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(PRESIDENTIAL ADDRESS)

FACTORS IN VARIATION.

By Heber A. Longman, F.L.S., F.R.A.I.

(Read before the Royal Society of Queensland, 31st March, 1920)

Introduction.

In his inaugural address in January, 1884, our first President, the late Hon A. C. Gregory, referred to the field of investigation by this Society as being "Natural Science and its practical application." That ideal of thirty-six years ago bears a far wider interpretation to day. In an official pronouncement as Secretary of State for the Colonies, Lord Milner has clearly pointed out that "there is scarcely any industry which can develop or even maintain its position without the aid of scientific research."* He mentions the "liberal grant" provided by the British Government to be expended in stimulating scientific research overseas, and gives his opinion that the "greatest possible importance" is attached to this question. Lord Milner's words are to be welcomed as a sign of the times, and we believe that they will be sympathetically endorsed by Australian statesmen. The recognition of the great value of scientific work has been too tardy for, as Huxley pointed out long ago, science has been the world's Cinderella, working mostly out of sight. With the recognition of the need for wide encouragement of scientific work, and the endowment of research, emphasised by the war, it is sincerely to be hoped that there will be a growth of the best scientific spirit: that is, of undeviating allegiance to truth and a sense of fair play, for these ideals are of even greater value than those of material importance.

So far as this Society is concerned our activities are outlined in the report of your Council and need not be detailed here.

* Science and Industry," Nov., 1919. p 403

Since our last annual meeting Sir William MacGregor, G.C.M.G., who as Governor of Queensland, was Patron of this Society from 1910 to1914, has passed away. The name of this distinguished administrator will always be closely associated with the ethnology and the avifauna of Papua, and his collections, housed in the Queensland Museum, are a remarkable memorial to his energy and enthusiasm.

An ex-member in the person of Thomas Parker, F.G.S., died during the year. In 1914, Mr. Parker contributed two short papers on Underground Waters to our Proceedings.

FACTORS IN VARIATION.

The above title requires an immediate qualification. An adequate exposition of the facts and theories which may be associated with a study of variation would be beyond the powers of any one individual, even though he were given the three lives which Fredk. Bond* desired for the fruition of a naturalist's work. No such exposition will be attempted in this address. My task is to record certain notes on evolution which have accumulated during many years of study, supplementing those given in a previous paper†, and to point out that we have now definite knowledge of many of the factors which cause variation.

The facts of organic evolution are undeniable. Even in the days of Darwin they formed an incontrovertible array. Since that time innumerable supplementary observations have been tabulated by biological workers. No thinking, qualified person can ignore the fact that organisms have changed and are changing, and this is all that evolution implies when reduced to its simplest terms. But when we come to analyse the subsidiary theories associated with these facts, we find that the supposedly serene atmosphere of science is perturbed by violent controversies.

Circumspice! Compare the views of the Mendelians, the Lamarckians, the Darwinians and neo-Darwinians, the Weismannians, the transformists and the mutationists,

*Quoted in "The Entomologist," XXII., 1889, p. 266.

†Longman: Proc. Roy. Soc. Q'ld., XXVI., 1914

to say nothing of philosophic implications ranging from rigid mechanistic conceptions to various forms of vitalism and to theological interpretations. If Darwin could return to-day he would certainly need the assist nce of his "bull-dog"—Huxley. One wonders what the twain would have thought of the remarkable utterances in Australia in 1914 by Professor Bateson, who is prepared seriously to consider the whole course of evolution "as an unpacking of an original complex which contained within itself the whole range of diversity which living things present."* Professor Bateson also refers sympathetically to Lotsy's views that all variations may be due to crossing: "to segregation and recombination of series of factors on pre-determined lines" (p. 15), or to a loss of factors. He goes on to say: "In spite of seeming perversity, therefore, we have to admit that there is no evolutionary change, which in the present state of our knowledge, we can positively declare to be not due to loss." (p. 20). He also informs us that "competent men are even denying that variation in the old sense is a genuine occurrence at all" (p. 11).

If this view be summarily interpreted, it means that, in a novel sense, there is nothing new under the sun, that the course of evolution is topsy-turvy, that the microcosm holds the macrocosm, that all the wealth of the world's biota to-day, to say nothing of myriad extinct forms, was segregated in definite factors in the primitive life of the past, that man himself would still be an ape had he not lost pre-human factors, and that progress is invariably the result of loss and not of gain.

How will exponents of these views account for the advent of new structures? To quote a few instances (which might be indefinitely extended): how does this ultra-mendelian evolution account for the development of the pouch of marsupials, of the "flying-membrane" of various mammals, of the venom fangs of snakes, of the pharyngeal teeth of fishes, the copulatory apparatus of the male dragon fly†, or, to quote a case which bears on

*Bateson: Report British Assn., Australia, 1915, p. 17.

†R. J. Tillyard: The Biology of Dragon Flies, 1917, p. 215

the psychological evolution of man himself, of the rich development after birth of myelinated fibres in the brains of human beings?

These structures have surely evolved through gain and not by loss. How came about the adaptations of specialised animals to exceptional environments? Did the germ cells of the progenitors of the mammalia contain, packed in inconceivable complexity, factors to account for all the morphological variations which have arisen within the order?

Professor Bateson smiles at the "teleological fustian" which clothed the theory of evolution in Victorian days, but he has given us an inverted teleology which works backwards. Palaeontologists would need to turn their tables of strata and of the march of life up-side-down to bring nature into line with such views.

In the same address, Professor Bateson says:—"We go to Darwin for his incomparable collection of facts." And there he would draw the line. Recognising Bateson's great ability and remembering the great amount of work he has accomplished, we go to Bateson for his "collection of facts," but we cannot accept the views put forward, tentatively, it is true, on his authority. It may be that "the seed-pan and the incubator" do not provide the broad outlook which was gained by such men as Darwin, Huxley and Wallace who found in the wide world a laboratory for study.

Professor Dendy is surely nearer the truth when he says:—"The fact that many new and apparently permanent combinations of characters may arise through hybridisation, and that the organisms thus produced have all the attributes of what we call distinct species, does not justify us in accepting the grotesque view—as it appears to me—that all species have arisen by crossing, or even that the organism is entirely built up of separately transmissible unit characters." He also adds:—"I think it is a most significant fact that the only characters which appear to be inherited in Mendelian fashion are comparatively trivial features of the organism which must have arisen during the last stages of phylogeny."*

It is interesting to note, as H. F. Roberts has pointed out,† that as a necessary application of his theory of pangenesis, Darwin in his "Animals and Plants under Domestication" gave what is virtually a statement of the Mendelian theory of the distribution and recombination of factors in hybrid offspring. A recognition of these facts is a very different thing from the sweeping generalisation which would use the formulae of Mendelism as a key to the whole course of evolution.

Darwin did not believe that variations were due to "chance." On the contrary, he expressly points out that his use of this "incorrect expression" was due to "our ignorance of the cause of each variation."‡

Darwin is greater than Darwinism. He outstripped his own theories and, here and there, exhibited a breadth and a depth of mind and a range of knowledge which might be envied by the controversialists of to-day. In certain quarters there is a tendency to restrict Darwin's views in an unwarrantable way, and to present him as the exponent of arbitary principles. But his own books provide the material for an instauration, and we may often turn with advantage from present-day writers back to the pages of the great master. His transparent honesty caused him to extend some of his earlier views. Huxley gives an important quotation from a letter written by Darwin in 1876 to M. Wagner, where he says:—"In my opinion, the greatest error which I have committed has been not allowing sufficient weight to the direct action of the environments, *i.e.*, food, climate, etc., independently of natural selection. . . . When I wrote the 'Origin,' and for some years afterwards, I could find little good evidence for the direct action of the environment; now there is a large body of evidence. . . . ."§

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*Dendy: Report British Assn., Australia, 1915, p. 393.

† "Nature," August 14, 1919.

‡C. Darwin: The Origin of Species, 6th edit., 1886, p. 106.

§Proc. Royal Society, Vol. 44, 1888.

The "large body of evidence" is now far more impressive. In a notable work*, J. E. Adami states:—"To the worker in bacteriology the hesitancy on the part of biologists to accept environment as a most important factor in originating variation is almost incomprehensible." Later he adds (p. 161):—"Individual variation is not primarily due to any inherent tendency on the part of living matter to vary. On the contrary, living matter is capable of *being varied* according to its environment."

Lloyd Morgan and others have restricted "variation" to differences arising germinally, whilst acquired characteristics are called "modifications," the former being a product of nature, and the other of nurture. Archdall Reid has shrewdly criticised these distinctions and has shown that they cannot logically be maintained. It might almost be stated that a variation, in this sense, is a modification so deeply rooted that the cause is obscure. In any case, light is now being shed on the origin of germinal variations. Lloyd Morgan suggests that plastic modifications may pave the way for them. The exponents of vitalism postulate potencies or entelechies in the germ which they claim are the real factors of variation. But this is but a confession of our ignorance of causes and is a mixture of metaphysics and science. Professor E. W. MacBride criticises† the views of Driesch "in calling up spirits from the void," and adds:—"We thus come to the conclusion that for the present we may dismiss the conception of the entelechy from our minds as a working hypothesis and adopt instead the conception of organ-forming substances. . . . ." One may appropriately add here Dr. J. S. Haldane's remark:—"We neither need, nor will have, any ghosts in physiology."‡

There is still much controversy on the inheritance or non-inheritance of acquired characteristics. It seems to the writer that the arbitary distinction made between somatogenic and blastogenic characteristics is due to our

*J. G. Adami: Medical Contributions to the Study of Evolution, 1918, p. 151.

†E. W. MacBride, Rep. Brit. Assn., 1916, p. 409.

‡J. S. Haldane: The New Physiology, 1919.

taking as evidence a mere transverse section of the tree of life. At the most, only a few generations of the more complex organisms can be studied. Let me risk re-stating an old argument by outlining the development of an organism in a special and novel environment. It can be demonstrated by experiment, and it will be generally admitted, that most organisms tend to vary when subjected to unusual conditions, *i.e.*, when placed in a novel environment which is not so abnormal as to bring about extinction. In the lifetime of the first individual any variation would be classed as "transient" (Weismann), and the proof of its heritability is not accepted. But if the novel environment be maintained, as in the substitution of fertile conditions for eremian plants, or lower altitudes for alpine species, each generation would be re-subjected to the same stimuli. Such changes in environment frequently occur in nature owing to geological and climatic factors. The cumulative effects of such responses on the race is to give specific and even generic distinctions from allies in an adjacent primitive environment. Ultimately we find in special environments, which have apparently existed for long periods, remarkable modifications to the needs of the organism in that environment. Natural selection would of course, weed out unsuitable individuals. It is surely more logical to assume that these once acquired characteristics are heritable to a very large extent and that each individual does not go through, as an individual, the whole process of transformation. To assume that natural selection has to wait for the occurrence of favourable fortuitous germinal variations is to blind one's eyes to the many experiments demonstrating that a multitude of organisms are plastic, and that great modifications in *a particular direction* may be induced by an artificial change in environment.

Sir Ray Lankester has criticised the two laws of Lamarck which have been summarised by Prof. Poulton, as follows:—Lamarck's "first law assumes that a past history of indefinite duration is powerless to create a bias by which the present can be controlled; whilst the second assumes that the brief history of the present can readily raise a bias to control the future." Lankester points out that these first and second laws of heredity are contradictory the one of the other, and therefore may be dismissed."*

But with all due deference to the great authority of Lankester, it is possible to outline developments of environments which would provide stimuli in consonance with the requirements of Lamarck's two laws. It is obvious from geological teaching, that environments have been stable and unstable, periods of fixation alternating with periods of change: an environment continually changing in a definite direction (such as the rise of the Himalayas, or the transforming of a fertile region into a desert), and then maintaining that changed condition, would enable Lamarckian laws to operate, providing one admits—though this contention would be strongly criticised—that cumulative effects of stimuli through many generations would be more potent than the stimuli apportioned to a single life-time.

Modern biologists have, of course, gone far deeper than Lamarck, for they are giving us the key to the mechanism which brings about functional adaptations, which is not apparently to be found in the "entelechy" of the organism.

In his well-known book on Heredity, J. A. Thomson gives a comprehensive summary of the question.† He suggests that neo-Lamarckians may be identifying *post hoc* with *propter hoc*, and states a formidable list of "Misunderstandings." Although making judicial qualifications, he gives strong support to those scientific writers who, in defiance of Huxley's dictum, have adopted a creed—that acquired characteristics cannot be transmitted. From this standpoint all difficulties can be explained. If gout be inherited, then gout is not an acquired character, but a germinal variation made manifest by habits which give a stimulus to its expression. Whenever a modification is proved to be transmissible, it should be regarded as a congenital variation or else as a "reappearance." If transmissibility be demonstrated for unicellular organisms,

*Ray Lankester: The Kingdom of Man, R.P.A. Reprint, 1912, p. 76.

†J. A. Thomson: "Heredity," 1908, Chapter VII.

or for moulds, rule them out because of the lack of marked distinctions between soma and germ-plasm. When experiments show that brine shrimps (*Artemia*) may be transformed from one type to another by lessening the salinity of the water, Professor Thomson suggests that "the altered salinity simply pulled the trigger of variability."

In a review of this subject, H. M. Fuchs quotes* a large number of experiments by W. E. Castle and J. C. Phillips, Kammerer and others which yield contradictory evidence. Kammerer's results with ingrafted ovaries in salamanders demonstrate that the characters of the foster-soma had impressed themselves on the grafted ovary. Fuchs concludes that "we are compelled to question the teaching of Weismann regarding the total independence of the 'germ-plasm.'"

Experiments with plants are also contradictory. When the seeds of lowland *Capsella* were sown in high altitudes, plants of the distinct highland type developed, whereas the highland form remained true when bred in the lowlands. Alpine specimens of *Solidago* also retained their peculiarities when removed to lowlands, the acquired characteristics being heritable. Nägeli's similar experiments with *Hieracium*, however, showed no stability, the environment being capable of transforming and retransforming them.

Adami quaintly remarks that around this question "there has been developed such a muddle that no amount of midnight oil and wet cloths bound around the temples permit the ordinary mortal to disentangle and follow the course of one theory." Although the writer has not been driven to the exigencies suggested, this address may demonstrate still further the truth of Adami's remarks. One thing is clear: the processes of nature were not teleologically conceived to meet the needs of students of philosophical biology.

There may be, as in the conflict over the hanging trophy shield of old, one side of which was golden and the other silver, two correct views. Just as in the long record

*H. M. Fuchs: "Bedrock," April, 1914.

of palaeontology we have our Lingulas, the Nautilus and other forms remaining practically unchanged, so in the world of life to-day many organisms, largely by reason of their complete adaptation to a certain type of environment, remain invariable, the hereditary forces being more potent than the factors which make for change; others, in contrast, are protean in their plasticity, and still in process of rapid evolution.

In the "Origin of Species," Darwin definitely expressed his belief in the inheritance of modifications caused in domesticated animals through the use or disuse of certain parts (Chapter V.) He also quotes an instance in free nature which affords valuable evidence on similar lines, natural selection not being lost sight of in the citation. The instance is that of the development of the eyes of the Pleuronectidae or flat-fishes, which in very early life are situated opposite from each other, the body being symmetrical, but which in the adult flat-fishes are found close together on the upper side of the head. Quoting Malm's observations, Darwin* states: "The Pleuronectidae whilst very young and still symmetrical, with their eyes standing on opposite sides of the head, cannot long retain a vertical position, owing to the excessive depth of their bodies, the small size of their lateral fins, and to their being destitute of a swim-bladder. Hence soon growing tired, they fall to the bottom on one side. Whilst thus at rest they often twist, as Malm observed, the lower eye upwards, to see above them; and they do this so vigorously that the eye is pressed hard against the upper part of the orbit. The forehead between the eyes consequently becomes, as could be plainly seen, temporarily contracted in breadth. On one occasion Malm saw a young fish raise and depress the lower eye through an angular distance of about seventy degrees. We should remember that the skull at this early stage is cartilaginous and flexible, so that it readily yields to muscular action. . . . Judging from analogy, the tendency to distortion would no doubt be increased through the principle of inheritance. . . . We thus see that the first stages of the transit of the eye from one side of

*Darwin: The Origin of Species, 6th ed., 1886, pp. 186-188.

the head to the other . . . may be attributed to the habit, no doubt beneficial to the individual and to the species, of endeavouring to look upwards with both eyes, whilst resting on one side at the bottom. . . . We should keep in mind as I have before insisted, that the *inherited effects of the increased use of parts and perhaps of their disuse*,* will be strengthened by natural selection. For all spontaneous variations in the right direction will thus be preserved : as will those individuals which inherit in the highest degree the effects of the increased and beneficial use of any part. How much to attribute in each particular case to the effects of use, and how much to natural selection, it seems impossible to decide."

There can be no question that the ability of the young flat-fish to move the lower eye to the position seen in the mature fish is now part of the inherited outfit of the organism, enabling it to respond to the stimuli of environment. It does not appear as a novel character in each individual. The result, however, depends on favourable circumstances. To quote Alexander Agassiz on flounders : "There are right-sided and left-sided species, and it is curious to note that nature does not furnish the individual with an unfailing instinct as to which side it is fitting to lie down on. In one case, out of fifteen individuals, no less than eight lay down on the wrong side, and perished of what appeared to be a sort of brain trouble."†

In his logical enumeration of "four different complexes of causes" underlying variation of type, H. F. Osborn,‡ the well-known American scientist, regards environment as a powerful factor in evolution, but emphasises the energy of the organism. Obviously his views cannot be summarised in this address. (We note parenthetically an important point made by Osborn on the origin of life itself by regarding it as "a continuation of the evolutionary process rather than an exception to the rest of the cosmos . . . ." A twentieth century

*Italics ours.

†Life of Alexander Agassiz, 1913, p. 156.

‡H. F. Osborn : The Origin and Evolution of Life, 1918 etc.

Bastian will probably demonstrate this by undeniable laboratory experiments).

The dominance in a variety of habitats of such a plant as *Oxalis corniculata* and such an animal as *Epimys rattus* might be mentioned as an instance of the energy of an organism. But surely we must recognise that at the foundation of this energy or "initiative" there are physico-chemical causes.

The character of the environment is obviously of vital importance. It is a mere truism to say that without a suitable environment, containing water, carbon dioxide and salts, life would be impossible. There are reciprocal relations between adaptations in organisms and special conditions in the environment. Changes in environment necessarily precede special adaptations in organisms. Thus, on primary grounds, environment is the dominant factor in evolution. Temperature and humidity are of paramount importance, and, as pointed out by Gadow, a "change into a colder environment is a more powerful factor than change into a warmer climate."* A prolonged drought will change the character of the biota of a country and will exterminate whole species. Parallel effects must obviously have been associated with the great glacial periods of the past, and, in certain areas, with the great periods of volcanic activity. Subsequent changes doubtless provided special opportunities for organic extension. We may surely quote here from R. S. Lull a record of palaeontology:—"The stream of life flows so slowly that the imagination fails to grasp the immensity of time required for its passage, but like many another stream, it pulses as it flows. There are times of quickening, the expression points of evolution, and these are found to be coincident with geologic change."† Darwin's inference "that variability mainly depends on changed conditions of life"‡ is now surely proven. It will probably be found,

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*H. Gadow: The Wanderings of Animals, 1913, p. 53.

†R. S. Lull: The Evolution of the Earth and its Inhabitants, Yale, 1918.

‡Darwin: Variation of Animals and Plants, II., 2nd edit., 1890, p 413.

as in a case noted by the writer in conjunction with C. T. White,* that most mutations arise when organisms are subjected to a novel environment. Unusual nutritive factors, as recognised by De Vries, are obviously of importance.

Among instances of modifications in a particular direction as the result of a change in environment we may note three examples: several unrelated species of mangroves tend to develop in their usual habitat asparagoid pneumatophores, and if found on reclaimed land they tend to dispense with these, as pointed out by A. A. Hamilton.† If a change of environment cause a loss, surely the original gain was the result of environmental stimuli. In a dry habitat the stomata of plants are found, by comparison, to be fewer than those in allied species in more fertile zones.‡ In a marine environment such diverse mammals as the walrus, seal, dugong and various Cetaceans exhibit a simplification of the stapes, associated with disuse of the organ of hearing. It is difficult to conceive that such changes result from fortuitous germinal variations corrected by natural selection, although that great factor necessarily operates and eliminates the unfit. Many minor structures, however, seem to be of no special utility, neither are they disadvantageous, as outlined in my previous paper. In a special environment factors may operate which bring about an orthogenetic development. But if a variety of environments is studied, developments in allied forms will be most complex and may be termed radiogenetic. M. O'Connell has instanced§ an interesting case of orthogenesis in tracing the development of the costae of Perisphinctes. If large numbers of different Ammonites were studied, however, the term orthogenesis would be too restricted to apply. Probably a variety in diet was an important factor in bringing about the extraordinary diversity of the Ammonites, as we have evidence for the operation of this cause in the mollusca to-day.

*Longman and White, Proc. Roy., Soc., Qld. XXX., p. 162.

†A. A. Hamilton, Proc. Linn. Soc., N.S.W., XLIV., 1919, p. 471.

‡Warming: Oecology of Plants, 1909, p. 105.

§M. O'Connell, Amer. Journ. Science, Dec., 1919.

Had we the necessary knowledge to enable us fully to analyse the complex of stimuli afforded by environment —using the word in its widest sense—we should probably be able to account for the origin of all variations which cannot be directly traced to Mendelian mechanisms. The factors of what may be called radial evolution (outlined by the writer in a former paper under the term radiogenesis) would then be made clear. It is difficult to realise the full significance and magnitude of the work done by such experimenters as Jacques Loeb in analysing the mechanism of animal conduct and in demonstrating the role of tropisms.* Loeb does not accept the inheritance of acquired characters as adequately proved, but he boldly states that "the quantitative laws prevailing in the effect of environment upon organisms leave no more room for the interference of a 'directing force' of the vitalist than do the laws of the motion of the solar system" (loc. cit., 1916, p. 317).

Although Weismann in his great work, "The Evolution Theory," gives no support to neo-Lamarckian views, it is noteworthy that in the second volume there is a whole chapter on "Influence of Environment." He also records the influence on the germ-plasm of "very minute nutritive changes" (p. 196).

The importance of food as a factor in variation is generally recognised. Charles Darwin stated:—"Of all the causes which induce variability, excess of food, whether or not changed in nature, is probably the most powerful."† The great diversity to be found in land shells is well known, and this is probably due to divergencies in diet. The contours of the shells of Helicidae correspond with the shape of the visceral sac. According to the experiments of Simroth, quoted by Weismann,‡ "a change of diet may evoke many kinds of changes in the structure of the food-canal, which may indirectly compel changes in the shell."

*J. Loeb: The Dynamics of Living Matter, 1906: The Organism as a Whole, 1916. Forced Movements, Tropisms and Animal Conduct, 1918.

†Darwin: Variation of Animals and Plants under Domestication, II., 2nd edit., 1890, p. 244.

‡Weismann: The Evolution Theory, II., 1904, p. 302

The extraordinary variation in the teeth of vertebrates may also be instanced. Many writers have pointed out the wide range of dental characters to be found in the Marsupialia, obviously illustrating adaptations to diet. Herbert Spencer was apparently the first to remark how plastic were the teeth of domesticated dogs, through use and disuse, and how they had degenerated in the pug-dog, King Charles Spaniel and other indoor dogs.* N. Hollister has demonstrated that lions reared in captivity show cranial differences which would be considered of specific value in wild animals. These differences are the result of the non-development of "gripping, holding, tearing, biting and shaking" muscles owing to methods of feeding in captivity. These changes "are thus produced in the life of a single individual within from five to seven years almost as rapidly as if by 'mutation.'"† The megadont molars of a negro or of an Australian Aboriginal, when compared with those of a European reared on a comparatively soft diet, are of interest here. The third molar in these lower races is frequently larger than the second and may have five cusps. It is, of course, true that such characters remind us of those of anthropoid apes, and the occasional presence of a fourth molar may be a primitive feature,‡ accessory molars being common in apes.

Many well-known examples can be quoted with regard to insects. As Prof. W. M. Wheeler points out in his important study of ants, the food of the larva is "one of the most important of all stimuli."§ By feeding larval workers with "royal jelly," the period of development in the bee is accelerated and a queen is formed. (Parenthetically, it may be noted that Wheeler criticises in this book Weismann's views as to the powerful support given to his theories by the prevalence of neuters amongst certain Hymenoptera).

The functions of endocrine organs or ductless glands (such as the pituitary body, the pineal gland, the thyroid

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*H. Spencer: Essays, I., 1891, p. 401.

†N. Hollister: Proc. U.S. Nat. Mus., LIII., 1917, p. 177.

‡Longman: Mem. Qld. Mus., VI., 1918, p. 4.

§W. M. Wheeler: Ants, Their Structure etc., 1912 p. 103

gland and the suprarenal bodies), only investigated in recent years, show how greatly an organism may be modified from within. Prof. Arthur Keith, in his address to the Anthropological section of the British Association in 1919,* reviewed the morphogenetic mechanism of these glands. He gives the opinion that a reduction or alteration in the activity of the thyroid has been a factor in determining some of the characteristics of the Mongol and Negro races and supports the theory that "the conformation of man and ape and of every vertebrate animal is determined by a common growth-controlling mechanism which is resident in a system of small but complex glandular organs." Some of the modifications effected are the result of abnormal conditions in these glands, initiated by an injury or by disease, the stimulus being derived from the environment. It seems probable that food may indirectly play an important part in stimulating or inhabiting the functions of these glands. According to W. W. Swingle's experiments, metamorphosis in tadpoles is accelerated when they are fed with iodine, the thyroid being enlarged Dr. J. T. Cunningham has expressed the view that external stimulations may effect the genital cells through the chemical influences of these glands, "so as to produce some hereditary effect in succeeding generations."†

The origin of variations—the fundamental problem of evolution—is thus no longer wrapped in complete mystery. It seems that the vitalists are being gradually driven to restricted areas in the fields of biology. Samuel Butler said that all progress is based upon a universal desire on the part of every organism to live beyond its income. But it is surely the result of organisms living in an environment which supplies them with an income in excess of their needs. One thing is obvious: the less complex the environment the more uniform is the fauna and flora, whether we study the present or the past. The march of life through the long ages has developed in consonance with the growing complexity of environments, from the simplicity of tellurian conditions in the earliest geological periods on to the diversity of to-day.

*A. Keith, "Nature," Nov. 13, 1919.

†J. T. Cunningham, P.Z.S., 1908, p. 434.

We find that the facts of evolution are far wider than the theories. Such writers as Windle indirectly discredit scientific work when they gibe at discrepancies in theories. Windle quotes, for instance, six different views as to the evolution of vertebrates.* But instead of stultifying the doctrine of evolution, these theories, in so far as they are entitled to serious consideration, provide new data for it. This may be illustrated by taking W. Patten's book on the evolution of vertebrates.† Whether one accepts the main contention or not, we must recognise the value of many enumerated facts. The book demonstrates the relationships of organisms, and shows how the impress of common descent has been woven into the web of many groups now divergent.

In conclusion, I venture to break somewhat away from the subject matter to claim that man—modern man—cannot be placed in the category of organic things as a servile subject of environmental forces. It is probably true, as J. Barrell points out,‡ that changes in climate causing disappearance of jungles may have influenced the evolution of bipedal man from arboreal anthropoids. But man to-day has power largely to make and control his environment. In his wonderful epic-drama, "The Dynasts," Thomas Hardy has depicted man as a puppet in the thrall of circumstance. But man as a social and a reasoning animal refuses to be bound Ixion-like to the wheel of circumstances. He deliberately attempts to mould nature to suit his needs: nay, more, he attempts to control and mould himself. In his remarkable Romanes Lecture on Evolution and Ethics, Huxley claimed that the progress of society depended upon man's combat with the "cosmic process"; man had long since emerged from the heroic childhood of our race, and he was now able to influence and modify the cosmic process, the dwarf bending the Titan to his will. Although there may be no millenium ahead, we are grown men and must play the man.§

*B. Windle: "Facts and Theories," 1912, p. 121.

†W. Patten: "The Evolution of the Vertebrates and their Kin," 1912.

‡J. Barrell: Scientific Monthly, Jan., 1917.

§Huxley: Evolution and Ethics, 1895.

Biological workers have gone far beyond the portals of the great domain of knowledge. We realise a prodigious diversity of forms, living and extinct, ranging from the commonplace to the grotesque and to the beautiful, and varying in attributes from the malignant to the beneficent. A globule of fluid, seen under the microscope, may reveal a multitude of deadly bacteria. A tiny fragment of some organism may exhibit a complex structure of marvellous beauty. "Whence this process . . . ? To what end ?" asked Herbert Spencer, at the close of a life spent in searching for truth. And the adequate answer is yet to be given. We dare not dogmatise. Man gropes from the known to the unknown, from the measurable to the unmeasured. It is high task of scientific workers to win here and there definitely recorded facts of nature, as the years go by, and our hope is that the conquests of the future will bring a far wider knowledge within the purview of the mind of man.

NOTES ON THE CHALCID PARASITES OF MUSCOID FLIES IN AUSTRALIA.

By Prof. T. HARVEY JOHNSTON, M.A., D.Sc., and M. J. BANCROFT, B.Sc., Walter and Eliza Hall Fellow in Economic Biology, University, Brisbane.

(*Read before the Royal Society of Queensland 28th April*, 1920).

(Text-figures 1-7).

On account of the economic importance of Muscoid flies, since they include not only the house fly or typhoid fly but also most of the various sheep maggot flies or blow-flies as well as the common "bush flies" of Australia, considerable attention has been given to the study of their hymenopterous parasites, at least one of which has been utilised in New South Wales and Queensland as an agent to assist in controlling the spread of these Diptera. It has also been suggested to the Federal authorities by an eminent British entomologist that a number of species might, with advantage, be introduced from England to assist in this work.

Mr. W. W. Froggatt has done a considerable amount of work on fly parasites, having dealt with no less than three, viz., *Nasonia brevicornis*, *Chalcis calliphoræ* and *Dirrhinus sarcophagæ*, which destroy pupæ of one or more of the sheep maggot flies.

In this paper we propose (1) to give our own observations on two species, one of which is now recorded for the first time as occurring in Australia; (2) to briefly review the work on the parasites recorded as being already present in the continent; and (3) to discuss the suggestion that certain other wasps might be profitably introduced.

The following five muscid-destroying chalcids are now known to occur in Eastern Australia: (1) *Spalangia muscidarum*; (2) *Nasonia brevicornis*; (3) *Chalcis calliphoræ*; (4) *Dirrhinus sarcophagæ*; (5) *Pachycrepoideus dubius*. The first, second and fifth belong to the Pteromalidæ and to the subfamilies Spalangiinæ, Pteromalinæ, and Sphegigasterinæ respectively: while the others are members of the Chalcididæ. The first, second and fifth are known from Queensland, the second, third, fourth, and perhaps also the first, from New South Wales.

(1) *Spalangia muscidarum* Richardson
(Text-figures 1-7).

