUM 2.

Since the foregoing has been printed, I have received from Dr. L. de Blieck, Director of the Government Veterinary School at Buitenzorg, Java, a statement by Dr. Smit of the results of the enquiries made by the Dutch authorities at my request, into the occurrence of worm nodules in Netherlands India.

The following is a translation of this report:—"I have often observed the 'worm-nodules' caused by *Onchocerca gibsoni* at the abattoir at Buitenzorg. They have been seen in native as well as in cross-bred cattle (i.e., of native with European, Australian, and Bengal (Zebu) cattle). They have been mostly found in cattle originating from Gombong, and Poerworedjo, principally in Javanese cattle. Several times, however, they have been seen in animals originating from the Buitenzorg district and Bantam, also in cross-bred Australian and in the few Australian cattle killed at Buitenzorg.

"At Batavia, Mr. Jenne found them to occur in nearly every animal killed (these being imported Australian).

"In native cattle they were only found in the breast muscles; in Australian cattle at Batavia, however, they were found also in the abdominal muscles in front of the stifle.

"Out of about 4000 karbouws inspected, two were found to have one worm-nodule each—in both cases in the breast muscles—which macroscopically differed in no way from the worm-nodules in cattle. It is seen from this, that they only very rarely occur in karbouws. Mr. Solms was able to inform me that they have been repeatedly found by him in the residencies of Rembong and Kediri, in the breast muscles of native cattle. He also found them in the karbouws, but only very seldom.

"Finally, it may be stated that Mr. de Does a short time ago personally intimated to me, that he had also seen them in cattle at Poeloe Laoet, an island at the S.E. point of Borneo.

"Briefly stated, it may therefore be accepted that worm-nodules caused by *Onchocerca gibsoni* occur over the whole of Java in native as well as cross-bred native cattle, and in karbouws. Further, that the said disease has also been found on other islands (Poeloe Laoet) of the Archipelago."

The term, native cattle, employed in Dr. Smit's report, cannot obviously refer to the original wild ox of Java, the Bantin (*Bos (Bibos) banteng*). It is, however, undoubtedly applied to animals of the *Bos indicus* type bred in Java, and possibly the direct descendants—either pure bred or hybrid—of the Bantin, which, as pointed out above (see p. 3), is regarded as being, at least, closely allied to the ancestor of the Zebu.

Material has been sent to me from Java, but is not yet to hand. The results of its examination, and the relationship of the nodule worms in the Javanese *Bos indicus*, in the hybrid *Bos indicus* (Javanese X Bengalese), and in the Javanese Karbouw, will form the subject of a later report by myself.

In reference to the Indian cattle, *Bos indicus*, imported into the United States of America from infected areas in India (see p. 14), I am informed by Dr. B. H. Ransom that so far as the officers of the Bureau of Animal Industry have been able to make any observations, worm-nodules have not been discovered.

26th May, 1915.

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Fig. 11. Tails of three male specimens of *O. indica*, from *Bos bubalis*, India.
Fig. 12. Showing relationship of superficial nodule in *Bos bubalis* to skin and subdermal tissues—microphotograph.

All other figures than photographs outlined by camera lucida.

TABLE 1.—MALES FROM NODULES FROM INDIAN CATTLE.

Males.	Bi.	Bii.	C.	Di.	Dii.	E.	Range.	Average.
Length of male	cm. 5·3	cm. 9·3	cm. ? 5·5	cm. 6·2	cm. 4·5	cm. 3·38	cm. 3·38—9·3	cm. 5 69
Diameter ·15 mm. from anterior end	mm. ·079	mm. ·069	mm. ·075	mm. ·069	mm. ·075	mm. ·062	mm. ·062 — ·079	mm. ·071
Diameter at middle	·193	·204	·220	·207	·175–·183	·207	·175 — ·220	·198
,, ·5 mm. from anterior end	·100	·096	·103	·103	·103	·082	·082 — ·103	·098
,, level of cloacal opening	·050	·062	·062	·051	·054	·042	·042 — ·062	·053
Excretory pore from anterior end	?	?	?	? ·219	? ·282	?	? ·219 — ·282	? ·250
Nerve ring from anterior end ..	·188	·172	·188	·172	·188	·188	·172 — ·188	·182
"Cardia" from anterior end ..	1·08	"Cardia"	1·16	1·00	·877	"Cardia"	·877 —1·16	1·03
,, length	·069	ill-	·062	·062	·062	not	·062 — ·069	·064
,, diameter	·069	defined.	·053	·053	·047	seen.	·047 — ·060	·053
Œsophagus, length	1·15	1·08	1·22	1·067	·942	·847 +	·847+ —1·22	1·051 +
,, diameter	·033	·037	·039	·036	·039	·031	·031 — ·039	·036
Cloacal opening from posterior end	·062	·086	·083	·072	·062	·062	·062 — ·086	·070
Spicules—length .. long	·266	·274	·266	·262	·266	·207	·207 — ·274	·257
short	·083	·094	·091	Absent.	·086	·080	·080 — ·094	·087
,, diameter .. long	·012	·0117	·013	·011	·0124	·0094	·0094 — ·0124	·0116
short	·012 (flat)	·007	·0078	Absent	·0062	·0062	·0062 — ·012	·0078
Cuticle thickness	..	..	..	..	..	..	·003 — ·004	..
Transverse ridges apart ..	..	..	..	..	..	..	·005 — ·006	..
Anal papillæ (see Table 2 for details)	R. L. 7. 9.	R. L. 8. 9.	R. L. 9. 8.	R. L. 8. 9.	R. L. 9. 9.	R. L. 8. 9.	R. L. 7–9. 8–9.	..

TABLE 2.—ANAL PAPILLÆ OF MALES FROM NODULES FROM INDIAN CATTLE.

—	Bi.		Bii.		C.		Di.		Dii.		E.		Range.	
Side of Body.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L
Preanal	?	1	1	1	1	1	1	1	1	1	1	1	1	1
Par- or ad-anal ..	2+2	1+3	2+2	3	3+1	3+1	2+1	3+1	3+1	2+2	3	2+2	3−4	3−4
Postanal	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Precaudal ..	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Caudal	1	2	1	2	2	1	2	2	2	2	1+1	2	1−2	1−2
Totals ..	7.	9.	8.	8.	9.	8.	8.	9.	9.	9.	8.	9.	7−9.	8−9.

[In this table, the figures succeeding the sign + indicate the number of papillæ smaller than those preceding the sign.]

TABLE 3.—FEMALES FROM NODULES FROM INDIAN CATTLE.

Females.	A.	B.	C.	D.	E.	Range.	Average.
Length of female	..	..	cm. 100	..	..	cm. 100+	..
	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Diameter ·15 mm. from anterior end ..	·096—·117	·082	·075	·093	·069	·069 — ·117	·089
,, at middle	·38	·47	·527	·483	·63	·38 — ·63	·47
,, just in front of vulva	·103	·124	·096	·114	·096	·096 — ·124	·106
,, level of anus	..	(Not seen)	·189	·172	·125	·125 — ·189	·162
Excretory pore from anterior end	..	(Not seen)	..	..	..	(Not seen)	..
Nerve ring from anterior end	..	·188	·188	·188	?	·188	·188
" Cardia " from anterior end	..	1·03	1·05	1·13	?	1·03 — 1·13	1·07
,, length	..	(Ill-defined)	Very	·062	?	·062	·062
,, diameter	..	·055	slight	·045	?	·045 — ·055	·050
Œsophagus, length	..	1·17	1·1	1·20	1·44	1·1 — 1·44	1·23
,, diameter	..	·031	·031	·034	·031	·031 — ·034	·032
Vulva from anterior end	·63	·62	·60	·55	·75	·55 — ·75	·63
Anus from posterior end	..	(Not seen)	·232	·125	·204	·125 — ·232	·187
Cuticle thickness (middle)	..	..	..	..	..	·0209— ·024	..
Spiral ridges (middle)	..	..	..	..	..	·138 (apart)	..
Segmented ovum	..	..	..	..	..	·026 × ·017	..
Eggs containing developed larva	·0314 × ·0196	·0251 × ·0172	·0282 × ·0235	·0329 × ·0251	·0314 × ·0204	·0251—·0329 × ·0172—·0251	·0298 × ·0211
Larva just escaped from egg	..	·12 × ·0021	·182 × ·0023	·126 × ·0021	·196 × ·0024	·12 — ·196 × ·0021—·0024	·156 × ·0022

Table 4.

Males.	Cleland and Johnston.	Breinl.	Leiper.	Gilruth and Sweet.	Average of own Measurements.	Average of all observers' Measurements.
	Range of Measurements in Species of Onchocerca found in the Subcutaneous and Intermuscular Connective Tissues of Cattle. Onchocerca gibsoni.					
Length of male	..	cm. 3·316—5·5 at ·175 mm.	cm. 5	cm. 3·8—5·3	cm. 4·6	cm. 4·297
Diameter ·15 mm. from anterior end	mm. ..	mm. ·042—·066	mm. ..	mm. ·052 — ·062	mm. ·059	mm. ·054
,, at middle	·15 at ·65	·143—·196	·15	·141 — ·151	·145	·167
,, ·5 mm. from anterior end	·085	..	..	·069 — ·082	·078	..
,, at level of cloacal opening	..	·035—·056	·04	·042 — ·051	·045	·044
Cervical dilatation	..	..	..	..	..	..
Excretory pore from anterior end	..	·238—·280	..	·251	·251	·256
Nerve ring from anterior end	·18	·140—·175	·2	·172 — ·188	·180	·164
"Cardia" from anterior end	..	..	..	..	..	..
,, length	..	..	..	..	..	..
,, diameter	..	[? ·075]	[? ·05]	..	..	..
Œsophagus length	..	·484—1·074	·8	·65 — ·72	·68	·742
,, diameter	..	·015—·075	·02 — ·05	·0155	·0155	·020
Cloacal opening from posterior end	·072*	·052—·087	·07	·048 — ·062	·054	·066
Spicules—length { long	·14 and ·197	·143—·220	·18	·148 — ·155	·153	·177
Spicules—length { short	·047 and ·082	·063—·085	·08	·078 — ·094	·083	·075
,, diameter { long	..	·007—·014	·005	·0078—·010	·0089	·0083
,, diameter { short	..	·006—·008	·002—·005	·0061—·0078	·007	·0068
Cuticle thickness	..	..	..	·0033—·0047	..	..
Transverse ridges apart	100 to ·5 = ·005	..	·045 [? G.S.]	·0045—·0060	..	..
Oral papillæ and lips	..	No papillæ, 3 lips	..	3 lips and 3 papillæ	..	..
Anal papillæ	R. L.	R. L.	R. L.	R. L.		
Side of body					..	..
Preanal	0 0	1–2 1–2	0 0	1 1–2	..	..
Par- or adanal	4 4	3 3	4 4	3 3	..	..
Postanal	2 2	3 3	0 0	1 1	..	..
Caudal	.. ..	.. ..	2 2	2 2	..	..

* ·65 mm. in same paper is obviously an error in transcription.

TABLE 4—*continued.*

Males.	Range of Measurements in Species of Onchocerca found in the Subcutaneous and Intermuscular Connective Tissues of Cattle.				Other Species of Onchocerca.				
	O. indica.		O. gutturosa.	O. bovis.	O. fasciata.	O. volvulus.	O. reticulata.	O. cervicalis.	O. armil-lata.
	Range.	Average.							
Length of male	cm. 3·38—9·3	cm. 5·69	cm. 2·83—3·38	cm. 4—5·5	unknown	cm. 2·0—4·5	cm. 27	(?)	cm. 8·87
	mm.	mm.	mm.	mm.		mm.	mm.	mm.	mm.
Diameter ·15 mm. from anterior end	·062 — ·079	·071	..	..	..	..	..	..	..
,, at middle ..	·175 — ·220	·198	·091 — ·105 at ·45 mm.	·085— ·095	..	·150— ·200	·150	·175— ·20	·190
,, ·5 mm. from anterior end	·082 — ·103	·098	·35 [?·035 G.S.] at ·45 mm. post	..	..	..	..	..	..
,, at level of cloacal opening	·042 — ·062	·053	·058	..	..	..	..	..	..
Cervical dilatation ..	..	..	·08 at ·35 fr. ant.	..	..	..	..	..	..
Excretory pore from anterior end	·219 ? — ·282?	? ·250	..	..	..	..	..	..	..
Nerve ring from anterior end	·172 — ·188	·182	..	..	..	..	..	..	..
"Cardia" from anterior end	·877 — 1·16	1·03	..	..	..	..	..	..	..
,, length	·062 — ·069	·064	..	..	..	..	..	..	..
,, diameter ..	·047 — ·060	·053	..	..	..	..	..	..	..
Œsophagus length ..	·847+?—1·22	1·051+	·95	·75 — ·80	..	..	..	2·3— 2·4	..
,, diameter ..	·031 — ·039	·036	very thick at cervical dilatation	..	..	..	..	..	..
Cloacal opening from posterior end	·062 — ·086	·07	. . .	..	..	..	..	..	..
	sometimes bifid	point	bifid point	pointed					
Spicules—length { long ..	·207 — ·274	·257	·225 — ·295	·180— ·210	..	·166— ·230	·200— ·260	·330— ·350	·195
{ short	·082 — ·094	·087	·075 — ·088	·065— ·075	..	·080— ·082	·100— ·120	·100— ·120	·126
,, diameter { long ..	·0094 — ·0124	·0116	..	..	..	..	..	..	..
{ short	·0062 — ·012	·0078	..	..	..	..	..	..	..
Cuticle thickness	·003 — ·004	·0035	·004	..	..	..	..	..	..
Transverse ridges apart ..	·005 — ·006	·0055	{ only striæ ·0015— ·0018	·005— ·006	..	..	..	..	..
Oral papillæ and lips ..	3 lips and 3 papillæ	..	2+2 papillæ	..	..	..	..	..	..
Anal papillæ { Side of body ..	R. L.	..	R. L.	R. L.	..	R. L.	R. L.	R. L.	..
Preanal ..	1 1	..	0 0	0 0	..	0 0	2 3	1 1	?
Par- or adanal	3–4 3–4	..	4 3–4	4 4	..	4 4	4 4	4 4	..
Postanal ..	1 1	..	2 2	1 1	..	0 1	0 2	2 2	?
Caudal ..	1+1–2 1+1–2	..	1 1	2 2	..	2 2	1 1	2 2	..

TABLE 5.

Females.	Range of Measurements in Species of Onchocerca found in the Subcutaneous and Intermuscular Connective Tissue of Cattle.					
	Onchocerca gibsoni.					
	Cleland and Johnston.	Breinl.	Leiper	Gilruth and Sweet.	Average of own Measurements.	Average of all observers' Measurements.
Length of Female	cm. 97	cm. 77—133	..	cm. 52·6—140·3	cm. 94·3	cm. 73
Diameter ·15 mm. from anterior end	mm. ..	mm. ·049 — ·143 · at ·18 mm.	mm. ·1 ? here	mm. ·078 — ·123	mm. ·101	mm. ·104
,, at middle	·43 — ·38	·4—·6	·4—·5	·37 — ·45	·40	·43
,, just in front of vulva	·16	..	..	·106 — ·207	·138	..
,, at level of anus	..	·175 — ·245	..	·207	·207	·188
Cervical dilatation—diameter	..	..	..	..	..	..
Excretory pore from anterior end	..	·175 — ·294	..	·358 — ·379	·368	·301
Nerve ring from anterior end	..	·102 — ·182	..	·142 — ·188	·170	·171
" Cardia " from anterior end	..	..	..	·41 — ·86	·66	..
,, length	..	..	..	·031 — ·062	·039	..
,, diameter	..	..	..	·031 — ·040	·033	..
Œsophagus, length	..	·615 —1·424	1	·52 — ·92	·71	·758
,, diameter	..	·0175— ·052	·03	·02 — ·021	·0206	·027
Vulva from anterior end	·8	·332 —1·176	1·23	·46 —1·138	·689	·721
Anus from posterior end	..	·175 — ·402	..	·175 — ·207	·191	·250
Cuticle thickness	..	..	..	·0078— ·0109	·0093	..
Spiral ridges apart	6-8 in ·5 mm.	..	..	..	..	..
Oral papillæ and lips	..	3 lips and 3 papillæ	..	3 lips, each with 1 papilla	..	..
Caudal papillæ	..	3	..	..	..	..
Ovum just segmented	..	..	..	·026 × ·017	..	..
Egg containing developed larva	·03 × ·045	..	·03 × ·04	·043 — ·045 × ·03 — ·039	..	..
Larva just escaped from egg	·22 — ·27 × ·0033— ·004	..	·22 × ·003	·23 — ·35 × 0031— ·0041	..	..

TABLE 5—*continued.*

Females.	Range of Measurements in Species of Onchocerca found in the Subcutaneous and Intermuscular Connective Tissue of Cattle.				Other Species of Onchocerca.				
	O. indica.		O. gutturosa.	O. bovis.	O. fasciata.	O. volvulus.	O. reticulata.	O. cervicalis.	O. armillata.
	Range.	Average.							
Length of Female	cm. 100 mm.	. . mm.	cm. 55+ mm.	cm. 26+ mm.	? mm.	cm. 60—70+ mm.	cm. 75+ mm.	? mm.	? mm.
Diameter ·15 mm. from anterior end	·069 — ·117	·089	·081 ? here	. .	. .	. .	. .	. .	. .
,, at middle . .	·38 — ·63	·47	·3	·26 — ·29	·40— ·475	·30— ·35	·30	·40	·40 — ·45
,, just in front of vulva	·096 — ·124	·106	. .	. .	. .	. .	. .	. .	. .
,, at level of anus . .	·125 — ·189	·162	. .	. .	. .	. .	. .	. .	. .
Cervical dilatation, diameter	. .	. .	·09 — ·1	. .	. .	. .	. .	. .	. .
Excretory pore from anterior end	. .	. .	. .	. .	. .	. .	. .	. .	. .
Nerve ring from anterior end	·188	·188	. .	. .	. .	. .	. .	. .	. .
"Cardia" from anterior end	1·03 —1·13	1·07	. .	. .	. .	. .	. .	. .	. .
,, length	·062	·062	. .	. .	. .	. .	. .	. .	. .
,, diameter . .	·045 — ·055	·050	. .	. .	. .	. .	. .	. .	. .
Œsophagus, length . .	1·1 —1·44	1·23	1·15	·82 — ·85	. .	. .	3·5	2·4	. .
,, diameter . .	·031 — ·034	·032	. .	. .	. .	. .	. .	. .	. .
Vulva from anterior end . .	·55 — ·75	·63	·55	63 — ·65	. .	·55— ·76	·40— ·58	·275— ·410	1·150—1·300
Anus from posterior end . .	·125 — ·232	·187	·2	. .	. .	. .	. . .	. .	. .
Cuticle thickness	·0209— ·024	. .	·035— ·047	. .	. .	. .	. .	. .	. .
Spiral ridges apart . .	·138	. .	. .	. .	. .	. .	. .	. .	. .
Oral papillæ and lips . .	3 lips each with 1 papilla	. .	2 + 2 papillæ	. .	. .	. .	. .	. .	. .
Caudal papillæ	. .	. .	. .	. .	. .	. .	. .	. .	. .
Ovum just segmented . .	·023 × ·017	. .	. .	. .	. .	. .	. .	. .	. .
Egg containing developed larva	·0251— ·0329 × ·0172— ·0251	·0298 × ·0211	·035— ·045 × ·028— ·035	·048— ·053 × ·034— ·036	. .	. .	. .	. .	. .
Larva just escaped from egg	·12 — ·196 ×0021 — ·0024	·156 × ·0022	·170— ·195 × ·004	·230— ·265 × ·0055	. .	. .	. .	. .	. .

TABLE 6.—MALES FROM NODULES FROM SIAMESE (1 AND 2) AND MALAYAN CATTLE (3 AND 4).

Males.	1	2	3	4i.	4ii.	4iii.	Range.	Average.
	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.
Length of male	5	4·3	4·5	3·5+	4·8	4·3	3·5 + – 5	4·4+
	mm.	mm.	mm.	mm.	mm.	mm.	mm. — mm.	mm.
Diameter ·15 mm. from anterior end	·062	·034	·055	·044	·055	·055	·034 — ·062	·051
,, at middle	·148	·180	·168	·125	·125	·157	·125 — ·180	·150
,, ·5 mm. from anterior end	·069	·055	·079	·062	·075	·075	·055 — ·079	·069
,, level of cloacal opening	·043	·040	·039	·0314	·039	·039	·031 — ·043	·038
Excretory pore from anterior end ..	..	..	..	..	..	..	..	..
Nerve ring from anterior end ..	·188	·172	·188 ?	·157	..	?	·157 — ·188	·176
" Cardia " from anterior end ..	..	..	..	..	..	..	..	..
,, length	..	..	..	..	..	..	..	..
,, diameter	..	..	..	..	..	..	..	..
Œsophagus, length	·94	1·1	·828	·828	·690+	·82	·690+ — 1·1	·867+
,, diameter	·023 — ·028	·015	·018	·019	·018	·015	·015 — ·023	·019
Cloacal opening from posterior end ..	·062	·062	·062	·062	·067	·070	·062 — ·070	·064
Spicules—length .. .. {long	·152	·188	·190	·172	·172	·188	·152 — ·190	·177
{short	·078	·062	·070	·065	·070	·078	·062 — ·078	·070
,, diameter .. {long	·009	·007	·011	·007	·008	·007	·007 — ·011	·008
{short	·005	·006	·003	·003	·004	·004	·003 — ·006	·004
Cuticle thickness	·0039	·0031	·0055	·006	·006	·004	·003 — ·006	·0047
Transverse ridges apart	·005	·005	·005	·005	·005	·005	·005	·005
Anal papillæ (see Table 7 for details)	R. L.	R. L.	R. L.	R. L.	R. L.	R. L.	R. L.	..
	7. ?.	6. ?.	5+1 ?. 7.	5+?. 7.	4+?. 7.	6. 5+1 ?.	4+?–7. 7–8.	..

TABLE 7.—ANAL PAPILLÆ OF MALES FROM SIAMESE (1 AND 2) AND MALAYAN CATTLE (3 AND 4).

—	1		2		3		4i.		4ii.		4iii.		Range.	
Side of Body	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.
Preanal	1	..	—	.	—	1	?	1	—	1	—	—	1	1
Par- or ad-anal ..	3	..	3	..	3	2+2	2	3	2	3	3	3	2—3	3—4
Postanal	1	?	1	?	1	—	1	1	?	1	1	1	1	1
Precaudal ..	1	..	1	..	1	1	1	1	1	1	1	1	1	1
Caudal	1	..	1	..	1 ?	1	1	1	1	1	1	1 ?	1	1
Totals ..	7.	?.	6.	?.	5+1 ?.	7.	5+ ?.	7.	4+ ?.	7.	6.	5+1?.	4+?—7.7—8.	

[In this table, the figures succeeding the sign + indicate the number of papillæ smaller than those preceding the sign. In 1 L and 2 L, the papillæ were much obscured.]

TABLE 8.—FEMALES FROM NODULES FROM SIAMESE (1 AND 2) AND MALAYAN CATTLE (3 AND 4).

Females.	1	2	3	4iv.	4v.	Range.	Average.
Length of female	The head and tail of this worm could not be found.		(Not taken out whole.)				
		mm.	mm.	mm.	mm.	mm.	mm.
Diameter ·15 mm. from anterior end..		·089	·079	·069	·103	·069 — ·103	·085
,, at middle		·517	·607	·607	·600	·517 — ·607	·583
,, just in front of vulva ..		·124	·124	·103	·131	·103 — ·131	·120
,, level of anus		·207	·147	..	..	·147 — ·207	·177
Excretory pore from anterior end ..		..	..	·282	·282	·282	·282
Nerve ring from anterior end ..		·157	·172	·188	·157	·157 — ·188	·168
"Cardia" from anterior end ..		..	..	..	..	..	..
,, length		..	..	..	..	..	..
,, diameter		..	..	..	..	..	..
Oesophagus, length..		·89	·76+?	·879	·966	·76+ — ·96	·874+
,, diameter		·017	·025	·017	·024	·017 — ·025	·021
Vulva from anterior end		·45	·66	·55	·56	·45 — ·66	·55
Anus from posterior end		·276	·414	..	..	·276 — ·414	·345
Cuticle, thickness		·007	·006	·013	·005	·005 — ·013	·008
Spiral ridges apart		·110	·083	·110	·106	·083 — ·110	·105
Segmented ovum		..	·0314 ×	·0188	·026 × ·017	·026 — ·0314 × ·017 — ·0188	·0287 × ·0179
Eggs containing developed larva ..		..	..	..	..	..	..
Larva just escaped from egg ..		·22 × ·0047	·23 × ·005	..	·188 × ·0039	·188 — ·23 × ·0039 — ·005	·209 × ·0044

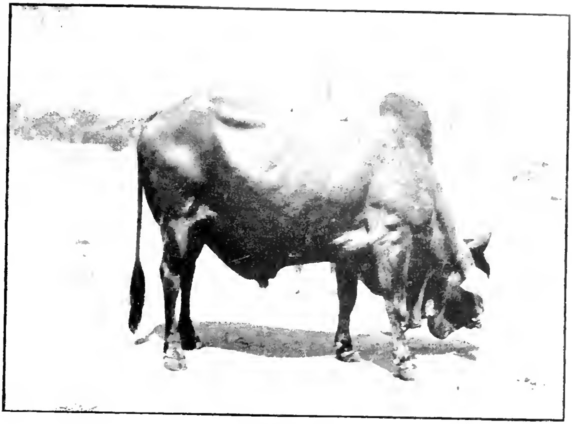


Fig. 1.

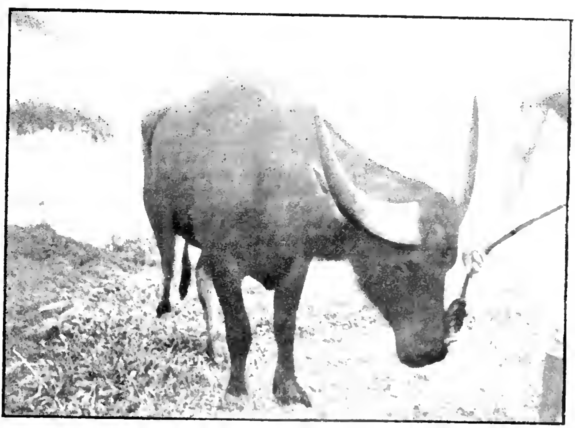


Fig. 2.

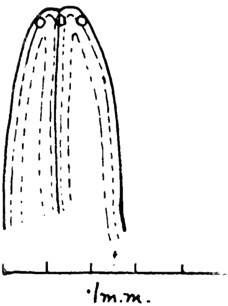


Fig. 5.

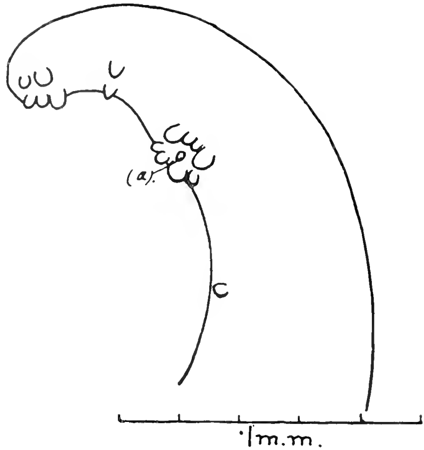


Fig. 6.

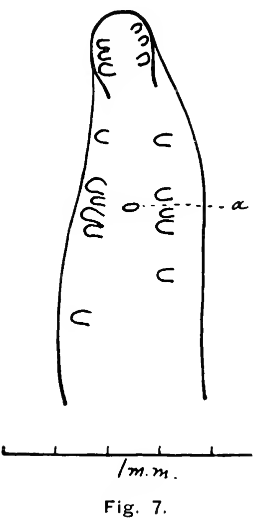


Fig. 7.

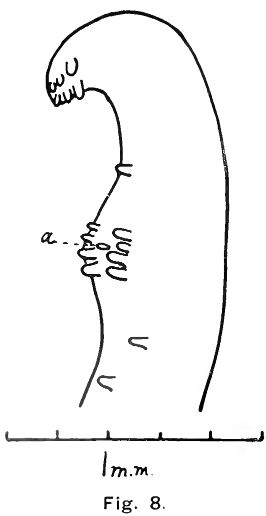


Fig. 8.

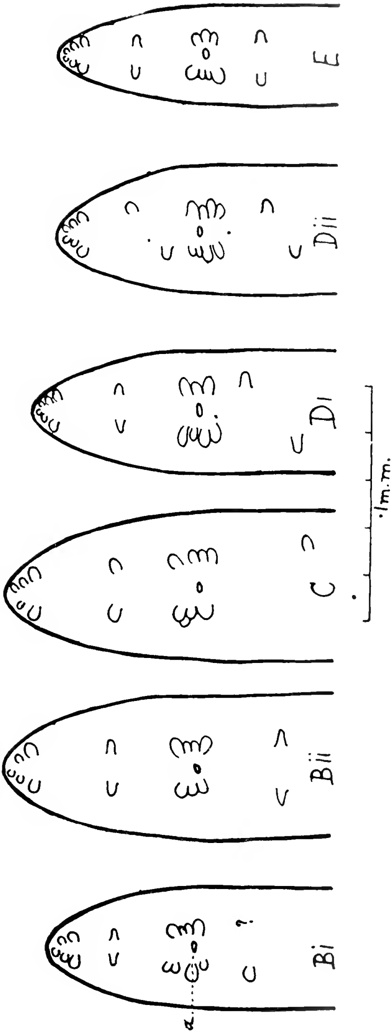


Fig. 9.

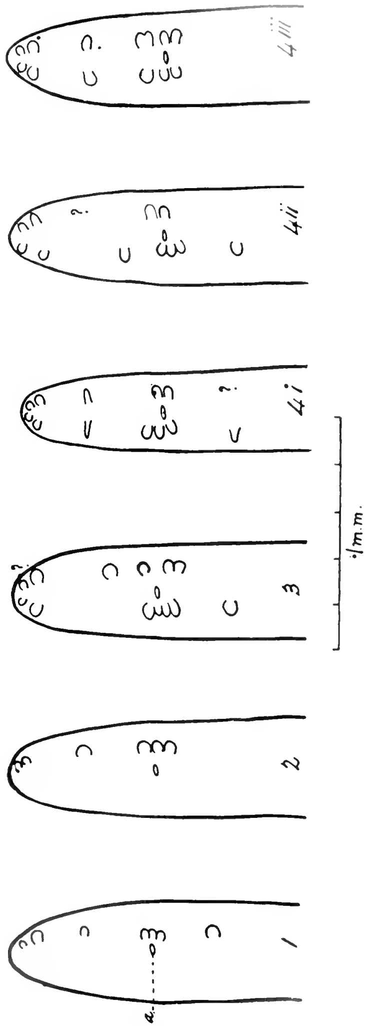


Fig. 10.

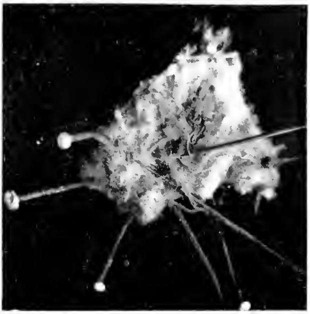


Fig. 3.

Fig. 4.

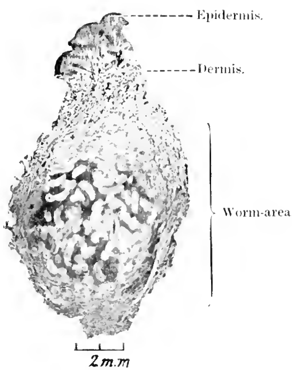


Fig. 12.

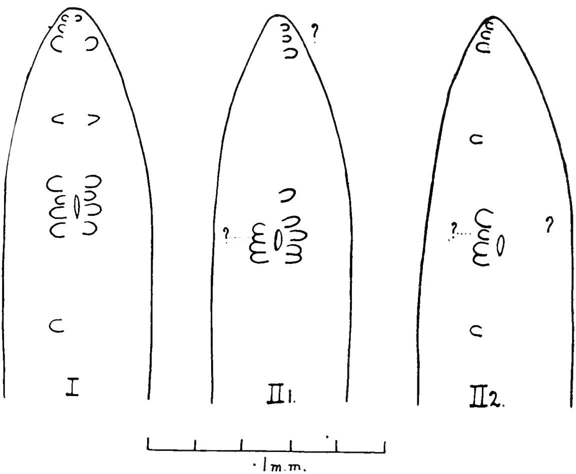


Fig. 11.

TABLE 9.—MALES FROM NODULES FROM INDIAN BUFFALOES.

Males.	I.	II 1.	II 2.	III.	Range.	Average.
	cm.			cm.	cm. cm.	
Length of male	7·2	?	?	5·5+	5·5+ —7·2	..
	mm.	mm.	mm.	mm.	mm. mm.	mm.
Diameter ·15 mm. from anterior end ..	·075	·079	·069	..	·069 — ·079	·074
,, at middle	·153	·180	·169	·180	·153 — ·180	·170
,, ·5 mm. from anterior end ..	·089	·113	·096	..	·089 — ·113	·099
,, level of cloacal opening ..	·062	·058	·062	·062	·058 — ·062	·061
Excretory pore from anterior end ..	..	..	..	..	..	..
Nerve ring from anterior end ..	·172	·172	·172	The	·172	·172
" Cardia "	Very ill-	..	..	anterior	..	..
,, length	defined.	..	..	end of	..	
,, diameter	·038	..	·039	this worm	·038 — ·039	·038
Œsophagus, length	1·016	·928	·966	was	·928 —1·016	·970
,, diameter	·031	·038	·024	missing.	·024 — ·038	·031
Cloacal opening from posterior end ..	·085	·094	·094	·073	·073 — ·094	·086
Spicules—length .. .. long	·266	·266	·219+*	·235 +†	·219+ — ·266	·246+
Spicules—length short	·082	·080	·088	·089	·080 — ·089	·085
Spicules—diameter .. long	·0117	·0102	·0108	·0109	0102 — ·0117	·0109
Spicules—diameter short	·0039	·0078	·0054	·0039	·0039 — ·0078	·0052
Cuticle thickness	·0039—·007	·0078	·0069	·0047	·0039 — ·0078	·0061
Transverse ridges apart	·0078	·0089	·0078	·0071	·0071 — ·0089	·0079
Anal papillæ (see next Table for details)	R. L.	R. L.	R. L.	R. L.	R. L.	
	7. 9.	5+3 ?. 3+?.	?. 8+1?.	‡. ?.	7—5 +3? 3+?—9	

* This long spicule was broken off short. † This may have been broken off slightly at the tip. ‡ The tail of this individual was distorted and torn by the long spicule having passed through its tissues, posterior to the anus, and the papillæ were not visible.

TABLE 10.—ANAL PAPILLÆ OF MALES FROM NODULES FROM INDIAN BUFFALOES.

—	I.		II1.		II2.		III.		Range.	
Side of Body.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.
Preanal	..	1	..	..	..	1	..		..	1
Par- or ad-anal	3+1	3+1	4	3+1?	..	3+1?	..		4	4
Postanal	1	1	1	..	..	1	..		1	1
Precaudal	1	1	1 ?	?	..	1	..		1	1
Caudal	1	2	2 ?	?	..	2	..		1—2 ?	2
Totals	7.	9.	5+3 ?.	3+ ?.	?.	8+1 ?.	?.		7—9.	9.

TABLE 11.—FEMALES FROM NODULES FROM INDIAN BUFFALOES.

Females.	I.	II.	III.	Range.	Average.
Length of female	..	..	..	?	..
	mm.	mm.	mm.	mm.	mm.
Diameter at ·15 mm. from anterior end	·062	*	·069	·062 — ·069	·065
,, at middle	·314	·448	·462	·314 — ·462	·408
,, just in front of vulva	·100	..	·110	·100 — ·110	·105
,, at level of anus	·189	..	·172	·172 — ·189	·180
Excretory pore from anterior end	? ·219	..	..	? ·219	..
Nerve ring from anterior end	? ·157	..	? ·188	? ·157 — ·188	..
"Cardia" from anterior end	Absent		Absent.		
,, length					
,, diameter					
Œsophagus, length	1·06	..	·931	·931 — 1·06	·995
,, diameter	·0235 — ·03	..	·031	·0235 — ·031	·027
Vulva from anterior end	·690	..	·483	·483 — ·690	·586
Anus from posterior end	·20	..	·138	·138 — ·20	·169
Cuticle, thickness (middle)	·0133	·0157	·0196	·0133 — ·0196	·0162
Spiral ridges apart (middle)	·094	·125	·115	·094 — ·125	·111
Transverse striations		4 — 5 to each spiral ridge.	4 to each ridge.	..	..
Segmented ovum	·029 × ·022 ·034 × ·025 ·036 × ·022	.. .. ..	.. .. ..	·029 — ·036 × ·022 — ·025	·033 × ·023
Egg containing developed larva	·039 × ·023	..	·031 × ·023 ·042 × ·025	·031 — ·042 × ·023 — ·025	·037 × ·024
Larva just escaped	·157 × ·031	·157 × ·039	·110 × ·030	·110 — ·157 × ·030 — ·039	·141 × ·033

* Owing to the considerably advanced caseation, neither anterior nor posterior ends could be found of this female.

[Proc. Roy. Soc. Victoria, 28 (N.S.), Pt. I., 1915].

Art. II.—*Revision of the Australian Cistelidae*

Order Coleoptera.

By H. J. CARTER, B.A., F.E.S.

(With Plate VI.).

[Read May 13th, 1915].

There is considerable difficulty in determining the species and sometimes the genera of insects of this family. The ill-defined genera and the uncoordinated work of individual authors have alike contributed to this. The following attempt to clear the atmosphere may be some assistance towards the coherent classification of the whole group. A great quantity of material has been placed at the author's disposal, for which special thanks are due to the following museum authorities and private collectors:—The British Museum of Natural History (specimens sent from which have been compared with the types of Pascoe, Bates and Blackburn), National Museum, Melbourne, South Australian Museum, Queensland Museum, Mr. A. M. Lea (who owns the best private collection in Australia), Dr. E. W. Ferguson. The author's own collection contains material largely taken by himself in various parts of Australia, while an examination of Macleay's types has been made in the Australian and Macleay Museums in Sydney, the latter also containing the valuable collection made by the late Mr. G. Masters. In the new catalogue of Junk (Berlin), this family has been edited by Herr Borchmann, under the name *Alleculidae*, the genus *Cistela*, F. (Sys. Ent., 1775), being placed as a synonym of *Gonodera*, Muls. (Col. Fr. Pect., 1856). Not having been able to procure the papers by Seidlitz, which apparently discusses this point, I have kept to the historically earlier name *Cistelidae*, as employed by Lacordaire. The earliest reference to *Allecula*, F., is Sys. El. ii., 1801, p. 21.

According to Leconte and Horne the only two characters that isolate this family are—(1) The pectinate claws; (2) Anterior coxal cavities closed behind.

The family is also clearly separated from the *Tenebrionidae* by the presence of lamellae on the tarsi; in the Australian species there are in general two on each of the four anterior tarsi, and a single lamella on the penultimate joint of the post tarsi. Our genera may be readily arranged into two groups

Group I.—Mandibles simple, acutely pointed, head produced into a muzzle.

Group II.—Mandibles bifid at apex, head little produced.

The genera belonging to Group I. may be tabulated as follows :—

Group I. Mandibles simple, acutely pointed. Head produced into a beak.

1	8	Prothorax oblong or cylindric	
*2	6	Antennae with joint 11 nearly or quite as long as 10, body navicular	
3		Prothorax cylindric, intercoxal process truncate or rounded	*aethyssius*, Pasc *atractus*, Lac *neoatractus*, Borch
4	6	Prothorax more depressed, intercoxal process sharply triangular	
5		Elytra brilliantly metallic, ♂ with post tibiae excised and flattened	*alcmeonis*, Bates
6		Elytra not brilliantly metallic, ♂ with post tibiae (and sometimes femora) widened	*chromomoea*, Pasc.; *Licymnius*, Bates
7		Antennae with joint 11 much shorter than 10, body oblong	*anaxo*, Bates
8		Antennae with joint 11 nearly three times longer than 10, body obovate	*synatractus*, Macl
9		Prothorax transverse with evenly rounded sides	*hemicistela*, Blackb
10	16	Prothorax much wider at base than at apex	
11	15	Antennae short	
12		Eyes large and approximate, tibiae generally curved	*apellatus*, Pasc
13	15	Eyes smaller and distant, tibiae straight	
14		Elytra not wider than base of prothorax, procoxae separated by lamina	*neocistela*, Borch (now praeocc.) *pseudocistela*, Blackb
15		Elytra wider than base of prothorax, procoxae contiguous	*atoichus*, n. gen.
16		Antennae long	*tanychilus*, Newm

In some of the genera, especially of Group I. (e.g., *Aethyssius* and *Chromomoea*), the species exhibit great colour variations. This is more notable in the legs, which are sometimes bicoloured, sometimes monocoloured, with either of the two colours prevailing. The abdomen and sometimes the elytra undergoes change of colour. In such cases it is difficult to say how far—if at all—colouration may alone constitute specific differentiation. The combined information of the field and cabinet naturalist is necessary to state if certain variations are constant geographical characters, or merely indivi-

* Except in *C. foveicollis*, Bates, in which the apical antennal joint is shorter than 10, though not so markedly as stated by Bates.

dual "freaks." In specimens examined by the author from the Bates's collection (British Museum), every such colour variation is noted by a label, with n. sp. written thereon—and often with a specific MS. name. The author does not agree with the great majority of these distinctions, and ventures further to suggest that some of Bates's genera are insufficiently differentiated from their kindred.

It would appear also that the late Canon Blackburn's writings, to whose industry and comprehensive work Australian entomology owes a great debt of gratitude, tend somewhat in the same direction. It is Blackburn who pointed out the necessity for studying the sexual characters of Group I.—in differentiating genera. He also first, so far as I know, pointed out the forciculate anal appendage in the male of the species he (mistakenly) believed to be *Metistete pimeloides*, Hope (Proc. Linn. Soc., N.S.W., 1888, p. 1436). I find this anal appendage in all cases examined of the larger species of Group II. (e.g., *Homotrysis*), and in some genera of Group I., and it is only the difficulty of examining small specimens in a dried condition that prevents at present a more complete statement on this point.

For example, in *Chromomoea* (*Licymnius*) *foveicollis*, Bates, the anal appendage can be readily extruded—if not already evident—and presents the appearance of a lamina, on which the forceps are seen in relief. It was apparently this appendage that was considered by Bates as the sixth abdominal segment. It is also evident in ♂ of *Chromomoea picta*, Pasc., though neither Pascoe nor Bates mention the number of abdominal segments in this genus. I have drawn this appendage with the aid of a camera lucida from specimens of eight species, shown in the accompanying plate.

Aethyssius, Pasc.

Atractus, Lac.

Neo-atractus, Borch.

1 (5) Whole upper surface brilliantly metallic
2 Surface densely pubescent, closely and strongly punctate
eros, Pasc
3 (5) Upper surface slightly, or not, pubescent, pronotum and elytral intervals sparsely punctate
4 Legs and underside (in general) dark, seriate punctures large and transverse *viridis*, Boisd
var. *columbinus*, Boisd
var. *rubriventris*, n.var.

5		Legs red, seriate punctures smaller and round	*virescens*, Boisd.
6	8	Prothorax black, elytra metallic, legs dark	
7		Elytral intervals coarsely rugose punctate	*rugosulus*, Macl
8		Elytral intervals very lightly punctate	*cyaneus*, Macl
9		Prothorax red with central black vitta	*vitticollis*, Macl
10	14	Prothorax red, without black vitta	
11		Head red (except in var. of *ruficollis*)	
12		Pronotum densely punctate, elytra reddish	*flavipes*, Macl
13		Pronotum sparsely punctate, elytra blue	*ruficollis*, Macl
14		Head black, elytra red	*atriceps*, n.sp.

Pascoe long since pointed out that Lacordaire's generic term *Atractus* was preoccupied, and proposed the name *Aethyssius* (Jour. Ent., 1863, p. 45). It is difficult to see any reason for Herr Borchmann's proposal of *neo-atractus* (Deutsch Ent., Zeihschr, 1909, p. 713), as well as the placing of *Aethyssius* merely as a sub-genus in the new catalogue of Junk, both very needless complications.

The species of *Aethyssius* are often closely related, vaguely described, and not easy to tabulate except by colour distinction, which may prove misleading. Boisduval unfortunately described three, which, Lacordaire notes, might well be varieties of the same species. That *viridis* and *columbinus* are merely colour variations admits of little doubt, the latter being purple or violet, the former (the more common), green or golden. It is a very common insect, ranging from South Australia to Queensland, found on the flowers of *leptospermum* in early summer in countless numbers. Like all common insects, it is subject to great variations in colour and size. Specimens with red legs cannot be otherwise distinguished from the typical *viridis* (with dark or metallic legs), while a Queensland variety (generally purple or violet above) has the whole underside and legs red, and would be considered by some writers as a distinct species. It may be named *viridis var. rubriventris.* I have specimens that vary in size from 8 x 2.5 mm. to 15 x 4.5 mm. The pronotum is only lightly and sparsely punctured, the elytra has series of large transverse punctures, separated by sub-cancellate ridges, the intervals being sparsely punctured and more or less wrinkled.

Ae virescens, Boisd., is quite distinct, and constant in colour—so far as I have seen—with quite a different elytral sculpture, the intervals more nitid, not wrinkled, the seriate-punctures smaller. The elytra are dark green, legs clear red, abdomen black, or very dark metallic.

Ae. eros, Pasc., is common in the Blue Mountains, and other inland districts of New South Wales. It differs from *viridis* Boisd., in its strongly pubescent upper surface, and closer and stronger punctuation of pronotum and elytral intervals; its size too is generally larger than *viridis*.

I have examined all Macleay's types. Of these *rugosculus*, *cyaneus*, *vitticollis*, and *flavipes*, appear to have been described from single specimens, or very scanty material, and do not appear in other collections. *Rugosulus* may readily be separated by its rugose sculpture, and *vitticollis* by its colour distinction, though it may well be an immature example of *Ae ruficollis*, with some adventitious black marking.

Ae cyaneus, Macl., may only prove to be a small dark variety of *viridis*: at present it can be distinguished by its black pronotum.

Ae flavipes, Macl., gives the appearance of immaturity. The description is also misleading, stating the colour as "brownish-black, opaque, the elytra nitid brassy-brown, the legs yellow"; whereas the coloration is as follows:—Head and basal half of antennae red, prothorax obscure, reddish above, clear red beneath, elytra metallic but reddish; abdomen and tibiae red, femora pale yellow. The pronotum is densely and confluently punctate; scarcely "granulate."

Atractus vittipennis, Macl., from its triangular intercoxal process, smaller and more transverse eyes, thin first joint of antennae must be placed in *Chromomoea*, near *picea*, Macl., and *rufescens*, Bates.

Ae ruficollis, Macl., seems to be more generally known in collections. The colour variations I note as follows:—

(a) Legs, dark. New Holland. Brit. Mus.

(b) Abdomen with three basal segments red, apical segments black. A second specimen has moreover the elytra margined yellow.

(c) Head and prosternum black.

The three specimens under (b) and (c) are labelled "Rockhampton, Bates's Coll.," and have separate MS. names.

Aethyssius atriceps, n. sp.

Elongate, navicular, nitid, head (except labrum), antennae scutellum, tarsi and underside (mostly) black, pronotum, elytra and legs, also basal segments of abdomen red, elytra with a slight metallic lustre. Head rather coarsely punctate, maxillary palpi long, last joint narrowly cultriform, labrum red, eyes large, reniform, separated by a space equal to the diameter of one, antennae long, robust, joint 1 twice as long as 2, 3 longer than 4, 4-10 subequal and obconic, last joint oval and about as long as 10.

Prothorax truncate at base and apex, sub-cylindric and slightly flattened, feebly narrowed and rounded in front, posterior angles obtuse, finely and evenly punctate, without medial line, and with a round depression near base. *Scutellum* widely rounded behind. *Elytra* considerably wider than prothorax at base, shoulders rather prominent and round, flanks slightly depressed in middle, moderately tapering to the apex; striate punctate, the punctures in striae round and regular, the two sutural intervals convex, the rest flat, intervals finely punctate, underside with short, sparse white pubescence, and finely punctate. Hind femora of ♂ swollen, but not dentate, last segment of abdomen in ♂ with small quasi-forciculate appendages.

Dimensions.—6-9 x 2-3 mm.

Habitat.—Rockhampton (Bates's Coll., Brit. Mus.), Port Denison (Macleay Mus.).

Var.—One specimen in the Brit. Mus. has the legs and underside entirely black, but is, I consider, conspecific with the others, though labelled by Bates with a different MS. name. Type in Brit. Mus.

Alcmeonis, Bates.

Prothorax red, elytra blue, abdomen black	*pulcher*, Bates
Prothorax, elytra and abdomen metallic	
♂ with post femora dentate	*punctulaticollis*, Blackb
♂ with post femora undentate	*excisipes*, n.sp.
Whole surface metallic black	*paradoxus*, n.sp.

This genus is very doubtfully distinct from *Aethyssius* in the slightly flatter form, wider prothorax (its base feebly bisinuate) and post intercoxal process sharply triangular. In *Aethyssius* the metasternal plate is not in general excised behind, thus forming a truncate limitation of the triangular intercoxal process. In *Alcmeonis* and *Chromomoea* this plate is also triangularly excised, so that the triangular process is fully completed—not rounded or truncate at apex. The distinction between *Alcmeonis* and *Aethyssius* can scarcely be defined by sexual characters, the dentate femora in the ♂ of *Aethyssius* only being found in the first three sp. of my table; while from an examination of eight specimens of *A. pulcher*, I can find no leg character indicating sex; certainly nothing like the curious male characters displayed in the post tibiae of *A. punctulaticollis* and *A. excisipes*. In *A. paradoxus* the post-tibiae of the ♂ are a little flattened and feebly hollowed on the basal half.

Alcmeonis excisipes, n. sp.

Elongate, navicular, upper and lower surface bronze purple, with short white pubescence, this scanty above, denser beneath, basal joints of antennae, legs and tarsi pale testaceous, with knees black and apical two-thirds of antennae fuscous. *Head* densely and rather coarsely punctate, eyes large and distinct, epistoma arcuate, antennae with joint 1 thickened, 2 short, 3 longer than 4, 4-8 subequal, somewhat filiform, but thickened at outer end; 9-11 thinner than 10, but of some length, 11th finely pointed. *Prothorax* oblong, depressed, slightly narrower than head, feebly narrowed at apex, posterior angles slightly obtuse, rather closely punctate and a little rugose, a faint medial line terminating in a large foveate depression before the base, the latter slightly transversely ridged. *Scutellum* very transverse. *Elytra* wider than prothorax at base, shoulders squarely rounded, sides tapering rather straightly towards apex, striate punctate, the seriate punctures irregular in size and somewhat transverse, intervals convex and strongly punctate. Sternum closely and strongly, abdomen very minutely punctate, posterior intercoxal process narrowly triangular, abdomen with 6 segments in ♂, 5 in ♀, the 4th shorter than the rest; the 6th segment in the ♂ is long, divided into two pointed lobes, with a triangular excision in the middle. Legs long and thin, femora *much less* expanded than in *A. punctulaticollis*, Blackb., and without any angulation or tooth, tibiae of ♂ hollowed on the inside, with a large curved excision about the middle. Tarsi lamellate on the penultimate joint in posterior, on the two penultimate joints in the other feet.

Habitat.—Dorrigo (R. J. Tillyard).

Compared with *A. punctulaticollis*, Blackb., this species shows the following differences:—*Colour*, unicolorous bronze-purple, the purple predominating above the bronze beneath, with pale testaceous legs and black knees. Form flatter than usual, the femora undentate, the post tibiae of ♂ excised on inside, the sixth segment of abdomen long and divided throughout. In the ♂ of *A punctulaticollis*, Blackb., the sixth segment of abdomen is shorter, and not divided throughout, while its post femora are strongly thickened and dentate.

Types in the Queensland Mus.

Alcmeonis paradoxus, n. sp.

Elongate, navicular, glabrous, nitid metallic black, elytra with violet reflections, basal joints of antennae and legs red, with apex of femora and tarsi (sometimes wholly or in part) black, labrum yellow. *Head* coarsely punctate, the punctures defined, round and not very close, eyes widely separated and prominent, antennae long, extending to the basal third of elytra in the ♂ joint 1 tumid, 2 very short, 3 cylindric, 4-10 shorter than 3, but wider (elongate ovate), 11th shorter and much finer than 10. *Prothorax* longer than wide, sub-cylindric, more convex and a little narrowed in front. slightly depressed behind, truncate at apex and base, distinctly but more finely and sparsely punctate than on head (as in *Ae virescens*, Boisd.), medial line distinct, but not quite continuous to the apex, and a large basal foveate depression. *Scutellum* very small and transverse. *Elytra* one and a-half times wider than prothorax at base, shoulders prominent and squarely rounded, sides gradually tapering to a finely pointed apex; striate punctate, the striae deep, the seriate punctures encroaching on the raised intervals, the latter much more sharply convex than in *Ae virescens*, Boisd. Underside finely pubescent, and minutely punctate, procoxae contiguous, post intercoxal process slightly rounded, mid-tibiae rather strongly curved, hind tibiae of ♂ flattened and hollowed on the inside, of ♀ rounded. Legs, especially the posterior, very long, claw joints of tarsi very fine.

Dimensions.—♂ 10 x 2.2 mm., ♀ 11 x 3 mm.

Habitat.—North Sydney (Dr. Clark), Gosford and Blue Mountains (the author), Dorrigo (W. Heron).

Four specimens, 3 ♂, 1 ♀, examined The maxillary palpi base the last joint narrowly cultriform, the short terminal joint of antennae, unarmed femora, navicular form, long legs give it a position between Bates's *Alcmeonis* and *Licymnius*, but on his plan would still require a new generic title. There are distinct metallic reflections on the upper surface. It may for the present be considered as an anomalous member of the genus *Alcmeonis*, the long legs, antennae and coxal structure prohibiting its inclusion under *Chromomoea*. The prothorax is much as in *Aethyssius*, the antennae show an alliance with *Anaxo*. Types in the author's coll. :—

Table of Chromomœa, Pasc.

Licymnius, Bates.

1	21	Species without strong hairy covering	
2	8	Elytra with pattern (white vitta on black ground)	
3	7	Surface finely pubescent, prothorax black	
4	6	Femora of ♂ dentate	
5		Antennae, legs (except apex of post femora) and elytra largely yellow	*picta*, Pasc

6		Antennae (except base) black, legs bicolorous, elytra with narrower vitta	*pascoei*, Bates *vittata*, Bates
7		Femora of ♂ not dentate, elytral vitta shorter	*fastigiata*, Germ *forcicollis*, Bates
8		Surface glabrous, prothorax yellow	(atractus) *vittipennis*, Macl
9	21	Species with elytra more or less concolorous	
10	14	Head black, elytra testaceous (sometimes subfuscate at suture and sides)	
11	13	Prothorax nearly smooth	
12		Antennae dark (not necessarily synonym of preceding)[1]	*pallida*, Bates *nigriceps*, Champ
13		Antennae variegated	*maculicornis*, Blackb
14		Prothorax closely punctate, shorter and wider than preceding	(Anaxo) *occidentalis*, Blackb
15		Head and thorax black, elytra red	
16		Antennae and legs black	*Deplanchei*, Fauv *rufipennis*, Blackb
		Antennae brown, legs red	var. *Mastersi*, Macl
17	19	Species with whole surface red	
18		Elytral intervals evidently punctate	*rufescens*, Bates ? (Anaxo) *puncticeps*, Blackb
19		Elytral intervals smooth (or nearly so)	*picea*, Macl
20	21	Species with surface distinctly metallic	*unicolor*, Bates (Anaxo) *aereus*, Blackb var. *Sydneyanus*, Blackb var. *lindensis*, Blackb
21		Elytra with finer sculpture than preceding	[1]*affinis*, Blackb
22	26	Species with strong hairy covering	
23		Elytra yellow, with apex and basal spot black[2]	*ornata*, n.sp.
24	26	Upper surface concolorous	
25		Prothorax subcylindric	*fusca*, n.sp.
26		Protsorax subquadrate	*ochracea*, n.sp.
27		Elytra with sparse covering of long white hair, prothorax as in *occidentalis*	*opacicollis*, n.sp.

Notes on the Species.—The distinction drawn by Bates for the generic characters of *Licymnius* are inadequate to separate this genus from *Chromomoea*, of which he admitted himself to be ignorant when describing *L. forcicollis* (Trans. Ent. Soc., 1868, p. 272). In a later paper (l.c., p. 317) he expressed doubts as to the sex of the specimen so described, while stating that *Licymnius* is quite distinct from *Chromomoea* without giving any reason. Having subjected many specimens to a microscopic scrutiny, the only distinctions to be noted are—(1) The rather (not "much shorter," as the author states) shorter terminal joint of antennae; (2) no pronounced sexual features in the posterior legs of ♂.

[1] Species unknown to, or not definitely determined by the author.

[2] For varietal coloration of this readily determined species see description infra.

Bates's note as to the punctures and rugosity of the antennae is valueless. I find the same feature in many sp. of *Chromomoea*. Finally, there seems little doubt but that *L. foveicollis*, Bates, had already been described by Germar as *Allecula fastigiata*, a name omitted from Borchmann's catalogue, and unnoticed by Blackburn, though a common insect in South Australia.

Licymnius strigicollis, Fauv., is quite unknown to me, and has therefore been omitted from the above table.

L. bicolor, Blackb.—This insect is so unlike *L. foveicollis*, Bates, in the structure of the prothorax and antennae that it cannot be included in the same genus. It will be found later under my n. gen. *Atoichus*.

C. picta, Pasc.—It may be considered doubtful whether *picta*, *pascoei*, Bates, and *vittata*, Bates, are not merely varieties of the same species. Specimens compared with the types have been sent from the British Museum, and I am unable to separate *pascoei* from *vittata*, which must be considered as synonyms. In *C. picta* the yellow colour largely predominates on the elytra, only the suture and sides being black, while the legs and antennae are yellow (except the apex of the hind femora). I have only seen specimens of *C. picta* from Queensland, and Northern New South Wales. Pascoe gives Brisbane as its habitate. Most Australian collections have used the three names rather indiscriminately, and I have hitherto regarded the common Sydney species (*C. pascoei*, Bates) as *picta*, Pasc. Specimens from Dorrigo, N.S.W., which I regard as *Pascoei var.*, are unusually dark in colour, with the elytral vitta reduced, and the legs sometimes quite black. It is very probable that *Eutrapela australica*, Bohem., is the same as *C. pascoei*, Bates, in which case the latter name becomes a synonym.

C. nigriceps, Champ.—I have never seen an authentic specimen of this, even from an old Tasmanian collector like Mr. Lea. From the description I am unable to separate it from *pallida*, Bates, though its author says he has compared it with all Bates's types. While placing it under *pallida* in my table, I do not necessarily imply that it is a synonym of that species, which, however, is a very variable insect, and may well include its Tasmanian ally.

C. maculicornis, Blackb.—I think I have identified this, which again may be considered but a variety of *pallida*.

C. Mastersi, Macl., only differs from *C. Deplanchei*, Fol., in the colour of the legs, and shade of the antennae—characters of doubtful value. I have a specimen from Sydney like the Queensland type. I include under *Chromomoea* several species that Blackburn called *Anaro*—a genus very narrowly differentiated from *Chromomoea*, but which must be more strictly limited if retained as distinct from *Chromomoea*. Evidently Blackburn's idea of *Anaro* differs from Bates's, since *A. aereus*, Blackb. = *C. unicolor*, Bates. The latter author specially excluded the narrower navicular species from *Anaro*, while the wider, more depressed form, short terminal joint of the antennae, black colour, more robust head (less contracted behind the eyes), are characters which in combination are true of the species retained below under *Anaro*.

Synonymy.—*C. pascoei*, Bates = *C. vittata*, Bates = (?) *Eutrapela australica*, Bohem.

C. (alleculа) *fastigiata*, Germ. = *C.* (Licymnius) *foveicollis*, Bates.

C. Deplanchei, Fauv. = *C. rufipennis*, Blackb.
var. *C. mastersi*, Macl.

C. rufescens, Bates = *Anaro puncticeps*, Blackb.

C. unicolor, Bates = *Anaro aereus*, Blackb.
var. *sydneyanus*, Blackb.
var. *lindensis*, Blackb.

The first two cases above have been already discussed. The synonymy of *rufipennis*, Blackb., with *Deplanchei*, Fauv., has been noted by Borchmann. Evidently *C. mastersi*, Macl., is only a slight colour variety, the antennae being castaneous brown instead of black, and the legs, except the apex of post femora, red.

Anaro puncticeps, Blackb.—There are three specimens so named in the Melbourne Museum, probably by Blackburn, from Victoria, the original habitat. These correspond with the description, and are certainly conspecific with what I consider is *C. rufescens*, Bates, a fairly common insect in New South Wales.