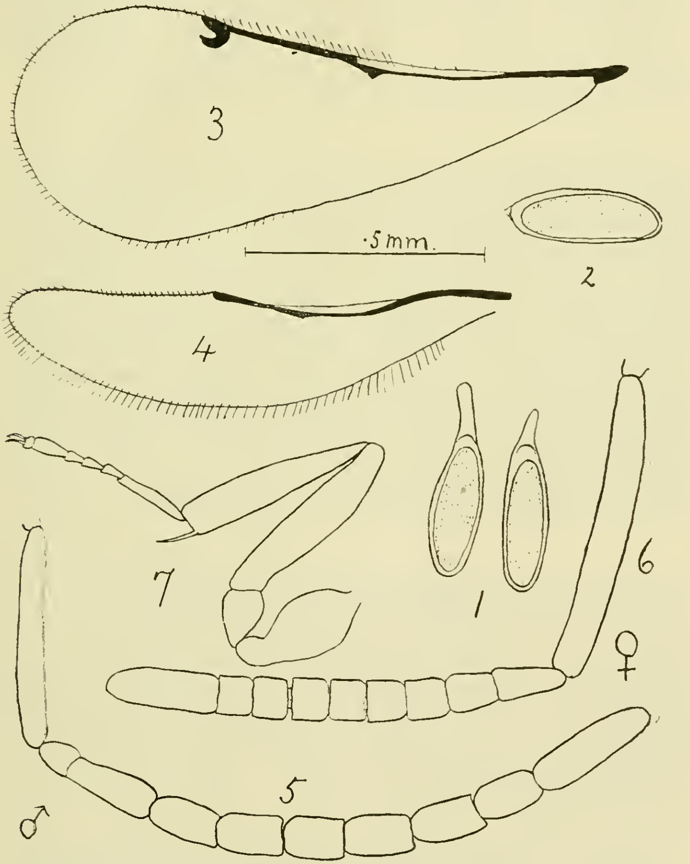
During November and December, 1919, when numbers of *Musca domestica* L., *M. fergusoni* Johnston and Bancroft, *M. vetustissima* Walker, and *M. terræreginæ* Johnston and Bancroft* were being raised in the laboratory at Eidsvold, Burnett River, Queensland, in connection with our work on flies as transmitters of worm parasites of stock, it was noticed that in several batches the percentage of flies emerging was very low, viz., from 15% to 61%. Thus in one experiment with house flies the larvæ pupated on November 21st and a few flies emerged on November 29th and 30th. No more having emerged after the lapse of over a week, the pupæ were collected and counted, when it was found that flies had emerged from only 15 per cent. of them. The remaining pupæ were placed in tubes. On December 15th several small black chalcids averaging about 3 mm. in length were noticed, more emerging during the succeeding days. As they appeared, the little insects were transferred to a large jar the end of which was covered with a piece of cloth, and were fed by smearing honey and water on the cloth. Copulation was observed to occur at once and females readily attacked fresh fly pupæ on the day of emergence.

When about to oviposit, the female walks over the pupæ testing the surface with her long flexible antennæ. A suitable place having been found, the sharp piercing stylet connected with the ovipositor is brought into play and a tiny hole bored in the chitin of the puparium. A few minutes is usually sufficient to effect a puncture, the stylet being thrust for its whole length into the wound.

The eggs are minute oval structures measuring from 0.4 to 0.45 mm. in length by 0.1 mm. in breadth. The shell is minutely papillose except at one end which is drawn

*If Townsend's genera be accepted, then these flies are respectively *Promusca domestica*, *Viviparomusca fergusoni*, *Eumusca vetustissima* and *Promusca terræreginæ*.

out into a blunt projection (fig. 1) varying somewhat in length. This point is not obvious in the uterine egg (fig. 2). The larva on hatching is a tiny white segmented creature which applies its mouth to the surface of the fly pupa and gradually increases in size at the latter's expense. When the chalcid larva pupates, it assumes the form of the adult, the structures being, however, soft and white and surrounded by a clear envelope. During the pupation stage the hard chitinous cuticle of the imago is developed.



Text-figures—camera lucida drawings, all to the same scale.

Spalangia muscidarum: fig. 1, egg from fly pupæ; 2, egg from uterus; 3, 4, fore and hind wing of female; 5, antenna of male; 6, antenna of female; 7, third leg of male.

When the insect is ready to leave the pupa case of its host, it gnaws an irregular hole at the anterior end and crawls out. Nothing is left of the fly pupa by this time but a dark shrivelled mass. Both sexes of the chalcid are capable of flight immediately upon emergence.

The sexes differ (as has been mentioned by Richardson) in the form of the abdomen which is shorter and more spindle-shaped in the male, whereas that of the female has a prominent projecting terminal region ; and in the shape of the head, which in front view is seen to be relatively broader and shorter in the male. The antennæ are also unlike, the difference being indicated in our figs. 5 and 6.

As far as our experience goes only one chalcid develops in each parasitised fly pupa, thus from 53 pupa cases of which individual record was kept only 53 chalcids emerged. The size of the perfect insect depends upon the size of the pupa in which it developed. In one instance a pupa was examined two days after oviposition had taken place, six eggs and two small larvæ of the chalcid being found in it. Two *Spalangia* have occasionally been seen ovipositing at the same time in one pupa. The period of time elapsing during summer (December to February) between the laying of the egg and the emergence of the wasp is between three and four weeks (21 and 28 days).

Pinkus (1913) found that in the laboratory in Texas during the winter months the period varied from 79 to 109 days when the average mean temperature was 56° Fahr. ; but that in a situation which was considerably warmer the period was shortened to 61 days ; while in parasitised puparia kept out of doors during the winter the larvæ developed very slowly and did not emerge, no doubt overwintering in the pupæ.

Our results show that larval development is passed through very rapidly under Queensland summer conditions. This is a factor which renders it particularly valuable as a means for controlling the spread of noxious muscids in this State.

Pupæ of various muscids were collected and examined during the summer in order to ascertain the percentage infection.

Species.	No. examined	No. parasitised	Percentage
M. domestica	76	64	84
M. fergusoni	214	84	39
M. vetustissima	15	11	73
M. terræreginæ	83	16	73
Total	386	175	45

In addition to these four flies, others were found to be liable to become parasitised and destroyed by *Spalangia*, viz., *Musca hilli* Jnstn. and Bancr. ; *Stomoxys calcitrans* ; and certain blowflies (*Pycnosoma rufifacies*, *P. varipes* and *Sarcophaga misera*). We have not yet experimented with other local blowflies (*Lucilia sericata*, *Neopollenia stygia*, *Anastellorhina augur*, *Calliphora* spp. *Sarcophaga* spp., *Ophyra*, etc.), but there can be little doubt but that the parasite is able to attack them as well as local species of *Fannia*, *Pyrellia* and *Pseudopyrellia*.* The fruit fly, *Tephritis tryoni*, did not prove a suitable host in the one experiment carried out by us.

As far as we have been able to ascertain this constitutes the first record of *S. muscidarum* from a locality outside the United States. Froggatt and Froggatt (1917, p. 32-3), gave a brief description and figures of an unidentified parasite obtained from a blowfly (? *Ophyra nigra*). Though the figures do not quite agree with those of our specimens they probably refer to *S. muscidarum*. In 1918 (p. 18) these authors referred to the species having been bred from pupæ of *Musca domestica*, near Hay, N.S.W.

* We have since found that *Spalangia* will parasitise *N. stygia*; *A. Augur*; *Calliphora incisuralis* (so named in Mr. H. Tryon's repo ts, but Dr. E. W. Ferguson informs us that it is known as *Pycnosoma dux* in Sydney); and the two common species of *Sarcophaga* found in Brisbane, one being apparently *S. frontalis* while the other is a large golden-faced species with an elongate abdomen.

There appear to be three species of Spalangia described as parasites of fly pupæ, viz., *S. hirta* Hal (Graham-Smith, 1919, p. 375, fig. 18) and *S. nigra* Boule from Europe: and *S muscidarum* Richardson from various localities in the United States. *Spalangia* sp. was figured by Hewitt (1914. p. 167).

Howard (1911, p. 89) referred to finding one (*S. muscæ*, MSS. name) parasitising house fly pupæ in Washington D.C. This was not described until 1913 when Richardson named it *S. muscidarum*, his material coming from Massachusetts (*Musca domestica*) and Texas (*Stomoxys calcitrans*).

Bishopp (1913, p. 124) reported that two species of Pteromalidæ parasitised the pupæ of *Stomoxys*, one of them being S. *muscæ* (*i.e.*, *S. muscidarum*). Forty per cent. of the pupæ bred at Dallas, Texas, were found to have been destroyed by these wasps which were capable of killing the pupæ of the house fly and certain other muscids as well.

Pinkus (1913) mentioned that *S. muscidarum* was the commonest parasite of the stable fly at Dallas, Texas, and gave a description of its habits and larval stages. It was stated that the wasp did not discriminate, when given the opportunity to oviposit in the pupæ of various specified muscids.

Girault (1913, p. 332-3) described three species of *Spalangia*, *S. grotiusii*, *S. australiensis*, and *S. virginica* as well as two of *Spalangimorpha*, *Sp. fasciatipennis* and *Sp. frater* (p. 334) all from North Queensland. The three species of *Spalangia* as well as another, *S. parasitica* (also from North Queensland), and *Sp. fasciatipennis* were further described by him in 1915 (pp. 345-6). As far as is known none of these attack flies.

(2) *Nasonia brevicornis* Girault and Sanders.*

This tiny chalcid was described in 1909, the account being supplemented in 1910.† The first record of its occurrence in Australia seems to have been made by

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*Reference to the habits of this and other hymenopterous parasites of flies is made by Howard (1911, p. 89-95); Hewitt (1914. p. 167-170); Graham-Smith (1914, p. 242-4).

†Girault, A.A. and Sanders, G.E. The Chalcidoid parasites of the common house or typhoid fly and its allies. Psyche. 16. 1909. pp. 119-132: 17, 1910, pp. 9-28.

Girault (1913, p. 307) who found it in Brisbane in October, 1911, and subsequently reported it (1915, p. 316) as having been bred in October, 1913, by Mr. E. Jarvis, from the sheep maggot fly at Longreach and Aramac in Western Queensland. Jarvis (1913, p. 15) gave a brief account of the parasite, but did not identify it.

Froggatt (1914, p. 110) called attention to the presence in New South Wales of these active ant-like wasps (which he then believed belonged to a native species), parasitising certain blowflies, *Calliphora villosa* and *C. oceaniæ* (*i.e.*, *Neopollenia stygia* and *Anastellorhina augur* respectively), as well as the prevalent "sheep maggot fly" *C. rufifacies*. The parasite (evidently a female) was figured and a short account of its habits published. Later in the same year he and McCarthy (1914), reported the chalcid to be *N. brevicornis* which was stated to attack particularly those blowflies which possessed smooth thin-skinned pupæ, *C. villosa*, *C. oceaniæ* and *C. erythrocephala*, only infesting the stoutly-spined pupæ of *C. rufifacies* when the former were not available. A detailed account of the breeding habits was given (see also Froggatt, 1915 ; Froggatt and Froggatt, 1916, 1917, 1918—also quoted at length by Graham-Smith, 1916, p. 534, 536-7). Figures of both sexes as well as a short account of the breeding habits have been published recently by Graham-Smith (1919, p. 372-4, figs. 14, 15).

The Commonwealth Institute of Science and Industry has been engaged in rearing this chalcid species near Roma, Queensland, and distributing it where desired in order to control the "sheep blowfly" pest.

We have bred out numbers from pupæ forwarded from Roma by Mr. F. H. Taylor. The maximum number obtained by us from any one blowfly pupa was 18. Froggatt and McCarthy (1914, p. 763) reported finding as many as 75 and as few as two, the usual number being between 25 and 36 per pupa. We found that *Nasonia* will parasitise *Musca domestica*, *M. vetustissima*, *M. hilli* and *M. terræ-reginæ* as well as the blowflies already mentioned. We have not yet tested its action regarding other Muscoid flies. Froggatt and Froggatt (1917, p. 29), stated that in their laboratory experiments the wasp would indiscriminately lay eggs in fly pupæ of any species (presumably muscoid) apparently showing no particular preference.

(3) *Chalcis calliphoræ* Froggatt.

This chalcid was described from the Hay district of New South Wales by Froggatt (1916, p. 506), as a black wasp about the size of a house fly, with reddish-yellow antennæ, oval shining red-brown abdomen and with thickened hind legs. It is a hardy species which breeds readily in captivity, a single insect killing and emerging from each parasitised pupa. The insect attacks the blow-fly (*Calliphora oceaniæ*) while the latter is in the active maggot stage and apparently does not prevent its pupation (See also Froggatt and Froggatt, 1917, pp. 29-31).

(4) *Dirrhinus sarcophagæ* Froggatt.

This rather large chalcid (6 mm. long) which is about the size of a large house fly, has been recently described by Froggatt (1919) as parasitising the pupæ of the "common flesh fly" (*Sarcophaga aurifrons*). It has highly modified hind limbs which are used to enable the wasp to burrow into the loose soil to reach the pupæ lying an inch or more below the surface.

A species *D. biffardi* Silvestri has been used in Hawaii against the fruit fly.

(5) *Pachycrepoideus dubius* Girault and Sanders.

This chalcid parasite belonging to the Pteromalidæ was recorded by Girault (1913, p. 330) as having been caught on windows at Nelson (March and April, 1912), Cooktown (February 1912) and Herberton (December, 1911), North Queensland. It was originally described as a house fly parasite in U.S.A. No doubt it attacks and destroys various flies in Queensland.

Remarks on certain other hymenopterous parasites capable of controlling the spread of flies, and which might be utilised in Australia against "sheep maggot flies."

Graham-Smith in two excellent papers containing his observations on the habits and parasites of common flies in England (1916, 1919), has published interesting information regarding the hymenopterous parasites which attack fly pupæ or larvæ, ultimately destroying them. The most important as fly controllers seem to be *Alysia manducator*, *Aphæreta cephalotes* Hal. (both belonging to the Braconidæ) and *Melittobia acasta* Walker (Chalcididæ).

Alysia manducator: Graham-Smith's observations (1916, p. 524-531, figs. 12, 13; 1919, p. 376-381, fig. 20), on this relatively large Braconid which is as long as a house fly, show that it is fairly common in England, parasitising as many as 83 per cent. of fly pupæ collected at certain times, being present particularly in those obtained from sheltered situations. "These facts reveal the extraordinary destruction wrought by these parasites and indicate that larvæ feeding in warm and sunny situations are more liable to attack than those living in shady places" (Graham-Smith, 1916, p. 530). The female which lives only a few days in confinement, attacks and oviposits in larger living larvæ, not waiting for them to pupate. In one experiment Graham-Smith (1919, p. 380) found that a female deposited eggs in at least 206 out of 544 larvæ provided; that 80 other larvæ died, possibly due to infection by the insertion of the ovipositor: and that no less than 343 eggs were still contained in the wasp's ovaries. "Under more natural conditions it is likely that she would have infected a greater number, as the ovaries contained at least 549 eggs." This wasp over-winters as a pupa, emerging in the spring. Its habits should make it a very desirable insect for use against sheep maggot flies in Australia.

Aphæreta cephalotes Hal. This is a much smaller Braconid, being only half the length of the preceding wasp (Graham-Smith 1916, p. 531, fig. 15; 1919, pp. 381-2, fig. 21). From each parasitised blowfly pupa a number (7 to 14) of these insects have been bred out. The species appears to prefer sunny situations for oviposition, small larvæ being selected for the purpose. It passes through the winter while within the fly puparium. From the information available it does not seem to be as valuable a fly-controller as the preceding species.

Melittobia acasta Walker. This is a tiny chalcid whose habits are described in an interesting account by Graham-Smith (1916, p. 532-543, figs. 16 and 17; 1919,

p. 360-371, figs. 10-12). There is a very marked sexual dimorphism, the male possessing rudimentary wings and eyes, as well as peculiarly modified antennæ. The female can live in confinement for a long period (33 to 36 days average—95 the maximum noted) and lay up to 300 eggs. The males have a short life and do not leave the puparium in which they were developed.

This remarkable insect also parasitises the larvæ of solitary wasps, as well as the pupæ of the Tachinid fly which itself parasitises the wasps (Malyshev 1913, *fide* Graham-Smith 1919, p. 371). It is thus both a parasite and a hyperparasite. Howard and Fiske (1912) whose remarks are quoted by Graham-Smith (1919, p. 368, 370), found it attacking several kinds of fly puparia (including Tachinids) and hymenopterous cocoons. Graham-Smith (1916, p. 533) reported that it was not only a parasite of fly pupæ, but acted as a hyperparasite towards the above mentioned Braconid *Alysia*. *M. acasta* is "capable of causing an immense amount of destruction. If it is usually a hyperparasite on the braconid larvæ it is not an insect to be encouraged, since it kills off large numbers of parasites very destructive to flies; if, on the other hand, it usually attacks fly pupæ during the summer months it is most beneficial, its powers of destruction being so great; if, lastly, both braconid and fly larvæ are commonly parasitised, its beneficial action is somewhat neutralised."

In view of the above statement by such an authority as Graham-Smith, and in view of the fact that it is capable of parasitising Tachinid flies and solitary wasps which may be of considerable economic importance in controlling various insect pests, it would probably be unwise to introduce into Australia such a form as *M. acasta* as an agent for controlling the spread of flies.

Dibrachys cavus, another chalcid, seems to be of value as a parasite of fly pupæ, but little information is available to us regarding it (Graham-Smith 1919, p. 371-2, Fig. 13).

None of the foregoing insects were bred out by Mellor (1919) during his work on the habits of various English flies.

SUMMARY.

1. There exist in Eastern Australia at least five hymenopterous parasites which destroy flies (including sheep maggot flies) namely, *Spalangia muscidarum*; *Nasonia brevicornis*; *Chalcis calliphoræ*; *Dirrhinus sarcophagæ*; and *Pachyocrepoideus dubius*.

2. Of the various hymenopterous parasites known elsewhere as destroying fly pupæ, three others appear to be of outstanding importance, viz., *Alysia manducator*, *Aphæreta cephalotes* and *Melittobia acasta*. The last named acts also as a hyperparasite of many useful insects (including *A. manducator* and Tachinids) and should not, in the light of our present knowledge, be introduced into Australia. The other two could apparently be safely introduced if desired to assist those parasites already present. The first named seems to be especially valuable in this connection.

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EXPERIMENTS WITH CERTAIN DIPTERA AS POSSIBLE TRANSMITTERS OF BOVINE ONCHOCERCIASIS.

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(With 16 Text-figures).

(*Read before the Royal Society of Queensland, 28th April,* 1920).

Onchocerca gibsoni Cleland and Johnston.

A survey of the early work on bovine Onchocerciasis was published by one of us in 1911, while later work was again summarised in 1916 (Johnston 1911, 1916).

The probable origin of the parasite and its geographical distribution have been dealt with by Cleland and Johnston (1910) and by Gilruth and Sweet (1911, 1915). The anatomy of the worm, pathological effects and seat of infection have been fully treated by the above mentioned authors and also by Leiper and Breinl.

Nothing is yet definitely known regarding its life history. All efforts to find the embryos in the blood circulation have been unsuccessful, though Cleland showed that they may occur in the subcutaneous tissue. In post mortem examinations of infected cattle, they have been found in smears from the reflected skin or subcutaneous tissue of various parts of the brisket, legs and neck. Cleland also found living embryos in thickened areas under the skin of cattle. Breinl showed that embryos can penetrate the skin of the beast, though he himself regarded the result as perhaps pathological. Nicoll, though unable to confirm Breinl's work demonstrated that the larvæ were capable of migrating through the thick capsule of the nodule in considerable numbers.

The possibility of direct transmission has not been overlooked but it is considered highly improbable. Subcutaneous injection of larvæ, smearing them on the skin and drenching them to a calf in milk have been tried unsuccessfully by several investigators. Various theories have been put forward as to the intermediary host. The idea that it might be (1) a carnivorous animal (Gibson 1893), (2) a leech (Gilruth and Sweet, Breinl), (3) a crustacean (Cleland and Johnston, Breinl), has each been suggested and rejected with little attempt at investigation.* The theories that lice and flies are likely transmitters have received more attention. Gilruth and Sweet (1911) considered that the calf louse *Hæmatopinus vituli* L. presented the most hopeful possibility. Later, however, as a result of their experiments they were compelled to abandon the idea that either of the cattle lice, *H. vituli* or *H. eurysternus*, could act as a means of transmission of *O. gibsoni* (1912).

With regard to the fly theory, the most important work has been carried out by Cleland who examined numerous *Stomoxys calcitrans* after they had been allowed to feed on fresh nodules. Living Onchocerca embryos were found in one case on the third day after feeding (1914). Attempts were also made by the same author in conjunction with Dodd and McEachran (1917) to infect calves by exposing them to the attacks of certain insects. *Stomoxys calcitrans*, *Tabanids* and mosquitoes (*Culicelsa vigilax* and *Scutomyia atripes*) tested thus all gave negative results.

Breinl examined Tabanids, *Stomoxys calcitrans* and several species of mosquitoes fed over nodules, all with negative results (1913).

McEachran and Hill (1915) carried out work similar to Breinl's using *Stomoxys calcitrans*, *Lyperosia exigua*, several species of *Tabanus* and *Silvius* and also *Hæmatopinus tuberculatus* (buffalo louse), but were unable to shew any infection.

The two similar experiments carried out in Darwin by McEachran and Hill (1915) and by Dickinson and Hill (1917) have not lent support to the fly theory (Hill and

*Miss M. Henry has apparently examined Cladocera as possible transmitters (P.R.S., N.S. Wales, 52, 1918, p. 463).

others, 1917). In both these experiments Victorian calves were imported; those allowed to run with the herd became infected, but those confined in an open pen with a concrete floor in close proximity to the paddock containing infected cattle remained unaffected, as also did those kept in a fly-proof pen.

More recently work has been carried out in New South Wales by Dr. Cleland and Miss Somerville (1919) who have made a "nodule survey" of certain parts of that State which shows that nodules are more common in parts of the State which have summer rains than in those where the rainy season occurs in the winter.*

Large numbers of Tabanids have been examined at Kendall, N.S.W. by trained assistants under the direction of Professors S. J. Johnston and J. B. Cleland. Out of several thousands of flies dissected, worms were found in three (Cleland 1918, p. 27), but so far an account of these parasites has not been published.

In 1914, Mr. Henry Tryon (Ann. Rep. Dept. Agric. Queensland 1914, p. 116) suggested the possibility that the larval worms (*Habronema* sp.) which infest the cattle fly, *Musca vetustissima*, might represent a stage in the life history of "*Spiroptera* (*Onchocerca*) *gibsoni*." Mr. Tryon informed us that he had some years previously mentioned the presence of these worms to several individuals interested in helminthology. We now know that the parasites in question are larval stages of *Habronema muscæ* and *H. megastoma*. Cleland stated in 1914 that Onchocerca larvæ were not found alive in the alimentary canal of *Musca vetustissima* 24 hours after ingestion.

A further attempt to follow out the life history of *O. gibsoni* was made during the period November, 1918, to January, 1920. Lines of work were indicated firstly by the prevalent idea that the intermediary was a Tabanid, and secondly by the suggestion of Dr. Bancroft that the intermediary was to be found among the non-blood-sucking flies living in association with cattle, *e.g.*, *M. fergusoni* (Johnston and Bancroft, 1919).

*Robles (Bull. Soc. Path. Exot. 12, 1919, p. 442) believes that certain species of *Simulium* are transmitters of *O. cæcutiens*, a human Onchocerca related to *O. volvulus*, and recently described by Brumpt (Bull. Soc. Path. Exot. 12, pp. 464-473).

The work of Breinl and Nicoll has shewn that the larvæ can penetrate both the capsule of the nodule and also the skin of the beast. It is also possible that the larvæ may travel in the lymphatics and reach a surface where the skin is tender, *e.g.*, round the lips and eyes. If this were the case, their ingestion by certain non-blood-sucking flies would be very probable, since such are commonly to be found round these mucous surfaces. Re-inoculation of the beast would occur by the escape of the larvæ from the fly, while the latter was feeding at a mucous surface.

The investigation centred on the one hand round *Tabanus circumdatus,* the commonest Tabanid of the district, and on the other around *Musca fergusoni* and, to a less extent, *M. vetustissima*, *M. terræreginæ*, and a small black *Fannia* sp.

The method of procedure was as follows:—

(1) Attempt to infect flies by feeding them on fresh nodules.

(2) Examination of wild flies.

Only the latter method yielded at all interesting results, the former being consistently negative. Although the investigation failed in its main object there has been collected a certain amount of information in regard to the helminth parasites of the flies dealt with.

Among the Tabanidæ of the Eidsvold district (Upper Burnett River, Queensland), specimens of the following species have been taken from time to time by Dr. T. L. Bancroft, some of the identifications being made by E. Austen, of the British Museum, and by F. H. Taylor, formerly of the Townsville Tropical Institute, but for most of them we are indebted to Dr. E. W. Ferguson, of the Bureau of Microbiology, Sydney, who has undertaken to work out the various species. There are at least 26 Tabanids, 19 belonging to *Tabanus* (12 named and 7 not fully identified), three to *Silvius*, three to *Pangonia* and one to *Erephopsis*.

Erephopsis guttata Donovan
Pangonia auriflua Donovan
,, *bancrofti* Austin (*Erephopsis bancrofti* Taylor)
,, *concolor* Walker

*	*Silvius*	*australis* Ricardo
*	,,	*notatus* Ricardo
*	,,	*psarophanes* Taylor
	Tabanus	*regis-georgii* Macquart
	,,	*cyaneus* Wied.
	,,	*circumdatus* Walker
	,,	*mastersi* Taylor
	,,	*doddi* Taylor
	,,	*parvicallosus* Ricardo
*	,,	*duplonotatus* Ricardo
*	,,	*oculatus* Ricardo
*	,,	*rufinotatus* Bigot
*	,,	*dubiosus* Ricardo
	,,	*eidsvoldensis* Taylor
*	,,	*australicus* Taylor
*	,,	*hackeri* Taylor
*	,,	sp. near *laticallosus*, probably *T. batchelori* Taylor
*	,,	sp.?
*	,,	*Walteri* Taylor
*	,,	sp. nov. Therioplectes group near *T. edentulus* Macq.
*	,,	*pallipennis* Macq.

During the period November, 1918, to January, 1920, only the following species were taken, *T. circumdatus*, *T. dubiosus*, *T. cyaneus*. *T. mastersi* and *T. australicus*. The first named was the only species at all plentiful and then only during March and April, 1919. A few specimens were taken in May, 1919, after which no more were seen until October. During the later months of 1919, and the beginning of 1920, they remained extremely scarce, probably owing to the severe drought. *T. circumdatus* was found to be most plentiful in country thickly timbered with wattle and in the vicinity of scrubs even though several miles away from permanent water; the two striped Tabanids, *T. mastersi* and *T. australicus* were usually taken along the river. Many attempts were made to discover the breeding habits of these Tabanids but the few larvæ discovered in the muddy sand at the edge of the river water have so far yielded only uncommon species of *Tabanus* and *Silvius*.

Captured Tabanids were kept in captivity and fed on nodules when the latter were obtainable. The flies were fed on honey and water, dates (when procurable) and raisins. They usually lived well on this food and one

*Those species marked thus were identified for us by Dr. E. W. Ferguson.

was kept alive for thirty days, so that blood is not necessary to sustain life, though it may be for the production of fertile ova. Although all the flies dissected were females, very few were found to contain ripe ova and then usually only one ripe ovum was seen in each ovary in spite of the very large number of follicles present.

ATTEMPTS TO INFECT TABANIDS ARTIFICIALLY.

1. On November 30th, 1918, seven *T. circumdatus* and five striped tabanids *T. mastersi* and *T. australicus*, were given access to fresh nodules. These flies were examined at intervals of from two to four days but no development had occurred.

2. On December 30th. 1918, 20 *T. circumdatus* were fed on a fresh nodule. These were dissected at intervals of from one to ten days but no development had taken place. In one a living larva was found in the intestine one day after feeding, but in all other cases when found they were dead.

3. On April 4th, 1919, fifteen *T. circumdatus* were fed on a nodule. These were examined at intervals of from one to eight days, but no development had occurred. In one examined one day after feeding there were numerous fairly large filarial embryos encysted in the fat body.

4. On May 16th, 1919, one *T. circumdatus* was fed on a nodule. It died next day but no live embryos were seen.

5. On January 8th, 1919, two *T. dubiosus* were fed on a worm nodule. On dissection after two and three days respectively, no embryos were seen.

Total 43 *T. circumdatus*.
5 Striped Tabanids (*T. mastersi* and *T. australicus*).
2 *T. dubiosus*.

Cleland, Dodd and McEachran (1917) failed to infect calves, using *Tabanus regis-georgii*, *Diatomineura inflata* and *Silvius* sp., also the mosquitoes *Culicelsa vigilax* and *Stegomyia atripes*.

Hill, McEachran and Dickinson did not detect larvæ in cattle ticks (*Boophilus australis*); *Lyperosia exigua*, *Stomoxys calcitrans*; *Tabanus mas ersi* and *T. nigritarsus*; and the mosquitoes *Myzorhynchus bancrofti*, *Culicelsa* *vigilax*, *Chrysoconops acer*, *Culex sitiens*, *Pseudoskusea basalis* and *Tæniorhynchus uniformis* (1917).

RESULT OF EFFORTS TO INFECT *M. fergusoni*, *M. vetustissima*, *M. terræ-reginæ* AND THE SMALL BLACK *Fannia* WITH *Onchocerca gibsoni*.

The method followed was to allow the caged flies to suck the juices from a freshly cut live worm nodule obtained as soon as possible after the slaughter of the bullock.

The above species of flies which fed very eagerly on nodules were killed at varying intervals for dissection. In the case of *M. fergusoni* and *M. vetustissima* it was noticed that only a few flies out of each batch actually ingested the embryos in any quantity. Dead embryos were found in an undigested state in flies up to the 6th day after feeding. Living embryos were once found in a fly one day after feeding. In the case of the small black *Fannia*, on the other hand, embryos were ingested by the majority of flies in one batch experimented with, many remaining undigested, chiefly in the crop, for as long as 14 days after feeding. On another occasion undigested embryos were found in a fly of this species 16 days after feeding. In all cases, however, the embryos were dead In no case was there any suggestion of development of the Onchocerca embryos within the fly, and, as far as these experiments go, they do not indicate any of the above flies as carriers of the parasite. It must be remembered, however, that the method of allowing flies to feed on an opened nodule is totally unnatural, since the majority of the embryos obtained in this way are liberated from the uterus of the female by the act of cutting and may not be in a fit state to commence development in the intermediate host. In nature the embryos in their passage from the parent to the exterior—however this may be accomplished—may become, as it were, strengthened and fitted to begin their cycle in the invertebrate host.

Our results are given for convenience in tabular form. The number of flies dissected out of each batch, whether captured or bred in the laboratory, and the number of days which were allowed to elapse before dissection are indicated. Other parasites present are noted under "Remarks."

M. fergusoni.

No. of experiment.	No of flies.	Bred or Captured.	No. of days after feeding when dissected.	Remarks.
1	11	captured ..	2– 4 days	No Onchocerca embryos seen *Habronema* in one.
2	25	,, ...	2–10 days	Half digested Onchocerca embryos seen in one fly on 3rd day. *Agamospirura muscarum* in 5. *Habronema* in one.
3	12	bred cowdung ..	3 days	No Onchocerca seen.
4	21	16 captured .. 5 bred cowdung	3– 7 days	No Onchocerca seen. *Agamospirura muscarum* in one captured fly.
5	94	captured ..	1–15 days	No Onchocerca seen, *A. muscarum* seen in 2 flies dissected on 11th day.
6	54	,, ...	1– 8 days	A large number of dead but undigested Onchocerca embryos seen in intestine of several flies dissected 1–6 days after feeding. *Habronema* spp. present in 5; *A. muscarum* in one and *Agamonema fanniae* in one.
7	22	bred cowdung ..	3–14 days	Numerous Onchocerca embryos and eggs in intestine of one fly dissected on 3rd day; one dead but intact seen in a fly on 6th day.
8	69	bred cowdung ..	1– 5 days	Living Onchocerca embryos were seen in intestine of a fly dissected after one day. Dead embryos were detected in two flies on 2nd and 3rd day.
9	5	captured ..	4 days	No Onchocerca seen. *A. muscarum* present in 3 of these flies.
Total	313	flies		No development noted in any.