Anaro aereus, Blackb.—The synonymy of this with *C. unicolor*, Bates, is confirmed by Mr. Blair, who has compared the types. Blackburn himself surmised this in his note under *A. sydneyanus* (Trans. Roy. Soc., S. Aus., 1893, p. 134), the latter having slight colour differences in the antennae. With regard to *lindensis* the author gives slight differences of size, colour and the relative width of head to that of prothorax to distinguish its from *aereus*. The size and colour are of no account. I have seen so-called specimens from the South Aus. Mus. of both species, of varied size, and colour without any distinction, as is also the case with labelled specimens from the Brit. Mus. The head wider or narrower than the prothorax, is again a variable character, so difficult to assess, that with eight so-called *aereus* and seven so-called *lindensis* before me, four of each showed little, if any difference. I think it extremely likely that *A. affinis*, Blackb., is only another variety, but not having seen any authoritative specimen, I must withhold any opinion on this. My specimens are largely from the Blackburn collection, kindly lent by Mr. A. M. Lea.

C. (*atractus*) *vittipennis*, Macl.—A species generally easy to identify, from its large size, and the ninth antennal joint clear yellow, the others being black (except the basal joints). Two smaller insects from Cairns are probably males of this species, and are without this yellow joint, a fact noticed by Macleay.

Synatractus variabilis, Macl. (misspelt *syntractus* in the Junk catalogue), is well named, and exhibits more than the usual colour variations of this group, the elytra being red, black or variegated, the thorax always red. The species is readily determined by its marked antennal characters, as well as by the distinct but small basal angles of the prothorax, formed by the raised collar-like basal margin.

Hemicistela discoidalis, Blackb., is apparently a common insect in New South Wales and Victoria. It has very much the facies of *apellatus*, from which it differs in its transverse round-sided prothorax. I have specimens taken near Sydney, identical with a co-type in the South Aus. Mus. Having examined it under a Zeiss binocular, I find it has one-pointed mandibles—not bifid—as surmised, but not ascertained by Blackburn (Trans. Roy. Soc., S.A., 1891, p. 332).

Chromomoea ornata, n. sp.

Ovate, depressed, clothed with short, recumbent hair; head, antennae (except apical joints), underside, tarsi and legs (except middle part of front femora) *black;* prothorax red, elytra *red* with a large circular macula behind scutellum, and the apical third *black;* apical joints of antennae and middle part of front femora red. *Head* strongly produced in front, narrower than prothorax, eyes moderate, not prominent, surface closely punctate, antennae with joint 3 scarcely longer than 4, cylindric; 4-10 subtriangular and successively shorter, 11th oval, narrower than 10. *Prothorax* trapezoidal, slightly wider at base than at apex, truncate at both, sides straight, rounded anteriorly, subrectangular behind, medial line impressed throughout and foveate at base, recumbent hairs on surface lying transversely on each side of medial line.

Scutellum black, small and round. *Elytra* wider than prothorax at base, ovate and rather flat, widest behind middle, apex bluntly rounded; finely striate, any puncturation obscured by the close recumbent clothing; sternum closely and finely punctured, abdomen with a short, sparse and fine reddish pubescence.

Dimensions.—9 x 3 mm.

Habitat.—Endeavour River (South Aus. Mus.), Coen River (W. Dodd).

Var. A.— With elytra black, shoulders and sides near base narrowly red, sometimes also with a red spot on each elytron near middle, and the middle femora with a variable amount of red.

Var B.—Elytra red, apex black, without the black circular spot near base.

Eight specimens examined, two of which are coloured as in *Var. A*, one as *Var. B*. It is easily distinguished from all described species by its depressed and more ovate form, trapezoidal prothorax and coloration.

Types in the South Australian Museum.

Chromomoea fusca, n. sp.

Narrowly elongate ovate, navicular; upper surface opaque fuscous, sometimes reddish brown, covered with fine adpressed reddish hair, underside and legs black (or nearly so), tibiae underside of the femora, and parts of abdomen, sometimes reddish, tarsi, palpi and basal joints of antennae red.

Head as wide as prothorax, eyes prominent, oral parts less produced than usual, apical joint of maxillary palpi shortly securiform; antennae short, joint 3 cylindric, slightly longer than 4, 4-10 triangular, nearly equal, 11th oval as long as 10. *Prothorax* subcylindric, longer than wide, slightly rounded in front, sharply rectangular at base, truncate, and of equal width at apex and base; like the head, thickly clothed with fine adpressed hair, longitudinally arranged, sometimes with a faint indication of a medial line at base. *Scutellum* oval, larger than usual.

Elytra convex, narrowly ovate, wider than prothorax at base, shoulders rounded, sides tapering to a pointed apex; finely seriate punctate, the seriate punctures visible, though more or less obscured by hirsute clothing; underside, especially sternum, closely punctate and clothed with whitish pubescence, legs without sexual distinction, the sex easily seen by the usual structure of the last segment of abdomen, excavate with a small quasi-sixth segment in the ♂. The ♀ usually larger and wider.

Dimensions. 5-6 x 1.5-1.8 mm.

Habitat.—Brisbane, Queensland (H. Hacker), Camden, N.S.W. (Macleay Mus.).

Many specimens sent by the Queensland Mus., also from the South Aus. Mus., from the same source. The colour is variable from a unicolorous grey-brown to a reddish-brown, the latter showing the reddish legs, and in some examples a partly reddish abdomen. Types in the Queensland Museum.

Chromomoea ochracea, n. sp.

Narrowly ovate, upper surface and prosternum flavous, abdomen black, sometimes yellow, legs yellow (in some examples apex of femora and the whole tibiae black) antennae with basal joints yellow, the rest black, whole surface clothed with yellow adpressed hair.

Head narrower than prothorax, eyes large and prominent, widely separated surface closely punctured, antennae short (not extending far beyond base of prothorax), joints less widely triangular than in *C. fusca*, joint 3 scarcely longer than 4, 4-10 of equal length, but successively wider, 11th ovate, as wide and long as 10. *Prothorax* subquadrate, a little rounded in front, rectangular at base, truncate at base and apex, medial line indicated near base only, clothing as in *C. fusca*. *Scutellum* small, oval. *Elytra* convex, slightly wider than prothorax at base, shoulders rounded, apex less acute than in *C. fusca*, very finely striate punctate, the punctures obscured by the close recumbent hair. Underside less strongly punctate than in *C. fusca*.

Dimensions.—6-8 x 2-3 mm.

Habitat.—Galston (Sydney district, Dumbrell), Mackay, Queensland (Adelaide and Melbourne Museums).

Thirteen specimens examined, show an insect very near some of the ligther coloured specimens of *C. fusca*, but evidently differing, apart from colour distinctions, in the shorter, squared, prothorax, greater size, more robust form, and quite differently shaped antennal joints.

Type in the South Australian Museum.

Chromomoea opacicollis, n. sp.

Elongate, elliptic; dark chestnut brown, prothorax reddish, and (with the head) opaque, elytra very nitid, underside nitid piceous red, almost black at apex of abdomen, upper surface sparsely clothed with long upright white hairs. *Head* and pronotum coarsely, confluently punctate with short white hairy pubescence, eyes prominent and widely separated, last joint of maxillary palpi securiform, antennae moderately long, joint 1 tumid, 2 considerably shorter and thinner, 3 subcylindric and as long as 4, 4-8 elongate, enlarged and rounded at apex, 9-10 of same length as preceding but finer, 11 as long as 10, finely pointed. *Prothorax* convex, wider than long, truncate at apex and base, sides well rounded, widest near (or rather in front of) middle, widely rounded before the narrowed apex, basal half slightly converging, nearly straight, posterior angles subrectangular, slightly blunted, a faint medial depression near base, but without distinct medial line, or the usual basal foveae. *Scutellum* widely rounded behind. *Elytra* one and a-half times wider than prothorax at base ($2\frac{1}{4}$: $1\frac{1}{2}$ mm.), narrowly elliptic, striate punctate, the striae well marked, punctures regular and round, sutural intervals slightly convex at apex, all intervals with a single distinct row of setiferous punctures, each bearing a long upright white hair. Procoxae contiguous, post intercoxal process rather widely triangular, sternum closely and coarsely punctate, abdomen finely setose punctate, the hairs shorter than on elytra, and very sparse. Legs slender, tibiae curved.

Dimensions.—5-6 x 1.7-2 mm.

Habitat.—Sydney (Dr. E. W. Ferguson and the author).

Seven specimens of this puzzling little species are before me. They show no sexual characters in legs and antennae. At first considered as a *neocistela*, I find the antennae, head and especially the prothoracic structure quite exclude this classification. Though differing in the wider and rounded prothorax from the typical *Chromomoea*, it is so close to the species which Blackburn called *Anaxo occidentalis*, in structure, that it must be placed in the same genus as that species. Possibly these two insects will be placed on further evidence in a separate genus. The nitid setiferous elytra, with the pale coloured but quite opaque pronotum, renders it easy to identify. The legs vary in colour from red to piceous-red.

Types in the author's coll.

TABLE OF ANAXO, Bates.

1	8	Elytra black	
2	5	Punctures of head evidently closer than those of prothorax	
3	5	Interstices of elytra closely punctate	
4		Legs black, femora of ♂ angulate	[1]*ater*, Blackb
5		Legs partly yellow, femora of ♂ simple	*brevicornis*, Bates
6	8	Punctures of head and prothorax equally (or nearly so) close	

1 Species unknown to, or not definitely determined by the author.

7		Interstices of elytra finely and sparsely punctate	[1] *sparsus*, Blackb
8		Interstices of elytra more closely and strongly punctate	*cylindricus*, Germ
9		Elytra violaceus	[1]*fusco-violaceus*, Fairm

NOTE.—The above table is largely following Blackburn (Trans. Roy. Soc., 1891, p. 312), omitting the species placed now in *Chromomoea* (vide supra).

TABLE OF APELLATUS.

1	3	Elytra with suture, apex and sides black	
2		Eyes of ♂ nearly contiguous	*lateralis*, Boh *palpalis*, Macl *Mastersi*, Macl
3		Eyes of ♂ more widely separated	*apicalis*, Blackb
4	9	Elytra with sides and apex only black	
5	8	Lateral black vitta of elytra narrow	
6		♂ with front tibiae dentate, mid and post tibiae strongly ciliate	*amoenus*, Pasc *lateralis*, Pasc
7		♂ with post tibiae nodose within	*nodicornis*, Blackb
8		♂ with all tibiae entire	*simplex*, n.sp.
9		Lateral black vitta of elytra wide	*tasmanicus*, Champ
10		Elytra testaceous, with dark-red lines	*lineatus*, n.sp.
11	15	Elytra concolorous	
12		Surface non-pubescent, elytra brown	*plebejus*, n.sp.
13	15	Surface pubescent	
14		Elytral intervals raised, tibiae black	*nigripes*, n.sp.
15		Elytral intervals flat, legs pale yellow	*concolor*, n.sp.

A. nigricornis, Blackb., has been omitted as undetermined. It seems possible that it is one of the many varieties of *lateralis*, Boh.

As Blackburn pointed out, the most striking character of this genus lies in the antennae of the male. For this reason a close examination is necessary. With a Zeiss binocular the species can be thus readily differentiated. The following notes have been made on the species.

Synonymy.—*A. lateralis*, Boh. = *A. palpalis*, Macl. = *A. Mastersi* Macl.

The synonymy of the last two was noted by Blackburn. The Queensland specimens of the ♀ (*Mastersi*) are often nearly black.

A. lateralis, Boh., was described as from Sydney, and the description answers to the commonest Sydney species, which I find identical with the type of *palpalis*, Macl. The wide distribution of this from Queensland to South Australia is noteworthy.

The ♂ has short antennal joints of nearly equal length, joints 8-10 strongly hollowed beneath, with one angle a little produced.

1 Species unknown to, or not definitely determined by the author.

and joint 11 flattened. In the ♀ all joints are rounded, not hollowed beneath or flattened.

A. apicalis, Blackb.—I cannot make out very definite distinctions between some West Aus. specimens I have (which answer to Blackburn's description) and the former species, except that the eyes are certainly less approximate in the ♂

A. Amoenus, Pasc.—The description was evidently taken from a female, though Pascoe thought it a male (Jour. Ent., 1863, p. 46), or he could scarcely have overlooked the strong sexual characters shown (i.e., if the specimen sent from the British Mus., labelled *A. amoenus*, Pasc., compared with type, is correctly named). In this specimen the front tibiae are dentate on the inside, in the middle, the mid and posterior tibiae are clothed with long, curly cilia on the inside, the post tibiae being curiously flattened, widened and strongly curved. The joints 6-8 of antennae have a sharp triangular tooth on the inside apex, that does not occur in the ♀. The two apical joints are much narrower than the preceding. Besides the British Mus. specimen (without locality label), I have only one other ♂ specimen before me. This is on a card with a ♀ specimen, labelled "*Forest Reefs*, A. M. Lea."

A. nodicornis, Blacbk.—The ♀ specimens are very like those of *amoenus*, but the 3rd antennal joint is of the same length as the 4th, whereas in *amoenus* 3 is shorter than 4. The elytral punctures are smaller in *nodicornis*. In the ♂ the 7th joint of antennae is widely produced, and the *four* apical joints are evidently finer and smaller.

A. Simplex mihi is also very close to both *amoenus* and *nodicornis* so far as female specimens go, but it is usually smaller, with much stronger and closer punctures on the head. In the ♂ joints 6-9 are hollowed beneath, and triangularly widened, but are not produced at the apex, joints 10-11 are much finer, the 11th very finely pointed. The hind angle of the prothorax is rather less than 90 deg. The species *tasmanicus*, *lineatus* and *plebejus* may be readily identified by colour, and more filiformed antennae. In *A. tasmanicus* the black colour nearly covers the elytra, only the suture is distinctly yellow, soon shading off into the black.

Apellatus simplex, n. sp.

Elongate ovate, head and antennae black or piceous, the basal joints of the latter red, prothorax and elytra reddish-yellow, the sides and apex of the latter narrowly black, underside red, with apex of abdomen piceous.

♂ Head, eyes large and approximate, nearly contiguous beneath, forehead strongly punctate, antennae joint 3 as long as 4, cylindric, 4-11 about equal in length, 7-9 triangularly widened and hollowed beneath, not at all produced at apex, 10-11 much narrower than preceding.

Prothorax less wide than head, and rounded in front, widest at middle, then subparallel to the subrectangular posterior angles, these with a slight acute tendency, base bisinuate, with a medial basal depression and two small basal foveae. *Scutellum* rounded behind. *Elytra* very much as in *A. amoenus*, Pasc., for colour arrangement, but seriate punctures larger. Intervals flat, strongly pubescent and finely punctate, underside closely punctate, fore and mid tibiae straight, post tibiae slightly curved, without any sign of nodose enlargement.

♀ With eyes less approximate, antennae joints 7-9 less enlarged and not hollowed beneath.

Dimensions.—♂ 6 x 2 mm., ♀ 8.5 x 3 mm.

Habitat.—Brisbane (H. Hacker), Killarney (the author), Sydney (Lea), Clarence River (Zietz, South Aus. Mus.).

Twenty-six specimens examined. Very near *A. amoenus*, Pasc., so that female specimens can be easily confused, but for the very different sculpture. Under a Zeiss binocular the difference is strongly marked in the closer and coarser punctures of the head and thorax. The males may easily be differentiated by their simple tibiae and the antennal joints not at all toothed, nor the apical joints flattened as in Pascoe's species. It cannot be very near *A. nigricornis*, Blackb., which has a black suture, and apical joint of antennae longer than joint 10. Types in the author's coll.

Apellatus plebejus, n. sp.

Elongate, subparallel, pale-brown, sometimes piceous, glabrous, antennae piceous or reddish, femora pale yellow, underside tibiae and tarsi red, head black, labrum and palpi red. *Head*, eyes large, separated by a space about half the diameter of one eye, closely punctate, antennae joint 3 rather shorter than 4, 4-11 of about equal length, subfiliform (slightly enlarged at apex). *Prothorax* rounded in front, rectangular behind, base sinuate; closely punctate with a large post-medial and two small basal foveae. *Scutellum* rather widely rounded behind. *Elytra* wider than prothorax at base; striate punctate, the striae well marked, the punctures small and close, intervals minutely and sparsely punctate. Underside closely punctate. Tibiae simple in both sexes.

Dimensions.—6 x 1.5 mm.

Habitat.—Murray River, South Australia (H. S. Cope).

Ten specimens examined show very slight sexual, or other, differences. The males have joints 7-8 slightly flattened beneath. The antennae are much slenderer and more filiform than usual, and in this respect are like those of *A. tasmanicus*, Champ. It is a rather characterless insect, of uniform colour, and of narrower form than usual, without the usual pubescence. Types in the South Aus. Mus.

Apellatus lineatus, n. sp.

Elongate, subcylindric. Head black or piceous, antennae, palpi, underside, tibiae and tarsi red, prothorax reddish or testaceous, elytra pale testaceous, with dark red lines following the striation throughout. Underside yellow, apex of abdomen piceous, femora pale testaceous. *Head*, eyes large, prominent and rather approximate, space between about $\frac{1}{4}$ diameter of one eye; closely and strongly punctate, antennae with joints 3 and 4 of about equal length. All joints subfiliform, 4-9 slightly widened at apex, 10-11 very thin, 11th finely pointed. *Prothorax* rounded in front, subrectangular behind, with rather blunted angles; densely and finely punctate. *Scutellum* widely rounded behind. *Elytra* wider than prothorax at base, rather cylindric; finely punctate striate, and clothed with a hairy pubescence; intervals minutely punctate. Underside finely punctate, all tibiae straight and simple.

Dimensions.—6-7 x 2 mm.

Habitat.—Geraldton, West Australia (Lea).

Two specimens, the sexes in Mr. A. M. Lea's collection, differ from all described species in their subcylindric form, and the elytra with dark red lines on a testaceous ground. The antennae are somewhat as in *plebejus* (above), but the joints are more enlarged at apex, except the apical two. In the female the eyes are wider apart, and the prothorax is wider and darker in colour (the last probably individual).

Types in Mr. Lea's coll.

Apellatus concolor, n. sp.

Elongate ovate, pubescent; whole surface, legs and appendages pale testaceous, the apical half of antennae slightly piceous. Head and prothorax closely punctate (forehead more sparsely so). Eyes more widely separated than usual, the distance between them fully half diameter of one in the ♂ rather wider apart in the ♀. Antennae subfiliform, joints 4-10 subequal, very slightly enlarged at apex, 3rd shorter than 4th, 11th shorter than 10, the two penultimate joints in ♂ slightly flattened. *Prothorax* rather wider than usual, and of the typical shape, rounded and narrowed in front, rectangular behind, with three subequal foveae at base. *Scutellum* arcuate triangular. *Elytra* wider than prothorax at base, ovate elliptic, finely striate punctate, the intervals quite flat and strongly punctate. Underside minutely punctate. Legs simple, tibiae straight.

Dimensions.—5-6.5 x 1.5-2 mm.

Habitat.—Brisbane (A. M. Lea).

A pair in Mr. Lea's collection are the only specimens I have seen. It is quite distinct from *plebejus* in its lighter colour, and pubescent clothing, while from *nigripes* besides colour it may be distinguished by its flat elytral intervals. Types in Mr. Lea's coll.

Apellatus nigripes, n. sp.

Elongate navicular, pubescent; head, prothorax, elytra, underside, base of femora, and tarsi, red; antennae, tibiae and apex of femora, black. Eyes very large and almost contiguous, epistoma closely and deeply punctate, antennae rather short, joint 3 cylindric as long as 4, 4-10 nearly equal in length and thickness, obconic, moderately enlarged, but not produced apically, 11th as long as 10, thin and finely pointed. *Prothorax* closely punctate, narrowed and rounded in front, sides parallel on base half, posterior angles rectangular, medial line marked throughout by a wide depression, foveate at base with two transverse basal foveae. *Scutellum* rounded behind. *Elytra* only slightly wider than prothorax at base, soon widening and gradually tapering to the apex; striate punctate, the striae deeper, the punctures therein larger than usual, intervals distinctly convex and quite impunctate. Underside, especially meso and metasternum, very closely dotted with deep round punctures, abdomen with smaller punctures. All tibiae straight, hind tibiae nodulose on the inside near apex.

Dimensions.—6.5 x 1.5 mm.

Habitat.—Nicol Bay, West Australia.

A single ♂ (?) specimen, with locality label, and a second label with "F. Bates, 81-19," thereon, has been sent from the British Museum. It differs from its congeners in colour, large seriate punctures, and smooth raised intervals. The antennae are rather fine, and equal jointed, not excavate beneath. The nodular hind tibiae suggests the male sex from analogy. Type in the British Museum.

Neocistela, Borch.

Pseudocistela, Blackb. (nom-praeocc.).

Having dissected and examined *N. ovalis*, Blackb., very closely, I find that the maxillary palpi have the last joint securiform, not triangular, as the author states, with the apical edge much longer than the longer side. The antennae are remarkable in having the 2nd joint nearly as long as, but less tumid than, the first joint. The eyes are somewhat as in *Chromomoea*.

Atoichus, n. gen.

Head prolonged into a beak, mandibles simple and acutely pointed, maxillary palpi last joint cultriform, labial palpi last joint triangular, antennae robust, 2nd joint nearly as long as the 1st, 3-10 obconic subequal, 11th as long as 10, finely pointed. Prothorax widest at base, arcuately narrowed, or nearly straightly converging to the apex. Elytra ovate, wider than prothorax at base, procoxae contiguous without separating partition, posterior inter-coxal process sharply triangular, tibiae straight and slender, claw-joint very slender, minutely pectinate.

A genus which includes the insect named by Blackburn, *Licymnius bicolor*, which may be taken as the type. It differs from *Neocistela* in having the elytra wider than prothorax at base, and in the procoxae being contiguous, without any separating partition. The species may be differentiated inter se as follows:—

Atoichus, n. gen.

1	3	Head, elytra and legs black	
2		Prothorax yellow or red	*bicolor*, Blackb
3		Prothorax black	*tasmanicus*, n.sp.
4	6	Upper surface (mostly) and legs yellow	
5		Base of head and eyes black, knees piceous	*flavus*, n.sp.
6		Elytra with black markings	*crassicornis*, n.sp.

Atoichus tasmanicus, n sp.

Ovate, nitid black, glabrous, tibiae, base of femora, prosternum, and (sometimes) basal joints of antennae reddish. Head and prothorax strongly punctate, the punctures round and sub-contiguous, apical joints of maxillary palpi securiform, eyes small and widely separated, head narrow; antennae with joint 3 cylindric, as long as 4, 4-10 shortly obconic and of equal size, last joint as long as 10 and pointed. *Prothorax* narrower than in *N. ovalis*, Blackb., widest at base, thence arcuately narrowed to apex, and there as wide as the head, posterior angles acute. *Scutellum* small, transverse. *Elytra* slightly wider than prothorax at base, glabrous, and strongly striate punctate, the seriate punctures large, the intervals transversely rugose punctate and slightly raised at apex, underside nearly smooth; tibiae simple and straight.

Dimensions.—6-7 x 1.6-2 mm.

Habitat.—Hobart, Tasmania.

Six specimens examined, one pair in the author's coll., possibly taken by himself, three in Mr. Lea's coll., and one in the South Aus. Mus. It is readily separated from *neocistela ovalis* by its strongly punctate and glabrous upper surface, the well-defined striation of the elytra, the narrower head and prothorax, and contiguous procoxae. Types in the author's coll.

Atoichus flavus, n. sp.

Oval, base of head and eyes black, rest of surface and appendages reddish-yellow, knees piceous, elytra with sparse hairy pubescence. *Head* and *prothorax* closely subconfluently punctate, the punctures coarser than in *N. ovalis*, but finer than in *A. tasmanicus*, eyes small and flat, antennae as in those species, but joints rather more elongate than in *N. ovalis*. *Prothorax* shaped as in *A. tasmanicus*, subconvex, widest at base, the posterior angles subrectangular (slightly blunted), base bisinuate. *Elytra* slightly wider than prothorax at base, clearly striate punctate, the seriate punctures finer and closer than in *tasmanicus*, intervals quite flat and minutely punctate, underside finely punctate, post-intercoxal process narrowly triangular; tibiae straight.

Dimensions.—5-6 x 1.2-2 mm.

Habitat.—Dividing Range, Victoria. (South Aus. Mus.).

Var.—Head and prothorax black.

Ten specimens examined, including two coloured as in *var.*, which are indistinguishable otherwise from the rest (the more so since both specimens have mutilated antennae). The species is intermediate in sculpture between *neocistela ovalis* and *A. tasmanicus*, but while quite differing in colour is nearer the latter in form. The ♂ specimens are smaller, narrower, with the apical joints of the antennae more enlarged than in the ♀.

Types in the South Aus. Mus.

Atoichus crassicornis, n. sp.

Narrowly ovate, head, prothorax, and legs yellow, elytra yellow with irregular black or piceous markings, and the extreme apex black, abdomen, apical joints of tarsi, antennae (except the two basal joints yellow) also black. *Head* and prothorax sparsely punctate, eyes prominent, as in *N. ovalis*, making the head slightly wider than base of prothorax, antennae short, unusually stout and hairy, joint 2 nearly as long as 1, 3 cylindric, 4-10 subequal, subovate (wider at apex than at base), 11th shorter than 10. *Prothorax* widest at base, rounded and narrowed in front, anterior sides deflexed, posterior angles obtuse and slightly blunted. *Elytra* slightly wider than prothorax at base, subcylindric or narrowly elliptic, finely punctate striate, intervals flat and sparsely punctate setose. Legs simple, tibiae straight, underside finely punctate.

Dimensions.—4.5 x 1.5.

Habitat.—Brisbane, Queensland (H. Hacker).

Two specimens examined (sex ?). It can readily be distinguished from *flavus* by its smaller size, black underside and antennae, and the short, thick joints of the last. There may be a doubt as to whether this insect may not require separate generic rank, but at present the combination of pointed mandibles, obconic prothorax, widely separated eyes, justifies its inclusion under *atoichus*.

Type in the Queensland Mus.

Tanychilus, Newm.

1	3	Colour metallic (sometimes greenish) black, elytral intervals convex, 15-25 mm. long	
2		Meta- and epi-sterna densely and finely punctate, legs black	*striatus*, Newm
3		Meta- and epi-sterna sparsely and coarsely punctate, legs red	*dubius*, Newm
		var. legs black,	*splendens*, Bless
4		Colour brilliant purple, elytral intervals nearly flat	*pulcher*, n.sp.
5		Prothorax back, elytra red, 10 mm. long	*minor*, n.sp.
6		Whole surface red	*ruber*, n.sp.

There are also two species *T. metallicus*, White, and *T. sophorae*, Brown, from New Zealand, and one *T. kanelensis*, Perroud, from New Caledonia, which are not included in the above table. The first of these has been omitted from Junk's catalogue (edited by Borchmann).

T. dubius, Newm., should really be considered as the *var.* of *T. splendens*, Bless., but it has priority of publication in its favour.

Immature specimens of all the black species are red, but the distinction between *striatus* and *splendens* is very marked in the sculpture of the undersurface, while the seriate punctures of *striatus* are smaller and less defined than in *splendens* and *dubius*.

T. minor and *T. ruber* differ from the first four species in the above table, in the forehead between the eyes being wider, and without the raised subcarinate impression shown in those species.

Tanychilus pulcher, n. sp.

Ovate and convex; upper surface brilliant metallic purple, prothorax darker, sometimes greenish, the suture and apex of elytra brilliant green, antennae underside and legs black, abdomen with purple reflections. Head and prothorax very similar to that of *T. striatus*, Newm., but more decidedly, but not strongly punctate, antennae long, joint 3 longer than 4, 4-10 successively shorter than the preceding, two apical joints, narrower than the 9th, 11th as long as 10. *Prothorax* widest and truncate at base, arcuately narrowing to apex, posterior angles rather widely acute, a small basal depression, without medial line.

Scutellum, scutiform, punctured. *Elytra* scarcely wider than the prothorax at base, ovate and convex, striate punctate, the punctures in striae small, close and regular, the intervals flat, or nearly so, minutely punctate; meso and metasternum coarsely punctate, abdomen finely striotate. Legs, especially the posterior, long, tibiae and femora simple in both sexes.

Dimensions—14 x 5 mm.

Habitat.—Mary River, Northern Territory (Dodd).

Five specimens examined, two (slightly damaged) in the author's coll., from Mr. Dodd, one old specimen labelled " New Holland " in the British Mus. consignment, and two fresh specimens (type ♂ and ♀) in the South Aus. Mus. While very similar in structure to the common southern species, *striatus*, Newm., and *splendens*, Bless., it is readily differentiated by its brilliant colour, and flat elytral intervals. Types in the South Aus Mus.

Tanychilus minor, n. sp.

Elongate, navicular, glabrous, prothorax black, head, elytra, abdomen and basal points of antennae red, apical joints obfuscate, tips of mandibles black, legs and palpi yellow, the knees sometimes piceous. *Head*, labrum strongly produced; closely punctate, eyes very large and prominent, separated by a distance less than the apparent diameter of one, antennae long, joints sublinear, 3rd little longer than 4, 4-7 equal, 8-11 successively shorter. *Prothorax* at base a little wider than the length, sides parallel on basal half, then arcuately narrowed to apex; this considerably narrower than base, narrowly margined at base and apex, medial line impressed and terminating in a large basal foveate depression; disc closely and rather coarsely punctate. *Scutellum* transverse, widely rounded behind. *Elytra* narrowly elliptic, slightly wider than prothorax at base and three and a-half times as long, shoulders rounded, apex finely pointed; striate punctate, seriate punctures large and close, intervals convex and finely punctate; sternum distinctly and closely, abdomen minutely and sparsely punctate, mid-tibiae curved. Male without sexual characters, except the extended quasi-sixth segment, with its small external forceps; posterior intercoxal process rounded.

Dimensions.—10 x 3 mm.

Habitat.—Sydney (the author).

Four examples taken by the author are superficially like *Chromomoea rufescens*, Bates, but the following are amongst the many structural differences:—(1) Long, linear joined antennae; (2) large prominent eyes, width of head across eyes 2 mm., space between .5 mm.; (3) prothorax black, much wider at base than at apex, apical half arcuately narrowed; (4) widely rounded intercoxal process. Types in author's coll.

Tanychilus ruber, n. sp.

Elongate, sharply ovate, the whole red except the eyes, tips of mandibles, and apex of femora (sometimes) black.

Head elongate in front, closely punctate, the clypeus more coarsely so than the forehead, and separated from it by an arcuate depression; forehead wider and flatter between the eyes than in *T. splendens*, Bless., space between eyes about two-thirds of the diameter of one eye; last joint of maxillary palpi securiform, of labial triangular; antennae with joints filiform and elongate, 2nd very short, 3 longer than 4, 4-11 successively and very gradually shorter than the preceding. *Prothorax* narrower than the head and truncate at apex, feebly bisinuate at base, slightly arcuately widening from apex to base; sides not so much constricted and rounded as in a typical Tanychilus, distinctly margined throughout, but only basal and apical margins visible from above, closely and distinctly punctate, with a defined medial line and large basal foveate depression, and two narrow transverse foveae near basal margin. *Scutellum* widely rounded behind, finely punctate. *Elytra* wider than prothorax at base, and more than three times as long, finely pointed at apex, striate punctate, the punctures in striae less defined and more irregular than in *T. minor*, the intervals convex, and more distinctly and closely punctate than in that species. Underside rather finely and distantly punctate, mid-tibiae curved, legs simple, femora tumid, posterior tarsi with basal joint as long as the rest combined, ♂ with distinct anal clasping appendage.

Dimensions.—♂ 9-11 x 2.6-3 mm., ♀ 13 x 4 mm.

Habitat.—Dorrigo (Tillyard), Tambourine Mountain (Hacker), Blue Mountains (Dr. Ferguson).

Five examples. Both this species and *T. minor* differ from the typical Tanychilus (striatus and *splendens*) in the wider and flatter forehead, and in the less subconic form of the prothorax, with the anterior part less constricted and rounded (in section). In these respects they form a link between *Chromomoea* and *Tanychilus*. The filiform and elongate antennae, very large eyes, head wider than apex of prothorax, the latter not cylindric or oblong, justify their inclusion under *Tanychilus* unless another ill-defined genus is to be founded for their reception. The type ♂ in the Queensland Mus., the ♀ in the author's coll.

Group II. Mandibles bifid at apex, head little produced.

1	19	Winged.	
2		Mandibles grooved (scarcely bifid) at apex (one sp. one pointed?)	*Dimorphochilus*, Borch
3	25	Mandibles distinctly bifid at apex	
4	14	Hind femora much longer than the distance from their base to the external margin of the elytra.	
5	12	Head much narrower than apex of prothorax	
6	9	Antennal joints more or less elongate and slender	
7	13	Elytra striate punctate	
8		Eyes, in general, more or less widely separated	*Homotrysis*, Pasc
9		Eyes large and approximate in ♂	*Hybrenia*, Pasc
10	14	Antennal joints short and widened at apex	
11		Upper surface metallic, colour dark	*nypsius*, Champ
12		Upper surface non-metallic, colour yellow	*Jophon*, Champ
13		Head scarcely narrower than apex of prothorax	*Ommatophorus*, Macl
14		Elytra finely striate, prothorax as wide as elytra	*Barycistela*, Blackb
15	19	Hind femora scarcely longer than the distance from their base to the external margin of the elytra	
16		Body very convex and oval (facies of *Cholera*)	*Nocar*, Blackb
17	19	Body more depressed, elytra parallel on basal half	
18		Head very narrow (facies of *Harpalides*)	*Scaletomerus*, Blackb *Otys*, Champ

19 Head wide (facies of *Alphitobius*) *Taxes*, Champ
20 25 Apterous ,
21 Eyes small, widely separated, body ovate, epipleurae wide (facies of Otiorrhyncus) *Simarus*, Borch
Ismarus, Haag
22 Eyes large, more approximate, ♀ obvate, epipleurae narrow [1]*Metistete*, Pasc
Lisa, Haag
23 25 Epipleurae scarcely separated from elytra, labial palpi oval or clavate
24 Legs without sexual characters, elytra striate punctate *Melaps*, Cart
(?) *Oocistela*, Borch
25 Tibiae dentate, femora hollowed and laminated in ♂, elytra tuberculate *Notocistela*, n.gen.

Synonymy.—*Scaletomerus*, Blackb. = *Otys*. Champ.

By comparison of types in the Brit. Mus. Mr. Blair notes that—

S. proximus, Borch. = *O. harpalinus*, Champ.

Simarus, Borch. = *Ismarus* Haag. (nom pre-occ).

The former name was substituted by Borchmann for Ismarus.

Metistete, Pasc. = *Lisa*, Haag.

(?) *Melaps*, Cart. = *Oscistela*, Borch.

The synonymy of *Lisa*, Haag., with *Metistete* is pointed out under *Metistete* below.

I am not quite sure as to the synonymy of *oocistela* with *Melaps*, having been unable to understand the last phrase in Herr Borchmann's description, "rundlich-viereckige Endglied der Maxillartaster." If this last word is a misprint, as would appear from the figure and description, and applies to the *labial* and not the *maxillary* palpi, I think the synonymy would hold good. In *Melaps pilosus* the palpi and mentum are very similar to those in the figure of *Oo. convexa*. My original classification of *Melaps* as a *Tenebrionid* was an error, the tarsal claws being finely pectinate.

Dimorphochilus, Borch.

Herr Borchmann has described three species, *D. apicalis*, *D. diversicollis* and *D. sobrinus*. It seems quite possible that all three are but varieties of a very common insect, which I have taken myself in West Australia, and which is found in all collections. Having closely examined by microscope several specimens of *D. diversicollis*, I find that the mandibles distinctly place the genus in my second group, having a broad apex, more or less distinctly divided, as in fig. given (Fauna Sud., West Aus., 1905, p. 354), though in general

1 The ♂ of *Metistete gibbicollis*, Newm., is winged.

facies this species most resembles *Tanychilus*, but with much less prolonged muzzle. *D. apicalis* was described from a single specimen, in which both mandibles had lost their points, so that the statement, "jaws probably one-pointed" (oberkeifer wahrscheinlich einspitzig) seems rather hazardous. The character chiefly relied on for distinguishing this species may be merely individual (the inner edge of each elytron at apex widened and forming two points).

D. sobrinus, also described from a single specimen, is stated in the very brief description to have one pointed mandibles. As the only other distinctions of this species from *D. diversicollis* are the want of yellow edging to the clypeus (which I find in some specimens of *diversicollis*), shorter and more compressed form, very slight differences of sculpture and more curved tibiae, this species requires further investigation. The figure given by the author of a mandible of *D. sobrinus* is so different from any I have examined, as to suggest the possibility that this also has been mutilated. The insect described by Macleay as *Metistete Pascoei* is certainly congeneric with *D. diversicollis*, and, indeed, is very close to it as a species. Macleay might well have been misled by Pascoe's scanty diagnosis of *metistete*, with its final and erroneous clause, "rest as in *Tanychilus*," but the insect is actually widely separated from *metistete*. *D. Pascoei* may be readily distinguished from *D. diversicollis* by the following differences :—

(1) Without strong sexual dimorphism.
(2) Mandibles very clearly bifid at apex.
(3) Prothorax longer, more Tanychilus like, with larger and coarser punctures on the basal half, the apical half, especially near sides, nearly smooth. (A character noted by Borchmann for *D. sobrinus*.)

The species of Dimorphochilus may thus be tabulated :—

Dimorphochilus, Borch.

Apex of mandibles distinctly bifid	*Pascoei*, Macl
Apex of mandibles slightly grooved	*diversicollis*, Borch
	var. (?) [1]*apicalis*, Borch
Apex of mandibles, one pointed (?)	[1]*sobrinus*, Borch

Homotrysis, Pasc.

Group I. The "*Carbonaria*" group.—Form very convex, sexual dimorphism pronounced. Size generally large (12-15 mm. long). Eyes widely separated.

1	7	Whole upper surface black	
2		Prothorax strongly pilose	*carbonaria*, Germ

1 Species unknown to author, of doubtful value.

3	7	Prothorax smooth (or nearly so)	
4	6	Elytral intervals punctate .	
5		Antennae and middle of tibiae red	*ruficornis*, Macl
6		Antennae and legs black (striae subgeminate)	*subgeminatus*, Macl
7		Elytral intervals laevigate	*regularis*, Macl
8		Elytra obscurely bronze, intervals clearly punctate	*debilicornis*, Haag
9	11	Elytra brown, intervals rugose	
10		Scutellum smooth (♂ with elytra sometimes red or pale brown)	*cisteloides*, Newm
11		Scutellum albo-pilose	*canescens*, Hope
12	14	Elytra variegated with patches of white hair	
13		Ground colour reddish-brown, patches irregularly placed	*maculata*, Haag
14		Ground colour black, patches regularly placed	*ornata*, n.sp.

Group II.—Sexual dimorphism not pronounced (at least in size and colour), less convex, size smaller than in Group I. (7-12 mm. long, except with *H. luctuosus*, Champ., which is 14½-17 mm.), eyes in general less widely separated.

1	14	Upper surface black	
2	4	Upper surface very nitid	
3		Prothorax at base almost, or quite, as wide as elytra, surface smooth	*laticollis*, Boh
4		Prothorax at base much narrower than elytra, surface with short erect pile	*tenebrioides*, Blackb
5	9	Upper surface subnitid black	
6		Size large, intervals almost laevigate	*luctuosus*, Champ
7	9	Size small, intervals densely punctate	
8		Eyes approximate, antennae and tibiae red	*rufulicornis*, Borch
9		Eyes more distant, antennae and tibiae black	[1]*lugubris*, Blackb
10	14	Upper surface opaque black, prothorax widest anteriorly	
11	13	Prothorax normally convex	
12		Size larger, elytral intervals nearly flat, seriate punctures small	*Pascoei*, Macl
13		Size smaller, elytral intervals convex, seriate punctures large	[1]*obscura*, Borch (?)
14		Prothorax depressed on disc, size smaller than 13	*planicollis*, Macl
15		Upper surface cyaneous, form narrow and parallel, elytra subsulcate	[1]*curticornis*, Haag
16		Upper surface brown	
17		Prothorax as wide as elytra at base, elytral intervals slightly convex	*flavicornis*, Macl
18		Prothorax not as wide as elytra at base, elytral intervals flat	*Mastersi*, Macl
19	33	Upper surface wholly red	
20	24	♂ with triangular tooth on inside of front tibiae	
21	23	Prothorax not widened anteriorly	
22		Prothorax canaliculate	*rufipes*, F
23		Prothorax not canaliculate	*rubicunda*, n.sp.
24		Prothorax widely rounded and widened anteriorly	*callabonensis*, Blackb

25	33	♂ without triangular tooth on front tibiae	
26	28	Prothorax narrowed to apex, little rounded on sides	
27		Head strongly and closely punctured between eyes	[1]*lurida*, Blackb
28		Head finely and sparsely punctured between eyes	[1]*sitiens*, Blackb
29	33	Prothorax short and strongly transverse	
30	32	Third joint of antennae longer than the fourth	
31		Elytral intervals finely and closely punctate	*fusca*, Blackb
32		Elytral intervals subgranulate	[1]*scabrosa*, Champ
33		Third joint of antennae shorter than the fourth	*rubra*, n.nom. *rufa*, Blackb
34		Elytra obfuscate or black	*bicolor*, Champ
35		Elytra with lateral vittae obfuscate or black	*limbata*, Blackb

Synonymy.—(1) *H. carbonaria*, Germ. = *H. tristis*, Germ.

(2) H. (allecula) *cisteloides*, Newm. = *H. fuscipennis*, Bless. = *H. microderes*, Pasc.

(3) H. (Helops) *rufipes*, F. = H. (allecula) *angusticollis*, Boh. = H. (allecula) *australis*, Bois. (?)

(4) *H. rufulicornis*, Borch. = *H. ruficornis*, Blackb. (nom praeocc).

(5) *H. rubra*, Cart. = *H. rufa*, Blackb. (nom praeocc).

With regard to (1) Blackburn has pointed out that *carbonaria* is the ♂ and *tristis* the ♀ of the same species.

(2) Specimens of *H. cisteloides*, Newm., and of *H. microderes*, Pasc., sent me from the Brit. Mus., show their identity with *H. fuscipennis*, Bless. This very common insect occurs in all the eastern States, from Queensland to South Australia, and, like all common insects, is very variable in size and colour, the ♂ being generally darker, sometimes nearly black. It can be distinguished from other species by the confused transversely rugose punctate sculpture of the elytral intervals. It is doubtful if *H. canescens*, Hope, is specifically distinct. Specimens labelled *canescens*, Hope, in the Blackburn coll., is a smaller insect with a white scutellum caused by a close clothing of white recumbent hair, which I have only seen from Brisbane and Northern New South Wales. (Blackburn's specimens were from Werris Creek, N.S.W.) These are also identical with a specimen from the Brit. Mus. labelled with a MS. name by Bates. For the present I have followed Blackburn's determination in this until it is possible to clear up Hope's species. I have been much disappointed in failing to get the Hope types for examination.

(3) A specmen of *Helops rufipes*, F., compared with type, was sent from the Brit. Mus., and is identical with the common Sydney

1 Species determined from description only.

species H. (allecula) *angusticollis*, Boh. Fabricius' description is misleading, not only in its brevity and misplaced genus, but in the words "caput nigrum," "thorax niger," whereas in fresh specimens the whole insect is ferruginous. Boisduval's few words of description of the species *Allecula australis* apply also to this insect, and is so determined by Blackburn.

(4) *H. ruficornis*, Blackb.—This name was praeoccupied by Macleay, and Borchmann suggested the name *rufulicornis*.

(5) If I am correct in merging the Australian species of *Allecula* with *Homotrysis*, *H. rufa*, Blackb., is praeoccupied by *A. rufa*, Solier, which may be the same insect. I have not been able to get M. Solier's paper, so that I am unable to give any opinion on this (vide infra).

Allecula.—This genus has not been clearly defined, and has been used as a "dumping ground" for Australian species of a very different facies. Following the classification of Solier and Mulsant, who reserve this genus for species having (1) only one small lamella on the penultimate joint of each tarsus, (2) antennae with joint 3 much shorter than 4, I find that none of the so-called "*Allecula*" of Australia comply with condition (1), while *H. rufa*, Blackb., is the only species I have examined which fulfils condition (2), and that species, like all the others, has two distinct lamellae on the anterior four feet, and one on the two posterior. Moreover, except in size and colour, and in variable proportions in size of antennal joints, I cannot distinguish between *Allecula* and *Homotrysis*. The species described under these genera have therefore been classed together as *Homotrysis*. After deducting those species which have been considered as *Hybrenia*, or other genera, and synonyms, I find 37 sp. described, to which I propose to add two new species. The following eight species have not been identified:—*A. costata*, Haag., *A. cylindricollis*, Bois., *A. foveicollis*, Hope, *A. Gouldii*, Hope, *A. Melancholica*, Hope, *A. nigricans*, Hope, *A. rotundicollis*, Casteln., *A. rufa*, Sol.

Notes on the Species.—*H. ruficornis*, Macl., and *H. subgeminatus*, Macl., are closely allied in size, form and sculpture, but the former has red antennae, the latter dark antennae, while the striae are narrowly branched, at least on the apical part of elytra, forming the subgeminate striae referred to in the description. I have only seen three specimens of the latter.

H. laticollis, Boh., is a common Sydney insect, found also in many other parts of New South Wales (Blue Mountains, Illawarra, Northern Rivers district), and was described as from Sydney. It is strange that Blackburn apparently failed to identify it.

H. tenebrioides, Blackb.—I have been much puzzled by the discrepancy between the description of this insect and specimens so labelled in Blackburn's handwriting, in his own coll. (kindly sent me for examination by the authorities of the South Aus. Mus.). These specimens correspond with a species I have from *Cootamundra, Forbes, Angledool* (N.S.W.), *Toowoomba*, (Q.), and *Eucla* (S.A.). They do *not* correspond with the description in colour "nigro-coeruleo, prothorace laete cyaneo-micans, sutura obscure rufescenti," being quite black. It is possible that the type was a colour var., but the description reads very much like that of *H. curticornis*, Haag., especially in the subgibbous prothorax and the elytra "fortiter striatis." As tabulated above I have considered the specimens labelled by Blackburn as correct. If this is wrong, the species so placed in my table will require a name.

H. luctuosus, Champ.—I believe I have correctly determined this in a specimen taken by myself on Mt. Wellington, Hobart, and two specimens in Mr. Lea's coll., from Gladestone, Tasmania. It is much the largest species in the group in which I place it, and as anomalous in other ways in facies somewhat like a *Tanychilus* (without, however, the prolonged head), the elytra considerably widened posteriorly. The wide, flat, almost smooth elytral interstices are a distinguishing feature.

H. obscura, Borch.—I have rather doubtfully identified this as a very common Western Australian species, found in most collections, and taken by myself at Perth, Armadale and Gin-gin. The description is meticulously detailed in head and mouth characters, which are common to many species (or only microscopically differentiated), while it omits important details in elytral sculpture, in which the *Cistelidae* vary greatly. From the other opaque black species *obscura* (as identified by me) is distinguished by its large somewhat rectangular seriate punctures separated by subcancellate ridges, on the same plane as the convex intervals. There is a specimen in the Brit. Mus. consignment bearing a MS. name by Bates.

H. arida and *H. sitiens*, Blackb., have been included in my tabulation, since they are among the few species tabulated by that author. They are unknown to me, and appear very slightly differentiated.

Allecula rugulosa, Bois.—Specimens so labelled by Blackburn in his coll., and evidently referred to (Trans. Roy. Soc., South Aus., 1891, p. 323), are, I find, identical with *Ommatophorus Mastersii*, Macl.

H. limbata, Blackb., has a wide distribution throughout New South Wales and Victoria. I have taken it on flowers at Gosford, Medlow, Jindabyne, Mount Macedon. There is a variety in which the black lateral vitta is wanting.

Homotrysis ornata, n. sp.

Ovate, nitid black, elytra adorned with white pubescent longitudinal patches placed on the 1st, 3rd and 5th intervals; head, underside and legs clothed with recumbent white, silky hair, tarsal claws red. *Head* punctate and pubescent, eyes large and separated by a distance less than the diameter of one, antennae joint 3 of equal length to 4, and slightly longer than the succeeding, 5-11 subequal. *Prothorax* about as long as wide, wider at base than at apex, basal half parallel, arcuately narrowed apically, the apex bisinuate, anterior angles rounded, depressed and feebly advanced, posterior angles obtuse, base truncate, disc with sparse shallow punctures, medial line clearly impressed on anterior half, a medial basal fovea and transverse basal depressions on each side. *Scutellum* rounded behind, pubescent. *Elytra* oval, wider than prothorax at base, shoulders well marked, raised and rounded, apex rather finely pointed; striate punctate, with a short scutellary row, and nine other rows of rather large round regularly placed and equal sized punctures placed in shallow striae (these striae only well marked on apical half), intervals nitid and impunctate, except where pubescent; the white pubescence forming short longtitudinal patches covering parts of the 1st, 3rd and 5th intervals behind the middle (when abraded these patches marked by close, fine punctures), with some irregular pubescence on apical declivity. Sternum and abdomen with rather close white pubescence, the anal segment of ♂ showing the usual falcate protuberance (meeting behind), tarsi with the usual lamellation (two on the four anterior feet, one on the posterior). Legs simple, tibiae straight.

Dimensions.—9-11 x 3.2-4 mm.

Habitat.—Cooktown, North Queensland (H. Hacker and R. J. Tillyard). A very common North Queensland species, of which seven specimens are under examination, of which six are certainly ♂. At first it seemed that it might be the ♂ of *H. maculata*, Haag., but I find both sexes of the latter, which may be distinguished by the following characters:—Size larger, colour reddish-brown, pubescence irregular and extending over the whole surface of elytra (if abraded their position indicated by punctures), prothorax coarsely punctate, with sulcate medial line, and much less cylindrical in form inter alia. In *ornata* the clear white patches are found in two regions only on the elytra, (a) a post median generally consisting of three parallel patches, (b) apical declivity, with irregular patches.

Types in the author's coll.

Homotrysis rubicunda, n. sp.

Elongate ovate, red, upper surface thickly clothed with short red tomentum; oral organs, antennae and legs pale red or testaceous. *Head* and pronotum closely, finely punctate, last joint of maxillary palpi securiform, of labial triangular, eyes large; prominent, in ♂ close in front, wider behind, in ♀ separated by a space about half the diameter of one, antennae very thin, joints linear, 4-11 subequal. *Prothorax* widest at base, gradually narrowing to apex, sides rounded and a little deflexed anteriorly, posterior angles acute, narrowly margined throughout (not evident from above on sides near anterior angles), apex truncate, base bisinuate, medial depression distinct, and two triangular basal depressions near sides. *Scutellum* triangular, rounded behind.

Elytra of same width as prothorax at base, convex and oval, shoulders evident, slightly rounded; striate punctate, the striae containing close, deep punctures, separated by fine cancellate divisions, intervals convex, finely and closely punctate, and a little transversely rugose. *Sternum*, with round, sparse and rather coarse punctures, abdomen more closely and finely punctate; fore-tibiae of ♂ with angulate enlargement inside near base; hind tibiae swollen; tarsi bilamellate on front four, unilamellate on hind feet.

Dimensions.—10 x 4 mm.

Habitat.—Cairns (A. M. Lea).

Six specimens in the S.A. Mus. belong to the *angusticollis*, Boh., section; differing from that species in the wide prothorax, and dense puncturation of pronotum and elytra. Types in the South Aus. Mus.

Hybrenia, Pasc.

1	21	Colour black	
2	17	Appendages black (or nearly so)	
3	9	Elytral intervals flat (sometimes slightly convex at sides)	
4	8	Pronotum strongly (not densely) punctate	
5		Seriate punctures much larger than interstitial	*nitida*, Blackb
6	8	Seriate punctures about the same size as the interstitial	
7		Eyes contiguous in ♂	*elongata*, Macl
8		Eyes not contiguous in ♂	*pimeloides*, Hope
9		Pronotum sparsely and finely punctate	*sublaevis*, Macl

10	17	All elytral intervals convex	
11	16	Whole surface nitid	
12	14	Pronotum densely punctate	
13		Seriate punctures large, intervals subcarinate	*subsulcata*, Macl
14		Seriate punctures smaller, intervals subconvex	*angustata*, Macl
15		Pronotum sparsely punctate, seriate punctures very large	*laticollis*, Macl
16		Pronotum smooth	*nitidior*, n.sp.
17		Head and pronotum opaque	*rugicollis*, n.sp.
18	20	Appendages red	
19		Size large (22 mm. long), posterior angles of prothorax obtuse	*grandis*, Borch
20		Size smaller (13-15 mm. long), posterior angles of prothorax acute	*planata*, n.sp.
21		Femora yellow, tibiae black	*femorata*, n.sp.
22		Elytra with alternate intervals red[1]	*vittata*, Pasc
23		Colour pale yellow	*pallida*, n.sp.

Hybrenia is, I consider, generically distinct from *Homotrysis*, though it must be admitted that the dividing line between them is not very clearly defined. In so large a group, however, as that formed by insects described under *Allecula*, *Homotrysis* and *Hybrenia*, it is convenient to seize on any characters that facilitate classification. The genus *Hybrenia* as tabulated above contains the largest insects of the Australian Cistelidae, and have the following combinations of characters:—Eyes, large and approximate (especially so in the ♂ prothorax closely applied to the elytra and generally but slightly narrower than it; form generally less convex (more flattened) than in *Homotrysis*.

Synonymy.—*H.* (*Allecula*) *pimeloides*, Hope = *H. princeps*, Blackb.
H. vittata, Pasc. = *H. insularis*, Pacs. = *H. subvittata*, Macl.

I have pointed out Blackburn's mistaken determination of *H. pimeloides* as a *Metistete* (see Metistete below). A specimen compared with Hope's type has been sent me from the Brit. Mus. As Blackburn noticed Hope's insect is larger than any specimens of *M. omophloides*, Hope, which he (Blackburn) described at length (Proc. Linn. Soc., N.S.W., 1888, p. 1436), under the name *pimeloides*. I have a specimen of *H. pimeloides*, Hope, from Angledool (Western New South Wales).

Specimens of *H. vittata*, Pasc., and of *H. insularis*, Pasc., have also been sent for examination. Pascoe carelessly overlooked the

[1] *H. vittata*, *var. concolor*, n. var., may be distinguished from the other black species by the following combinations: Appendages black, eyes of ♂ subcontiguous, pronotum and elytra intervals densely punctate, elytra striate, intervals quite flat, seriate and interstitial punctures commingled and of equal size.

subdominant but evident (in certain lights) vittae in *insularis.* (These are often very obscure). But there is no doubt of their identity. I have compared these with the type of *H. subvittata*, Macl., and find them identical. The species of *Hybrenia* are in general readily distinguished by their very strongly individualised sculpture. There is a concolorous black species in N. Queensland not to be otherwise distinguished from *H. vittata*, which I have named *H. vittata* var. *concolor*.

H. grandis, Borch.—I think I have correctly identified this species from the description. I have only seen three specimens; a pair (the sexes) in the Melbourne Mus., from Victoria, and a ♂ in my own coll., taken by myself at Medlow, Blue Mountains. The sexual differences are well defined, as stated by the author, the ♂ having a triangular enlargement on the fore tibiae. Borchmann gives West Australia as the locality, but this seems open to question, i.e., assuming my determination to be correct.

Hybrenia rugicollis, n. sp.

Elongate, ovate (♂ sometimes slightly obovate), black subnitid (head and prothorax subopaque), oral organs, antennae and tarsi piceous. Head and pronotum densely rugose punctate, eyes large, prominent and subapproximate (about .8 mm. apart in ♂ about 1.2 mm. in the ♀), antennae long, joint 1 stout, 2 very short, 3 half as long again as 4, 4-11 successively shorter than preceding, labrum with castaneous fringe, maxillary palpi with last joint triangular. *Prothorax* convex, about as long as broad, widest at middle, slightly wider at base than at apex, bisinuate at both. the anterior angles widely rounded and slightly advanced, sides well rounded, feebly sinuate near the subrectangular and well-marked posterior angles, with raised margins throughout, but lateral margins not evident from above; disc with slight medial and a transverse basal depression.

Scutellum very large, scarcely, or very finely, punctate, widely rounded behind. *Elytra* considerably wider than prothorax at base, and about three times as long, subparallel or slightly obovate, sulcate punctate, with a short scutellary and nine other rows of large square punctures, placed in wide sulci and separated by subcancellate ridges, continuous, with little difference of size to the extreme apex, the 4th and 5th connected before the apex; intervals rather sharply ridged and smooth; underside very coarsely and rather closely punctate, except the two apical segments of abdomen, these more finely but definitely punctate, the anal segment of ♂ showing a strongly protruding forceps, hollowed on the inside. Legs long, simple; tibiae straight, tarsi bilamellate on the anterior four, unilamellate on the posterior tarsi, the latter with the basal joint as long as the rest combined.

Dimensions.—19 x 6 mm.

Habitat.—Cowra, Culcairn, Young, Forbes (New South Wales) (Dr. E. W. Ferguson and the author).

A common Metistete-like insect, from the western districts of New South Wales, but winged and more elongate than in *Metistete*, and may be recognised by its combination of convex rugose prothorax, wide sulci and large punctures of the elytra, these scarcely modified to extreme apex.

Types in the author's coll.

Hybrenia planata, n. sp.

Elongate, parallel, depressed, brownish-black, oral organs, antennae and legs red; upper surface (especially head and pronotum) with rather thick clothing of short, fine, upright red hair, legs and abdomen still more densely pilose. *Head* and pronotum coarsely punctate, the punctures round and large on the neck, base of head and pronotum, smaller on epistoma and apical part of pronotum, rather irregularly and not closely placed on the last. Eyes large and approximate (about ½ mm. apart); labrum thickly fringed, antennae shorter and stouter than usual, joint 3 evidently longer than 4, 5-11 gradually shorter than preceding, and of nearly the same thickness. *Prothorax* considerably wider than long, convex and rounded in front, explanate behind, widest in front of middle, apex advanced in the middle, anterior angles rounded and deflexed, sides anteriorly well rounded, slightly sinuately converging behind to the well-defined subrectangular posterior angles (these appearing acute from above), base bisinuate, with large irregular depressions near base. *Scutellum* widely triangular, rounded behind, finely punctate. *Elytra* slightly wider than prothorax at base, and more than three times as long, sides parallel, surface rather flat, striate punctate, each with a short scutellary and nine other rows of large deep oval punctures, these larger towards sides and smaller towards apex (about 20 punctures in the sixth row), intervals a little raised and finely setose. Posternum rugose, metasternum coarsely, abdomen sparsely and more finely, punctate. Legs simple, tibiae straight.

Dimensions.—13-15 x 4-5 mm.

Habitat.—Dorrigo, New South Wales (R. J. Tillyard), Dividing Range, South Aus. (South Aus. Mus.).

Four specimens (unfortunately all ♀) examined are very distinct from all known species. The prothorax is somewhat as in *Allecula planicollis*, Macl., on a larger scale. The combination of depressed and parallel form, large seriate punctures and red appendages make it readily recognisable.

Type in the author's coll. ♂ wanting.

Hybrenia pallida, n. sp.

Elongate, elliptic, pale yellow, glabrous, prothorax, head and underside a darker shade of yellow. *Head* sparsely punctate, eyes very large and prominent, subapproximate (space between less than ⅓ diameter of one), antennae long, joints 4-11 very gradually and successively shorter than preceding. *Prothorax* subquadrate, slightly wider than long, front angles widely rounded, posterior rectangular, disc irregularly dotted with large round punctures with a more or less laevigate medial line, and irregular laevigate intervals elsewhere; base slightly sinuate and impressed near middle. *Scutellum* triangular. *Elytra* not much wider than prothorax at base, and four times as long, striate punctate, with a short scutellary, and nine other rows of large, round, closely placed punctures, becoming smaller towards apex; intervals smooth, except for a few iregularly placed punctures of about the same size as those in striae; underside coarsely and sparsely punctate, except on apical segments of abdomen, fore tibiae swollen, posterior tibiae flattened and curved, posterior tarsi with basal joint as long as the rest combined.

Dimensions.—14-15 x 5 mm.

Habitat.—C. York, North Australia.

Two ♂ specimens examined, the type in the Brit. Mus. coll., and a less perfect specimen in the Macleay Mus., Sydney. It may be recognised by the colour, the somewhat vermiculate smooth spaces on the pronotum, and the regular close punctures of elytral series, with nitid but sparsely punctate intervals. *H. vittata*, Pasc., from the same region, differs in colour, in its pubescence, closely punctate pronotum, and elytral intervals, and smaller seriate punctures.

Hybrenia femorata, n. sp.

Elongate, ovate, nitid black, with sparse, short, brown pubescence, tarsi castaneous beneath, femora with apical two-thirds pale yellow.