M. vetustissima.

No. of experiment.	No. of flies.	Bred or Captured.	No. of days after feeding when dissected.	Remarks.
1	15	captured ..	1–13 days	No Onchocerca embryos seen *Habronema* spp. present in two.
2	20	captured ..	4– 6 days	Dead Onchocerca embryos seen in crop of one fly dissected on 4th day, *Habronema* present in two. *Agamospirura muscarum* in one.
3	26	bred cowdung ..	4 days	No Onchocerca present.
Total	61	flies		No development seen in any.

M. terræ-reginæ.

1	41	bred cowdung ..	14–26 days	No Onchocerca embryos detected.
Total	41	flies		No development noticed in any.

Black Fannia.

1	44	captured ..	3–14 days	Onchocerca embryos were found in 34; the embryos were recovered up to the 14th day in an undigested conditions, but in all cases quite motionless. They were usually found in the crop or intestine, but occasionally free in the abdomen, having in these cases probably been set free by the rupture of one or other of the above organs during dissection.
2	9	captured ..	2–18 days	Dead Onchocerca embryos were found in 3 flies dissected on 6th, 11th and 16th days.
3	24	captured ..	1–11 days	Dead Onchocerca embryos were found in one fly on the 2nd day.
4	2	captured ..	1 day	No Onchocerca detected.
Total	79	flies		No development observed in any.

Onchocerca bovis, Piettre.

We desire to mention the occurrence of a second species of *Onchocerca* in Australian cattle. Our attention was drawn to its presence by Mr. N. V. Brown who forwarded specimens from cattle slaughtered at Rockhampton. He stated that they occurred in a more or less tangled condition in the connective tissues between the ligamentum nuchæ, also in the stifle joint, and mentioned that the same kind of parasite was to be met with between the spleen and stomach. This situation is similar to that in which Stiles and Hassall found their undescribed *Filaria lienalis* which is now generally regarded as being an *Onchocerca*, and which we now suggest is probably a synonym of *O. bovis.*

The material was sent to us early in 1919 but was only cursorily examined at the time, being provisionally labelled as *O. gutturosa* Neumann, the female resembling that of the Algerian species.

The finding of many males while recently overhauling the material led to their re-examination. It was seen that they differed from the males of *O. gutturosa* but apparently resembled those of *O. bovis* Piettre, as far as available information allowed us to compare them. We have not been able to obtain Piettre's original paper (1912) in Brisbane, and have had to content ourselves with a translation of another of his articles (1916) on bovine Onchocerciasis in South America; and with the tabulated measurements contained in Dr. Sweet's excellent paper on "Onchocerciasis in Cattle, etc., in countries other than Australia" (1915, pp. 45-7).

The male papillary arrangement is of the *Onchocerca* type, there being on each side four closely set perianal papillæ, a post anal near the tail, and two caudal. The longer spicules measure from .180 to .215 mm. and the shorter .050 to .070 mm. The measurements in Dr. Sweet's table are .180 to .210 and .065 to .075 mm. respectively. The males lie free in a more or less loosely coiled manner while the females are more or less loosely entwined in the fibrous tissue. At least four males were obtained from the tissue which contained apparently a single female. The body markings of the latter are of the type figured by Neumann as occurring in *O. gutturosa.*

We are of opinion that the *Onchocerca* worms (male and female) which Cleland found in a loose coil near the hip joint of an ox in N.S. Wales (1914, p. 47 ; 1914, p.p. 137, 150), belonged not to *O. gibsoni*, but to the same species as that which we now identify as *O. bovis*. The situation is one of those mentioned by Piettre (1916), in which *O. bovis* may be met with.

Examination of Captured Flies for the Presence of Parasites.

We deem it of interest to give an account of the various parasites found in flies during our examinations. The species of *Habronema*, *H. muscæ*, *H. megastoma* and *H. microstoma* are omitted, since they have been dealt with in another paper (Johnston and Bancroft, 1920).

Examination of Tabanidæ.

Tabanus circumdatus was found to be infected with one species of microfilariæ. The total number of flies examined and the number infected were as follows :—

T. circumdatus			
Nov 10th, 1918, to Jan. 11th, 1919..	111 examined ..	4 infected	
March 25th—April 19th, 1919	305 ,, ..	9 ,,	
April–May, 1919 : ..	32 ,, ..	3 ,,	
October 11th, 1919—January 14th, 1920	17 ,, ..	2 ,,	
Total for *T. circumdatus*	465 ,, ..	18 ,,	or 3.8%
T. cyaneus—the blue Tabanid	1 ,, ..	0 ,,	
T. dubiosus—the black Tabanid	5 ,, ..	0 ,,	
T. mastersi / *T. australicus* {Striped Tabanids}	30 ,, ..	0 ,,	
Total for all species	501 ,,	18 ,,	or 3.5%

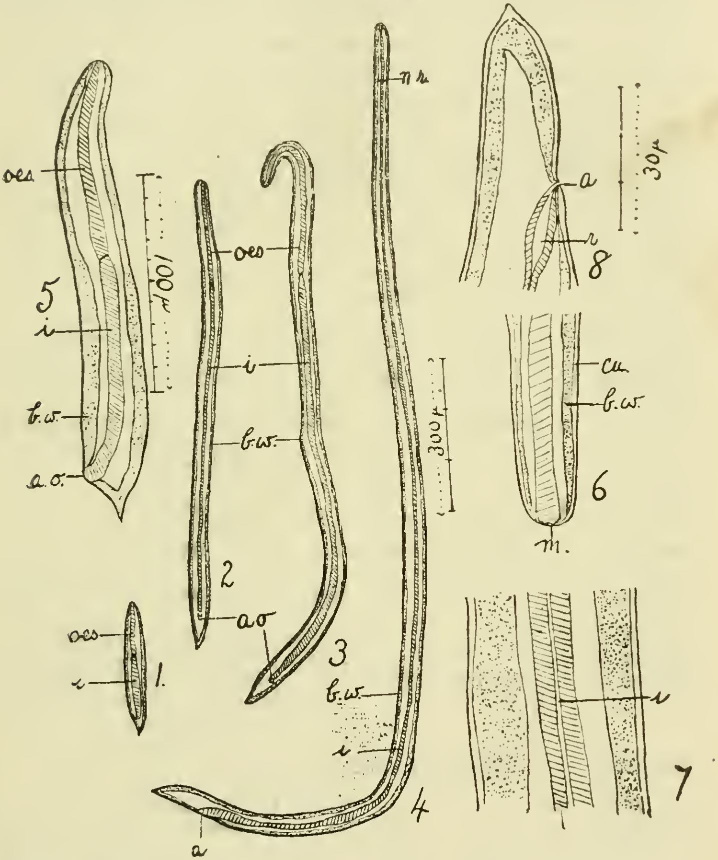
Extent of infection. In three cases very few larvæ embryos (1-9) were found, but in all other cases the infection was extremely heavy. In eight instances only young encysted forms were seen, in the remaining 10 cases fully developed larvæ were present, small forms occurring also in some of them. In one case where an actual count of the number of embryos was made the fly was found to contain 234 fully developed and very active worms, 94 being contained in the head and proboscis, 116 in the thorax and 24 in the abdomen. Other instances would probably have yielded still larger figures had time been spent in counting them. The enormous number of larvæ does not seem to inconvenience a fly greatly since the individual referred to above had lived for a fortnight in captivity in apparent good health prior to dissection.

Agamofilaria tabanicola n.sp.
(Text-figures 1-8).

The microfilariæ taken up with the blood or lymph of their vertebrate host by the March fly leave the gut and encyst in the fatty tissue in the abdomen of the insect, the earliest stages found being in this region. Larvæ ranging in length from 150 μ to 1250 μ have been met with in this situation (figs. 1-3) The final stage in the fly has been found free in the abdomen, thorax, head and proboscis (fig. 4). The worms seem to be attracted to the proboscis and in a heavily infected fly they are seen to be congregated in and around the base of that organ. In one instance after the proboscis was severed from the head in normal saline, two larvæ emerged for about half their length from the apparently uninjured tip of the proboscis.

The youngest worms seen measured 150 μ-260 μ in length with a maximum width of 21-30 μ (fig. 5). There is a definite cuticle ; the œsophagus is clearly marked off from the intestine and the anus lies at about 25 μ from the pointed posterior end. The nerve ring lies at about 50 μ from the anterior end (stage 1).

As development proceeds (stages 2 and 3) there is a progressive lengthening but only a slight increase in width ; in fact the final stage is thinner at either end (though not in the mid region) both relatively and absolutely than in the earlier stages. In the final stage (stage 4) the worms measure from 1.93-2.4 mm. with a maximum width of 35 to 40 μ. The nerve ring lies at 115-120μ from the anterior end. The œsophago-intestinal junction, which is so well marked in the earlier forms, becomes gradually less distinct and cannot be made out in the final stage. The intestine is a long narrow tube and is somewhat dilated to form a rectum. The anus lies at about 40 μ from the tip of the tail which is bluntly rounded, though at the tip of the tail the cuticle is drawn out into a little point giving a characteristic appearance (fig. 8). There is a clear cuticle 1 μ in width, internal to which is the body wall from which the intestine is separated by a space (fig. 7). The surface of the parasite is marked by very numerous transverse structures which are so low and closely arranged that they are recognisable only under the oil immersion. Hence the cuticle appears to be quite smooth.



Text-figures 1–4 .. Stages in growth of *Agamofilaria tabanicola*; drawn to same scale shown beside fig. 4.
Text-figure 4 .. Fully developed larva of *A. tabanicola*.
Text-figure 5 .. Very young stage of *A. tabanicola*, drawn to adjacent scale.
Text-figures 6–8 .. Highly magnified views of fully developed larva of *A. tabanicola*, drawn to scale adjacent to fig. 8.
Text-figure 6 .. Head.
Text-figure 7 .. Portion of middle of body.
Text-figure 8 .. Tail.

EXPLANATION OF LETTERING.

a, anus; *a.o.*, anal operculum; b.w., body wall; *cu.*, cuticle; *gr.*, granules; *i.*, intestine; *i.r.*, rudiment of intestine; *m.*, mouth; *n.r.*, nerve ring; *oes.*, œsophagus; *p.*, papilla; *ph.*, pharynx.

Larvæ in different stages of development may be observed in the same fly. In some cases the discrepancy in sizes was so marked—large forms being found in the head and very small ones encysted in the fat body—as to suggest that the smaller forms belonged to a subsequent infection.

DETAILS OF INFECTION.

Date.	No. of days in cap'ty.	No. of worms counted from			Remarks.
		Head.	Thor'x	Abdo.	
26/11/18	2	1	—	8	2 small, 7 fully developed larvæ.
12/12/18	7	all regions	heavily in-	fested	all larvæ fully developed
4/12/18	30	1	—	—	larva fully developed.
30/12/18	14	94	116	24	total 234, all fully developed
29/3/19	2	infected	—	infect.	larvæ in head fully developed small and encysted in abdomen.
2/4/19	1	1	—	—	fully developed.
2/4/19	1	all regions	infected		fully developed.
3/4/19	2	—	—	infect.	very small encysted, Stage 1.
3/4/19	2	—	—	infect.	small encysted, Stage 2.
7/4/19	6	—	—	infect.	small encysted, Stage 2.
7/4/19	6	all regions	infect	ed	fully developed in head and thorax, some small stages in abdomen.
15/4/19	1	all regions	infect	ed.	do. do. do.
5/4/19	4	—	—	infect.	fairly large larvæ, encysted, Stage 3.
—	—	—	—	infect.	very small larvæ, encysted, infection not heavy, Stage 1
—	—	—	—	infect.	small, encysted, heavy infection, Stage 2.
—	—	—	—	infect.	do. do. Stage 2.
15/10/19	7	all regions	heavily in-	fected.	fully developed.
9/1/20	1	—	—	infect.	Heavy infection, numbers fully developed, but most were small and encysted.

It is almost certain that these microfilariæ do not represent the intermediate stage of *O. gibsoni*. The smoothness of the cuticle is different from what one would expect in the final larval stage of such a markedly corrugated worm as *O. gibsoni*. Again, judging by the post mortem findings of others only a few Onchocerca embryos occur in any one spot of the body of the beast and very rarely if at all in the blood stream. It would be extremely difficult to explain how the fly could come to ingest such an enormous number of embryos as are commonly found in a single fly, unless it had access to embryo laden lymph in a superficial nodule. The worms appear to have all the characteristics of a typical *Filaria* and in all probability represent a stage in a species parasitising one or other of the vertebrates of the Eidsvold district.

A number of the local mammals, birds and reptiles harbour filariæ. *F. websteri* Cobbold is found fairly frequently in the knee joint of the kangaroo *Macropus giganteus* and the whiptail *M. parryi*. The embryos of this filaria have only once been found in a blood film (taken from the neck) of a whiptail by Dr. Bancroft who considers that the microfilariæ may have been liberated into the blood by the cutting of a lympahtic. Besides, the adult female filaria has well marked transverse annulations, some sign of which might be expected to be shewn by the final larval stage. The common opossum, *Trichosurus vulpecula*, harbours *Filaria trichosuri* Breinl, the embryos of which occur in the blood stream, but as the host is a nocturnal animal hiding away during the day, it does not seem likely that it should be attacked by Tabanids.

Of the numerous species of local birds which harbour filaria, the soldier bird, *Myzantha garrula* is the most common. Other possibilities are :—the grey jumper, *Struthidea cinerea* ; the blue eared honey eater, *Entomyza cyanotis* ; the babbler, *Pomatostomus frivolus* ; the mutton bird, *Corcorax melanorhamphus* ; the blue jay, *Coracina robusta* ; the magpie, *Gymnorhina tibicen* ; the chip-chip, *Pardalotus melanocephalus* ; the mopoke, *Podargus strigoides* ; the nightjar, *Aegotheles novæhollandiæ* ; the crow, *Corvus coronoides* ; the darter, *Plotus novæhollandiæ* ; the black cormorant, *Phalacrocorax sulcirostris* ; and a number of others (see Johnston, 1916).

Among the reptiles the "goanna" *Varanus varius* is commonly infested with a large filaria, but the embryos have not been found in the blood stream. The jew lizard, *Amphibolurus barbatus*, harbours a small filaria, the embryos of which occur abundantly in the blood of some individuals. It has been proved, however, by Dr. T. L. Bancroft, that *Culex fatigans*, the common house mosquito, can act as a host for this latter filaria; consequently its normal host is almost certain to be one of the native mosquitoes. The water dragon, *Physignathus lesueurii*, is parasitised by *F. physignathi* Johnston.

It had been intended during the latter months of 1919 to try to infect Tabanids by feeding them on the infected blood of several of the commoner species of birds and on the fluid surrounding the knee joints of kangaroos parasitised by *F. websteri*, but the extreme scarcity of the flies prevented the work from being proceeded with. This seasonal scarcity of Tabanids has been recently referred to by Ferguson and Henry (P.L.S., N.S.W., 1919, p. 829).

Examination of Muscids, etc.

Examination of wild flies of the species *M. fergusoni* Jnstn. and Bancr., *M. vetustissima* Walker, *M. terræ-reginæ* Jnstn. and Bancr., and the little black Fannia *Homalomyia* sp., all, with the exception of *M. terræ-reginæ* Jnstn. and Bancr., common on stock at certain times in the year, revealed the fact that local flies are parasitised by four distinct kinds of nematodes, namely: *Habronema muscæ*, *H. megastoma*, *Agamospirura muscarum* and *Agamonema fanniæ*. *M. fergusoni and M. vetustissima* harbour all four kinds; *M. terræ-reginæ* only the first three as far as is known; and the Fannia only the last named.

M. fergusoni.

Total number of flies examined	1176		
Number infected with *Habronema* spp.	26	=	22%
Number infected with *Agamospirura muscarum*	81	=	68%
Number infected with *Agamonema fanniæ* ..	5	=	0.4%

M. vetustissima.

Total number of flies examined	280		
Number infected with *Habronema* spp. ..	14	=	5%
Number infected with *Agamospirura muscarum*	4	=	1.4%
Number infected with *Agamonema fanniæ* ..	1	=	0.3%

M. terræ-reginæ.

Total number of flies examined	21		
Number infected with *Habronema* spp. ..	1	=	5%
Number infected with *Agamospirura muscarum*	1	=	5%

Fannia (*Homalomyia*) sp.

Total number of flies examined	259		
Number infected with *Agamonema fanniæ* ..	4	=	1.5%

DETAILS OF INFECTION.

M. fergusoni.

Date.	Number Examined	No. parasitised by *Habronema* spp	*Agamospirura muscarum*	*Agamonema fanniæ.*
Nov. 17th—Dec. 7th, 1918	54	4	1	—
Dec. 8th—Jan. 9th, 1919	61	1	6	2
March 23rd—April 16th	87	1	3	—
May 9th—May 31st ..	201	3	5	1
June 1st—June 24th ..	147	6	2	—
June 25th—Sept. 13th ..	278	10	9	2
Sept. 15th—Sept. 29th ..	127	—	24	—
Sept. 30th—Oct. 9th ..	134	—	19	—
Oct. 14th—Dec. 3rd ..	67	—	10	—
Jan. 3rd—Jan. 12th, 1920	20	1	2	—
Totals ..	1176	26	81	5

M. vetustissima.

Nov. 19th—Dec. 6th, 1918	33	—	—	1
Dec. 12th—Jan. 9th, 1919	26	6	—	—
Mar. 19th—April 16th ..	13	1	—	—
May 9th—Sept. 13th ..	36	3	—	—
Sept. 15th—Jan. 12th, 1920	172	4	4	—
Totals ..	280	14	4	1

M. terræ-reginæ.

Mar. 25th, 1919—Jan. 21st 1920	21	1	1	—

Fannia, sp.

Nov. 14th–23rd, 1918 ..	13	—	—	—
Mar. 29th—April 16th ..	51	—	—	—
May 9th—Aug. 6th ..	91	1 (?)*	—	3
Aug. 7th—Sept. 25th ..	104	—	—	1
Totals ..	259	1 (?)	—	4

*(?) *Habronema* embryo from egg, probably recently ingested by fly as no development had occurred.

Habronema spp.

The infection of *M. fergusoni*, *M. vetustissima* and *M. terræ-reginæ* by *Habronema muscæ* and *H. megastoma* has been fully dealt with in another paper.

Agamospirura muscarum n. sp.

(1) *M. fergusoni.* A few specimens of this fly were found infected from time to time up till September, 1919. From that time up till January 1920, when the work was concluded, the percentage of infected specimens rose considerably, while at the same time the percentage of *M. fergusoni* infected with *Habronema* fell to almost nil. Flies from all localities around Eidsvold township showed similarly high infection, whether collected along the river or in dry scrub country. Out of 81 cases of infection, the number of worms ranged from 1 to 12 with an average of 3.

The head alone was infected	13 times
The proboscis alone	6 times
The head and proboscis together	5 times
The thorax alone	5 times
The abdomen alone	26 times
The head (including proboscis) and abdomen	9 times
The head (including proboscis) and thorax	10 times
The thorax and abdomen	3 times
The head (including proboscis), thorax and abdomen ..	4 times

The small stages were found in rather thick yellowish cysts among the viscera in the abdomen ; fully developed worms were also seen still encysted, but this stage was more commonly found free in abdomen, thorax or head. The tendency of the mature larva appears to be to migrate through the thorax to the head and proboscis. In many cases where fully developed worms were found in the head or thorax an equal number of the large, rather characteristic looking, empty cysts could be found in the abdomen. In several instances similar cysts were noticed in the abdomen but no worms could be found in any part of the body of the fly. It is almost certain that these flies were originally infected, the worms having escaped (as *Hab.onema* has been proved capable of doing) from the tip of the proboscis of the fly, while the latter was feeding on a wet surface.

M. vetustissima. An infected specimen was first met with in September, 1919. Of four cases of infection, the number of worms ranged from 1 to 16, with an average of 8. The abdomen alone was infected twice ; the head, proboscis and abdomen once ; while in the fly containing 16 worms—the heaviest infection met with in any fly—all regions of the body were infected, three parasites being present in the head, four in the proboscis, three in the thorax and six in the abdomen.

M. terræ-reginæ. A single infected specimen of this species was met with on March, 1919, when a fly containing four worms in the proboscis was dissected.

In every case of infection in the three species dealt with, the parasitised subject was a female fly. Many more females were dissected than males, since among flies captured on stock the former sex predominates. However, the number of males dissected was quite large enough to warrant the expectation that an occasional infected specimen would be met with, at any rate during the latter part of 1919, when the percentage of infected *M. fergusoni* remained high. This, however, was not borne out by experience, although Habronemic infection occurred quite frequently among males. Two sets of figures giving record of the sex of flies (*M. fergusoni*) will illustrate this point. Out of 102 (seven males and 95 females) dissected during May and June, 1919, three males and one female were infected with *Habronema* spp. and four females with *Agamosp'rura muscarum*). During the last three and a-half months of 1919 out of 238 flies (21 males and 217 females) 31 females were infected with *Agamospirura muscarum*, no other nematodes being met with.

Description of Agamospirura muscarum n sp.

(Text-figures 9-15).

The early stages are found encysted in the abdomen of the fly. The smallest embryo met with measured 610 μ in length by 50 to 60 μ in breadth (fig. 9-13). The mouth led into a shallow pharynx 8 μ in depth, followed by a short thick œsophagus, the distance of its base from the oral opening being 120 μ. A nerve ring surrounded the œsophagus at a distance of 65 μ from the mouth. The intestine was a long straight tube leading into a rather large rectum 75 μ in length. An anal operculum was present.

The tail was drawn out into a point situated 60 μ from the anus. At this stage the transverse annulations were only faintly marked. A gradual increase in size takes place (figs. 10, 11), the fully developed worm measuring from 2 8 to 3.4 mm. in length. This stage (figs. 12, 14, 15) is usually found in the head and proboscis. The mouth is surrounded by several small papillae and leads into the pharynx which now measures 25 μ in depth by 15 μ in width (fig. 14). The œsophagus gradually increases in width from 20 μ to 35 μ at the œsophageo-intestinal junction which is situated 230 μ from the mouth. The nerve ring encircles the œsophagus at a distance of 160 μ from the anterior end. The long straight intestine leads into the rectum, which is 180 μ in length by 40 μ in the widest part. The anus, now open, is situated 85 μ from the tip of the tail. Three small papillæ are present on the tail, one terminal and two situated on either side a short distance in front of it. The worm is thick anteriorly tapering off towards the posterior end. The breadth at the base of the œsophagus is 95 μ, and at the anus 45 μ. At this stage the transverse annulations are well marked in the anterior portion of the worm, being most prominent about the junction of the œsophagus and intestine. They are situated from 5 to 7 μ apart. Towards the posterior end they become fainter and cannot always be made out in the anal region. In one specimen the annulations were rounded off, giving a different effect from that shown in fig. 14. In other respects the worm was a typical *Agamospirura muscarum*.

The characters of the parasite suggest that it represents the larval stage of one of the *Spiruroidea*, perhaps of the *Spiruridæ*, hence the larval collective generic designation. The specific name is given owing to the comparative frequency of the occurrence of the worm in many local Muscidæ.

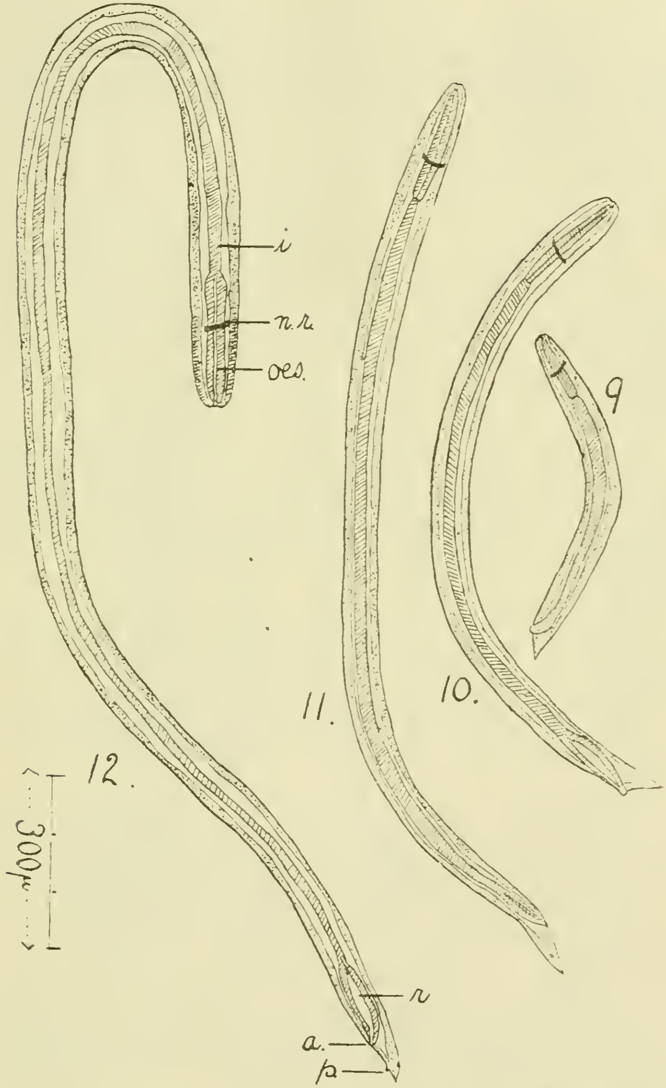
Attempts were made to trace the origin of the nematode by breeding out flies from various materials.

The results were as follows.

M. fergusoni.

(1) *Cow dung.* Two hundred and seventy-eight specimens (including a few pupæ) bred from cow dung from

various localities were examined, but none were found to harbour *Agamospirura muscarum.*



Text-figures 9–12 Stages in growth of *Agamospirura muscarum*, drawn to scale shewn beside fig. 12.
Text-figure 12 .. Fully developed larva.

(2) *Horse dung.* Of fifty eight (including a few pupæ) bred from horse dung from various sources, fifty-five

were infected with *Habronema* spp. but *A. muscarum* was not found.

(3) *Wallaby dung*, chiefly of *Macropus dorsalis*. Pellets collected in various parts of several different scrubs in the neighbourhood of Eidsvold, were moistened with water and either flies allowed to larviposit on the material or young larvæ were transferred to it from cow dung. Thirty two flies bred in this way were examined, but no infection had occurred.

(4) *Bird dung*. The excrement of various water birds was collected along the margin of the river. Flies could but rarely be induced to larviposit in this material, but young larvæ transferred to it from cow dung grew well. Thirty-one flies bred in this manner were examined but the presence of *A. muscarum* was not detected.

(5) *Fowl dung*. Eight pupæ, the larvæ of which had been raised partly on fowl dung, were examined. but no infection was observed. Nine house flies bred from the same source were likewise free from parasites.

M. vetustissima.

(1) *Cow dung*. Thirty-three flies bred from this material were examined with negative results.

(2) *Horse dung*. Sixty-flies bred therefrom all proved to be infected only with *Habronema* spp.

M. terræ-reginæ.

(1) *Cow dung*. Forty-one flies bred from cow dung were examined and found to be free from any infection.

(2) *Horse dung*. Ten flies bred from horse dung were all infected with *Habronema* spp. alone.

Musca hilli.

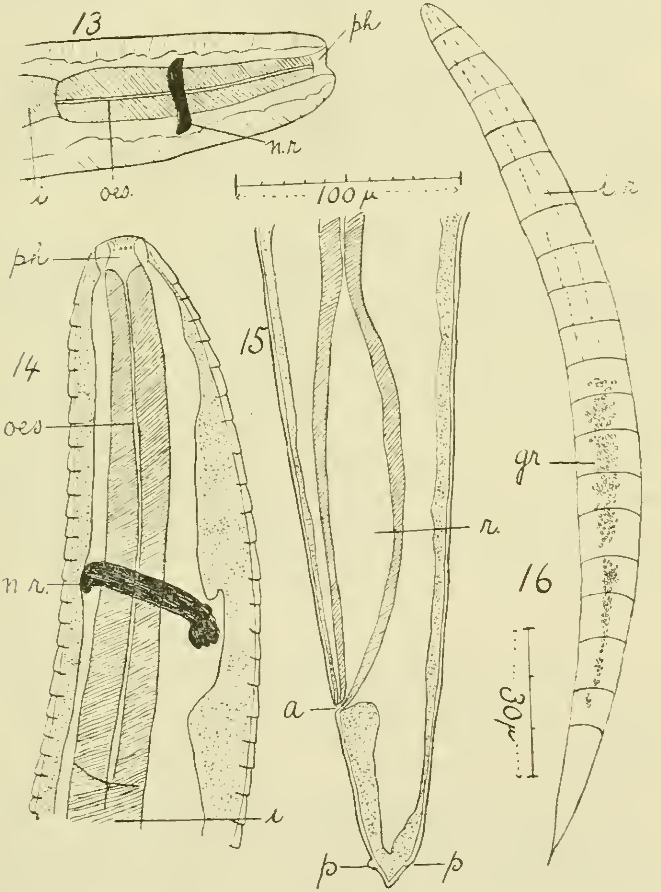
(1) *Wallaby stomach*. Thirteen flies bred in the food material from the stomach of a scrub wallaby, *M. dorsalis*, proved to be free from any infection.

Agamonema fanniæ n. sp.

(Text.-fig 16).

This tiny active parasite was first met with in a specimen of *M. vetustissima* dissected in December, 1918. The worms were free in the abdomen when noticed, but may have been liberated by the rupture of the genital ducts. It was not again met with in this species of fly.

On five occasions *M. fergusoni* was found to harbour this nematode. In one instance there were numerous worms in the common oviduct and conglobate glands or accessory



Text-figures 13–15 Drawn to scale adjacent to fig. 15.

Text-figure 13 .. Head of young stage of *A. muscarum*, shewn in fig. 9.

Text-figure 14 .. Head of fully developed larva of *A. muscarum*.

Text-figure 15 .. Tail of same.

Text-figure 16 .. *Agamonema fanniœ* entire specimen highly magnified; drawn to adjacent scale.

copulatory vesicles. In all other cases the flies were lightly infected, the worms being located in similar parts of the body. In one fly, which had been bred from cow dung and had been confined in a cage with captured specimens of *M. vetustissima* and the black *Fannia*, and had had access to cow and horse dung for larviposition, two worms were found, one being in a conglobate gland and the other free in the body.

The small black *Fannia* was found to be infected on four occasions. In three captured females a few worms were detected usually in the common oviduct ; in one male fly, bred from cow dung, a single worm was seen free in the abdomen.

Description of worm. The majority of specimens obtained were in a very early stage of development, measuring from 126 to 180 μ in length with a breadth of 13 to 14 μ. Those taken from the single infected *M. vetustissima* were larger, measuring 235 μ in length by 13 μ in breadth. In the smaller forms only the rudiments of the intestine could be made out, but in the larger forms it appeared as a thin tube. A number of greenish refractive granules were usually present in the posterior half of the body. The tail was sharply pointed. The delicate cuticle was seen to be ornamented with about nineteen distinct transverse rings, fairly regularly arranged (fig. 16).