Head coarsely punctate, eyes of ♂ almost contiguous, of ♀ nearly 1 mm. apart, antennae long, joint 3 much longer than 4, 4-11 gradually diminishing in length, 9-11 more attenuate than preceding. *Prothorax* subquadrate, convex, sides nearly parallel, anterior angles rather squarely rounded and depressed, posterior angles (from above), rectangular, base bisinuate and closely applied to the elytra, with basal border clearly raised, surface sparsely covered with irregularly placed large round punctures (larger and more thickly placed than in *H. sublaevis*, Macl.), with upright reddish hairs, medial depression distinct, though not uniform in extent or impression, two large basal depressions. *Scutellum* arcuate triangular, punctate. *Elytra* rather wider than prothorax at base, elongate, obovate, slightly widened beyond middle, finely striate, the striae showing some signs of seriate punctures only near base; the basal half showing an arrangement of series of large round punctures, arranged in rows of three, with smooth subreticulate intervals, towards the middle this reticulation becoming more transverse and irregular, on apical part the sculpture much finer, showing the simple striation more clearly. Sternum coarsely, abdomen more finely punctate, fore and mid tibiae with lines of castaneous tomentum on inside. Legs simple, tibiae straight, posterior tarsi with basal joint as long as the rest combined, tarsi with the usual lamellation.

Dimensions.—16 x 6 mm.

Habitat.—Cooktown, North Queensland (H. Hacker, C. French).

A common North Queensland species, which appears to have escaped notice, and found in most collections. Twelve specimens examined. An ally of *H. sublaevis*, Macl., but the sculpture is much coarser, and the leg coloration is constant. The sexual distinction seems confined to (a) distance between eyes, (2) apical segment of ♂ showing the usual forceps. Types in the author's coll.

Hybrenia nitidior, n. sp..

Elongate, parallel, nitid black, glabrous; palpi, antennae and tarsi piceous, labrum with red citea. *Head*, epistoma, sparsely punctate, forehead impunctate, eyes large and prominent, in ♂ subcontiguous (separated only by a narrow carina), in ♀ more distant; antennae long, joint 3 longer than 4, 4-11 gradually diminishing in length, 9-11 more attenuate than the preceding. *Prothorax* convex, subquadrate (3 x 3.7 mm.), apex and base feebly bisinuate, widest before the middle, sides well rounded and feebly sinuately narrowed behind, anterior angles widely obtuse and deflexed, posterior angles (seen from above) rectangular, margins raised throughout, the lateral margins not evident from above, disc *quite smooth and impunctate*, with distinct but shallow medial depression throughout its length, a transversal basal depression and two small foveae at base near the angles. *Scutellum* longitudinally oval, impunctate.

Elytra considerably wider than *prothorax* at base, and nearly four times as long, shoulders moderately pronounced, but rounded, sides parallel for the greater part in both sexes, striate punctate with a short scutellary row, and nine other rows of large, deep, oval punctures, larger towards sides (except extreme lateral row), smaller towards suture, and much smaller towards apex, striae deep, subsulcate, the 4th and 5th ending, but not connected, on apical declivity, intervals convex and impunctate; posternum coarsely punctate, episterna with a few very large punctures, metasternum with a few large punctures near base; abdomen scarcely punctate. Legs long, simple, tarsi with usual lamellation.

Dimensions.– 17 x 5 mm.

Habitat.—Otford, Gosford, Bulladelah (the author), Tambourine Mountain (A. M. Lea and the author).

A common species in New South Wales and South Queensland, showing relationship to *H. nitida*, Blackb., and *A. laticollis*, Macl., but distinguished from both by its impunctate pronotum. The seriate punctures are larger, and elytral striae deeper and wider than in *H. nitida*, though smaller and less pronounced than in *H. laticollis*.

Types in the author's coll.

Nypsius, Champ.

Nitid, metallic, flower haunting insects, with a short, wide prothorax, deeply canaliculate, and sometimes deeply foveated, described from Tasmania. Both species occur in Mr. Lea's fine coll. There are also two specimens which cannot be distinguished from *N. foveatus*, Champ., except that the foveae are wanting or subobsolete. The species varies in size from 6 to 9½ mm. long. I have taken *N. aeneo-piceus*, Champ., in the Australian Alps, Vic. (near St. Bernard's Hospice). The two sp. may be thus distinguished :—

1 Elytral intervals with a single row of widely separate punctures ... *aeneo-piceus*, Champ

2 Elytral intervals thickly punctate ... *foveatus*, Champ

Ommatophorus, Macl.

Clearly separated from *Homotrysis* by the short transverse prothorax, the short, thick, serrated antennal joints, and the thick clothing of upright hair, as stated above, Blackburn's determination of *A. rugulosa*, Bois., proves to be *O. Mastersi*, Macl., but there is too much doubt about a Boisduvalian sp. to give it precedence. I have added a n. sp., which may be distinguished as follows:—

1 Elytra with sides and apex black, antennae and legs red *Mastersi*, Macl
(?) A *rugulosa*, Boisd

2 Elytra concolorous red, antennae, tibiae and apex of femora black *atripes*, n.sp.

Ommatophorus atripes, n. sp.

Ovate, red, upper surface and legs sparsely clad with long, upright white hair, oral organs, antennae and legs black. *Head*, eyes large, occupying the greater part of upper surface in front, and approximate in ♂ more widely separate in ♀, antennae, very short, joints 3-10 subtriangular, 11th ovate, 3 longer than 4, 6-8 much widened, succeeding joints attenuated; forehead sparsely punctate. *Prothorax* short, transverse, sides straight behind, widely rounded and deflected anteriorly, apex truncate, base bisinuate, margined, with transverse depression near margin, posterior angles rectangular, disc with sparse round punctures, closer near sides, showing laevigate spaces near middle, medial basal fovea large, without medial line. *Scutellum* rounded behind. *Elytra* considerably wider than prothorax at base, shoulders rather tumid and rounded; ovate or obovate, slightly widened behind middle in ♀ punctate-striate, seriate punctures large, round and regular; intervals nearly flat, each with a single line of irregularly placed punctures, smaller than those in striae, each bearing a long white hair. Underside moderately punctate, legs simple, tibiae straight, enlarged at apex, tarsi lamellate as usual, and finely pectinate.

Dimensions.—♂ 6.2 x 2.5 mm., ♀ 8 x 3 mm.

Habitat.—Brisbane (H. Hacker), Muswellbrook, N.S.W. (Dr. E. W. Ferguson), Tamworth (A. M. Lea).

Six specimens examined, show the usual sex distinction in distance between the eyes. The short transverse prothorax, pilose surface, stouter legs and antennae show it as an ally of *Mastersi*, Macl. Type ♂ in the Queensland Mus., ♀ in the author's coll.

Nocar, Blackburn.

1	9	Elytra striate punctate	
2	8	Intervals flat, or nearly so	
3	5	Punctures in striae distinctly larger than those of intervals	
4		Bicolorous, elytra yellow or red with black margins	*australicus*, Blackb
5		Concolorous, elytra pale red or yellow	*securigerus*, W. S. Macl
6	8	Punctures in striae scarcely larger than those on intervals	
7		Size larger, shortly and sparsely pubescent, tibiae curved	*convexus*, Macl
8		Size smaller, strongly pubescent, tibiae straight	*depressiusculus*, Macl
			ovatus, Macl
			debilis, Blackb
			var. *latus*, Blackb
9		Intervals convex and rugose, colour black	*rugosus*, n.sp.
10		Elytra non-striate	*simplex*, Blackb

Cistela securigera, W. S. Macl. (type in the Macleay Mus.), is a Nocar, as is also *C. convexa*, Macl.

C. ovata, Macl.—The type, in the Aus. Mus., is in a bad condition, and appears to have fallen into a gum bottle. Where the sculpture can be seen it is almost certainly = *Nocar depressiusculus*, Macl.

C. polita, Macl., is a *Scaletomerus* and = *S. harpaloides*, Blackb.

The following synonymy is my conclusion after a close examination of co-types of Blackburn's species and Macleay's types :—

N. debilis, Blackb. = *N. latus*, Blackb., *var.* = *N. depressiusculus*, Macl. = *N. ovatus*, Macl.

N. latus, Blackb., is larger than *debilis*, but smaller specimens occur amongst them, with slight individual differences. I have been unable to find the constant difference of elytral sculpture noted by Blackburn (Trans. Roy. Soc., South Aus., 1891, p. 329). The following species is undescribed :—

Nocar rugosus, n. sp.

Oval, black, subnitid glabrous; labrum, tarsi and basal joints of antennae reddish. *Head* and *pronotum* densely punctate, eyes rather close, in ♂ wider apart than in *N. securigera*, W. S. Macl., antennae stout, joints subtriangular, widened and angled in front. *Prothorax* widest at base, arcuately coverging to apex, there about as wide as head, more elongate, and narrowed anteriorly than usual, front angles obsolete, posterior acute, base bisinuate, with a small medial and two larger sublateral foveae. *Scutellum* triangular. *Elytra* as wide as prothorax at base, deeply striate punctate, seriate punctures large, round and regular, intervals convex, finely and closely punctate, and rather coarsely transversely rugose. Underside with sternum coarsely, abdomen finely punctate.

Dimensions.—7.5 x 3 mm.

Habitat.—Queensland.

I find two specimens both ♂ in my collection, which differ markedly from the common *depressiusculus*, Macl., in the darker and stouter antennae, less convex and more elongate prothorax, the strongly rugose and convex elytral intervals, with much larger seriate punctures, and almost hairless surface. Type in the author's coll.

Scaletomerus, Blackb.

Otys, Champ.

1	6	Body glabrous, tibiae unarmed	
2	5	Upper surface more or less concolorous, antennae ferruginous	
3		♂ with ventral segment deeply foveate, fore and mid tibiae dilated, eyes pale	*harpaloides*, Blackb
4		♂ with ventral segment lightly impressed, tibiae not dilated, eyes black	*proximus*, Blackb (Otys) *harpalinus*, Champ
5		Elytra more deeply striate, intervals more clearly punctate than in 4	[1]*pallens*, Champ
6		Head, prothorax and antennae black, elytra and legs testaceous	*bicolor*, n.sp.
7		Body pilose, protibiae dentate, post tibiae dilated, sinuate and grooved	[1]*armatus*, Champ

The species of this genus are very closely allied. As stated above. *S. proximus*, Blackb. = *S.* (*otys*) *harpalinus*, Champ. (fide H. K Blair). Having examined co-types of *harpaloides* and *proximus* in the Blackburn collection, the only distinction I can make out clearly lies in the colour of the eyes, *black* in *proximus*, *pale* in *harpaloides*. There is also a slight enlargement of the pro and meta tibiae in the ♂ of *harpaloides;* but I am not sure of having seen both sexes of *proximus*, in which the tibiae of ♂ are simple, according to Blackburn, while Champion states of *O. harpalinus*, "anterior and intermediate tibiae sinuous within." *Otys pallens* was described from a single mutilated specimen. It is possible that the first four names in the above table are merely varietal forms of one widely distributed species. I have specimens of *proximus*, taken by myself near Sydney. A specimen taken also by me at Cottesloe (near Perth, W.A.) differs from all the above,

1 Species tabulated from description only.

except *armatus*, in its strong pubescent clothing, but being much mutilated it is inadvisable to describe it. It differs, moreover, from *armatus* in its densely punctate upper surface.

Scaletomerus bicolor, n. sp.

Oblong, oval, convex, glabrous, nitid. Head, prothorax, antennae and tarsi black, elytra and legs testaceous, abdomen piceous. *Head* very finely and closely punctate, eyes moderately large, not prominent, widely separated, antennae short and stout, joints 4-11 successively shorter than preceding, and oval (submonite form). *Prothorax* widest at base, somewhat narrowed and deflected towards apex, rounded on sides, anterior angle rounded, posterior obtuse, disc minutely and closely punctate, with indications of a depressed medial line. *Scutellum* black, triangular. *Elytra* of same width as prothorax at base, ovally rounded behind, very finely striate punctate, intervals flat and minutely punctate. Underside densely and finely punctate. Legs simple.

Dimensions.—4 x 2 (vix) mm.

Habitat.—North-West Australia (Macleay Mus.).

Two specimens (types) in the Macleay Museum differ from the described species markedly in colour, the more narrowed prothorax, and the stouter antennae.

Simarus, Borch.

Ismarus, Haag., Rut.

1 3 Intervals of elytra regular and convex
2 Form rather widely ovate, pustules on surface small *Goddeffroyi*, Haag
3 Form elongate elliptic, pustules on surface coarse *elongatus*, n. sp.
4 Alternate intervals carinate, irregularly interrupted *carinatus*, Haag

This genus consists of *Otiorrhyncus*-like insects, with ovoid prothorax and elytra, the latter wider than the former. I have examined specimens of *S. Goddeffroyi*, Haag., from Peak Downs, Townsville, and other parts of Queensland, of *carinatus*, Haag., from Port Darwin.

Simarus elongatus, n. sp.

Elongate, elliptic, dark brown, thickly clad with short reddish bristles, oral organs and tarsi red, antennae fuscous. Head and prothorax closely granulose, the sculpture (of head especially) often concealed by the hairy clothing. Eyes large and widely separated, clypeal depression arcuate; antennae joint 3 longer than 4, but less than 4-5 combined, 4-11 successively shorter than preceding, joints 3-7 narrowly obconic, 8-11 narrowly ovate, the three apical joints finer than the rest. *Prothorax* bulbous, about as long as wide, truncate at apex and base, sides well rounded, greatest width in front of middle, wider at base than at apex, margins and angles deflexed, all angles obtuse, the posterior the more widely so, surface evenly convex without depressions or medial line. *Scutellum* triangular, rounded behind. *Elytra* elongate and convex, two and a-quarter times as long as the prothorax, and of same width as prothorax at base, elliptically widening without humeral angles, widest behind the middle; striate punctate and pustulose, with eight wide and rather deep striae, containing series of large square punctures, the intervals wide, convex, and thickly studded with rather large pustules, each bearing a short, upright bristle; underside pustulose, with bristly clothing most evident on sternum and sides of abdomen. Legs moderately long, the femora finely pustulose, tibiae and tarsi with strong fringe of castaneous hair, posterior tarsi with basal joint as long as the rest together, the four anterior feet with two penultimate joints lamellate, the posterior with one lamella.

Dimensions.—11-12 x 4-4.5 mm.

Habitat.—Cue, West Australia (H. W. Brown), Nicol Bay (W. Duboulay), Roeburne (Mr. Lea's coll.)

Six specimens examined, show very slight sexual distinctions, and evidently differ from *S. Goddeffroyi*, Haag., in the more elongate form, much more convex (subcarinate) elytral intervals, coarser and more close pustulation of surface, with denser hairy clothing. From *S. carinatus*, Haag., it differs more widely in its much narrower form, as also in its uninterrupted intervals.

Types in the author's coll.

Metistete, Pasc.

Lisa, Haag.

1 (5) Elytra obovate in ♀ more or less ovate in ♂

2 Surface subdepressed, prothorax densely rugose punctate and subopaque ... *gibbicollis*, Newm

3 (5) Surface convex

4 Prothorax closely punctate (scarcely rugose) and nitid ... *omophloides*, Hope
pimeloides, Blackb. (nec Hope)
(*Lisa*) *singularis*, Haag

5 Prothorax with round irregularly and not closely placed punctures ... *punctipennis*, Macl

6		Prothorax impunctate	*ebeninus*, n.sp.
7	12	Elytra elongate ovate	
8	11	Elytral intervals little raised	
9		Prothorax densely rugose punctate, fore tibiae dentate	*armata*, n.sp.
10		Prothorax obsoletely, but frequently, punctate, tibiae unarmed	[1]*incognita*, Blackb
11		Prothorax sparsely and subobsoletely punctate	*Lindi*, Blackb
12		Elytral intervals costiform	*costatipennis*, Champ

(1) The species determined by Blackburn as *pimeloides*, Hope, and fully described by him (Proc. Linn. Soc., N.S. Wales, 1888, p. 1436) has been definitely determined by Mr. Blair as M. (Allecula) *omophoides*, Hope., while *M. gibbicollis*, Newm. (which Pascoe named as the type of the genus), is not synonymous with that species. *M. omophloides*, Hope, is common in South Aus., N.W. Victoria, western parts of N.S. Wales, and South Queensland, while the *gibbicollis*, Newm., is found near Sydney, the Blue Mountains, and other parts of New South Wales. From identified specimens in the British Museum, the elusive genus *Lisa* has been tracked down, as a synonym. Thus M. (Allecula) *omophloides*, Hope = *pimeloides*, Blackb. (nec Hope) = *Lisa singularis*, Haag.

Allecula punctipennis, Macl.—An examination of the type of this in the Aus. Mus. shows it to be clearly a *Metistete*, while there is little doubt but that *A. Cisteloides*, Newm., placed in this genus by Borchmann, is a Homotrysis = *H. fuscipennis*, Bless. = etc. (vide infra). The ♂ is winged.

A. pimeloides, Hope, is almost certainly the insect described by Blackburn as *Homotrysis princeps*, which is, in the author's opinion, a true Hybrenia, and has been dealt with above as *Hybrenia pimeloides*, Hope.

Metistete armata, n. sp.

Elongate, subparallel, nitid brownish-black, with moderate clothing of short, upright reddish hair, labrum, palpi and tarsi red, antennae and tibiae darker red. *Head* and *pronotum* closely rugose punctate, the head and anterior part of pronotum longitudinally rugose, the basal part of pronotum closely and rather coarsely punctate. Eyes large, prominent and separated by a distance equal to the diameter of one, antennae wanting beyond the fifth joint, joint 3 considerably longer than 4. *Prothorax* bulbous, with sides and angles deflexed, as long as wide, about as wide at base as at apex, widest in front of middle, anterior angles widely rounded, posterior

1 Species unknown to the author.

angles obtuse, sides well rounded, without any medial line or foveae. *Scutellum* widely triangular. *Elytra* wider than prothorax at base, subparallel and subcylindric on basal two-thirds; punctate striate with about ten rows, besides a short scutellary row of rather large, deep, rectangular punctures, separated by subcancellate ridges, the two lateral rows less distinct and not impressed in striae; intervals convex, with a single row of punctiform impressions on each. Prosternum with very coarse punctures, rest of undersurface rather strongly and sparsely punctate, anal forceps strongly protruding (evident from above), reddish in colour. Legs long, front and middle femora angulately swollen and tomentose within, front tibiae with large triangular tooth on the inside at the middle, hind tibiae flattened on the inside and very sinuous, posterior tarsi with basal joint as long as the rest combined. Tarsi bilamellate on the four anterior feet, unilamellate on the posterior.

Dimensions.—13.5 x 4 mm.

Habitat.—Cue, West Australia (H. W. Brown), Kalgoorlie (F. H. Duboulay).

Two male specimens in my coll. might possibly be the male of *M. incognita*, Blackb., but the words, "prothorace obsolete, crebre et subtilius punctatis," and of the elytra "puncturis in striis" (his leviter impressis), "interstitiis subplanis," are inconsistent with this view. The strong tibial and femoral characters (and certainly the anal forceps) are probably sexual. Type in the author's coll.

Metistete ebeninus, n. sp.

♂ ovate, ♀ obovate, very nitid ebony black, glabrous, palpi and antennae piceous red. *Head*, with fine, shallow punctures on epistoma and neck, generally smooth between eyes (in one ex., also punctate there), labrum showing yellow membrane at base and red cilia at apex, arcuate clypeal suture well marked; eyes large, equally distant in both sexes (about half diameter of one eye), antennae of moderate length, joint 1 very tumid, 3 longer than four, 4-11 of nearly equal length, 9-11 attenuated. *Prothorax* convex, and strongly transverse (about 2 x 3 mm.), apex and base of about equal width, slightly arcuate at apex, front angles wide, deflexed, and a little advanced, sides widely rounded, widest at middle, slightly sinuate before the subrectangular (subacute as seen from above), posterior angles, base bisinuate, with rather thick margin, lateral margins not evident from above, apical margin very fine, disc very convex, quite smooth and mirror-like, a shallow basal medial and two transverse depressions near hind angles. *Scutellum* wide, rounded behind, smooth.

Elytra considerably wider than prothorax at base, and about four times as long (about 9 x 4.8), convex striate-punctate, with a short scutellary, and nine other rows of large oval punctures, rapidly becoming smaller on apical half, and almost concealed in striae on declivity; striae subsulcate on basal half, narrow on apical, epipleurae with a single row of large punctures. Prosternum with large round punctures, apex of mesosternum, and the episterna coarsely punctate, abdomen finely striolate, submentum with large yellow patch at base, legs stout and moderately long, mid and hind tibiae curved, ♂ with short, thick anal forceps.

Dimensions.—11-13 x 4-5 mm.

Habitat.—Mt. Barker and Swan R. (A. M. Lea), Cleve, S.A. (S.A. Mus.), W.A. (H. Brown).

Four specimens, two of each sex, examined. The species is very distinct from the combination of very nitid impunctate prothorax and the very coarse and characteristic puncturation of the basal half of elytra, suggesting some of the species of *Hypaulax*.

Type ♂ in the author's coll., ♀ in Mr. A. M. Lea's coll.

Melaps, Cart.

? *Oocistela*, Borch.

1		Elytra irregularly punctate	*cisteloides*, Cart
2	8	Elytra striate punctate	
3	7	Glabrous	
4		Intervals of elytra flat	*victoriae*, n.sp.
5	7	Intervals of elytra convex	
6		Seriate punctures coarse and distant	*punctatus*, n.sp.
7		Seriate punctures small and close	[1]*convexa*, Borch
8		Pilose	*pilosus*, n.sp.

Melaps victoriae, n. sp.

Ovate, convex, nitid black, glabrous, epistoma, oral organs, antennae and underside red. *Head* and *pronotum* with rather close, fine, shallow punctures, eyes (from above) round and widely separated, head rather short and wide, epistomal suture wide and nearly straight, antennae moderately long, joint 2 more than half as long as 1, 3 scarcely longer than 4, and rather wide, 4-10 subequal, slightly enlarged at apex, 11 as long as 10, ovate. *Prothorax* convex, longer than wide, subtruncate, and equally wide at apex

1 Species determined only by description.

and base, anterior angles deflexed and rounded, deflexed sides (seen from above), subparallel, with anterior slightly rounded (seen sideways), the sides appear well rounded in the middle, posterior angles (from above) sharply rectangular; disc evenly, closely, not deeply, punctate, a narrow basal margin perceptible, without medial line or basal depression, two small transverse foveae near hind angles. *Scutellum* transverse, oval.

Elytra convex, ovate, of same width as prothorax at base, and about three times as long, scarcely widened behind, sides deflexed and without clearly defined epipleurae; finely striate-punctate, the seriate punctures round and regular, in the sutural striae close, in others more distant; the striae only well marked near suture and sides; intervals flat, with a few sparse punctures of the same size as those in striae. Procoxae narrowly separated by raised part of prosternum; sternum coarsely, abdomen finely punctate striolate, posterior intercoxal process widely arcuate triangular, abdomen and legs thickly clothed with red hair, femora tumid, tibiae straight, slightly enlarged at apex, anal segment of abdomen showing short curved forceps. ♀ wanting.

Dimensions.—6 x 2 mm.

Habitat.—Victorian Alps (Blackburn coll., South Aus. Mus.).

A single ♂ specimen shows a close affinity to *M. cisteloides*, Cart., from Kosciusko, from which it is distinguished by its more narrow, cylindric form, and its definite but fine striations of the elytra.

Type in South Aus. Mus.

Melaps punctatus, n. sp.

Biovate (prothorax and elytra separately ovate), convex, glabrous, subnitid black, antennae and legs reddish, palpi and tarsi paler red. *Head* and pronotum finely and very densely punctate, epistomal suture straight, short and lightly impressed, eyes nearly round and widely separated, maxillary palpi, last joint triangular, labial with last joint spherical, mandibles bifid at apex, antennae moderately long, rather stout, 3-11 successively shorter and thicker, apical joints piriform, 11th oval. *Prothorax* longer than wide, base and apex of equal width, subtruncate at both, base evidently margined, lateral margins not evident from above, sides evenly rounded, anterior angles rounded and deflexed, posterior obtuse; base with small medial and two shallow lateral depressions; disc evenly, closely punctate without medial line. *Scutellum* transverse, oval and convex. *Elytra* of same width as prothorax at base, and about twice as long, widest slightly behind middle, tapering at apex; punctate-striate, with a short scutellary row of about three punctures, and nine other rows of large, deep, oval punctures connected by (rather than lying in) striae, the two sutural striae subsulcate, intervals subconvex, quite smooth and impunctate, the punctures smaller, and striae more marked at apex. Tibiae, especially posterior, strongly curved, underside very coarsely punctate on sternum, finely striolate on abdomen, posterior tarsi, with basal joint as long as rest combined, with a single lamina on the penultimate joint, and two on each of the four anterior feet.

Dimensions.—6-8 x 2-2.5 mm.

Habitat.—Wolgon Valley, Blue Mountains, N.S.W. (the author and C. Deane).

Specimens taken on ground under stones, can be readily distinguished from allies by large, deep punctures of elytral series. Types in the author's coll.

Melaps pilosus, n. sp.

Shortly ovate, coppery or brownish-black, nitid, upper surface rather thickly covered with long, upright reddish hair, oral organs, antennae and legs red (in one ex. legs testaceous, with knees obfuscate), underside darker red. *Head* short and wide, rather closely and deeply punctate, epistomal suture straight and deep, eyes (from above) round, smaller than in *M. victoriae*, widely separated; antennae slender, joint 1 very short, 2 nearly as long as 1, 3 twice as long as 1, 3-11 subequal and lineate; maxillary palpi with last joint triangular, apical side longest. *Prothorax* convex, subquadrate, sides less deflexed than in the other species, wider than long, subtruncate and of equal width at apex and base, widest in front of middle, sides a little rounded, more strongly anteriorly, very gradually posteriorly, anterior angles deflexed, but evident and obtuse, posterior obtuse, disc rather coarsely and not very closely punctate, a long hair springing from each puncture, two small lateral basal foveae, narrow basal margin perceptible. *Scutellum* transverse, oval, raised. *Elytra* very slightly wider than prothorax at base, convex, oval, a little widened behind middle, strongly striate punctate, the striae deeply marked throughout, seriate punctures round, deep, regular and close, intervals nearly flat, each with a single line of punctures, smaller and more distant than those in striae; sternum coarsely, abdomen more finely punctate, a fine hair springing from each. Legs strongly pilose, tibiae straight, tarsi as in *M. victoriae*.

Dimensions.—7 x 3 mm.

Habitat.—Bridgetown, W.A. (the author), Champion Bay (Duboulay, Brit. Mus.), Port Augusta, S.A. (Brit. Mus.), Port Lincoln, S.A. (A. M. Lea), Ardrossan, S.A. (T. G. Tepper).

Five specimens examined. I have been unable to see any sexual distinctions, though I believe one specimen at least to be male. The species is clearly distinguished by its shorter, wider prothorax, and strongly pilose surface. Type in the author's coll.

Notocistela, n. gen.

Body ovate, elliptic, convex, prothorax cordate, elytra without well-defined epipleurae, apterous; mandibles bifid at apex, mentum very transverse, upper edge faintly three-sided, with slightly convex middle lines, maxillary palpi, with last joint widely triangular, with the apex as long as the other joints combined, labial palpi with last joint subclavate (subquadrate, with rounded angles), elytra with setiferous pustules on the intervals, fore and mid tibiae dentate in both sexes, posterior tibiae of ♂ enlarged, laminated and hollowed as in *Alemconis;* rest as in *melaps.*

Notocistela tibialis, n. sp.

Ovate, glabrous, head and prothorax subopaque black, elytra nitid metallic black, underside pitchy red, oral organs, antennae and legs red. *Head* moderately elongate, epistoma truncate in front with rectangular angles, closely and strongly punctate and limited behind by deep, straight suture, forehead densely subconfluently punctate and a little rugose, eyes (from above), round and widely separated, antennae rather long, setiferous, joint 2 half as long as 1, 3 considerably longer than 4, 4-11 successively and gradually diminishing in length, the apical three slightly attenuated. *Prothorax* subcordate and convex, widest in front of middle, apex truncate, and about as wide as the feebly arcuate base, very finely margined at apex, more widely so at base, side margins not evident from above, anterior angles defined and obtuse, sides rounded anteriorly, slightly sinuately narrowed before the (from above) subrectangular posterior angles, disc densely, subrugosely punctate as on forehead, with a few sparse short hairs, without medial line or distinct foveae. *Scutellum* transverse and convex. *Elytra* convex and narrowly ovate, of same width as prothorax at base, shoulders distinct, finely striate punctate, punctures in striae small, round and closely placed, intervals with general surface flat, the 3rd, 5th and 7th, with rather large conical tubercles placed widely apart, each bearing a short, upright hair, a few irregular smaller tubercles at apex outside the 7th interval. Sternum finely punctate, abdomen almost smooth, or very finely striolate. Legs long, femora tumid, fore and mid tibiae with sharp tooth on the inside at middle, all tibiae curved and somewhat flattened, posterior tibiae of ♂ enlarged, flattened and hollowed (as in *Alcmeonis*, but more so). Tarsi bilamellate on four anterior, unilamellate on posterior feet.

Dimensions.—9 x 2.8 mm.

Habitat.—Perth (H. Giles and the author), Champion Bay (Duboulay, Brit. Mus. coll.).

Three specimens examined, all apparently ♂ of which one was taken by the author in a rotten "*Nuytsia*" trunk at South Perth. The British Museum specimen is apparently immature, and reddish-brown in colour, but being glued to a card I have not examined the last segment of abdomen, the other two show the distinct forcipital process. The special elongate elliptic form, sculpture and tibial characters seem sufficient to separate this and the succeedign species generally from *Melaps*. Type in the author's coll.

Notocistela pustulatus, n. sp.

Very similar to the preceding in form, but differing essentially in the following:—Elytra reddish-brown, upper surface and legs thickly clothed with long, upright red hairs. Elytra with *all* intervals more closely studded with smaller, less raised setiferous pustules, these more elevated towards apex. Tibial characters very much as in *N. tibialis*, but less accentuated, especially in the posterior tibial characters. Rest as in *N. tibialis*.

Dimensions.—7.5-9 x 2.5-2.8 mm.

Habitat.—Shark Bay (Blackburn coll., South Aus. Mus.), Roebuck Bay (Melbourne Mus.), Hermannsburg, Cent. Aus. (H. J. Hillier, Brit. Mus. coll.).

Three specimens examined, 2 ♂, the 3rd specimen (Brit. Mus. coll.), shows a small tooth on the fore and mid tibiae, but is without the enlargement of "hollowing out" of the posterior tibiae. The differences between this sp. and *N. tibialis* are constant, and too distinctive to allow it to be treated as a *var.* Type ♂ in South Aus. Mus., ♀ in Brit. Mus.

EXPLANATION OF PLATE.

Fig. 1.—Forciculate anal appendage of *H. nitida*, Blackb. ♂ (dissected).

2.—Penis of *H. nitida*, Blackb. (dissected).

3.—5th abdominal segt., showing appendages, etc., of *H. cisteloides*. Newm.

4.—5th abdominal segt., showing appendages, etc., of *H. rufipes*, F.

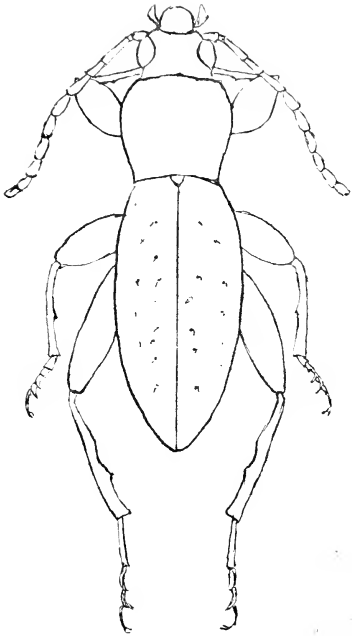
5.—5th abdominal segt., showing appendages, etc., of *Hybrenia H. rugicollis*, n. sp.

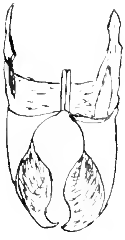
6.—5th abdominal segt., showing appendages, etc., of *H. vittata*, Pasc.

7.—5th abdominal segt., showing appendages, etc., of *H. femorata*, n. sp.

8.—5th abdominal segt., showing appendages, etc., of *Metistete, omophloides*, Hope.

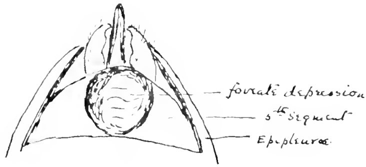
Text-figure of Notocistela tibialis, n. gen. and sp.





1

2

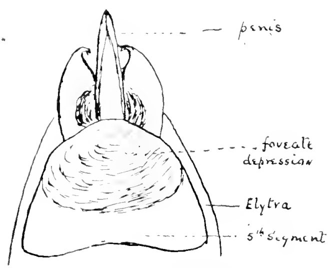

foveate depression
5th segment
Epipleurae

3

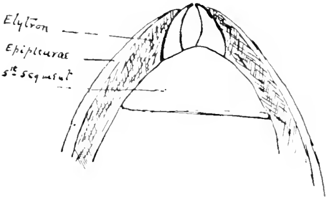

fovea
5th segt
4th segt
Elytron

4

5


penis
foveate depression
Elytra
5th segment

6


Elytron
Epipleurae
5th segment

7

8

[Proc. Roy. Soc. Victoria 28 (N.S.), Part I., 1915.]

Art. III.—*Notes on certain species of Pterostylis.*

By R. S. ROGERS, M.A., M.D.

(With Plates VII.-IX.).

[Read March 11th, 1915].

It has recently been discovered that botanists in Victoria and South Australia when referring to the orchid *Pterostylis cucullata*, Br., were dealing with two very distinct species of the genus.

In South Australia the name has always been applied to the plant known in Victoria as *Pterostylis Mackibbini*, F.v.M. This determination had the sanction of Tate, and, as I personally remember, of Baron von Mueller also. This is a plant of sturdy habit, radical leaves very large and generally crowded, flowers pubescent with characteristic chocolate markings and usually rather docked sepals.

In Victoria the name is retained for a plant of very different appearance; a slender plant, whose leaves are not particularly large and not crowded at the base, whose flowers are glabrous and green without any brown markings, and whose sepals have long caudâe.

Reference to the National Herbarium in Victoria shows that the Baron held the opinion for very many years that the plant with the brown facings was the true *P. cucullata*, Br. One of his earliest specimens (1848) from St. Vincent's Gulf, South Australia, is marked "*P. cucullata*, var.," and another bearing a much later date (1882) from Mt. Lofty, S.A., is marked "*P. cucullata*" What caused him to change his views in this matter is not clear, unless it was the receipt of very striking specimens, almost a foot high, collected by Mr. Mackibbin in King's Island in 1888.

He published his description of *P. Mackibbini* in the Victorian Naturalist in 1892 (vol. IX., p. 93).

The inadequacy of mere verbal description and the great advantage of illustrations becomes evident on reference to Brown's original description of his species (Prod. 327), and that of Bentham (Fl. Aust., VI., 357). Making the usual allowances for variations, geographical and otherwise, these descriptions serve almost equally well for the South Australian *P. cucullata*, or for the very dissimilar Victorian plant known by the same name.

In order to correct this anomaly an application was made to Kew (England) for typical specimens of the true plant. This has afforded me the opportunity of examining nine specimens from the Hooker Herbarium. The sheet contained ordinary-sized and dwarfed plants collected by R. C. Gunn (Hooker's collector) at Circular Head, Tasmania, in 1836. They are unquestionably identical with the plant known as *P. cucullata*, Br., in this State and *P. Mackibbini*, F.v.M., in Victoria. Quite recently Dr. Rendle, of the British Museum, supplied me with a photograph (and some notes) of the type specimen in that Herbarium. This confirms the opinion I had previously formed that Brown's species and *P. Mackibbini*, F.v.M., are one and the same. The type comes from Port Dalrymple in Northern Tasmania.

The identity of Brown's species having thus been established, it becomes necessary to give a description and a new name to the plant which has usurped its place in Victoria. With the fate of this plant, is also involved that of another orchid, which has hitherto ranked as one of its varieties, but which, I feel satisfied, is entitled to full specific rank. These will be described as *P. falcata* and *P. alpina* respectively.

It would seem appropriate here to say also a word regarding the plant known as *P. furcata*, Lindl., which has been recorded from Victoria, Tasmania, and South Australia. Its rank has been questioned by F. von Mueller and also by Bentham. Lindley's specimens came from R. C. Gunn's collection (Tasmania); so also did Hooker's (Fl. Tasmania, II., 20). A careful analysis of plants from the same collection has enabled me to supply the accompanying illustration of *P. furcata*, which, together with the incidental remarks on the differential diagnosis between this and the two new species, will serve to support Lindley's view that it is entitled to specific rank.

The illustrations of *P. furcata*, *P. falcata* and *P. alpina* are from herbarium specimens. That of *P. cucullata* is from the living plant.

Pterostylis falcata, sp. nov.

Plant varying in height, usually five to nine inches. Basal leaves present, seldom strictly rosulate; ovate-lanceolate or oblong-lanceolate; sessile, or almost so; 7-9 nerved; rarely exceeding 1½ inches. Stem slender, glabrous; bracts 2 to 3, lanceolate, sheathing, upper one usually some little distance below the ovary and rarely including it. Flower solitary, glabrous, very large (often 2 inches from top of ovary to tip of galea), green; galea erect, very acuminate, sickle-shaped; conjoined sepals cuneate at the base, including rather a wide sinus of 70-80 deg., produced into long filamentous caudâe almost equal in length to the dorsal sepal. Labellum considerably longer than column, curved forward in its distal fourth so as to protrude through the sinus of conjoined sepals; rather blunt, lanceo-spathulate; traversed throughout its upper surface by a longitudinal ridge very prominent in its anterior half, with a corresponding groove on lower surface of the lamina; upper surface of lamina convex on transverse section; appendage densely penicillate. Column about $\frac{3}{4}$ as long as labellum, wings hatchet-shaped, upper lobe toothed and ciliated, lower lobe obtuse and ciliated. Stigma rather narrow, oblong-lanceolate, point upwards, lower end rounded. The following table shows the chief points of distinction between this plant and *P. cucullata*, Br. :—

	P. falcata	P. cucullata
Plant	5-9 inches, slender	2-10 inches, stout, often dwarfed
Basal leaves	Not crowded; not unusually large; rarely exceeding 1½ inches	Generally crowded; often 3-3½ inches; generally wider and blunter than in *P. falcata*.
Bracts	Ovary rarely included in upper bract	Ovary usually included in upper bract; larger, wider and more leaf-like than in *P. falcata*.
Flower	Very large, often 2 ins. (without ovary); glabrous; green and white	Not exceeding 1½ inches (without ovary); pubescent; generally green dorsal sepal with chocolate petals, labellum and lateral sepals.
Galea	Produced into long point	Acute or shortly acuminate.
Conjd. Sepals	Lobes tapering into filamentous antennae; sinus 70°-80°	Lobes tapering into short, sharp points; sinus 35°-40°.
Labellum	Lanceo-spathulate	Oblong-elliptical or narrow-elliptical.
Column	Much shorter than labellum	Quite as long as labellum.
Stigma	Narrow, long, oblong-lanceolate	Broad, short, ovate-lanceolate or elliptical.
Time of flowering	October and November	August and September.

I have seen specimens of this plant from the following Victorian localities :—

Upper Yarra (Chas. Walter).

Orbost (E. E. Pescott).

Dandenong Creek, near Oakleigh (C. French, jun.).

Near Dandenong Ranges (C. French, jun., 1890).

In addition to these localities, Mr. C. French, jun., has recorded the following :—

Sandringham, Cheltenham, Mordialloc, Frankston, Beaconsfield.

It has not been recorded in South Australia, but it is said to occur in Tasmania.

Pterostylis alpina, sp. nov.

Plant glabrous, slender, often very tall, varying in height from 7 to 19 inches. No radical rosette; leaves, leaf-like bracts or bracts generally 5, more rarely 4, of varying size and shape, usually lanceolate, ovate-lanceolate or oblong-lanceolate, clasping at the base, the larger ones sometimes attaining a length of 3 inches, the lowest often represented by a mere scale-like bract, but sometimes leaf-like and large, though not exceeding the one immediately above it in size, the second and third from the base of the stem usually the largest, occasionally nearly all equal. Flower single, erect, glabrous, green, large, 1-1¼ inch (not including the ovary); galea gradually curved forward above the anther, not produced into a fine point, but rather blunt; conjoined sepals narrowly cuneate at the base, including a sinus of about 100 deg., lobes produced into filiform points embracing the galea, and about as long or slightly longer than dorsal sepal. Labellum linear-lanceolate, curved forward at the tip, rather blunt; lamina of nearly equal breadth until the bend, tapering towards the tip, under surface of lamina convex in transverse section, traversed throughout its length by a well-marked mesial raised line, concave below with groove corresponding to raised line; appendage rather densely penicillate. Column rather shorter than labellum, anther oblique; upper lobes of wings toothed; lower lobes rather narrow, blunt, ciliated. Stigma prominent, wide, ovate-lanceolate with the point upwards.

The shape of the flower is very similar to that of *P. curta*, Br., but in no other respects does it resemble that species. The differential diagnosis between *P. alpina*, *P. falcata* and *P. furcata*, Lindl., is shown in the following table :—

	P. alpina	P. falcata	P. furcata
Radical Leaves	None	Present, sessile or subsessile	Present, petiolate.
Flower	1–$1\frac{1}{4}$ inch (without ovary)	$1\frac{1}{2}$–2 inches (without ovary)	$1\frac{1}{2}$–$1\frac{3}{4}$ inches (without ovary).
Galea	Rather blunt	Prolonged into long point, sickle-shaped	Curving forward and upwards, markedly acuminate.
Conjd. Sepals	Shortly tailed; sinus about 100°	Long tails sinus 70°–80°	Rather long tails, about equal to dorsal sepal; sinus 70°–80°.
Labellum	Linear–lanceolate, width almost equal until near the bend; longitudinal raised line equally marked throughout; margins of lamina turned downwards; transverse section of lamina convex on it upper surface	Lanceo–spathulate, narrow at base, gradually increasing in width towards tip; longitudinal raised line only prominent in anterior half; relatively much larger than in *alpina*; margins of lamina turned downwards; transverse section of lamina convex on its upper surface	Oblong–linear; rather wider at base than towards the tip; longitudinal raised line prominent throughout; margins upturned; transverse section of lamina showing double cusp on upper surface, thus ⌣⌣.
Stigma	Broad, short, ovate-lanceolate	Narrow, long, oblong-lanceolate	Narrow, oblong-lanceolate.
Time of flowering	September and October	October and November	December and January.

I have examined specimens of this plant from the following Victorian localities:—

Summit of Mt. Dandenong (C. French, jun.).

Watts River, Healesville (C. French, jun., and E. E. Pescott).

Fernshawe (C. French, jun.).

Condah (F. M. Reader).

I believe that we owe the discovery of this orchid to Mr. C. French, jun.

EXPLANATION OF PLATES.

Plate VII.

Pterostylis cucullata, Br.

The plant is shown natural size.

1. Column from the side. × 2.
2. Three-quarter view labellum, showing longitudinal raised line and appendage. × 2.
3. Labellum, showing the upper surface of the lamina. × 2.
4. The stigma. × 2.
5. The conjoined sepals (natural size), showing the narrow sinus.

The drawings are from the living plant.

Plate VIII.

Pterostylis furcata, Lindl.

The plant is shown natural size.

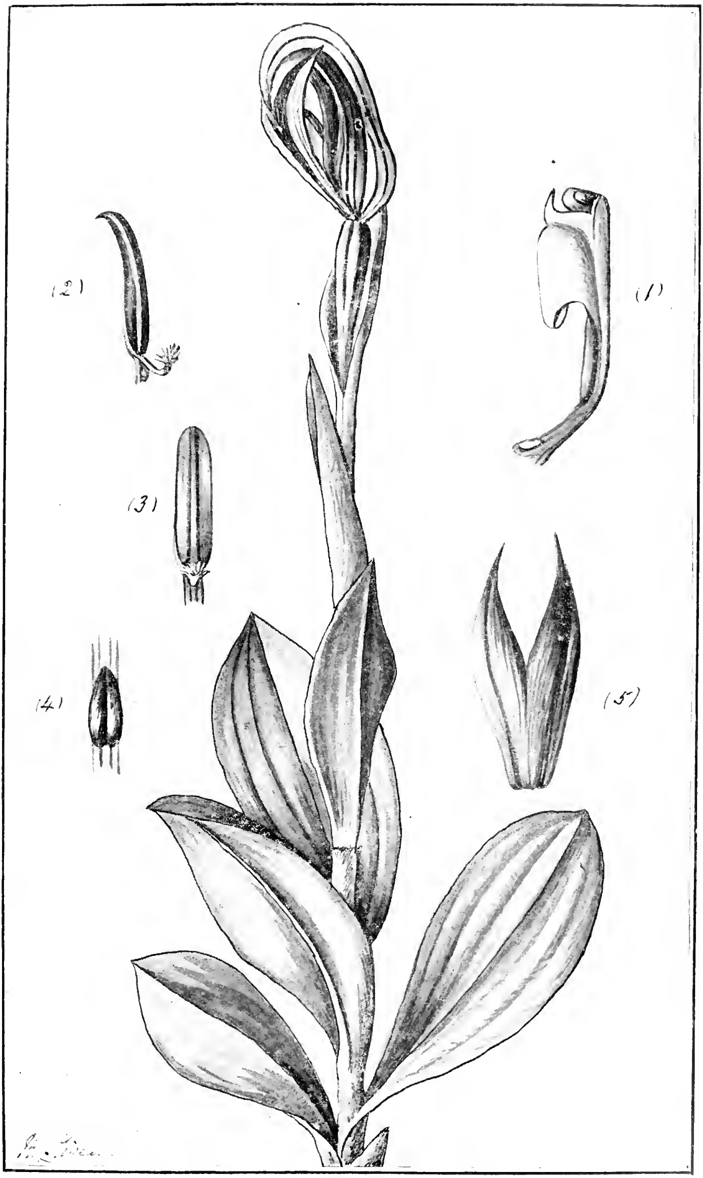
1. Three-quarter view labellum, showing longitudinal raised line and very long basal appendage. × 2.
2. Labellum, showing upper surface of lamina and upturned margins, longitudinal raised line and appendage. × 2.
3. Labellum, showing lower surface of lamina with longitudinal groove corresponding to the raised line on upper surface. × 2.
4. Column from the side. × 2.
5. The narrow stigma. × $1\frac{1}{2}$.

The drawings are from herbarium specimens.

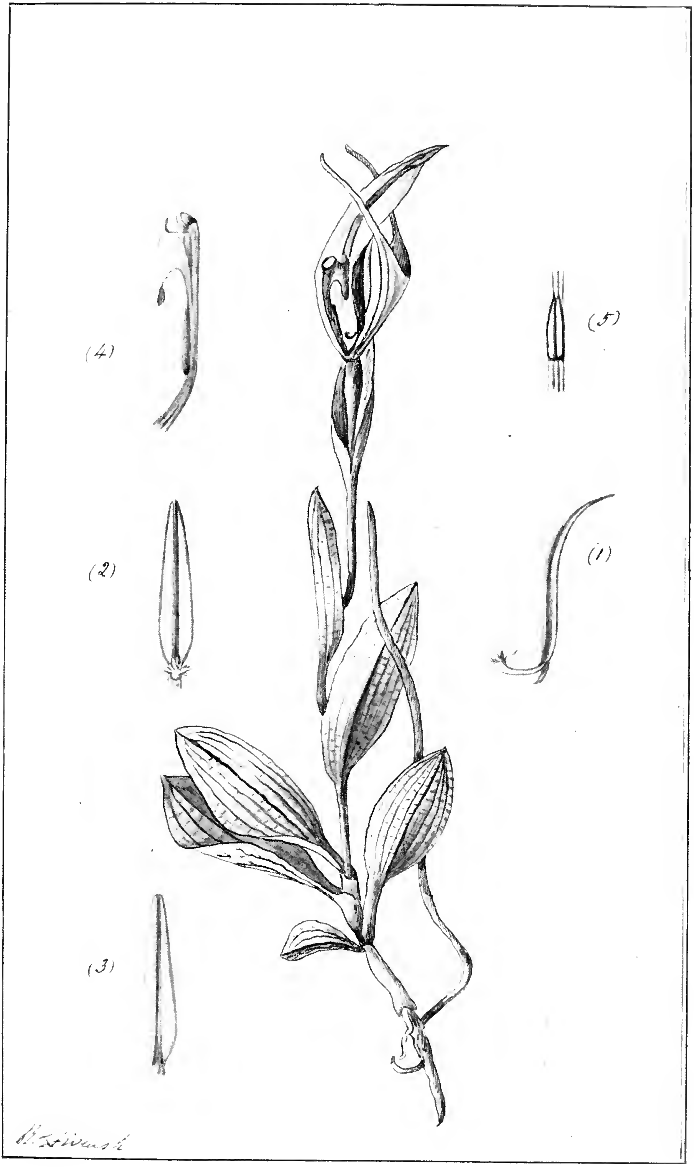
Plate IX.

Pterostylis falcata and *P. alpina*.

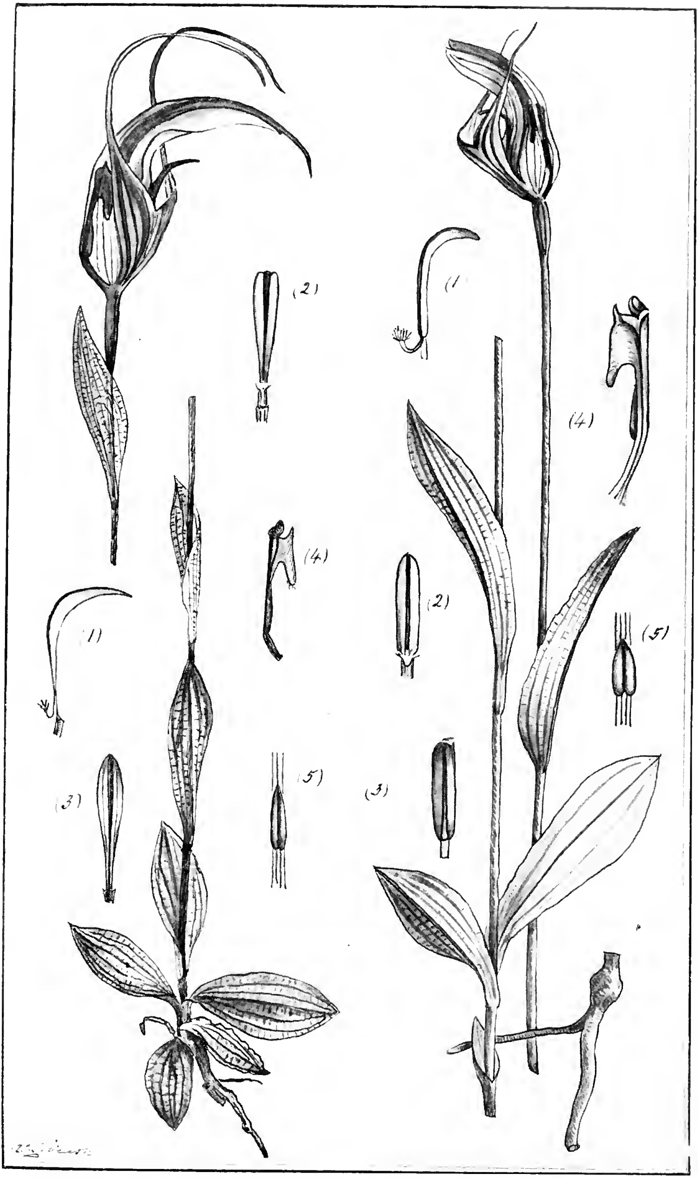
The plants are shown natural size.



P. cucullata, R. Br.



P. furcata, Lindl.



P. falcata. P. alpina.

(All natural size).

P. falcata.

1. Labellum from the side, showing raised longitudinal line on upper surface of lamina and basal appendage. Seen in this position the labellum is markedly falcate in shape. The drawing is natural size.
2. Labellum from top. The narrow base and raised line on upper surface of the lamina are shown, but not the tip, owing to its curvature. Drawing natural size.
3. Labellum from below, showing groove corresponding to the raised line. Natural size.
4. Column from side. Natural size.
5. Stigma, rather long and narrow. Enlarged. Drawings from herbarium specimens.

P. alpina.

1. Labellum from the side, showing the raised longitudinal line on upper surface, and basal appendage. × 2.
2. Labellum from above. Owing to the curvature the free tip of labellum is not seen in this view, but the raised line and the appendage are both shown. × 2.
3. Labellum from below, showing the lower surface with groove corresponding to the raised line. × 2.
4. Column from the side. × 2.
5. Front view of the short and rather wide stigma. × 2.

The drawings are from herbarium specimens.

[Proc. Roy. Soc. Victoria, 28 (N.S.), Part I., 1915].

Art. IV.—*Geological Notes Northern Territory, Australia.*

By E. J. DUNN.

(With Plates X. and XI.).

[Read June 10th, 1915].

Remarkable Sedimentation.

The accompanying plate is a faithful representation, natural size, of the surface of a two-inch core obtained in boring for coal in No. 1 Bore, Borroloola, McArthur River, at a depth of 255 feet from the surface, in sedimentary rocks, considered by Dr. Jensen, Government Geologist, as of Carboniferous age, and known as the Bukalara Beds.

In the plate the white portion represents very fine white siliceous sand, now altered to quartzite; the dark portions represent black to dark grey shales that were originally deposited as mud or silt in thin laminae. In some places extremely thin layers of sand alternate with layers of black shale.

What renders this core specially remarkable is the complicated nature of the sedimentation and the manner in which it has been modified and interfered with subsequently to deposition, and while yet in a soft condition. The original deposition no doubt was in thin layers more or less horizontally disposed, but this condition was very different to its present confused structure.

The plate, of course, does not represent a straight vertical section through the bedding, but a circular section through the beds. By joining the edges at a and b, the original cylindrical form of the core would be restored.

Dr. Jensen, to whom I am indebted for the specimen from which the photograph was taken for the plate, is of the opinion (Plate III., Bulletin No. 10, Geological Survey, Northern Territory) that worms were the cause of the extraordinary structure seen in the core, and with this view the writer coincides as the only feasible explanation. The worms must have burrowed into and through the soft, recently deposited layers of sand and silt, with the result that, in places the lamination was disturbed, or interrupted, as at the points marked c, d, e, f, g, on the plate, and at other places. In all cases the burrows were filled in with fine sand, and these sand-

Surface of 2 inch core.

Borroloola, Northern Territory, Australia.

(Natural size).

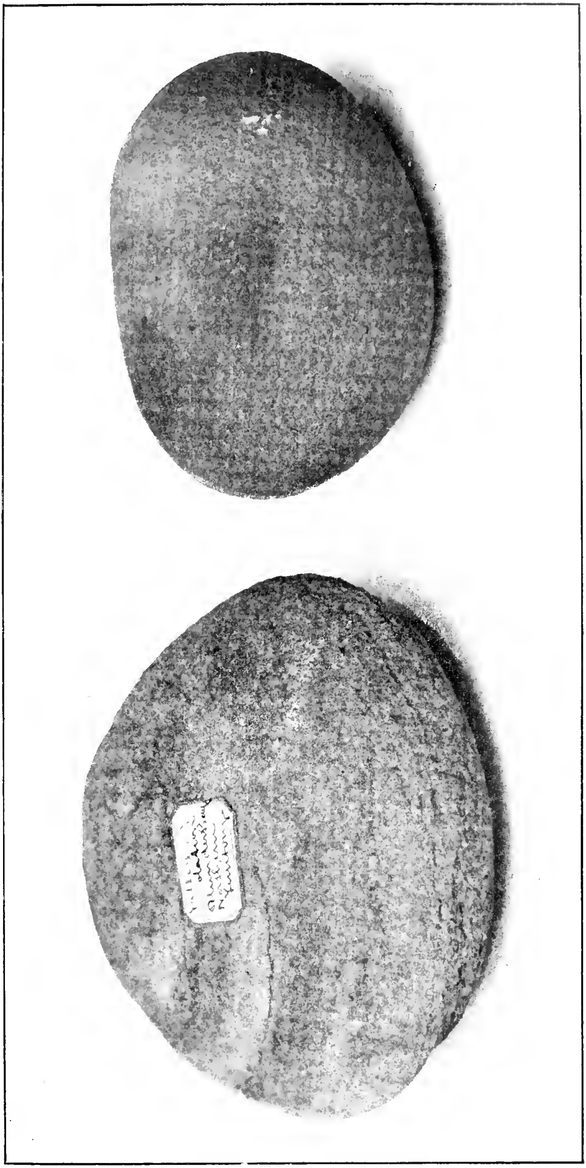


Fig. 2.

Fig. 1.

Saltwater Pebbles.
Northern Territory, Australia.

filled burrows were sometimes nearly vertical, while the normal bedding was horizontal. The section cuts these sand filled burrows at all angles, hence the strange and curious markings.

Saltwater Pebbles.

During a visit in June, 1913, to the Victoria River, Northern Territory, an interesting and to me novel method of pebble formation came under notice. The Victoria River rises in the Barkly Highlands, and in the lower part of its course flows through a sunken valley, which has been filled to its present level by fine silt brought down by flood waters from the higher country drained by its sources. At the river's mouth a great delta is being formed of similar material, which extends as islands for miles out to sea. Most of this deltaic material is just covered at spring tides, and is being consolidated by the agency of two or three species of mangroves.

Where the river debouches into the sea, silt constitutes about one twenty-fifth in bulk of the muddy water. The mangroves perform the initial work of settling this sediment and converting it into solid land.

Along the main valley and in the branch valleys the silt has accumulated to a level only covered by high tides, and forming narrow and in places wide mud flats.

When these impinge upon the hills high-water mark is strewn with blocks and fragments of rock that have rolled down the generally steep slopes on to the edge of the mud flats. The hills are formed of shales, with bands of extremely hard quartzite of various shades of colour, that range from a few feet to over 100 feet in thickness. Inland these quartzite bands form precipices that make very secure boundaries quite inaccessible for miles on end. Later on, when the country becomes occupied, these may be utilised as portions of enclosures.

As the rocks crumble down the shales quickly become disintegrated, and the quartzite blocks are principally represented along the high-water line. At first the blocks and fragments of quartzite are angular, as they reach the edge of the mud flats. At high tides the salt water reaches these blocks as they lie in the mud and the wind causes the spray to cover them with salt water. When the tide recedes an incrustation of saline material coats the surface of the quartzite. Alternately the quartzite blocks are wetted with salt water and dried by a tropical sun, with the result that the water enters every minute crack and fissure in the surface, and is then evaporated, causing the salts in the sea water to crystallise, and so gradually, grain by grain, the rock is disintegrated, leaving the surface quite rough and disclosing the original sand grains, of which the sandstone was constituted before the interstices between these grains were filled in by secondary silica, and the rock transformed into quartzite.

When the rock is wetted mechanical effects are produced on its texture by the crystallisation of the salts present in the sea-water. Whether in addition any chemical effects are produced is not certain. Such might be the attacking of the secondary silica present, which acts as a cementing substance, binding the grains of sand together. Certain appearances suggest that this cementing substance has been removed.

The sharp edges of the blocks are first attacked, and all angles are removed; in time the whole mass is reduced to a rounded form simulating the rounded forms due to moving water, except for the rough granular surfaces. Every stage is in progress, and perfectly rounded pebbles such as shown in figures 1 and 2 ultimately result. The blocks are not moved but disintegration takes place *in situ*. The solid quartzite at high water mark is disintegrated in the same way as the loose blocks.

As to the time occupied in reducing a large angular block of quartzite to a well-rounded pebble no idea could be formed. The quartzite is unusually hard, breaking with a clean, even fracture, and under other conditions would remain unaltered indefinitely, and it seems remarkable that such a resistant material to ordinary disintegrating agencies should yield so readily to salt water. Whether the process is slower than where attrition by moving water occurs is uncertain, but probably the alternate wetting and crystallising effects a fairly rapid reduction in size.

The process by which these salt-water pebbles are produced is not unlike that which is universal where fresh water attacks rock surfaces by penetrating cracks and fissures, perhaps originally caused by expansion and contraction of the rock mass. The water in these cracks and fissures becomes frozen, expanding in the process, and thrusting the particles and fragments asunder. Crystallisation is the prime cause of the energy exerted in both cases.

[Proc. Roy. Soc. Victoria 28 (N.S.), Part I., 1915].

Art. V.—*Notes on some Victorian Species of Teredo.*

BY

J. H. GATLIFF

AND

C. J. GABRIEL.

(With Plates XII., XIII.).

[Read June 10th, 1915].

Through the courtesy of Mr. G. Kermode, Engineer of Ports and Harbours, and Mr. H. Hopcraft, contractor, of Flinders, an opportunity has been afforded us of examining closely the depredations of our Victorian shipworms, and of ascertaining the specific identity of the creatures responsible for this ravaging work. The alterations at Lakes Entrance provided some excellent material for examination. Mr. Kermode kindly forwarded a piece of Oregon pine about two feet in length, completely riddled by these vermiform mollusks—many of them being alive—the result of eighteen months' immersion. In March, 1914, the Portsea Pier was in course of repair, nine of the piles, of a species of Eucalyptus, being removed. They were badly infested, and with the generous assistance of Mr. Hopcraft, specimens with the animal, shell, and pallets complete were procured. From time to time, considerable attention has been paid to the shipworms, owing to their damaging effects; and from a scientific standpoint, these peculiar mollusks have provided much scope for the anatomist and systematist. Much has been written on the subject and the synonymy will show how, more or less, the species have been misunderstood, many early writers, and engineers' reports, attributing the work of these "worms" to *Teredo navalis*, whereas the mischief has been caused by several species. To quote Forbes and Hanley, "Writers of the Linnaean school, both British and Foreign (with the honourable exception of Spengler), contented themselves with classing all the shipworms under the one appellation *navalis*, describing the tube, but neglecting the more important anterior valves and the characteristic pallets."