The state of immaturity prevented us from determining the affinities of the parasite which is probably an *Agamospirura*. We prefer to use the wider term *Agamonema*, associating the name of the fly as the specific name of the worm.

A tiny parasite, *Agamonema* sp., somewhat resembling *A. fanniæ* was found in two out of eight specimens of the common Borborid (*Sphærocera* sp) which frequents and breeds in horse dung in Brisbane. Two worms occurred in one and one in the other.

Herpetomonas (*Leptomonas*) spp.

Flagellates resembling *H. muscæ-domesticæ* Burnett, were found at Eidsvold in the intestine of *Musca fergusoni*, *M. vetustissima* and *M. terræ-reginæ*, while members of the same genus occurred also in *Tabanus circumdatus* and *T. mastersi.* They were found in Brisbane in *Sarcophaga misera.*

The following is a list of parasites referred to in this paper as occurring in the Diptera examined :—

Musca fergusoni J. & B. ..	*Herpetomonas* sp. (? *H. muscæ-domesticæ* Burnett).
	Habronema muscæ Carter.
	Habronema megastoma Rud.
	Agamospirura muscarum Jnstn. & Bancr.
	Agamonema fanniæ J. & B.
Musca vetustissima Walker	*Herpetomonas* sp. (? *H. muscæ-domesticæ*)
	Habronema muscæ Carter.
	Habronema megastoma Rud.
	Agamospirura muscarum J. & B.
	Agamonema fanniæ J. & B.
Musca terræ-reginæ J. & B.	*Herpetomonas* sp. (? *H. muscæ-domesticæ*)
	Habronema muscæ Carter.
	Habronema megastoma Rud.
	Agamospirura muscarum J. & B.
Sarcophaga misera Walker.	*Herpetomonas* sp.
Fannia sp... ..	*Agamonema fanniæ* J. & B.
Tabanus circumdatus Walker.	*Herpetomonas* sp.
	Agamofilaria tabanicola J. & B.
Tabanus mastersi Taylor.	*Herpetomonas* sp.
Sphærocera sp. ..	*Agamonema* sp.

Summary.

1. An examination of the following flies captured in the Eidsvold district where worm nodules are known to occur in cattle, failed to reveal the presence of Onchocerca larvæ: (1) *Tabanus circumdatus* (2) *T. mastersi,* (3) *T. dubiosus,* (4) *T. cyaneus,* (5) *T. australicus,* (6) *Musca fergusoni,* (7) *M. vetustissima,* (8) *M. terræ-reginæ,* (9) *Fannia* sp.

(2) The Tabanids, *T. circumdatus, T. dubiosus, T. mastersi,* and *T. australicus,* as well as the three above named species of *Musca* and *Fannia* sp. failed to become infected with larvæ when fed on freshly cut worm nodules.

3. A second species of *Onchocerca* (*O. bovis* Piettre) infests Australian cattle.

4. *Tabanus circumdatus* is commonly parasitised by a filarial larva (*Agamofilaria tabanicola*); while the three Muscids, in addition to harbouring larval *Habronema muscæ* and *H. megastoma*, are infested by certain other larval nematodes. A species of *Fannia* commonly associated with cattle, also harbours a larval nematode.

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NOTES ON THE OCCURRENCE OF PETROLEUM IN QUEENSLAND.

By J. B. HENDERSON, F.I.C., Govt. Analyst.

(*Read before the Royal Society of Queensland, 28th April, 1920*).

Doubt has been expressed as to the actual occurrence of petroleum compounds in Queensland. Mr. L. C. Ball, B.A., B.E., of the Queensland Geological Survey, collected data and published them in an article in the *Government Mining Journal* for August, 1910, page 390. The instances there noted of occurrences of oil on water are certainly clear proof of the presence of petroleum. The gas occurrences, however, can only be accepted as having been proved of petroleum origin in the case of the Roma Bore gas. Some of the other gases may, on analysis, prove to be of petroleum and not of coal seam origin, but that has not yet been determined. The gas from the Maria Creek Bore proved, on analysis, to be carbon dioxide.

Full details of the gas from the Roma Bore are given in Publication No. 247 of the Queensland Geological Survey. The gas is most certainly of petroleum and not of coal seam origin.

Samples of oil from the Ruthven Bore at 4,105 feet and from the Springleigh Bore 5,800 feet were shown to the Society.

The bore water was in each case hot and the hot oil, after skimming and cooling, was found to solidify into a dirty brown-black wax, the Ruthven sample being much softer than the Springleigh sample. On examination they gave the following results :—

	Ruthven.	*Springleigh.*
Soluble in petrol ether	90.0 per cent.	65.5 per cent.
Soluble in turps then chloroform	4.0 per cent.	16.5 per cent.
Other organic matter (by difference)	0.7 per cent.	5.2 per cent.
Inorganic residue	5.3 per cent.	12.8 per cent.
	100.0 per cent.	100.0 per cent.

The oil in these cases only came up intermittently and ceased coming when boring was finished. In the case of the gas, in some wells it behaved in exactly the same way.

* * * * * *

In the exposition which followed, Mr. Henderson demonstrated by means of a simple apparatus that if, in boring with a big head of water in the bore, a stratum is struck containing oil or gas at less pressure than the pressure of the column of water in the bore, the water in the bore will flow into the stratum—not the oil or gas into the bore. When the tools or bailer are lifted, thereby momentarily decreasing the bore water pressure, some oil or gas will follow the tools or bailer; but, as they ascend, the pressure again increases and stops the flow. For obvious reasons greater volumes of gas would be liberated than of oil.

If the volume of gas liberated was sufficient to establish an "air lift" then the gas would continue flowing so long as the air lift worked. This was shown by the apparatus, and reference made to how this worked at the Roma Bore.

If the air lift is once blocked and the excess pressure from the bore water gets at the gas bearing stratum, then the gas flow will cease. This was also demonstrated by the apparatus, and a parallel drawn with the loss of gas in the Roma Bores.

The lecturer then pointed out that the conditions demonstrated undoubtedly occurred in several of the Queensland bores in which small quantities of oil were found while boring. It is therefore certain that oil bearing strata were pierced in several bores, most of them in the Central District, and it is also certain that, had the bores been pumped out to lower the pressure, a supply of oil would have been obtained. What the supply would have amounted to per day, and what is the quality of the oil, is, of course, not known. It is also impossible to foretell the result of the great water pressure on these strata for the long time which has elapsed since boring. It may have driven the oil away and may not. The lecturer demonstrated with the apparatus conditions under which it would be driven away, and some in which it would not.

In the case of the Roma gas, the supply was still there after water pressure on the strata for two and a-half years from a bore 80 yards away, and is still there in the new Government bore. Probably the least expensive way to test the strata for oil would be to pump out sone of the oil bearing bores under the guidance of experienced geologists and well borers.

THE LIFE HISTORY OF *HABRONEMA* IN RELATION TO *MUSCA DOMESTICA* AND NATIVE FLIES IN QUEENSLAND.

By Professor T. HARVEY JOHNSTON, M.A., D.Sc.: and M. J. BANCROFT, B.Sc., Walter and Eliza Hall Fellow in Economic Biology, University, Brisbane.

(With 7 Text-figures).

(*Read before the Royal Society of Queensland*, 31st May, 1920).

The first observer to call attention to the occurrence of nematodes in domestic flies was Carter, who, in 1861, reported the presence in *Musca domestica* of worms which he named *Filaria muscæ*. A little later the species was transferred by Diesing to the genus *Habronema*. Though a few European workers experimented with the parasite with a view to elucidating its life history, it remained for Ransom (1911, 1913) to prove that the worm was the larval stage of *Habronema muscæ*, a parasite of the horse's stomach. He gave an excellent account of all stages from the egg to the adult.

In 1912, one of us (Johnston 1912, p. 76) recorded the presence of *H. muscæ* in *Musca domestica* in Sydney and Brisbane, and in *Stomoxys calcitrans* in Sydney, stating that a similar parasite infested the head region of the Queensland cattle fly, *Musca vetustissima*, the worm being listed as *H. muscæ* in 1914. We have re-examined the material, and have found it to be *H. muscæ*. In 1914, H. Tryon (Ann. Rep. Dept. Agricult. Q'land, 1914, p. 116), mentioned the presence of the helminth, *Habronema* sp., in this native fly, and suggested that it might possibly be the larva of "*Spiroptera* (*Onchocerca*) *Gibsoni*."

In 1916, Bull published an account of a granulomatous affection of the horse in certain parts of Victoria and South Australia, pointing out that the cause was a species of *Habronema* in its larval condition, and that the malady was similar to the cutaneous habronemiasis described by Raillet. He believed that the larvæ, which were in the final larval stage, as described by Ransom, were introduced by a biting fly. "Swamp cancer" of horses in the Northern Territory was regarded as being a form of habronemiasis, this opinion being opposed by Lewis and Seddon (1914, 1918).

In 1918, the two last-mentioned investigators called attention to the rather common occurrence in Victorian horses of a habronemic conjunctivitis, but were unable to state which species of *Habronema* was the cause.

In the same year the presence of the adult of *H. muscæ* in New South Wales and Queensland was noted by one of us (Johnston, 1918, p. 214). Shortly afterwards Hill published an important paper dealing with the life history of the three species of *Habronema* infesting the horse's stomach, viz., *H. muscæ*, *H. megastoma* and *H. microstoma*, showing that the two former utilised the common house fly, *Musca domestica*, as an intermediate host, while the stable fly, *Stomoxys calcitrans*, was proved to be able to act similarly for *H. microstoma*.

Soon after the appearance of Hill's work, Bull (1919) published an important contribution to the study of habronemiasis, in which he dealt briefly with the larvæ of the three species in the fly hosts just referred to, his paper being mainly concerned, however, with a study of the granulomata found in horses and also of the nematode associated with the condition.

Contemporaneous work has then been in progress in at least three Australian centres, viz., by Bull in Adelaide, Hill in Melbourne, and ourselves at Eidsvold, Queensland. We have confined our study to the larval stages and their relation to domestic and native flies. Of these the most important are the house fly, *Musca domestica*, and the two flies which especially molest stock in Queensland, viz., *Musca vetustissima* Walker and *Musca fergusoni* Johnston and Bancroft. The latter was previously known in literature as *M. australis* Macquart, but we have lately redescribed the insect as *M. fergusoni*, since the specific name was preoccupied (Johnston and Bancroft, 1919).

Ransom worked with one species of fly (*M. domestica*) and one species of *Habronema*. Both Bull and Hill employed two species of flies (*M. domestica* and *S. calcitrans*), and three of *Habronema*, but dealt almost entirely with artificially-infected material. We have utilised nine distinct species of flies—eight belonging to the Muscidæ, and one to the Sarcophagidæ—and three of *Habronema*, our work showing that no less than six Muscids and one Sarcophagid species can harbour both *H. muscæ* and *H. megastoma*: that one Muscid (a blowfly) can become infected with *Habronema* sp. indet.: and that the remaining Muscid can become parasitised by *H. microstoma*

The characters of the larval worms have been so carefully described and illustrated by Ransom and by Hill that there is no need for repetition by us.

In the following table we give a list of our measurements in millimetres (range and average) of mature larvæ. Hill's figures are inserted for purposes of comparison :—

	H. muscæ.			*H. megastoma.*			*H. microstoma*	
	Range.	Average of 8 Specimens.	Hill's figures (6 specimens)	Range.	Average of 7 Specimens.	Hill's figures (1 specimen).	Brisbane Specimen.	Hill's figures (6 specimens)
Length ..	2.04 –2.8	2.38	2.3 –2.541	1.61–2.12	1.95	2.244	1.93	1.600–1.815
Breadth at base of œsophagus)	.05 –.07	.062	.049–.066	.05–.06	.055	.096	.050	.046–.072
Mouth to base of œsophagus	.69 –.94	.82	.830–.970	.45–.55	.51	.630	.79	.650–.792
Mouth to nerve ring ..	.12 –.15	.136	.132–.140	.10–.15	.124	.138	.12	.105–.132
Anus from tip of tail ..	.085–.110	.097	.082–.089	.07–.09	.08	?	.10	.066–.086
Length of pharynx ..	.04	1 specimen	.046–.049	.059	1 specimen	.066	.04	.046–.053

We have found the following ratio (expressed as a percentage) to be a useful and ready means for identifying the larvæ of the three species, viz., the ratio which the distance from the mouth to the base of the œsophagus bears to the total body length. The average percentages are about 37 in the case of *H. muscæ*, 28 for *H. megastoma*, and 42 (38-44) for *H. microstoma* (based on Hill's figures).

Previous observers do not appear to have noted the presence of well-marked annulations on the anterior region of many fully-developed larvæ of *H. megastoma*, *H. muscæ*, and *H. microstoma*.

MUSCA DOMESTICA *as an intermediary of* H. MUSCÆ *and* H. MEGASTOMA.

Examination of captured flies.

Flies were captured on several occasions in Eidsvold in stables where race-horses were kept. Only the one species, *M. domestica*, was represented in the collection from this situation. Of 122 flies so caught, 10 were found to be infected with *Habronema*; in one case no record of species was kept; *H. muscæ* occurred alone 8 times; while *H. muscæ* and *H. megastoma* were present together once. Of 8 flies captured away from stables none were infected. Both sexes were present in the parasitised material.

Date.	No. of flies.	No. infected.		Infection. Head.	Proboscis.	Thorax.	Abdomen.	Total Worms.	Remarks.
November 11-21st, 1918	40	1		infected					No record of number or species.
December 23, 1919 (captured in stables)	82	9	(a)	—	—	1	—	1	*H. muscæ*
			(b)	—	—	1	—	1	*H. muscae*
			(c)	—	—	—	1	1	*H. muscæ*
			(d)	—	—	2	—	2	1 *H. muscæ* 1 *H. megastoma*
			(e)	—	—	3	—	3	*H. muscæ*
			(f)	—	—	1	—	1	*H. muscæ*
			(g)	1	1	7	—	9	*H. muscæ*
			(h)	1	—	—	—	1	*H. muscæ*
			(i)	—	—	1	—	1	*H. muscæ*
December, 1918	8	0						0	Captured away from stables.

The percentage of naturally infected house flies found at Eidsvold was thus 7.6. Hill (1918, 18) examined 182 flies caught in Melbourne stables and found 14 infected, *i.e.*, also 7.6 per cent., *H. muscæ* being the only species found by him. Both *H. muscæ* and *H. megastoma* were represented in our material. Carter (1861) reported that a third of the house flies examined by him in Bombay were infected with *H. muscæ.* Generali (1886) found about 12.6 per cent. infected in Modena, Italy, during the summer of 1884. Piana (1897) stated that in certain Italian localities the presence of the larva was rarely observed, but that in other districts 20 to 30 per cent. of the flies were parasitised by *Habronema*. Leidy (1874) discovered that about 20 per cent. of the house flies in Philadelphia harboured the nematode. Ransom kept statistical record of 137 flies, finding 39, *i.e.*, 28 per cent. infected, his material coming from three widely separated localities in the U.S.A.

As it is now known that *Musca domestica* can harbour *H. megastoma* as well as *H. muscæ*, it is quite probable that both species were represented in the material examined by the European and American observers. Hill (p. 58) failed to find *H. megastoma* in any one of the 182 adult *M. domestica* collected in stables between May and November, 1917.

Bred flies—M. domestica (Eidsvold experiments).

Experiment I.—Horse manure was collected on two occasions during November, 1918, from the stable referred to above. Thirty-nine of the flies which bred out from this material were examined, 32 being found to be parasitised by *Habronema*, the degree of infection ranging from one to 40 worms. No record was kept regarding the number of each species present.

Experiment II.—In June, 1919, flies were bred from dung of horse "S." Sixteen were examined, all of which proved to harbour *Habronema*, the number counted ranging from two to 41 worms, the average being 16. Both species of *Habronema* were present, but *H. muscæ* predominated.

Experiment III.—In August, 1919, eight flies bred from dung of horse " S " were examined. All proved to be infected with *Habronema*, both species being present. No record was kept of the number of worms found in each case.

Experiment IV.—In August-September, 1919, six flies bred from dung of horse " S " were examined. All were infected with *Habronema*, the number ranging from 1 to 25, both species of *Habronema* being present.

Experiment V.—In December, 1919, fifty flies, bred from horse dung from the stable referred to in Experiment I., were examined, but none were infected with *Habronema*.

Experiment VI—In January, 1920, forty-six flies, bred from dung of horse " S " were examined, 36 proving to be infected with *Habronema*, the amount of infection ranging from one to 20 worms, with an average of four. Details of this experiment are given later when contrasting the infection of native and domestic flies.

TOTALS.

Experiment I.	..	39 examined	..	32 infected	
Experiment II.	..	16 examined	..	16 infected	
Experiment III.	..	8 examined	..	8 infected	
Experiment IV.	..	6 examined	..	6 infected	
Experiment V.	..	50 examined	..	0 infected	
Experiment VI.	..	46 examined	..	36 infected	
		165 examined	..	98 infected	or 59 per cent.

or omitting Experiment V. (in which case the dung used was almost certainly uninfected with *Habronema*), the totals are 115 examined, 98 infected, *i.e.*, 82 per cent.

During February, 1920, we examined 77 specimens of *M. domestica* bred out from horse dung obtained from a stable in Brisbane, 37 being infected, 23 with *H. muscæ* alone, three with *H. megastoma* alone, two with both species, and nine in which the species present were not recorded. The percentage of infected flies was thus 48. The number of worms present ranged from 1 to 16.

NATIVE FLIES AS INTERMEDIATE HOSTS.

I.—M. FERGUSONI Jnstn. and Bancr.

Captured flies (Eidsvold).

These flies were usually captured right away from stables or yards, and usually near ground where cattle had been camping. Out of 1,176 specimens dissected 26 were found to be infected with *Habronema*, *i.e.*, 2.2 per cent. In 11 cases the worms were too small to be specifically identified, and in eight cases no record of the species was made. In the remaining seven cases, *H. megastoma* occurred alone four times; *H. muscæ* alone twice, while both species were present in one fly. Where count was made of the number of worms present, it ranged from one to 18, with an average of four. This average is very low compared with the high average infection of flies bred on infected material, and coupled with the fact that heavily infected flies are sickly and short-lived in captivity, suggests that under natural conditions also, such heavily-infected flies die off rapidly, and it is only when flies are bred in very lightly-infected material that they survive for any length of time. The occurrence of one or a few very tiny embryos encysted in the fat body of a fully-matured fly in which no large *Habronema* occurred, has suggested that, in some cases at any rate, these embryos have been ingested by the *fly* itself, while feeding on fresh horse dung (fig. 3). In one case a fly bred on cow dung, and kept in captivity for a month, during which time fresh horse dung was placed in the cage for larviposition was found on dissection to contain a very small *Habronema* encysted in the fat body (fig. 4). The embryo measured 190 μ in length by 3.7 μ in breadth. Embryos measuring 147 μ to 200 μ, and in which the gut was undifferentiated, have been taken from a fully-matured captured fly. This stage of the parasite usually occurs in the pupa.

Captured *M. fergusoni* infected with *Habronema*—details of infection.

Date.	No. of flies. examined.	No. infected.		Head.	Proboscis.	Thorax.	Abdomen.	Total.	Remarks.
November 17th, 1918 –January 9th, 1919	115	5	(1)	–	–	–	1	1	No record of species.
			(2)	–	–	–	1	1	Free, no record of species.
			(3)	–	–	–	1	1	Encysted, no record of species.
			(4)	1	–	–	2	3	No record of species.
			(5)	–	–	–	5	5	Very small, encysted.
March 22nd, 1919 –May 28th 1919	288	4	(6)	–	–	–	1	1	No record of species.
			(7)	10		–	–	10	No record of species.
			(8)	–	–	–	4	4	No record of species.
			(9)	–	9	–	–	9	All *H. megastoma*
May 30th, 1919–September 13th, 1919	425	16	(10)	2	–	–	–	2	All *H. megastoma*
			(11)	–	–	–	6	6	Very small.
			(12)	–	–	–	1	1	Very small.
			(13)	–	–	–	3	3	Very small.
			(14)	2	1	–	–	3	*H. muscæ*
			(15)	3	1	–	5	9	No record of species.
			(16)	–	–	1	2	3	*H. muscæ.*
			(17)	5	–	–	–	5	3 *H. megastoma*, 2 *H. muscæ*
			(18)	–	–	–	1	1	Small, encysted.
			(19)	–	–	–	3	3	Small, encysted.
			(20)	–	–	–	4	4	Small, encysted.
			(21)	–	–	–	1	1	Very small, encysted.
			(22)	–	–	–	1	1	Very small, encysted.
			(23)	–	–	3	15	18	Very small, encysted.
			(24)	–	–	–	4	4	Very small, encysted.
			(25)	–	–	2	–	2	*H. megastoma.*
September 15th, 1919 –December 3rd, 1919	328	0							
January 3 –January 12th, 1920	20	1	(26)	–	3	–	–	3	*H. megastoma.*
	1176	26						104	

A record of the localities in which the flies were captured was made, but as all places appeared equally infected the record is not given here. There was no obvious difference in regard to the infection of the two sexes.

Bred flies—M. fergusoni (Eidsvold).

M. fergusoni when bred on infected material becomes very heavily parasitised by *Habronema*.

Experiment I.—During May-June, 1919, two larvæ and nine pupæ of *M. fergusoni* bred on dung of horse "S." on examination were all found to be infected with *Habronema.* Owing to the small size of the embryos, very few could be found in the larvæ and very young pupæ, but in older pupæ considerable numbers of the parasite were noticed. In one pupa 35 days old, 32 worms were present in the head, 29 in the thorax and 30 in the abdomen, making a total of 91 worms in the whole insect (figs. 5-7).

Experiment II.—During June-July, 1919, a few larvæ collected in cow dung were transferred to horse dung of unknown origin; eight flies which emerged were used to test the escape of *Habronema* from flies. The result of dissection after death is given.

Date.	No. of flies.	No of worms found in				Total.	Remarks.
		Head.	Proboscis	Thorax.	Abdomen.		
16/6/19	1	8	–	11	25	44	Both species present.
21/6/19	1	11	–	16	50	77	Both species present.
22/6/19	1	–	–	35	40	75	Both species present.
25/6/19	1	–	–	40	38	78	Both species present.
25/6/19	1	6	–	20	50	76	Both species present.
26/6/19	1	10	–	35	20	65	Both species present.
30/6/19	1	19	6	14	7	46	Both species present. *H. megastoma* predominating.
4/7/19	1	22	2	2	–	26	Both species present. *H. megastoma* predominating.

Total worms, 487; average per fly, 61.

Experiment III.—During July-August a few larvæ were collected and transferred to horse dung in the same manner as in Experiment II. Some of these larvæ were almost full grown at the time of transference. Of 14 flies which were examined 13 were found to be infected with *Habronema,* both species being present. The numbers ranged from 18 to 46 in those in which a complete count was made. In one 27 worms occurred in the head, 10 in the proboscis, six in the thorax and three in the abdomen, making a total of 46, of which 42 were *H. megastoma* and *H. muscæ.*

Experiment IV.—During September, 1919, a few larvæ found in cow dung were collected and transferred to horse dung as in the two preceding experiments. Seven flies were examined, all proving to be fairly heavily infected with *Habronema* of both species.

Experiment V.—Seventeen pupæ and one fly bred in horse dung from various sources were examined, one fly and one pupa were uninfected; the remaining pupæ were infected with from 20 to 60 *Habronema.*

TOTALS.

Experiment I.	2 larvæ 9 pupæ	bred wholly on infected horse dung	11 infected
Experiment II.	8 flies	bred partly on infected horse dung	8 infected
Experiment III.	14 flies	bred partly on infected horse dung	13 infected
Experiment IV.	7 flies	bred partly on infected horse dung	7 infected
Experiment V.	17 pupæ 1 fly	bred on horse dung	16 infected

Thus out of 58 specimens of *M. fergusoni.* no less than 55 (95 per cent.) became infected when given the opportunity.

II.—Musca vetustissima Walker.

Captured flies (Eidsvold).

Specimens of this fly were captured in the same manner as those of *M. fergusoni.* The species, though common in the Eidsvold district during the late spring, summer and autumn, was very scarce throughout the winter and early spring. *M. fergusoni*, on the other hand, was plentiful throughout the year with the exception of a few weeks in the middle of winter (July-August, 1919).

Of 280 specimens dissected, 14 were found to harbour *Habronema, i.e.*, 5 per cent. In seven cases no record of the particular species was kept; in three cases the worms were too small for identification; of the remaining four cases, *H. muscæ* occurred alone twice, *H. megastoma* alone once, and both species were present in one fly. The number of worms ranged from one to about 25.*

Details of infection :—

Date.	No. of flies.	No. infected.		No. of Worms found in Head	Proboscis.	Thorax.	Abdomen.	Total.	Remarks.
November 17th, 1918 –January. 9th, 1919	59	6	(1)	*	*	*	*		*All parts heavily infected. No record of number or species.
			(2)	20	–	–	–	20	No record of species.
			(3)	1	–	–	–	1	No record of species.
			(4)	*	*	*	*		*All parts heavily infected. No record of number or species.
			(5)	*	*	*	*		* do. do.
			(6)	*	*	*	*		* Do. Do.
March 22 –May 28th, 1919	21	2	(7)	3	–	–	–	3	No record of species.
			(8)	3	–	2	–	5	*H. musca.*
May 30th– September 13th, 1919	14	0							
September 15th, 1919 –January 12th, 1920	186	6	(9)	5	–	–	–	5	*H. megastoma.*
			(10)	–	–	–	2	2	Small, encysted.
			(11)	–	–	–	sev	'l	Very small, encysted.
			(12)	*	*	*	*		*All parts infected. *Both species present.*
			(13)	–	–	–	2	2	Very small, encysted.
			(14)	1	1	3	–	5	*H. muscæ.*
	280	14	or 5	per	cent				

Bred Flies, M. vetustissima (Eidsvold).

Experiment I.—In August-September, 1919, five flies bred in dung from horse "S" were examined. All were very heavily infected with *Habronema*, both species being present.

Experiment II.—In November, 1919, 16 flies bred in dung of the same horse were examined, all being heavily infected with *Habronema*. In one case 44 worms were

*We have detected the presence of both species in specimens of *M. vetustissima* collected in the vicinity of horsedung, Melbourne Zoological Gardens, April, 1920, and forwarded to us by the Director, Mr. D. Le Souef. Two infected flies were found amongst thirty examined.

present in one fly, in the head and proboscis alone; in another 84 worms were counted from the head, thorax and abdomen. No specimens of *H. megastoma* were identified in this batch.

Experiment III.—In December, 1919, six flies bred in dung of the same horse were examined. All were heavily infected with both species of *Habronema*, *H. muscæ* predominating.

Experiment IV.—In December, 1919, 11 flies bred in dung of the same horse were examined with the same result as in Experiment III. Over 100 worms were obtained from one fly, the thorax alone containing 90.

Experiment V.—In January, 1920, twenty-two flies were bred from dung of the same horse and examined, all proving to be infected with *Habronema*, the number ranging from 39 to 97 with an average of 71. Where final stages were present, both species of *Habronema* could be identified, but *H. muscæ* predominated as in the other experiments. Details of this experiment are given later when comparing the infection of native and domestic flies.

In these five series altogether 60 flies were examined and all were found to harbour *Habronema*, thus 100 per cent. infection of *M. vetustissima* occurred under experimental conditions.

III.—Musca terræ-reginæ Jnstn. and Bancroft, 1920.

This fly was very rare in Eidsvold, only 21 captured specimens being examined. One of these was infected with a single *H. muscæ*, present in the head.

Specimens of the species when bred on infected horse dung become very heavily infected with *Habronema*.

In November-December, 1919, ten flies bred on material from horse "S" were examined. All proved to be very heavily parasitised by *Habronema*, both species of which were present. The intensity of infection was practically the same as that recorded for *M. vetustissima* in Experiment V.

IV.—Musca hilli Jnstn. and Bancroft, 1920.

This is a rather uncommon fly which occurs in the Eidsvold and Brisbane districts. It breeds readily in captivity. Under experimental conditions specimens became parasitised by *Habronema* when bred out from infected material, both *H. muscæ* and *H. megastoma* being found.

Many flies belonging to this species were bred out (January and February, 1920—Eidsvold and Brisbane) from sterilised horse dung and allowed to oviposit—some on sterilised material and some on fresh, untreated dung from a Brisbane stable (February 20th), larvæ maturing on 26th February, flies emerging on 2nd to 4th March. Those bred from sterilised manure were not infected, while of eighteen examined from untreated dung fifteen were found to have been parasitised by *Habronema*, both *H. muscæ* and *H. megastoma* being represented. The number of worms present in infected flies ranged from three to nine, with an average of about five.

V. to VIII.—Flies other than *Musca* spp. acting as hosts for *Habronema*.

V.—*Pseudopyrellia* sp., a large bluish-green Muscid fly which becomes cobalt-blue when dead. (*Lasiopyrellia* sp. in Johnston and Bancroft, 1919, p. 182). This species usually oviposits on cow dung, but a few specimens have also been bred naturally from horse dung. If bred on infected material this fly becomes parasitised by *Habronema*. Thus six flies bred partly on cow dung and partly on infected horse dung proved on examination to have been invaded by *Habronema*. In five, examined on the day of emergence, most of the worms were in an early stage encysted in the abdomen. In one fly several days old the worms were free and in the final stage, both *H. muscæ* and *H. megastoma* being identified.

VI.—*Anastellorhina augur* Fabr. This common blow fly has not been found breeding naturally in cow or horse dung, but a number of small larvæ which had been deposited on meat, when removed to horse dung grew to full size and pupated. Twenty-eight of the resulting flies were examined, two of them proving to be infected with *Habronema*. In one fly one worm occurred, in the other, two worms. In both cases the parasites were too small to be specifically identified. It is not known whether *Habronema* larvæ can develop fully in this fly. Probably certain other blowflies could be similarly infected.

VII.—*Sarcophaga misera* Walker. This fly has been found breeding naturally in horse dung, though it is usually a carrion feeder in the larval stage. Three larvæ taken from horse dung were examined, and a minute *Habronema* found in each. Twenty-five flies bred from the same material were subsequently examined, eleven of them being found to contain *Habronema*. The number of worms found ranged from one to eight, both *H muscæ* and *H. megastoma* being present in several flies.

VIII.—*Fannia* sp. A small black species of *Fannia* (Anthomyidæ) commonly associated with cattle, has been found breeding naturally only in cow dung, and an attempt to induce it to breed in horse dung failed, the young larvæ being killed by a growth of mould. It is quite probable that, under favourable circumstances, *Fannia* larvæ would mature in horse dung, but whether *Habronema* could develop in this fly is only a matter of conjecture.

Heavier infection of native species of Musca than of M. domestica.

For some time it has been observed that when flies belonging to either of the common native species of *Musca* were bred on dung from a certain horse, the resulting infection was far heavier than when house flies were reared from material from the same source. Thus, during May and June, 1919, a number of heavily infected *M. fergusoni* pupæ bred on dung of horse "S" were examined and actual count of the worms in one gave 91, whilst during June a number of house flies bred on material from the same horse were examined, the average infection being 16 with a maximum of 41—less than half the number counted in a pupa of *M. fergusoni* taken at random. To test this observation more thoroughly, a number of eggs of *M. domestica* and *M. vetustissima*, laid on the same day, were placed together in a jar with fresh dung from horse "S." Fresh material always from the same horse was added when necessary. The larvæ of *M. vetustissima* matured and pupated first, and the flies emerged several days before the house flies. In this way the two species were easily separated. A fairly accurate count of the number of worms in each *M. vetustissima* was made, the worms being killed by heating after dissection of the fly in order to facilitate the process. In the case of *M. domestica* fewer worms were present and an accurate count could be easily made.