We have experienced difficulty in separating the species by the valves, and, apart from the animal, we regard the pallet as the one certain means of identification.

Early in the field of Victorian writers was the Chief Harbour Master of Williamstown, Captain Ferguson, who, in a report on Class III. Indigenous Vegetable Substances Catalogue of the Victorian Exhibition of 1861, pp. 8-11, issued a "Return, showing the approximate injury done by the *Teredo navalis*, and other sea-worms, to submerged timbers within the waters of Victoria," giving interesting and commendable particulars under the following heading:—

Locality.	Date when pile was driven.	Description of timber.	Depth of water from the bottom surface to high water mark.	Diameter of pile when driven.	Present thickness of pile at low water line.	Destruction of pile by worms.	Strength of tide when pile was driven.	Fresh or sea water.
		Red Gum, Stringy-bark, Blue Gum, White Gum, Blackwood, Sheoak, Teak (vessel) Swan River—Mahogany.				So many inches in so many years.		

Attributing the injury to *Teredo navalis*, whereas, it is probable that a scientific examination would have revealed the existence of all the species under question.

Under the name of *Calobates saulii*, E. P. Wright, in 1866, described a form, the type locality of which is given as Port Phillip, Australia. Following this, the "Victorian Naturalist," Dec., 1888, published one of the first lists of Victorian Marine Mollusca, compiled by the senior author of this paper, in which will be seen a record of *T. navalis*, Linn. In a paper, entitled "The Marine Wood-Borers of Australasia and Their Work," read before the Australasian Association for the Advancement of Science, year 1901, Mr. C. Hedley discussed at length the shipworms under the following headings:—General Aspect, Propagation, As an Esculent, Natural Enemies, and Classification. In the latter we are unable to concur in all his decisions. Firstly, Mr. Hedley remarks "neither the species *navalis* nor the genus *Teredo* are present in our waters." Here we differ, and report its undoubted existence in Victoria. The other points of difference are detailed in the observations of each species.

Pritchard and Gatliff also dealt with the forms in their catalogue of the Marine Shells of Victoria, but, as will be seen, alterations have been found necessary.

The destruction of these pests has proved a matter of considerable anxiety. Countless schemes having been advanced, adopted, and found wanting. An American plan, as quoted by Marshall in the Journal of Conchology, 1914, p. 207, shows some practicability, and should have a fair measure of success. It is as follows:—"The latest method to be adopted for overcoming this destruction and loss to wharves, harbours, and submarine works generally, has been successfully carried out by American contractors who can now electrocute them by millions, and although the process is not altogether permanent in its effects, yet by occasional applications it is proving sufficient to overcome the difficulties experienced in many extensive operations, and to supersede the use of divers and other highly-skilled operatives. The method of electrocution is carried into effect by the use of a floating electric-power plant, capable of generating heavy currents of electricity at a comparatively low intensity. A net work of wires is first lowered into the sea facing the wharf or harbour to be attacked, and these are coupled with one of the poles of the dynamo on the vessel; similar wires are then suspended beneath the ship in electrical contact with the other pole. Directly the current is switched on, electrolytic action occurs in the sea water between the two metal nets, and chlorine gas is thereby liberated. This deadly gas envelopes the *Teredines* in their borings, and speedily causes death."

From the timber mentioned in this paper we have obtained and critically examined over 300 pallets. Four species, all of which were detected in the one piece of timber, at Lakes Entrance, three of them also being present in the timber of the piles at Portsea Pier, constitute the representation of shipworms in Victoria, as far as we have been able to ascertain; three at least most probably having been introduced by ships from European localities.

They are as follow:—

TEREDO NAVALIS, Linn.

1767. Teredo navalis, Linn. Syst. Nat. ed. 12, p. 1267.

1806. Teredo navalis, Linn. Home, Phil. Trans., pl. 12, f. 7-10.

1828. Teredo navalis, Linn. Chiaje, Memorie., Vol. IV., pp. 23 and 32, pl. 54, f. 2 and 8.

1853. Teredo navalis, Linn. Forbes and Hanley, Brit. Moll., Vol. I., p. 74, pl. 1, f. 7, 8, and pl. 18, f. 3, 4.

1862. Teredo navalis, Linn. Chenu, Man. de Conch., Vol. II., p. 10, f. 59.

1875. Teredo navalis, Linn. Reeve, Conch. Icon., pl. 1, f. 1a, b.

1884. Teredo navalis, Linn. Tryon, Syst., Conch., Vol. III., p. 120, pl. 104, f. 48.

1884. Teredo navalis, Linn. Sowerby, Thes. Conch., Vol. V., pl. 469, f. 1, on plate not f. 2 (numerals on plate reversed).

1893. Teredo navalis, Linn. Clessin, Conch. Cab., Vol. XI., p. 67, pl. 15, f. 3-6.

Hab.—Lakes Entrance.

Obs.—The characteristic little pallet readily serves to distinguish the species. It is composed of a thick, shelly plate, flat on one side and convex on the other, with its extremity bifurcated. The plate, devoid of a central rib, has a strong cylindrical stalk of lesser length. European specimens in the National Museum, Melbourne, cannot be separated from our series.

Teredo bruguieri, Delle Chiaje.

1792. Teredo norvagicus, Spengler. Skriv. Nat. Selsk., Vol. II., p. 102, pl. 2, f. 4-6, B (not binomial).

1822. Teredo navalis, Linn. Turton, Dithyra Brit., p. 14, pl. 2, f. 1-3.

(?) 1822. Teredo navalis, Linn. Sowerby, Genera, Vol. 1., pl.

1827. Teredo navalis, Linn. Crouch, Introd. Lam. Conch., pl. 2, f. 10.

1828. Teredo bruguieri, Delle Chiaje. Memorie., Vol. IV., pp. 28 and 32, pl. 54, f. 9-12.

1844. Teredo navalis, Linn. Brown, Ill. Conch. G. Brit., p. 116, pl. 50, f. 3, 6, 7.

1852. Teredo navalis, Linn. Sowerby, Man. (4th edition), p. 291, pl. 2, f. 48, 49.

1853. Teredo norvagica, Spengler. Forbes and Hanley, Brit. Moll., Vol. I., p. 66, pl. 1, f. 1-5, and pl. F, f. 1.

1856. Teredo norvegica, Spengler. H. and A. Adams, Genera., Vol., II., p. 332, pl. 90, f. 6, a, b, c, d.

1862. Teredo norvegica, Spengler. Chenu, Man. de Conch., Vol. II., p. 11, the third figure only of fig. 60.

1873. Teredo antarctica, Hutton. Cat. Mar. Moll., p. 59.

1875. Teredo norvagica, Spengler. Reeve, Conch. Icon., pl. 1, f. 1c, d; 2a, b, c.

1880. Teredo antarctica, Hutton. Man. N.Z., Moll., p 133.

1880. Teredo norvegica, Spengler. Woodward, Man., p. 507, f. 270 (in text), and pl. 23, f. 26, 27.

1884. Teredo norvegica, Spengler. Tryon, Syst. Conch., Vol. III., p. 120, pl. 105, f. 70-73.

1884. Teredo (Xylotrya) antarctica, Hutton (?). E. A. Smith, "Alert," Zool., p. 93, pl. 7, f. E-E2.

1884. Teredo norvegica, Spengler. Sowerby, Thes. Conch., Vol. V., pl. 469, f. 2, on plate, not f. 1 (numerals on plate reversed).

1887. Teredo norvegica, Spengler. Fischer, Man. de Conch., p. 1138, f. 869, 870.

1893. Teredo norvegica, Spengler. Clessin, Conch. Cab., Vol. XI., p. 64, pl. 15, f. 7-9, in explanation of plate (not f. 1-3 as in text).

1893. Teredo antarctica, Hutton. Clessin, Conch. Cab., Vol. XI., p. 76, pl. 20, f. 12, 13, in explanation of plate (not f. 11-13, as in text).

1894. Teredo edax, Hedley. P.L.S.N.S.W., Vol. IX., pp. 501-505, pl. 32, f. 1-5.

1894. Teredo antarctica, Hutton. Hedley, P.L.S.N.S.W., Vol. IX., p. 503, pl. 32, f. 6, 7.

1898. Teredo antarctica, Hutton. Hedley, P.L.S.N.S.W., Vol. XXIII., p. 95.

1901. Nausitoria antarctica, Hutton. Hedley, Aust. Ass. Adv. Sci., Vol. VIII., p. 248, pl. 10, f. 9 in explanation of plate (erroneously 8 on plate), is japonica, Clessin, and not antarctica after Clessin.

1901. Nausitoria edax, Hedley. Aust. Ass. Adv. Sci., Vol. VIII., p. 248, pl. 10, f. 5 in explanation of plate (erroneously 6 on plate).

1903. Nausitora edax, Hedley. Pritchard and Gatliff, P.R.S., Vic., Vol. XVI. (N.S.), p. 98.

1913. Teredo bruguieri, Delle Chiaje. Suter, Man. N.Z. Moll., p. 1019, pl. 55, f. 7, a-d.

1914. Teredo norvegica, Spengler. Marshall, Journ. of Conch., Vol. XIV., p. 207.

Hab.—Drift timber, Balnarring, Western Port; San Remo; Lakes Entrance; Portsea Pier; Port Albert.

Obs.—Spengler's name being non-binomial, the employment of *norvegica* is inadmissable. Much confusion has arisen in regard to this species. The earlier writers, more particularly those of the British school, discussing and figuring the various parts under the appellation of *Teredo navalis.* Forbes and Hanley grasped the distinction, minutely describing and illustrating the animal, valves, pallets, and tube. That the species has since been misunderstood is obvious from the following observations. The description of *T. antarctica*, Hutton, leaves no doubt as to its identity with *T. norvegica*, Spengler. Endeavouring to establish *T. antarctica*, Hutt., Mr. Hedley (loc. cit) figured the type valves and later on illustrated the pallet (after Clessin). Through an unfortunate discrepancy in the text-figure numerals in the Conchylien Cabinet, Mr. Hedley erroneously copied the pallet figure of *T. japonica*, Clessin, to represent *antarctica.* Clessin's text-figure numbers of *T. antarctica*, Hutton, are 11 to 13, while the shell is illustrated by two figures only, 12 and 13, as in the explanation of Plate, figure 11 being the pallet of *japonica*, and not *antarctica.* Mr. H. Suter, in his Manual of the New Zealand Mollusca, p. 1021, notes Mr. Hedley's wrongful figure of the pallet of *antarctica*, and remarks, "is certainly the bipinnate pallet of *T. navalis*, but not *T. antarctica.*" In this respect we disagree with Mr. Suter, Clessin's figure depicting *T. japonica.*

Actual comparison of British examples of *T. norvegica* in the National Museum, Melbourne, with a specimen kindly identified from the type by the author as being his *T. edax*, fails to disclose any differentiating characters, and we regard them as absolutely synonymous. Closely allied is the British form *T. megotara*, Hanley, but, as the author remarks, the species may be separated by the pallets being less elongated in the handle, and they taper to a fine point at the apex. In the other they are blunt at the termination and solid throughout. We have examined specimens of *T. megotara* in our museum collection, and notice the distinction. The calcareous tube of *T. norvegica* exhibits a strong concamerated structure at the posterior extremity, vanishing anteriorly where the tube becomes fragile; these characters showing better development in some cases than in others. The largest burrow we have examined was from the Portsea Pier; it attained a length of two feet six inches, and the large bat-shaped pallet abstracted therefrom measured 28 mm. The size and structure of the tube lend aid as a means of identification.

We wrote to Mr. H. Suter stating that we considered *T. edax*, Hedley, to be a synonym of *T. bruguieri*, and asked his opinion. He wrote in reply, "I think that *T. edax*, Hedley, is most likely a synonym of *T. bruguieri.*"

Teredo pedicillatus, Quatrefages.

1849. Teredo pedicillatus, Quatrefages. Ann. Nat. Sci. Ser. 3, Zool. Vol. II., p. 26, pl. 1, f. 2.

1875. Teredo pedicillatus, Quatrefages. Reeve, Conch. Icon., pl. III., f. 11a, b, c.

1884. Teredo pedicillatus, Quatrefages. Sowerby, Thes Conch., Vol. V., pl. 469, f. 14.

1893. Teredo pedicillata, Quatrefages. Clessin, Conch. Cab., Vol. XI., p. 68, pl. 17, f. 12-14.

1914. Teredo pedicillata, Quatrefages. Marshall, Journ. of Conch., Vol. XIV., p. 207.

Hab.—Lakes Entrance; Portsea pier.

Obs.—As representing the pallet of this species we are unable to accept the figures by Reeve, Sowerby, and Clessin, their illustrations being quite at variance with Quatrefages' original description—"Les palmules sont étroites, allongees et portees â l'extrémite d'une sorte de manche d'apparence cartilagineuse. Ce pédicule est toujours blanc. tandis que les palettes qui le terminent sont colorées en brune fonce." The remarks by Sowerby—"Palmulae biarticulatae. The pallets are very peculiar, being divided by a horny joint,"—fail to convey Quartrefages' meaning. Our National Museum collection contains specimens under this name from Guernsey, and an actual comparison endorses our identification.

Teredo (Xylotrya) saulii. E. P. Wright.

1866. Nausitora saulii, E. P. Wright. Trans. Linn. Soc Lond., Vol. XXV., p. 567, pl. 65, f. 9-15.

1875. Teredo saulii, Wright. Reeve, Conch. Icon., Vol. XX., pl. 3, f. 10a, b, c, d.

1884. Teredo saulii, Wright. Sowerby, Thes. Conch., Vol. V., p. 123, pl. 469, f. 18.

1893. Teredo saulii, Wright. Clessin, Conch. Cab., Vol. XI., p. 70, No. 10, pl. 17, f. 7-9.

1894. Nausitora saulii. Wright. Hedley, P.L.S.N.S.W., Vol., IX., p. 503.

1898. Calobates saulii, Wright. Hedley, P.L.S.N.S.W., Vol. XXIII., p. 94, f. 7-9.

1901. Nausitoria saulii, Wright. Hedley, Aust. Ass. Adv. Sci., Vol. VIII., p. 248, pl. 10, f. 6 in explanation of plate (not f. 5 in plate).

1901. Nausitora saulii, Wright. Tate and May, P.L.S.N.S.W., Vol. XXVI., p. 421.

1903. Nausitora saulii, Wright. Pritchard and Gatliff, P.R.S. Vic., Vol. XVI (N.S.), Pt. 1, p. 97.

1903. Nausitora thoracites. Pritchard and Gatliff (non Gould), P.R.S. Vic., Vol. XVI. (N.S.), Pt. 1, p. 98.

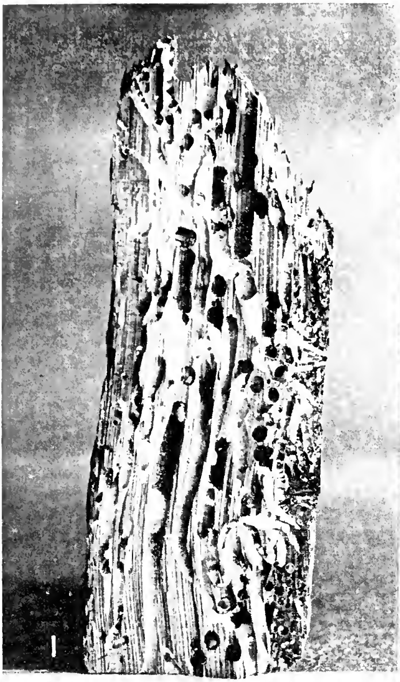
1913. Teredo saulii, Wright, Suter. Man. N.Z., Moll., p. 1021, pl. 55, f. 8, a, b.

Hab.—Lakes Entrance; Portsea Pier.

Obs.—Of the Victorian representatives, this species alone belongs to the group possessed of articulated pallets, a grouping adopted by Quatrefages and others. They are extremely fragile. Surmounted on a thin, cylindrical stalk is a lamina or blade composed of imbricating and pectinate joints, flat on the inner area, and rounder on the outer. Much variation exists in respect to the number of articulations and their approach to one another; however, the general character is apparent, and the pallet serves as a ready means of recognition. On the assumption that the pallet of *T. fragilis*, Tate, was incomplete, and represented the basal joint of *Calobates saulii*, Wright, Mr. Hedley, P.L.S.N.S.W., 1898, p. 95, states: "The apparent difference in the pallets is due to the fracture of the specimens figured, wherein all joints but the basal one have been snapped off," and, therefore, he reduced it to a synonym, this synonymy in turn being accepted by Tate and May, Pritchard and Gatliff, and Suter. We are much indebted to Dr. J. C. Verco for sending to us for examination the type pallet of *T. fragilis*, Tate. This enables us to pronounce the validity of Tate's species. Herewith a figure of the type is presented, which, consistent with the author's description, "small shelly clavate pallets, the stalk much attenuated, the enlarged, somewhat compressed upper portion crowned with a cartilaginous crust, which has a projecting horn at each end," cannot be confused with a basal joint.

Possibly the authentic specimens seen by Mr. Hedley may not be identical with the type sent to us.

The articulations of the pallet of *T. saulii* are formed on a continuing stalk, whilst in *T. fragilis* the stalk does not continue beyond the base, but is merged into it; this fact, in our opinion, conclusively proves that the pallet of the latter cannot be a fractured pallet of *T. saulii*.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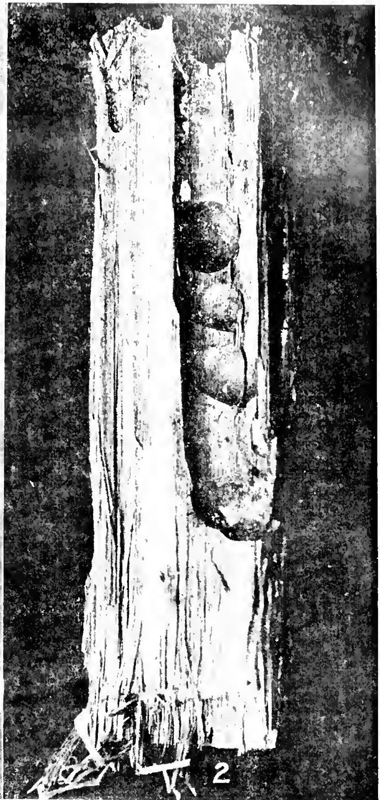
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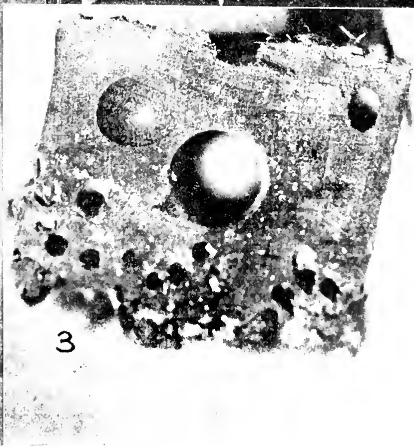
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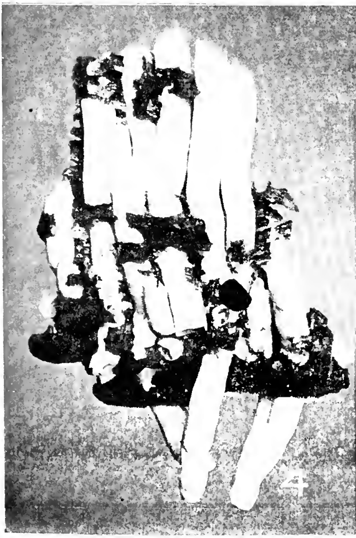
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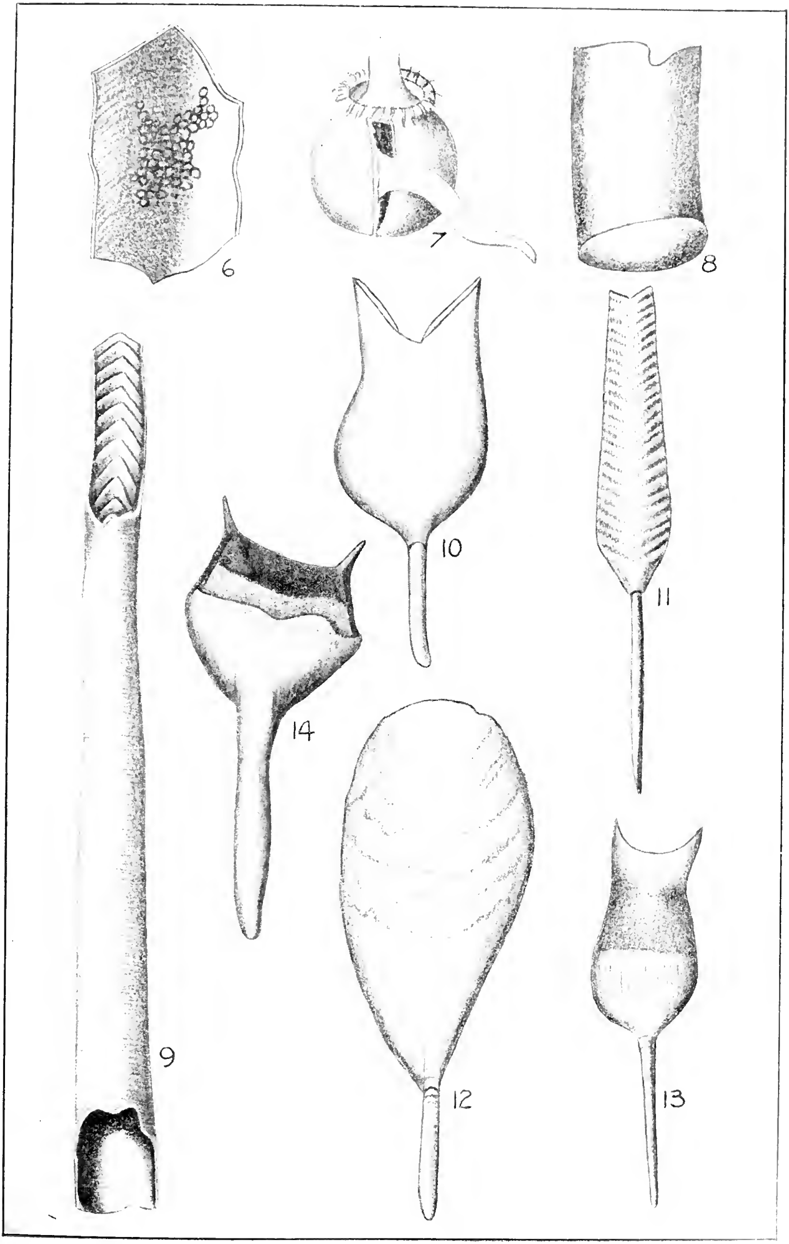

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EXPLANATION OF PLATES.

Plate XII.

Fig. 1. Oregon Pine, after 18 months' immersion at Lakes Entrance. Attacked by—
Teredo bruguieri, Chiaje.
Teredo navalis, Linn.
Teredo pedicillatus, Quatrefages.
Teredo saulii, Wright.

Fig. 2. Eucalyptus from pile, Portsea Pier. The two large burrows are those of Teredo bruguieri, Chiaje., the larger one attaining a length of 2 ft. 6in.

Fig. 3. Eucalyptus from pile, Portsea Pier. Cross-cut to show burrows. The large bore is that of Teredo bruguieri, Chiaje., its diameter being 18 mm.

Fig. 4. Drift timber from Port Albert. Bored by Teredo.

Plate XIII.

Fig. 6. Portion of calcareous lining of a burrow, with larvae thereon.

Fig. 7. Larva of Teredo (after Quatrefages).

Fig. 8. Shelly layer at termination of burrow.

Fig. 9. Calcareous tube or sheath of Teredo bruguieri, Chiaje, showing internal concamerated structure at posterior end, and its absence at anterior extremity.

Fig. 10. Pallet of Teredo navalis, Linn. Length, 6.5 mm.

Fig. 11. Pallet of Teredo (Xylotrya) saulii, Wright. Length, 19 mm.

Fig. 12. Pallet of Teredo bruguieri, Chiaje. Length, 10 mm.

Fig. 13. Pallet of Teredo pedicillatus, Quat. Length, 5 mm.

Fig. 14. Pallet of Teredo fragilis, Tate (type). Length, 2 mm.

All of the figures are variously magnified.

[Proc. Roy. Soc. Victoria, 28 (N.S.), Part I., 1915].

Art. VI.—*Notes on an Occurrence of Quartz in Basalt.*

By CHARLES FENNER, B.Sc.

(School of Mines, Ballarat).

(Communicated by Professor E. W. Skeats).

[Read June 10th, 1915].

I.—Introductory.

My attention was first directed towards occurrences of quartz in basalt by noting, some four years ago, the abundance of angular quartz fragments that are to be found over the basaltic plains which stretch to the southward from Mt. Greenock, a volcanic hill in Central Victoria.

Following this up, it was found that at a spot on McCallum's Creek, where the stream has cut through to the Ordovician bedrock, the cliffs on the left bank showed a remarkable exposure of quartz in the basalt. Since then, the occurrence of quartz, sparsely, in our basalts has been found so common, that attention has been given, as far as the literature was accessible, to similar or related occurrences in other parts of the world. While results in the Mt. Greenock area are somewhat disappointing, they are certainly not without interest.

II.—Description of the Mt. Greenock area.

As will be seen by the small sketch map (Fig. 1), copied from that published by the Geological Survey of Victoria, the geology of the area is simple. East and west of the basalt flow, low timbered ordovician ranges occur; the ordovician slates are traversed by innumerable quartz veins.

The deep lead gravels which were buried by the basalt were wide, and, in places, up to 30 feet thick; the basalt sheet averaged about 100 feet in thickness. The eastern drainage is now carried off by McCallum's Creek to the Loddon River, and the eastern edge of the basalt has been much more vigorously dissected than the western. The buried gravels were highly auriferous, and have been extensively mined for practically their full length.

The mount itself is a volcanic cone, built of scoriaceous material, and with a well-preserved breached crater, the breach being to the north-west. It cannot be said for certain that the lava in the southern part of the area came from Mount Greenock; it may be from Mt. Mitchell, some four miles further south. The probability is, however, that it is mainly from Mount Greenock.

Fig. 1. Sketch map of the Mount Greenock area. A and B are specially referred to in the text. The cycles represent mines following the buried leads.

III.—Previous mention in literature.

Since the commencement of investigations into this occurrence, two prior references to it have been found; the exact places referred to are not known, but there are several places where the abundance of quartz is striking.

(a) Major Mitchell, who ascended and named Mt. Greenock in the year 1836, records in the "Journal" of his explorations, that on September 25th, when nearing the mount, he "passed over a ridge of trapean conglomerate, with embedded quartz pebbles." Again, on September 26th, he records more hills of the "trapean conglomerate." "The rock," he says, "consists of a base of common felspar, with embedded grains of quartz, giving to some parts the character of a conglomerate, and there are also embedded crystals of common felspar."

(b) Mr. E. J. Dunn, who knew this district very well, says, in his book on "Pebbles," page 47: "At Mount Greenock (Vic.) the auriferous tertiary lead was broken through by a volcanic outburst, and the crater of Mount Greenock formed over its former course . . . The pebbles became entangled in the flow of basalt." Again, on page 63: "Where volcanoes break through conglomerates, pebbles may become entangled with the lava flows, and by this means be transported to some fresh site; an instance of this occurs at Mt. Greenock."

While this simple explanation may be the true one, there is no definite proof that such is the case. Indeed, there are some reasons for doubting that this would fully account for the presence and mode of occurrence of the quartz.

IV.—Distribution, etc., of the Quartz.

In the Mt. Greenock flow, as far as it has been examined, over an area of about two square miles, the distribution of the quartz through the rock is by no means uniform. While there are places, such as Walker's Cliffs (A in map), the schoolyard (B in map), and others, where the quartz is so abundant that the basalt resembles a conglomerate, yet in other places it is sometimes only possible to find one small crystal to an ordinary hand specimen, and in other places it is still more rare.

The size of the quartz fragments is very variable, and in shape much irregularity is also shown. Nothing that could be definitely called rounded or even sub-angular occurs.

The large amount of quartz that must be present in the whole flow, and its distribution through the same, although not uniform, seems to debar the possibility of its having been picked up at the crater as the lava came through originally; further, from the mode of flow of a lava stream it is just as difficult to imagine how the quartz could be picked up from the floor of the valley, and distributed through the flow. The lack of any "pebble" form, and the extent of chemical interaction with the magma also seem to militate against this supposition.

Some of the instances from England, South Africa, etc., which have been investigated, and recorded, are apparently very similar to this case, and for none of these was such an explanation advanced. J. Cosmo Newbery, in a catalogue of Victorian rocks, published in 1894, says: "Quartz occurs in the newer basalt of Baringhup, Maldon, frequently in grains and irregular patches of bluish-white colour, and in such association with the rock as to leave no doubt of its original formation in it."

V.—General description of the Lava.

The volcanic products of Mount Greenock may be roughly described under three heads :—

(a) Scoriaceous material; the mount is almost wholly composed of this fragmentary rock, bombs are common, while ropy structure and surfaces showing "flow" lines are of striking freshness.

(b) The lower ledges of the mount show outcrops of extremely dense compact basalt, very fine grained.

(c) The remainder of the flow, extending as a sheet southward, and locally known as part of Nicholl's plains, is of a less fine-grained type, often with a coarse doleritic texture, occasionally vesicular, and generally resembling the material so common in the road metal quarries of Ballarat or Melbourne.

The general characters of these three types are set out below, especially with reference to the quartz content as seen in the hand specimen, and under the microscope.

(a) The quartz in the scoria is generally very small in size; the largest seen formed the centre of a small bomb, and was about $\frac{5}{8}$ in. in greatest length. Crystals of $\frac{1}{8}$ in. diameter are common, and in a section cut where only one small piece of quartz was visible to the eye, a dozen were revealed by the microscope. The scoria contains abundant tiny idiomorphic felspars, a good deal of irregular-shaped augite, and some olivine, with abundant glass. No sign of reaction rims could be detected around the microscopic quartz grains, although the shapes suggested that corrosion had taken place. Hyalite is common, lining cavities in the scoria.

(b) The second type of basalt hardly appears to contain any quartz. Under the microscope the rock consists of a ground-mass of glass and oxides of iron, packed with tiny acicular felspars, and dotted with porphyritic olivine. There is very little augite present, which is rather a contrast to the third type of rock, where augite is common. The most definite augite present in this dense type consists of the tiny green pyroxenic needles forming the reaction rim around one of the rare pieces of contained quartz.

(c) This third type is that of the main flow. As stated, the appearance in hand specimen is quite similar to that of the great majority of the Victorian newer basalts, except that in places throughout the mass it is thickly mottled with corroded quartz. In addition, quartz fragments occur sparsely right throughout the flow. These are quite uncommon as microscopic pieces, but range from $\frac{1}{8}$ in. diameter up to $\frac{3}{4}$ in., and even larger, one mass seen being 14 inches in diameter.

In the hand specimen the quartz shows a great amount of fracturing, and is sometimes surrounded by a minutely vesicular discontinuous border. It very frequently has a peculiar chalcedonic lustre, but is mostly dull-grey in colour. Where the quartz is most abundant, hyalite occurs, and was always noted on the roofs of the containing cavities (Fig. 2).

Under the microscope the rock is of a coarse doleritic texture, with large felspar laths, interspersed with granular augite, and abundant porphyritic olivine. Apatite is present, in bunches of needle-like crystals, and iron oxides occur throughout. "Contraction vesicles" are also common.

Where the quartz comes into contact with the other minerals of the rock, there is always a reaction rim of pyroxenic material, with sometimes a thin band of glass separating it from the quartz. This border is sometimes granular, darkened apparently by the presence of iron oxides; at other times the pyroxene prisms are parallel, roughly normal to the edge of the quartz, presenting under crossed nicols a very pretty appearance. Fig. 3 shows these typical relations diagrammatically.

The quartz shows abundant inclusions, running in lines through the mineral, and negative crystals were observed. The larger pieces of quartz are not single crystals. Along many of the fractures, seams of brown glass occur. In shape the quartz is irregular, and embayed, and cavities occasionally occur in it, lined by a rim of pyroxene.

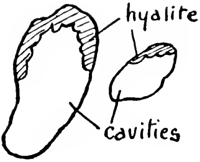


Fig 2.

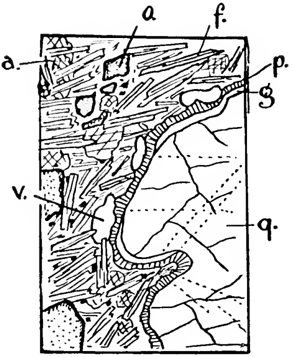


Fig. 3.

Fig. 2. Sketch of hyalite as it occurs on the top of the cavities.

Fig. 3. Diagrammatic representation of the general relations of the quartz to the basalt, as seen under the microscope—q., quartz; g., glassy border; p., pyroxenic rim; v., part of vesicular border; o., olivine; a, augite; f., felspar.

VI.—Other occurrences in Victoria.

A fact worthy of note in connection with these occurrences is that, in the area within 30 miles of Ballarat, where basalt is generally abundant, an investigator who is trying to find fragments of quartz in the basalt rarely fails to do so. Certainly no extreme cases have been found, such as those at Mt. Greenock, nor have any been found with the wonderfully abundant and uniform distribution recorded by Diller and Iddings. A list of localities in Victoria, where pieces of quartz have been found in the basalt, follows :—

Baringhup, J. Cosmo Newbery, Des. Cat. Vic. Rocks, 1894.
Mt. Franklin, Selwyn. Catalog. Vic. Rocks, 1868.
Gleeson's Hill, Selwyn. Catalog. Vic. Rocks, 1868.
Kilmore, with hyalite, Selwyn. Catalog. Vic. Rocks, 1868.
Skipton, near the basalt caves at Mt. Widderin, 1914.
Ballan, near the railway station, 1914.
Lake Burrumbeet, north and east shores, 1914.
Piggoreet, in the "Devil's Kitchen," 1914.

Warrion Hills, in scoria, 1914.
Warrenheip, in scoria, 1914.
Flow above Pike's dam, at Ballan, 1915.
Near new Moorabool dam, Ballarat, 1915.
Mount Elephant, in scoria, 1915.

VII.—World-wide occurrence.

The occurrence of quartz in basalt and allied basic rocks is world-wide, and a large amount of literature exists concerning the same. "Quartz basalt" as a rock type appears to be generally recognised, and in such cases as those of North America, described by Diller, Iddings, and others, it seems impossible to doubt that "the quartz is just as much a primary constituent of the rock as is the olivine." Daly gives the total area covered by quartz basalts in North America as eight square miles. The occurrence mentioned in this paper can only be claimed, at most, as a "quartziferous basalt"—analogous to some of the recorded occurrences of South Africa, Scotland, etc. Daly, in "Igneous Rocks and Their Origin," records quartz basalts "or their allies" from practically every corner of the earth—from Antarctica to Greenland.

VIII.—Literature.

Books and articles that have been consulted include:—

(a) "A late volcanic eruption in Northern California, and its peculiar lava." J. S. Diller Bull. 79, U.S. Geol. Survey, 1891.
(b) "The occurrence of primary quartz in certain basalts." J. P. Iddings, Bull. 66, U.S. Geol. Survey, 1890.
(c) "Igneous Rocks and Their Origin," R. A. Daly, 1914.
(d) A.J.S., Art. XX. J. P. Iddings, 1888.
(e) "Tertiary Igneous Rocks of Skye." A. Harker, chap. XX., etc., 1904.
(f) Intrusions of Kilsyth, Croydon district, Scotland. G. W. Tyrell, Geol. Mag., 1909.
(g) Q.J.G.S. J. W. Judd, pp. 175-186, May, 1889.
(h) Lamprophyres of N. England. Geol. Mag., pp. 109-206. A. Harker, 1892.
(i) Porphyritic quartz in basic igneous rocks, p. 485. A. Harker, 1892.
(k) Petrology for Students. A. Harker, 1897 edn., pp. 138, 190.

(l) Natural History of Igneous Rocks, p. 322. A. Harker.
(m) Data of Geo-chemistry. F. W. Clarke, 1911.
(n) Petrology of the Kalgoorlie Goldfield. J. A. Thomson. Geol. Mag., Vol. LXIX., 1913.
(o) Geology of Kalgoorlie. C. O. G. Larcombe. Proc. Aust. I.M.E., Vol. V., No. II.

IX.—Final considerations.

The efforts to account for the presence of quartz in basic igneous rocks have been many :—

1. Iddings believes that at great depths, and under the mineralising influence of water, in the case of great pressures, quartz could crystallise out from a basic magma, and while in most cases the quartz would later be entirely resorbed, the quartz basalts represent cases where the resorption is incomplete. This theory, while it would satisfactorily explain most features of the case, takes us deep into the region of practically unknown physical properties and processes. Iddings suggests that the occurrence of free quartz in basic rocks is analogous with the occurrence of iron-olivine in acid rocks.

2. Daly suggests, in accordance with his theory of a fundamental basalt magma, from which all igneous rocks are derived—that the quartz found in basalts represents part of the overlying lighter siliceous layer caught up and not fully assimilated by the basalt. This fascinating generalisation would easily lend itself to an explanation of all quartz in basic rocks, but from its fundamental nature it is a question the discussion of which must be left to expert petrologists.

3. The most common explanation advanced is that the quartz is derived from acid rocks through which the basalt has passed on its way to the surface.

As far as is known, the country rock at Mt. Greenock is wholly Ordovician sediments; these are all fine grained, and contain no beds from which the quartz could be derived. If the latter mineral came from the very numerous quartz veins that traverse the ordovician sediments—and from its microscopic nature this is quite possible—we should also expect some fragments of the slates themselves to be still undigested. Close search has failed to reveal any trace of a slate inclusion, a fact which seems sufficient to invalidate that theory.

4. It is also suggested that the quartz was picked up by the lava at the surface.

Some reasons have already been advanced to show that this might not answer in the case of the Mount Greenock occurrence. The chief points were—(a) The difficulty of forming a mental picture of any means whereby the quartz could be "picked up" by a viscous stream, which is really not "flowing" in the same sense as water flows; (b) the extent of the chemical inter-action between the quartz and the containing rock.

As stated by Diller, in his discussion of this matter, all quartz grains in a basic lava, whether native or foreign at the time of its effusion, "would be subjected to the same conditions, all would be corroded by the magma, and each have its re-action rim of pyroxene formed." Still, the amount of inter-action must be largely dependent on the heat of the magma at the time the quartz was "picked up." Clarke, in his Data of Geo.-chemistry, p. 282, gives the temperature of emerging lavas as "rarely if ever below 1000 deg. C., while the actual temperature not long before emission may be hundreds, perhaps 1000, degrees higher." The most reliable data as to the fusion point of quartz give its transformation to tridymite at 800 deg. C., and subsequent fusion at about 1625 deg. C. Geikie records that "lava from Terre del Greco fused the sharp edges of flints."

In the occurrences under discussion, however, the amount of corrosion has been very great, the embayed quartz in some cases showing traces of having been originally twice as large. In the scoria, as has been described, the only minerals showing corrosion are the quartz, and the olivine, suggesting that both these minerals were in the molten material before ejection.

Efforts were made, in the assay laboratory at the Ballarat School of Mines, to reproduce the supposed conditions of "picked up" quartz. Some normal basalt was melted, quartz was dropped in, and the process of cooling retarded as much as possible. Sections were then cut and microscopically examined. Owing to lack of a proper control over the cooling, the crystallisation was not sufficient to enable any observations of value to be made.

In conclusion, while the Victorian occurrences, as so far investigated, have shown no striking characters, they appear to suggest an intratelluric origin of the quartz, and are of sufficient interest to have some bearing on the still unsettled question of the origin of quartz in basalts. With our hundreds of square miles of basalt still uninvestigated, some facts may yet be brought to light that will have a closer bearing on the problem.

[PROC. ROY. SOC. VICTORIA, 28 (N.S.), PART I., 1915].

ART. VII.—*An Occurrence of Ammonium Chloride at Frankston.*

BY E. J. HARTUNG AND A. C. D. RIVETT.

[Read July 8th, 1915].

In the immediate neighbourhood of the Sports Oval at Frankston there was, until some two years ago, a small, shallow lake, with an island about forty yards in diameter in the centre. The lake has gradually drained, and, except after heavy rain, a dry, firm annular bed of earthy material surrounds the one-time island. The island and the banks consist of accumulations of decaying wood, roots, and leaves, together with much siliceous earth (see analytical results below). The living vegetation consists of *Acacia*, *Melaleuca*, rushes, etc.

About the middle of March, 1915, a fire was started by some boys in the ti-tree scrub on the banks and island. Apparently the fire was soon extinguished on the surface, but it has since spread underground, and has defied the efforts of local municipal officers to put it out. The authors visited the place on May 15, and again some ten days later. During these ten days heavy rain had fallen, without greatly affecting the fire. The combustion was still active and the diameter of the unburnt central portion of the island had decreased by some six or eight yards. No flames were to be seen, but white smoke issued from a number of vents in the ground. This smoke had a very specific smell, and on the walls of the fissures and in the openings whence it escaped, there were deposited very beautiful incrustations of ammonium chloride crystals, in cubes and interlacing needles. The white colour of the smoke and its specific smell were doubtless due almost solely to fumes of this salt. As the fire spread, the surface vegetation was killed at the roots, and fell down. It was unsafe to walk over the burning areas without the support of branches of scrub.

The ash left was, for the most part, very voluminous, and varied in colour from dirty white, through pink and red, to brownish purple. In parts the ash was more compact. The bed of combustible matter was apparently several feet deep.

Analytical Work.

One might reasonably suspect that in the course of slow combustion, the nitrogenous constituents of the decaying plant material would undergo chemical action with sodium chloride, the presence of which in a dried-up lake near the sea would be probable. Ammonium chloride would result, and at the temperature of the combustion would be volatilised. A number of analyses have been carried out in order to ascertain definitely the nature of the materials taking part in, or produced during, the reactions which occur. The following paragraphs summarise the results.

1. Specimens of the crystalline sublimate from one of the vents contained 99.4 per cent. pure ammonium chloride, calculated from the weight of silver chloride obtained by double decomposition with silver nitrate. The balance was probably moisture, or a trace of contaminating ash. It contained no sulphate. A natural product from Vesuvius, analysed by Klaproth, contained 99.5 per cent. ammonium chloride, and 0.5 per cent. ammonium sulphate.

2. Specimens of red ash gave the following proportions of the main constituents :—

TABLE I.

	I.	II.
Silica	85.22	86.55
Alumina	8.66	6.98
Ferric oxide	4.52	5.33
Lime	0.55	0.26
Magnesia	0.43	0.68
Sulphur trioxide	trace	trace
	99.4	99.8

Alkalis were not determined quantitatively. Sodium was present in small amount, and there was a minute trace of potassium. Qualitative tests showed that manganese, zinc, cobalt, nickel, barium, strontium, chromium, carbonate and chloride were absent. The complete absence of chloride is to be noticed. It is unlikely that sodium chloride would be volatilised during combustion, and unless it were washed out of the layer by heavy rain before combustion began, it is probable that there was more than sufficient ammoniacal matter produced to convert the whole of the chloride to the ammonium salt. This possibility is supported by the fact, to be mentioned later, that the yield of ammonium chloride may be increased by addition of common salt to the combustible matter. A small amount of soluble matter could be extracted by water from the ash. It contained calcium, magnesium and sulphate. On treating the ash with boiling hydrochloric acid, chlorine was evolved. As higher oxides of manganese were absent, one is inclined to suppose this oxidation of hydrogen chloride to be due to atmospheric oxygen, the action being catalysed in a marked manner on the surface of the very finely divided ash. The acid yielded a yellow solution containing aluminium, trivalent iron, calcium, magnesium and a little sodium. An undissolved residue of fine white powder was mainly, if not entirely, silica.

The air-dried ash retained about 6 per cent. of moisture, but much larger proportions were present in samples freshly collected. From the earths, the analyses of which are detailed in the next paragraph (3), ashes were obtained which were extracted with hot water and also with dilute nitric acid. In each of the four cases examined, chloride and sodium proved to be present. These ashes were obtained by burning in an open dish small quantities of earth and organic matter; probably under such conditions of ready combustion in an abundance of air, the action between salt and nitrogenous matter does not occur to more than a slight extent.

3. Samples of earth, with accompanying organic matter, were taken from four different places. Big decayed roots and thick leafy surfaces were rejected, so that from the point of view of vegetable matter, these samples are below the general average. The water content was, of course very variable.

It would be absurd to claim that such samples represent fairly the composition of the heterogeneous area undergoing combustion. Nevertheless, the analyses of them are not without value in giving an idea of the nature of the area.

The samples will be referred to as A, B, C and D respectively. A was taken from just below the top layer on the island, about six feet from a smoking vent; it was more earthy than the samples from other parts. B was from the middle of the island, about eight or nine inches below a very thick, leafy surface. It contained many fine roots. C was about one foot below the surface, and was quite close to a vent. It was hot and smoking when collected, fairly free from fine roots, very moist, and contained a number of tiny white specks, probably of ammonium chloride. These three samples were all from the island. D was from the bank of the lake just under the surface layer, and six feet from a smoking vent.

The following remarks are necessary in explanation of the analytical tables :—"Moisture" is that portion of the specimens which was volatilised in an air oven at 110 deg. C. "Combustible matter" represents the portion oxidised and volatilised on heating to redness in an open platinum or silica dish. The "ash" is the residual matter. "Total nitrogen" was determined by the method of Kjeldahl, oxidation of the organic material being readily accomplished by sulphuric acid and potassium sulphate. By "free nitrogen" is to be understood that nitrogen which may be distilled (as ammonia or substituted ammonias) from a sample of earth by boiling with sodium hydroxide solution for one hour. It cannot be taken as giving a measure of the ammonium salts present before combustion, because even after prolonged boiling the steam distilling was found to be alkaline. Doubtless there is a progressive action between the alkali and the nitrogenous matter; to limit the time of distillation to one hour is arbitrary. The estimations of total chloride proved to be very tedious. Portions of each sample were extracted three or four times with boiling water; the resulting filtrates contained brown colloidal matter. They were evaporated to small volumes, and in one case taken completely to dryness. In this case, sodium chloride crystals separated along with the brown matter. Evaporation did not suffice to render the latter insoluble; the greater proportion again formed a colloidal suspension on the addition of water. To each extract a few drops of nitric acid were added, the solution boiled and silver nitrate added. The silver chloride formed was fine grained and yellowish owing to colloidal contamination. It could not be made to coagulate except in one case (D), where much less colloidal matter had been removed in the extraction. After settling, the supernatant liquid was decanted through a Gooch crucible, and the residue dissolved in ammonia. The deep brown colour of this solution was possibly due in part to the reduction of the ammoniacal silver complex to colloidal metal, by organic matter. On reprecipitation with excess nitric acid, the silver chloride was white and coagulable. The liquid was poured through the Gooch crucible, but on addition of water or dilute nitric acid, the precipitate turned to a milky suspension, which the asbestos layer in the crucible would not retain. Boiling again coagulated it. The liquid was decanted away, the precipitate dissolved in ammonia (the solution again being deep brown in colour), and reprecipitated with nitric acid. A repetition was necessary before a satisfactory product was obtained. In the following tables, all figures represent percentages:—

TABLE II.

	A.	B.	C.	D.	A.	B.	C.	D.
Moisture	35.3	47.8	47.4	50.4	Calculated on dried material.			
Ash	53.7	37.1	43.2	31.5	83.0	71.1	82.0	63.4
Combustible matter	11.0	15.1	9.5	18.2	17.0	28.9	18.0	36.6

All subsequent figures are percentages calculated upon dried material.

TABLE III.

	Total Nitrogen.				Free Nitrogen.			
	A.	B.	C.	D.	A.	B.	C.	D.
Calculated as								
Nitrogen	0.47	0.84	0.79	1.14	0.07	0.10	0.16	0.13
Ammonia	0.57	1.02	0.96	1.39	0.08	0.12	0.20	0.16
Ammonium chloride	1.80	3.19	3.00	4.37	0.26	0.37	0.62	0.51

TABLE IV.

	A.	B.	C.	D.
Chloride, calculated as				
Chlorine	0.44	0.64	0.36	0.22
Sodium chloride	0.72	1.06	0.59	0.36
Ammonium chloride	0.66	0.97	0.54	0.33

Production of Ammonium Chloride.

Some experiments were carried out with a view to ascertaining the yield of ammonium chloride from slow combustion of sample B. It was not, of course, possible to reproduce the conditions prevailing at Frankston.

A short, hard glass tube was filled with material. Owing to difficulty in absorbing the products from large amounts, it was necessary to work with only five grammes at a time. The sample, heated from the outside, was slowly burnt in a current of air. The current carried the products of combustion through a long tube in which were spaced twelve wet glass-wool plugs, and then through a bubbler containing water. All visible smoke or fume was removed before the last plug was reached. Care was taken to make the combustion complete, and to prevent condensation of products in the hard glass tube. The plugs in the long tube were pushed together, and washed with hot distilled water until free from chloride. The washings, together with the water from the bubbler, were made alkaline with potassium hydroxide free from chloride, and evaporated to dryness. The residue was very gently ignited, the solution then acidified with nitric acid, filtered and precipitated with silver nitrate. The silver chloride was weighed in a Gooch crucible. Calculating the chloride as ammonium chloride, the amount of the latter obtained was equal to 0.092 per cent. of the quantity of (dried) B taken. When 10 per cent. of sodium chloride was mixed with the earth sample before analysis, the yield was increased to 0.29 per cent. These figures must not be given too much weight, for the amounts of material dealt with were small, and it is possible that traces of sodium chloride may have been volatilised during the combustion. In any case, the amount of ammonium chloride produced must depend very largely upon the conditions of the combustion, such as air supply, temperature, time, and so on. The attempt to reproduce artificially the natural combustion is, of course, difficult, and the result is inevitably unsatisfactory.

Conclusion.

In most, if not all, places where ammonium chloride occurs naturally, there is present vegetable matter in a more or less advanced state of decay, together with chlorides. The production of ammonium chloride is greatly accelerated by heating, and the occurrences near volcanoes such as Etna, Stromboli, Vesuvius, and others are greatest where lava spreads over soil and vegetation.

Abegg (Hdb. anorg. Chem., III., 3, p. 250) states that in Egypt, where ammonium chloride is obtained from the soot from burnt camel dung, ammonia is probably formed by processes of decay in the dung before burning. This, however, is most likely not so in the other case cited by Abegg, where ammonium chloride is produced by burning a mixture of coal, salt, animal offal and clay. Probably here the first stage is the destructive distillation by heat of the organic matter, with the production of ammonia or simple ammoniacal compounds. Reaction occurs between these and the metallic chlorides. There is every reason to suppose that this is what is happening in the Frankston deposit. One may suppose that there is a considerable supply along the seashore of the material necessary for such a formation of ammonium chloride.

The authors wish to record their thanks to Mr. T. W. Corrigan, of Frankston for bringing this occurrence to their notice, through Mr. H. Hartung, and for facilitating their observations.

[Proc. Roy. Soc. Victoria, 28 (N.S.), Part I., 1915].

Art. VIII.—*On the Faunal Subregions of Australia.*

By THOMAS G. SLOANE.

(Communicated by J. A. Kershaw).

[Read July 8th, 1915].

"A considerable amount of ingenuity has been expended in trying to solve the interesting problem of the distribution of southern faunas. * * * * * No doubt our knowledge will increase, but it seems hardly possible to make any more theories."

The quotation above from Captain Hutton's erudite paper, "Theoretical Explanations of the Distribution of Southern Faunas," published in the Proceedings of the Linnean Society of New South Wales, 1896, epitomises the position of our present subject in its general bearings as left by Hutton. My intention is only to deal with the zoogeographic sub-regions and districts of the continent of Australia, and, for this purpose, it is only necessary to refer to two previous essays, viz., Professor R. Tate's address "On the Influence of Physiographic Changes in the Distribution of Life in Australia," published in the "Report of the Australasian Association for the Advancement of Science," 1888; and Professor W. Baldwin Spencer's "Summary of the Zoological, Botanical and Geological Results," embodied in the "Report on the Work of the Horn Scientific Expedition," 1896.

For zoologists Spencer's splendid summary is indispensable, while the ability shown in Tate's work makes it of first-class importance.

To make clear my point of view towards this much-discussed subject, and to establish a meeting-ground for my readers and myself, the following definitions of my position in regard to some fundamental tenets of zoogeography are offered.

1. Permanence of continents. Darwin's position was that the great continents had maintained approximately their present positions since early geological times. Wallace also held strongly the same view. But when we admit the union of Australia with an Antarctic continent, probably in the Miocene, the idea of any necessary permanence for the present continents beyond the middle of the Tertiary Era must be given up.

2. Length of time required for the distribution of any group of land animals. We must suppose that sufficient land bridges have occurred in the Tertiary Era to have enabled any group to have spread over the whole earth. The case of the struthious birds may be cited in support of this view, for this terrestrial group of the Tertiary Era, as is shown by its geological and present distribution, has found land connections which enabled it to send members into every faunal region of the globe.

3. Insects—including the order Coleoptera—are older than the angiospermous plants; therefore, any biological regions established for plants will likely also be suitable for insects.

4. Wallace's view that the great faunal regions should be founded on the mammalia ought to be adhered to.

5. Plants and insects of the order Coleoptera were in Australia in Pre-Cretaceous times, and have always been there since.

6. Parts of Australia—(e.g., ranges of south-west Australia, Mount Lofty and Flinders Ranges, MacDonnell Ranges, parts of Australian Alps)—have been dry land since the Palaeozoic Era.

7. Following Deane and Spencer, the idea of a cosmopolitan Tertiary flora which occupied Australia must be abandoned.

8. There are entomological reasons for supporting the existence of the Huxley-Hutton Mesozoic Trans-Pacific continent in warm latitudes.

9. The entry of the marsupials into Australia from an Antarctic source, as advocated by Hedley and Spencer, is to be accepted.

10. Tate's idea of a Post-Miocene extension of Australia to the southward, to account for some analogies which Kangaroo Island and Port Lincoln present with his Autochthonian Region, is a good one. It has some entomological support.

Hutton and Spencer have agreed in ascribing four separate elements to the fauna of Australia Tate, in his able exposition of the botanical geography of Australia, divided the flora into two primary parts. I shall quote his words:—

"The flora of Australia consists of the following constituent elements:—

I. An immigrant portion.

II. An endemic portion."

He then divided the immigrant portion into two parts in the following words:—

"(a) Oriental, which is dominant in the littoral tracts of tropical Australia. (b) Andean. For the most part this type of vegetation is restricted to the high mountains of Tasmania, Victoria and New South Wales."

In regard to the endemic portion, he says :—

"I will divide the Australian Endemic Flora into three types.

1. Euronotian, dominant in the south and east parts of the continent.

2. Autochthonian, restricted to the south-west corner of West Australia, and approximately coinciding with the rainfall limit of twenty inches.

3. Eremian, dominant in the dry region, which has its centre in the Lake Eyre Basin."

Towards the end of his address, he says briefly of the fauna—"Not only in the Eremian Region, but in the others, the fauna of each will exhibit, though perhaps in a less degree, similar relationships to one another as the floras."

Summing up with regard to the fauna of his Autochthonian and Eremian Provinces, his words are as follows :—

"The Autochthonian Province is without distinctive features other than specific.

The Eremian Province has many specific, and some generic peculiarities, but is essentially Australian."

In the year 1896 Spencer reviewed the question of faunal subregions for Australia in a masterly manner, and published a map showing the results he arrived at from a careful study of the distribution of the higher animals. In this map two of Tate's botanical regions are adopted, viz., the Euronotian and the Eremian; but, owing to Spencer's faunal sub-regions, in no case corresponding altogether with Tate's regions, new names are proposed for the three faunal sub-regions of Australia, viz., Torresian, Bassian and Eyrean sub-regions. The Torresian and Bassian subregions are together the same as Tate's Euronotian region, which is divided into two at the Clarence River; the Eyrean sub-region comprises Tate's Eremian and Autochthonian regions united together.

Spencer briefly sums up the elements found in the fauna of Australia. I shall quote his words :—

"The present fauna may therefore be regarded as consisting of some four elements which may be very briefly outlined as follows :—(1) An older one derived from a land connection with Asia, the constituents of which it is difficult to define, and which existed partly in the western and partly in the eastern division when these two were separated. * * * * * * (2) A series derived from a connection with a land area lying to the east of the continent (and connected also with the Papuan region) represented by Microphyura and Acanthodrilus amongst lower forms and the struthious birds amongst vertebrata. (3) A series derived from the Austro-Malayan region. * * * * * * (4) A large and important series derived from the south and indicating a former connection with South America across Antarctic lands during a period not later than the Miocene."

With regard to the Pacific element, Mr. Hedley's views require attention. His paper, entitled "A Zoogeographic Scheme for the Mid-Pacific," published in the Proceedings of the Linnean Society of New South Wales, 1899, ends with the following sentences:—"No sign of an American immigration can be traced in the Central Pacific. Had the Trans-Pacific Jurassic Continent, advocated by such writers as Hutton and Baur, any foundation in fact, then, if not terrestrial, at any rate, marine forms should now extend eastwards from America along its former site." My view is that the close relationship between the Carabidae of Australia and New Caledonia (half the genera of the New Caledonian Carabidae are found in Australia), the presence in Australia of Cicindelidae belonging the genera Megacephala and Rhysopleura (the nearest relations of which are now found in South America), and, also, some evident relationships which exist between some of the Carabidae of Australia, New Zealand, and the Hawaiian Islands (the genus *Mecyclothorax* is found in these three lands) require the ancient Trans-Pacific continent for their explanation.

For the four elements found in the Australian fauna by Spencer and others I shall adopt the names *New Holland*, *Pacific*, *Antarctic* and *Austro-Malayan*. All these names except New Holland are in general use, but I have seen no satisfactory term for the element for which the name New Holland is now proposed. It is Tate's "endemic" element, and is perhaps not quite the same as Hutton's "Australasian" element. The term endemic is objectionable, for being an adjective in common use it cannot be given a restricted and technical meaning without causing confusion. It is not easy to choose such terms, and New Holland could perhaps be improved upon, but, at least, it is distinctive, and having become obsolete its assignment as a term to designate the primary element in the Australian fauna may be allowed, at any rate till a better name is proposed.

I shall now briefly review the Cicindelidae and Carabidae to see how the four elements of the Australian fauna appear in their case. It will be convenient to take the most recently arrived elements first, because the more recent constituents are more readily discerned than those of older date.

1. *Cicindelidae.*—This family may be taken to be wholly an immigrant group, derived from the Austro-Malayan and Pacific sources. The genera *Cicindela* and *Tricondyla* are Austro-Malayan; *Megacephala*, *Nickerlea*, *Distypsidera* and *Rysopleura* are of Pacific origin.

2. *Carabidae.*—The Carabidae of Australia with Tasmania as at present known are comprised of 28 tribes, 200 genera and 1430 species; amongst this great complex are found representatives of the four elements of the Australian fauna, but it is not yet easy to define clearly the Pacific and Antarctic types from one another, nor either of these from the New Holland element.

(1) Austro-Malayan.—This element is very largely represented in the fauna of Australia, especially in the Cape York Peninsula. The following 10 tribes are wholly Austro-Malayan as far as their Australian representatives go:—Apotomini, Panagaeini, Chlaeniini, Masoreini, Perigonini, Odacanthini, Dryptini, Physocrotaphini, Zuphiini, Brachynini. These tribes contain 20 genera and 52 species. Only one of these genera, viz., *Eudalia*, belonging to the tribe Odacanthini, is peculiar to Australia. The percentages of the Australian totals shown by this immigrant fauna are:—Tribes 35.7, genera 10, species 3.6; and there are besides at least 25 genera belonging to cosmopolitan tribes which are of evident Austro-Malayan origin; the addition of these would make 45 Austro-Malayan genera in Australia or 22.5 per cent. of the total number. If we take away from the Australian total of 28 tribes the 10 Austro-Malayan tribes recognised above, it leaves Australia with a Carabfauna poor in tribal types. Europe had in 1896 34 tribes, 145 genera, and 2180 species.

(2) Antarctic.—There is one tribe in Australia of undoubted Antarctic origin, viz., Migadopini; it is confined to the Bassian subregion, and has representatives in New Zealand and South America (also in the Falkland and Auckland Islands). The Mecodemides (Genera *Percosoma*, *Lychnus*, etc.), a group of the tribe Broscini, largely represented in New Zealand, is also an Antarctic group.

(3) Pacific.—I have not been able to recognise satisfactorily the constituents of the Pacific element in the Australian Carab-fauna. Probably this can only be done by someone with a good knowledge in nature of the faunas of New Caledonia and New Zealand.