M. vetustissima. Twenty-two flies (17 females and 5 males) were examined, all being heavily infected with *Habronema.* Details of infection were as follows :—

Age of fly.	Sex.	No. of worms found in: Head.	Proboscis.	Thorax.	Abdomen.	Total.	Remarks.
few hours	f	–	–	5	71	76	Mostly small and encysted, none in final stages.
few hours	f	–	–	7	81	88	do. do. do.
few hours	f	2	–	4	75	81	do. do. do.
few hours	f	1	–	2	50	53	do. do. do.
few hours	f	–	–	3	64	67	do. do. do.
few hours	f	–	–	7	76	83	do. do. do.
few hours	f	2	–	6	54	62	do. do. do.
few hours	f	4	–	8	47	59	do. do. do.
1 day	f	–	–	35	48	83	Final stages present, chiefly *H. muscæ*, a few *H. megastoma.*
1 day	f	2	–	11	76	89	do. do. do.
1 day	f	1	–	45		46	do. do. do.
1 day	f	2	–	20	63	85	do. do. do.
1 day	f	–	–	2	57	59	Very small and encysted.
3 days	f	4	–	18	17	39	Both species present, chiefly *H. muscæ.*
1 day	m	5	–	49	29	83	do. do. do.
1 day	m	3	–	21	30	54	do. do. do.
3 days	f	19		30	20	69	do. do. do.
3 days	m	20		40	23	83	do. do. do.
3 days	m	45		5	15	65	do. do. do.
3 days	m	26		31	30	87	do. do. do.
4 days	f	24		50	23	97	do. do. do.
4 days	f	3		44	12	59	do. do. do.

M. domestica. Forty-six (26 females and 20 males) were examined—36 (21 females and 15 males) being infected with *Habronema*. In 26 cases a record of the species was kept, *H. muscæ* occurring alone 18 times, *H. megastoma* alone once, while both species were present together 7 times.

Age.	Sex.	No. of worms found in: Head.	Proboscis.	Thorax.	Abdomen.	Total.	Remarks.
1 day	m	7		–	3	10	No record of individual species.
,,	f	9		–	3	12	do. do. do.
,,	m	2	–	1	–	3	do. do. do.
,,	m	1	–	–	1	2	do. do. do.
,,	f	1	–	1	–	2	do. do. do.
,,	f	1	–	–	2	3	do. do. do.
,,	m	2	–	3	–	5	do. do. do.
,,	m	2	–	1	–	3	do. do. do.
,,	m	2	–	6	1	9	do. do. do.
,,	m	1	–	3	16	20	do. do. do.
,,	m	2	–	1	–	3	all *H. muscæ*
,,	f	–	1	1	1	3	all *H. muscæ*
,,	f	1	–	3	6	10	9 *H. muscæ*, 1 *H. megastoma*
Up to 6 days	m	–	–	1	–	1	*H. muscæ*
,,	m	3	–	–	–	3	*H. muscæ*
,,	f	–	–	2	–	2	*H. muscæ*
,,	f	1	–	–	–	1	*H. muscæ*
,,	f	–	–	2	–	2	1 *H. muscæ*, 1 *H. megastoma*
,,	m	2	–	2	–	4	all *H. megastoma*
,,	f	–	–	1	–	1	*H. muscæ*
,,	f	2	–	4	–	6	3 *H. muscæ*, 3 *H. megastoma*
,,	m	–	1	–	–	1	*H. muscæ*
,,	f	–	–	2	–	2	*H. muscæ*
,,	f	1	–	–	–	1	*H. muscæ*
,,	f	3	–	–	–	3	All *H. muscæ*
,,	f	1	–	–	1	2	All *H. muscæ*
,,	f	1	–	–	–	1	All *H. muscæ*
Up to 10 days	f	1	1	1	–	3	All *H. muscæ*
,,	f	–	–	6	1	7	5 *H. muscæ*, 2 *H. megastoma*
,,	f	5		1	–	6	All *H. muscæ*
,,	m	4	2	2	–	8	5 *H. muscæ*, 3 *H. megastoma*
,,	f	1	1	6	1	9	7 *H. muscæ*, 2 *H. megastoma*
,,	f	1	–	–	–	1	*H. muscæ*
,,	f	1	–	1	–	2	*H. muscæ*
,,	m	3	–	–	–	3	2 *H. muscæ*, 1 *H. megastoma*
,,	m	3	–	–	–	3	All *H. muscæ*

IX.—*The stable fly*, STOMOXYS CALCITRANS Geoff.

Both Hill and Bull have shown that this fly is apparently the normal transmitter of *H. microstoma*, but they have pointed out that the parasite may at times undergo abnormal development in *Musca domestica*. They, moreover, failed to infest *Stomoxys* with either *H. muscæ or H. megastoma*. Hill (p. 32), in one of his experiments in which he examined five pupæ and 16 adult *Stomoxys*, all infected, found them to contain from 4 to 50 larval *H. microstoma*, the average being about 25. He mentioned having obtained as many as 60 in one fly, 35 being in the proboscis and head, and 25 in the thorax and abdomen (p. 33). Linstow (1875) discovered larvæ in the heads of two out of 41 stable flies examined by him. His figures and measurements of *Filaria stomoxeos* from this host-species agree sufficiently with those given by Hill for the arvæ of *H. microstoma* for one to assume that the names are synonymous.

Hill examined 63 captured *Stomoxys*, finding only one infected, this containing only one larval *Habronema*. Ten pupæ and 12 larvæ were collected and examined with negative results. Both Hill and Bull, however, reported that experimental infection of the stable fly with *H. microstoma* was very readily brought about. Graham-Smith (1914, p. 241) found *Stomoxys* infected naturally at Cambridge, England, the percentage ranging from four in 1908 to 13 in 1910. The parasite was regarded as being probably *H. muscæ*.

As *Stomoxys* was very scarce in the Eidsvold district we were not able to carry out any experiments with it, and had to content ourselves with examining only 18 specimens (June, July, 1919), none of which were found to harbour larvæ. We might mention that we did not observe in any of the flies examined there, any *Habronema* resembling the larval stages of *H. microstoma*.

We have recently (February, 1920) examined four specimens of the fly bred out from horse dung collected in Brisbane, and have found two infected, one containing in its proboscis six worms, and the other only one, all of which agree with the description given by Hill for

H. microstoma. The measurements of one of our specimens are given in the table early in this paper. *Musca domestica, M. hilli* and *M. terræ-reginæ* bred out from the same material were not parasitised by this species, but by both of the others (*H. muscæ* and *H. megastoma*).

X.—*The buffalo fly* LYPEROSIA EXIGUA Meij.

We regard it as highly probable that *Lyperosia exigua*, the buffalo fly, whose habits have been studied by Hill (P.L.S., N.S.W. 41, 1916, p. 763-8) acts as a carrier of *Habronema* in the Northern Territory. It breeds in horse dung and readily attacks horses, much in the same way that its relative *Stomoxys* does. It would be of interest to test this fly experimentally as a possible carrier of *Habronema* spp., especially *H. microstoma.* Its breeding habits and its relation to horses and "fly sores" on these animals, suggest that it may also be concerned in causing "cutaneous habronemiasis" or swamp cancer (see later).

Escape of the larvæ from infected flies.

Ransom (p. 15) found an active larva in moisture in a jar in which flies (*M. domestica*) had been confined since the previous day, but as many of the flies were dead, it was not known whether escape occurred before or after the death of the host, or whether the host had suffered injury which allowed the worm to gain its liberty. "The escape of larvæ from flies into water or into moist material liable to be ingested by horses is a possible mode by which infection of the final host may occur, but the fact that the worms, so far as observed, are unable to live more than a few days outside the body of a host goes to prove that this is not a normal occurrence in their life history. The fact that the proboscis is a favourite location of the larval worms suggests that they may abandon their intermediate host in some such manner as Filaria larvæ abandon the mosquito. It is conceivable that they might escape through a slight rupture of the proboscis occurring at a moment when the fly was sucking moisture from the mucous membrane of a horse's lips, after which they could readily reach their final location in the stomach. As yet, however, no evidence of such an occurrence has been obtained." He believed the accidental swallowing of living or dead infested flies was the means by which horses became infected with *H. muscæ* (p. 15, 23).

Bull (1916, p. 193) in discussing *Habronema* larvæ as the causative agents of certain granulomata of equines, stated that it seemed certain that they were introduced by a biting fly, and suggested *Stomoxys* as a possible vector. The larvæ found in the granulomata in Australia and in the "summer sores" elsewhere showed the characteristics of the last larval stage occurring in flies. They would be accidentally inoculated in such cases during the feeding operations of the fly.

Lewis and Seddon (1918, p. 92) in dealing with habronemic conjunctivitis of horses in Victoria, referred to the possible infection of the eye by *Habronema* larvæ deposited accidentally by some species of fly.

Hill failed to bring about the escape of larvæ from living and dead flies (p. 20, 34) by using moisture and also saline solution. He stated his opinion that the accidental ingestion of both living and dead infected flies provided the normal means by which the larva found its way to the horse's stomach, there to be liberated by digestive agencies; in other words, he supported Ransom's contentions. He mentioned, however (p. 63), that he had not come across any flies in the 39 horses' stomachs examined, though in 37 at least one species of *Habronema* was present. He found that heavily-infected *Stomoxys* flies were not able to puncture a horse's skin.

Bull (1919, pp. 98, 100, 102) endeavoured, by using sugar solution, to ascertain how the larvæ of the three species escape from their hosts. Though a few larvæ were liberated, he did not know whether they came from living or dead flies, or whether there had been any injury to the proboscis as a result of handling. From dead flies placed in saline solution, larvæ were obtained. He found that worms could live in saline or in horse serum for 48 or even 72 hours, and for several days in the bodies of dead flies, if loss of moisture were prevented.* The escape from the

*Our experience in respect to these facts was similar.

proboscis was found to depend upon the rupture of some portion of the organ, this apparently depending upon the pressure exerted by the larvæ, such pressure being dependent on the number and activity of the worms present (p. 103). He showed that under certain experimental conditions, the larvæ could set up granulomata in the horse.

In order to ascertain whether the worms could escape from living flies we carried out some tests which were suggested to us by observation of the habit of these flies, especially *M. australis* and *M. vetustissima*, in frequenting the mouths and eyes of stock.

Escape of Habronema from M. fergusoni.

A few *M. fergusoni* bred partly on cow dung and partly on infected horse dung, and emerging from 18th to 23rd May, 1919, were placed in a cage and fed on drops of warm meat juice in a well-slide, the meat juice being obtained by teasing up a small piece of raw beef in a little water. The flies were also fed occasionally on honey and water.

On May 18th 4 flies present	No *Habronema* escaped
On May 19th 4 flies present	No *Habronema* escaped
On May 20th 7 flies present	4 *H. muscæ* escaped
On May 21st 5 flies present	13 *H. muscæ* escaped
On May 22nd 4 flies present	No *Habronema* escaped
On May 23rd 5 flies present	No *Habronema* escaped
On May 24th 5 flies present	No *Habronema* escaped
On May 26th 2 flies present	No *Habronema* escaped
On May 27th 2 flies present	1 *H. muscæ* escaped.

One of the two surviving flies lived for three days, and the other for seven days longer, but no more *Habronema* escaped. On 22nd, 23rd, 24th and 25th May, warm gravy from cooked beef was used instead of raw meat juice.

The total number of flies used in this experiment was eight, while the total number of *H. muscæ* escaping was 18. The escaping worms showed intense activity, as was also the case in succeeding experiments where warm human *saliva* was used instead of meat juice.

Escape of Habronema from M. vetustissima.

Experiment I.—On November 26th, 1919, about 18 *M. vetustissima* bred on infected material were placed in a cage and fed on moistened raisins. They were offered warm human saliva in a welled slide daily without result until November 28th, when two *H. muscæ* escaped, only two flies being alive on this date, though they died during the day. All these flies were heavily infected with *Habronema*, over 80 being counted in one fly. No specimens of *H. megastoma* were identified in this batch.

Experiment II.—On November 30th, six *M. vetustissima* were placed in a cage and treated in the same manner as in Experiment I. On 1st December, one *H. muscæ* escaped into warm human saliva. These flies also died off rapidly, and no more nematodes escaped. All flies were heavily infected with *Habronema*, both species being present.

Experiment III.—From 10th to 12th December about twelve *M. vetustissima* bred on infected material were placed in a cage. On December 13th, five flies were alive, and during the day a total of 49 *Habronema* (chiefly, *H. muscæ*) escaped into warm human saliva. On December 14th, all the flies were dead.

Escape of Habronema from M. domestica.

Experiment I.—On 13th and 14th January, 1920 about 20 house flies bred on infected horse dung were placed in a cage and fed on moistened raisins. A drop of human saliva in a well-slide was placed in the cage on a slab of stone which had been previously warmed to about 40° C. The slide was withdrawn and examined from time to time, more saliva being added and the slab of the stone heated again. It happened occasionally that the saliva dried up in the well-slide before examination, and when this occurred it was difficult to determine the species of any which might have escaped, such worms being recorded merely as *Habronema*. The total number of nematodes escaping each day is given :—

January 14th	..	none escaped
January 15th	..	2 *H. muscæ* and 1 *Habronema* sp. escaped
January 17th	..	7 *H. muscæ* and 2 *Habronema* sp. escaped
January 19th	..	10 *Habronema* sp. escaped
January 20th	..	24 *H. muscæ* escaped
January 21st	..	5 *H. muscæ* escaped
January 22nd	..	none escaped
January 23rd	..	none escaped
		Total number of *Habronema* 51.

Experiment II.—On January 15th, 1920, about 300 house flies bred on infected material were placed in a cage and the same routine followed as in Experiment I.

On January 16th .. 11 *Habronema* escaped
On January 17th .. 3 *H. muscæ* escaped
On January 19th .. 1 *H. muscæ* escaped.
On January 20th .. 8 *H. muscæ*, 1 *H. megastoma* escaped
Total number of *Habronema* 24.
Total number which escaped in the two experiments 75.

These observations lead us to the opinion that when the larvæ have reached their final stage in the fly, they naturally make their escape from the proboscis by rupturing it when the fly alights around the horse's mouth, moist with saliva. The worms are then readily transferred to the stomach with the saliva and proceed with their development.

We are of opinion that the larvæ will also be similarly liberated when the fly comes into contact with a suitable surface, *e.g.*, the conjunctiva, where they may set up habronemic conjunctivitis; any abrasion or sore, where they could cause a granuloma; or they may reinfect a granuloma and such would afford an explanation of cases referred to by Bull, where parasites of different ages were found.

The wound made by one fly, *e.g.*, a biting fly, serves as an attraction for other flies, especially *Stomoxys calcitrans*, *M. fergusoni* and *M. vetustissima* (see Johnston and Bancroft, 1919), and may become infected with *Habronema* larvæ. Of course, all which fail to reach the mouth are doomed to destruction.

It seems to us probable that in Australia the chief transmitter of *Habronema*, whether *H. muscæ* or *H. megastoma*, is *Musca vetustissima*, whose habits are so closely associated with cattle. This species has a very wide range, embracing the whole continent, being not only the common "bush fly," but one which invades the towns and cities where it is commonly met with out of doors (Johnston and Bancroft, 1919). Our observations show that it becomes readily and heavily infected with *Habronema* when the opportunity occurs. The larger species, *M. fergusoni*, is also, no doubt, a very important disseminator, but, though its habits are somewhat similar, its range is restricted to the more northerly parts of Australia. In Queensland, as far south as the Burnett River, it appears to be the commoner species. Though met with occasionally in the Brisbane district, the common outdoor Muscid fly there is *M. vetustissima*. *M. domestica* is essentially a house fly, *i.e.*, it is in close association with man, houses and stables, and occurs especially indoors. The other two are, as already stated, outdoor species.

In discussing "swamp cancer" of horses in the Northern Territory, which Bull (1916; 1919) regards as a form of habronemiasis in opposition to the view held by Lewis (1914) and Seddon (1918), Bull mentioned the possibility of the condition being due to any one of the three species of *Habronema* (Bull, 1919, p. 120). He went on to say that evidence was not in favour of either *H. muscæ* or *H. megastoma* being the cause since they passed through their larval stages in *M. domestica*, a fly which was not usually found far afield. He believed (p. 121) that *H. microstoma* was much more likely to be the cause since its intermediate host, *Stomoxys calcitrans*, possessed a wider range. He thought it possible that swamp cancer might be due to other species of *Habronema* carried by some other Muscid, *e.g.*, *M. vetustissima*, but that if this be responsible then one would expect to find lesions in the conjunctiva.

Perhaps the discovery that the two widely distributed "bush flies" can carry infection may assist in elucidating the problem of swamp cancer. Both of these flies (as do also *M. terræ-reginæ* and *M. hilli*) frequent injured surfaces, and will visit the puncture made by a blood-sucking fly. In the serum, worm larvæ could be deposited from an infected fly and thus a granuloma be initiated while frequent reinfection would lead to extensive tissue alterations.

Bull (1919, p. 131) mentioned that the microscopic picture of "swamp cancer" which is present in 75 per cent. of horses in the Solomon Islands was very like that described as occurring in habronemic granulomata in Australia, larvæ, apparently of different ages, being seen in the tissues. We might state that one of the flies with which we worked, *M. fergusoni*, is almost certainly identical with *M. australis* Macquart (*non* Boisduval), a type locality for which is the Solomon Islands. It would be of interest to know whether a similar condition is met with in Fijian horses, as Fiji is another locality where, according to Macquart, *M. australis* occurs.

Patton and Cragg (1913, p. 345) mention that in Madras, *Musca nebulo* is frequently infected with larvæ of an *Oxyuris* (? *O. curvula*) from horses, these worms being ingested while the fly is a larva. Infected flies are said to soon die, being unable to feed owing to the proboscis becoming rigid on account of the large number of mature worms present. The short account suggests that the worms are *Habronema* spp. *H. muscæ* is known to occur in flies in Bombay.

We have not had an opportunity to test whether *M. fergusoni*, or *M. vetustissima*, can become infected with *Habronema microstoma*.

SUMMARY.

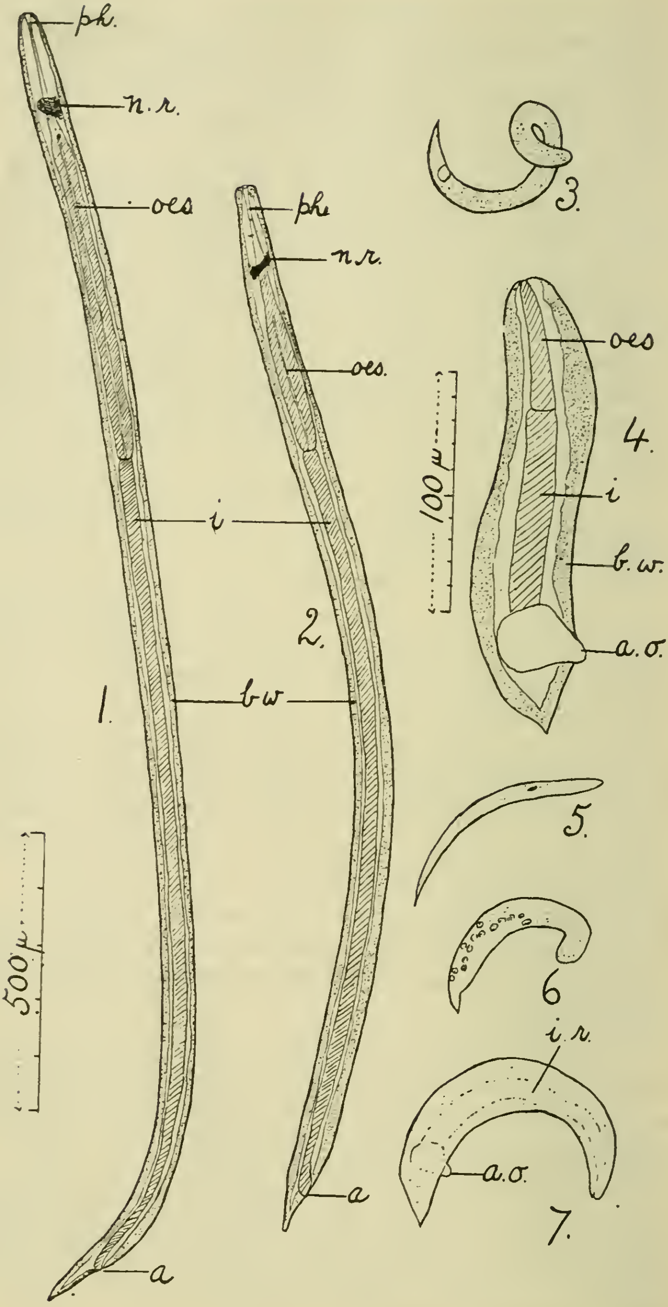
1. Various flies, both native and introduced, are capable of acting (in Queensland) as transmitters of one or more of the three species of *Habronema* infesting the stomach of horses.

2. *H. muscæ* and *H. megastoma* may be transmitted by the Muscids, *Musca domestica*, *M. vetustissima*, *M. fergusoni*, *M. terræ-reginæ*, *M. hilli*, and *Pseudopyrellia* (cobalt blue sp.)—also by *Sarcophaga misera* ; no doubt by other *Sarcophaga* spp. also.

3. *Anastellorhina augur* can become infected with *Habronema* ; probably other blow flies with similar habits could also. They are not, apparently, normal transmitters of the parasites.

4. *H. microstoma* undergoes its larval development in *Stomoxys calcitrans* and not in *M. domestica*. We have not specially tested any of the other flies as possible transmitters of the parasite. *Lyperosia exigua* is suggested as an intermediate host for this species.

5. *Habronema* spp. can make their escape from infected flies into saliva. This is apparently the normal mode. Thus horses become infected by larvæ escaping from parasitised flies settling on the mouth.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Text-figures.

1. Mature larva of *Habronema muscæ* (glycerin preparation) from bred flies.
2. Mature larva of *Habronema megastoma* (glycerine preparation) from bred flies.

The succeeding figures were drawn from specimens in saline solution

3. Young stage of *Habronema* from captured *Musca fergusoni.*
4. Young stage of *Habronema* found in a *M. fergusoni* which was bred in cow dung, and, after emergence as an imago, was fed on infected horse manure.
5. *Habronema* embryo from a *M. fergusoni* larva—not more than 2 days in larva.
6. *Habronema* embryo from a *M. fergusoni* pupa,—not more than 9 days in larva and pupa.
7. *Habronema* embryo from *M. fergusoni* pupa,—not more than 14 days in larva and pupa.

Figs. 1 and 2 are to the same scale; figs. 3 to 7 are to the same scale (shown beside fig. 4).

References to Lettering.

a., anus; *a.o.*, anal operculum; *b.w.*, body wall; *i.*, intestine; *i.r.*, rudiment of intestine; *n.r.*, nerve ring; *oes.*, œsophagus; *ph*, pharynx.

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ON THE OCCURRENCE OF CYANOPHORIC GLUCOSIDES IN THE FLOWERS OF SOME PROTEACEAE.

By F. Smith, B.Sc., F.I.C., and C. T. White, F.L.S.

(*Read before the Royal Society of Queensland*, 31*st May*, 1920).

In a previous paper[1] we have already drawn attention to the occurrence of hydrocyanic acid in the flowers of two Proteaceae *Grevillea Banksii* and *Lomatia silaifolia*, from the foliage of which it is absent. As fresh material has become available we have further investigated various Proteaceae, especially with a view to determining the distribution of cyanophoric glucosides in the floral members, and the results to be here cited appear to us worthy of notice as being phytochemically new.

The following are summarised accounts of the reactions with the floral parts of various Proteaceae examined since the publication of our last paper.

Grevillea Banksii R. Br.	HCN.
Foliage, floral rhachis, pedicels, anthers, hypogynous glands	Negative reactions.
Petals, ovary, style and stigma, capsules, seed.	Strong positive reactions.
Dry capsules (from which the seed had been shed)	Positive reaction.

The reaction of the green capsules was especially strong, an amygdalous odour being pronounced when the material was cut up.

Grevillea robusta A. Cunn., Common Silky Oak of Southern Queensland and New South Wales.	HCN.
Foliage, pedicels, petals, anthers, hypogynous glands.	Negative reactions.
Pistil, capsules, seed.	Strong positive reactions.
Dry capsules (from which the seed had been shed).	Negative reaction.

Hakea saligna Knight.	HCN.
Foliage, capsule, seed	Negative reactions.
Flowers	Positive reaction.

The test being carried out late in the flowering season, only the one with the flowers as a whole was made; further material for individually testing the different floral members was not available.

Lomatia silaifolia R.Br.	HCN
(*a*) Foliage leaves, pedicels, petals, hypogynous glands, capsules, seed.	Negative reactions.
Anthers, pistil.	Strong positive reactions.
(*b*) Leaves, panicle branches, pedicels, petals, ovary, hypogynous glands.	Negative reactions.
Anthers, style and stigma	Strong positive reactions.
(*c*) Leaves, petals, ovary, hypogynous glands.	Negative reactions.
Anthers, stigma	Strong positive reactions.
Stigma (with the surface cleaned of pollen).	Positive reaction.

L. silaifolia is of special interest owing to the reported properties of the flowers of killing flies.[1 2 3] The flowering plant has also been suspected as the cause of mortality in calves.[4]

The material for tests (*a*) and (*b*) was collected at Sunnybank in May and November, 1919, respectively. As some doubt existed as to whether the positive reaction with the pistil was due to the pollen adhering to it, a further test (*c*) was carried out with the stigmatic surface cleaned of pollen with the above results. This last material was collected in the Glass House Mountains district in February, 1920.

The anthers of *Lomatia* flowers are strongly cyanogenetic. There is still some doubt in regard to the stigma owing to the difficulty of completely freeing the stigmatic surface of pollen grains, many of which are in a state of germination. The possibility of *Lomatia* flowers proving dangerous to bees owing to the cyanophoric properties of the pollen seems to us worthy of consideration by entomologists and apiarists.

Lomatia silaifolia R.Br. var. *induta* F. v. M.

This variety yielded in all its parts reactions identical with those recorded for the normal form.

Both foliage and flowers of the following species have been tested with negative results :—

Conospermum taxifolium Sm. ; *Strangea linearis* Meissn. ; *Grevillea Hilliana* F.v.M. ; *Grevillea pinnatifida* Bail ; *Stenocarpus sinuatus* Endl. ; *Banksia integrifolia* Linn. f. ; *Buckinghamia celsissima* F.v.M.

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NEW OR LITTLE-KNOWN AUSTRALIAN CRANE-FLIES (*TIPULIDAE, DIPTERA*).

By Charles P. Alexander, Ph.D. (Cornell), State Natural History Survey, Urbana, Illinois, U.S.A.

(*Read before the Royal Society of Queensland, May 28th,* 1920).

In a small collection of crane-flies received from Dr. James F. Illingworth from the vicinity of Cairns, North Queensland, several species of exceptional interest were included. Some of these species were described by Skuse thirty years ago and not recorded in the literature since that time, while a few others had not been discovered in Australia hitherto. Besides the described species a few others proved to be new to science and are discussed herewith. The types of the species are preserved in the collection of the writer. I would express my sincere thanks to Dr. Illingworth for his many kindnesses at this time and in the past.

Family TIPULIDÆ.

Subfamily Limnobiinæ.

Tribe Limnobiini.

Genus Dicranomyia *Stephens*.

1829, *Dicranomyia* Stephens, Catalogue of British Insects, vol. 2, p. 243.

Dicranomyia illingworthi Alexander.

1914, *Dicranomyia illingworthi* Alexander, Annals of the Entomological Society of America, vol. 7, pp. 239, 240, pl. 34, fig. 1 ; pl. 35, fig. 7.

Two alcoholic females of this species were included in the collection. The fly was described from the Fiji Islands and has not been recorded from Australia.

The female sex has not been described and one of these specimens is made the allotype.

Allotype. — Female, length 7.3-7.5 mm.; wing, 6.3 mm.

Very similar to the male, differing as follows :—

The flagellar segments are more oval, becoming more elongated toward the end of the organ. Legs with the coxæ yellow, the bases brown; trochanters dull yellowish brown; femora yellow with a narrow pale brown ring before the tip; tibiæ dull yellow, the tips narrowly but conspicuously dark brown; first and second tarsal segments brownish yellow, the tips narrowly dark brown; last three tarsal segments dark brown; claws with a large tooth near midlength and a series of smaller denticles nearer the base. Abdomen, brown, the pleural membrane still darker brown. Ovipositor with the tergal valves slender, only slightly upcurved; sternal valves compressed, almost straight.

Allotype, ♀, Meringa, near Cairns, 1918 (J. F. Illingworth). Taken at light.

Genus RHIPIDIA *Meigen.*

1818, *Rhipidia* Meigen, Systematische Beschreibung, vol. 1, p. 153.

Rhipidia pulchra de Meijere.

1904, *Rhipidia pulchra* de Meijere, Bijdragen tot de Dierkunde, vol. 17, p. 92, pl. 8, fig. 7.

One female taken at light, Meringa, near Cairns, 1918, J. F. Illingworth.

Genus LIBNOTES *Westwood.*

1876, *Libnotes* Westwood, Transactions of the Entomological Society of London, 1876, p. 505.

Libnotes parvistigma, sp.n.

Belongs to the *familiaris* group; antennæ pale; head dark; pronotum and mesonotal præscutum pale brownish yellow with a broad dark brown median stripe; femora with a narrow dark brown subterminal ring; wings subhyaline, the stigma small, dark brown, *Sc* very long, the basal deflection of Cu_1 near mid-length of the long cell 1*st* M_2.

Female.—Length 9-10.4 mm.; wing, 6.6-8.5 mm.

The following description is made from alcoholic specimens.

Rostrum and palpi dark brown. Antennæ pale yellow, the scape and the terminal flagellar segments more brownish. Head dark.

Pronotum pale with a broad dark brown median stripe. Mesonotum pale brownish yellow, the præscutum with a dark brown median stripe that is broadest in front, rapidly narrowed to a point at the suture, in front being confluent with the pronotal stripe; each scutal lobe with a rectangular longitudinal mark; scutellum brown, with an indistinct paler median dividing line; postnotum with a distinct brown median stripe. Pleura yellow with a small brown spot beneath the wing-root. Halteres pale, the knobs large. Legs with the coxæ and trochanters pale yellow; femora brownish yellow with a narrow dark brown ring immediately before the tips; tibiæ pale brown, the tips indistinctly darkened; tarsi brown. Wings subhyaline, stigma small, dark brown, rounded and sending a short cloud basad along vein R_1; veins dark brown. Venation: Sc very long, Sc_1 ending about opposite r-m, Sc_2 far back from the tip of Sc_1, nearly opposite the fork of Rs; r at the tip of R_1; Rs almost straight, in alignment with the basal deflection of R_{4+5} which is about one-half its length; cell 1*st* M_2 long, closed, the basal deflection of Cu_1 at or beyond the middle of its length.

Abdominal tergites brownish yellow, segments one to six with a large brown, roughly triangular area in the centre of each; sternites dull yellow. Ovipositor with the tergal valves very small and slender, the sternal valves much more powerful, compressed, almost straight.

Habitat.—North Queensland.

Holotype, ♀, Meringa, near Cairns, 1918 (J. F. Illingworth).

Paratopotypes, 25 ♀'s.