(4) New Holland.—Tribes Pamborini and Cuneipectini. Groups Carenides (tribe Scaritini) Promecoderides (tribe Broscini), the

Australian section of the tribe Helluonini, the Australian section of the tribe Pseudomorphini, etc. The Carabidae are not sufficiently carefully worked out and compared with those of other regions for any work of value to be done yet.

There is apparently no reason for entomologists to dissent from the adoption of Spencer's three faunal sub-regions; they seem to suit the Carabidae, though the order Coleoptera is so ancient that its distribution might have been expected to accord with that of the plants rather than with that of the mammalia. We will take a brief glance at these three faunal sub-regions, and the districts into which I divided them on entomological grounds in the year 1905.

The Torresian has the richest fauna of any of the sub-regions of Australia, and is largely stocked by Austro-Malayan types found nowhere else on the continent. It is a tropical and sub-tropical country with a variable climate, which in some places near the seaboard has a high average rainfall, and a tropical flora, such as accompanies a heavy rainfall where the soil is good; in other parts rather dry, and with open forests; its rivers are numerous, though, owing to there being no lofty mountains and the nearness of the watershed to the coast, no such great rivers as might have been expected are present. The Torresian and Eyrean sub-regions are now fused together, with the arid climate of the Eyrean subregion as the chief obstacle to the complete intermixture of their faunas. It is impossible to draw a definite line between these subregions, unless empirically, as was done by Tate when he adopted the line of twenty-five inches of mean rainfall as the boundary between his Euronotian and Eremian botanical regions. It is reasonable to expect that the hardy Eyrean fauna will have been able to encroach into the more favoured Torresian region to a greater extent than has the Torresian fauna into the Eyrean steppes, though the comparative freedom from competition in the sparsely inhabited Eyrean country may have been favourable to a widespread range for some hardy Torresian forms.

The districts proposed by me in the year 1905 for the division of the continental part of the Torresian sub-region were three, as under:—

(1) West Torresian District.—This was divided from the rest of the sub-region by a line drawn north and south from near the bottom of the Gulf of Carpentaria. The typical insect fauna of the West Torresian district will probably be found about the Daly River, but I know very little of the entomology of this district. The strange genus *Delinius* of the tribe Pterostichini is peculiar to the district.

(2) Middle Torresian District.—This extends from about the bottom of the Gulf of Carpentaria to near the tropic, having the Bellenden Kerr Mountains for its central feature. The genera *Steganomma* (tribe Scaritini), *Mecynognathus* and *Loxogenius* (tribe Pterostichini) are not found beyond the limits of this region; also *Rhysopleura*, a remarkable genus of the family Cicindelidae.

(3) South Torresian District.—This extends from the tropic to the Clarence River. Its typical Carabidae are found from the Burnett to the Richmond River. *Liopasa*, *Leirodira* and *Notolestus* are distinctive genera (tribe Pterostichini) belonging to this district.

The Bassian sub-region is a country of mountains, rivers and forests. In its past history we may imagine great ranges of mountains covered with perpetual snow, which presented a barrier to the southward progress of the fauna of the north; for this reason, we may suppose the Cicindelidae failed to reach Tasmania, or, except as very recent immigrants, Victoria south of the dividing Range; for the same reason such characteristic Australian groups of the Carabidae as the Carenums and Helluonini have not extended to Tasmania, and are hardly represented in Southern Victoria.

Through the continental part of the Bassian sub-region five reciprocal routes of past migration may be perceived; viz., three from north to south, and two from east to west. The north and south routes will be, one over and along the mountains, and a route on each side of the mountains available for the fauna of the lowlands. Such species as the Carenums *Laccoscaphus loculosus* and *L. foveipennis* may be taken as lowland forms, which spread into Victoria and the south-eastern parts of South Australia along the western lowland route. The two east and west routes will be, (a) Tate's Post-Miocene route across a former southward extension of Australia. This must have been a forest-clad land across which have passed such Carabidae as the ancestors of the present species belonging to the genera *Promecoderus*, *Amblytelus*, *Platylytron*, *Hormacrus*, and the single species of *Notonomus* found in Western Australia. (b) The route which became available on the union of the Bassian and Eyrean sub-regions, and which has been taken advantage of by both Bassian and Eyrean types.

In the scheme proposed by me the Bassian sub-region was divided like the Torresian into three districts, viz., a northern, middle and Tasmania. There is apparently no true line of demarcation between (4) the North Bassian district, which centres on Sydney, and (5) the Middle Bassian district, of which the Australian Alps are the great natural feature.

The Eyrean Sub-region.—This immense division has generally a hot, dry climate; in no part has it a winter that brings snow nor even (except near Cape Leeuwin) decided dampness. There is abundant evidence of the long-continued prevalence of these conditions, with the result that the now dominant types of the fauna are composed of comparatively few wide-ranging species; such species being often found in isolated colonies, sometimes at great distances from one another. Attention was drawn to this fact by Professors Tate and Spencer in the Report of the Horn Expedition. Some of the most distinctive wingless Carabidae of the Eyrean sub-region range from the coastal districts of Western Australia to New South Wales (such are *Carenum elegans*, *C. scaritioides*, *Neocarenum elongatum*, *Parroa howitti*).

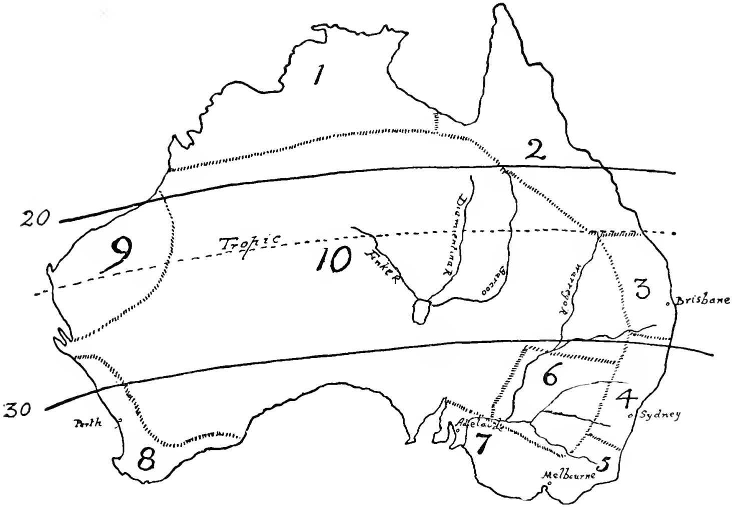
Doubtless there are several centres of distribution in the present Eyrean sub-region (e.g., Flinders Range, MacDonnell Ranges, ranges of South-western Australia). There has been a great deal of immigration into it from the Torresian and Bassian sub-regions. The Carabidae of the Eyrean sub-region are not numerous, considering its great area; the eastern parts have more genera and species than the western parts, owing to the numerous Torresian and Bassian forms which have invaded the eastern borders of the sub-region. Characteristic groups are:—The tribe Cuneipectini (one genus with two species), the group Carenides (tribe Scaritini), and such genera as *Gnathoxys*, *Parroa* and *Adotela* (tribe Broscini), *Phorticosomus* (tribe Harpalini), *Helluarchus* and *Helluapterus* (tribe Helluonini).

I divided the Eyrean sub-region into five districts in 1905. These were numbered on my map from 6 to 10.

(6) The Riverina district is probably merely part of the eastern marches of the Eyrean sub-region. It may be considered to take in the whole of the basin of the River Darling, its western boundary being the watershed between the Darling and Barcoo Rivers. Its chief distinctive character is the prevalence of immigrant forms from the Bassian and Torresian sub-regions.

(7) The South Australian District.—This has for its centre the Mount Lofty and Flinders Ranges; probably it should include the Victorian Mallee districts, and it may extend round the head of Spencer's Gulf to take in Eyre's Peninsula. It has two very isolated genera of the tribe Pterostichini, viz., *Secatophus* and *Teropha*.

(8) South-west Australia.—This district should be defined by the rainfall line of twenty inches to correspond with Tate's Autochthonian Province.



Map showing entomological districts of Australia as now suggested.

1. West Torresian District 2. Middle ,, ,, 3. South ,, ,,	Continental part of Torresian Subregion of Spencer.	Euronotian Province of Tate.
4. North Bassian ,, 5. Middle ,, ,,	Continental part of Bassian Subregion of Spencer.	
6. Riverina ,, 7. South Australian ,, 8. South West Australia 9. North West Australia 10. Central Australia	Eyrean Subregion of Spencer.	

6, 7, 9, 10 form Eremian Province of Tate, with rainfall less than 25 in.; 8 is Autochthonian Province of Tate.

(9) The North-west District.—This is perhaps a weakly defined portion of the Eyrean sub-region; probably all the country watered by the De Grey, Ashburton, Gascoigne and Murchison Rivers should be included in it, but its Carabidae are too little known, especially in regard to their eastward range, for this district to be treated of with confidence.

(10) Central Australia—as intended by me in 1905—corresponded to the Larapinta district of Tate (Horn Expedition, Botany), which centres round the MacDonnell Ranges, but in practice it may be

taken to comprise all that is left of Spencer's Eyrean sub-region after the other four districts treated of above are removed.

In conclusion. I wish to emphasise the view that such faunal districts are better suited than any political divisions for use by biologists to show the distribution of genera and species. Such districts can be employed to impart a greatly added value to published lists of species, without adding to their bulk (this being an important consideration in dealing with such an order as the Coleoptera, which requires a large volume for the mere enumeration of the names of its innumerable species). If a map be given with the districts numbered on it, these numbers can be added on the same line as a name of a species in the list without increasing its bulk or price. It is much to be desired that workers in different groups should use the same set of faunal districts, and it is not to be supposed that a system of districts which will commend itself generally to zoologists can be evolved without much study and research. At present I can only feel confident of Tate's Autochthonian Region being a surely defined faunal district.

[Proc. Roy. Soc. Victoria 28 (N.S.), Part I., 1915].

Art. IX.—*Further Notes on the Essential Oils of Australian Myrtaceae.*

By A. E. DAWKINS, B.Sc., and J. C. EARL, A.I.C.

(Government Research Scholars).

Communicated by Dr. Heber Green.

[Read July 8th, 1915].

Part I.—*The Essential Oil of Eugenia Smithii.*

By A. E. DAWKINS, B.Sc.

Eugenia smithii (N.O. Myrtaceae), commonly known as "Lilly-pilly," occurs in Eastern Australia from Victoria to Queensland. It is a magnificent evergreen ornamental tree, reaching a height of from fifty to eighty feet; the leaves are dark green, oval, slightly pointed, and covered with oil-dots; the flowers are small and pale green, and produce numerous white, lilac and mauve berries, which are very showy when fully ripe.

The wood produces a dark, close-grained timber, said to be well adapted to ornamental furnishings. Baron von Mueller records that the bark contains 17 per cent. of tannin.

Some species of the genus *Eugenia* produce large, juicy table fruits of a wholesome, agreeable flavour; the young flower-buds of *E. caryophyllata* form the spice well-known as "cloves"; "allspice" is the product of *E. pimento;* and the seeds of *E. jambolana* have been used as a remedy for diabetes.

As Eugenia Smithii is found in such profusion in the native state, and grows rapidly under cultivation, it was thought desirable to investigate and place on record the nature of the oil contained in its foliage.

The material from which the oil was steam-distilled was obtained from the Melbourne Botanical Gardens, through the courtesy of the Curator.

Physical Constants.

The yields and physical constants of the two samples worked with were as follow :—

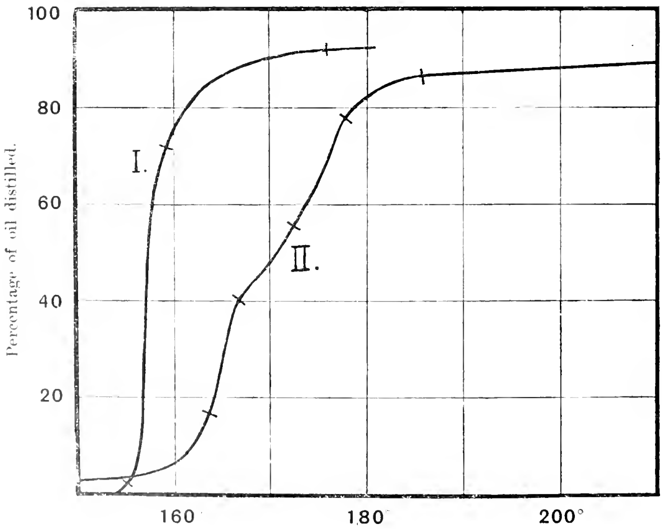
TABLE I.

Date of Distillation	May, 1914	July, 1914
Weight of leaves in lbs.	148	165
Ounces of oil	10.5	7.5
Percentage yield	0.44	0.28
Specific gravity $d_{15\ 15}$	.866	.863
Optical rotation α_{D15}	+35.0°	+34.6°
Refractive Index μ_{20}	1.4701	1.4675

The difference in yield illustrates the seasonal variation usually observed in the distillation of oils from the Myrtaceae, but the physical constants are so similar that the two samples may be regarded as identical in composition, The oil is pale yellow in colour and possesses a sweet penetrating odour.

Fractional Distillation.

By way of exploration 50 c.c. of the oil was submitted to a fractional distillation in a still of standard dimensions, the results of which are embodied in the graph and in Table II.



Temperature of oil distilling.

I. *Eugenia Smithii.* II. *Eucalyptus platypus.*

TABLE II.

Fraction.	Temperature of distillation.	Percentage of total by volume.	Specific gravity $d_{15\ 15}$	Optical rotation α_{D15}	Refractive index μ_{20}
I.	Below 155 c	1.6	—	—	1.4673
II.	155° - 159°	69.6	.860	+38.9°	1.4661
III.	159° - 176°	21.1	.877	+31.3°	1.4697
Residue	Above 176	7.7	—	—	1.4813

The curve indicates that the oil contains one preponderating constituent, and suggests that this is probably pinene.

Chemical Examination.

α Pinene.—From a fraction boiling at about 156 deg. C. a nitrosochloride was prepared; melting point = 104-105 deg., indicating presence of α-pinene. The rotation of the original oil and that of the pinene fraction show that the hydrocarbon is present in the dextro form, a conclusion in agreement with the observation that the nitrosochloride was formed only with difficulty (v Gildemeister and Hoffmann—*The Volatile Oils*, p. 296).

β Pinene.—In order to test for the presence of β pinene or nopinene), which is associated with the α-pinene of turpentine oils, the following experiment was carried out (Wallach, *Liebs. Ann.* 356, (1907), 228):—30 c.c. of a fraction boiling between 157 deg. and 166 deg., was oxidised with excess of cold alkaline solution of potassium permanganate, the liquor was filtered from manganese dioxide, steam-distilled to remove unchanged oil, and concentrated to a third of its original bulk. There was no separation of the sparingly soluble sodium nopinate. (A control experiment using a similar fraction from oil of turpentine yielded a sodium salt, the acid set free from which had the melting point characteristic of nopinic acid.)

Phellandrene.—The presence of phellandrene and other nitrosite-forming hydrocarbons, was tested for with negative result.

Acids.—Absent.

Esters.—The saponification number was 11.6, representing 4 per cent. of esters, calculated as $C_{12}H_{20}O_2$. In order further to investigate the esters 100 c.c. of the original oil was saponified with 50 c.c of a 0.5 N. alcoholic solution of sodium hydroxide. After saponification 60 c.c. of water was added to precipitate the oil; the aqueous liquor was separated and evaporated to one-third of its bulk, acidified with hydrochloric acid, and extracted with ether. The ethereal extract was dried over calcium sulphate, and allowed to evaporate in the air. The acid crystallised in shining laminae, resembling those of benzoic acid. They were recrystallised from ether; melting point 119-120 deg. (M.P. of benzoic acid=121 deg.) The crystals were only sparingly soluble in water, but were readily so in ammonium hydroxide. A neutral solution of the ammonium salt gave a buff-coloured precipitate with ferric chloride solution. These reactions indicate the presence of a benzoate in the oil; there was not, however, sufficient material to identify the esters further.

Alcohols.—Saponification number after acetylation was 24.9, corresponding to 3 7 per cent. of free alcohols of the formula $C_{10}H_{18}O$.

Phenols.—Shrinkage in volume on treatment with a 5 per cent. solution of sodium hydroxide was nil.

Aldehydes and Ketones.—Absence shown by bisulphite absorption.

Cineole.—The presence of this substance was not indicated by the physical properties of the oil, nor could any trace be detected by Hirsch's delicate iodole test.

Summary.

The oil consists as follows:—

d α-Pinene, 80 to 90 per cent.

Esters (partly benzoates), 4 per cent.

Alcohols, 3.7 per cent.

The oil is interesting as the source of a highly dextrorotatory pinene, but this has at present no technical application which would, taking into account the small yield, make the distillation of the oil in quantity a commercial success.

The author is indebted to Mr. P. R. H. St. John for the introductory botanical characterisation, and for assistance in collecting the leaves and distilling the oil, and to Dr. Green for much helpful advice in the analysis.

Addendum.—A sample of Eugenia myrtifolia, another species indigenous to Eastern Australia, was also examined, but although some forty pounds of the foliage were submitted to steam distillation in the usual manner no visible traces of oil were obtained.

Part II.—*The Calculation of the Oil Content of Foliage from Measurements of the Number and Size of the Oil Glands.*

By A. E. DAWKINS, B.Sc.

The collection and distillation of oil-containing materials is often a matter involving much labour. Since therefore the oil is well known to occur in the case of many species in small, well-defined oil-dots or oil-glands, it was thought that it might be possible to forecast the oil content of any particular species by making a few measurements of the size and number of the oil-dots, weight of leaf, etc.

Let $\frac{\pi}{6}\overline{d^3}$ be the average volume of the glands in *c.c.*,

- n the number per sq. c.m.,
- g the specific gravity of the oil,
- w the weight of leaf per sq. c.m.,
- p the ratio of the weight of leaves to the total weight of leaves and stalks as usually taken for distillation.

Then assuming that the oil glands are spherical the percentage yield of oil will be

$$\frac{52.4p\overline{d^3}ng}{w}$$

The measurement of the size and number of the oil-glands can readily be accomplished microscopically, using an eye-piece provided with suitable micrometer scales.[1]

The specific gravity of the oil can of course only be determined when a sample of the oil is available. For most oils, however, a sufficient approximation will be attained by giving g the value of 0.9.

The value p is determined by stripping one or two typical branchlets, and weighing the leaves and the stalks separately.

The accuracy of this method may be judged from the following series of measurements on several species of oil-bearing plants which we have recently had the opportunity of distilling.

---

1 A convenient scale for counting the number of oil-dots can be easily made by ruling a series of squares on a thin sheet of mica.

Species.	Nature of leaf.	Oil-glands. Mean diam. mms.	Oil-glands. *n* per sq. cm.	*g*	*w*	*p*	Percentage yield of oil. calc'd.	Percentage yield of oil. realized.
Eucalyptus radiata.	large	.113	1310	.88	.0197	.71	3.06	2.70
	small	.097	1465		.0208		2.10	
Eucalyptus viminalia.		.113	850	.92	.039	.67	1.03	1.32
Eucalyptus kitsoni.		.155	227	.91	.032	.76	.95	.85
Leptospernum lanigerum	large	.075	1090	.98	.017	.46	.60	.56
	small	.078	960		.013		.82	
Eugenia Smithii.	large	.091	475	.86	.033	.82	.44	.36
	small	.072	940		.037		.33	

The distillations were carried out on fresh material, from a half to three hundred-weights of foliage being used in each case. It will be seen that the agreement is as close as can be expected in view of the difficulty of obtaining a representative sample.

The method and formula may, therefore, be applied to indicate the approximate yield of oil to be expected from any oil-producing plant.

Part III.—*The Essential Oil of Eucalyptus platypus.*

By J. C. EARL, A.I.C.

By courtesy of the Director of the Melbourne Botanic Gardens, a supply of the leaves of *Eucalyptus platypus*, a tree indigenous to Western Australia, was obtained from the Gardens for the purposes of distillation.

The yield of oil obtained on distillation of the fresh leaves was 1 per cent.

The oil had the following constants :—

Specific gravity at 15°/15°	0.9045
Optical rotation in 100 mm. tube at 12° C, α_D	+9.1°
Refractive index at 20° C, n_D	1.4675
Saponification number	6
Saponification number after acetylation	24
Aldehyde-and ketone-content detetermined by absorption with 30 % sodium bisulphite solution	nil
Cineole content by direct absorption with 50 solution of resorcin	59 % by weight.

The results of a fractional distillation of 50 c.c. of the oil under atmospheric pressure, and of the examination of the fractions obtained, are given in the following table:—

Fraction.	Temperature.	Volume of oil distilled.	S.G. 15°C/15°C	$a_D^{15°C}$	$n_D^{11.5°C}$
A	Up to 163.5°C	2.15 c.c.	—	—	—
B	163.5°C – 167°C	9.3 c.c.	0.886	+20.8°	1.4680
C	167 °C – 170°C	10.05 c.c.	0.893	+16.1°	1.4673
D	170 °C – 175°C	9.55 c.c.	0.903	+ 8.5°	1.4667
E	175 °C – 184°C	8.75 c.c.	0.916	+ 0.2°	1.4660
F	184 °C – 206°C	2.95 c.c.	0.926	—	1.4692
G	206 °C – 240°C	2.85 c.c.	0.937	—	1.4845
H	Residue boiling above 240°C	4.4 c.c	0.952	—	1.5040

The low initial boiling temperature combined with the positive rotation of the oil, indicated the probable presence of pinene. In confirmation of this, a crystalline nitroso-chloride of melting point 106° C was prepared from fraction B. Fraction D yielded a small quantity of a crystalline nitrosite which could only be purified by dissolving in chloroform and precipitating with petrol; thus obtained it had a melting point of 104° C. This indicated the presence of a small proportion of phellandrene in the oil. The residue, H, was dissolved in dry ether, and dry hydrochloric acid gas passed through; no crystalline hydrochloride could be isolated from the resulting product.

For further examination of the oil and confirmation of the results of the above preliminary investigation, 200 c.c. of the oil were fractionated at 32 to 34 mm. pressure. The following results were obtained:—

Fraction.	Temperature.	Weight distilled.	S.G. 15°C/15°C	a_D at 19°C
I.	Up to 72°C	33.75 gms.	0.879	+21.4°
II.	72°C – 75°C	53.73 gms.	0.882	+15.5°
III.	75°C – 79°C	37.70 gms.	0.900	+ 6.7°
IV.	79°C – 92°C	27.70 gms.	0.912	– 1.5°
V.	Residue + loss	28.02 gms.	0.946	—

Pinene—Fraction I. yielded a nitroso-chloride similar to that previously obtained. The nitrol-piperide prepared from this compound melted at 118-119° C.

Phellandrene.—Fraction II. yielded a small quantity of nitrosite, which after purification melted at 105-106° C. There seems little doubt that this was phellandrene nitrosite.

Cineole (eucalyptol).—The cineole-iodol addition compound, melting at 113° C, after recrystallisation from benzene, was readily obtained from a portion of fraction III.

Aromadendrene.—The residue, V., gave the colour reactions attributed by Baker and Smith to aromadendrene.

Summary.

The following approximate composition may be assigned to the oil :—

Pinene - - - - - -	20–25%
Phellandrene - - - - -	10–15%
Cineole - - - - - -	55–60%
Aromadendrene - - - -	10–15%
Alcohols, free, and combined as esters, up to - - - - -	5%

I have to acknowledge my thanks to Professor Masson for encouragement and permission to use the University laboratories, to Dr. Green for many suggestions in the course of the work, and to Mr. St. John for assistance in the distillation of the oil from the leaves.

[Proc. Roy. Soc. Victoria, 28 (N.S.), Part I., 1915].

Art. X.—*New or Little-known Victorian Fossils in the National Museum.*

Part XVIII.—Some Yeringian Trilobites.

By FREDERICK CHAPMAN, A.L.S., &c.
(Palaeontologist to the National Museum, Melbourne).

(With Plates XIV-XVI.).

[Read July 8th, 1915].

Introduction and Summary.

Descriptions of five Victorian trilobites appeared in Part XIV. of this series[1], four of which are restricted to the Melbournian horizons. In the present paper some trilobites of the Yeringian group are dealt with, many of which have already been found in a similar fauna in New South Wales. Our knowledge of the Victorian Silurian trilobites shows that the majority of the New South Wales species are found in our upper series, or Yeringian, beds; and it seems fairly certain that the Silurian beds in the neighbouring State, are, as at Bowning and Yass, of an Upper or Newer Silurian facies. Not only do the trilobites of this upper series point to a younger phase of the Silurian, but some of the species are closely related to Lower, Middle and Upper Devonian trilobites in Bohemia and North America, such as *Goldius greenii*, sp. nov. (Lower Devonian), and *Cheirurus sternbergi*, Boeck sp. (Silurian to Upper Devonian).

On the other hand, forms like *Goldius cresswelli*, sp. nov., *Proetus euryceps*, McCoy sp., *Cyphaspis lilydalensis*, sp. nov., *C. yassensis*, Eth. fil. and Mitch. (with its *Arethusina*-like cephalon), *Calymene angustior* sp. nov., and *C. blumenbachi*, Brongn., are more or less Silurian in aspect

Eleven species of trilobites are included in this paper:—

Goldius greenii, sp. nov.
Goldius cresswelli, sp. nov.
Proetus euryceps, McCoy sp.
Cyphaspis bowningensis, Mitchell (Also N.S.W.).

1 Proc. Roy. Soc. Victoria, vol. xxiv., pt. ii., 1912, pp. 293-300, pls. lxi.-lxiii.

Cyphaspis lilydalensis, sp. nov.
Cyphaspis yassensis, Eth. fil. and Mitch. (Also N.S.W.).
Calymene angustior, sp. nov.
Calymene cf. *blumenbachii*, Brongn. (Also Brit. Ids., continent of Europe, N. America and N.S.W.).
Cheirurus sternbergi, Boeck sp. (Also England and continent of Europe).
Phacops crossleii, Eth. fil. and Mitch. (Also N.S.W.).
Phacops serratus, Foerste. (Also N.S.W.).

DESCRIPTION OF THE FOSSILS.

Trilobita.—Order Opisthoparia.

Fam. Goldiidae, Raymond (Bronteidae, Angelin).

Genus Goldius, De Koninck.[1]

Goldius greenii, sp. nov. (Plate XIV., Figs. 1, 2).

Description of Holotype.—Form short, broadly ovate. Cephalon short, arcuate. Glabella unusually small at the base, expanded in front; only the middle furrow is well marked, the anterior and posterior being shallow and indistinct. Anterior margin of glabella sulcated, with a narrow and fairly deep furrow, the surface of which is ornamented by a faint undulate striation more or less parallel with the border. Neck-ring distinct. Palpebral lobes rugosely ornamented.

Thorax with ten slender segments, the distal extremities of which appear to be free; their surface relieved with fine, strongly curved or wavy transverse striae. Axal furrows of thorax practically parallel and deeply incised.

Pygidium moderately large, semi-circular; with seven radial ribs or coalesced segments, and one caudal which is bifurcated for more than half its length. Pygidial axis small, roundly angular at the distal apex; the central ridge divided by seven transverse furrows, the segments convex. Pygidial margin entire. General surface of the pygidium convex proximally, gradually becoming depressed and concave towards the posterior margin. Surface of radiating pygidial ribs ornamented by thin raised wrinklings or

1 The well-known genus-name *Bronteus* has unfortunately to give place, according to priority ruling, to De Koninck's less known name, *Goldius*. The position may be thus stated. In 1839 Goldfuss named this generic type, *Brontes*, but the name was already occupied for a genus of coleoptera by Fabricius (1801), whilst Montfort had similarly named a genus of mollusca (1810). Seeing this, Goldfuss in 1831 (cf. Barrande, Syst. Sil. Bohême, vol. i., p. 830) changed the name to *Bronteus*, but the genus had in the meantime been renamed *Goldius* by De Koninck, in 1841.

striae, which are transverse or normal in the median, bifurcated rib, but in maintaining approximately the same direction on the lateral ribs as on the median rib, the striae are disposed in an increasingly oblique manner as the thoracic region is approached. The interspaces between the pygidial ribs, and even the proximal ends of the ribs, are traversed by microscopic raised striae disposed parallel to the margin of the pygidial shield.

Dimensions.—Total length, 39.5 mm.; greatest width at thorax, 35.25 mm. Length of cephalon, including neck-ring, 11.25 mm.; length of thorax, 10.25 mm.; length of pygidium, 18 mm. Greatest width of pygidium, 30.5 mm. Width of thoracic axis, 8 mm. Width of pygidial median ridge, 2.25 mm.

Observations.—The same quarry from which the above holotype was obtained, has yielded several other, more or less imperfect examples, chiefly pygidia, which I tentatively refer to the same species. They range from the moderate-sized and neatly-ornamented flabellated pygidial specimens, to some nearly of twice the dimensions, having a slightly coarser rugose ornament. No distinction can be drawn between them. Differences of size and ornament probably represent, in some cases, sexual features.

The whole carapace in this species is remarkably short; otherwise it compares rather closely with Barrande's *Bronteus formosus*.[1] The Bohemian species, moreover, differs in its narrower frontal margin to the glabella, and the shallower and broader posterior furrow.

A related but much longer form is Hawle and Corda's *Bronteus oblongus*,[2] with similar ornament; the axial ridge of the pygidium in this species, however, is proportionally smaller. In general form, Hawle and Corda's *Bronteus berkeleyanus*,[3] from the red limestone of Mnenian, Bohemia (Ff2 of Barrande, or Lower Devonian), is almost identical. It differs in having the axis of the thorax narrower, the pygidial axis expanding terminally, and the median ridge bifurcated to one-third of its length, instead of to more than one-half as in *G. greenii*.

In reference to the Devonian aspect of a portion of our Silurian fauna, it is interesting to note that the Bohemian allied species, *G. formosus*, occurs at Dvoretz, in Lower Devonian strata, of the same group of beds as that containing *G. oblongus* above mentioned.

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1 Syst. Sil. Bohême, vol. i., 1852, p. 851, pl. xlvi., fig. 14; pl. xlvii., figs. 1-5.

2 Prodrom Monogr. d. böhm. Trilobiten, 1874, p. 60. See also Barrande, Syst. Sil. Bohême, 1852, p. 853, pl. xlvii., figs. 13-17.

3 Hawle and Corda, Prod. Mon. Tril., 1847, p. 61, pl. iv., fig. 34.

Horizon and Occurrence.—Silurian (Yeringian), Ruddock's Quarry, near Lilydale. Holotype presented by Mr. J. S. Green, after whom the species is named. Also several other fragmentary specimens from the same locality, in the Museum collection.

Goldius cresswelli, sp. nov. (Plate XIV., Fig 3; Plate XVI., Fig. 17).

Description of pygidium.—Comparatively short, one-third broader than long. Surface gently convex below the pygidial axis and falling away to a plane surface round the circumference. Pygidial axis prominent, surface covered with distinct, rounded granules, rather closely set, and extending over the whole of the flabellate portion. Pygidial fused segments six on each side of the median ray, which is simple except for a short bifurcation close to the margin. Pygidial segments fairly conspicuous around the axis, flatly rounded; slightly sinuous and concave towards the median axis; divided by a very narrow groove, which disappears near the outer margin of the pygidium.

Dimensions.—Width of pygidium, 17 mm.; length, 11 mm. Length of pygidial axis, circ. 3.5 mm.

Observations.—Although the above species is founded on a pygidium, the characters of this portion of the carapace are so well defined as to afford a good basis for its specific identification; moreover, the pygidial characters are especially distinct in this genus.

There is already one described species of the genus which bears a striking resemblance to the present form, namely, *Goldius edwardsi*, Barrande sp.[1]; found in the Silurian of Bohemia in Etage Ee2, the upper bed of the Silurian in the present interpretation of that system, and which practically agrees with the Yeringian series of the Victorian Silurian. *G. edwardsi*, although agreeing with *G. cresswelli* in form, general style of ornament, and non-bifurcation of the median axial rib, has more convexly rounded ribs in the anterior region; the median axis is more swollen; and the granulations are coarser.

Horizon and Occurrence.—Silurian (Yeringian). Cooper's Creek, Gippsland. Presented by the late Rev. A. W. Cresswell, M.A., after whom the species is named, in recognition of his valued collecting in the Silurian of this State.

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1 *Bronteus edwardsi*, Barrande, Syst. Sil. Bohême, vol. i., 1852, p. 882, pl. xlii., figs. 30-33.

Fam. PROETIDAE, Corda.

Genus **Proetus**, Steininger.

Proetus euryceps, McCoy sp. (Plate XIV., Fig. 4).

Forbesia euryceps. McCoy, 1876, Prod. Pal. Vict., Dec. III. p. 17, pl. XXII., figs. 10, 10*a*.

Observations.—Since McCoy's description, several specimens have come under my notice.

A finely preserved example from Ruddock's quarry near Lilydale, in the possession of Mr. J. S. Green, shows the surface of the carapace to be minutely granulated. This serves to clear up any doubt regarding the surface ornament; for McCoy remarked, in his description of the species[1]: "The surface is indistinctly preserved, but I think it is minutely granular."

A small, but nearly perfect example of the same species was found by Mr. Annear, near Lilydale, and is now in the Museum collection. It measures only 7 mm. in length. In this specimen the free cheeks and genal spines are distinctly granulate.

In a series of Silurian fossils from Loyola submitted for description by Mr. Geo. Sweet, F.G.S., there is another example of the above species. This has since been presented to the collection. The cephalon is fairly well preserved, and the rest of the carapace can be generally made out, showing the rapidly tapering axis. The granulation above referred to is well shown, especially on the glabella and anterior rings of the thorax. This example is also small, measuring only 7.5 mm. in length.

Horizon and Occurrence.—Holotype (described by McCoy) in Nat. Mus. Silurian. Broadhurst's Creek, E. of Kilmore. Bb18, Geol. Surv. Vict.[2]. Also specimens from the Silurian (Yeringian) of Ruddock's quarry, near Lilydale, coll. by Messrs. J. S. Green and R. H. Annear; and from Loyola, near Mansfield, coll. by Mr. Geo. Sweet, F.G.S.

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1 Loc. supra cit., p. 17.

2 In my paper "on the Palaeontology of the Silurian of Victoria," (Rep. Austr. Assoc. Adv. Sci., Melbourne Meeting, 1913, vol. xiv.), p. 208 and lists, this locality was included in the Melbournian Series. Further considerations of the faunal assemblage of these and the allied beds at Wandong, containing *Dalmanites meridianus*, lead me to place them low down in the Yeringian, or probably representing a passage series.

Genus **Cyphaspis**, Burmeister.

Cyphaspis bowningensis, Mitchell. (Plate XIV., Fig. 5; Plate XVI., Fig. 18).

Cyphaspis bowningensis, Mitchell, 1888, Proc. Linn. Soc. N.S. Wales, vol. II., 2nd ser., pt. III., p. 418, pl. XVI., fig. 3. Etheridge, junr., and Mitchell, 1894, Ibid., vol. VIII., 2nd ser., p. 170, pl. VI., figs. 3, *3a-h;* pl. VII., figs. *3i-k*.

Observations.—In the Sweet collection from Loyola, near Mansfield, there are two examples of *Cyphaspis*, somewhat crushed and otherwise distorted. One of these, showing the cephalon and upper part of the thorax, is here figured. At first sight it appears to be distinct from *C. bowningensis*, on account of its large palpebral lobes, elongate glabella and depressed genal spines. A detailed examination, however, shows that all these differences are due to gentle lateral compression which the carapace has undergone; and a second specimen, still more compressed, confirms this view. As in typical specimens of *C. bowningensis*, the glabella is distinctly granulate and the pleura characteristically grooved with broad sulci.

C. bowningensis, or a closely related species, is represented in the Melbournian series by a specimen from South Yarra, consisting of a cephalon with sickle-shaped or incurved genal spines and a few anterior thoracic rings with grooved pleura. The glabella of this specimen is proportionately smaller than any figure of *C. bowningensis*, but this feature is variable amongst the known examples.

Another probable Melbournian occurrence is that of a diminutive specimen from Whittlesea, measuring only 7.5 mm. in length, as against 12 mm. in a normal specimen. It is rather more elongate in habit than usual, but has not suffered lateral compression, as in the Loyola specimen, since it occurs in a typical, undisturbed sandy mudstone. The locality of this specimen (Bb12) is described in the Geological Survey notes as "Hills in township of Whittlesea." This is probably situated on the Whittlesea anticline of Jutson,[1] the rocks on which line of strike contain Melbournian fossils, as at Yan Yean to the south.

Horizon and Occurrence.—Silurian (Yeringian). Loyola, near Mansfield. Presented by Mr. Geo. Sweet, F.G.S.

Also examples probably referable to this species from the Silurian (Melbournian) of South Yarra (coll. by Mr. F. P. Spry); and from Whittlesea (coll. Geol. Surv. Vic.).

[1] Proc. Roy. Soc. Victoria, vol. xx. (n.s.), pt. i., 1908, p. 213.

Cyphaspis lilydalensis, sp. nov. (Plate XIV, Fig. 6; Plate XVI., Fig. 19).

Description.—Body suboval. Cephalon large in proportion to the rest, rapidly tapering to the pygidial extremity.

Cephalon semi-circular, anterior border rounded and deeply folded behind. Glabella of moderate size, inflated towards the back; basal lobes pyriform, more deeply incised towards the lateral glabellar sulci. Free cheeks missing. Facial sutures deeply incised in the middle, widely divergent to the anterior border, behind, sweeping outwards to cut the posterior margin near the genal angles. Glabella finely granulate.

Thoracic segments 12; axis strongly inflated, slightly wider than pleura; axal furrows deeply incised. Pleura strongly convex proximally, rapidly falling away from the fulcrum and becoming concave at the outer margins; pleura medially furrowed, ends bluntly rounded, or curving downwards to a blunt angle.

Pygidium small; axis less than one-third of the width.

Dimensions.—Total length of specimen (imperfect), 9 mm. Approximate length when complete, 10.75 mm. Greatest width of thorax, 6.5 mm. Greatest width of axis, 2.5 mm. Greatest width of pleura, 2.25 mm. Length of cephalon, including neck-ring, 3.6 mm. Length of glabella measured from neck-furrow, 2 mm.; width, 2 mm.

Relationships.—This trilobite belongs to the *C. burmeisteri* type described by Barrande[1], from the Ordovician and Silurian of Bohemia. The axis in that species, however, is slenderer, and the glabella longer, whilst the posterior extremity is not so tapering. *C. bowningensis*, Mitchell,[2] somewhat resembles *C. lilydalensis*, differing in the longer and larger glabella, the narrower axis and the broader posterior extremity.

The British species, *C. megalops*, McCoy sp.,[3] is perhaps most closely related to *C. lilydalensis*, the chief points of difference in the latter being the more oval outline of the body, absence of a thoracic spine (although this may have become detached before fossilisation), and the neater or smaller cranidial characters, as the glabella together with the basal lobes. It may, therefore, be reasonably regarded as a southern variant of the British form.

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1 Syst. Sil. Bohême, vol. i., 1852, p. 484, pl. viii., figs. 61-71.

2 Proc. Linn. Soc. N.S. Wales, vol. ii., 2nd ser., pt. iii., 1888, p. 418, pl. xvi., fig. 3. Etheridge jnr. and Mitchell; ibid., vol. viii., 2nd ser., 1894, p. 170, pl. vi., figs. 3, 3*a-h*; pl. vii., figs. 3 *i-k*.

3 ? *Harpes megalops*, McCoy, Syn. Sil. Foss. Ireland, 1846, pl. iv., fig. 5. Salter. Mem. Geol. Surv. Un. Kingd., dec. vii., 1853, pl. v.

C. bowningensis, above mentioned, is also clearly related to *C. megalops* in possessing a thoracic spine, but differing in many details, such as the longer glabella and more depressed carapace.

In its tapering extremity, *C. lilydalensis* resembles the Lower Helderbergian species, *C. coelebs*, Hall and Clarke;[1] a form remarkable for its very long genal spines.

Horizon and Occurrence.—Silurian (Yeringian). Wilson's quarry, near Lilydale. Coll. by Mr. R. H. Annear.

Cyphaspis yassensis, Etheridge fil. and Mitchell. (Plate XIV., Fig. 7; Plate XVI., Figs. 20, 21).

Cyphaspis yassensis, Etheridge fil. and Mitchell, 1894, Proc. Linn. Soc. N.S. Wales, vol. VIII. 2nd ser., p. 172, pl. VI., figs. 1, 1*a-d*.

Observations.—The Victorian specimens agree in all particulars with those described from the Lower Trilobite bed of the Bowning series between Bowning and Yass, N.S. Wales. Their occurrence in these Yeringian beds seems to point to the view that the whole of the Bowning series may be stratigraphically not lower than the Newer Silurian of Victoria.

As remarked by Messrs. Etheridge and Mitchell, the large size of the pygidium in this species points to a relationship with *Proetus*. The Victorian specimens show the same peculiar, supposed auditory organs first noticed in this genus by those authors.

Horizon and Occurrence.—Silurian (Yeringian). In yellow, micaceous mudstone (topmost bed), Wombat Creek, a tributary of the Mitta Mitta River, N.E. Gippsland. The remains are fairly common. Coll. Geol. Surv. Vict. (W. H. Ferguson).

Also a pygidium probably referable to this species from the junction of the Woori Yallock and Yarra; Geol. Surv. Vict. (B23).

Portion of a cranidium (associated with *Orthis testudinaria*); Glenburnie Road, Whittlesea. Presented by Mr. J. T. Jutson.

Fam. Calymenidae, Milne Edwards.

Genus **Calymene**, Brongniart.

Calymene angustior, sp. nov. (Plate XV., Figs. 8-10).

Description.—Body, long ovate.

Cephalon semi-circular, more than one-third the total length. The glabella comparatively narrow and high, and the width less

[1] Pal. N. York, vol. vii., 1888, p. 151, pl. xxiv., fig. i.

than that of the free cheeks and nearly equal throughout. Side lobes three, the posterior moderately large, the median small and the anterior hardly developed. Frontal lobe prominent; the anterior limb quadrate and deeply furrowed behind. Neck furrow deep, and continued to the slightly rounded genal angles. Free cheeks gibbous, usually not so inflated as the glabella. Eyes situated on the elevated portion of the free cheeks and slightly anterior to the middle lobe of the glabella. Furrows between glabella and free cheeks deep. Neck ring thick in middle, thinning out laterally.

Thorax.—The body axis is of about the same width as the pleura, and at the sides invariably thickened into tubercles. Axis rings deeply furrowed, Fulcra of pleura situated about half-way to the lateral border; ends posteriorly rounded and bent forward. Pleura deeply ridged.

Pygidium almost semi-circular, strongly convex. The axis is deeply incised at the junction with the lateral ribs. Axial rings gently arched. The prominent lateral ribs are medially furrowed half-way to the margin. Surface of carapace finely tuberculate. apparently with granules of one size.

Dimensions.—Total length of holotype, 54 mm.; made up as follows:—Cephalon, 17.5 mm.; thorax, 25 mm.; pygidium, 11.5 mm. (these measurements are approximate, especially for the thorax, which has undergone compression and recurvation); width of cephalon between genal angles, 39 mm.

Relationships.—This species show relationship to two British forms, *C. tuberculosa*, Dalman,[1] and *C. blumenbachi*, Brongniart,[2] as well as to a North America species, *C. niagarensis*.[3] The narrow, elongated glabella and the deep and extended neck furrow separate the Victorian species from *C. tuberculosa*, the glabella in that form being short and anteriorly tapering. The lateral riblets of the pygidium in *C. angustior* are furrowed or bifurcated distally, but in *C. tuberculosa* they are simple. In both species the lateral ends of the axial rings of the thorax are tuberculate.

In the latter feature, *C. niagarensis* is related to the Victorian,

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1 ***C. blumenbachii***, var. a, ***tuberculosa***, Dalman, Ueber die Paläaden oder die sogenannten Trilobiten, a. d. Schwedischen übersetzt von Fr. Engelhard, 1828.

C. tuberculosa, Dalman, Salter, Mem. Geol. Surv Gt. Brit., vol. ii., pt. i., 1848, p. 342, pl. xii.

2 ***C. blumenbachii***, Brongniart, Crust. foss., vol. ii., pt. i., 1822, pl. i., fig. 1A-C. Barrande, Syst Sil. Bohême, vol. i., 1852, p. 566, pl. xix., fig. 10; pl. xliii., figs. 46-48. Brit. Trilob. (Pal. Soc. Mon.), pt. ii., 1865, p. 93, pl. viii., figs. 7-16; pl. ix., figs. 1, 2.

3 ***C. niagarensis***, J. Hall. Geol. N. York, pt. 4, 1843, p. 102, fig. 3. Weller, Bull. Chicago Acad. Sci., No. iv., pt. ii., 1907, p. 261, pl. xxiii., figs. 9, 10.

and it also has a narrow glabella; the body, however, is not so elongate as in *C. angustior*, and it is a typically smaller form.

C. blumenbachi has a wider and more evenly convex gabella, and the neck furrow is, as a rule, not so strongly marked. Moreover, the rings of the axis are not conspicuously tuberculate, as in *C. tuberculosa*, *C. angustior* and *C. niagarensis*. The granulose surface agrees with that of *C. tuberculosa* rather than with *C. blumenbachi*.

Horizon and Occurrence.—Silurian (Yeringian). Holotype and paratype from Ruddock's quarry, near Lilydale; in olive brown mudstone.[1] Presented by Mr. J. S. Green.

Silurian (probably Yeringian). Range on E. side of commonage, Kilmore; Coll. Geol. Surv. Vict. (Bb 23.)—A nearly complete cephalon in reddish coloured sandstone. Also Kilmore Creek, north of the special survey. Coll. Geol. Surv. Vict. (Bb 20).—A cephalon in indurated mudstone.

Calymene cf. *blumenbachi*, Brongniart.[2] (Plate XV., Fig. 11).

Remarks.—A cephalon, tentatively referred to the above species, is found in the Victorian Yeringian series. It is characterised by its broad and strongly convex glabella, and in this respect quite unlike the previously described *C. angustior*. The anterior limb bordering the glabella is deeply furrowed behind, and its horizontal margin gives a subquadrate aspect to the cephalon. The lateral tubercules are even larger than *C. angustior*.

To the above species I have also referred a well-preserved specimen from the Melbournian of Moonee Ponds Creek, Flemington. This consists of thorax and pygidium, in which the width of the carapace exceeds that of the Yeringian species, *C. angustior*.

C. blumenbachi also appears to occur in New South Wales, in the Hume beds of the Bowning district, if I am correct in referring to that species the form figured by C. Jenkins[3] under the name of *Calymene duplicata*, Murchison.

Horizon and Occurrence.—Silurian (Yeringian). Yellow, sandy mudstone; sect. 12, parish of Yering, Geol. Surv. Vict.

1 Attached to the same slab as the holotype is a cast of *Nucula opima*, J. Hall, var. *australis*, Chapm., a variety already described from both the Melbournian and Yeringian facies of the Victorian Silurian (Mem. Nat. Mus. Melbourne, No. 2, 1908, p. 31, pl. iii., figs. 39-43).

2 For references see antea.

3 Proc. Linn. Soc. N.S. Wales, vol. iii., 1879, p. 27, pl. vi., fig. 4.

Fam. CHEIRURIDAE, Salter.

Genus **Cheirurus**, Beyrich.

Cheirurus sternbergi, Boeck sp. (Plate XV., Figs. 12, 13; Plate XVI., Fig. 22).

Trilobites sternbergi, Boeck, 1827, Not. til laeren, Trilob., Mag. for Naturvid., vol. VIII., p. 37. Burmeister, 1843, Organ. d. Trilob., p. 132, pl. III., figs. 7, 8.

Cheirurus sternbergi, Beyrich, 1845, Ueber böhm. Tril., p. 15, fig. 4. Hawle and Corda, 1847, Prod. Monogr. d. böhm. Trilobiten, p. 135. Barrande, 1852, Syst. Sil. Bohême, vol. I., p. 795, pl. XLI., figs. 29-39.

Description.—A rather undersized, but fairly complete specimen found near Lilydale shows the cephalon and seven thoracic segments; the remainder with the pygidium having split off the rock, a brittle mudstone, during extraction. The whole of the cephalon has a granulate surface. The thoracic body rings are well marked and the distal ends of the pleura are free, and curved downwards to a greater degree than are shown in Barrande's fig. 31 on Pl. XLI. (loc. supra cit.). This specimen probably measured when complete about 16 mm. in length. The width of the cephalon is 10 mm.

The cephalon of a larger example, coll. by Mr. J. S. Green, from Seville, measures 30 mm. in width and 21 mm. in length. The greatest width of the glabella, in front of the anterior furrow, is 16 mm.

Observations.—Several cranidia of a *Cheirurus* have been found at various times in the Victorian Yeringian beds in the neighbourhood of Lilydale and Seville. The shape of the anterior part of the glabella in these specimens and the character of the anterior and median furrows in cutting transversely across the central area, together with the inclined posterior furrow, which makes an X-shaped figure with the neck furrow, shows it to belong to the above species.

The only other species comparable with the Victorian appears to be *C. gibbus*, Beyrich.[1] This species, however, has a narrower body, a more inflated glabella, straighter anterior and median furrows, and a less salient anterior angle to the middle of the neck ring.

1 Ueber böhm. Trilob., 1845, p. 16, fig. 5. Also Barrande, Syst. Sil. Bohême, vol. i., 1852, p. 792, pl. xl., figs. 35-39; pl. xli., figs. 17-27; pl. xlii., figs. 12-15.

The Rev. G. F. Whidborne has described from the Middle Devonian of Lummaton, Devonshire, England, a species named *C. pengellii*,[1] which appears to be midway between *C. sternbergi* and *C. gibbus*. The glabella is not so broad as in the Victorian specimens, and the posterior lateral wings of the fixed cheeks not so extended.

The Victorian specimens show the fixed cheeks to be finally granulated, as in typical specimens of *C. sternbergi*.

The stratigraphical distribution of the three species above referred to affords an interesting comparison with regard to the Victorian occurrence. *C. gibbus* and *C. pengellii* are both found in the Devonian alone, whilst *C. sternbergi*, with which the Victorian specimens are identified, has a range extending from the Silurian to the Upper Devonian (Etages E-H).

Horizon and Occurrence.—Silurian (Yeringian). In mudstone, Ruddock's quarry, near Lilydale. Presented by Mr. J. S. Green.

In dark grey limestone, Wandin Yallock, near Seville, coll. by F. Chapman. Also a wax squeeze from a specimen in Mr. J. S. Green's collection, from the same locality.

Fam. Phacopidae.

Genus Phacops, Emmrich.

Phacops crossleii, Etheridge fil. and Mitchell. (Plate XV., Figs. 14, 15).

Phacops crossleii, Etheridge, jur., and Mitchell, 1896, Proc. Linn. Soc. N.S. Wales, vol. X., 2nd ser., p. 489, pl. XXXIX., figs. 9-11.

Observations.—This species has been described by the above authors from the Upper Trilobite bed of Bowning, near Yass, N.S. Wales. In Victoria it has been met with in the Yeringian synclinal fold of the Lilydale district, and it thus agrees in stratigraphical position with its occurrence in New South Wales.

The specimen here figured from the Lilydale district is almost perfect (fig. 14). It measures about 41 mm. in length, and equal to that of Etheridge and Mitchell's type from Bowning, judging from the figures of the thorax and pygidium given by those authors. One of the eyes is well preserved, and the vertical rows of lenses number about 21; the New South Wales specimens average about 17.

1 The Devonian Fauna of the S. of England, pt. i. (Mon. Pal. Soc.), vol. xlii., 1889, p. 8, pl. i. s. 10 12, 13, 15.

Another locality in Victoria for *P. crossleii* is on a branch of the Saltwater River, one mile west of Gisborne. It is interesting to note that the rock in which this specimen occurs bears a strong resemblance to the Keilor graptolite-bearing mudstones, the latter series showing relationships in regard to the trilobitic and graptolitic contents, to the Newer Silurian series.[1] This specimen, except for a certain amount of crushing, is fairly complete, and its essential characters are easily seen; it occurs in olive grey mudstone. The only other trilobite with which it could be compared is *P. serratus*, Foerste, which also is a Yeringian form in Victoria.

In the museum collection there is a fine specimen of *P. crossleii*, from Kinglake West, measuring 44 mm. in length. The rock in which this occurs is a black indurated mudstone, and contains several Yeringian fossils, among which are *Pleurodictyum megastomum* and *Dalmanites meridianus*. The granulate thorax and absence of dorsal spines place it with the species *P. crossleii*.

Horizon and Occurrence.—Silurian (Yeringian). Ruddock's quarry, near Lilydale; collected by Mr. R. H. Annear.

Also from Kinglake West; presented by Mr. Allan M. Savage.

Also Silurian (probably Yeringian), from a branch of the Saltwater River, one mile west of Gisborne; coll. by Geol. Surv. Vict.

Phacops serratus, Foerste. (Plate XV., Fig. 16).

Phacops serratus, Foerste, 1888, Bull. Sci. Lab. Denison Univ., vol. III., p. 126, pl. XIII., fig. 1. Etheridge, jnr., and Mitchell, 1896, Proc. Linn. Soc. N.S. Wales, vol. X., 2nd ser., p. 495, pl. XXXIX., figs. 7, 8; pl. XL., figs. 7, 8, 11.

Observations.—Etheridge and Mitchell point out the rather close relationship which this species bears to *P. crossleii*. I have found the Victorian examples of *P. serratus* considerably smaller than *P. crossleii*, and this, with its feebler granulation on the thorax and the development of the spiny or angular axis, serve to show that there is a distinction, which, as Etheridge and Mitchell observe, may be only a sexual one.

The larger of the two Victorian specimens of *P. serratus* has a length of 21 mm.

Horizon and Occurrence.—Silurian (Yeringian). One and a-half miles below Simmond's Bridge Hut, on the Yarra. Coll. Geol. Surv. Vict. (B16).

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1 See Chapman, Pal. Sil. Vict. Rep. Austr. Assoc. Adv. Sci., Melbourne meeting, 1913, p. 210, and lists of fossils.

EXPLANATION OF PLATES.

Plate XIV.

Fig. 1.—*Goldius greenii*, sp. nov. Holotype. Silurian (Yeringian). Ruddock's quarry, near Lilydale. Pres. J. S. Green.

,, 2.—*G. greenii*, sp. nov. Paratype; pygidium of a larger example. From the same locality. Pres. by J. S. Green.

,, 3.—*Goldius cresswelli*, sp. nov. Holotype; pygidium. Silurian (Yeringian). Cooper's Creek, Gippsland. Pres. Rev. A. W. Cresswell, M.A. (See also fig. 17.)

,, 4.—*Proetus euryceps*, McCoy sp. Silurian (Yeringian). Ruddock's quarry, near Lilydale. Coll. R. H. Annear.

,, 5. *Cyphaspis bowningensis*, Mitchell. Silurian (Yeringian) Loyola, near Mansfield. Pres. G. Sweet, F.G.S. (See also fig. 18.)

,, 6.—*Cyphaspis lilydalensis*, sp. nov. Holotype. Silurian (Yeringian). Wilson's quarry, near Lilydale. Coll. R. H. Annear. (See also fig. 19.)

,, 7.—*Cyphaspis yassensis*, Etheridge fil. and Mitchell. Silurian (Yeringian). Wombat Creek, N.E. Gippsland. Coll. Geol. Surv. Vict. (See also fig. 20.)

All figures on this plate about natural size.

Plate XV.

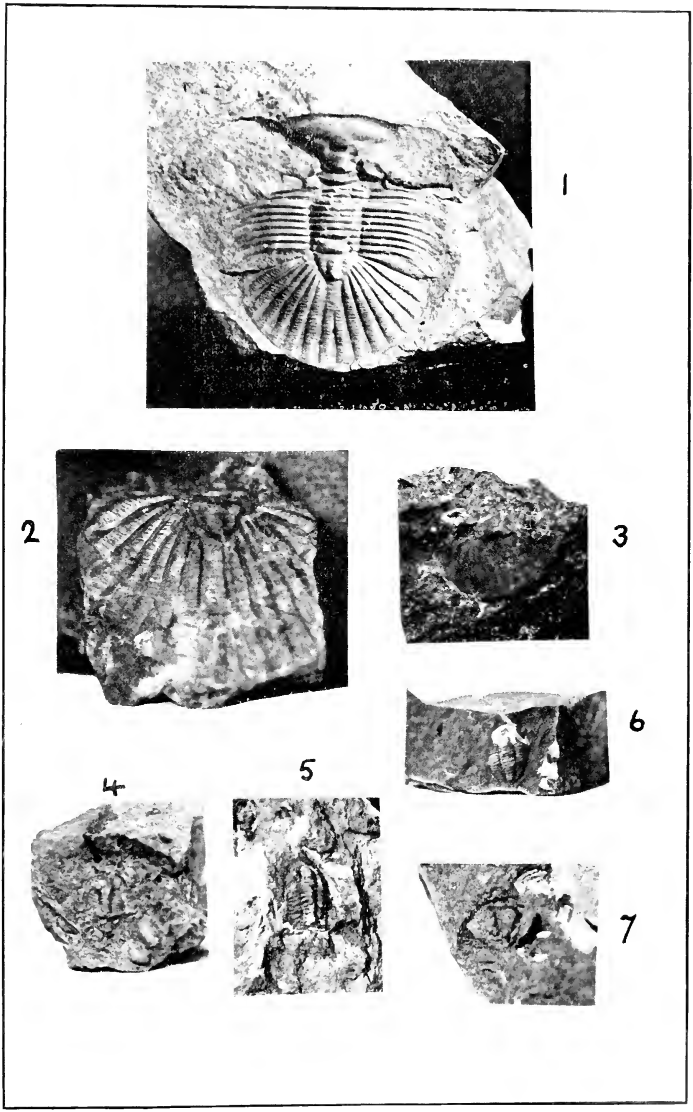
Fig. 8.—*Calymene angustior*, sp. nov. Holotype. Silurian (Yeringian). Ruddock's quarry, near Lilydale. Pres. J. S. Green.

,, 9.—*C. angustior*, sp. nov. Paratype. Same locality. Coll. J. S. Green.

,, 10.—*C. angustior*, sp. nov. Silurian (probably Yeringian). Kilmore Creek, north of the special survey. Coll. Geol. Surv. Vict. Bb 20.

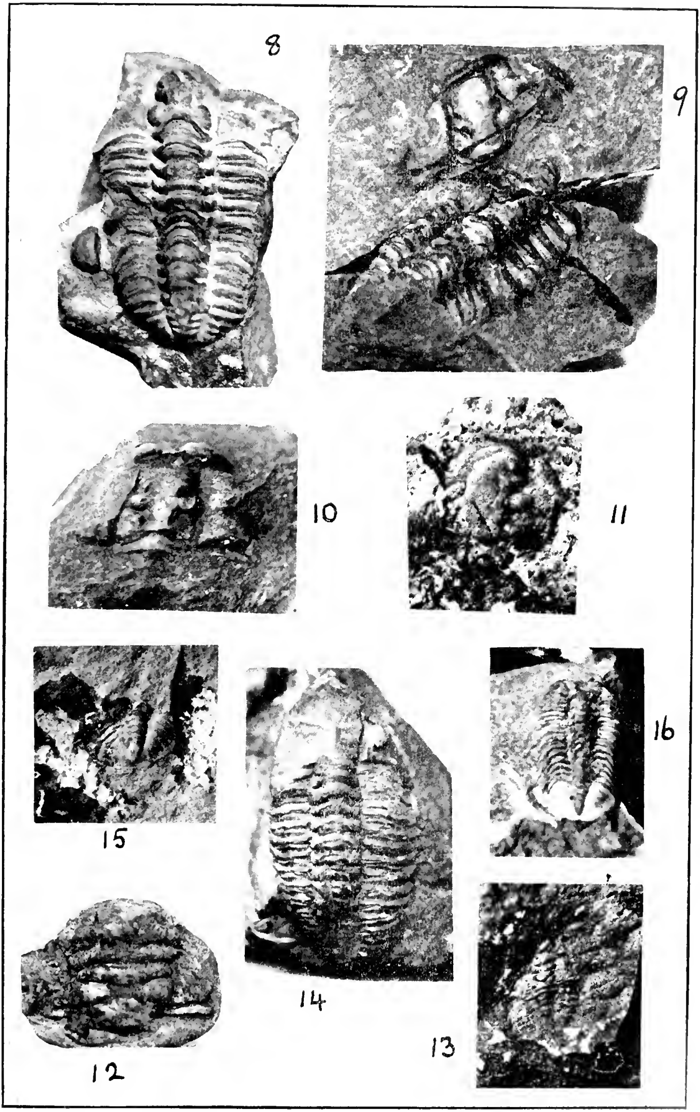
,, 11. *Calymene* cf. *blumenbachi*, Brongniart. Silurian (Yeringian). Parish of Yering. Geol. Surv. Vict. coll. 1862.

,, 12.—*Cheirurus sternbergi*, Boeck sp. A wax squeeze from a mould in limestone. Silurian (Yeringian). Wandin Yallock, near Seville. Coll. J. S. Green.



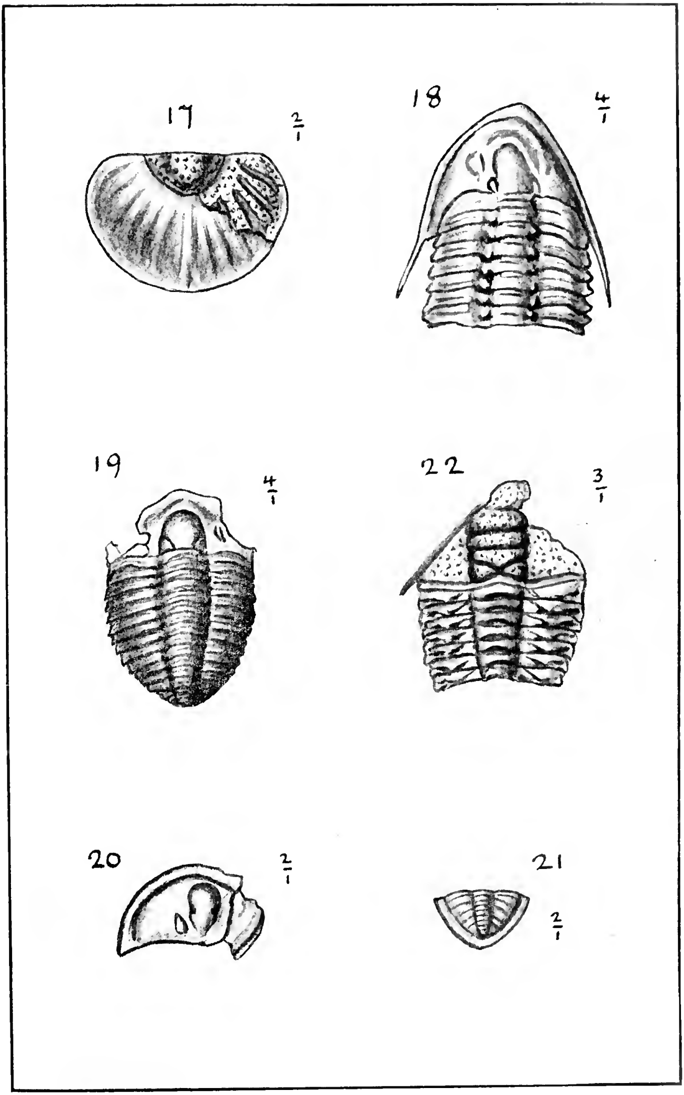
F.C., Photo.

Yeringian Trilobites.



F.C., Photo.

Yeringian Trilobites.



F.C., ad. nat. del.

Yeringian Trilobites.

,, 13.—*C. sternbergi*, Boeck sp. Silurian (Yeringian). Ruddock's quarry, near Lilydale. Pres. J. S. Green. (See also fig. 22.)

,, 14.—*Phacops crossleii*. Eth. fil. and Mitchell. Silurian (Yeringian). Ruddock's quarry, near Lilydale. Coll. R. H. Annear.

,, 15.—*P. crossleii*, Eth. fil. and Mitch. Pygidium. Silurian (Yeringian). Same locality. Pres. J. S. Green.

,, 16.—*Phacops serratus*, Foerste. Silurian (Yeringian). 1½ miles below Simmons' Bridge Hut, on the Yarra. Coll. Geol. Surv. Vict. B16.

All figures on this plate about natural size.

Plate XVI.

Fig. 17.—*Goldius cresswelli*, sp. nov. Holotype; pygidium. Silurian (Yeringian). Cooper's Creek, Gippsland. Pres. Rev. A. W. Cresswell, M.A., × 2.

,, 18.—*Cyphaspis bowningensis, Mitchell*. A distorted example. Silurian (Yeringian). Loyola, near Mansfield. Pres. G. Sweet, F.G.S., × 4.

,, 19.—*Cyphaspis lilydalensis*, sp. nov. Holotype. Silurian (Yeringian). Wilson's quarry, near Lilydale. Coll. R. H. Annear. × 4.

,, 20.—*Cyphaspis yassensis*, Eth. fil. and Mitch. Cephalon. Silurian (Yeringian). Wombat Creek, N.E. Gippsland. Coll. Geol. Surv. Vict. × 2.

,, 21.—*C. yassensis*, Eth. fil. and Mitch. Pygidium. Silurian (Yeringian). Same locality. Coll. Geol. Surv. Vict. × 2.

,, 22.—*Cheirurus sternbergi*, Boeck sp. Cephalon and thorax. Silurian (Yeringian). Ruddock's quarry, near Lilydale. Pres. J. S. Green. × 3.

END OF VOLUME XXVIII., PART I.

[Published October, 1915.]

THOMAS SERGEANT HALL.

Born 23rd December, 1858.

Died 21st December, 1915.

THOMAS SERGEANT HALL.

It is with deep regret that we have to record the death, on December 21st, 1915, of Dr. T. S. Hall.

Thomas Sergeant Hall was born in Geelong on December 23rd, 1858, and was educated at the Geelong Grammar School where he remained until 1877. At an early date he began to take great interest in natural history, more especially in geology and palaeontology. In 1879 he held a mastership in Wesley College, and in 1884 and 1885 secured exhibitions in Ormond College in the University, taking the degree of B.A. in the latter year with honours in Natural Science. At a later date, in 1908, the University conferred upon him the Degree of D.Sc. in recognition of his valuable original scientific work.

In 1887 he was teaching in Bendigo but the following year found him once more in Melbourne, working at the University where the new Chemical, Physical and Biological Laboratories had been equipped since his earlier student days. He passed through the complete three years' course in Biology.

From 1890 to 1893 he was Director of the School of Mines in Castlemaine where, though his energies were largely devoted to organizing work and teaching a wide range of science subjects, he managed to find time in which to study the geology of the district and became especially interested in graptolites. Though obscure, the group is an important one, because certain species have definite relationships to the gold-bearing rocks of the Bendigo and Castlemaine district, and his most important paper is probably that on "The Geology of Castlemaine, with Sub-divisions of Part of the Lower Silurian Rocks of Victoria, etc.," published by the Royal Society of Victoria in 1894. The last paper that he published was entitled "Victorian Graptolites, Part IV.," which was read in July 1914.

In 1893 he succeeded Dr. Dendy as Lecturer on Biology in the Melbourne University, a post that he held until his death.

In 1888 he had published his first paper on "Two New Species of Fossil Sponges from Sandhurst" and when he returned to Melbourne he identified himself closely with the work of the Royal Society, devoting a large amount of time to its interests. In 1896 he became a member of Council; from 1897-1899 he was Librarian; for fifteen years, from 1899-1914, he was Hon. Secretary, taking the leading part in everything concerned with it. In 1914 and 1915 he was President, though failing health and strength prevented him from attending its meetings during the last year of his term of office. In all he contributed twenty-nine papers to the "Proceedings" of which six dealt with graptolites, nine with the Tertiary Deposits of Victoria (written in conjunction with Dr. G. B. Pritchard) and fourteen with various other palaeontological and geographical subjects. He made a special study of Graptolites and was regarded as the one authority in Australia on this group, his work in connection with which was recognised by the award to him of the "Balance of the Murchison Fund" by the Geological Society of London in 1901.

Not only did Dr. Hall take a large share in the work of the Royal Society but he devoted much time to that of the Field Naturalist' Club and was closely associated with the Australasian Association for the Advancement of Science of which he was Secretary for Victoria from 1907 onwards and President of the Geology Section at the Hobart meeting in 1902. During the recent visit of the British Association in 1914 he was local Secretary of the Zoology Section and his wide general knowledge of Australian Zoology and Geology enabled him to be of great service to many visiting, overseas members.

He was keenly interested in all that referred to the fauna of Australia and took a leading part in securing the reservation of Wilson's Promontory as a National Park, of the Committee of Management of which he was an active member.

In 1899 he published a valuable "Catalogue of the Scientific and Technical Periodical Literature in the Libraries of Victoria" and in 1911 a second and much enlarged edition of the same.

He was always ready to place his knowledge, time and services at the disposal not only of institutions and societies engaged in the organisation and furtherance of science work but at that of individual workers also and his death at the comparatively early age of 57 leaves a gap which will not easily be filled. In him many of our members have lost a personal friend respected not less on account of the solid, unostentatious work that he did for science in Victoria, than for his modesty of character and generous nature.

[Proc. Roy. Soc. Victoria 28 (N.S.), Pt. II., 1916].

Art. XI.—*Notes on the Geology of the Coburg Area.*

By G. A. COOK, B.Sc.

(Kernot Research Scholar in Geology, University of Melbourne).

(Communicated by Professor E. W. Skeats).

(With Plate XVII.)

Read 12th August, 1915.

Introduction.

The area that will be discussed in this paper is about four square miles of country to the east and north of Pentridge Stockade. It has been mapped by the Geological Survey of Victoria on quarter sheets (Nos. 1 N.E. and 1 N.W.), but the independent mapping of the writer shows slight differences from that of the quarter sheet. (For this independent mapping the contours were obtained from a map published by the Metropolitan Board of Works.)

The following stratigraphical horizons occur :—

Palaeozic -	Silurian sediments.
Tertiary -	Basic dykes.
	Tertiary sands.
	Sub basaltic gravels and sands.
	Newer Basalt.
Recent -	River alluvium.

Physiography.

The area constitutes a portion of the peneplain around Melbourne, and is drained by the Merri Creek. The country is of an average height of 200 feet above sea level. To the West and North basalt occurs, and forms a nearly uniformly flat plain, the highest level of which is about 240 feet. Through this basalt plain in the North, the Merri Creek follows a rather sinuous course, flowing between narrow V-shaped valleys, and over rapids and miniature waterfalls, with an average grade of 1 in 170. These are all characteristics of a stream young in development. To the South, however, where the stream is flowing through Silurian or along the junction of Silurian and basalt, the grade flattens to 1 in 480, and the valleys widen out. The pre-basaltic Merri was a mature stream, and did most of the work in the peneplanation of the area. After, however, the outpouring of the basalt it was rejuvenated, and now in the Northern area is rapidly cutting down into the basalt, and into the Silurian in places towards the South.

There is also evidence in the area of the Merri having changed its course in recent times. Just North of the Pentridge Stockade, on the North bank of the Merri a recent alluvial flat occurs. Through this flat a creek meanders, which may be termed "Falls Creek." From its headwaters down to the alluvial flat this creek is very young; in fact, it enters the flat over a waterfall formed by a bar of Silurian rock. In all probability the Merri Creek, which now cuts across the South boundary of the alluvial flat, formerly flowed right round its Northern boundary. This would account for the sudden change in the grade of Falls Creek. This change of course of the Merri is post basaltic in age, for the alluvial flat contains occasional boulders of Silurian and of basalt.

Stratigraphy.

Silurian.—This series consists of the fine sandstones and shales of the Melbournian division of the Victorian Silurian. South of the Bell Street bridge a river cliff section shows a very good ripple marked surface on an exposure of one of these beds. The hollows average three inches in diameter.

No fossils were found in these rocks. The beds are only folded to a medium extent, giving a general strike 10 deg. East of North, and the dips in general are about 30 deg. In the area studied the beds usually dip to the West, but occasionally a small anticline and syncline occur, giving a few minor Easterly dips. The preservation of the North and South ridge to the East of Falls Creek is probably due to the compression of the rocks caused by such a local pucker. This method of preservation is also exemplified by the Silurian ridge North of the Coburg Cemetery. The road section just to the West of the cemetery shows a somewhat complicated pucker in the Silurian, which pucker can be traced South over Bell Street. In this connection it is significant that these two ridges have a North and South direction, i.e., a direction parallel to the strike, and to the major fold axes of the rocks.

The Silurian also shows evidence of faulting in a North and South direction. In the bend (concave to Pentridge) of the Merri just North of Pentridge, Silurian outcrops in the bed of the stream.

This outcrop is much shattered and fractured, and it is difficult to determine the strike and dip of the beds. A hard band of breccia striking North and South forms a miniature waterfall. This breccia is composed of angular and rounded Silurian fragments set in a finer paste of the same material, and the whole is iron-stained and cemented with limonitic material. Silica solutions also seem to have played a part in the cementation, for some of the breccia has the nature of a quartzite. The breccia is probably due to a North and South fault. The hade is obscured, but what evidence there is points to a Westerly one. A similar breccia occurs in an inlier of Silurian to the North-West of this last outcrop. The direction of the fault is obscure, there being only the one outcrop in the walls of a road section running North and South. The fault, however, appears to be an East and West one, hading to the South. This would suggest that pressures along both North and South, and East and West lines have occurred, and have produced both folding and faulting along these directions. This conclusion is further borne out by a road section cutting through the Silurian inlier. The latter is seen to be the axis of an E. and W. syncline, to which fact it probably owes its preservation. To the N.E. of this inlier

Section along Murray St   Vertical Scale 1 inch = 400
Horizontal Scale 1 inch = 2640

Section along ABC on map

again, in a river section near the waterfall on Falls Creek, the same E. and W. folds are again seen, this time in an anticlinal axis. These East and West folds show very low dips, and undoubtedly the dominant fold movements are those in a North and South direction.

A river section just N.E. of the northern end of Sydney Road, and just North of Pentridge Stockade, shows the basalt resting upon the tilted and eroded surface of the Silurian sediments. The Silurian mudstones dip in a Westerly direction at 25 to 30 deg. The joint planes and bedding planes just beneath the basalt are filled with an impure limestone, which represents material leached out of the basalt, and deposited in the spaces in the Silurian rocks below.

Some of this calcareous material has been analysed by Mr. C. E. Crooke in the Agricultural Chemistry School, under Dr. Heber Green.

The result is as under:—

CaO	= 13.82%
MgO	= 8.01
Al_2O_3 and Fe_2O_3	= 0.46
Soluble SiO_2	= 0.31
Insoluble residue	= 55.18
Organic matter and CO_2 (after ignition)	= 19.70
Hygroscopic moisture (105°C)	= .06
Alkalies	= n.d.
	97.54

The low summation is probably due to the fact that the alkalies were not determined. Expressed as carbonates the alkaline earths are $CaCO_3 = 24.68$; $MgCO_3 = 16.82$. Total, 41 50.

The total expressed as oxides is 21.83. Organic matter is practically absent since the difference between these figures, viz., 19.67, practically agrees with the figures obtained for CO_2 and organic matter, viz., 19.70. The insoluble residue was obtained by digesting the limestone with hydrochloric Acid (strength 182.5 grams per litre).

Tertiary Dykes.—A dyke very much decomposed and basic in character occurs in the Silurian river cliff South of Bell Street bridge. It is about 100 feet away to the West of the axis of an anticline in the Silurian, which anticline strikes a little East of North. The dyke has the same strike, and dips 70 degs. to the West. Its age is probably Tertiary, and it is probably a member of the lamprophyric series of dykes found in other places penetrating the lower Palaeozoic series of Ballarat, Bendigo and Daylesford. At Coburg the relation of the dyke to the Tertiary sands is not clear. It appears, however, to be overlain, both by the newer basalt, and by the outcrop of Tertiary sands, which latter form a small outlier South of the Bell Street bridge. This would make the dyke pre-newer basaltic, and also pre-Tertiary sands. This would mean that it is connected not with the newer basalts, but with older earth movements, possibly those of the time of the outpouring of the

Victorian Tertiary alkalic basalts. In this connection F. L. Stillwell,[1] M.Sc., has suggested that this alkalic basalt horizon is the age of the monchiquite dykes, which come up along the anticlinal axes of Bendigo. Nowhere in the Melbourne district are dykes similar to that at Coburg found penetrating the Tertiary sands, so that the upper age limit of these dykes is certainly the horizon of the sands. As to the lower limit it is obviously Silurian. There is the possibility of the Devonian being the age of the dyke. The evidence of the other areas is against this, however, e.g., at Bendigo the quartz reefs are connected with the Devonian granodiorite to the South, and these reefs are frequently cut across by younger monchiquite dykes.

Tertiary Sands.—This series is composed for the main part of a system of unfossiliferous, iron-stained sandstones. Similar sand deposits are also found capping the Silurian hills in many parts around Melbourne, e.g., Studley Park, Kew and Hawthorn. At Coburg the finer grained beds have grains as much as 3 millimeters in diameter. Occasionally a coarser band of quartz pebbles occurs, pebbles up to 3 cm. in diameter being frequent. The series now occurs capping the hills. Its lower limit is about 160 feet above sea level. The series was laid down in pre-basaltic time, the area uplifted and the sands partly eroded away before the outpouring of the basalt. Whether they are of marine or fresh-water origin still remains a problem. Many of the grains are angular, indicating a source near at hand.

The basalt filled up the low level portions of the area, which portions were low lying, partly because their burden of sands had been eroded away. Hence it is difficult to get the relation between the basalt and the sand series. However, in places, e.g., on the banks of the Merri North of Pentridge, basalt is seen to overly a thin deposit of quartz pebbles, which again, rest on Silurian. This pebble bed is probably re-sorted Tertiary sands, and the basalt a later formation than the sands.

A sample of the fine sand deposit was taken and boiled in hydrochloric acid to get rid of the ferruginous coating. The sand was then washed in water and agitated, so getting a division into coarse sand and fine sand. This latter was then dried and examined under the microscope. It consists almost entirely of quartz grains, but there is a very slight content of a black mineral. Some of this is strongly magnetic, and hence is magnetite. Other

1. Proc. Roy. Soc. Victoria, vol. xxv. (n.s.), 1913, p. 1.

crystals are not so magnetic, and are probably ilmenite. Then again some of the crystals are not magnetic at all, but they show pleochroism, high polarization colours, and all the characters of tourmaline. The coarse sands were then examined, and a non-magnetic black crystal picked out and examined chemically. This examination showed the presence of iron and boron, thus confirming the presence of tourmaline. This presence of magnetite, ilmenite and tourmaline is not very important from the point of view of origin of the sands, as they occur in such small quantities. However, it is interesting to note that N. R. Junner,[1] B.Sc., finds them all in the Silurian sediments of Diamond Creek to the North-East of Coburg.

North of the Coburg cemetery in the V-shaped outcrop of this series a small watercourse only 400 yards long has given rise to miniature buttes and canyons. The boundary of sands and Silurian is V-shaped, with the apex of the V pointing Westwards. This is due to the sands filling up a depression in the Silurian, possibly a pre-Tertiary stream valley. After the uplift of the area following the deposition of the sands obliterating this stream, this little local area was placed in a very unstable state as regards erosion. It only required the digging of a gutter, some few years back, for water to get a start down the site of the old pre-Tertiary stream. The result has been a very rapid deepening of the bed of the present watercourse, so that now it is in places 20 feet deep, and everywhere has vertical walls. A short distance down from the highest portion of these "bad lands" the stream in places has up to four parallel paths, each separated by a few yards. During storms water flows rapidly at the bottom of these watercourses, often 20 feet below the surface, and rapidly undercuts the soft sands. The result is that often the different courses converge towards one another, and further down the hill unite in various places, forming a complicated network of watercourses under the hard surface of matted soil on top. This top hard surface is often undercut to such an extent that it caves in, leading to the formation of little islands or buttes. These buttes are generally only a few feet in diameter, and stick up as pillars sometimes 20 feet high. They are protected from rapid erosion by the top hard crust.

Discussing this area in 1906 Dr. Leach[2] emphasises the importance of surface tension in the formation of these "bad lands." He

1. Proc. Roy. Soc. Victoria, vol. xxv. (n.s.), Pt. ii., 1913, p. 333.
2. Proc. Roy. Soc. Victoria, vol. xix. (n.s.), Pt. ii., 1907, pp. 54-59.

states that the water is in too small a quantity to splash about. During storms this is not so, but usually, however, the quantity is only small, and as the run off after a storm dies away, the water merely trickles over the edges, and then undoubtedly surface tension comes into play. However, surface tension alone can only explain the formation of a vertical face, and it is difficult to explain the complicated system of watercourses at Coburg by any other agent than running water. Erosion as pictured by Dr. Leach is necessarily a slow process, and it is most probable that the water running over the canyons after a heavy fall of rain, does more erosive work than six months of water just trickling over. During some periods of the year several months may elapse during which no heavy rain occurs. During this time surface tension is steadily at work after showers of rain, and certainly gives the walls of the canyon those characteristics enumerated by Dr. Leach. These, however, are more or less obliterated after the next heavy fall of rain.

The exact stratigraphical horizon of this sandstone series is difficult to determine, for they are unfossiliferous. One has to leave Coburg and examine neighbouring localities. At Royal Park, to the South, a similar series appear to overly a fossiliferous bed outcropping in the railway cutting. This latter series is generally regarded as Kalimnan in age. Also at Keilor in Green Gully thick, unfossiliferous sands overly thin beds of highly fossiliferous limestones of Barwonian and Kalimnan age. The horizon of the Coburg sands then appears to be post-Kalimnan and pre-newer basaltic.

Newer Basalt.—This occurs in the West of the area. Petrologically it can be divided into two types—(a) Low level, (b) High level.

(a) Low Level Type.—The low level basalt is chiefly found filling up the pre-basaltic depressions, such as river beds, etc. In the hand specimen the rock is compact and medium fine grained, with a few small phenocrysts of olivine. In the bed of the Merri just East of Pentridge, it exhibits columnar jointing, seen in a basalt pavement. A study of this particular pavement shows that the cracks radiate in threes from a centre, and at various angles to one another. The angle between cracks in this limited exposure is always greater than 90 deg., so that the prisms in plan are never less than five-sided. The centres frequently seem to be joined by a crack, making the other cracks symmetrical about it. The result is that the five cracks resemble the arms of, say, Tetragraptus quadribrachiatus. The distance between centres varies from 2 inches to 24 inches.

Microscopically the rock from this pavement is typical of the low level basalt found in the area. Olivine is sparingly present in large, perfectly fresh phenocrysts. Light green augite is very plentiful in smaller crystals. A feature of the rock is the ophitic structure, which this augite shows with plagioclase needles. These latter are very plentiful, and show typical flow-structure. The angle of extinction of the lamellae of a number of laths has a maximum of 30 deg. This would indicate labradorite. There is also a very slight content of another untwinned felspar. This has very low polarization colours, and a very low extinction angle. It is possibly anorthoclase, which F. L. Stillwell[1] finds in the newer basalt at Broadmeadows. An examination of a number of slides would be necessary to confirm its presence. The order of crystallization was olivine first, then plagioclase, and then augite; for large crystals of olivine are frequently seen completely surrounded by aureoles consisting of ophitic augite and labradorite.

Oxide of iron is also rather frequent in the rock. The majority of the crystals are long and needle shaped, and hence most of them are ilmenite.

Glass, dusty green in colour, and containing many needles of ilmenite, is also very common. This high glass content is typical of the low level basalt in the area. The rock at the pavement also contains a fairly large content of a greenish-brown zoned material filling up what appear to be cavities. Under crossed nicols this material shows low polarization colours masked by the greenish colour of the mineral. No clear interference figures are obtainable, probably due to the material being an aggregate of small crystals. It is faintly pleochroic. Another characteristic is that it is invariably associated with the glass in the rock. It is probably chlorite.

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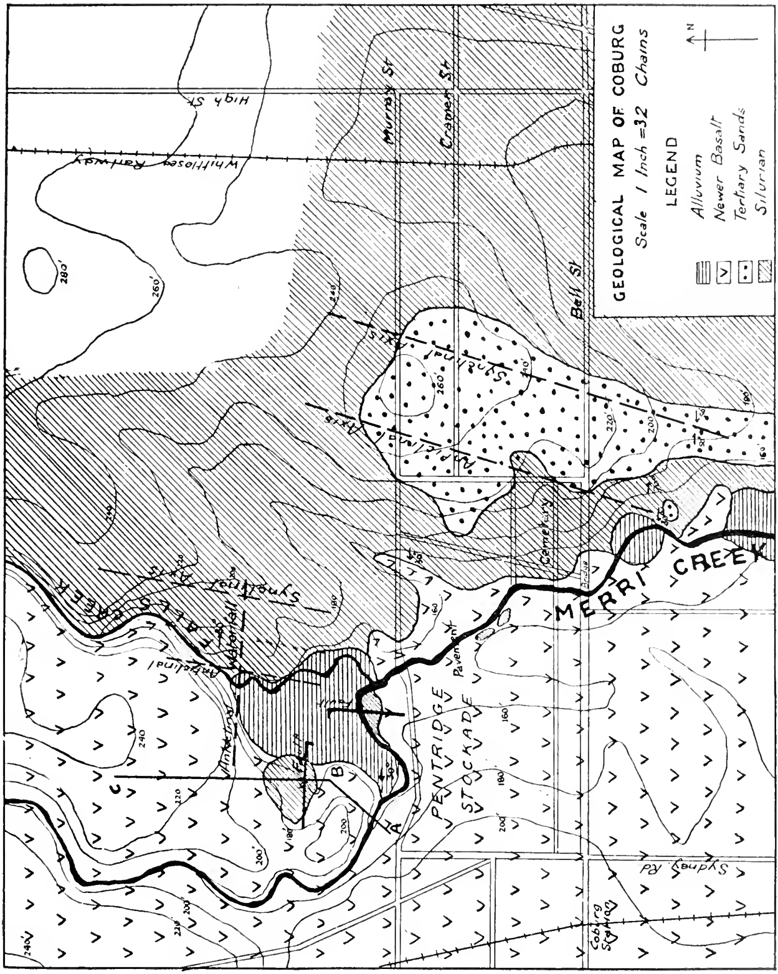
1. Proc. Roy. Soc. Victoria, xxiv. (n.s.), Pt. i., p. 159, 1911.


GEOLOGICAL MAP OF COBURG
Scale 1 Inch = 32 Chains
LEGEND
Alluvium
Newer Basalt
Tertiary Sands
Silurian
N
MERRI CREEK
PENTRIDGE STOCKADE
Murray St
Bell St
High St
Whittlesea Railway
Sydney Rd
Coburg Station
Cemetery
Pavement
Waterfall
Bridge

A chemical analysis of the rock is :—

	A.	B.	C.
SiO_2	49.01	46.43	44.95
Al_2O_3	16.60	17.60	15.50
Fe_2O_3	2.97	8.51	2.04
FeO	8.55	2.44	10.47
MgO	7.81	8.03	7.43
CaO	8.21	8.12	8.24
K_2O	0.85	0.92	1.98
Na_2O	2.91	3.56	3.04
H_2O +	0.44	1.20	2.60
H_2O –	1.24	0.81	0.52
TiO_2	1.56	2.25	2.77
P_2O_5	0.32	0.37	0.52
		(NiCo)O 0.07	CO_2 0.18
	100.48	MnO 0.22	MnO 0.21
		100.53	100.45

A. Rock from basalt pavement in bed of Merri, East of Pentridge. G. A. Cook.

B. Fine grained basalt, Greensborough. N. R. Junner. Proc. Roy. Soc. Victoria, 1913, p. 335.

C. Older basalt, A quarry, Tullamarine. F. L. Stillwell. Proc. Roy. Soc. Victoria, 1911, p. 165.

Analyses B and C are given for purposes of comparison.

Following the method of the American classification of rocks, the norm of the rock from Coburg was calculated.

It is :—

	Percentage.
Orthoclase	6.0
Albite	21.2
Anorthite	38.6
Corundum	2.9
Hypersthene	21.8
Olivine	2.5
Magnetite	4.0
Ilmenite	2.9
Apatite	0.20
	100.0

The rock is therefore classified :—

Class	2	-	Dosalane	-		
Order	5	-	Perfelic	-	Germanare
Rang	4	-	Docalcic	-	Hessase
Sub-rang	3	-	Presodic	-	Hessose

Typical low level basalt occurs in the area between the heights of 125 feet and 140 feet above sea level.

High Level Basalt.—This occurs typically at heights of about 240 feet. It is a more vesicular rock than the low level type. It is also coarser in grain, with larger and more plentiful phenocrysts, and, following Harker's nomenclature, may be classed as a dolerite. Microscopically it is seen to contain a larger proportion of olivine than the low level type. This olivine is generally iron stained, due probably to the porous character of the rock. Augite is present, but is not nearly so ophitic as in the low level type. Another chief point of difference between the two is the almost total absence of glass. Ilmenite and labradorite occur similarly to the occurrence in the low level type. The chief points of difference then between the two types are :—The high level type is coarser in grain, has no glass, and is richer in olivine. All these characteristics tend to show that the high level type has cooled more slowly than the low level.

This conclusion is also helped by the field characters and relations. The low level basalt frequently shows prismatic cleavage, indicating rather rapid cooling. The high level type on the other hand is more massive, the joints being more irregular and further apart. As the first specimens of the two types were collected from localities separated by the Silurian inlier North of Pentridge, it was at first thought likely that two distinct basalt flows occurred in the district. Further field work, however, showed that the flows were united to the West of the inlier, and further petrological work showed that the types grade into one another, and that the differences probably arose due to different conditions of cooling rather than to different composition of magma. Specimens collected from heights intermediate between 140 and 240 feet shew characters midway between the two extreme types, more and more glass developing as the traverse goes down hill from the top of an outcrop.

In conclusion I would gratefully thank Professor E. W. Skeats for his help and valuable suggestions throughout the prosecution of the work; also for his very kind criticism of this paper. I would also like to thank Dr. H. S. Summers for many discussions on debatable points that frequently arose.

Art. XII.—*A Comparative Examination of the Blood of Certain Australian Animals.*

By GWYNNETH BUCHANAN, M.Sc.

(With Plates XVIII. and XIX.).

[Read August 12th, 1915].

The study of the histology of the blood is a comparatively recent one, since it appears only to have been taken up in earnest in the latter half of the 19th century. These early workers were necessarily hampered by imperfections in the apparatus at their disposal. Gulliver (1) in 1875 published the results of an exhaustive examination of the shapes and sizes of red corpuscles of vertebrates, and this had been preceded by a paper on the taxonomic import of the nucleus of these cells. He was followed in 1878 and '79 by the appearance of two publications by Erhlich, whose name in connection with histology and reactions of the blood is, of course, a household word to all students of the subject to-day. So lately as 1892, however, Newton Parker (2) writes: "The fact that the white corpuscles of the blood are not all alike is now well known in the case of most vertebrates, although it is not possible, in most cases at any rate, to state definitely whether these do or do not correspond to stages in the development of one and the same thing, and whether different functions are performed by these different kinds of leucocytes."

In later years the intimate relation between the state of the blood and various conditions of disease, together with the very perfect methods of manipulation which the modern knowledge of staining and fixing has evolved, have produced an extensive literature on the histology of the blood. The work done in this direction being principally descriptions of pathological conditions or comparisons of normal blood with that of diseased individuals, is mainly confined to an examination of man and the domesticated animals. In a recent paper (3) Drs. Cleland and Harvey Johnston have, however, endeavoured to point out that some indication of the probable line of evolution of vertebrate forms may be deduced from a comparative study of the shapes and sizes of the red cells of the blood. In the present paper I have essayed to collect some data in regard to the native Australian animals, and have tried to obtain as many types in each group as possible.

The chief difficulty has been the fact that the native animals available can seldom be said to exist under normal conditions, being principally captive specimens, mainly from the Zoological Gardens; and in many cases the smears were so distinctly pathological as to be useless for comparative purposes. Bearing this in mind I have been careful in forming generalisations from my results unless the material has been sufficient and reliable enough to warrant so doing. I have to acknowledge my indebtedness to Professor Spencer and Dr. Sweet, of the Biological School, Melbourne University, for the use of books, specimens, and apparatus; to Dr. Gilruth, sometime Professor of Veterinary Pathology; Acting-Professor MacDonald, Dr. Dodd, and Mr. H. R. Seddon—all of the Veterinary School, Melbourne University—for the use of books, smears, and for advice as to methods of staining, etc.; also to the members of the Biological Laboratory, past and present, especially to Mrs. J. L. F. Woodburn, for smears from wild and native forms of N.S.W.

Methods.

Actual Counts were only made in a few cases. The instrument used was the Thoma Zeiss Haemocytometer, with Hayem's diluting fluid. Where possible the blood was taken from the ventricle, immediately after death; and in most cases, for lack of time, the white corpuscles were counted with the red.

Smears.—Wherever possible the smears were fixed in alcohol before staining, and several specimens were obtained, so that at least two varieties of stains might be employed. Those stains found to give the most consistent results were those of Jenner and Giemsa ("Tabloid" brand). These, however, do not both react in the same way to the various classes of white cell, making the determination of a differential count somewhat uncertain at times. Thus most cells were found to differentiate better with Giemsa, and in some cases only with that stain, though Burnett (4) describes mast cells whose granules take a purple stain with Jenner. Mononuclear forms, especially of amphibia, showed best with Giemsa; while cells with eosinophile characteristics stained more satisfactorily with Jenner—with the doubtful exception of one marsupial form—and the crystalloid eosinophile cells showed their preference for this stain markedly. These observations are borne out by the statement of Daniels in "Laboratory Studies in Tropical Medicine." p. 67, where he remarks, in reference to slides stained with Giemsa. "They (eosinophile granules) do not form as conspicuous objects as specimens stained by Louis Jenner's stain.".

Nomenclature.

These facts have given rise to a difficulty in arriving at a completely satisfactory method of naming the various forms of leucocyte, and probably as Fantham (5) remarks, p. 726, "The differences in opinion of the various investigators are explicable by reference, to slight variations in the stains."

In arriving at any satisfactory nomenclature it has been necessary to compare the several methods employed by different investigators.

Erhlich, (6) dealing with human blood, distinguishes six normal types—1, Lymphocytes; 2, Large mononuclear leucocytes. Between 1 and 2 he states there are no transitional forms. 3. Transitional forms derived from 2. 4. "Polynuclear" leucocytes. 5. Eosinophil cells. 6. Mast cells. In addition he describes various pathological forms.

Burnett (4) distinguishes five varieties of leucocyte in normal blood—1, Lymphocytes. 2. Large mononuclear and intermediate forms between 1 and 2. 3. Polymorphonuclear forms, or finely granular oxyphils. In this group he includes those cells in the blood of birds which contain large spindle granules. 4. Eosinophiles. 5. Mast, which he describes as coarsely granular basophiles, but which I have usually found to be distinguished by their metachromatic staining properties. He also notes many degenerate forms of leucocyte, evidently present under fairly normal conditions, such as swollen or irregular nuclei; degenerating nuclei; ruptured cell bodies and pale nuclei, etc.; beside many forms found under pathological conditions, such as myelocytes, plasma cells, and various abnormal kinds of erythrocytes. The blood dust described by Burnett perhaps corresponds to the substance attributed by Cullen (7) to the free granules of the mast cells, and to which the same name is given.

Cullen (7) describes four kinds of leucocytes in fishes and birds. 1. Small mononuclear, which closely resemble the corresponding cells in man, and which I take to mean the lymphocytes of most classifications. 2. Large mononuclears. 3. Eosinophiles, in which he distinguishes a granular form, and an oxyphilic spindle form, in this respect differing from Burnett. From my own observations

I am inclined to agree with Cullen in placing the spindle granules of birds as eosinophile forms just as the spindle granules of the cat are described under that heading by Burnett. (*Goodall* (8) also remarks that neutrophile cells are absent in the fowl, their place being taken by eosinophiles, with oxyphilic spindles.) 4. Mast cells.

Fantham (5) distinguishes, in the normal blood of the grouse (a). Erythrocytes, among which he finds normal cells, cells without nuclei, and erythroblasts—cells which are rounder and have more spherical nuclei than the ordinary form, and whose cytoplasm stains blue with Giemsa.

(b) Leucocytes, under which he puts—1. Lymphocytes, both large and small, the large variety merging into small mononuclears.[1] 2. Large mononuclears, whose protoplasm is basophil, staining deeply with Giemsa, and less darkly with Jenner. 3. Polymorphonuclear leucocytes (Burnett), or crystalloid eosinophil cells (Cullen, Warthin). 4. Eosinophile leucocytes (Burnett) or coarsely granular eosinophile (oxyphile) cells. 5. Mast cells (coarsely granular basophile cells). 6. Thrombocytes, which suggest very narrow and slightly small erythrocytes. The whole cell is basophile in its reactions, staining rather faintly blue with Jenner's stain.

Gruner (14) gives a classification of the human blood cells based on biological principles, and, following this, a valuable summary of the work done on their comparative cytology, together with an exhaustive bibliography. Deriving all blood corpuscles from the primordial cell he describes various forms in both normal and pathological blood:—1. Red cells, which are only present in vertebrates, and may be divided into—(a) orthochromatic, (b) polychromatic, and (c) megaloblasts. Platelets are absent where the red cells are nucleated. Spindle cells occur in all vertebrates below mammals, and are pear-shaped, or almond-shaped plaques, which in birds are sometimes regarded as identical with the mammalian thrombocytes, and physiologically have the same function as the platelets. 2. Lymphocytes, uninuclear, basophile, nongranular cells, which may be divided into—(a) small, and (b) large lymphocytes, and (c) large mononuclear cells, with transitional forms between the two former and the latter, and characteristic of infra-mammalian species. 3. Large mononuclear cells, which are of two types—(a) lymphoid, and (b) granular, and which are present in all animals in which blood may be detected. They

[1] In this connection we must note Erhlich's statement that in human blood there are no transitional forms between lymphocytes and mononuclears. This raises the question as to the homology of these forms in the various groups of animal.

appear to play the part of macrophages in reptiles and amphibia, and are frequently possessed of so-called "secretory vacuoles." 4. Neutrophile leucocytes, consisting of an oval, large, basophile cell body, fibrillar in structure, with oxyphilic paraplasm; round, indented, or polymorphous nuclei; not found far back in the vertebrate scale, and probably not corresponding to the phagocytes of cold-blooded vertebrates. These apparently correspond to the polymorphonucleate cell of other writers, and are regarded by Gruner as being absent in their true specific form in cold-blooded vertebrates, the part of the human polymorph being played by the macrophage in the frog and reptiles. In birds he includes under this group mast cells, eosinophile cells, with rod-like granules (pseudo-eosinophiles), and cells of the same size full of minute oxyphilic granules. 5. Eosinophiles, with granules of various shapes and sizes. 6. Mast cells, which are mono- or polynucleate, variable in size, with a vacuolated cell body. They are divided into those containing fine, irregular granules, staining red-violet with Giemsa, and those containing scanty, coarse granules. Besides these there are forms more or less characteristic of certain pathological conditions, such as plasma cells, giant cells, etc.; as well as various structures which may represent stages in the life history of the normal blood cells. For the work under discussion I have adopted the following terms in an attempt to reduce the blood cells of the various groups of animals to a common classification.

1. *Erythrocytes.* Nucleated or non-nucleated cells, according to the group of animal. Normally staining yellow-orange or brick-red, but polychromatic or basophil forms were common in all species. In all cases irregular forms were present, even when the blood was not apparently pathological. In amphibia, reptiles, and some birds, I noted, besides these ordinary forms, structures which I have called spindle cells, and which I take to correspond to the thrombocytes of Burnett and Fantham. In the lower vertebrates these cells are thought to perform the function of blood platelets (Gruner). In many cases these cells were distinctly bi-polar, though in the majority they were drawn out at one end only. They were not as consistently basophil as the authors quoted describe, but their tendency seemed to be decidedly towards basic or polychromatic reactions. They have been described to me as artefacts, but as I have repeatedly observed them in the haemocytometer while making an estimation of corpuscles, and once in an examination of fresh frog's blood during a laboratory demonstration, while

I have frequently found them elongated at right angles to the length of the smear. I adhere to my first belief that they are fairly usual constituents of the blood of certain animals.

2. *Leucocytes.*
   (a) *Lymphocytes.* Small, round or irregular cells, with basophil and practically homogeneous protoplasm. Deeply basophil nucleus filling the greater portion of the cell.
   (b) *Mononuclear.* Larger basophil forms, frequently containing basophil granules, and with large and often excentric nuclei.
   (c) *Polymorphonucleate.* Large forms, with irregular and frequently excentric basophil nucleus, the cell protoplasm often exhibiting faint acidophil properties, or even granules.
   (d) *Transitional forms.* Basophil cells, whose nuclei present intermediate stages between (b) and (c).
   (e) *Eosinophile*, containing large or small acidophil granules, and irregular nuclei.
   (f) *Mast cells*, containing granules, staining more or less metachromatically, and faintly basophil cytoplasm.

Fishes. (Plate XVIII.; Figs. 1-6.)

Only one form was examined—the teleostean Sea-hedgehog (*Diodon histrix* (!))—and the smear contained many bacteria. The red cells were much rounder than those of batrachians or reptiles, averaging 12.5μ × 9.2μ. The protoplasm of many took a basic stain. One doubtful spindle form was observed, measuring 13.2μ × 8.3μ. The lymphocytes were round, and the most conspicuous leucocytes were mononuclear forms, with deeply basophil granules, averaging 12.4μ in diameter; while others resembling the polymorph type in general characteristics, but containing basophil protoplasm, averaged 11.6μ. No eosinophil forms were apparent on treatment with either Jenner's or Giemsa's stain. [1]Newton Parker (2) gives the average sizes of the red as much larger (40-46μ × 25-27μ), but Johnston and Cleland (3) remark that they find a wide diversity among fishes, dipnoi running as high as 29μ × 23μ, while in some teleosts their reading is as

1 Gruner (14) notes that in general the lymphocytes are fairly typical in this group, showing transitions to the large mononuclear type; also the fact that the mononuclear forms are typical of the lower vertebrates, occasionally replacing the polymorphs in function. He also draws attention to the absence of eosinophil and mast cells in fishes.

low as $6\mu \times 6\mu$. As these latter observers point out, the Teleostei have evidently branched off from the main stem, giving rise to batrachians and reptiles, so that there is little of comparative interest in this reading.

Batrachia. (Plate XVIII.; Figs. 7-17.)

Red Corpuscles.—Considerable variations in the size of all types of cell were observable in this group; but, with the doubtful exception of one slide from a tadpole, the young forms have larger corpuscles than the adult. Spindle cells were found in *Lymnodynastes dorsalis*, averaging $23\mu \times 12.45\mu$, also in fresh blood of *Hyla aurea*, used for laboratory demonstration purposes, and in the haemocytometer; while in the majority of cases basophil polychromatic reds were found. Some of these stained more deeply than others, and, with the exception of *L. dorsalis*, averaged smaller than the ordinary red. The chromatin of these forms did not stain as deeply as that of the typical erythrocytes. The smears also contained masses of a homogeneously staining substance, or, in other cases free nuclei (cf. Fantham (5) p. 728); while in one young *H. aurea* were forms with vacuolated protoplasm, and very densely stained nucleus. In some cases the red cells were apparently in a state of active division. This was observed chiefly in *L. dorsalis*. Gruner (p. 94) remarks seven varieties of red cell in the frog, giving their average size as $14.5 \times 25\,\mu$, and their number as half a million per c.cm, being much fewer than in other animals.

Lymphocytes varied much in size and shape, ranging from 6.6μ to $13.4\mu \times 5.3\mu$: and were occasionally, e.g., *H. aurea* and *L. dorsalis*, observed with the nucleus in a state of division. In *L. dorsalis* they showed a distinctly fringed outline, comparable to that described by Erhlich in human blood. They were always basophil.

Mononuclear forms were strongly basophil, and varied much in size, and also in relative numbers, showing all gradations from 8.6μ-19.9μ in diameter [cf. description of intermediate forms by Stephens and Christopher (9), p. 19], the average size falling, however, between 10μ and 14μ. The nucleus tended to become segmented, and the cell substance to contain granules.

Eosinophils were not, as a rule, clearly defined, with the exception of *L. dorsalis* and *H. peronii*, in which there was a decided increase in the relative numbers of these cells, together with a marked difference in the size of the granules as compared with those of other members of the group. The granules in these two forms closely resembled in appearance those figured by Burnett (4) for the horse. In *L. dorsalis* also, the eosinophil cells differed from those of other batrachia examined, in averaging larger than the true polymorph cells. Gruner, on the other hand, regards the eosinophil cells as forming the important features of the blood of amphibia.

Polymorph cells of the true type are denied by Gruner, but he notes forms containing a true polymorph nucleus, and faintly basophil or amphophil cell substance, and these I found were very distinct in most cases. In *H. peronii* these were represented by forms with somewhat irregular nuclei, much pressed to the side of the cell.

In tadpoles the leucocytes were apparently all of the mononuclear type, averaging 12.1μ-16.9μ; while the spindle cells and basophil reds containing large and less dense nuclei than the orthochromatic were numerous, and in one form the true red cells tended to become vacuolated. In such smears a differential count was obviously impossible.

Gruner regards the mononuclear as the primitive type of cell, and, as such, they are to be expected in the more or less undifferentiated blood of young animals.

BATRACIAN CORPUSCLES.

Name	Percentage Counts of Leucocytes.			
	Lymphocytes.	Mononuclears.	Polymorphs.	Eosinophils.
Hyla aurea (young)	35.2 – 40.4	56.7 – 61.1	1.6 – 2.7	1.1 – .9
„ „ (adult)	51.2	28.3	8.2	1.4
Lymnodynastes dorsalis	68.2 – 73	10.6 – 12	15.7 – 13	3.2 – 2.1

BATRACIAN CORPUSCLES.

Sizes measured in μ.

Name.	Red. Spindle. L.	Red. Spindle. B.	Red. Ordinary. L.	Red. Ordinary. B.	Polychromatic and Basophil. L.	Polychromatic and Basophil. B.	Lymphocytes.		Mononuclears. Small.	Mononuclears. Medium.	Mononuclears. Large.	Polymorphs.	Eosinophils.
Hyla aurea (young			18.6	10.8	14	10.2	6.6	10.4 × 4.3	8.6	14.4 – 17.2	18.6 – 19.9	14.9 – 16.6	16.6 – 17.7
Hyla aurea (adult)			17.4	11.1	9.1		6.3	13.2 × 5.3	10.9	14.9		15.1	19.9
Hyla aurea (tadpole)			16.1	8.7								15.9	
Hyla peronii			15.5	11.2				10.95	10.7			12.1	11.6
Lymnodynastes dorsalis	23	12.45	20.4	11.6	22	11.1	6.6	10.8 × 6.1	10.8	14.1		13.7	12.45
Tadpole sp. (?)	18.2	9.1	18.2	10.6								12.1	
Lymnodynastes tasmaniensis (tadpole)			18.3	8.3									
L. tasmaniensis (adult)			16.1	9.4	15.93								

Reptiles. (Plates XVIII. and XIX.; Figs. 18-33.)

Red Corpuscles.—The counts of the absolute number of red cells varied, probably due to the effect of different seasons. For instance, *Chelodina longicollis* would not give enough blood for a haemocytometer count when pricked in May, apparently because the animal was then hibernating, and the estimation of its cells could not be made until it was killed in July.

The red corpuscles varied in size, the largest observed being found in *Chelodina longicollis*, and measuring 21.9μ × 13.3μ, which is a larger reading than that given by Cleland and Johnston (3), viz., 18.5μ – 19.5μ × 12.5μ. The increase in size in young forms as compared with adults of the same species characteristic of batrachia, is no longer apparent, except in *Tiliqua scincoides*, which ranked next in size to *Chelodina longicollis;* but for purposes of comparison I was not, in this case, able to obtain the adult. My measurement (19μ × 10.3μ) is, however, a slightly larger reading than is given by Cleland and Johnston for the same form (presumably adult). In one case, *Til. nigra-lutea*, the cells varied enormously, running from 19.9μ × 11.6μ to 9.9μ × 6.6μ; and in *Gramatophora barbata* there were some small round cells, appearing normal in reaction to stain (microcytes), while in *Trachydosaurus rugosus* these small forms were also observed, bearing in this case a very darkly staining nucleus. Anaplasms were common in the cell of *Chel. longicollis*, while others showed different stages of vacuolation, and variously disintegrated structures, closely resembling those of *Hyla aurea* were found. In other cases the red cells seemed to be losing their nuclei, e.g., in *Tiliqua scincoides* (10). In some the nuclei of the ordinary forms tended to become irregular, with a distinct appearance of budding, and in the young specimen of *Gramatophora muricata* one was observed in a state of division. The reaction to stain was fairly normal, but in some the cytoplasm of ordinary red cells took on a green tinge with Jenner.

In reptiles, in distinction to batrachia, the larger forms of leucocyte approach more nearly the size of erythrocytes, the largest observed being the eosinophil cells of *Chel. longic.*, which measured 21.5μ. Spindle cells were very common in all specimens, and might be pointed out at one or both ends. They rather inclined towards basophil characteristics, and among such cells binucleate forms were fairly numerous, as well as among the ordinary spindles. In the young *Tiliqua scincoides*, in which these cells were first observed, they averaged slightly smaller than the ordinary erythrocytes, with rounder nuclei. The smaller cells tended to be basophil, the larger staining normally. Normal basophil cells were also common, their nuclei being larger, and taking the stain less darkly than the ordinary forms, and showing a great tendency to branch or bud; in fact, in *T. rugosus* one was observed showing three nuclear masses.

Lymphocytes varied in size, the largest being found in young *Gramat. muricata*. These were distinctly oval in shape, measuring 11.9μ × 6.6μ. On the other hand those of young *Tiliqua scincoides* ran smaller than any other form, viz., 4.8μ. The percentage counts also varied, being fairly high in young individuals. The fringe of ragged protoplasm observed in some batrachia was also seen in this group (*Trach. rugosus* and *Til. nigra-lutea*). In the former these cells were most distinct when treated with Jenner's stain, and an appearance was obtained resembling division. The general shape varies from oval in *Gram. muricata* to round in *Trach. rugosus*, while in other cases it was almost impossible to distinguish lymphocytes from free nuclei.

Mast cells were common in this group, averaging larger than the mononuclear forms, but they were not present to any large percentage. The greatest number was found in the young of *Gram. barbata*, where they were present to the extent of 13.8 per cent. of the total white cells. They were common in *Chel. longicollis*, in which, as in *Trach. rugosus*, they showed both large and small varieties. In *Trach. rugosus* also, one was seen apparently in a state of division, and in this species the granules of the corpuscle were distinctly divided into large and small; while some cells appeared transitional in staining between the mononuclear and the mast variety, staining more darkly purple than the ordinary mononuclear forms, and with a few characteristic granules in the protoplasm.

Transitional forms of ordinary type were not observed.

Mononuclear cells varied in size, and might be divided into two classes—(a) Small, ranging from 7.9μ-9.9μ; (b) those corresponding more nearly to those of other forms, and ranging from 11.7μ-15.4 μ, while in the carpet snake (specimen in very pathological condition) they ran up as high as 21.1μ.

The percentage counts were fairly high, but it was difficult in many cases to make a rigid distinction between large specimens of class (a) and small specimens of class (b). The small forms of *Chel. longicollis* were distinguished from the lymphocytes by the presence of many basophil granules. In others (*Gram. barbata*) the protoplasm tended to be vacuolated, and in *Til. scincoides* this vacuolation extended to the nucleus (cf. Erhlich, p. 86). As in amphibia Gruner regards these cells as playing the part of macrophages, true polymorphs being absent.

Polymorphonucleate Cells.—These were roughly about the same size as the eosinophiles, but gave a small percentage count except in young *Gramat. muricata*, where they ran up to 42 per cent. of total leucocytes; while in the Monitor it was not possible to distinguish them from the eosinophil cells. In smears from *Chel. longicollis*, large cells were seen in which the nucleus was pressed to one side, and the protoplasm scarcely stained at all. In other cases, e.g., *Gram. barbata* forms containing a horseshoe-shaped nucleus, and faintly pink protoplasm, scarcely to be distinguished from eosinophils, and comparable to those of some frogs, were seen. Similar cells were noted in *Til. nigra-lutea*. In other cases, e.g. *Gram. muricata*, the protoplasm was vacuolated, and the nucleus not so strongly basophil, as in the ordinary types. These, under Gruner's classification, must be regarded as eosinophils

Eosinophil Cells.—These were fairly well marked, though giving small percentage counts, except in *Chel. longicollis*, in which the granules could be distinctly divided into small and large. The latter closely resembled the spindle-shaped structures of birds, and were much more numerous than the former, the total eosinophil count giving 40 per cent. of leucocytes present. In size, with the exception of *Chel. longicollis*, which ran as high as 21.5μ, these cells average about the same as the polymorph forms. The eosinophils of *Chel. longicollis* are further peculiar in showing, besides the spindle-shaped granules already mentioned, finely and coarsely granular cells, the latter not unlike those of *Lymnodynastes dorsalis*, among the amphibia, though not staining so distinctly. In most cases, also, in this species, the eosinophil granules, with the exception of the large ones, did not stain with Jenner at all, so making it hard to distinguish true polymorphs from eosinophils, both of which carry nuclei pressed to the side. The same fact was also observed in *Gram. barbata*. In *Til. nigra-lutea* these cells did not show up with either Jenner or Giemsa; while *Trach. rugosus*, both young and adult, showed scattered granules staining best with Jenner, some cells being not clearly granular, while all had the nucleus pressed to one side. On the other hand, in *Til. scincoides* the nucleus was round in distinction to that of the polymorph cells, and the granules were few and refractive. Gruner questions the analogy between the cells containing spindle-shaped granules (crystalloids), and the eosinophil cells of mammals (human), just as in places the "pseudo-eosinophile" cells of birds in the polymorph series. If the structures I have called polymorphs in amphibia and reptiles, and which show amphophil or acidophil affinities, are to be regarded as eosinophils, then this class of cell is certainly the most characteristic of amphibian and reptilian blood.

REPTILIAN CORPUSCLES.

Names	Reds. per c.mm.	Whites. per c.mm. (taken with red)	Leucocytes				
			Lymphocytes.	Mast.	Mononuclears.	Polymorphs.	Eosinophils.
Gramatophora barbata	1,589,446	50,000	14.5		65	12.2	8.03
Gramatophora muricata (young)			37.9	13.8		42.5	
Tiliqua nigra-lutea	988,095	21,875					
Trachydosaurus rugosus	753,125	12,500					
T. rugosus	1,222,222	33,333	28.3	3.5	51.1	16.2	.6
T. rugosus	1,522,222	43,333	55.0	2.4	40.0		
T. rugosus (young)	646,423	32,812	42.0	4.2	40.0	19.5	1.4
Tiliqua scincoides (young)	721,428	15, 33	65.6		30.6	1.8	2.8
Chelodina longicollis	102,380 (taken in Winter)	7,386 (taken in Winter)	26.1	1.5	23.7	8.4	40.0
Varanus (varius or gouldi)			47.9		29.9	22.3 (polymorphs and eosinophils together)	

REPTILIAN CORPUSCLES.

SIZES MEASURED IN μ.

Name.	Red. Spindle. L.	Red. Spindle. B.	Red. Ordinary. L.	Red. Ordinary. B.	Polychromatic and Basophil. L.	Polychromatic and Basophil. B.	Lymphocytes.	Mast.	Mononuclears. Small.	Mononuclears. Large.	Poly-morphs.	Eosino-phils.
Gramatophora muricata (young)			16.7	11.6	11.1		11.9 × 6.6	14.6		9	15.6	
G. barbata	15.7	7.5	16	8.96			6.6		7.9	14.5		15.27
Tiliqua nigra-lutea	15.9	8.3	17.9	10.2	16.6	11.4	6.4	11.6	1.3	13.2		16.6
Trachydosaurus rugosus	18.9	11.1	16.4	9.6	16.2	10.9	5.9	10.9		12.9		14.9
,, ,, ,,			15.7	8.79	14.9	9.46	6.4 × 8.6	14.1 × 8.3	9.96	11.78 × 15.77	12.6	12.4
,, ,, ,, (young)	16.6	8.7	16.8	10.67	18.2	11.6	7.5 × 4.2	11.6	7.6	12	13.2	
Tiliqua scinoides (young)	17.	6.6	19	10.3	13		4.8			15.4		16.7
Chelodina longicollis			21.9	13			7.3	16.6 × 9.1				21.5
Varanus (varius or gouldi) or Monitor			16.9	9.6	16.2	10.9	6.97	9.96	10.2		14.27	11.28
Carpet snake			17.9	10.37			5.39		10.2 (8.3 - 12.45)	15.6 (13.2 - 21.1)		14.7

Aves. (Plate XIX.; Figs. 34-37.)

Red Corpuscles.—The actual counts varied, but scarcely beyond the limits of the figures given by Burnett (4) for the blood of the domestic fowl, the highest being found in the Black Mountain Duck, and the lowest in the White Pekin. In size they averaged smaller than those of reptiles, the largest being found in the Spoonbill ($16.1\mu \times 8.7\mu$). The cells of young individuals showed an increase in size as compared with those of the adult. Basophil types (thrombocytes or erythroblasts of Fantham?) were not common, but were observed in the Chestnut Breasted Teal and young Mudlark and Heron, and averaged smaller than the ordinary forms. In the Heron a few cells resembling the spindle forms of reptiles were seen, but this smear was full of cocci, and in all probability not normal. In the Spoonbill, young Mudlark, and young Mountain Duck the basophil cells were also well marked, and showed great variety of shape, some even approaching that of spindle cells. It is worthy of note, from the standpoint of evolution, and in view of the occurrence of these cells in amphibia and reptiles, that they were more conspicuous in the younger forms of the birds examined, which is to be expected if they are a primitive type. Gruner, however, states they are present in all vertebrates below mammals. In the Spoonbill and young Mudlark also, the nuclei of many red cells were slightly moniliform, and in some cases almost completely divided, with the most dense chromatin at the centre of the nucleus. This aggregation of chromatin was best marked in the basophil forms, in which also division of the nucleus was well seen. Degenerate cells, resembling those found in reptiles, and described by Fantham (5), and consisting apparently of free nuclei, non-nucleated fragments and nuclei surrounded by a thin film of protoplasm, were also observed.

Lymphocytes.—These varied in size from 3.8μ in the Black Mountain Duck (*Anas superciliosa*), to 6.7μ in the Spoonbill. Their percentage counts were fairly high, running to 75.8 per cent. of the total leucocytes in the Chestnut Breasted Teal. In the young Mudlark the count was extraordinarily low (15.8 per cent.). These cells have a decided tendency to aggregate (cf Fantham (5)); and degenerating forms appearing like large nuclei of lymphocytes were present in certain smears, being in many cases difficult to distinguish from the true cell (cf. Burnett (4)). In the young Mudlark they are surrounded by a clear ring of cytoplasm.

Mast Cells.—These were not found on any slide, with the possible exception of the Chestnut Breasted Teal (*Casarca tador-*

noides) smear stained with Giemsa. In the Heron and Spoonbill there were also doubtful forms, but neither of these slides were very reliable, being fairly pathological.

Mononuclear Cells.—These varied in percentage count, but never ran higher than 28 per cent. of total leucocytes. They were distinctly divisible into small and large types, the former ranging from 6.8μ-9μ, and the latter from 8.5μ-14.5μ. The relative difference between the two forms ran as high as 6.5μ in one bird (Heron).

Polymorphonucleate Cells.—These were difficult to distinguish from the eosinophil, and a percentage count could only be made in the young Mudlark, in which they amounted to 3.5 per cent. of the total leucocytes. In this species also, their diameter was only 6.2μ, while that of the true eosinophils ran as high as 11.6μ. Gruner includes under this head mast cells, eosinophiles with rod-like granules, and cells of the same size full of minute oxyphile granules.

Eosinophil Cells.—In general, the size of these cells averaged less than those of reptiles. They were in most cases divided into those with round granules, and those with the spindle or crystalloid variety (polymorphonucleate leucocytes of Burnett, neutrophile of Gruner), though it was not always possible to distinguish clearly enough between the two forms in order to make a differential count. The crystalloid variety were particularly well marked in the White Pekin Duck and young Mudlark, in each of which they gave a high percentage count, very greatly in excess of the ordinary cells with rounder granules. As a rule the percentage of eosinophil corpuscles was fairly high, running up to 32.4 per cent. of total leucocytes in the Black Mountain Duck. In some cases, notably the Heron, the granules were very sparse, resembling those of certain reptiles, while in the Black Mountain Duck several large mononuclear cells showed an apparent eosinophilous granulation. In the Ibis there were distinctly three forms, (a) with small granules, (b) with ordinary spindles, (c) with large spindles—the last two classes being about equal in number, and varying slightly in size (11.6μ-10.9μ).

AVIAN CORPUSCLES.

Name.	Reds.	Whites.	Lymphocytes.	Mononuclears.	Polymorphs.	Eosinophils.
	per c.mm.	per c.mm.				%
Muscovy Duck	2,350,000	91,600	67.0	5.06		28.0
Asarca tadornoides (chestnut-breasted teal)	3,000,000	55,555	75.0	5.35		18.4
Anas superciliosa (black mountain duck)	4,450,000	50,000	64.9	6.5		32.4
Ardea (Sp. ?) (heron)			56.4	27.9		15.6
Spoonbill			69.6	1.35		29.0
Ibis			65.9	25.5		8.5
Grallina picata (young mudlark)	3,768,750	103,125	15.8	28.0	3.5	53.5

AVIAN CORPUSCLES.

SIZES MEASURED IN μ.