From the fact that the type series consisted only of females we may surmise that this material was taken at light.

Libnotes parvistigma bears a marked resemblance to *L. indica* (Brunetti) of India, a much smaller fly with dark brown legs, a dark cloud at the origin of the sector and a slightly different venation (*Sc.* shorter ; basal deflection of Cu_1 close to the fork of M).

Libnotes pulchripes, sp.n.

Antennæ dark brown, the flagellar segments oval, moniliform : fore femora with the tips broadly blackened ; tibiæ white with a postmedial black ring : tarsi white ; wings grayish subhyaline, stigma small, dark brown ; anal angle of the wing lacking, cell *1st* M_2 open.

Male.—Length 5.3-6 mm. : wing, 5.7-5.9 mm.

Mouth parts small, pale brown. Antennæ dark brown, the segments oval, strongly moniliform. Head pale yellowish brown.

Mesonotum pale brownish, the præscutum without apparent stripes. Pleura dull yellow, sparsely pruinose ; a brown mark on the mesosternum between the fore and middle legs. Halteres elongate, brown, the knobs dark brown. Legs with the coxæ pale ; trochanters brown ; femora yellow, the tips of the fore femora broadly blackened and incrassated ; middle femora scarcely enlarged or darkened apically ; hind femora slightly incrassated and infuscated ; tibiæ white, immediately before midlength with a conspicuous black ring : tarsi white, the claws black. Claws long and but slightly curved, simple, the base with about two acute bristles ; the last tarsal segment with a few slender setigerous tubercles bearing very long, powerful bristles.

Wings grayish subhyaline ; stigma small, oval, dark brown : veins dark brown ; wings cuneiformly narrowed at the base, the anal angle lacking. Venation : *Sc* moderately elongated, Sc_1 ending some distance beyond the origin of *Rs* and not far before its fork ; Sc_2 far from the tip of Sc_1, slightly beyond or even proximad of the origin of *Rs*, Sc_1 usually being longer than *Rs* : *Rs* almost straight, about in alignment with R_{4+5} ; cell *1st* M_2 open by the atrophy of the outer deflection of M_3 ; basal deflection of Cu_1 at the fork of M ; *2nd Anal* vein sinuous.

Abdomen pale brown ; hypopygium small.

Habitat.—North Queensland.

Holotype, ♂, Gordonvale, February, 1918 (J F. Illingworth).

Paratopotype, ♂.

The types were from grass.

The reference of this curious fly to *Libnotes* is somewhat provisional but the only other course would be the erection of a new genus. The almost simple claws, the open cell 1*st* M_2 and the cuneiform wings are aberrant characters in the genus *Libnotes*.

Tribe Antochini.

Genus Styringomyia *Loew.*

1845, *Styringomyia* Loew, Dipterologische Beitrage, vol. 1, p. 6.

Styringomyia bancrofti Edwards.

1914, *Styringomyia bancrofti* Edwards, Transactions of the Entomological Society of London, 1914, pt. 1, p. 222, pl. 23, figs. 44, 45 ; pl. 25, figs. 80, 81.

Two females from Meringa, near Cairns, 1918 (J. F. Illingworth).

Tribe Eriopterini.

Genus Erioptera *Meigen.*

1803, *Erioptera* Meigen, Illiger's Magazin, vol. 2, p. 262.

Erioptera (*Erioptera*) *angustifascia*, sp.n.

Antennæ pale brown ; head dark brown, paler along the inner margin of the eyes ; femora with a broad brownish ring before the tips ; wings grayish subhyaline with a narrow brown seam along the cord ; R_{2+3} short, at a marked angle with the end of the sector, *r* at the fork of R_{2+3}.

Female.—Length 4.8 mm. ; wing, 3.5 mm.

The following description is made from an alcoholic specimen.

Rostrum pale brown ; palpi dark brown. Antennæ pale brown, the segments beyond the sixth broken ; flagellar segments oval. Head dark brown, broadly yellowish adjoining the inner margin of the eyes.

Mesonotum brownish yellow without distinct stripes. Pleura brownish yellow. Halteres pale. Legs with the coxæ and trochanters yellow; femora yellow, before the tips with a broad, indistinct brownish annulus; tibiæ and tarsi yellowish, the terminal segments of the latter darkened: claws very small. Wings grayish subhyaline: a narrow brown seam along the cord, extending from *r* to the fork of *M*; veins brown. Venation: Sc_1 ending nearly opposite *r*, Sc_2 a short distance beyond the origin of *Rs*; *Rs* long, almost straight; R_{2+3} short, about equal to *r-m*, forming a marked angle with the end of *Rs*, *r* at its fork, oblique; cell 1*st* M_2 open: 2*nd Anal* vein strongly sinuous before its end.

Abdomen pale brown. Ovipositor with the valves very slender; tergal valves strongly upcurved, the margins smooth.

Habitat.—North Queensland.

Holotype, ♀, Meringa, near Cairns, 1918 (J. F. Illingworth).

Erioptera (*Erioptera*) *illingworthi*, sp.n.

Antennæ pale brown; legs yellowish, the terminal tarsal segments darkened: wings pale brownish yellow, *r* inserted on R_2.

Female.—Length about 5.5 mm.; wing, 4.3 mm.

The following description is made from an alcoholic specimen.

Rostrum pale yellowish brown; palpi brown. Antennæ light brown. Eyes rather small, widely separated by the vertex. Head pale brownish yellow.

Mesonotum pale brownish yellow, the præscutum without distinct darker stripes. Pleura yellow. Halteres pale. Legs with the coxæ and trochanters yellow; remainder of the legs yellow with only the terminal segments of the tarsi darkened. Wings pale brownish yellow: veins pale brown. Venation: Sc_1 ending nearly opposite *r*, Sc_2 just beyond the origin of *Rs*; *Rs* long, straight; *r* on R_2 about its own length beyond the fork of R_{2+3}; cell 1*st* M_2 open; 2*nd Anal* vein strongly sinuous before its end.

Abdomen brownish yellow. Ovipositor with the tergal valves very long and slender, the upward curve almost a semicircle.

Habitat.—North Queensland.

Holotype, ♀, Meringa, near Cairns, 1918 (J. F. Illingworth).

It is with the greatest pleasure that this interesting little *Erioptera* is dedicated to its collector, my friend Dr. James F. Illingworth.

Genus GONOMYIA *Meigen.*

1818, *Gonomyia* Meigen, Systematische Beschreibung, vol. 1, p. 146.

Subgenus LEIPONEURA *Skuse.*

1889 *Leiponeura* Skuse, Proceedings of the Linnean Society of New South Wales, vol. 4 (ser. 2), pp. 795, 796.

Gonomyia (*Leiponeura*) *cairnensis*, sp.n.

Antennæ dark brown, the scape conspicuously light yellow; mesonotal præscutum with three dark brown stripes: pleura yellow, longitudinally striped with dark brown: wings grayish yellow with small brown spots at the tips of Sc_1 and R_{2+3}; Sc_1 short with Sc_2 at its tip; basal deflection of R_{4+5} long; abdominal tergites brown, ringed caudally with yellow.

Male.—Length, 6.6 mm.; wing, 5.7 mm.

The following description is made from an alcoholic specimen.

Rostrum and palpi dark brown. Antennæ with the scape light yellow, the flagellar segments dark brown. Head yellow; a linear brown mark on the anterior part of the vertex between the eyes.

Mesonotal præscutum yellow with three broad dark brown stripes, the long median stripe very indistinctly divided by a capillary pale line; scutal lobes dark brown, the median area pale with a very indistinct brown median dash: scutellum and postnotum pale, the latter darker behind. Pleura yellow, longitudinally striped with dark brown, the stripe beginning as two narrow brown lines on the propleura, continued caudad, including the extreme base of the fore coxa, passing through the base of the halteres and continuing to the abdomen. Mesosternum dark brown, the pale stripe between this mark and the pleural stripe broad and distinct. Halteres pale. Legs with the coxæ pale, the base of the fore coxæ darkened ; trochanters pale ; remainder of the legs broken. Wings with a strong grayish yellow suffusion ; stigma oval, slightly darker gray ; a small dark brown spot at the tip of Sc_1 and another at the tip of R_{2+3} ; veins dark brown, deepest along the cord. Venation : *Sc* short, ending far before the origin of *Rs*. Sc_2 at the tip of Sc_1 : the distance on *R* between Sc_2 and the origin of *Rs* is about equal to the basal deflection of Cu_1 : *Rs* rather long, strongly angulated at origin ; basal deflection of R_{4+5} long, about equal to *r-m* : basal deflection of Cu_1 just before the fork of *M*.

Abdominal tergites dark brown, broadly ringed caudally with yellow to produce an annulated appearance ; sternites dull yellow, the segments with a very narrow and indistinct brown lateral stripe that is interrupted at the incisures. Male hypopygium with the pleurites rather stout, the inner caudal angle produced caudad into a small blackened chitinized point and a blunt fleshy protuberence that is covered with about 15 short setæ ; a single pleural appendage, elongate, flattened, blade-like, the tip obtusely rounded and a little darkened, at the base with a small rounded lobe that is densely covered with short hairs. Outer gonapophyses large, heavily chitinized, bifid, the apical point about three times as large as the subterminal spine. Penis-guard subtended on either side by a slender, curved hook with the subacute tips heavily chitinized.

Habitat.—North Queensland.

Holotype, ♂, Meringa, near Cairns, 1918 (J. F. Illingworth).

Gonomyia (*Leiponeura*) *queenslandica*, sp.n.

Antennæ brown : mesonotum dark brown ; pleura brownish yellow indistinctly marked with brown, wings with a strong grayish brown tinge, vein *Sc* short, Sc_2 far before the tip of Sc_1 ; cell 1*st* M_2 closed.

Female.—Length 4.6 mm. ; wing, 4mm.

The following description is made from an alcoholic specimen.

Rostrum pale ; palpi short, dark brown. Antennæ dark brown, the first scapal segment paler. Head dark ; vertex protuberent.

Pronotum pale. Mesonotal præscutum dark brown, the lateral margins and humeral angles paler. Pleura brownish yellow, indistinctly marked with brown. Halteres pale, the knobs a trifle darker. Legs with the coxæ brownish on their outer faces : trochanters pale brown ; remainder of the legs pale brown. Wings with a strong grayish brown suffusion : stigma indistinctly darker ; veins brown. Venation : *Sc* short, Sc_1 ending far before the origin of *Rs*, this distance nearly equal to the length of *Rs* alone ; Sc_2 far removed from the tip of Sc_1, Sc_1 alone being longer than *Rs* : *Rs* short, strongly arcuated at its origin ; basal deflection of R_{4+5} very short, subpunctiform ; veins R_{2+3} and R_{4+5} strongly divergent ; basal deflection of Cu_1 a short distance before the fork of *M*.

Abdominal tergites dark brown ; sternites yellow. Ovipositor with the tergal valves slender, acute, slightly upcurved.

Habitat.—North Queensland.

Holotype, ♀, Meringa, near Cairns, 1918 (J. F. Illingworth).

Gonomyia queenslandica is closest to *G. brevivena* (Skuse) but Sc_2 is not at the tip of Sc_1 and cell 1*st* M_2 is scarcely one-half the length of cell 2*nd* M_2 (second posterior).

Genus CONOSIA *van der Wulp.*

1880, *Conosia* van der Wulp, Tijdschrift voor Entomologie, vol. 23, p. 159, pl. 10, figs. 5-7.

Conosia irrorata (Wiedemann).

1828, *Limnobia irrorata* Wiedemann, Aussereuropäische zweifl. Insekten, vol. 1, p. 574.

A female specimen, taken at Meringa, near Cairns, 1918 (J. F. Illingworth).

Tribe Limnophilini.

Genus LECHRIA *Skuse.*

1889, *Lechria* Skuse, Proceedings of the Linnean Society of New South Wales, vol. 4 (ser. 2), pp. 830, 831.

The genus *Lechria* is a very isolated group that has been referred almost without question to the tribe Eriopterini although the fact that the insects possessed tibial spurs has been pointed out by several writers. De Meijere was the first to remove the genus from the Eriopterini to the Limnophilini, to where it runs by means of the existing keys, but it seems very possible that a new tribe may be required for it when the immature stages are made known. The chief venational peculiarities of *Lechria* are the apparent fusion of R_2 with R_1 near the tip of the latter, a condition that is quite comparable with that found in the tribe Pediciini as discussed by the writer in another paper, (Entomological News, vol. 29, pp. 201-205, pl. 12; 1918), and the union of *r-m* directly with the sector before its fork. Some features of structure are suggestive of *Dicranoptycha*, and more evidence may show these two genera to be closer than their present arrangement would indicate.

Lechria rufithorax, sp.n.

Antennæ dark brown; vertex very narrow; mesonotal præscutum dull rusty brown without stripes, the scutellum and postnotum dark plumbeous brown; femora brownish yellow, the tips dark brown, apical tarsal segments darkened; wings faintly grayish, the costal cells more infumed.

Male.—Length about 5 mm.; wing, 6.9-7 mm.

Female.—Length about 7.5 mm.; wing, 7.8 mm.

Rostrum reddish yellow; palpi dark brown, the basal segment pale. Antennæ dark brown, the scapal segments paler brown. Eyes very large, separated by a very narrow, linear strip of the vertex in both sexes. Head dark gray, provided with numerous black setæ.

Mesonotal præscutum dull rusty brown without apparent stripes; scutal lobes, scutellum and postnotum dark plumbeous brown. Pleura pale, very sparsely gray pruinose. Halteres short, brown, the base of the stem paler. Legs with the coxæ pale, sparsely grey pruinose, the outer face near the apex with a group of short black setæ; trochanters pale brown, the posterior inner face with a conspicuous blackened area that is produced into an acute chitinized tooth; femora brownish yellow, the tips dark brown; tibiæ and tarsi brown, the terminal tarsal segments dark brown. Wings with a faint grayish tinge, cells C, Sc, and Sc_1 strongly infumed; stigma linear, darker brown; wing-apex faintly margined with brown; veins dark brown;

veins with dense, moderately long macrotrichiæ, a group of about four macrotrichiæ at about midlength of the basal deflection of Cu_1. Venation: Sc_2 at the tip of Sc_1; *r-m* connecting with *Rs* at a distance before the tip of the latter about equal to its own length; R_2 apparently fused with R_1, the fusion less than one-half of the section of R_1 between Sc_2 and the juncture of R_2; basal deflection of Cu_1 about one-third the length of cell *1st* M_2.

Abdominal tergites dark brown, the lateral margins of the segments broadly paler; sternites pale brownish yellow, the ninth segment entirely dark brown. Male hypopygium with two pleural appendages, the outer appendage shortest, ending in an abrupt, slightly curved chitinized point, the inner face before the point microscopically denticulated; inner appendage pale, shaped like a boomerang. Gonapophyses four in number, the lateral pair flattened, blade-like, the proximal pair slender with the tips acute and slightly divergent. Ovipositor with the tergal valves long, strongly upcurved, greatly exceeding the sternal valves.

Habitat.—North Queensland.

Holotype, ♀, Gordonvale, November, 1917 (J. F. Illingworth).

Allotopotype, ♀.

Paratopotype, ♂.

The types were found resting on tree-trunks.

Lechria rufithorax agrees most nearly with *L. bengalensis* Brunetti (India) which species is known to the writer only from the figure and description. From these it is seen that the Indian species is much smaller (length 4 mm.) with the front broad and flat; the coloration of the thorax, legs and abdomen and the venational details differ as indicated in the accompanying key.

Key to the Species of the Genus LECHRIA *Skuse.*

1. R_1 beyond the stigma bent down to R_2 to form an apparent X (New South Wales). . *L. singularis* Skuse

No such X-shaped combination of veins in the radial field, R_2 being apparently fused with R_1 for a varying distance back from the wing-margin. 2

2. Tarsi conspicuously white. (Java) .... *L. leucopeza* de Meijere
Tarsi brown 3

3. Thorax shiny blackish brown, the humeral regions and margins reddish yellow; femora blackish brown. (Java)......... *L. lucida* de Meijere
Thorax yellowish or reddish..4

4. Mesonotum yellowish, the scutellum livid brown; fusion of R_2 and R_1 extensive, more than one-half of the free portion of R_1 beyond Sc_2. (India) .... *L. bengalensis* Brunetti
Mesonotum rusty brown, the scutal lobes, scutellum and postnotum dark plumbeous brown; fusion of R_2 and R_1 slight, less than one-half of the free portion of R_1 beyond Sc_2. (Queensland)................ *L. rufithorax*, sp.n

Tribe Hexatomini.

Genus Eriocera *Macquart.*

1838, *Eriocera* Macquart, Dipteres exotiques, vol. 1. pt. 1, p. 74.

The genus *Eriocera* has not been recorded from Australia hitherto. The present collection includes two species, both of which are undescribed.

Eriocera australiensis, sp.n.

Antennal flagellum yellowish brown; mesonotal præscutum brownish yellow with four dark brown stripes; scutal lobes dark brown; femora brownish yellow, the tips faintly darkened; wings pale brown; cell 1st M_2 closed; abdomen dull yellow, the segments narrowly ringed caudally with dark brown.

Female.—Length 11-13.5 mm.; wing, 10.5-11.5 mm.

The following description made from alcoholic specimens.

Rostrum and palpi light brown. Antennæ with the scapal segments brown, the flagellum yellowish brown, the terminal segments darker; antennæ with eight segments, the first flagellar segment longer than the second and third taken together; the remaining segments gradually decrease in size to the end of the organ; last segment constricted at midlength and evidently formed by the fusion of two small segments. Vertical tubercle large and conspicuous, with a broad V-shaped notch. Head brown.

Mesonotal præscutum brownish yellow with four dark brown stripes, the median pair separated by a much narrower pale line, broadest in front, narrowed behind and not attaining the suture: scutal lobes conspicuously dark brown; scutellum and postnotum pale brown. Pleura pale brown, marked with darker blotches. Halteres pale, the knobs dark brown. Legs with the coxæ and trochanters yellowish brown: femora brownish yellow, the tips but faintly darkened; tibiæ and tarsi brown. Wings with a pale brown suffusion, the costal and subcostal cells somewhat darker; stigma lacking: veins brown. Venation: *Sc.* long, ending beyond the fork of *Rs*, Sc_2 not far removed from the tip of Sc_1: *Rs.* shorter than R_3 alone: R_{2+3} about equal to or a little shorter than R_2 alone; *r* on R_2 about its own length beyond the fork of R_{2+3}: cells *R* and *1st* M_2 in alignment, much shorter than cell R_3: cell *1st* M_2 closed, elongate, subrectangular, about as long as vein M_{1+2} beyond it; the basal deflection of Cu_1 at about one-third the length of cell *1st* M_2: cell M_1 lacking; Cu_2 and the basal deflection of Cu_1 subequal.

Abdominal tergites dull yellow, the posterior margins of the segments narrowly ringed with dark brown to produce a distinctly annulated appearance: sternites similar but the pattern even better defined. Ovipositor with the valves long and powerful, the tergal valves much exceeding the sternal valves.

Habitat.—North Queensland.

Holotype, ♀, Meringa, near Cairns, 1918 (J. F. Illingworth).

Paratopotypes, 25 ♀'s.

Eriocera aperta, sp.n.

Antennal flagellum dark brown; mesonotum dark brown; femora brown, paler basally; wings brownish gray; cell *1st* M_2 open by the atrophy of *m*: abdomen dark brown.

Female.—Length 10.8 mm.; wing, 9 mm.

Rostrum and palpi brown. Antennæ with the scapal segments light brown, the flagellar segments dark brown; only four flagellar segments are evident in the type, these gradually decreasing in length from the basal to the terminal. Head brown, grayish pruinose.

Mesonotum dark brown, the præscutum without distinct stripes. Pleura dark brown indistinctly variegated with paler. Halteres dark brown. Legs with the coxæ and trochanters yellowish brown; femora brown, paler basally: remainder of the legs dark brown. Wings brownish gray, the costal and subcostal cells darker; veins dark brown. Venation: *Sc* rather short, Sc_1 ending a little beyond the fork of *Rs*, Sc_2 a short distance from the tip of Sc_1 and opposite the fork of *Rs*; *Rs* longer than in *E. australiensis*, being longer than that portion of R_{4+5} beyond *r-m*; cell 1*st* M_2 open by the atrophy of *m*; cell M_3 very small, shorter than its petiole; Cu_2 about equal to the basal deflection of Cu_1, their angle slightly greater than a right angle.

Abdomen dark brown, the caudal margins of the segments very narrowly and indistinctly yellowish. Ovipositor with the valves long and slender, dark-colored.

Habitat.—North Queensland.

Holotype, ♀, Gordonvale, June, 1918 (J. F. Illingworth).

The type was collected along a stream.

Eriocera aperta is the first species of the genus known to the writer in which cell 1*st* M_2 is open. The condition is probably a normal one since both wings of the type are quite the same.

Subfamily Tipulinæ.

Tribe Tipulini.

Genus PHYMATOPSIS *Skuse*.

1890, *Phymatopsis* Skuse, Proceedings of the Linnean Society of New South Wales, vol. 5 (ser. 2), pp. 97, 98.

Phymatopsis brevipalpis, sp.n.

Antennæ very short, 11-segmented, the distal five segments nearly globular and conspicuously crowded; palpi very short, the last segment equal to the third; mesonotal præscutum dull yellow with indistinct stripes; wings gray, the subcostal cell darker; abdomen yellow, the segments narrowly ringed caudally with brown

Male.—Length 9.5-10 mm.; wing, 9-9.3 mm.: hind leg, femur, 7.2 mm.; tibia, 8 mm.; metatarsus, 10.8 mm.; remainder of tarsus, 6.8 mm.

The following description was made from alcoholic specimens.

Frontal prolongation of the head rather slender, longer than the head, the outer half on the dorsal surface with numerous black hairs that are most dense at the apex; no distinct nasus; palpi very short, the third segment nearly globular, the last segment but little longer than the third. Antennæ with but 11 segments, the scapal segments dull yellow; flagellum brown; first scapal segment much longer than the oval second segment; first flagellar segment elongate, strongly narrowed at the base, enlarged distally; second to fourth flagellar segments gradually decreasing in size, a little narrowed basally; the five terminal flagellar segments subglobular, crowded; flagellum verticillate. Front and anterior part of the vertex yellow, remainder of the head dark brown, narrowly paler adjoining the inner margins of the eyes; vertical tubercle conspicuous.

Mesonotal præscutum dull yellow with three very broad light reddish brown stripes that are narrowly margined with darker brown and are confluent; the broad median stripe is split by a capillary brown line; scutum dull yellow, the median area brownish; scutellum dull yellow, brownish posteriorly; postnotum dull yellow with an indistinct brownish median line. Pleura dull yellow. Halteres brown, paler basally. Legs with the coxæ and trochanters dull yellow; femora brownish yellow, the tips narrowly darkened; tibiæ and tarsi dark brown; tarsi very long, the metatarsi longer than the tibiæ; claws simple. Wings gray; cell *Sc* brown; stigma very pale; veins dark brown; Venation: Sc_1 preserved, at the tip of Sc_2; cell *2nd* R_1 short-rhomboidal; cell M_1 sessile in the paratype, petiolate in the type; fusion of Cu_1 with M_{3+4} transient; cell *2nd A* very narrow.

Abdomen dull yellow, the segments narrowly and rather indistinctly ringed caudally with brown; eighth segment dark brown; pleural membrane dark. Male hypopygium of very simple structure, very similar to the type found in the Limnobiinæ; ninth tergite with a broad U-shaped notch, the lateral lobes broadly rounded; pleurites cylindrical; pleural appendages meeting across the genital chamber.

Habitat.—North Queensland.

Holotype, ♂, Meringa, near Cairns, 1918 (J. F. Illingworth).

Paratopotype, ♂.

Phymatopsis brevipalpis agrees well with the genotype and only described species, *P. nigrirostris* Skuse, in the prominent tubercle on the vertex, the long rostrum without a nasus, the short antennæ with the terminal segments distinctly smaller, the simple male hypopygium and the details of venation, especially the small, rhomboidal cell *2nd* R_1 and the very narrow cell *2nd A*. It departs from the characters of the genus in the unusually short palpi, the terminal segment being very small and not at all flagelliform, and in the antennæ having but eleven segments.

Genus CTENACROSCELIS *Enderlein.*

1912. *Ctenacroscelis* Enderlein, Zoologische Jahrbucher, vol. 32, pt. 1, pp. 1, 2.

Ctenacroscelis conspicabilis (Skuse).

1890, *Holorusia conspicabilis* Skuse, Proceedings of the Linnean Society of New South Wales, vol. 5 (ser 2), pp. 120 121.

One female specimen taken at light, Babinda, North Queensland, June 18th, 1919 (J. F. Illingworth). The female has never been described and the present specimen is made the allotype.

Allotype, Female.—Length, 26 mm.; wing, 27 mm.

Similar to the male, the following characters, additional to those given in the original description being noted:

Flagellar segments of the antennæ with the tips narrowly and indistinctly pale to produce a somewhat bicolorous appearance. Mesonotal præscutum with the lateral margins dark brown. Femoral ctenidium distinct; claws of female simple. The pale wing-apex includes the outer end of cell R_3, the outer half of R_5 and all of M_1. Ovipositor with the tergal valves very slender, the tips a little expanded; sternal valves much shorter.

Ctenacroscelis aberrans, sp.n.

Antennæ brown; mesonotal præscutum yellow with four indistinct brownish gray stripes; pleura unmarked; wings grayish fulvous; abdomen dark brown, the tergites broadly margined laterally with buffy gray.

Male.—Length, 19.5 mm.; wing, 22 mm.; hind leg, femur, 15 mm.; tibia, 18 mm.; metatarsus, 21 mm.

Frontal prolongation of the head brown, more yellowish beneath; nasus distinct; palpi dark brown, the segments paler at the tips. Antennæ short, brown, the flagellar segments darker; verticils distinct. Head brown, narrowly paler adjoining the inner margins of the eyes; vertex with a capillary brown line.

Mesonotal præscutum dull yellow with four indistinct brownish gray stripes, the intermediate pair narrowly separated; scutum yellow, each lobe with two indistinct darker marks; scutellum and postnotum dull yellow. Pleura pale fawn-yellow, unmarked. Halteres brown, the knobs darker, the extreme base of the stem paler. Legs with the coxæ and trochanters pale yellow; femora yellowish brown, the tips narrowly dark brown; tibiæ pale brown, the tips very narrowly and indistinctly darker; tarsi brown; ctenidium distinct; metatarsus longer than the tibia; claws large and powerful with a conspicuous basal tooth and a similar blunt tooth at about one-third the length of the claw, the space between these teeth nearly circular. Wings with a strong grayish fulvous tinge, deeper in the costal cell, saturated in the subcostal cell; stigma small, indistinct; veins bright chestnut brown; obliterative areas very restricted, represented only by a small spot before the stigma, the end of *Rs*, the basal deflection of M_{1+2} and the outer deflection of M_{3+4}. Venation: Vein R_3 but little arcuated; cell R_3 considerably widened at the wing-margin; *Rs* short.

Abdomen with the first segment yellowish, the remainder of the organ dark brown; caudal margin of the segments very narrowly, the lateral margins broadly, buffy gray; sternites similar, the caudal margins narrowly ringed with pale. Eighth tergite concealed beneath the seventh, visible only laterally. Male hypopygium with the ninth tergite subquadrate, with a small U-shaped median notch, the lateral lobes broadly subtruncate. Pleural appendages at the end of the rather short fused sterno-pleurite. Eighth sternite unarmed.

Habitat.—North Queensland.

Holotype, ♂, Gordonvale, December, 1917 (J. F. Illingworth).

The type specimen was taken at light.

This species must be considered as being an aberrant member of the genus *Ctenacroscelis*. The structure of the male hypopygium and the ctenidium are quite characteristic of this genus but the course of vein R_3 differs from that of other species of *Ctenacroscelis* and very nearly approximates the normal condition in the genus *Tipula*.

Genus NEPHROTOMA *Meigen.*

1803, *Nephrotoma* Meigen, Illiger's Magazin, vol. 2, p. 262.

Nephrotoma australasiæ (Skuse).

1890, *Pachyrrhina Australasiæ* Skuse, Proceedings of the Linnean Society of New South Wales, vol. 5 (ser. 2), p. 126, pl. 5, fig. 20.

♂ ♀, Cairns, September, 1917 (J. F. Illingworth).

♂ ♀, Mossman, May, 1919 (J. F. Illingworth).

THE ORIGIN OF BLACK COATINGS OF IRON AND MANGANESE OXIDES ON ROCKS.

By W. D. Francis, Assistant Botanist, Queensland Herbarium.

(*Read before the Royal Society of Queensland, June 30th,* 1920).

(Plate I.)

The coatings or incrustations dealt with particularly in this paper are found on rocks in or near freshwater streams in the Kin Kin district, which is situated about 100 miles north of Brisbane, and about 10 miles from the coast. Humboldt[1] describes and discusses coatings of apparently similar chemical composition observed by himself and others in the cataracts of the Orinoco, Nile and Congo. These will be referred to in the latter part of the paper. So far as I am aware, no explanation of the origin of the coatings has been advanced except that offered by direct chemical deposition upon the rock surfaces.

Kin Kin district is an area of about 30 or 40 square miles in extent originally consisting of dense rain forest land, much of which has been felled and grassed during the past 15 years. The soil of the greater part of the area, especially in the east, is derived from schists and slates, which, as stated by L. C. Ball[2], have been referred to the Gympie Formation (Permo-Carboniferous). In the western part are ranges strewn with boulders of a granitic rock. The streams, which flow in an eastward or north-eastward direction, contain clear water flowing over rocks of schist, slate, quartz and grano-diorite (?).

(1) Lichens.

The black coatings are divided into two kinds for the purpose of this paper. The kind that is less frequent will be discussed first. It is of a dull black colour, with a somewhat granular surface, is fairly uniform in thickness, varying from .085 to .136 mm., has only been observed on the schists and slates, and can be removed in small pieces with a penknife. The small pieces thus removed are quite opaque when examined with the microscope, and appear structureless. When fused with sodium carbonate, they produced the green colour reaction indicating the presence of manganese. In hydrochloric acid they partly dissolved, forming a pale brown solution and a residual bleached or whitish matrix. On the addition of ammonium hydroxide to the pale brown solution an abundant precipitate of ferric hydrate indicated the presence of iron in considerable quantities. Microscopic examination of the residual matrix showed that it consisted of fine filaments and small round or subangular cells, evidently the remains of the thallus of a lichen. Crustose lichens are very abundant on the schists and slates of the dense rain forests of the district, and it appears quite clear that the iron and manganese compounds are deposited in, or partly replace, the substance of the lichen thallus to form the black coating.

The incorporation of iron compounds in the substance of the thalli of incrusting lichens is not unrecorded in scientific work. De Bary[3] states :—" Another series of infiltrations and imbeddings is composed of inorganic matter. First and foremost is the rust colour not unfrequently assumed by individuals (' formae oxydatae ') of many crustaceous lichens which are typically of another colour : it has often been stated and has now been proved by Gumbel that this colour is due to the infiltration of a salt of iron, perhaps of a vegetable acid."

(2) Algae.

The other kind of black coating is more difficult to investigate. It is much thinner, varying from about 3μ to 41μ in thickness, and is more firmly adherent to the rock surface. It is very abundant on all kinds of rocks in the streams, both in cleared and uncleared areas. Hydrochloric acid was applied to it in order to assist in the removal of minute pieces. It gave the same reaction for manganese as the lichen-formed coating and dissolved in hydrochloric acid, forming a pale brown solution which yielded a precipitate of ferric hydrate on the addition of ammonium hydroxide, indicating the presence of iron in the coating. A minute quantity of bleached residue, which appeared to be structureless, was recovered in some cases.