Name.	Red. Ordinary. L.	Red. Ordinary. B.	Polychromatic and Basophil. L.	Polychromatic and Basophil. B.	Lymphocytes.	Mononuclear. Small.	Mononuclear. Large.	Polymorphs.	Eiosnophils.
Muscovy Duck	10.6	6.6			4.2		7.4		9
Asarca tadornoides (chestnut-breasted teal)	10.8	5.7	8.2		5.4	6.8	11		8.9–11
Anas superciliiosa (black mountain duck)	10.6	6			3.8		8.5		8.7
Anas superciliosa (young)	13.9	7.4			-	-	-	-	-
Ardea sp (?) (heron)	13	8.5			5	8	14.5		12
Spoonbill	16.1	8.7			6.7				13.2
Ibis					6	9	13.6		10–11
Grallina picata (young mudlark)	12.6	7.3	10.9	8.3	6.6	7.4	11.5	6.2	11.6–10.6

Mammalia. (Plate XIX.; Figs. 38-44.)

The representatives examined in this group all belonged to the Metatheria, being either marsupials or monotremes.

Platelets were observed for the first time in this group, being absent in all forms with nucleated red corpuscles (Gruner); and were very common in all species. In some of the marsupials they appeared to have a definite outline. Schäfer (12), p. 47, mentions blood platelets or thrombocytes in the frog, but I have found nothing to correspond strictly with these cells in appearance outside the mammalia.

Red Corpuscles.—These approached very nearly the actual number per c.mm in human blood. There was a marked decrease in the size of the cells as compared with in vertebrates; and in all cases they were non-nucleated, bi-concave discs. The variation in diameter is also much less than in other groups (5.1μ-7.8μ). In the young platypus (*O. anatinus*) they showed the greatest range, running from 6.6μ-9.9μ. There seemed to be no definite relation between the age of the animals and the size of the corpuscles. Poikilocytosis was fairly common in many marsupials, as well as polychromatophilia, while normoblasts were frequently present.[1]

There were also, in the smears of marsupial blood, a large number of corpuscles of normal shape, but small size (microcytes).

Lymphocytes averaged very much larger than the corresponding cells in birds, the greatest diameter being found in one species of wombat (*Phascolomys*), but there was no marked tendency towards increase in size in the young. The percentage counts varied enormously, running as high as 72.6 per cent. of the total leucocytes in *Trichosurus vulpecula;* but I could find no definite relationship between age and numbers, though, as a general rule, the young forms showed a high percentage count. In *T. vulpecula* and others the nuclei of some lymphocytes appeared to be distinctly dividing, and the size and amount of protoplasm in relation to the nucleus varied, but apparently the lymphocytes were non-granular, thus differing from the mononuclear forms. In *Petaurus breviceps* the lymphocytes were divided into two classes—(a) small, with very distinct outline to the nucleus, and very little cell substance; (b) larger cells, with less clearly marked nuclei, and protoplasm barely showing (cf. Gruner). In the young echidna the lymphocytes varied much in size, and were very granular; while the nuclei of several in the wombat smears showed distinct lobing, giving a kidney-shaped appearance. (Transitional forms?).

Mast cells were very rare, being only observed in *T. vulpecula* and the wombat, and in neither case numbering as much as 1 per cent. of the total leucocytes.

Mononuclear cells were divisible in some cases into small and large, and averaged as a rule, larger than the polymorphs[2] They showed, particularly in the young platypus, a great variation, as

1 Cleland and Johnston (3) suggest this may be an archaic feature.

2 Stephens and Christopher (9) remark on the frequent occurrence of "intermediate leucocytes," mid way between the large and small mononuclear cells.

well as an increase, in size (12.8μ 18.1μ). Percentage counts were never very large, reaching the highest in *P. breviceps* (female with young), where these cells numbered 35.7 per cent. of the total leucocytes. Degenerating cells (cf. Burnett) were common, while in others the nucleus tended to become vacuolated (cf. Erhlich (6), and one cell of *T. vulpecula* seemed to be clearly dividing. The chromatin of the nuclei in many showed very distinctly.

Transitional forms, between the mononuclears and the polymorphs, were observed in four cases, and in size corresponded most nearly with the polymorphs, but in no case did they amount to 3 per cent. of the total leucocytes.

Polymorphonuclear cells were numerous, reaching as high as 76 per cent. of the total leucocytes in the female wombat. In size they approximated, on an average, to the eosinophils, being particularly small in one species of *Echidna histrix*, in which the cytoplasm stained very indistinctly. In *T. vulpecula*, on the other hand, they showed fine acidophil granulations (cf. Schäfer (11) p. 34).

Eosinophil cells never gave a high percentage count, falling particularly low in echidna, in which, neither in the young nor adult form, did they reach 1 per cent. of the total leucocytes. They seemed to average slightly larger than the polymorphs, though this was not an absolute rule. The granules of some were very scattered, while in others they were very fine, resembling the finely granular polymorphs of some forms. In the young platypus they were only distinguishable with Giemsa's stain. Erhlich (6), p. 179, notes among the a-typical forms of white corpuscles which may be present, dwarf forms of the eosinophil variety, and I found that these were also very common in many marsupials. Macrophages were also present in the form of large basophil mononuclear cells, containing partially disintegrated corpuscles of various types.

MAMMALIAN CORPUSCLES.

Name.	Red. per c.mm.	White. per c.mm.	Lympho-cytes. %	Transi-tional forms. %	Mast. %	Mononuclear. %	Polymorphs %	Eosino-phils %
Echidna histrix			12.5			18 (+ transitional)	68.2	.77
„ „ (young)	6,520,000	60,000	43.6			7.5	48.5	.3
Ornith. anatinus (young)	7,671,428	17,187(?)	40.7	2.8		2.8	47.	4.
„ „ „	6,682,142	21,875						
Petaurus breviceps (young)			37.7	3.9		10.4 (+ transitional)	45.4	2.6
„ „ (mother)			59 – 66			35—23	4.2 – 7.4	2.4
Trichosurus vulpecula			27.	1.5		5.28	64.7	1.3
„ „			72.6		.83	9	16.3	1.2
Pseudochirus peregrinus			16.8			19.9 (+ transitional)	60.9	.78
Phascolomys wombat (male)			50.1			5.8	37.0	6.4
„ „ „			18.4			4.7	76.8	
„ „ (female)			50.7			3.4	43.6	2.7
„ „ „ (half-grown)			61.8			3.4	32.2	2.4
„ „ „ (full-grown			50.7			2.6	41.8	4.9
„ „ (female)			39		.4	2.09	57.2	1.2
„ „ (male)			49			2.4	46.7	1.6
„ „ „			45			2	45	8.6

MAMMALIAN CORPUSCLES.

Sizes measured in μ.

Name.	Red.	Lympho-cytes.	Mast.	Mononuclears Small. Large.	Transitional forms.	Polymorphs	Eosinophils.
Echidna histrix	6.6	9.6		8 11.6	6.6 – 9.1		
„ „ (young)	6.5	10.3		15	13		14.9
Ornithorhyncus anatinus	5.1						
„ „ (young)	7.8 (6.6 – 9.9)	10.2		12.86 – 18.1 (11.6 – 14.9)		10.2	10 45
Trichosurus vulpecula	6.2	9.3		13.6	13.9	12.3	14.3
Petaurus breviceps (young)	5.7	9.3		15.3	12.4	13.1	15.1
„ „ (mother)	6.2	9.4		15.5	13.9	13.6	
Phascolomys wombat (male)	5.9	11.2		11.7		10.7	11.4
„ „ (male)	6.1	10.1		13.2		11.1	
„ „ (female)	6.6	10.6		14.9		12.4	10.89
„ „ „ (half-grown)	6.4	10.29				11 95	10.37
„ „ „ (full-grown)	6.7	10.1				11.6	10.9
„ „ „	6.4	10.6	11.6 × 14.9	13.7		11 7	13.28
„ „ (male)	6.8	11.4		15.3		11.7	13.7
„ „ „	6.6	10.79		9.2 · 20.75		12.7	13.58

Summary.

Red Corpuscles.—Miss Clay-Pole (12) notes the decrease in size of red cells in passing from generalised to specialised types, and associates this with an increased haemoglobin capacity. I have found the same fact borne out by my observations, as well as a corresponding increase in the actual number of red cells, which, by increasing the total surface of the red cells, augments the area over which oxygen may be absorbed. There was a tendency towards larger size in young forms, which was, however, hardly apparent in marsupials. Spindle cells, when present, tended to be polychromatic or basophil in reaction, and were only found in any number in amphibia and reptiles.

Leucocytes.—(a) *Lymphocytes*, as a general rule, seem to be more numerous in young forms. The size was also greater in the young, and increased in passing through the various groups, being largest in marsupials. This large size in the young is evidently a reversion to the primitive type.

(b) *Mast cells* seemed to be more characteristic of the lower groups, as they were observed only once in marsupials, though they were numerous in reptiles.

(c) *Mononuclears* were more numerous in young animals, and the only form of white corpuscle found in the tadpole was nearest this type—primitive, according to Gruner. The average number of these cells became much less in monotremes and marsupials. In amphibia there were three distinct classes, according to the sizes, a giant type being well marked in the young. In reptiles only two classes were apparent, and the average size in the adults was less than in amphibia; while in birds they were smaller again, but still of two kinds. Monotremes resembled reptiles; but in marsupials we find one size with no marked difference between the young and adult.

(d) *Polymorphonuclears* in amphibia were not easy to distinguish from mononuclears by staining, and were also few in number; both facts being more clearly marked in the young. In reptiles also they were not clearly differentiated, and were only distinct in one bird. In monotremes, and still more in marsupials, they were numerous and apparent, except in the case of the adult female *Petaurus breviceps*, which was suckling its young when the smear was taken. Perhaps this fact may account for the extraordinary decrease in polymorphs, and rise in number of mononuclears in this particular specimen.

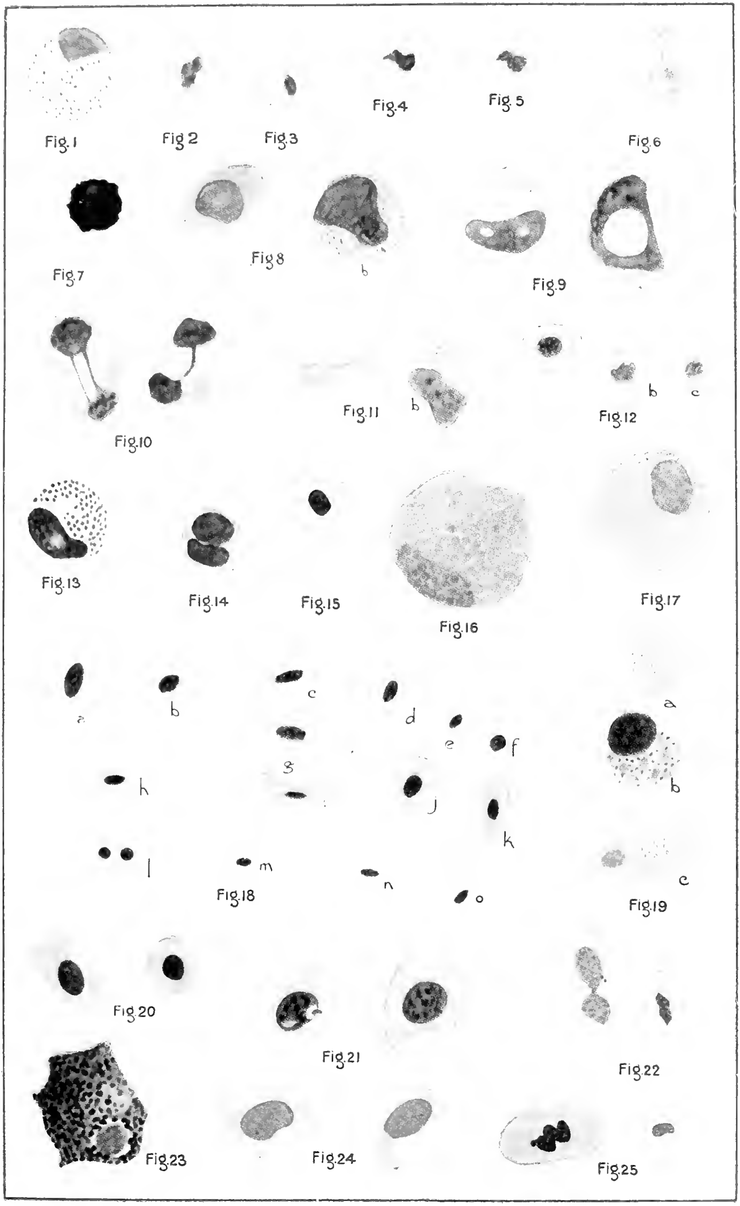


Fig. 1
Fig 2
Fig.3
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Fig. 5
Fig.6
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Fig 8
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Fig.10
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c
Fig.12
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Fig.18
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Fig.19
Fig.20
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Fig.23
Fig.24
Fig.25

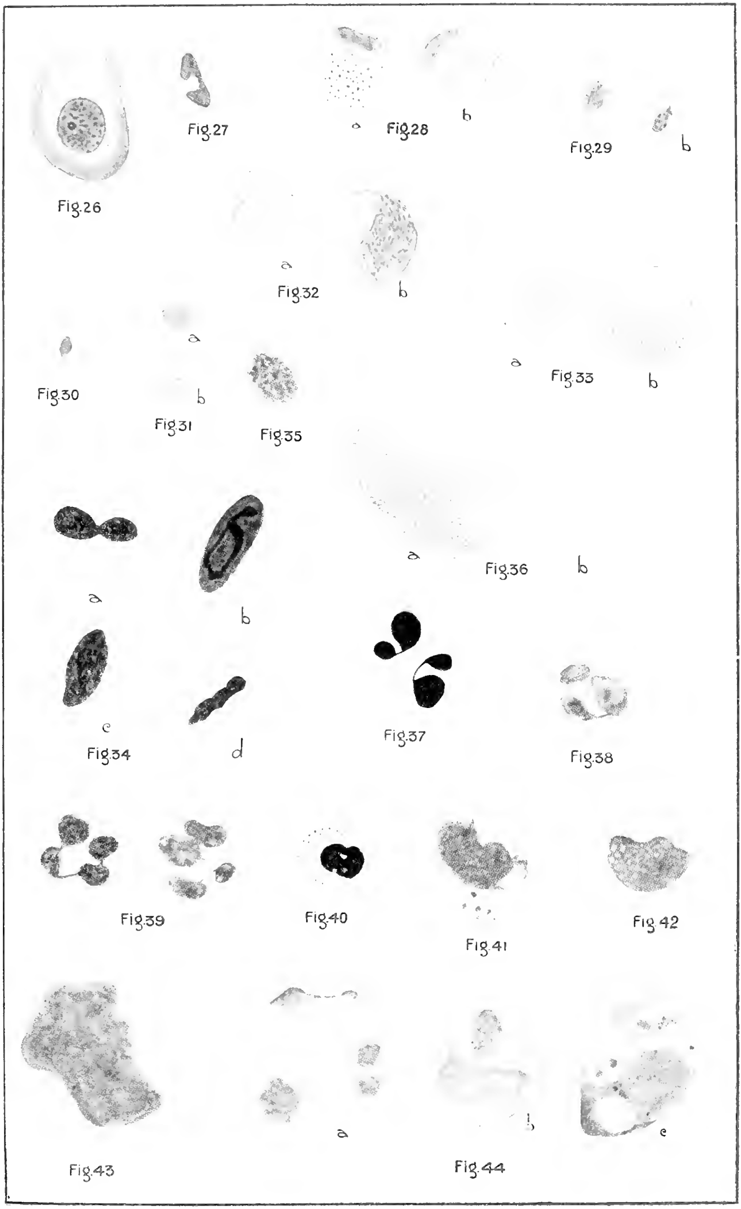
Fig.26
Fig.27
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Fig.33
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Fig.36
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Fig.34
Fig.37
Fig.38
Fig.39
Fig.40
Fig.41
Fig.42
Fig.43
a
b
c
Fig.44

The above differences in reaction to stain raises the question as to whether the polymorphs of mammalia are strictly to be compared with those of lower forms—a fact denied by Gruner, as I have stated.

(e) *Eosinophils* were few in amphibia, and frequently contained large, round granules. They were also poorly marked in reptiles, though in *Chel. longicollis* there were distinctly two kinds of granules, some cells containing large spindle structures comparable to those of birds, and about half as numerous as the ordinary form, containing round granules. Eosinophil cells were much more numerous in birds, and showed two kinds of granules in many forms. They were few in number in monotremes, and never exceeded 8 per cent. of the total number of leucocytes in marsupials.

Platelets were only apparent in mammals.

Conclusion.

There is a general decrease in size and increase in number of red cells in ascending through the various vertebrate groups.

There is a corresponding decrease in number, but increase in size of the lymphocytes. The mononuclears remain fairly constant in size, but decrease in numbers. The reptilian relationship of the monotremes is suggested by the similarity of the mononuclear corpuscles in the two groups. The polymorphs also increase in percentage counts as we rise in the scale of vertebrates. The eosinophils are only really numerous in birds and the higher reptiles (e.g., *Chel. longicollis*), where there are also two kinds of granules —a round and a crystalloid variety—possibly pointing to an avian relationship. The absence of those cells as well as that of mast cells in the fish points to their being a specialised nature. There is a slight decrease in the size of the eosinophils in passing through the various groups, but it remains fairly constant. The variations in reaction to staining of different classes of cells in the various groups raises the question as to the homology of the several types of leucocyte in vertebrate animals.

EXPLANATION OF FIGURES.

Figs. 1-6.—Porcupine Fish. Drawn with camera lucida. 1, Mononuclear cell, stained with Giemsa. 2 and 3, Red Corpuscles, stained with Giemsa. 4 and 5, Lymphocytes, stained with Jenner. 6, Polymorphonucleate cell, stained with Giemsa.

Figs. 7-12.—Young *Hyla Aurea*, stained with Giemsa. 7, Degenerating form. 8, (a and b), Mononuclear. 9, (a and b), Cells with irregular nuclei. 10, (a and b), Polymorphonucleate cell. 11, (a and b), Eosinophil cells. 12, (a, b and c), Basophil reds.

Figs. 13 and 14.—Adult *Hyla Aurea*, stained with Giemsa. 13, Mast cell. 14, Lymphocyte dividing.

Figs. 15-17.—*Lymnodynastes dorsalis*. 15, Spindle cell, stained with Giemsa. 16, Eosinophil cell, stained with Jenner. 17, Eosinophil cell, stained with Giemsa.

Figs. 18-21.—*Tiliqua scincoides*. 18, a-f, Stages in apparent distortion of red corpuscles; g, normal red corpuscle; h-o, Spindle cells. 19, a-e, Eosinophil cells, stained with Giemsa. 20, Basophil red cells, stained with Giemsa. 21, Vacuolated mononuclear cells, stained with Jenner and Giemsa.

Figs. 22 and 23.—*Trachydosaurus rugosus*, stained with Giemsa. 22, Polychromatic red cell dividing and normal red cell. 23, Mast cell.

Figs. 24-28.—*Trachydosaurus rugosus*, stained with Jenner. 24, Lymphocytes. 25, Basophil and polychromatic reds. 26, Mononuclear. 27, Polymorphonucleate. 28, (a and b), Eosinophils.

Figs. 29-33.—*Gramatophora barbata*. 29, (a), Polychromatic, (b) normal red cells, stained with Giemsa. 30, Spindle cell. 31, Lymphocytes, stained with Giemsa. 32, (a and b), Mononuclears, stained with Jenner. 33, (a and b), Eosinophils, stained with Jenner.

Fig. 34.—Spoonbill, stained with Giemsa (?) a, b, c, Basophil red cells, showing chromatin in nuclei. A normal red cell.

Figs. 35 and 36.—Ibis, stained with Giemsa. 35, Lymphocyte. 36, (a and b), Eosinophils.

Fig. 37.—*Grallina picata* (young Mudlark). Polymorphonuclear, stained with Jenner.

Figs. 38 and 39.—*Echidna histrix*. Polymorphonuclears, stained with Giemsa.

Figs. 40-42.—*Trichosurus vulpecula*, stained with Giemsa. 40, Eosinoblast. 41, Macrophage, with platelet-like bodies. 42, Vacuolated mononuclear.

Fig. 43.—*Phascolmys wombat*. Finely granular eosinophil.

Fig. 44.—*Ornithorhynchus anatinus*. Macrophages, stained with Jenner.

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Art. XIII.—*Phosphate Fertilisers.*

By BRENDA SUTHERLAND, B.Sc.

[Read 9th September, 1915].

The most important artificial manures used in Australia are those supplying phosphorus. Potassium and nitrogen applications are of occasional value only, but even small quantities of superphosphate may double or treble the yield. Experiments have shown superphosphate to be more effective than either bone dust or basic slag, but it remains to be seen if superphosphate is the best obtainable fertiliser. It, of course, precipitates as normal calcium phosphate in the presence of soil lime, and always tends to sour the soil. A neutral fertiliser in which this precipitation did not occur might be less deleterious and more effective, because more readily available.

Metaphosphates and pyrophosphates were the most obvious compounds to try, as the results obtained from them by previous investigators seemed indecisive. Eggertz and Nilson (Bied. Cent., 1893) gives potassium metaphosphate as being two per cent. less effective than potassium dihydrogen phosphate. Nilson (Bied. Cent., 1894) gives potassium metaphosphate and potassium orthophosphate as equally effective, and Märcker (Bied. Cent., 1895) records that potassium metaphosphate gave good results with barley. The original papers were not available, but, judging from the abstracts, the authors do not state which polymer of potassium metaphosphate was used. There are six polymers known, and among them trimetaphosphate (which is difficult to obtain and therefore not likely to have been used), is sharply marked off by the solubility of all its salts. So while all the other metaphosphates would, by double decomposition with the calcium carbonate of the soil, produce insoluble calcium salts, calcium trimetaphosphate would remain in solution, and so be immediately available.

Field experiments were therefore run, in which sodium orthophosphate, sodium pyrophosphate, and sodium trimetaphosphate were compared with one another, and with ordinary superphosphate. For the management of the plots I have to thank Mr. Whelan, Field Officer, and Mr. Adcock, Principal of the Rutherglen Viticultural College. They were arranged in four sets, planted respectively with early and late wheat, and early and late oats. Each set contained nine plots, of which four were check plots, not fertilised at all, and the remaining five were dressed with different phosphates, as shown in the accompanying table. The application was in each case such that the phosphorus pentoxide applied would be equal to a dressing of good superphosphate at 100 pounds to the acre. The fertiliser was sowed with the seed, except in one case, in which it was applied as a top dressing in the spring.

The area of each plot was 106 links by 5 links, and of this three links at either end was discarded on harvesting, so that the area on which results were based was 100 links by 5 links (=1-200th acre). The results are given as total produce per acre, cut when ripe enough for grain. The increase by manuring is reckoned as the difference between plot considered and adjacent check plot. (In the case of superphosphate take the average of the check plots on either side.)

Fertiliser	Federation Wheat (early ripening)		College Eclipse Wheat (later ripening)		Brown Oats (very early ripening)		Algerian Oats (later ripening)	
	Acre Yield.	Increase.	Acre Yield.	Increase.	Acre Yield	Increase.	Acre Yield.	Increase.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Nil	412		725		575		575	
Metaphosphate (applied with seed)	578	166	981	256	1075	500	875	300
Metaphosphate (top dressed in Spring)	459	53	778	66	662	37	700	125
Nil	406		712		625		575	
Pyrophosphate (applied with seed)	543	137	803	91	800	175	800	225
Orthophosphate (applied with seed)	600	157	862	150	825	250	787	262
Nil	443		712		575		525	
Superphosphate (applied with seed)	631	154	946	228	812	212	862	262
Nil	512		725		625		675	

The four main points to be noted in the tabulated figures are :—

(1) Metaphosphate gives in all cases a better crop than superphosphate, but with some plots the difference is negligible.

(2) Pyrophosphate is in every case less satisfactory than superphosphate.

(3) Metaphosphate applied as a top dressing in spring does very little good. Apparently the value lies in the initial start to the very young plant.

(4) In the case of brown oats, which grow rapidly, the advantage of using metaphosphate is very marked. This suggests that further experiments might be tried to find its value with rapidly growing crops, vegetables, etc.

We unfortunately lost the opportunity of determining yield of grain as distinct from total produce. The plants were damaged by a tornado to an extent which made threshing impossible. This point, and the question as to whether composition and quality of the grain is altered by the use of metaphosphate, are still unapproached.

In conclusion I desire to express my thanks to Dr. Heber Green, in whose department I worked, for continued advice and assistance.

[Proc. Roy. Soc. Victoria 28 (N.S.), Part II., 1916.]

Art. XIV.—*On the Generic Position of "Asterolepis ornata, var. australis," McCoy: with Description of a New Variety.*

By FREDERICK CHAPMAN, A.L.S., &c.
(Palaeontologist to the National Museum, Melbourne.)

(With Plates XX. and XXI.).

[Read October 14th, 1915].

Introductory Note.

The holotype of the above species and another specimen, practically a surface impression, were the only known examples when McCoy published his description in 1876.[1] Since then W. H. Ferguson, of the Geological Survey of Victoria, discovered a cranial shield at the same locality, Buchan, in Gippsland. This latter specimen I showed to Mr. D. M. S. Watson during his visit to Melbourne with the British Association last year, and he concurred with me in the view that the fish showed coccostean affinities. Comparison has also been made with some good examples in the National Museum of the Canadian species of *Phlyctaenaspis*, the genus to which I refer this Devonian fish.

Original Description.—The following is McCoy's description of the holotype. "Plates of body covered with close stellated tuberculations; tubercles rounded, sub-equal, smooth, each with about 12 short radiating ridges nearly equally spaced round its base, irregularly placed, averaging less than their diameter apart, rarely arranged more closely in lines, and rarely anastomosing into short vermicular ridges. Average number of tubercles, 5 in 3 lines. Interstices between the tubercles, granulo-punctate. Thickness of plates about 2 lines."

Neither the presence or disposition of sutures and sensory canals were mentioned by McCoy, although traces of the latter are well marked in the holotype and accompanying specimen. The feature of the stellate tubercular ornament of the dermal armour seems alone to have been relied upon for determinative purposes. This form of ornament of the dermal shield is, however, found both in the *Asterolepidae* and the *Coccosteidae;* hence the discovery of a more perfect specimen from Buchan showing the coccostean

1 Prod. Pal. Victoria, dec. iv., p. 19, pl. xxxv., figs. 7, 7*a*, 7*b*. [Figure reversed].

arrangement of the elements of the cranidial shield necessitates the removal of this interesting Australian Devonian type of fish to the latter family.

Generic and Specific Relationships.—The Australian specimens agree with *Phlyctaenaspis* (Traquair, 1890) rather than with *Coccosteus*, in the more ovate form of the cranial shield, and in the fusion of the separate elements with the exception of the ethmoidal. Traquair has shown[1] that the notch in the external angle of the cranial shield in *Phlyctaenaspis* was occupied by a small plate, which he terms the angular, and which is absent in *Coccosteus;* the remains of this plate are seen on the left side of the Buchan specimen of the variety *confertituberculata*, here described.

The Victorian specimens agree more closely with the Canadian species *Phlyctaenaspis acadica*, Whiteaves sp., than with the English, *P. anglica*, Traquair, in having the tuberculation somewhat regularly arranged in concentric lines parallel to the margin of the plates.

Additional Description of Phlyctaenaspis australis, McCoy sp.

The figured specimen (loc. cit., pl. XXXV., fig. 7) of McCoy shows definite sensory canals, and under a lens the sutures can be partly deciphered. The latter present some difficulty as they are closely fused. The disposition of these lines shows that the specimen consists of nearly two-thirds of the cranial shield in the anterior portion, the fracture of the posterior margin representing the anterior border of the left external occipital, the posterior of the central plates, and a part of the anterior of the median occipital; the fractured margin then cuts longitudinally through the right marginal, along the sensory canal, emerging about the middle of the plate (see pl. XX., fig. 3). The sutures and sensory canals are disposed, so far as they are visible, exactly as in *Phlyctaenaspis*.

Measurements.—The actual width of the holotype of *Phlyctaenaspis australis* is 55 mm., and the greatest length, 35.5 mm. The cranial shield, when complete, would approximately measure 55.25 mm. in length.

Description of Phlyctaenaspis australis, var. confertituberculata, nov.

In this variety the tuberculate ornament is very dense, and the tubercles smaller and more prominent. They are, moreover,

1 Ann. Mag. Nat. Hist., ser. vi., vol. xiv., 1894, p. 369, woodcut.

arranged in a sub-parallel manner along the outer margins of the shield, and in places along the sutures of the inner area, this resulting in a particularly striking and ornate appearance.

The specimens consist of the larger part of the cranial shield, only the anterior portion, comprising the orbital plates and parts of the marginal plates, being wanting. The sutures, where visible, are much the same in form and direction as in *Phlyctaenaspis acadica*, Whiteaves sp.,[1] with the exception that the sensory canals traversing the external occipital plate from its outer posterior angles extend farther into the cranial shield before meeting with that coming down from the marginals.

The tuberculation in *P. acadica*, whilst showing the same microscopic characters, is much less dense than in either the Australian species or variety.

Measurements.—The type of *P. australis*, var. *confertituberculata*, has a total length of 59.25 mm. Its approximate width, measured from the traces of the marginal plates, is about 69 mm. The width inside the marginal plates is 47 mm.

Distribution of Phlyctaenaspis.

In his paper descriptive of *Phlyctaenaspis*, Dr. Traquair records[2] two species of the genus, viz.—

P. acadica, Whiteaves sp., from the Lower Devonian of Canada; and *P. anglica*, Traquair, from the Cornstones (Lower Old Red Sandstone) of Herefordshire.

Dr. A. S. Woodward records[3] an undetermined species of *Phlyctaenaspis* (recorded as *Coccosteus* by Alth) from the Lower Devonian of Russian Poland.

To this we now add *P. australis*, McCoy, and the variety *confertituberculata*, nov., from the Middle Devonian of Buchan, Gippsland, Victoria.

From the above data we may infer that this genus made its appearance in the Australian region at a later stage of the Devonian than in Canada and England.

1 *Coccosteus acadicus*. Canadian Naturalist (n.s.), vol. x., 1881, p. 94, woodcut. Whiteaves. Trans. R. Soc. Canada, vol. vi., sect. iv., p. 95, woodcut, fig. 2, pl. ix. *Phlyctaenaspis acadica*, Whiteaves sp., Traquair, Geol. Mag., vol. vii., 1890, p. 55, pl. iii., figs. 1, 2. Idem, Annals Mag. Nat. Hist., ser. vi., vol. xiv., 1894, p. 369 and woodcut.

2 Geol. Mag., vol. vii., 1890, p. 60.

3 Cat. Foss. Fishes, Brit. Mus., pt. ii., 1891, p. 299.

Structure and Condition of the Rock in which Phlyctaenaspis australis was embedded.

The holotype described by McCoy, and the accompanying specimen, was found in a pale chocolate-coloured, fine-grained mudstone. The only other organic remains to be seen in these hand specimens are fragments and impressions of the common Middle Devonian *Spirifer*, *S. yassensis* (=*S. laevicostata*, McCoy, non Valenciennes).

The variety, *confertituberculata*, occurs on a weathered surface of hard, nearly black bituminous limestone full of the remains of *Spirifer yassensis;* a low power shows the matrix to contain numbers of small ostracoda, probably belonging to the genus *Primitia*.

Ostracoda seem to have formed part of the food supply of these early palaeozoic fishes, and it is interesting to notice in this respect that the rock in which the National Museum specimens of *Phlyctaenaspis acadica* are found, literally swarms with several genera of ostracoda, including *?Kloedenella* and *?Leperditia*.

Phlyctaenaspis was evidently more at home in the muddy Devonian sea with its accompanying crustacean and brachiopod life than in the clearer waters where the coral fauna existed.

EXPLANATION OF PLATES.

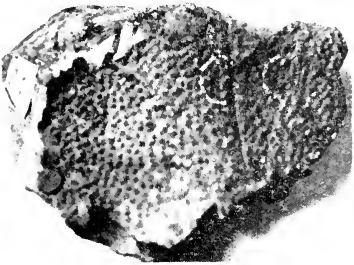
Plate XX.

Fig. 1.—*Phlyctaenaspis australis*, McCoy sp. Holotype of "*Asterolepis ornata*, var. *australis*," McCoy. Middle Devonian. Buchan, Gippsland, Victoria. Cir. nat. size.

Fig. 2.—*Phlyctaenaspis australis*, McCoy sp. Specimen showing a natural impression of the tuberculated plates of the cranial shield. Middle Devonian. Buchan, Gippsland. Cir. nat. size.

Fig. 3.—Diagram of plates of cranial shield of *Phlyctaenaspis anglica*, Traquair; with outline of holotype of *P. australis* (shaded) to show relative area.

Fig. 4.—*Phlyctaenaspis australis*, McCoy, var. *confertituberculata*, var. nov. An almost complete cranial shield. Middle Devonian. Buchan, Gippsland. Cir. nat. size.



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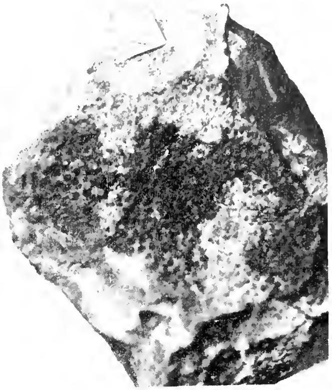

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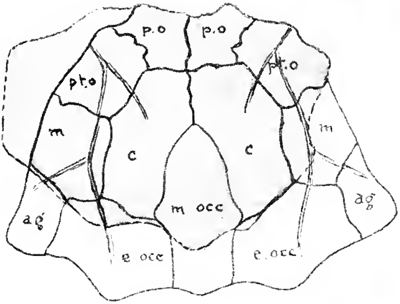

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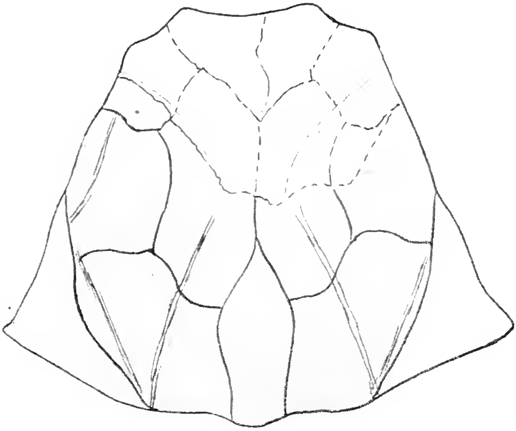
F.C., del. et photo.

Phlyctænaspis.—Devonian : Victoria.



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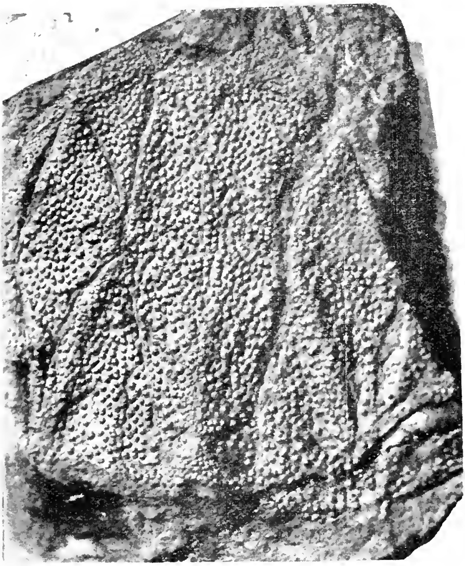

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F.C., del. et photo.

Phlyctænaspis.—Devonian: Victoria and Canada.

PLATE XXI.

Fig. 5.—Restored diagrammatic outline of sutures and sensory canals in *Phlyctaenaspis australis*, var. *confertituberculata*, based on the described specimen.

Fig. 6.—*Phlyctaenaspis acadica*, Whiteaves sp. Cranial shield; for comparison with Australian examples. Lower Devonian. Campbelltown, Canada. Specimen in the National Museum coll. Cir. nat. size.

[Proc. Roy. Soc. Victoria 28 (N.S.), Part II., 1916].

Art. XV.—*Contributions to the Flora of Australia, No. 23.*

BY

ALFRED J. EWART, D.Sc., Ph.D.

(Government Botanist of Victoria and Professor of Botany and Plant Physiology in the University of Melbourne).

(With Plate XXII.).

[Read October 14th, 1915].

Amaranthus albus, L. "Tumble Weed or White Amaranth." (Amarantaceae).

Ballarat, Victoria, H. B. Williamson, 1915.

A new locality for this naturalized alien, which has hitherto not been plentiful in this State.

Andropogon erianthoides, F. v. M. (Gramineae).

This grass, a native of Queensland and New South Wales, was recorded in the Victorian Naturalist, Vol. XXIV., page 12, 1907, from Victoria on the basis of specimens from Shepparton, December, 1900. These were from the Herbarium of Mr. C. Walter. Mr. E. Pescott informs me that he grew the grass in his garden at Shepparton during the years 1900-1904, and forwarded many specimens of it to Mr. C. Walter, who apparently in his locality record omitted the word "*Cultivated.*" As the grass seems to have died out since at Shepparton, its name cannot even be retained on the list of naturalized aliens for the State.

Artemisia vulgaris, L. "Mugwort." (Compositae).

Near Williamstown, J. J. Palmer, March, 1915.

A native of Europe, previously only recorded from Coode Island, Victoria.

Caladenia Cairnsiana, F. v. M. (Orchidaceae).

Lowden, Preston River, West Australia, Max Koch, September, 1910.

1. No. 22 in Proc. Roy. Soc. Victoria, vol. xxvii. (n.s.), p. 297, 1914.

The figure here given is a drawing of the original specimen, which Tate described in the Trans. and Proc. of the Roy. Soc. of South Australia, IX. (1887), 60, as a new species under the name, *Caladenia cardiochila*, showing the natural colours. The anterior perianth lobes are possibly a trifle broader than the type C. Cairnsiana, but the plant can hardly be distinguished even as a variety. In the Index Kewensis Suppl. primum, C. cardiochila is given as a synonym to C. Cairnsiana (Pl. XXII). The curious specimen shown on Plate XXII. was found by Mr. C. French at Ringwood, Oct., 1913. It has an imperfect lower flower, which is male, and has only two perianth parts, anterior and posterior, and a simple column, with a terminal pair of anther lobes. The labelium is entirely absent.

CHILIANTHUS DYSOPHYLLUS, Bentham. "Dense-leaved Chilianthus." (Loganiaceae).

Cheltenham, J. W. Audas, 7/9/1915.

A native of South Africa, and is a garden escape.

CRATAEGUS OXYACANTHA, L. "Common Hawthorn." (Rosaceae).

Berwick to Narre Warren, J. W. Audas, October, 1914.

This common hedge plant, a native of Europe, is now spreading in the above district, but apparently it has not yet established itself sufficiently to be considered naturalized.

CUSCUTA RACEMOSA, Mart. "Scented Dodder." (Convolvulaceae).

Sale, Victoria, Mr. T. Brittlebank, April, 1914.

This parasite, a native of Brazil, has now made its appearance in the Sale District, and may possibly occur in other localities, but has been confused with ordinary Dodder. It can be recognized by the long stalks of the flowers, and by having a sweet scent, especially noticeable at night time. At present it is hardly sufficiently established to be considered naturalized.

ECHIUM VIOLACEUM, L. "Paterson's Curse or Purple Bugloss." (Boraginaceae).

Cobram, Victoria, Rupert R. Chomley, Oct., 1915.

A specimen with white flowers.

ERIOCHLOA PUNCTATA, Hamilt. (Gramineae).

Near Echuca, per T. Purves, 14/11/1914.

Baron von Mueller gives one species, E. polystachya, as Victorian. In the Herbarium there was only one specimen from a Victorian locality, from Herbarium C. Walter, which proved to be wrongly named. Baron von Mueller, in his first Census of Australian Plants, and Bentham, in his Flora Australiensis, give two Australian species, Eriochloa punctata and E. annulata, the latter differing in size, hairiness, and in its rather more pointed spikelets. It is possible that both E. punctata and E. annulata may be varieties of E. polystachya.

FREESIA REFRACTA, Klatt. (Irideae).

East Camberwell and Canterbury, C. French, jnr., 1915.

The plant is spreading as a garden escape along the railway at East Camberwell and Canterbury. The spread of this handsome decorative plant is to be welcomed in the localities mentioned. It has no injurious properties, and may in years to come become definitely naturalized here and in other localities.

OLEARIA, EXUL, Lindl. (Compositae).

Recorded from the Victorian Alps, in Vict. Naturalist, Vol. 27, 1910, page 113, should be *Olearia Frostii*, F.v.M.

LEPIDIUM OXYTRICHUM, Sprague = L. PAPILLOSUM, F. v. M. (Cruciferae).

Sprague (Kew Bulletin No. 3, p. 123, 1915) raises this name as denoting a plant having a different clothing of hairs and a triangular sinus instead of a straight-sided sinus at the apex of the silicule. In the original description of *L. papillosum* (Linnaea, Vol. XXV., 370, 1852), the sinus is given merely as being narrow. In the Crystal Brook specimen the sinus varies from straight-sided to triangular, and the same is shown on many others.

Mueller attached too much importance to the "papillose hairs." Oldfield's Murchison River specimen, which was examined by Bentham, has the slender linear subulate hairs of "*L. oxytrichum*"; other specimens show hairs of intermediate character, and in the variety *intermedium* described by Reader, the plant has a tendency to a perennial habit, and the papillose hairs are very small or reduced to mere points. Hence too much importance should not be attached to a character derived from hairs.

LOMANDRA, Labill (1804); XEROTES, R. Br. (1810). (Liliaceae).

In Bentham's Flora Australiensis, Vol. VII., p. 94, the name of this Genus occurs as Xerotes, Banks. This must be an error, as no publication by Banks on Xerotes can be found. The first use of the term Xerotes for a genus of plants is made by Robert Brown in Prodromus, 1810, but the genus had been previously described by La Billardiere in Pl. Nov. Holl., I., p. 92, 1804, under the name Lomandra, with full descriptions and admirable plates of certain species. The Index Kewensis and Bentham in his Flora Australiensis adopt Xerotes, but Engler's Pflanzen Familien and Britten, in Bot. Cook's Voy., correctly adopt Lomandra.

The Genus as given in Mueller's Census of Australian Plants must therefore be altered as follows:—

LOMANDRA, Labill, in Pl. Nov. Holl., Vol. 1, p. 92, 1804. (XEROTES, R. Br., 1810).

- L. Banksii (R. Br. Prod. 263, 1810), Q.
- L. dura (F.v.M. in Trans. Vict. Inst. 42, 1854), S.A., V., N.S.W.
- L. longifolia, Labill. Pl. Nov. Holl., 92, t. 119, 1804, S.A., T., V., N.S.W., Q., W.A.
- L. rigida, Labill. Pl. Nov. Holl., 93, t. 120, 1804, W.A.
- L. Drummondii (F.v.M. in Benth. Fl. Aust. VII., 99, 1878), W.A.
- L. Sonderi (F.v.M. in Fragm. VIII., 206, 1874), W.A.
- L. odora (Endl. in Lehm., Pl. Preiss., II., p. 50, 1846), W.A.
- L. multiflora, J. Britt. in Bot. Cook's Voy. 95, 1905 (Xerotes Brownii, F.v.M.), S.A., V., N.S.W., Q., W.A.
- L. Ordii (F.v.M. in Fragm. XI., 23, 1878), W.A.
- L. sororia (F.v.M. Sec. Gen. Rep. 15, 1854), S.A., V., N.S.W., Q.
- L. Endlicheri (F.v.M. in Fragm., Vol. VIII., p. 205, 1874), W.A.
- L. sericea (Endl. in Lehm., Pl. Preiss., Vol. II., 51, 1846), W.A.
- L. purpurea (Endl. in Lehm., Pl. Preiss., II., 49, 1846), W.A.
- L. Preissii (Endl. in Lehm., Pl. Preiss., II., 50, 1846), W.A.
- L. effusa (Lindl. in Mitch., Three Exped., II., 101, 1838), W.A., S.A., V., N.S.W., Q.
- L. micrantha (Endl. in Lehm., Pl. Preiss., II., 49, 1846), W.A., S.A., V., N.S.W.

L. filiformis, J. Britt. in Bot. Cook's Voy., 95, 1905 (Xerotes Thunbergii, F.v.M.), S.A., V., N.S.W., Q.

L. caespitosa (Benth. in Fl. Aust., Vol. VII., p. 104, 1878), W.A.

L. pauciflora (R. Br. in Prod., p. 261, 1810), W.A.

L. flexifolia (R. Br. in Prod., p. 260, 1810), N.S.W.

L. glauca (R. Br. in Prod., p. 260, 1810), W.A., S.A., V., N.S.W., Q.

L. elongata (Benth. in Fl. Aust., VII., 106, 1878), S.A., N.S.W., Q.

L. rupestris (Endl. in Lehm., Pl. Preiss., II., 50, 1846), W.A.

L. collina (R. Br. in Prod., 260, 1810), W.A.

L. suaveolens (Endl. in Lehm., Pl. Preiss., II., 50, 1846), W.A.

L. turbinata (Endl. in Lehm., Pl. Preiss., II., 51, 1846), W.A.

L. spartea (Endl. in Lehm., Pl. Preiss., II., 51, 1846), W.A.

L. juncea (F.v.M. in Trans. Vict. Inst., 135, 1855), S.A., V.

L. leucocephala (R. Br. in Prod., 260, 1810), W.A., S.A., V., N.S.W., Q.

L. hastilis (R. Br. Prod., 263, 1810), W.A.

In addition F. von Mueller, under *Xerotes*, included in his Census three species, which were included under *Chamaexeros* and *Acanthocarpus* by Bentham in his Flora Australiensis, Vol. VII. These two Genera are distinguished from *Lomandra* (*Xerotes*) by the hermaphrodite flowers, single long style and small stigma, but cannot be satisfactorily distinguished generically from each other. As *Acanthocarpus* is the older name the three species should read as follows:—

Acanthocarpus, Lehm. Pl. Preiss, II., 274, 1847. (Chamaexeros, Benth., 1878).

A. Preissii, Lehm. in Pl. Preiss., II., 274, 1847 (Xerotes echinata, A. Cunn.), W.A.

A. Serra (Endl. in Lehm., Pl. Preiss., II., p. 49, 1846), W.A.

A. fimbriatus (F.v.M. in Fragm., VIII., p. 211, 1874), W.A.

Martynia proboscidea, Glox. (Pedalineae).

Narramine, N.S. Wales, per J. Harris, July, 1915.

This plant is a native of North America, sometimes grown in gardens, and stated to be growing wild on a sheep run at Narramine. Its large hooked fruits catch the hoofs of sheep, cattle or horses, or fix themselves in the hairs or fleeces. The incurved points of the fruit may even in time bore into the flesh, if not removed.

MESEMBRYANTHEMUM LAXUM, Haw. "Loose-flowered Pig's-face." (Ficoideae).

Cheltenham, J. R. Tovey, September, 1915.

This hardy evergreen trailer, a native of South Africa, may be classed as an exotic not yet sufficiently established to be considered naturalized.

MYAGRUM PERFOLIATUM, L. "Musk Weed." (Cruciferae).

Dimboola, St. Eloy D'Alton, 15/10/15.

This weed, whose presence in wheat crops seriously interferes with harvesting, and which was recently proclaimed for the whole State, is rapidly overrunning the Shire of Dimboola.

PINUS INSIGNIS, Doug. "Monterey Pine." (Coniferae).

Cheltenham and Mentone Districts, J. R. Tovey, September, 1915.

New localities for this tree. It having previously been recorded from the Beaconsfield and Emerald Districts, as evidently establishing itself as a naturalized alien.

POLYPODIUM PUSTULATUM, G. Forst. (Filices).

Tidal Creek, Wilson's Promontory, A. J. Ewart, 28/12/1913.

Recorded in the Vict. Nat., Vol. XXV., p. 147, 1909, as Polypodium Billardieri, Willd.

POLYPODIUM PUSTUTATUM, G. Forst. (Filices).

Upper Tidal Creek, Wilson's Promontory, F. G. A. Barnard, December, 1914.

Recorded in the Vict. Nat., Vol. XXXI., p. 152 (1915), provisionally as Polypodium scandens, Forst.

POLYPODIUM BILLARDIERI, R. Br. (Filices).

Doughboy Island, Wilson's Promontory, J. W. Audas, December, 1912.

Recorded in the Vict. Nat., Vol. XXIX., p. 177 (1913), as Polypodium pustulatum, G. Forst.

The synonymy of these two ferns has been extremely confused. P. pustulatum has thinner fronds and narrower leaf segments. P. Billardieri has more coriaceous fronds and broader leaf lobes. Both may have entire or compound fronds. In Baron von Mueller's Census P. pustulatum and P. scandens are given. The former is, however, a synonym to P. Billardieri, and P. scandens is a synonym to the true P. pustulatum. In the National Park (Wilson's Promontory) records, the Census was followed, and hence the above correction is necessary.

Senecio Behrianus, Sond. and F. v. M. "Stiff Senecio." (Compositae).

Gannawarra, near Koondrook, Victoria, H. B. Williamson (1915).

This species appears to be rather rare, it being represented in the National Herbarium previously only from two localities, namely, Murray River, Victoria, F. v. Mueller, and Darling River, N.S. Wales, Dallachy.

Sisymbrium Irio, L. "London Rocket." (Cruciferae).

Near Anderson Street Bridge, Melbourne, W. R. A. Baker, 11/10/15.

This introduced weed is a native of South Europe to the Caucasus, and grows in a few localities in Great Britain, where it was probably introduced from Europe. The name is derived from the fact that it sprang up in great abundance on the ruins after the great fire of London.

Trifolium pilulare, Boiss. "Syrian Trefoil." (Leguminosae).

Gunbower, Victoria, E. W Curtis, October, 1914.

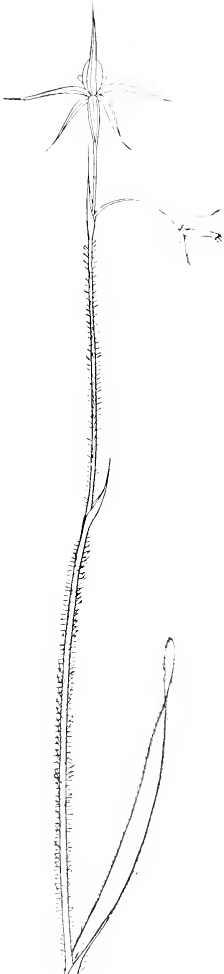
A native of Asia Minor and Syria. An exotic not yet sufficiently established to be considered naturalized. It is too hairy to be of much use as a pasture plant.

Xanthorrhoea hastilis, R. Br. "Spear Grass Tree." (Liliaceae).

In Mueller's Second Systematic Census of Australian Plants, this species is given from Victoria. There is a specimen in the National Herbarium given as from New South Wales, near the Victorian border, but as there were no specimens from any Victorian locality some doubt existed as to its being a native of Victoria. Specimens have, however, been received from Croajingolong (Oct., 1915), which belong to this species, and have the usual paler-yellow coloured resin, instead of the darker and reddish resin of *X. australis*. The resin of the grass tree yields as much as 20-30, or even more, per cent. of picric acid when treated with nitric acid, and seems likely to prove an important source of high explosives. The resin of *X. hastilis*, though less valuable as a varnish than that of *X. australis*, yields more picric acid, and hence it is of importance to find the plant growing in Victoria. Many other cases are known of typical N.S. Wales plants, which extend into Victoria down the East coast, where the neighbourhood of the sea makes the conditions more equable for plants of warmer regions.

DESCRIPTION OF PLATE XXII.

Caladenia Cairnsiana, F.v.M. Plant with abnormal flower, and figure in natural colours.



Caladenia cairnsiana

[Proc. Roy. Soc. Victoria 28 (N.S.), Part II., 1916].

Art. XVI.—*Additional Notes on Australites: Darwin Glass.*

By E. J. DUNN, F.G.S.

[With Plate XXIII.].

(Read November 11th, 1915).

Since my notes dated 4/7/13, and published in Records of the Geological Survey of Victoria, Vol. III., Part 3, were penned, further examples of Australites have come to hand that demand attention as affording valuable evidence of the manner in which they were formed. Among those dealt with are probably the smallest yet described; their importance, however, is not to be measured by their size, for the series, as illustrated, affords useful data not hitherto obtained. Apparently they show the progressive steps by which the original drop of fluid glass became moulded into the symmetrical australite. The several examples show individuals arrested at different stages of the process. The glass of which they consist having become rigid in some cases at an early stage, in other cases at later stages. In three examples they are deformed, and appear to have reached the surface of the earth while still in a semi-plastic condition.

The smaller figures in the illustration are natural size. The larger figures are the same objects magnified two diameters.

Fig. 1 shows an early stage, the drop of glass has assumed a discoidal form, there is a short line in the centre of the upper surface, and the outer edge of the rim is turned slightly up. There must have been a stage preceding this in which the molten glass was drop like. In Fig. 1 the thin short line is the only indication of a core. It seems as though a rotary impulse had been imparted to the drop of molten glass, and that the small body through loss of heat became rigid at this stage, and fell to the surface of the earth.

Fig. 2 shows an advance on Fig. 1, for a small conical pit has formed in the centre of the upper surface, but there is still no actual core present. This example may have rotated longer while still in a molten or plastic condition than was the case with Fig. 1. The rim has become more defined also.

Fig. 3 shows an advance on Fig. 2, and a small core appears in the centre, where only a pit existed in Fig. 2. This example may have rotated still more than was the case with Fig. 2 before the glass became rigid.

Fig. 4 shows still further development; the core became enlarged, and the rim became more strongly developed before the glass lost its viscosity.

Fig. 5. This example has been broken across, but enough remains to show the core much enlarged, and the rim to have become much more like that of normal australites, while the proportions of the rim to the core approximate more nearly to these found in normal australites. There is one feature, however, in this example which differentiates it from the usual forms, and that is its thickness, which is only $1\frac{1}{2}$ millimetre, and quite out of proportion to its diameter (15 millimetres) as compared with normal types. Although so thin that the glass is nearly transparent, there are the usual rudely spiral ridges on the underside. Comparison of the above forms with normal types of australites leaves no doubt as to both being formed in the same way, though in the case of those now dealt with conditions seem to have prevailed which caused some modification in their forms, for they are exceptionally thin as compared with their diameter. All the above examples evidently reached the surface in a rigid condition, though in different stages of development. Possibly this may have resulted from the varying distances above the surface at which their careers began. Rapid rotation would be necessary to produce such forms before rigidity set in.

Fig. 6 shows a deformed example. It was apparently in an early stage of development (between Figs. 1 and 2) when it reached the surface in a semi-plastic condition, with the result that impact with the soil or some hard object caused an interference with its symmetrical form, and distorted it as shown in the plate.

Fig. 7 shows a symmetrical ovoid form, with a centre or core less regular. It belongs to one of the aberrant types such as occur in the larger australites. It is quite symmetrical at its periphery, and evidently has not had its shape interfered with by impact with another body, but may have resulted from rotary action.

Fig. 8 is remarkable as being cup-shaped, and is the only example the writer has seen approaching this form. In its present state the cup has been flattened. This also appears to be an example that reached the surface while still in a semi-plastic condition, with the result that it collapsed on its side when it came in contact with the ground.

Fig. 9 is the smallest of the series, weighing only .2044 gram. It is deformed like Fig. 6 and apparently reached the earth in an early stage of formation and while still semi-plastic.

Fig. 10 is an example of Pele's Tears, cigar-shaped, and consisting of very scoriaceous grey pumice with a smooth skin on the surface, but so friable as to readily crush between the finger and thumb.

Fig. 11 is a dumb-bell shaped Pele's Tear similar to Fig. 10 in material. These examples of Pele's Tears are for comparison with some of the forms of australites. They are of volcanic origin, being found on the flanks of Kilauea, Sandwich Islands, and were presented to me by Professor Moore, of the State College, Pennsylvania, U.S.A.

Figures 1 to 9 suggest that the small australites may owe their form to rotary action. There is no process or remains of such a process around the periphery as would favour the theory of their forming part of a bubble, and here I may say that the theory that australites were the lower portions of bubbles was suggested by the hollow sphere 2 inches across in the Melbourne National Museum, and by other hollow examples. Further, on making sections across button-shaped examples, the broken edges marked *e* in the photographic illustrations in Bulletin No. 27 of the Geological Survey of Victoria and the flow structure appeared to confirm this view. The broken edges at *e* may, however, have been accidental.

The flow structure as shown in the photographic plates in the above Bulletin seem difficult to explain if australites were formed by rotary action, and the relation of the rim to the core seems a difficulty, for the Bulletin illustrations above referred to appear to indicate that the centre or core was first formed, and then the rim, while the examples of small australites here dealt with appear to imply the reverse, or that these bodies at the beginning were disc-like, and all rim, and that a portion of the centre of the disc was absorbed to form the core, and that this core increased in size at the expense of the rim by continued rotary movement until the glass became rigid. The formation of hollow spheres by a rotary process also presents difficulties, and the presence of perfectly spherical bubbles so common in the cores of australites is also difficult to understand if the core was rapidly rotated while yet in a viscous condition.

If these small objects were moulded by rotary movements, the rotation must have been about an axis at right angles to the plane of the disc, and if so then the more abnormal types such as ovoidal, elongated and dumb-bell forms must also have resulted from rotation about the shorter axes of these bodies, and in planes corresponding to the plane of the disc.

Professor Grant,[1] Dr. Summers,[2] Professor Skeats,[3] and others have suggested that the forms of australites are due to rotary action, and these small examples certainly appear to favour this view.

Darwin and the Rev. W. B. Clarke were the first to suggest that the forms of australites were due to rotary movement.

It is for the physicist now to demonstrate by actual experiment whether molten glass by rotation would form such bodies, and also whether the flow structure so well shown in sections of australites could be produced by rotary action alone.

Experiments might result in determining how long such small bodies would remain plastic in the atmosphere, and in this way the height above the surface at which they commenced their career could be determined, also the speed of the revolutions necessary to produce these forms from molten glass before it lost its original viscosity and became rigid.

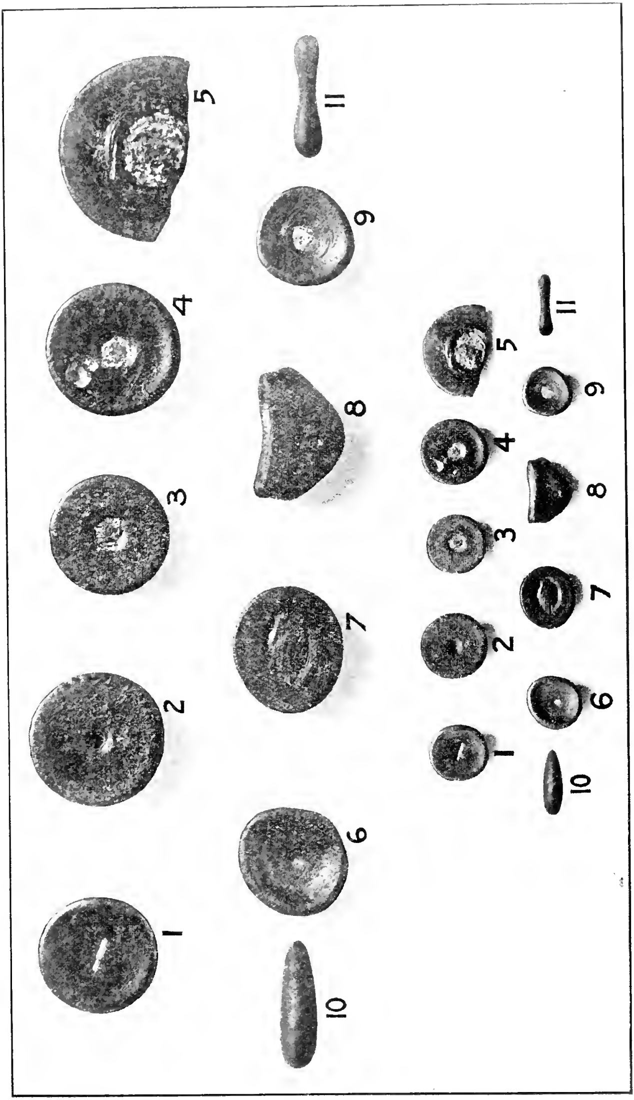
Should such experiments prove that australites owe their form to rotary movement, and that they are not the blebs of bubbles, then the problem of their distribution remains still to be solved, and in this connection it may be mentioned that in the auriferous alluvial gold working at Stony Creek, Grampians, Victoria, an irregular fragment of obsidian 2 inches long and $\frac{3}{4}$ inch broad, finely pitted on the surface and showing flow structure, was found in the wash-dirt associated with examples of australites. It is somewhat water worn and appears to have lain long in the gravel. A chip has quite recently been detached which shows its vitreous nature. The specimen belongs to Mr. Ferguson, an officer of the Geological Survey, and it is in the Geological Survey Museums, Melbourne. The same means that transported this fragment from its volcanic source could have also transported the australites found with it.

In the groove between the core and the rim of some australites there is a white substance that under the lens appears to be silica. Dr. Du Toit, of the South African Geological Survey, drew my attention to fine lines that radiate from the centre of the underside of some of the button-shaped australites. This feature occurs on several examples.

List of Localities of Australites shewn on Plate.

Fig. 1.	Mt. William Goldfield,	Grampians,	Victoria.	
„ 2.	do.	do.	do.	do.
„ 3.	do.	do.	do.	do.

[1] Proc. Roy. Soc. Victoria, vol. xxi., part ii., p. 413.
[2] Australian Association for the Advancement of Science, vol. xiv., Melbourne, 1913.
[3] Proc. Roy. Soc. Victoria, vol. xxvii., part ii., p. 363.



Small Australites and Pele's Tears.

Inset natural size. Other figures magnified 2 diameters.

Fig. 4. Mt. William Goldfield, Grampians, Victoria.
,, 5. do. do. do. do.
,, 6. In auriferous lead 30 ft. below surface, Rokewood, Vic.
,, 7. Mt. William Goldfield, Grampians, Victoria.
,, 8. Lintons, near Ballarat, Victoria (on surface).
,, 9. Mt. William Goldfield, Grampians, Victoria.
,, 10. Pele's Tear, Kilauea (volcano), Sandwich Islands.
,, 11. do. do. do. do.

Darwin Glass (Tasmania).

On comparing this glass with fulgurites from Griqualand, West South Africa, there appears to be more than a cursory resemblance. The high percentage of silica, 89.813, according to Ernest Ludwig, separates it from volcanic glasses, but not from fulgurites, which in some cases have a still higher percentage of silica. The peculiar ropy structure and the highly glazed channels traversing this glass greatly resemble some forms of fulgurites such as the tubes that result where lightning traverses sand. Professor Gregory's suggestion in relation to the glassy australites owing their origin to lightning may be quite applicable to the Darwin glass. Mr. Loftus Hills, M.Sc., in the Tasmanian Geological Survey Record, No. 3, has given a very complete account of the occurrence of this glass, which he considers to be of meteoritic origin.[1]

1 Darwin Glass. Geological Survey Record, No. 3, Tasmania, 1915.

[Proc. Roy. Soc. Victoria, 28 (N.S.), Part II., 1916].

Art. XVII.—*Notes on a New Acacia from Victoria River, Northern Territory.*

By E. J. DUNN, F.G.S.

[With Plates XXIV. and XXV.].

(Read November 11th, 1915).

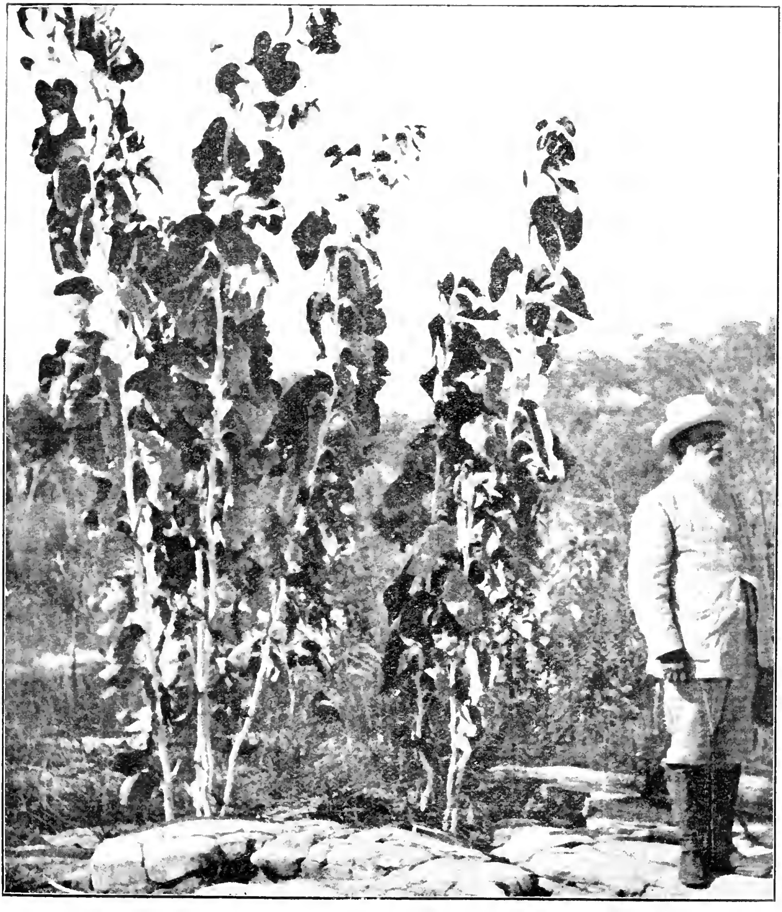
In the latter part of May, 1913, on a visit to Blunder Bay, about 10 miles up the Victoria River from its mouth, and in a gully called Gouty Gum Gully (Lat. 15° 14′ S., Long. 129° 39′ E.), about 1½ miles from the anchorage I found an acacia remarkable for its beautiful foliage. The stems, of which three or four grow out of a woody knob, are round, less than one inch thick at their base, and grow to a height of 12 or 14 feet. They are quite white. The phyllodes, commonly known as leaves, hang vertically on the stem, are leathery, strongly veined, lobe-shaped and of olive green colour, with a bloom on them that gives them a silvery sheen in the sunshine. At the top of each shoot there is a spray 12 to 18 inches long, of light yellow acacia blossom. The flowers are spherical, large and sparsely arranged. They appear in May, and the seed pods mature in June, and are probably dry in the month of July.

At the base of the stem, the phyllodes attain to 17 inches or more in length, and they gradually become smaller as they ascend the stem. It is a superb foliage plant, and ranks among the most beautiful of all the acacias.

The first plant observed was found growing in poor sandy soil, on the side of a small watercourse; but their proper habitat is on the quartzite ridges that rise to a height of about 150 feet above sea level, 1 mile S. from the anchorage. Here these plants grow without soil in intensely hard bare quartzite rock, as shown in the photograph, the roots penetrating the cracks and fissures of the rock. Very few seed pods form, only one or two were noticed on any of the sprays, and on some there was not a single pod.

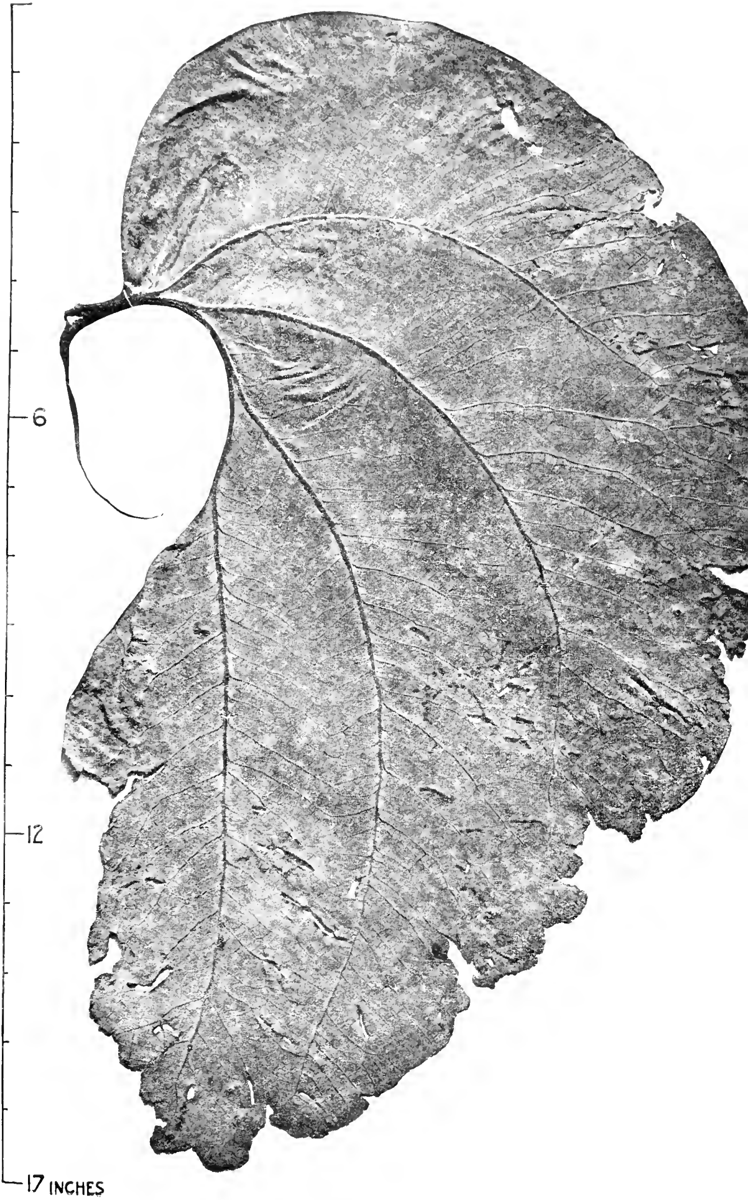
The photograph of the plant and the writer was taken by Mr. R. J. Winters, Geologist, of the Northern Territory Geological Survey, and kindly presented to me.

On my return to Melbourne, dried specimens of the phyllodes, flowers and pods were submitted to Mr. Maiden, F.L.S., Govern-



New Acacia.

Victoria River, Northern Territory.



Phyllode (leaf) of New Acacia.

Victoria River, Northern Territory.

ment Botanist, Sydney, who has determined it as a new variety, and has furnished the following botanical description :—

"Stems mealy.

Phyllodes to be separately described.

Flowers? Flower-heads in two's.

Calyx long and narrow, united irregularly about half way, more or less, distinct central nerve, thickened at the top, with hair reaching more than half way up the petals.

Petals, also narrow, united about two-thirds up; distinct central nerve; thickening at the apex, with hairs, 5-merous, very transparent.

Bracts, long and narrow, with capitate head of hairs, 5-merous."

Proc. Roy. Soc. Victoria, 28 (N.S.), Pt. II., 1916.

Art. XVIII.—*Contributions to the Flora of Australia, No. 24.*[1]

BY

ALFRED J. EWART, D.Sc.

(Government Botanist and Professor of Botany and Plant Physiology in Melbourne University),

AND

PERCY J. SHARMAN.

(With Plates XXVI., XXVII. and XXVIII.)

[Read 11th November, 1915].

Acacia Beauverdiana, n. sp.

Phyllodia rigid, erect, long linear, flattened, falcate, slightly narrowed towards base and apex, not so long as in A. coriacea, reaching some 10 cm. long and 1.5 mm. wide, thickly coriaceous, with numerous fine longitudinal nerves, finely perceptible with naked eye. Peduncles in pairs, each bearing globular heads very slightly cylindrical. Flowers, 5 merous. Calyx tubular, slightly pubescent lobes. Petals rather longer, divided about the middle, but quite glabrous. Pod not seen.

By Bentham's classification, this Acacia is very closely related to A. coriacea, from which it is separated by having much shorter phyllodes, and in the very marked difference of its corolla, which is quite glabrous in A. Beauverdiana, and very pubescent in A. coriacea (*vide* Mueller's Iconography of Australian Acacias).

Its calyx and corolla are somewhat similar to A. aciphylla, and it may possibly be an intermediate link between this species and A. coriacea.

Locality.—Coweowing, W. Australia. Max. Koch, 1904, No. 1289.

Named in honour of Gustave Beauverd, Conservator of Herbarium Boissier, Geneva, Switzerland.

1. No. 23 in the same issue of the Society's Proceedings.

CLAYTONIA PERFOLIATA, Don. "Perfoliate Claytonia." (Portulaceae).

Baulkamaugh, near Shepparton, W. H. Callister, October, 1915; Smythesdale, Mabel White, October, 1915.

It is a native of North America, naturalised as a weed in Europe, and now apparently in process of establishing itself as a naturalised alien in Victoria. It has no poisonous or injurious properties, and in pasture it will do no harm, as it is eaten by stock, and has also been used as a salad vegetable or spinach. In cultivated land or in gardens it would be troublesome, owing to its rapid powers of seeding. The plant can hardly be regarded as definitely naturalised as yet, and may not be permanently established in the Shepparton locality, as it was found by a farmer growing near a boot scraper at his kitchen door, apparently from seeds picked up on the boots when walking through the fields, but no other plants could be found growing in the open fields. They might, however, have died down after seeding, and may reappear later on.

HOMERIA COLLINA, Benth, var MINIATA, Sweet. Cape Tulip. (Irideae).

This poisonous weed, a native of S. Africa, has in the past 10 years spread at Carisbrook, until it now covers about 500 acres, a few fields containing more of it than of any other plant. The bulbils produced above and below ground make the plant very hard to suppress when once established. Thorough cultivation and leafy crops gradually suppress it. Where the ground is not broken frequent cutting is necessary. If dug out and the ground left bare, it soon reappears in greater abundance than before, owing to the small bulbils and seeds left behind in the soil.

ORTHOCARPUS PURPURASCENS, Benth. Purple Orthocarpus. (Scrophulariaceae).

Euroa, J. G. Saunderson, November, 1915.

This plant, a native of California, is injurious in pastures on account of its roots being parasitic on the roots of grasses. It is a freely seeding annual, introduced with fodder imported from N. America, but not sufficiently established to be considered naturalised. It is not poisonous, but suddenly appeared in many localities in 1915.

Species of Pterostylis.

Much confusion has existed in the determination of many of the species of this group.

Three species that are closely related are:—

1. P. revoluta, R.Br.
2. P. reflexa, R.Br.
3. P. praecox, Lindl.

I. Bentham grouped the first two in one group: P. reflexa, *vide* pp. 359. Flora Aust.—"In Brown's P. revoluta the flowers are considerably larger, and the labellum tapers towards the end; but without the long point of P. reflexa. . . . The long and short pointed labella, and large and smaller flowers, however, pass so much into one another, that I have been unable to sort the specimens into distinct varieties."

II. In his "Australian Orchids," Fitzgerald figures P. striata as a new species; but it is undoubtedly synonymous with P. praecox, Lindl.—*e.g.*, compare the plate with that of Disperis alata, Labill. Pl. Nov. Holl., ii., 59, t. 210. It agrees also with specimens in Melb. Herb., collected by Milligan, Flinders Is., and by Baron von Mueller at Wilson's Promontory.

III. There exists a larger form of P. praecox, which Bentham has placed in P. reflexa—*e.g.*, Hampden, W.A., W. Clarke. Baron von Mueller sometimes classed it as P. reflexa; but often also as P. praecox. One specially fine example of this type we have figured. It was collected in 1896 at Encounter Bay, South Australia, by Miss Hussey, and is noted in the Herbarium by the Baron as the true P. praecox.

IV. As there evidently existed a larger form of P. praecox, and since Bentham had grouped this in P. reflexa, Prof. Ewart came to the conclusion that the true type of P. praecox must essentially be placed in the one group of P. reflexa, and acting upon this classification he renamed P. praecox as P. reflexa, var. intermedia.

V. But when O. H. Sargent discovered and named P. constricta it was evidently related to this group of P. praecox. Oddly enough Bentham had evidently taken an orchid, identically similar to Sargent's as one of his type, P. reflexa—*e.g.*, No. 9. Greenough flat, Ch. Gray. If Bentham's classification be correct, then Sargent's P. constricta could only be a variety.

VI. After a very exhaustive examination of the specimens in the Melbourne Herbarium, in which the flowers were subjected to a thorough microscopic examination, we have come to the following conclusions:—

1. The column and its appendages, and the appendage on the labellum do not serve as a constant and sure guide in this group of orchids.

2. That evolution is evidently taking place in these related groups, and that so many stages in the scale are represented that it is difficult to limit the peculiarities, and to say that one type can be definitely separated from another.

3. That the arrangement of the vegetative leaves, the labella, and the characters of the petals and sepals in the galea and the claw are the surest guide to a clear distinction.

Acting on these conclusions, we have arrived at the following classification, which to us appears satisfactory.

(i.) That taking the species we have mentioned, there is one group having the *two lateral petals* of the galea *long and pointed*.

(ii.) And another group, having the *two lateral petals* of the galea *broader* and more rounded at the ends.

Thus—

Group (a) includes *P. reflexa* and *P. revoluta*.

Group (b) includes *P. praecox*, a larger form of P. praecox, mentioned above, and for which we have suggested the name P. praecox, var. robusta, and P. constricta.

Group A.—Petals and sepals of galea elongated, and ending in fine points, even when flower small.

1. *P. reflexa*, R. Br., broad labellum, terminating in a fine point, e.g., Pl. Preiss. 2203, Bentham's type.

Localities—

Victoria—

Grampians.
Upper Murray, C. French, Junr.
Bacchus Marsh, C. French, Junr.
Upper Avoca, A. Purdie, May, 1895.
Port Fairy, Rev. W. Whan, 1889.
Lower Yarra, G. Coghill, April, 1885.
Yarra, April, 1867.
Tarangower.

New South Wales—

Quildong, No. 442, W. Bauerlen.
Near Sydney, Fitzgerald.
Near Scone, N.S.W., Miss H. Carter, 1883.

South Australia—

Near Mount Lofty, A. Tepper, 1882.

2. *P. revoluta*, R. Br., long narrow, strap-like labellum.

Localities—

Victoria—

Grampians.
White Hills, Bendigo, A. Haggard, 1880.

Western Port.
Snowy River, John Cameron, 1889.
Near Nhill, Mallee, C. Walter, June, 1892.
Black Ranges, near Grampians, C. Walter, 1892.

New South Wales—

New England, C. Stuart.
Blue Mountains, E. Daintree.

Queensland—

South Queensland, Hartmann, 1875.

Group B.—Petals and sepals of galea short, the petals ending in blunt or rounded ends.

1. *P. praecox*, Lindl (P. striata, Fitz.), (P. reflexa, var. intermedia, Ewart), flower small, broad labellum.

Localities—

Victoria—

Flinders Establishments, July, 1847.
Dandenong Ranges, C. French, Senr.
Mentone, May, June, July, 1907, J. R. Tovey.
Brighton, July, 1882, C. French, Senr.
Portland, July, 1906, S. Johnson.
Queenscliff, 1908, G. Coghill.
Dimboola, July, 1897, C. Walter.
Cheltenham, April, 1809.
Kewell, July, 1908, C. French, Junr.
Albacutya, September, 1887, C. French, Senr.
Wilson's Promontory, F. Mueller.
Moyston, 1883 D. Sullivan.
County Follett, August, 1906, F. M. Reader.

South Australia—

Kangaroo Island, July, 1882, R. S. Rogers.

Tasmania—

Milligan.
Port Arthur, August, 1892, Rev. S. Bufton.

2. *P. praecox* (Lind.), var. robusta (Ewart), P. reflexa, (R. Br.). The whole habit of this plant is similar to that of P. praecox, but is larger and stouter, e.g., Encounter Bay, S.A., 1896, Miss Hussey.

Localities—

Victoria—

Loddon, McKibbin, 1882.
Dimboola, F. M. Reader, July, 1887.
Wedderburn, Fr. Colvin, May, 1880.
Little River, Fullagar.

South Australia—

Encounter Bay, Miss Hussey, 1896.

Mount Lofty Range.

Western Australia—

Vassey River, Oldfield.

Hampden, W. Clarke.

Tasmania—

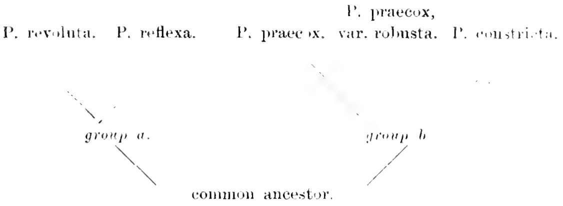
Gordon River, Miss Warburton, 1896.

3. *P. constricta.*—O. H. Sargent.

Localities—

Western Australia—

1. Cut Hill, York, No. 472, O. H. Sargent, July, 1907.
2. Cowcowing, No. 1073, M. Koch, 1904.
3. Greenough Flat, Ch. Gray, No. 9.



This diagram suggests a very interesting phylogenetic change.

Group A—Has long pointed petals and sepals in the galea, but the two species into which it divides have broad and strap-like labella indicated by the single and double lines respectively.

Group B—Has characteristic short, broad petals in the galea; and the two main species into which it is divided have broad and strap-like labella respectively.

It is quite possible in the evolution of the group that there could thus be divergence of external features of the flower, and likewise that both types of labella should be represented in the subsequent divergences

P. Toveyana, n. sp.

Leaves alternate, under 1 inch long, ovate or broadly oblong Scape 1 flowered. Petals and sepals of galea short and broad. Labellum much longer than column, broad at the base, and slightly tapering towards anterior end. Slightly but very distinctly bifid. Appendage hairs very pronounced.

Locality.—Vic., Mentone. J. R. Tovey, 1907, 1908, 1909, 1910, 1911, 1912, 1913, 1914, 1915. Mentone. A. Tadgell, July, 1909.

This orchid was first discovered by Mr. Tovey at Mentone, in June, 1907, and was growing near both P. praecox and P. concinna.

Its chief distinguishing features were that the vegetative leaves were arranged alternately along the stem as in P. praecox, while the labellum was slightly bifid; but not nearly so pronounced as in P. concinna. In examination of several fresh specimens, the labellum of P. Toveyana was found to be broader and longer than either of the two before-mentioned.

In some cases it was found that the rule was departed from. Occasionally some of the plants had the higher leaves alternately arranged as in P. praecox, and two or three basal ones as a radical rosette as in P. concinna.

This latter feature suggested hybridisation, and the orchids were exhibited in June, 1907, at the Field Naturalists' Club meeting as such. However, it was suggested that Mr. Tovey should keep the orchid under observation.

He has done so, and during the eight years that have elapsed since that date it has kept true to its original characteristics. But he has noted that when the plant is young, and first flowers, some of the leaves show as a basal rosette; but that the stem quickly elongates, and the leaves then take up the alternate arrangement, so that what was apparently a hybrid feature is thus shown to be only a question of the age of the plant.

Specimens for the years 1907, 1909, 1913, 1914, 1915, are preserved in the Melbourne Herbarium.

This orchid flowers in June, and we were able to visit the locality and see the orchid in its habitat, and obtain drawings from fresh specimens.

Notes on other Orchids.

1. A very large specimen of P. praecox, var. robusta, collected by Miss Bunbury, Geography Bay, W. Aust., suggests a very great similarity to P. truncata, Fitz. It agrees in many respects with that species, and especially so in a very striking feature—*i.e.*, in having a gland in the sinus of the column.

2. *P. grandiflora*, R.Br., a most characteristic feature, apart from its very distinct type of labellum, is the wing-like character of the lateral sepals of the galea. Both are broadened out, and have a somewhat pinnate veining. This was noted by Mr. Tovey.

3. P. grandiflora (R.Br.), var. Frenchii (Mueller), Upper Avoca, May, 1895, Alex. Purdie, is undoubtedly a typical form of P. reflexa.

4. In his "Australian Orchids," Fitzgerald has greatly exaggerated the width of the mid-rib of the labellum of P. reflexa.

5. *P. obtusa*, as determined by the Baron from the hills near Pt. Elliot, Miss Hussey, No. 427, in 1895, is undoubtedly P. pedunculata. No specimen of this orchid has therefore been recorded from the mainland of South Australia, *vide* Dr. Rogers, in "South Australian Orchids."

Restio ustulatus (F. Mueller, M.S.)

Stems erect, terete, sometimes divided, 1 to 2 ft. high. Lower sheathing scales closely imbricated, about 1 inch in length. The upper ones longer—1½ ins., and looser. All acute and well sheathing the stem.

The floral bracts acute. That below the lower spikelets ½ in. in length, while that below the terminal spikelet only ¼ in. in length.

Spikelets in both sexes somewhat different. The male are more conical, with very imbricate, appressed glumes. Those of the female are broader, with larger glumes, and not nearly so appressed.

Glumes in every case are obtuse.

Spikelets in both sexes few at the end of the stem, 1 to 3, sessile, or nearly so within the bracts, or one within a lower bract on a long pedicel that may extend to almost same length as terminal spike. Spikelets oblong, conical, 1 in. long, of a dark brown, and very closely resembling the solitary terminal spikelet of *Ecdeiocolea monostachya;* but the chief differences are:—

1. *No. of spikelets on each stem.*
2. Closeness of sheathing scale to spikelet.
3. Length of sheathing scale.
4. No. of sheathing scales.
5. R. ustulatus more flattened, and redder spikelet.

It also resembles in appearance the spikelets of Lepiconia among the Cyperaceae.

Glumes ovate, obtuse, very numerous, rigid, and closely imbricate. The outer ones shorter and empty. Perianth in both sexes very flat, about as long as the glumes, glabrous, or very hairy near the tips.

The three outer segments of the perianth hairy near the tips, the three inner ones quite glabrous and hyaline.

In the male flowers: Stamens 3, filaments free. Anthers of two distinct cells as seen in drawing. Attached to centre only.

Female flowers: Ovary 2-celled, style 2, free and stigmatic, almost from the base.

This Restio in no way resembles any hitherto described; but adopting the classification as given in Bentham's key, it would come near to R. deformis, from which in general appearance and spikelets it is very dissimilar.

EXPLANATION OF PLATES.

Plate XXVI.

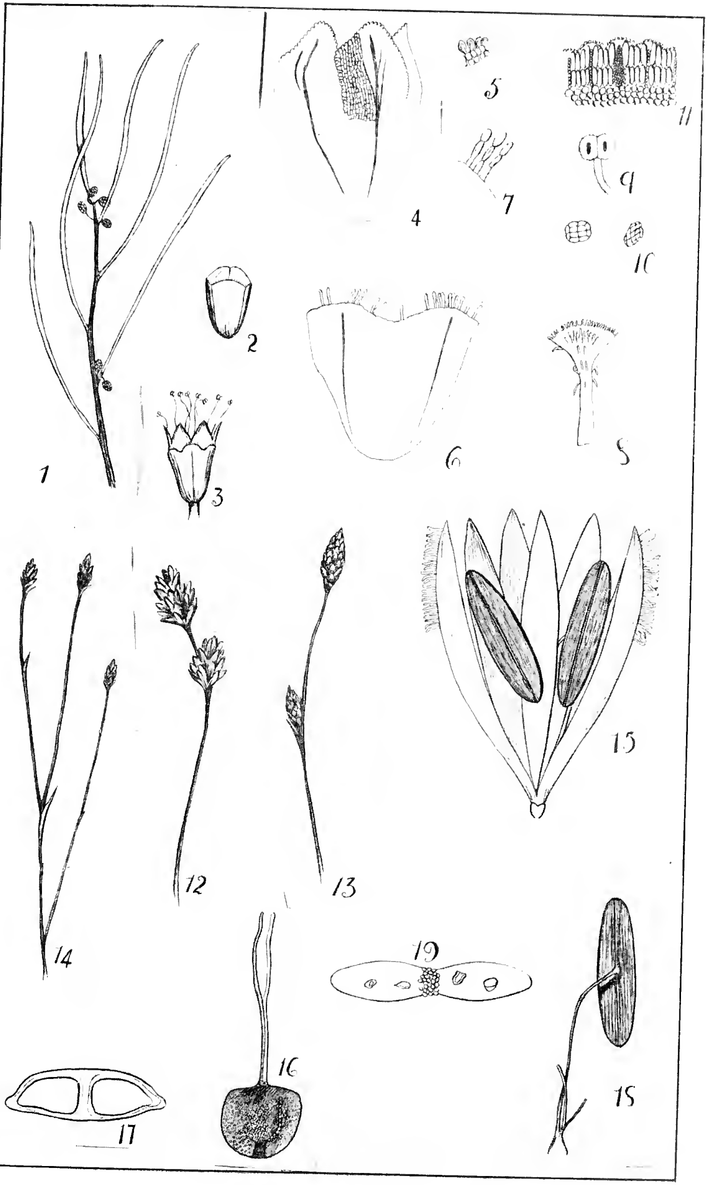
Acacia Beauverdiana, and Restio ustulatus. (Figs. 1-11.) (Figs. 14-18.)

Fig. 1.—Branch of Acacia Beauverdiana (½ natural size).
Fig. 2.—Flower bud (magnified).
Fig. 3.—Single flower (magnified).
Fig. 4.—Portion of corolla (magnified).
Fig. 5.—Processes from corolla (magnified).
Fig. 6.– Portion of calyx (magnified).
Fig. 7.—Hairs from calyx (magnified).
Fig. 8.—Single bract from flower (magnified).
Fig. 9.—Stamen (magnified).
Fig. 10.—Compound pollen grains (magnified).
Fig. 11.—Transverse section of edge of phyllode (magnified).
Fig. 12.—*Restio ustulatus.*—♀ inflorescence (½ natural size)
Fig. 13.—♂ inflorescence (½ natural size).
Fig. 14.—Abnormal ♂ inflorescence (½ natural size).
Fig. 15.—Single male flower (magnified).
Fig. 16.—Pistil (magnified).
Fig. 17.—T.S. two-celled ovary (magnified).
Fig. 18.—Single stamen (magnified).
Fig. 19.—Transverse section of anther.

Plate XXVII.

Pterostylis revoluta, Pterostylis reflexa, Pterostylis praecox, P. praecox var, robusta, Pterostylis constricta.

Fig. 1.—Flower of P. revoluta (½ natural size).
Fig. 2.—Labellum of P. revoluta (enlarged).
Fig. 3.—Flower of P. reflexa (½ natural size).
Fig. 4.—Flower of P. reflexa (smaller variety), (½ natural size).
Fig. 5.—Labellum of P. reflexa (enlarged).
Fig. 6.—Labellum of P. reflexa without terminal point (enlarged).
Fig. 7.—Plant of P. praecox, var. robusta (½ natural size).
Fig. 8.—Labellum of P. praecox (enlarged).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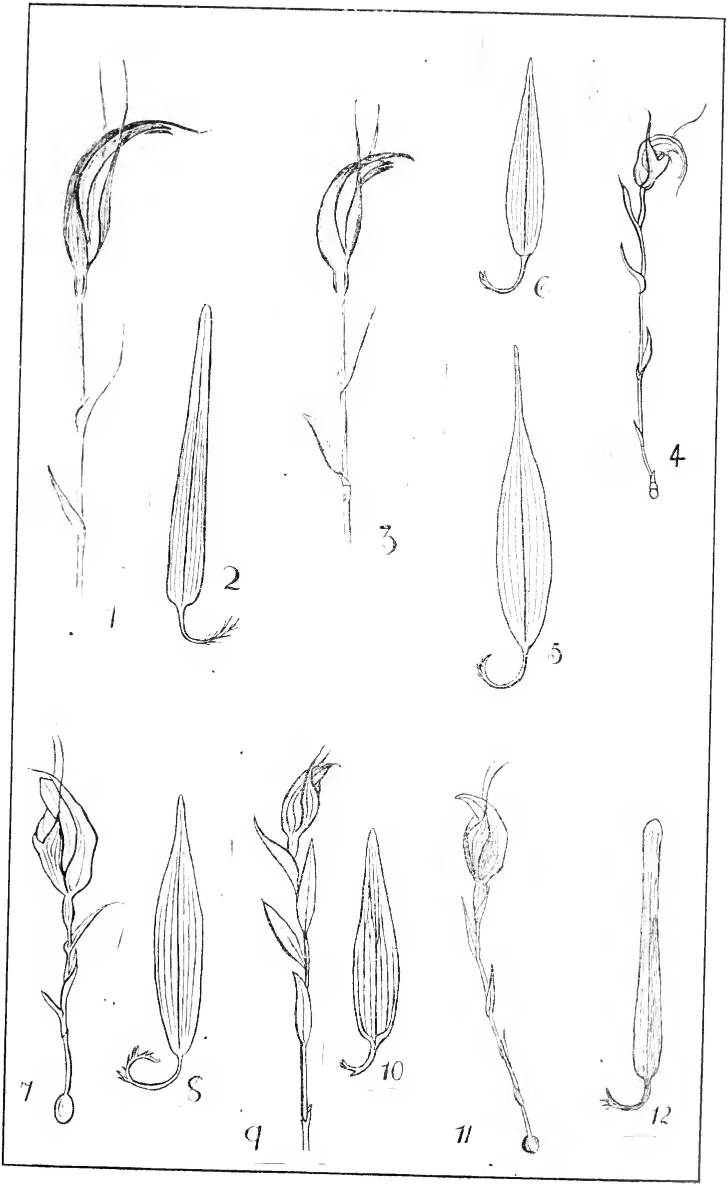
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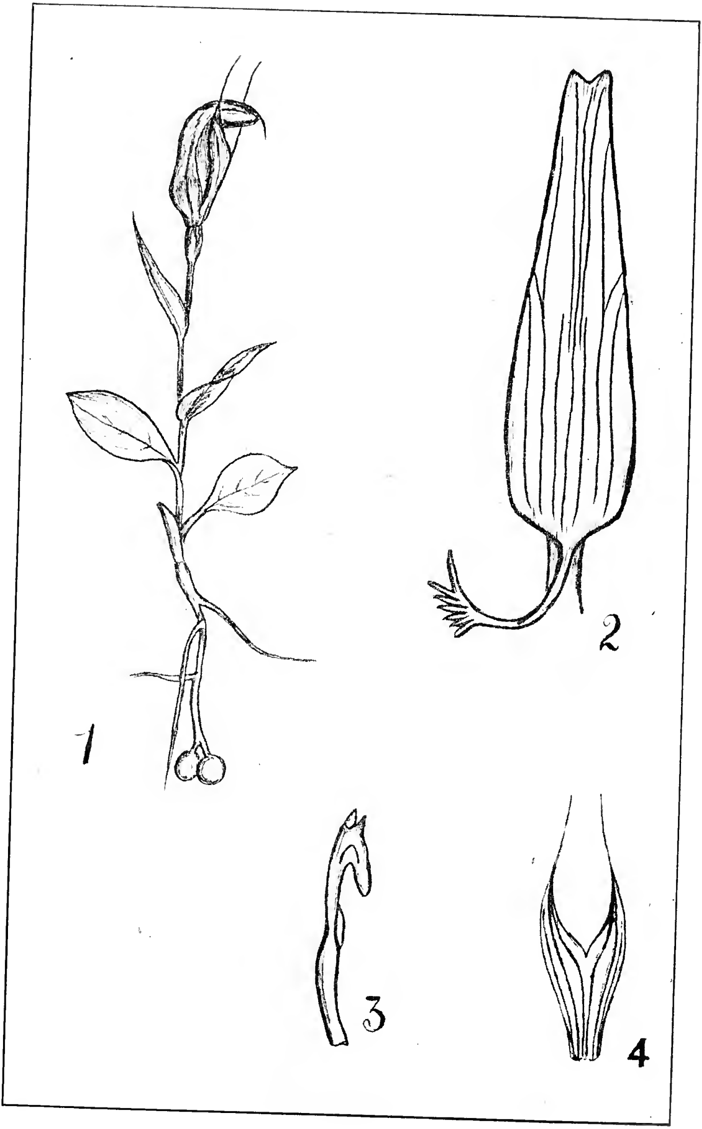
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Fig. 9.—Flower of P. praecox ($\frac{1}{2}$ natural size).
Fig. 10.—Labellum of P. praecox (enlarged).
Fig. 11.—Plant of P. constricta ($\frac{1}{2}$ natural size).
Fig. 12.—Labellum of P. constricta (enlarged).

Plate XXVIII.

Pterostylis Toveyana.

Fig. 1.—Plant and flower of P. Toveyana (natural size).
Fig. 2.—Labellum (enlarged).
Fig. 3.—Column (enlarged).
Fig. 4.—Claw (enlarged).

6A

[Proc. Roy. Soc. Victoria, 28 (N.S.), Part II., 1916].

Art. XIX.—*Teratological Notes; Part 1.*

By A. D. HARDY, F.L.S.
(Forests Department, Melbourne).

(With Plate XXIX.).

[Read December 9th, 1915].

By means of this and other papers to follow, it is intended to place on record occurrences of interest to specialists in vegetable teratology which have come under my notice during the past few years. The present paper includes references to seedlings only, leaving to future parts notes on heterotaxy and morphological deviations in foliage, etc., of older plants, particularly with regard to some of our indigenous flora.

Abnormal Seedlings.[1]

Cotyledonary leaves, regarded as of diagnostic value by Ray at the end of the 17th century, but not used by him in the genesis of the natural system of classification, were placed in commission, as it were, by Jussieu, in limiting the primary divisions of the angiosperms. Since then the cotyledons have been recognised with due regard for their importance in association with other characters, but occasionally—and in some cases frequently—polycotylous forms appear among normal contemporaries of the same species of dicotyledons; and other aberrations are not uncommon—at least in cultivated plants.

The most frequent abnormality noted by me was the polymerous whorl of cotyledons; the next, polyphylly (in the subsequent production of foliar leaves); the third in frequency was the cohesion of members of a cotyledonary whorl; the fourth was the bifurcation of the axis of the cotyledon; the fifth, fission or lobing of the cotyledon; and, last, stem abnormalities—bifurcation of the seedling axis, and hypocotylous supplementary shoots, being rare within my experience.

The specimens have all been taken from cultivation, and, further, my inquiry, as far as the seedlings are concerned, has been spread over a field limited to three nurseries and a suburban garden and to one season only excepting one species—*Coprosma lucida*.

1 In "A Contribution to our Knowledge of Seedlings" (Avebury) will be found a wealth of information as to normal plants, and a comprehensive bibliography.

Facilities were afforded me by the Conservator of Forests, Mr. H. Mackay; the Director of the Melbourne Botanic Gardens, Mr. J. Cronin; and Messrs. Brunning and Son, to examine the seedling beds in the respective nurseries. The State Forests Nursery, established principally for the sowing and nursing of eucalypts, is at Broadford; the other plants were observed in my private garden at Kew. Nothing like an exhaustive search was made or attempted in the limited time available, and though many genera were noticed, the quest was made with the study of seedlings of *Eucalyptus* as the main object in view.

Polycotyly.—In some species there appears to be a tendency to polycotyly, the deviation from normal conditions ending there; in others this tendency seems to have strengthened into a habit without subsequent growth of the plant being affected, while in a third phase the impulse given is continued into successive foliar organs in their arrangement relative to the axis. In frames containing some thousands of *Pittosporum nigrescens*, I failed to find a single dicotylous plant, although 3-merous and 4-merous forms were common, and 5-merous seedlings were in the proportion of about 1-100.

The species of which I exhibited specimens with increased number of cotyledons are as follows:—

Cupressus macrocarpa	-	3-, 4-, 5-, and 7-merous forms, frequent; 2-merous forms not seen
Cuprosma lucida[1] -	-	3-merous, in proportion of about 6:100
Eucalyptus Muelleriana	-	3-merous, rare.
,, *resinifera*	-	3-merous, 1:500.
,, *radiata* -	-	3-merous, about 1:100.
,, *Risidoni* -	-	3-merous, about 1:100.
,, *cornuta* -	-	3-merous, rare.
Dillwynia cinerascens	-	3-merous, 1.22.
Ligustrum (chinensis ?)	-	3-merous, 9:140.
Sterculia (sp.) -	-	3-merous, 1:20.
Pittosporum tenuifolium	-	3-, 4- and 5-merous.
,, *floribundum*	-	3-merous 3:80.
,, *Buchanianum*	-	Only two out of 17 in one lot were dicotylous, five were 3-merously whorled, nine 4-merously and one 5-merously.
,, *nigrescens*	-	3-, 4- and 5-merous (see above).
,, *undulatum*	-	Many 3-merous whorls seen.
Cytisus proliferus -	-	3-merous, about 3:100.
Mandevillea (sp.) -	-	3-merous, numerous.
Gleditschia triacanthos	-	3-merous about 3:1000.
Callistemon lanceolatus	-	A few, not counted.

1 Result of observation during 3 seasons of seedlings of the same tree.

Angophora intermedia	Of five seedlings at Broadford, two were 3- and four were 4-merous. As the seed came from the native habitat in Croajingolong the abnormal growth could not be credited to repeated cultivation.
Magnolia grandiflora	3-merous, 3:17.
Clematis (sp.)	3-merous, 1:4.
Schinus molle	3-merous, 8:2000.
Acacia stricta	3-merous, 1:30.
Cytisus alba	Account not kept.
Thujopsis borealis	3-merous, 3:100.
Bursaria spinosa	3-merous, a small percentage.

With few exceptions the whorls were characterised by radial symmetry, and this, taken with other characters such as venation, points to the numerical increase originating in corresponding superfluity of leaf primordia in the young seed rather than to early fission of the growing cotyledon.

Polyphylly.—Occasionally the whorl of cotyledons was found to be accompanied by a similarly increased whorl of foliar leaves, and in a few instances increase was repeated at successive nodes. Amongst 40 normal Linaria plants several had four whorls, including that of the cotyledons. The undermentioned species yielded forms with increase of foliar leaves supervening on tricotyly.

Coprosma lucida.
Eucalyptus cladocalyx.
E. resinifera.
E. Risdoni.
Linaria (Sp.).
Ligustrum chinensis.

Bifurcation of Axis.—This occurrence, known to some nurserymen as "double-heading," has an economic value at times in that a shrub or tree ordinarily too tall for some situations produces two equal branches near the ground, each being stronger than a lateral branch.

1. Epicotylous forking of the stem was observed in *Cytisus proliferus.* This may have been caused by early arrest of the normal shoot and consequent production of what might be termed cotylaxillary shoots, referred to later in connection with *Eucalyptus cornuta.*

2. Supercotylous forking of the stem axis was seen in a specimen of *Tilia Americana*, the division being about three cm. above the level of the cotyledons.

Cohesion of Cotyledons.—It is assumed that the presence of a "midrib" in each half of an over-broad cotyledonary member, together with appropriate venation and a thickened petiole, indicate connation of two leaves by their inner margins, or that the fusion has been due to the crowding of primordial papillae. Thus the following species, in which the forenamed conditions were evident, may be listed as having afforded specimens:—

Pittosporum tenuifolium.
P. floribundum.
Coprosma lucida.
Schinus molle.
Sterculia (hybrida?).
Raphanus (Sp.).—In the radish there occurred a form with trilobed seed leaves due to each leaf consisting of a fused pair.

I have not observed any but *lateral* cohesion of two members of polymerous whorls. Fusion of opposed members by their bases, thus giving a perfoliate appearance, may have existed among the many seedlings seen. This feature is less conspicuous, however and if present was unnoticed. The Sterculia had an asymmetric whorl composed of the two fused leaves and an aborted third.

Sterculia (hybrida?): Amongst 24, one with bifid leaf.
Pittosporum tenuifolium; One only with a bifid leaf.
P. Buchananum: One leaf of a trimerous whorl of cotyledons slightly bifid.
Daucus Carota: One cotyledon bifid slightly. In another plant one leaf bifid and the other unequally trifid. (Guppy found 25 out of 135 seedlings of *Lepidum sativum* with tripartite cotyledons.)

Other Abnormalities.—The only instance seen where axillary growths occurred in a very young seedling was in the case of *Eucalyptus cornuta*, in which buds were present in both cotylar and foliar axils. The cotyledons were verticillate, and the foliar leaves normal.

Linaria (purpurea?) cultivated at Kew showed a tendency to produce supernumerary shoots of hypocotylous origin (about 5 per cent.). When the plants had produced less than a fourth of their mature foliage, or earlier, they were found with a shoot developing near the ground, or sometimes hypogeal, and producing 3-merous whorls of foliar leaves. (Masters records a similar occurrence in *L. vulgaris*, *Anagalis arvensis*, *Euphorbia peplus* and some umbelliferae.)

Malposition of cotyledons occurred in *Acacia stricta*, the pair, instead of retaining an opposite position, being forced round by the vigorously growing, humiphilous shoot until they were to one side of the axis, and almost laterally connate. This was noticed in 7 of the 19 plants examined.

In the case of *Pittosporum tenuifolium*, the arrangement of the five cotyledons before expansion was noted. They were curled up within the seed, like straps rolled with flat surfaces in contact, but, as shown in the drawing, there was provision for radially symmetric growth after expansion; the outer leaves being slightly shorter than the inner, with petioles twisted obliquely in order to have the blades in mutual contact. The members, after artificial withdrawal from the seed coat, separated with a knife and immersed in water, soon assumed an approach to the radial form. This observation makes less tenable the fission theory of multiplication of linear cotyledonary leaves. (See Figs. 23 and 24 a, b.)

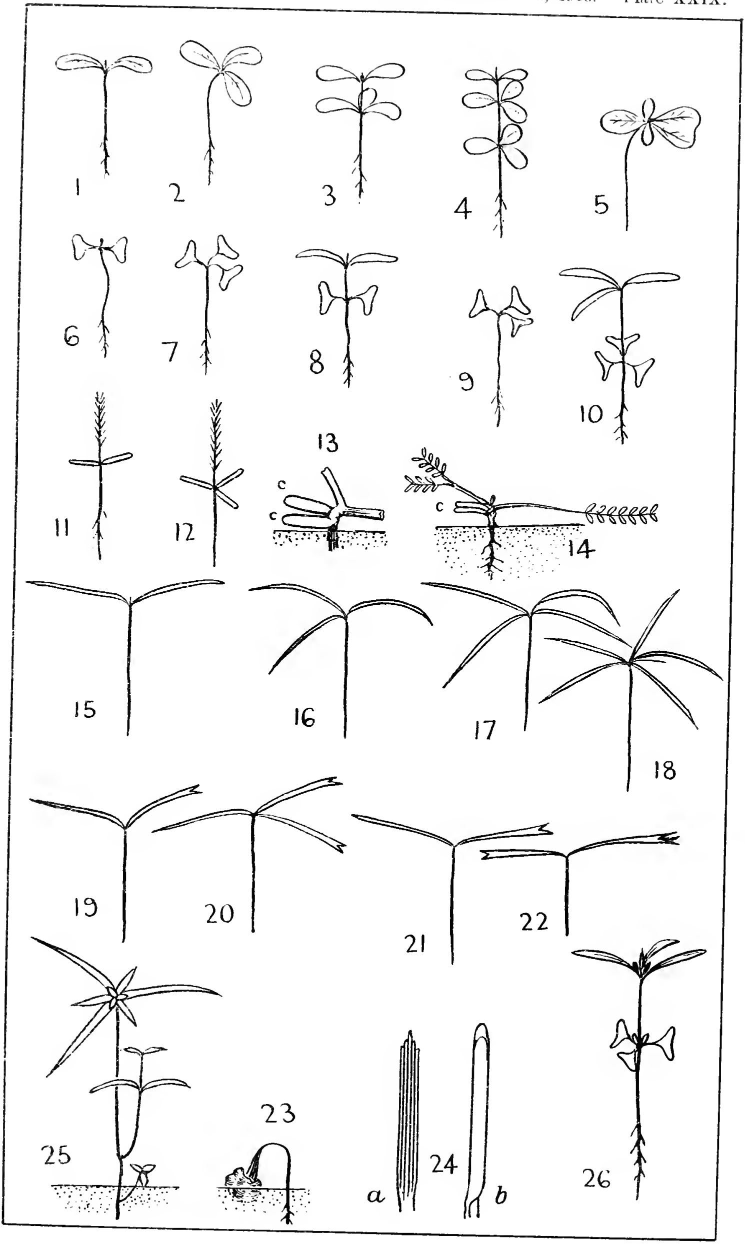
The many instances of seedling abnormalities given above, and a review of records by Avebury (Lubbock), Mueller, Masters, Guppy, Duchartre, Bailey, Schrenk, etc. (their observations affecting cultivated plants chiefly), leads one to think that there is ground for further interesting inquiry among the seedlings of native plants in their habitats. F. V. Mueller's[1] investigation, in 1882, of polycotyly in New Zealand species of the genus *Persoonia*, resulted in the surprising record of there being amongst 23 species examined only four with dicotylous seedlings; and, he wrote: "It may be fairly assumed that in the genus as a whole the pluricotyledonary embryo by far preponderates." This fact adds interest to the data given for Pittosporum nigrescens mentioned above, and perhaps to observations on other species such as P. tenuifolium and P. undulatum.

EXPLANATION OF PLATE.

Figs. 1 to 5 —Coprosma lucida.
,, 6 and 7 —Eucalyptus radiata.
,, 8, 9 and 10—E. Risdoni.
,, 11 and 12—Dillwynia cinerascens.
,, 13 and 14—Acacia stricta.
,, 15 to 18 —Pittosporum Buchanianum
,, 19 —P. tenuifolium.
,, 20 —P. Buchanianum.
,, 21 and 22—Daucus carota.
,, 23 and 24—Pittosporum tenuifolium.
,, 25 —Linaria (purpurea ?).
,, 26 —Eucalyptus cornuta.

Note.—All figures semi-diagrammatic.

1 N.Z. Jour. Sc. I., p 115.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[Proc. Roy. Soc. Victoria, 28 (N.S.), Pt. II., 1916].

Art. XX.—*The Influence of Gaseous Pressure on Growth.*

(Preliminary Communication).

By ETHEL McLENNAN, B.Sc.

[Read 9th December, 1915].

The British Association for the Advancement of Science granted the sum of £50 for the purpose of carrying out a research, "On the Influence of Varying Percentages of Oxygen, and of Various Atmospheric Pressures upon Geotropic and Heliotropic Irritability and Curvature."

This sum was expended on apparatus necessary for the above research, which, for the most part had to be obtained from England, and some delay was experienced owing to difficulties arising from the war. In consequence work so far has been mainly of a preliminary character, but a description of the apparatus employed and a summary of the results obtained to date may be of a little interest.

According to Pfeffer (Pfeffer's Physiology of Plants, Vol. II., p. 114):—" A mere rise of gaseous pressure, if sufficiently great, will produce a retardation and ultimate cessation of growth."

He explains this by stating that a high gaseous pressure outside the plant will antagonise turgor. This could only be a temporary effect, since the protoplasm and the cell wall are permeable to oxygen and nitrogen in solution, so these gases will pass through until the partial pressure of the dissolved gases inside the cell produces an increased osmotic pressure corresponding to the increased gaseous pressure outside the cell, thus producing a gaseous equilibrium.

Jaccard (Rev. Gen. d.Bot., 1893) states that growth in air at from 3-6 atmospheres, is not retarded, and may even in some cases be accelerated.

In order to test these results and those of other observers, I have been performing some experiments under more favourable conditions than was previously the case. It is important that the observations should be made under conditions where immediate responses can be observed in short intervals of time; this can only be done by the aid of the horizontal microscope watching the growth of seedlings in a pressure chamber.

The seedling, the growth of which was to be determined, was fixed to the roof of a pressure chamber by means of plasticene. In the first observations the seedling was fixed to a plate of cork. A curious error was noted—namely, the expansion and contraction of the cork under varying pressures gave apparent growth movements to the seedlings which did not actually take place. It is better to fix seedling to plasticene by means of metal rods, test experiments showed this was not affected by varying gas pressures.

The radicle was so arranged, that it could be clearly seen from the exterior through the glass ends of the chamber.

The air was kept constantly moist by means of a lining of wet cotton wool. A gauge was attached which registered the pressure to which the seedling was subjected. The chamber was connected to a high pressure pump, and so a pressure of any desired value could be produced in it.

A horizontal microscope was used for the readings. It was levelled carefully, and the tip of the root of the seedlings was focussed on to a scale in the eyepiece of the microscope. The divisions on the scale = .064 of a mm. In order to be as accurate as possible, the eye should be kept at the same level at each reading. To ensure this, a rod of certain length was placed in the same position, and the observer's chin rested on it at each reading. The initial position having been read, the seedling is left for one hour, and then its position is again read; this gives directly the amount of growth in fractions of a mm. during that time.

Before subjecting any seedling to pressure, the rate of growth in air was first determined, for this varies according to the individual, and having obtained its rate of growth in air a pressure of known amount was developed in the chamber, and readings were taken at intervals of an hour.

The effect of the pressure does not manifest itself immediately on the growth, at any rate such pressures as I have experimented with, so apparently the direct mechanical effect of increasing the gaseous pressure upon turgor is practically negligible as a factor which influences growth, contrary to Pfeffer's suggestion.

Generally in one day retardation became noticeable, the amount of retardation being dependent on the pressure; broadly speaking, the higher the pressure the greater the retardation.

It seems that at such pressures as I have experimented with, this retardation is not permanent, but the plant accommodates itself to the pressure and the rate of growth is gradually raised.

The temperature was noted throughout the experiments.

Not only does a fluctuation in the temperature affect the rate of growth, but also some seedlings appear to have inherently a higher rate of growth than others. Nevertheless, the effect of raised gaseous pressure is a relatively constant one, irrespective of temperature or of the inherent rate of growth of the seedling.

The seedlings used for all the experiments have been *Pisum arvense* (field pea), and so far as possible I have chosen those of about equal age and size.

Whether the retardation caused by increased gaseous pressure is due to an increase in the partial pressure of the dissolved oxygen or not has still to be determined.

Jentys found that oxygen under a pressure of from 3-4 atmospheres (= the same density as in air under a pressure of from 14-19 atmospheres) caused retardation of growth.

Since, however, air under 3-4 atmospheres pressure produces a similar retardation this is not due wholly to the increased oxygen pressure, but is due in part at least to increased gaseous pressure.

Summary of Results.

I.—Average rate of growth in air = .275 mm. per hour.

II.—Atmospheric Air + 15 lbs.

	Temp. °C.	Rate of growth per hr. mm.
(a) Beginning of experiment	16	.32
End of 1st day	16	.25
∴ retardation =		.07 in 1 day.
(b) Beginning of experiment	14	.192
End of 1st day	16	.097
∴ retardation =		.095 in 1 day.

III.—Atmospheric Air + 30 lbs.

	Temp. °C.	Rate of growth per hr. mm.
(a) Beginning of experiment	13.5	.25
End of 1st day	14	.128
∴ retardation =		.122 per hr.
(b) Beginning of experiment	15	.448
End of 1st day	14	.32
∴ retardation =		.128

IV.—Atmospheric Air + 45 lbs.

		Temp. °C.		Rate of growth per hr. mm.
(a)	Beginning of experiment -	14.5	-	.25
	End of 1st day - - -	16	-	.019
		∴ retardation	=	.231
(b)	Beginning of experiment -	20	-	.67
	End of 1st day - - -	21	-	.128
		∴ retardation	=	.542
(c)	Beginning of experiment -	17	-	.704
	End of 1st day - - -	18.5	-	.12
		∴ retardation	=	.584

Complete Set of Readings for One Seedling.

Atmospheric Pressure + 15 lbs.

Seedling in Air.

	Temp. °C.	Time read.	mm.	1 hours' growth mm.
(a) -	14 -	9.25 -	0	
		12.10 -	.95 -	.192
(b) -	14 -	12.20 -	1	
		1.40 -	1.5 -	.226

Atmospheric Pressure + 15 lbs.

	Temp. °C.	Time read.	mm.	1 hours' growth m m.
(a) -	14.5 -	1.40 -	1.5	
		2.40 -	1.8 -	.192
(b) -	14.5 -	2.40 -	1.8	
		3.50 -	2.2 -	.192
(c) -	14.5 -	3.55 -	2.2	
		4.55 -	2.45 -	.16
(d) -	12† -	5.20 -	2 55	
		9 -	5.3 -	.097

† Minimum temperature.

	Temp. °C.	Time read.	mm.	1 hours' growth m m.
(e) -	16 -	9.10 -	1	
		10.10 -	1.17 -	.097
(f) -	16 -	10.10 -	1.2	
		11.30 -	1.4 -	.096
(g) -	16 -	11.30 -	1.4	
		12.55 -	1.65 -	.097

Atmospheric Pressure + 30 lbs.

Seedling in Air.

	Temp. °C.	Time read.	mm	1 hours' growth mm.
(a)	11.5	9.15	0	
		10.15	.3	.192
(b)	14	10.15	.3	
		11.25	.3	.32
(c)	14	11.25	.9	
		12.25	1.4	.32

Atmospheric Pressure + 30 lbs.

	Temp. °C.	Time read.	mm.	1 hours' growth mm.
(a)	14.5	12.30	1.4	
		1.30	2.1	.448
(b)	15	1.30	2.1	
		2.30	2.8	.44
(c)	15	2.30	2.8	
		3.30	3.6	.51
(d)	15	3.30	3.6	
		5	4.9	512
(e)	10†	5	0*	
		9.15	8.4*	.32

† Minimum temperature. * Pressure fallen 20 lbs.

	Temp. °C.	Time read.	mm.	1 hours' growth mm.
(f)	12	9.25	0	
		10.25	.5	.32
(g)	13	10.25	.5	
		11.25	1.05	.35
(h)	14	11.30	1	
		12.40	1.6	.32
(i)	14	12.40	1.6	
		1.50	2.2	.32
(j)	14.5	1.50	2.2	
		2.50	2.7	.32
(k)	15	2.50	2.7	
		3.50	3.2	.32
(l)	15	3.50	3.2	
		4.50	3.8	.38
(m)	10†	5.5	0*	
		9.5	6.4*	.25

† Minimum temperature. * Pressure fallen to 20 lbs.

	Temp. °C.	Time read.	mm.	1 hours' growth mm.
(n)	12	9.5	1	
		10.5	1.35	.224
(o)	13	10.5	1.3	
		12.5	2.05	.226
(p)	13	12.5	2	
		12.5	2.75	.224

ATMOSPHERIC PRESSURE + 45 LBS.

Seedling in Air.

	Temp. °C.	Time read.	mm.	1 hours' growth mm.
(a)	20.5	11.5	1	
		12.5	2.1	.70
(b)	20.5	12.5	2	
		1.5	3	.64
(c)	20	1.5	3	
		1.50	3.85	.70

ATMOSPHERIC PRESSURE + 45 LBS.

	Temp. °C.	Time read.	mm.	1 hours' growth mm.
(a)	20	2	1	
		3	2.05	.67
(b)	20	3	2.05	
		5.55	5.25	.67
(c)		6	1*	
		10.15	gr. off scale*	
		* Pressure fallen 35 lbs.		
(d)	20	10.30	1	
		11.30	1.09	.057
(e)	20	11.30	1.2	
		12.30	1.25	.032
(f)	20	12.30	1.2	
		1.40	1.42	.098
(g)	20	1.40	1.4	
		2.40	1.6	.128
(h)	21	2.45	1.6	
		3.45	1.85	.16
(i)	21	3.45	1.8	
		4.45	2.15	.16
(j)	12†	4.50	1	
		10.10	1.45*	.08

† Minimum temperature. * Pressure fallen to 28 lbs.

INDEX.

The names of new genera and species are printed in italics.

END OF VOLUME XXVIII.

[PART II. PUBLISHED MARCH, 1916.]

PROCEEDINGS

OF THE

Royal Society of Victoria.

VOL. XXVIII. (New Series).

PART I.

Edited under the Authority of the Council.

ISSUED NOVEMBER, 1915.

(Containing Papers read before the Society during the months of March to July, 1915).

THE AUTHORS OF THE SEVERAL PAPERS ARE INDIVIDUALLY RESPONSIBLE FOR THE SOUNDNESS OF THE OPINIONS GIVEN AND FOR THE ACCURACY OF THE STATEMENTS MADE THEREIN.

MELBOURNE:

FORD & SON, PRINTERS, DRUMMOND STREET, CARLTON.

1915.

Publications of the Royal Society of Victoria, and of the Societies amalgamated with it.

VICTORIAN INSTITUTE FOR THE ADVANCEMENT OF SCIENCE.

Transactions. Vol. 1. 1855.

PHILOSOPHICAL SOCIETY OF VICTORIA.

Transactions. Vol. 1. 1855.

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The Society then became:—

ROYAL SOCIETY OF VICTORIA.

Transactions and Proceedings (Vol. 5, *entitled* Transactions). (8vo). Vols. 5–24.

Transactions. (4to). Vols. 1, 2, 3 (Pt. 1 only was published), 4, 5. 1888–1909.

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MICROSCOPICAL SOCIETY OF VICTORIA.

Journal (Vol. 1, Pt. 1, *entitled* Quarterly Journal). Vol. 1 (Pts. 1 to 4), 2 (Pt. 1), title page and index [*all published*]. 1879–82.

[*The Society then combined with the* ROYAL SOCIETY OF VICTORIA]

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PROCEEDINGS

OF THE

Royal Society of Victoria.

VOL. XXVIII. (New Series).

PART II.

Edited under the Authority of the Council.

ISSUED MARCH, 1916.

(Containing Papers read before the Society during the months of July to December, 1915).

THE AUTHORS OF THE SEVERAL PAPERS ARE INDIVIDUALLY RESPONSIBLE FOR THE SOUNDNESS OF THE OPINIONS GIVEN AND FOR THE ACCURACY OF THE STATEMENTS MADE THEREIN.

MELBOURNE:

FORD & SON, PRINTERS, DRUMMOND STREET, CARLTON.

1916.

Publications of the Royal Society of Victoria, and of the Societies amalgamated with it.

VICTORIAN INSTITUTE FOR THE ADVANCEMENT OF SCIENCE.

Transactions. Vol. 1. 1855.

PHILOSOPHICAL SOCIETY OF VICTORIA.

Transactions. Vol. 1. 1855.

These two Societies then amalgamated and became:—

PHILOSOPHICAL INSTITUTE OF VICTORIA.

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The Society then became:—

ROYAL SOCIETY OF VICTORIA.

Transactions and Proceedings (Vol. 5, *entitled* Transactions). (8vo). Vols. 5–24.

Transactions. (4to). Vols. 1, 2, 3 (Pt. 1 only was published), 4, 5, 6——1888——.

Proceedings (New Series). (8vo). Vols. 1——1888——.

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