Rarely the coating completely envelopes the rocks. Generally, there is a small or great part of the surface of the rock unincrusted, and the margin of the coating is mostly very irregular in outline. Sometimes small uncoated patches appear on a coated surface.

Field observations first suggested that the black coatings may be the altered remains of an incrusting alga. This conclusion is supported by the following facts: (*a*) correspondence in distribution; (*b*) comparability of thickness; (*c*) the presence of the cellular structure of the thallus of the alga in 50 per cent. of the examples of the black coating rendered transparent by hydrochloric acid.

The fine, red-coloured, incrusting alga grows on the rocks in the streams flowing through the rain forests. A specimen of it was sent to Mr. J. H. Maiden, Government Botanist of New South Wales, who replied :—" Mr. Lucas (Honorary Algologist to the National Herbarium, Sydney), thinks that the plant collected by Mr. Francis is a species of *Hildenbrandtia*, a red incrusting alga. The species are common on rocks on the Coast." It consists of a very thin coating, varying in thickness from about 5μ to 81μ, is very closely and firmly adherent to the rock surface, and is composed of a variable number of super-imposed cells (see Fig. 1, Plate I.). When small pieces are scraped from the rock and examined under the microscope, they present the appearance of a meshwork of minute cells which are angular or rounded, and vary from 3μ to 8μ in breadth. (See Fig. 2, Plate I). The variation in the thickness of the plant is proportionate to the number of cells which are super-imposed in any particular portion of the thallus (which constitutes the plant). The very thin portions of the thallus may be only one or two cells in thickness, and probably represent the young, growing margins. No special organs of reproduction were observed in my preparations, but the size and shape of the cells and their arrangement in the thallus are closely similar to that described [4 5 6 7] and figured [5 6 7] under *Hildenbrandtia*. Both marine and freshwater species are included in the genus which is widely distributed in different parts of the world.

The peculiar distribution of the black coatings on rock surfaces, as outlined above, is exhibited by the alga growing on the rocks ; the irregular margins and uncoated patches on coated surfaces are common features of its growth. When seen by me four years ago, the alga was as abundant on rocks in streams of the rain forests (which have since been felled) as the black coating was in felled areas. I have seen the rocky bed of a stream coated with the alga over an area of several square yards. The confinement of the alga to the rain forests on the one hand, and the maximum abundance of the black coatings in the felled areas on the other, suggested that the process of clearing may have accelerated and increased the production of black coatings by killing the alga. The occurrence of the alga on all kinds of rocks in the streams is another feature in which it corresponds with the black coating. Unlike lichens, which are generally dependent upon the substance of the rock they incrust for mineral food material, the alga is sustained by dissolved (and suspended) material in the water and is independent in that respect of the rock it incrusts.

Rock sections showing the thickness of the incrusting alga and the black coating were prepared by a lapidary. Unfortunately, only small portions of the black coating survived the grinding process, but sections of considerable extent of the alga remained in position, incidentally showing its extraordinary adherence to the rock surface. To supplement the material for studying the thickness of the black coating, a small piece of the black-coated rock with two plane surfaces, was ground. From these preparations, the following measurements were ascertained :—Alga from about 5μ to 81μ ; black coating from about 3μ to 41μ. The black coating is appreciably thinner than the alga. It appears feasible that a considerable amount of reduction in size may take place in the thickness of the thallus of the alga during partial decomposition, unless its whole substance, including its very high percentage of water, were replaced by iron and manganese compounds. (See Figs. 1 and 4, Plate I.)

Six black-coated rocks, each from different parts of two streams, were chosen for microscopical investigation. The small pieces of the coating removed by scraping were opaque and apparently structureless. Samples were then carefully treated with hydrochloric acid in order to render them transparent, when it was found that three out of the six examples definitely showed the cellular structure of the thallus of the alga.

Review.

While these investigations do not absolutely prove the second kind of black coating to originate from the incrusting alga, they indicate, at least, that such a conclusion is highly probable. Absolute proof would consist of the production of the black coating by experimental processes in the streams. Some experiments of that kind were begun, but the rocks were lost trace of through the action of floods.

The black coatings described by Humboldt[1] from the Orinoco, Nile, and Congo, and the brown ones observed by Darwin[8] at Bahia, in Brazil, are only known to me from the authors' descriptions. The following extracts from Humboldt's[1] work summarise his remarks :—

" Among the cataracts and wherever the Orinoco, between the missions of Carichana and of Santa Barbara, periodically washes the rocks, they become smooth, black and as if coated with plumbago. The colouring matter does not penetrate the stone which is coarse grained granite. . . . The black crust is 0.3 of a line in thickness. On breaking the stone with a hammer, the inside is found to be white. . . . M. Roziere, who had travelled over the valley of Egypt, the coasts of the Red Sea and Mt. Sinai, pointed out to me that the primitive rocks of the little catarcts of Syene display, like the rocks of the Orinoco, a glossy surface, of a blackish grey or almost leaden colour. . . . . The English naturalists were struck with the same appearance in the rapids and shoals that obstruct the River Congo Dr. Koenig has placed in the British Museum, beside the syenites of the Congo, the granites of Atures (Orinoco). . . . The black crust is composed, according to the analysis of Mr. Children, of the oxide of iron and manganese. . . Some experiments made at Mexico, conjointly with Senor del Rio, led me to think that the rocks of Atures which blacken the paper in which they are wrapped, contain, beside oxide of manganese, carbon and super-carburetted iron."

Incrusting organisms may have caused these foreign coatings. Evidence which is suggestive of organic origin is afforded by Humboldt and Senor del Rio's experiments indicating the presence of carbon and super-carburetted iron in the Orinoco incrustations. The environment of the incrusted rocks of the Orinoco, as described by Humboldt, resembles that of the Kin Kin examples in at least two respects, namely, clear streams and abundant vegetation.

Acknowledgments. I am indebted to Mr. C. T. White, F.L.S., Government Botanist, and Dr. J. Shirley, F.M.S., for some suggestions: to Professor T. H. Johnston, M.A., D.Sc. for kindly allowing me to use the photo-micrographic apparatus of the Biology Department of the University; and to Mr. O. W. Tiegs, B.Sc., Walter and Eliza Hall Fellow in Biology, for his assistance with the photo-micrographs.

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EXPLANATION OF FIGURES.

Plate I.

1. Photomicrograph of rock-section (quartz) ground at right angles to alga-incrusted surface, showing thickness and transverse section of the alga (*Hildenbrandtia*). The parallel series of minute, super-imposed cells arranged transversely to the rock surface are evident in parts of the picture. × 250 diameters.

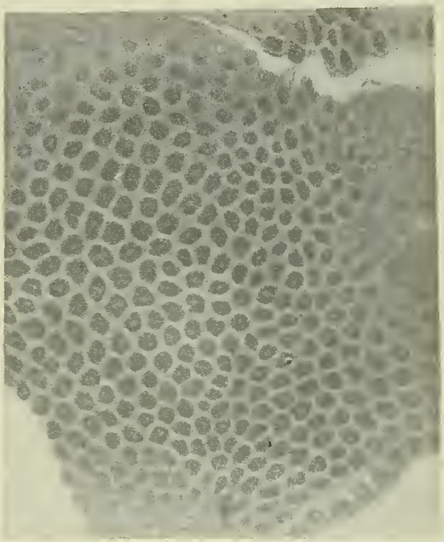
2. Photomicrograph of a flat, expansive fragment of the alga (*Hildenbrandtia*) scraped from rock surface showing the meshwork of cells. × 670 diameters.

3. Photomicrograph of a flat, expansive fragment of the black coating scraped from rock surface and rendered transparent by the action of hydrochloric acid. Outlines and impressions of the alga (*Hildenbrandtia*) cells are shown in the picture. × 670 diameters.

4. Photomicrograph of rock section (quartz) ground at right angles to incrusted surface, showing the thickness of the black, opaque coating whose origin is attributed to the incrusting alga. × 250 diameters.

Note.—In comparing figures 2 and 3, the slightly larger size of some of the cells in figure 3 is accounted for by the fact that the cell contents and not the cell walls are alone prominent in figure 2, whilst in figure 3 the impressions of the cell walls are chiefly conspicuous

1



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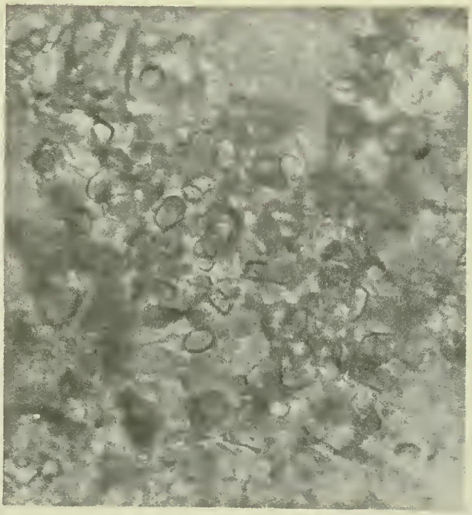

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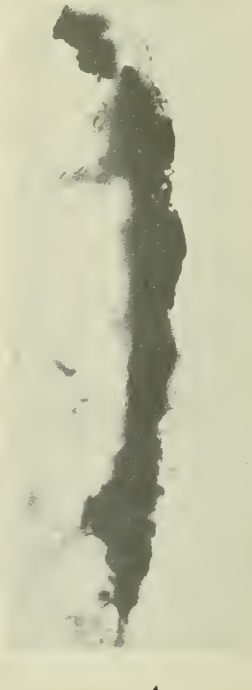


4

ROCK INCRUSTATIONS,—*Francis.*

CONTRIBUTIONS TO THE ORCHIDACEOUS FLORA OF QUEENSLAND.

No. 1.*

By R. S. Rogers, M.A., M.D., and C. T. White, F.L.S.

(*Read before the Royal Society of Queensland, 30th August, 1920*).

Acianthus amplexicaulis (Bail.), *Rogers and White*, n. comb.

(Text-fig. 1.)

Microstylis amplexicaulis, Bail., Bull. No. 9, Dept. Agric., Brisbane (1891), p. 18.

Listera amplexicaulis Bail., Queensl. Flora. V. 156 (1902).

Eudlo Creek, *F. M. Bailey* (Field Naturalists' Club Excursion, March, 1891).

This plant, originally placed in the genus *Microstylis* by the late F. M. Bailey, and subsequently removed by him to the genus *Listera*, is more correctly referable to the genus *Acianthus*.

This species may be distinguished from other Australian members of the genus by the shape of its dorsal sepal ; this is narrow linear, and shows no tendency to "hooding," which is so characteristic of all the others. Even in *A. caudatus* the base of this sepal is cucullate, although the apex is prolonged into a tail. The lobulation of the leaf is interesting, because this condition in lesser degree is not unfrequently met with in *Acianthus*. In *A. caudatus*, one of us (R.S.R.) has seen a specimen in which there are no fewer than five well-defined lobules.

*The present paper is the first of a series of contributions to our knowledge of Queensland orchids, and is the result of a critical examination of material in the Queensland State Herbarium. In addition to descriptions of new species and critical notes, the opportunity is taken of recording any locality records that add to our knowledge of the distribution of any particular species.

The deeply-dissected leaf-margins in *A. amplexicaulis* may therefore be regarded merely as an extreme form of a physical feature not uncommon elsewhere in this genus.

Text-fig. 1.—Acianthus amplexicaulis (*Bail.*), Rogers and White n. comb.

A. Plant, nat. size. B. Single flower, enlarged.

It seems strange that this little orchid growing within sixty miles of Brisbane has not been gathered again since the original specimens were collected nearly thirty years ago.

Dipodium ensifolium *F. v. M.*

Dunk Island, *E. J. Banfield*: Johnstone River, *W. R. Kefford*; Walsh River, *T. Barclay Miller.*

Eulophia venosa, *Reichb.f.*

Yarrabah, nr. Cairns, *Rev. N. Michael.*

Geodorum pictum *Lindl.*

Johnstone River, *H. G. Ladbrook*: Barron River, *F. M. Bailey, E. Cowley.*

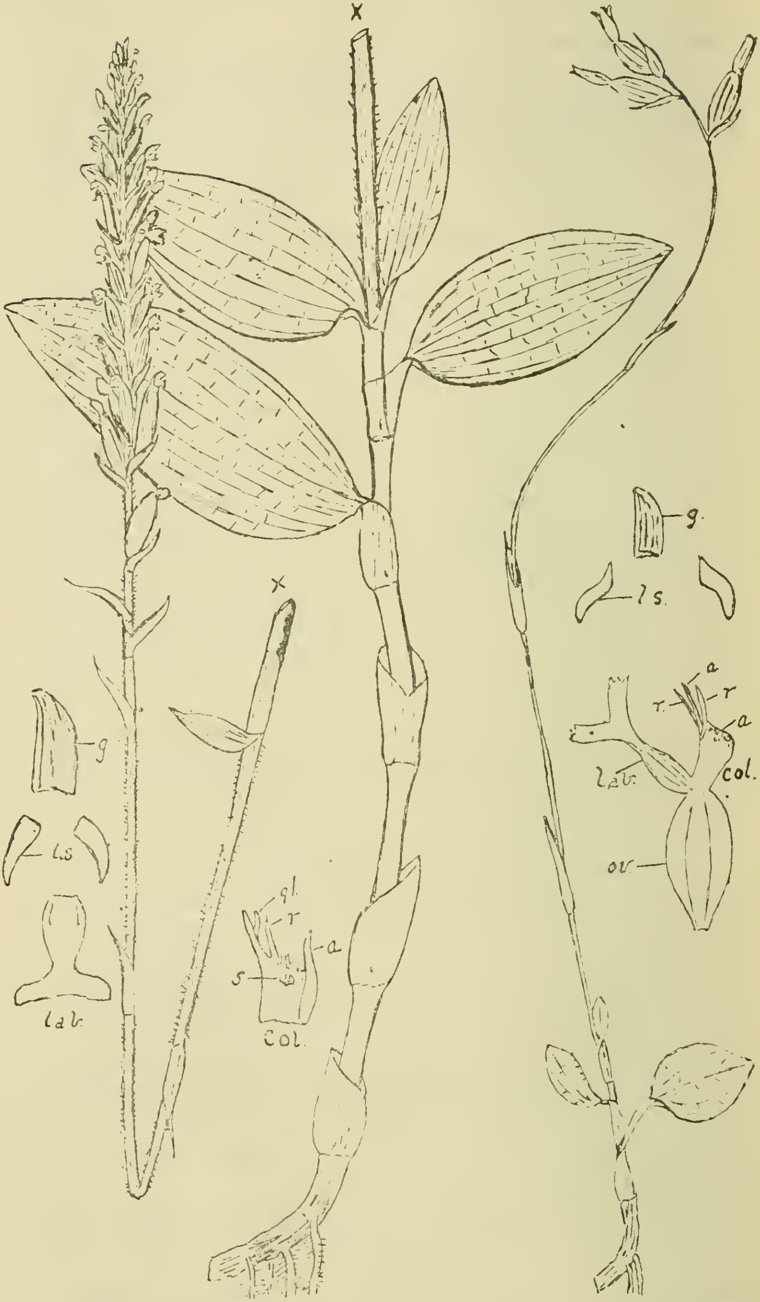
Zeuxine, *Lindl.*

Sepals nearly equal; the posterior erect, concave; the lateral ones spreading, free. Petals narrow, cohering with the dorsal sepal into a galea. Labellum very shortly adnate to the base of the column, erect, cymbiform or saccate in its lower half, two calli or spurs within the sac near the base, contracted beyond the sac, and then dilated into a shortly-clawed or sessile entire two-winged terminal lobe. Column very short, two-winged or keeled in front; stigmatic lobes two, lateral. Anther erect or inclined forward with contiguous cells; pollinia two, pyriform, attached by an oblong or elliptical gland to the erect rostellum with often an intermediate appendage or linear caudicle. Pollen coarsely granular (sectile). Capsule small erect, ovoid or nearly globular.

Slender terrestrial herbs, with a creeping rhizome. Leaves with petioles expanding at their bases into loose membranous sheaths. Flowers small, sessile on a dense or lax spike.

Distribution.—Species approximately 60, mostly Indian or Malayan with a few tropical African species and one endemic in S. Africa. Several species have also been recorded from the Philippines (*Adenostylis*) and Formosa, likewise from New Guinea, Bismarck Archipelago, Samoa and Fiji. No member of the genus has hitherto been recorded from Australia. The genus Zeuxine, as defined by Bentham and Hooker f. in the Genera Plantarum, absorbs *Adenostylis* Bl. (1825), but there seems to be a tendency of late, on the part of certain botanists, to re-establish Blume's genus.

Hooker in a note on the genus (Flora British India, vi. 106) states:—"The appendage between the gland of the pollinia and the pollinia itself is a very curious organ, and its real nature has not yet been ascertained, whether



Text-fig. 2.—Left.—Zeuxine oblonga, n. sp.
Right.—Zeuxine attenuata, n. sp.

rostellar or pollinar ; it occurs only in some species and in these under very various forms, so that it cannot be relied on as a generic character. It is further so difficult of analysis in dried specimens, that much allowance must be made for my description of it."

The appendage referred to is figured in his Icones Plantarum XXII., pl. 2173. figs. 4 and 5 ; also pl. 2174, fig. 5. This appendage is not present in the Australian *Z. oblonga*. but in this species there is a definite inflexion of the margins of the caudicle (as in pl. 2174), although the actual attachment of the pollinia to the lower end of the caudicle appears to be normal.

Such inflexion of the margins of the caudicle together with an abnormal attachment of the pollinia (as figured by him), Hooker regards as an early stage in the evolution of his " appendage."

Zeuxine oblonga, sp. nov.

(Text-fig. 2).

Planta circiter 30 cm. alta. Caulis ascendens, gracilis. Folia 6 vel 7 alternata, elliptica vel oblonga-elliptica, 2.5-7.5 cm. longa ; petioli basibus vagini-formes dilatati. Bracteae 2. vel 3, sub-hirsutae, acuminatae, membranaceae, basibus vagini-formes dilatatae. Flores parvi, sessiles, extus hirsuti ; spica 4-7.5 c.m. longa, medioeriter dense florifera. Sepalum dorsale cum petalis in galeam cohærente, circiter 3 mm. longum. Sepala lateralia libera, patentia, late lanceolata, 3-3.5 mm. longa, 1-nervosa. Labellum circiter 3 mm. longum inferum (interdum superum ?) sessile ; basi columnae adnatum brevissime ; basi cymbiforme, in medio contractum deinde in apicem terminalem bilobatum abrupte dilatatum, alae oblongae divaricatae ; intus bicallosum. Columna brevissima, antica (parte) bicarinata : anthera rostrata rostello aequans. Rostellum profunde bipartitum, erectum. Pollinia 2, ope caudiculae linearis glandulae longae lineari-ellipticae affixa. Stigmata 2, magna, lateralia.

Plants about 30 cm. in height, slender, with hairy stems on a creeping rhizome. Leaves six or seven, alternate on the lower half or third of the stem, the base of the petiole dilated into a loose membranous tubular sheath ; elliptic to oblong-elliptic, 2.5-7.5 cm. long, with a tendency

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Text fig. 2.—Plants natural size.

a. anther ; *col.*, column ; *g*. galea formed by the union of the dorsal sepal and the petals ; *gl.*, gland ; *lab.*, labellum ; *l.s.*, lateral sepals ; *ov.*, ovary ; *r*, rostellum ; *s.*, stigma ; all enlarged.

to become deciduous above the expanded portion of the petiole. Stem bracts two or three, slightly hairy, acuminate, membranous, forming a loose tubular sheath towards their bases. Flowers small, sessile, hairy on the outside, in a moderately crowded spike about 4-7.5 cm. long (occasionally reversed ?) ; 3-3.5 mm. long (not including the ovary) ; bracts hairy awn-like, shorter than the ovary. Perianth segments nearly equal, the dorsal sepal connate with the petals to form a galea over the column. Lateral sepals free, broadly lanceolate, rather blunt, 3-3.5 mm. long, 1-nerved ; galea erect on a wide base or slightly inclined forward, blunt, about 3 mm. long. Labellum inferior (occasionally superior ?) sessile, adnate to the base of the column ; cymbiform in its lower half, suddenly contracted about its middle, then abruptly dilated into a terminal expansion with two large divaricate entire oblong lobes ; lamina traversed by three longitudinal lines or nerves, a claw-like callus on each side within the saccate portion near the base.

Column-bed very short, two-keeled anteriorly. Anther ovate-lanceolate behind the rostellum, rostrate, the beak reaching as high as the latter. Rostellum deeply bipartite ; segments slender erect, surmounted by a long vertical linear-elliptical gland. Pollinia two, connected with the gland by a common linear caudicle with inflexed margins : gland readily detached from between the segments of the rostellum. Stigmas (stigmatic lobes) two, one on each side of the upper part of the column, separated by the base of the rostellum, relatively large.

Kamerunga (Barron River), *E. Cowley* ; Mackay, *L. J. Nugent* ; Daintree River, *Gus. Rosenstrom*.

In addition, there is one sheet containing several specimens, but with no particulars attached as to locality or name of collector.

This Australian orchid rather closely resembles the Asiatic species *Z. flava* Benth., of which it may possibly be a variety. In the material represented by it in the Queensland National Herbarium all the plants are old, and there is no information as to time of blooming. Some of the specimens are in a state of advanced seed, and the dehiscence of the capsules has been completed. In these specimens the flowers are reversed. It is thought that this may be the result of torsion changes in the ovaries due to age and weathering, and should not be regarded as the normal condition.

Z. attenuata, *sp. nov.*

Materiae vitiosissimae.

Planta gracillima, 15-17.5 cm. alta. Radix tuberosa? Caulis hirsutus, gracillimus. Folia 2 vel 3, prope basin, ovata, 5-nervosa, reticulata; lamina circiter 1.5 cm. longa, 1 cm. lata; petioli interdum laminae aequantes, basibus vaginiformes dilatati. Bracteae 3 vel 4, acuminatae, circiter 4 mm. longae, membranaceae, basibus vaginiformes dilatatae.

Uniflos vel flores pauci; laxi-racemosi, extus hirsuti; pedicelli breves graciles. Sepala lateralia fere ovato-lanceolata, libera, circiter 5 mm. longa; sepalum dorsale cum petalis in galeam cohaerente; galea circiter 4 mm. longa. Labellum circiter 6 mm. longum, pellucidum, membranaceum, basi columnae adnatum; in parte infero anguste cymbiforme, 3 nervosum, intus 4-callosum biseriatum; ultra medium contractum, deinde in apicem terminalem bilobatum dilatatum, alae divaricatae cuneato-oblongae marginibus remotis laceratis. Columna brevissima, antica bicarinata. Rostellum profunde bipartitum, erectum, supra basin columnae circiter 3 mm. al a. Anthera anguste elongata rostello aequans

Plants very slender, apparently not exceeding 15-17.5 cm. in height. Root tuberous (?) with loose fibrous investment. Stems very slender, hairy. Leaves basal or very near the base, two or three, ovate, five-nerved, reticulated as in a dicotyledon; lamina about 1.5 cm. long and about 1 cm. wide; petioles sometimes equalling the lamina in length, dilated at their bases into loose transparent tubular (often imbricated) sheaths. Stem-bracts three or four, acuminate, about 11 mm. long, membranous, converted for some distance above their insertion into loose tubular sheaths. Flowers single, or in a few-flowered loose raceme; hairy on the outside, on short slender pedicels. Lateral sepals almost ovate-lanceolate, free, about 5 mm. long; dorsal sepal connate with the lateral petals to form a galea about 4 mm. long. Labellum about 6 mm. long, thin, membranous, adnate to the base of the column: the lower part narrowly cymbiform, 3-nerved, with four (or three?) linear calli on each side near the base; contracted beyond the middle into a wide bi-lobed apex, the lobes divaricate, cuneate-oblong with lacerated outer margins.

Column very short, bicarinate in front. Rostellum deeply bipartite, erect, its segments lanceolate, membranous, reaching about 3 mm. above the base of the column. Anther narrowly elongated, membranous as high as the rostellum. Stigmata two, rather small, lateral, at the base of the rostellum.

Mackay, *L. J. Nugent*, 13-9-1895.

The material available for examination is fragmentary; no further specimens having apparently been gathered since Nugent collected the original material nearly twenty-five years ago.

The habit of the species is entirely different from that of the other Australian representative of the genus, the stem being exceedingly slender with basal leaves, and terminated by a single bloom or by two or three pedicellated flowers in a loose raceme; whereas in *Z. oblonga* the stem is much stouter with alternate leaves distributed over its lower half or third and ending in a moderately-crowded spike of sessile flowers. Further, in the former the labellum is relatively much longer, more slender and narrow, with very different calli and with wider and differently-shaped terminal lobes. Owing to poverty of material, the structure of the pollinarium could not be definitely ascertained, but there is reason to suppose that it differs considerably in type (especially as regards connection between pollinia and gland) from that which prevails in *Z. oblonga*.

Indications point to a root of tuberous origin.

NOTES ON THE LIFE HISTORY OF CERTAIN QUEENSLAND TABANID FLIES.

By Professor T. Harvey Johnston, M.A., D.Sc., and M. J. Bancroft, B.Sc., Walter and Eliza Hall Fellow in Economic Biology, University, Brisbane.

(Text-figures 1-8.)

(*Read before the Royal Society of Queensland, 30th August, 1920*).

In 1911, Mr. W. W. Froggatt, in his bulletin dealing with March flies (1911, p. 4), mentioned that nothing was known regarding the life history of any of the Australian Tabanidæ. As far as we are aware, no information has been published since. Taylor (1916, p. 753), has described the egg mass of *Silvius australis* Ricardo, a species which occurs at Eidsvold, Burnett River, where the material forming the subject of this paper was collected.

Since the Tabanidæ have been considered as possible transmitting agents of the nematode parasite, *Onchocerca gibsoni* Cleland and Johnston, which causes the formation of "worm nodules" in Australian cattle, considerable attention has been paid to them in Queensland and New South Wales. We have already published (J. and B., 1920, p. 34-5), a list of those recorded as occurring at Eidsvold, most of the identifications having been made by Dr. E. W. Ferguson, Sydney, who, with Miss Henry, has recently published an account of those met with at Kempsey, N.S. Wales (P.L.S., N.S.W., 44, 1919, p. 828), where work on *Onchocerca* is also in progress.

Since none of the Tabanids oviposited in captivity, we endeavoured to ascertain the life history of local species by breeding out such larvæ as were found under natural conditions, especially in damp soil along the banks of the

Burnett River. We do not yet know the complete life history of any one species, but in view of the importance of the group we have deemed it advisable to publish the following notes on the larval and pupal stages of two species of *Tabanus* (*T. pallipennis* Macquart and *T. batchelori* Taylor) and one of *Silvius* (*S. notatus* Ricardo). The identifications were kindly made by Dr. E. W. Ferguson, who examined all the flies which emerged.

In all cases mud from a similar situation to that in which the larvæ were found, was placed in the jar with them. This mud contained numerous delicate red Oligochætes as well as small dipterous larvæ (Tipulidæ) which probably served as food for the Tabanids.

Tabanus circumdatus Walker.

Though this is by far the most common March fly locally, we did not find its larva or pupa.

The female genitalia are of the usual Tabanid type. Each ovary contains about sixty follicles. The oviduct of each side, as well as the common oviduct, are very short since the ovaries are situated in the apex of the abdomen. The accessory glands are elongate thick organs, while the three spermathecæ are very long fine tubes doubled back on themselves so that, in their natural position, the slightly-expanded tips lie near the junction of the ducts with the common oviduct.

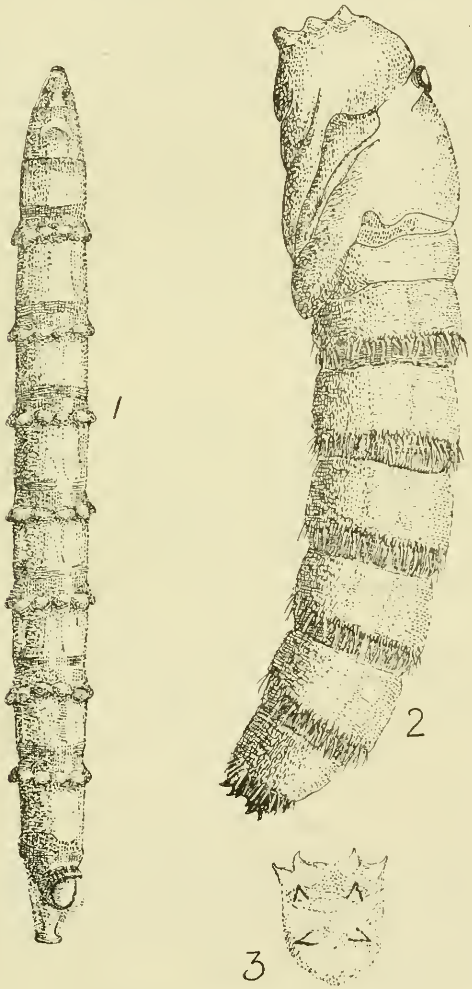
Though a large number of females belonging to this species were dissected, very few were found with large ova, and even in such cases it was usual to find only one or two well-developed ova in each ovary. The almost mature egg measures 1.8 mm. by 0.4 mm. Captured females kept in cages for varying periods of time up to thirty days have failed to oviposit or to exhibit any further development of ova.

Ferguson and Henry (1919, p. 846), record this as being the commonest species at Kendall, N.S. Wales, and as one which lives well in captivity.

Tabanus pallipennis Macquart.

(Text-figures 1 to 3).

Four large larvæ were collected in wet mud in the bed of a creek on 14th October, 1919, one being preserved (fig. 1) while the other three were allowed to pupate in a jar containing wet mud and small-chopped earth worms. No further food was given, but the mud was kept moist by the addition of water. On November 11th and 13th, 1919, a male fly emerged; on the 18th, a female. From



EXPLANATION OF TEXT FIGURES.*

Figs. 1 to 3—*Tabanus pallipennis*. 1, mature larva; 2, pupa: 3, view of 8th abdominal segment.

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*All figures were drawn for us by Mr. Hubert Jarvis, Assistant Entomologist, Brisbane.

a large larva collected on December 7th, a fly emerged on January 19th, 1920. On 4th January, 1920, a number of larvæ were taken in muddy sand at the edge of the Burnett River at the Euroka crossing; some of the smaller were preserved, whilst from the larger, after pupation, flies emerged on 17th February.

In no case were the jars disturbed after the larvæ were placed in them, consequently the date of pupation was not ascertained, but as the larvæ appeared to be full-grown when collected, the pupation period during summer was between four and six weeks, probably less in some cases.

It was noticed in all cases observed by us that when the imago was about to emerge, the pupa had worked its way up to the surface of the mud, so that, after emergence of the fly, the empty pupa case was seen projecting for about half its length.

Larva (fig. 1). The general colour is whitish, with narrow bands of light smoky grey on each segment dorsally. The skin is smooth except for the presence of very fine longitudinal striations. Each segment from the fourth to the tenth bears six fleshy tubercles. The largest larvæ (killed in hot water and preserved in formalin), measured 30 mm. in length, and 3 mm. in maximum breadth.

Puparium (figs. 2 and 3). The puparium is pale greyish, measuring 17 to 18 mm. long and 3 mm. broad. Each segment is provided posteriorly with a ring of long stiff hairs. On the eighth abdominal segment are three pairs of spines whose arrangement is shown in fig. 3.

The male and female flies which emerged were examined by Dr. Ferguson, who reported that the specimens agreed rather closely with the description of *T. pallipennis* Macquart, and that though certain small differences were noticeable, he preferred at present to regard them as belonging to that species rather than describe them as representatives of a new species.

Tabanus batchelori Taylor.

(Text-figures 4 to 6).

Three large black and white larvæ found in muddy sand at the edge of the Burnett River on December 7th, 1919, were allowed to pupate. One pupa died, a male fly emerged on 8th January, 1920, and a female on 14th January. Others collected in December were preserved for description, whilst six collected on January 4th, 1920, were allowed to pupate in a jar containing wet mud. From these pupæ one fly emerged on February 17th, two on 18th, and three on 21st February. The maximum pupation period during summer ranged from four to six weeks.

Larva (fig. 4). This is a characteristically-coloured organism, possessing well-defined black markings on the dorsal surface of each segment except the first and last. The bands are faint anteriorly, but become more distinct posteriorly, being very prominent on segments five to ten. Each band consists of a transversely-situated portion, with a thicker median and two smaller lateral backwardly-projecting prolongations. Fleshy tubercles are prominent on segments six to ten.

The larva when nearly mature measures from 27 to 33 mm. long by 3 mm. broad.

Puparium (figs. 5, 6). The length is 20 mm. and the breadth 3 to 4 mm. The general colour, which is greyish, and form closely resemble those of the preceding species,. Each segment is provided with a row of stiff backwardly-projecting hairs. The form and arrangement of the spines on the eighth abdominal segment are, however, quite different, as will be noted by comparing figs. 3 and 6.

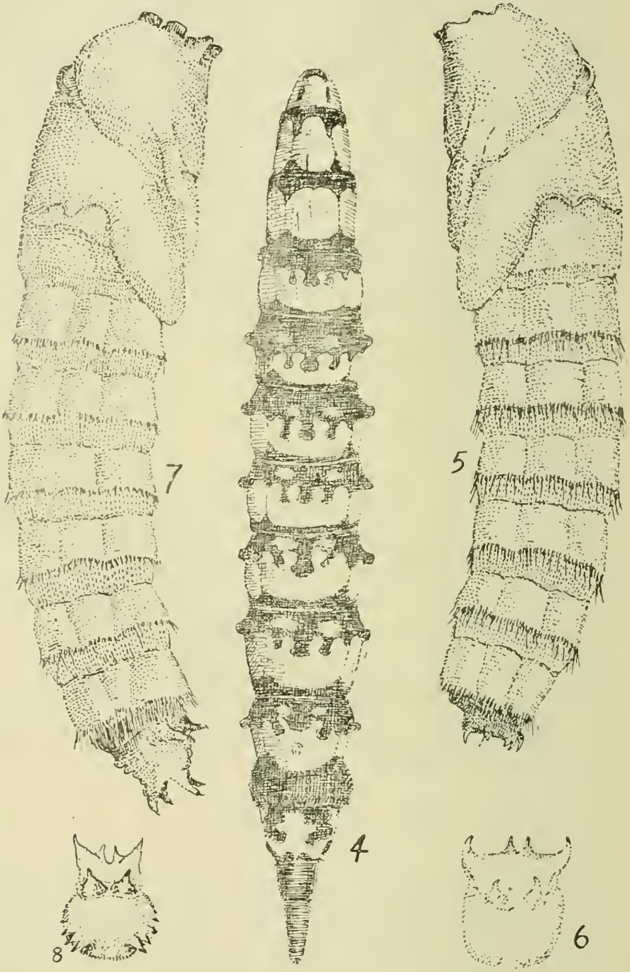
Dr. Ferguson identified the emerging flies as *T. batchelori* Taylor, remarking that the species was closely related to, if not identical with, *T. laticallosus*.

Silvius notatus Ricardo.

(Text-figures 7 and 8).

Three large larvæ, 23 mm. long and 4 mm. broad, of a greyish colour, and possessing fine longitudinal striations on the cuticle were found in the muddy sand at the edge of the water of the Burnett River on 5th October. They were allowed to pupate. One pupa died, while one fly (a male) emerged on November 18th, and a female on November 20th. The pupation period was thus not more than six weeks.

Puparium (figs. 7, 8). The thoracic region is yellowish-brown, the abdominal segment brown. Each segment is provided with a ring of stiff hairs posteriorly. The structure of the eighth abdominal segment is shown in fig. 8. The puparium measures from 19 to 20 mm. in length and 3 mm. in breadth.



EXPLANATION OF TEXT FIGURES.*

Figs. 4 to 6—*Tabanus batchelori*. 4, mature larva; 5, pupa; 6, view of 8th abdominal segment.

Figs. 7 and 8—*Silvius notatus*. 7, pupa; 8, view of 8th abdominal segment.

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*All figures were drawn for us by Mr. Hubert Jarvis, Assistant Entomologist, Brisbane.

The flies bred out were determined by Dr. Ferguson as *Silvius notatus* Ricardo, of which species he informed us *S. psarophanes* Taylor is a synonym.

As a result of our observations during the summer 1919-1920, the pupation period of the three species collected was ascertained to be less than six weeks, with four weeks as a possible maximum. Since these periods included an unknown number of days spent in the larval stage, our figures are merely approximations.

Davis (1919, p. 97, 99) reported that in the case of *Tabanus sulcifrons* and *T. atratus* common species in the eastern parts of the United States, the complete life cycle occupied about a year, the larvæ living through the winter and pupating in early spring, the pupal stage occupying about a month and a fortnight, respectively, for the two March flies mentioned.

Hindle (1914, p. 228-30), stated that Tabanid larvæ in temperate countries live through the year, pupating in the following spring, the whole life cycle occupying eleven to twelve months, the pupal period being usually three to four weeks.

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THE PEACH LEAF POISON BUSH. *TREMA ASPERA* BLUME: ITS OCCASIONAL TOXICITY.

By Frank Smith, B.Sc., F.I.C., and C. T. White, F.L.S.

(*Read before the Royal Society of Queensland, 29th November*, 1920).

Concerning many plants recorded as poisonous or injurious to stock in Australia there is much diversity of opinion among stockowners. As a case in point may be cited *Trema aspera*, common in the eastern states and variously known as "Peach-leaf Poison Bush," "Wild Peach," "Peach Poison," etc. This plant is regarded by some as a good and safe forage plant, but by others as one of our worst poisonous plants.

There are numerous references to *Trema* as a dangerous fodder in the writings of Australian botanists. The bark is very fibrous, and it has been held that the harmful effects attributed to the plant are due to its tough and indigestible nature when ingested by stock in the absence of softer and more palatable feed: this especially in view of the fact that the plant belongs to a family of plants—the Ulmaceae—the members of which as a general rule are quite wholesome and free from poisonous properties. This is the opinion of Bailey and Gordon[1], and of Ewart[2], though the latter states that Ferd. von Mueller recorded the plant as poisonous. Maiden[3],[4] records the plant as believed poisonous by many stockowners, but personally expresses no opinion on it. It is referred to by Greshoff[5] as a suspected poison plant in Australia. Bancroft[6] states that the most carefully made extracts of both the green and dried plant were not bitter nor did they have any effect on frogs. W. D. Francis[7] writing of weeds and scrub-undergrowth eaten by stock in a south-eastern dairying district (Kin Kin) during drought periods, states that *Trema* is extensively eaten but very few if any losses in the district have been caused by it. Cleland[8] quotes Shepherd (N.S.W. Med. Gaz. 11. 1871, 74) as saying that the plant is alleged poisonous to goats and cattle in Queensland but though frequently eaten in New South Wales no ill effects are noticed.

Hydrocyanic Acid in Trema aspera.—Recent observations of the writers would, however, definitely show that the plant is at times capable of producing mortality in stock, and is worthy of the reputation imputed in the popular naming.

The closely allied *Trema timorensis* Blume (Syn. *T. virgata* Blume, *Sponia virgata* Planch) is recorded as cyanophoric in Greshoff's original lists[9, 10]. In course of a survey of the Queensland Flora made by us[11] for the occurrence of prussic acid (cyanogenetic glucosides), the occasional presence of faint traces of this poison in *Trema aspera* was noted. Latterly (March, 1920) in connection with an enquiry into cases of fatality among stock in the Beaudesert district, Southern Queensland, portions of *Trema aspera* were gathered which evidenced the presence of an amygdalin-like glucoside both in the "bitter-almond" odour when the leaves were rubbed between the hands and also by pronounced positive reactions in the usual test made with Guignard's soda picrate paper. The record of tests (Guignard reaction) on specimens of Trema from various localities is as follows :—

Date.	Name of Plant.	Locality.	Presence of Hydrocyanic Acid.
30/6/17	Trema aspera	Ithaca Creek ..	Faint positive
28/5/18		Sunnybank	Faint positive
16/6/18		Moreton Bay ..	Negative
30/6/18		Ithaca Creek ..	Negative
13/2/20		Beenleigh	Negative
22/2/20		Beaudesert	Fairly strong positive
23/2/20		Beaudesert (second test confirmatory)	Fairly strong positive
6/3/20		McPherson Range ..	Negative
30/3/20		Marmor	Negative
29/1/18	Trema aspera var. viridis	Malanda	Negative
29/1/18	Trema amboinensis ..	Malanda	Negative

The transitory appearance of hydrocyanic acid has been noted by Greshoff[12] in Hydrangea and certain ferns, and its periodicity in economic plants of the Sorghum group is well-known.

Similar occurrence of the poison, as here shown, in *Trema aspera* in sufficient amount in certain situations or at certain seasons is in accord with the sporadic and sudden fatalities occasionally observed among stock grazing where the plant is abundant.

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    On account of the faint positive reactions recorded for the plant at the time it was not here recorded as definitely cyanophoric.
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CONTRIBUTIONS TO THE ORCHIDACEOUS FLORA OF QUEENSLAND.

No. 2.*

A REVISED ACCOUNT OF THE QUEENSLAND SPECIES OF *HABENARIA* WITH A KEY TO THE AUSTRALIAN MEMBERS OF THE GENUS.

By R. S. Rogers, M.A., M.D., and C. T. White, F.L.S.

(*Read before the Royal Society of Queensland, 29th November,* 1920).

HABENARIA, R.Br.

1. Habenaria elongata, *R. Br., Prodr.* 313, Lindley Gen. et. Sp. Orchid. 317; Reichb. f. Beitr. Orchid. 6; Benth. Flora Austr. vi. 394; F.v.Muell. Fragm. VII, 15; Bail. Queensland Flora V. 1590; Kraenzlin, Orchid. Gen. et. Sp. I. 386.

Habitat. Rockhampton, *O'Shanesy* (ex F. v. Muell l.c.), Mt. Cook, near Cooktown, *Miss Lovell.*

Distribution. Tropical Australia (Type from Arnhem's Land).

In Miss Lovell's specimens a notch (sometimes a distinct bifurcation) is shown at the base of each lateral petal, an important departure from the type.

2. Habenaria Millari, *Bail. in Bull. No.* 9‡ *Dept. Agriculture and Stock, Brisbane* (1890) p. 19; Queensland Flora, V. 1590.

Habitat. Walsh River, *T. Barclay Millar.*

Distribution. Endemic in Queensland.

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*No 1. These Proceedings pp. 117-124.

‡Always quoted by the late F. M. Bailey as "Botany Bulletin III." It was the third of the Bulletin series issued by the Queensland Department of Agriculture devoted to Botany, the title "Botany Bulletin III." does not, however, appear on the title page.

3. Habenaria divaricata, sp. nov.

Planta subrobusta, circiter 62.5 cm. alta. Folia 3 vel 4, sessilia, basibus vaginiformia. alternata, ascendentia, in bracteas foliaceas gradatim transeuntia. Bracteae circiter 6; inferae lanceolatae, ± 8 cm. longae; superae subulatae, ± 3 cm. longae. Spica subdensa, ± 9 cm longa. Flores fere sessiles; bracteolae subulatae, ovariis paulo breviores; ovarium cylindraceum, ± 1.5 cm. longum. Sepalum dorsale anguste ovatum, obtusiusculum, 3-5-nervosum, ± 4.5 mm. longum, 2 mm. latum; sepala lateralia semiovata, obtusiuscula, 3-nervosa, sepalo dorsali longiora, ± 6.5 mm. longa, ± 2.25 mm. lata; petala cum sepalo dorsali conniventia, falco-lanceolata, obtusiuscula, 3 nervosa, ± 5 mm. longa, ± 1 mm. lata. Labellum ± 6 mm. longum, profunde tripartitum; partitio intermedia anguste linearis, apice obtusiuscula, subter canaliculata, ± 5 mm. longa; partitiones laterales anguste lineari-lanceolatae, divaricatae, acuminatae, ± 2.5 mm. longae; basi callus semicirculus; calcar lineari-teres, clavatum, ± 10 mm. longum. Columna brevis; staminodia lateralia, verrucosa, prope a basibus canalium antherae; canales processus stigmaticos fere aequantes; processus stigmatosi longiusculi, carnosi, glandulosi, suboblongi, porrecti, apicibus rotundati.

Plant moderately robust, about 62.5 cm. high: a sheathing scale at the extreme base. Leaves 3 or 4, sessile, with vaginate bases, alternate, ascending, lower ones imbricate, merging insensibly into stem bracts: increasing in length but decreasing in width from below upwards; the lowest, near the base, ovate, about 4 c.m. long; the next in succession about 11.5 cm. long, 1.5 cm. wide; the third in succession about 13 cm. long, 0.75 cm. wide; stem-bracts about six, diminishing in length from below upwards; the lower ones lanceolate. 8 cm. or less in length: the upper ones subulate, about 3 cm. long. Spike rather dense, about 9 cm. long. Flowers nearly sessile: bracteoles subulate, somewhat shorter than the ovaries: unimpregnated ovary cylindrical, about 1.5 cm. long. Dorsal sepal narrowly ovate. blunt, 3-5 nerved, about 4.5 mm. long, 2 mm. wide: lateral sepals semi-ovate, rather blunt, 3 nerved, longer than the dorsal sepal, about 6.5 mm. long, 2.25 mm. wide; petals connivent with the dorsal sepal, falco-lanceolate, rather blunt, 3 nerved, about 5 mm. long, about 1 mm. wide. Labellum about 6 mm. long. deeply tripartite; middle division narrow linear, apex rather blunt, channelled below. about 5 mm. long; lateral divisions narrowly linear lanceolate, divaricate, acuminate, about 2.5 mm. long: semi-circular callus at the base; spur linear terete, clavate, about 10 mm. long. Column short; staminodes lateral, warty, situated near the base of the anther canals; the canals almost equal in length to the stigmatic processes: stigmatic processes rather long, fleshy, glandular, somewhat oblong, stretching forward rounded at the free ends.

Habitat. This fine Habenaria comes from Dunk Island off the North East Coast of Queensland. As in the case of *Habenaria Banfieldii* Bail. and *Habenaria ovoidea*, we are indebted to Mr. E. J. Banfield for the discovery of this species.

4. Habenaria graminea, *Lindl. Gen. et Sp. Orchid.* 318; Benth. Flora Austr. VI. 394; F. v. Muell. Fragm. VII. 16: Bail. Queens. Flora. V. 1590; Kraenzlin Orchid. Gen. et. Sp. I. 383.

Habitat. Rockingham Bay, *Dallachy* (ex F. v. Muell. l.c.); Pioneer River, *L. J. Nugent*: Magnetic Island, *J. W. Fawcett*; Cairns, *C. T. White.*

Distribution. Tropical Australia, New Guinea and India.

5. Habenaria xanthantha, *F.v.Muell. Fragm.* VII, 16; Benth. Flora. Austr. VI, 395; Bail. Queens. Flora V. 1591: Kraenzlin. Orchid. Gen. et Sp. I. 378.

Habitat. Rockingham Bay, *Dallachy* (ex. F.v.Muell l.c.): Kelsey Creek near Proserpine, *Rev. N. Michael* (No. 854).

Distribution. Endemic in Queensland.

This ill-defined species greatly interferes with any attempt at a clear-cut systematic arrangement of Australian forms.

It was at first thought that the founder might have accidently included within it more than one member of the genus, but an examination of his material* in the National Herbarium, Melbourne. reveals the nature of the difficulties which confronted him. This material was collected by J. Dallachy at Rockingham Bay, Queensland, and Baron

*Courteously lent by the Curator of the Herbarium.

Mueller's description was published in June, 1869 (Fragmenta, VII, 16). The plants which constitute it, bear a strong resemblance to each other as regards leaves, stature and general habit, but much variation was observed in the reproductive and accessory organs. These variations were chiefly noticeable in the lateral lobes of the labellum and in the spur, not only in different plants but actually on the same spike. In one individual it was possible to find flowers in which the lateral lobes of the labellum were symmetrical, extremely asymmetrical, or absent. These lobes were usually small or deltoid in shape, but in one flower the lobe on one side of the labellum was rudimentary, whereas on the other side its base was deltoid and its acuminate point attained at least half the length of the rather long middle division In another spike the spur varied from 1.5 mm. to 4 mm. in length. In some instances the spur was extremely short, not exceeding .5 mm. The type of spur common to all the plants was conical and incurved, not filiform. The few plants available could be roughly divided into those in which the anther canals and stigmatic processes were approximately equal in length, and those in which the anther canals were only about half the length of the "processes." It was further noticed that the former plants were provided with rudimentary spurs, and the latter as a rule with relatively long spurs. The suggestion that some of these variations might be the result of kybridization was almost irresistible, but until ample and suitable material is available, this polymorphic species must continue to embrace within its limits many doubtful forms.

In the Queensland Herbarium, von Mueller's species is represented by specimens collected by the Rev. N. Michael at Kelsey Ck., near Proserpine, Queensland. These specimens are superficially very much alike. The leaves are rather narrower and shorter than in Dallachy's specimens. They exhibit however, similar variations to those found in the latter.

In some cases the lateral lobes of the labellum are nearly as long as the middle lobe, and have a tendency in several instances to become circinate, as in *H. ochroleuca* Br. The leaf of the latter species is, however, very much lon er and wider, and the spur more than double the length.

In many of the flowers of the Kelsey Creek specimens, the spur is so rudimentary, that it becomes extremely difficult to trace. In other specimens it may attain a length of 3 mm. In all of them the stigmatic processes considerably exceed in length the anther canals, irrespective of the length of the spur. The staminodes are in all instances very distinct.

The locality where these specimens were collected is about two degrees (120 miles) of latitude south of Rockingham Bay where von Mueller's original material was obtained.

6. Habenaria propinquior, *Reichb. f. Beitr. Orchid* (1871) 53 : Kraenzlin, Orchid. Gen. et Sp. I 381.

Habitat. Cape York Peninsula Rockingham Bay.

Distribution. Endemic in Queensland.

This species is reduced to a synonym of *H. xanthantha*, F.v.M. in the Flora Australiensis, but is not so regarded by Kraenzlin in Orchid. Gen. et Sp. 378 and 381.

Although this plant is unrepresented in Australian National collections, it would appear to differ materially from *H. xanthantha* in several important respects, such as inequality in shape and length of perianth segments, and also in regard to the shape and length of the spur.

The following description is included for purposes of convenience.

Stem about 20-25 cm. high. Leaves at the base, linear-lanceolate, 3-4 cm long, 3-4 mm. wide, most of them awned and scale like. Raceme few-flowered. Dorsal sepal widely ovate, obtuse ; lateral ones longer, triangular : petals shorter, ligulate, obtuse. The lateral lobes of the tripartite labellum narrowly triangular : the middle one longer and wider. Spur filiform, inflexed, acute at the apex, hardly widening at the base ; equal in length, either to the whole or half of the pedicellated ovary. Stigmatic processes very short, equal in length to the anther canals. Flowers among the smallest of the genus : more constant than those of *H. ochroleuca*, R.Br.

7. Habenaria Banfieldii, *Bailey, Queens. Agric. Journ.* XVI (1906) 564 : Compr. Cat. Queens., Pl. pp. 539 and 540, fig. 528.

Habitat. Dunk Island, *E. J. Banfield.*

Distribution. Endemic in Queensland.

8. Habenaria ovoidea, sp. nov.

Planta erecta, gracilis, glabra, circiter 19-35 cm. alta. Folia 2 vel 3, basilaria, elliptica vel oblongo-elliptica, sessilia, multi-nervosa, ± 4-9 cm longa, .75 cm. lata. Bracteae 3 vel 4, ovato-lanceolatae, acuminatae, 1.25-2.5 cm. longae. Spica laxiflora, circiter 4-7.5 cm. longa. Flores sessiles, in speciem albicantes, ovaria elongata, gracilia; bracteolae ovariis breviores. Sepala lateralia obtusiuscula, ± 4.5 mm. longa, 3-nervosa, falco-lanceolata, basi labelli prope a calcari brevissime adnata; sepalum dorsale ovatum, cucullatum, obtusissimum, circiter 5 mm. longum, 3-nervosum; petala basibus contracta, 3-nervosa, libera, elliptico-lanceolata, ± 4.75 mm longa. Labellum inferum, sessile, circiter 5 mm. longum; basi columnae brevissime adnatum; tridentatum; segmentum intermedium circiter 1.5 mm. longum, strictum, lineari-oblongum, acuminatum; segmenta lateralia divaricata, falco-lanceolata, ± 3 mm. longa, segmento intermedio longiora latioraque; callus fere quadratus a basi unguis ad medium; calcar brevissimum, ovoideum. Columna brevissima, canales antherae breves; processus stigmatici minutissimi, ovati.

Scape glabrous, from 19-35 cm. high. Leaves 2 or 3, basal, elliptical or oblong-elliptical, sessile, multi-nerved, with rather prominent midrib, from about 4-9 cm. long, 0.75 cm. wide. Stem-bracts 3 or 4, ovate-lanceolate, acuminate from 1.25-2.5 cm. long. Spike laxi-flowered, about 4-7.5 cm. long. Flowers sessile, apparently white, on long slender ovaries, 4-5 mm. long (not including ovary). Flower bracts generally much shorter than the ovaries. Lateral sepals blunt, ± 4.5 mm. long, 3-nerved, falco-lanceolate, very shortly adnate to the base of the labellum near the spur; dorsal sepal ovate cucullate, very blunt, about 5 mm. long, 3-nerved; lateral petals contracted at the base, 3-nerved; about 4.75 mm. long, elliptic-lanceolate, free. Labellum inferior; sessile, about 5 mm. long; very shortly adnate to the base of the column; tridentate; central lobe about 1.5 mm. long, linear oblong, straight, shortly acuminate; lateral lobes divergent from the central, about 3 mm. long, falco-lanceolate, longer and wider than the middle segment; a somewhat raised widely oblong (almost quadrate) callus along the centre of the claw for almost half its length ; spur very short (about as long as the column), ovoid. Column very short ; anther canals short, glands 2 ; pollen sectile ; stigmatic processes ovate, minute, on each side of the base of the column.

Habitat. Dunk Island, *E. J. Banfield.*

This species in its general habit is very unlike H. Banfieldii, *Bail.* and *H. divaricata,* Rogers and White, which come from the same locality. It is more slender, with foliage more definitely basal and a much less bracteated stem than either of these species. In *H. Banfieldii* the labellum is traversed from the base almost to the tip of the middle lobe by a linear oblong callus : whereas in this new species the callus is almost quadrate and confined to the lower half of the claw. In *H. Banfieldii* the middle lobe is wider and at least as long as the lateral lobes : whereas in *H. ovoidea* the middle lobe is narrower and much shorter than the other segments. The stigmatic processes are cristate and much longer, but the flowers relatively smaller, in *H. Banfieldii* than in the new species. The specific name *ovoidea* has reference to the egg-shaped spur, a feature which it shares in common with *H. Banfieldii.*

Key to Australian Species.

The following analytical table will serve to show the relation of the different Queensland species to other Australian Habenariae.

Petals bipartite.

Stems leafy. Labellum 3-partite ; segments equal, narrow-linear, divergent. Spur filiform, inflated at apex, as long as ovary (7 mm.)...... *H. trinervis*

Petals undivided.

Spur more or less filiform-clavate, 8 mm. or more in length. Labellum deeply tripartite ; segments long, narrow-linear or filliform.

Spur 2.5 c.m. (1 inch) or more in length. Leaves basal or nearly so.

Segments of labellum linear ; lateral ones much shorter than central one. Lateral petals sometimes notched. Stigmatic processes horizontal terete, cristate.... *H. elongata*

Segments of labellum filiform ; lateral ones about 2.5 c m. (1 inch) ; middle one shorter. Stigmatic processes erect, with white, globose heads.................. *H. Millari*

Spur clavate, longer than the labellum, but not exceeding 1.5 c.m. (about ½ inch). Labellum *deeply* 3-partite, with well-developed lateral lobes.

Leaves distributed well up the stem beyond the middle. Middle segment of labellum linear, about 5 m.m. long: lateral ones about half as long, spur about 10 mm. long................ *H. divaricata*

Leaves at the base.

Leaves linear to oblong. Labellar segments about equal, approximately 4.25 mm. long, linear. Spur about 8 mm., genu-flexed in the middle.... *H. eurystoma*

Leaves linear, under 7.5 c.m. (3 inches) long. Middle segment labellum linear; lateral ones filiform, generally circinate, diverging at right angles with the middle one. Spur about 12 mm., rather longer than the ovary .... *H. graminea*

Leaves oblong or spathe-like; sometimes distant. Middle segment labellum linear; lateral ones a little shorter lanceolate-falcate, divaricate. Spur about 8 mm. long, much shorter than ovary and pedicel combined.... *H. ochroleuca*

Spur conical or filiform, sometimes obliterated, not exceeding 6 mm. (¼ inch). Lateral lobes of labellum seldom well marked, sometimes absent.

Leaves distributed well up the stem; linear to oblong. Lateral segments labellum many times shorter than the middle segment, deltoid or semi-circular; middle segment filiform-linear, about as long as sepals. Spur filiform clavate, about 6 mm. long .... *H. Holtzei*

Leaves at the base linear. Lateral segments of labellum often asymmetrical, usually minute or obsolete; middle segment linear-oblong or lanceolate, about as long as the sepals. Spur conical, incurved, sometimes obliterated, not exceeding 4 mm. in length. *H. Xanthantha*

Spur filiform, about the same width throughout, rather long, equal to at least half the length of the pedicellated ovary. Leaves basal, linear lanceolate. Lateral lobes of the labellum narrowly triangular, acuminate, shorter than middle lobe. .... *H. propinquior*

Spur ovoid or rotund, very short, approximating in length to the column. Labellum tridentate.

Leaves distributed over lower half of stem, widely elliptic; stem markedly bracteate. Plant rather stout. Middle lobe of trident wider and either equal to or longer than lateral lobes; a linear-oblong callus extending along centre of lamina from base of claw nearly to tip of middle lobe .... *H. Banfieldii*

Leaves at the base, oblong-elliptic. Plant slender, stem-bracts few. Middle lobe of trident about 1.5 mm. long, narrower and much stouter than lateral lobes; lateral lobes about 3 mm. long, falco-lanceolate; an almost quadrate callus occupying the posterior half of the claw.................... *H. ovoidea*

Excluded Species.

Habenaria mesophylla, Kraenzlin, Orchid. Gen. et Sp. I 204.

Kraenzlin (l.c.) includes this species among Australian representatives of the genus. The material was supplied by Baron von Mueller from the Melbourne Herbarium, but, as it was unaccompanied by names of locality and collector, it is unsafe to assume that it is of Australian origin. It has, in fact, the features of Ceratopetalae, an African section of Habenaria. The dried flowers show an apparently undivided labellum, owing to the adhesion between the lateral lobes of that organ and the anterior divisions of the petals.

Owing to defective data, it has not been included in the above key.

THE

Royal Society of Queensland.

Abstract of Proceedings.

REPORT OF COUNCIL FOR 1919.

To the Members of the Royal Society of Queensland.

Your Council have pleasure in submitting their Report for the year 1919.

We desire to place on record our gratification over the official announcement of Peace, and our intense admiration for the part played by men of our race and their allies in the late gigantic struggle.

Taking into consideration the effect of the influenza epidemic, the work of the year has been very satisfactory, twelve papers being accepted for reading and publication. During the visit of the Royal Australasian Ornithologists' Union to Queensland, a lecture on Central Australia was delivered before the Society, by Captain S. A. White, C.M.B.O.U., of Adelaide, and the meeting was the largest held within recent years.

We have to express our indebtedness to the Queensland Government, who have again voted a sum of £50 to assist the Society in the publication of scientific work. Our thanks are also due to the Trustees of the Walter and Eliza Hall Fund, for assistance in the publication of the paper on "The Life Histories of *Musca australis* Macq., and *M. vetustissima* Walker," by Prof. T. H. Johnston and Miss M. J. Bancroft, Walter and Eliza Hall Fellow in Economic Biology.

There have been twelve meetings of the Council, the attendances being as follows :—H. A. Longman (President), 11 ; C. D. Gillies, 12 ; T. H. Johnston, 10 ; J. Shirley, 12 ; A. B. Walkom, 0* ; F. Butler-Wood, 3 ; E. H. Gurney, 8 ; H. C. Richards, 7 ; F. Smith, 3 ; S. B. Watkins, 8 ; C. T. White, 11.

Our roll of members consists of ten Corresponding, and eighty-nine Ordinary Members, making a total of ninety-nine. During the year five members were admitted to the Society, and five resignations were presented and accepted.

The thanks of the Society to Mr. C. D. Gillies, M.Sc., who now retires from the position of Honorary Secretary, are placed on record, and we wish him all possible success in his new work.

Our thanks are also due to the University of Queensland for accommodation for meetings and for housing the library.

The attention of members is directed to the provision made in the rules for the enrolling of associates at the moderate subscription of half-a-guinea per annum.

The Financial Statement for the past year shows a credit balance of £68/7/4, but against this there is a printer's bill amounting to £99/8/6.

Signed, HEBER A. LONGMAN,
President.

Signed, C. D. GILLIES,
Hon. Secretary.

4th March, 1920.

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*Dr. Walkom left for Sydney in March, 1919.

THE ROYAL SOCIETY OF QUEENSLAND.

Cr. **BALANCE SHEET for Year ended 31st December, 1919.** **Dr.**

RECEIPTS.	£	s.	d.
By Bank Balance—			
January 1st, 1919	4	0	9
Government Subsidy	50	0	0
Subsidies to Proceedings	20	0	0
Sale of Proceedings	1	4	0
Subscriptions	91	3	0
	£166	7	9

EXPENDITURE.	£	s.	d.
Printing	83	9	9
Hon. Secretary	11	7	9
Insurance	0	18	0
Hon. Treasurer	0	12	11
Advertisements	1	4	0
Bank Charge	0	5	0
Exchange	0	3	0
Total	98	0	5
Balance	68	7	4
	£166	7	9

The Printers' final account for Vol. XXXI was not to hand at the time of balance.

Treasurer, JOHN SHIRLEY.

Hon. Auditor, PAUL SYLOW.

Abstract of Proceedings, 31st March, 1920.

The Annual General Meeting of the Royal Society was held on Wednesday, 31st March, 1920, at 8 p.m., in the Geology Lecture Theatre, University.

Mr. H. A. Longman, F.L.S., President, in the chair.

The minutes of the previous Annual General Meeting were read and confirmed.

Messrs. H. Tryon, A. Cayzer, B.Sc., and L. E. Cooling were proposed for membership.

The Annual Report of the Council and the Annual Financial Statement were adopted on the motion of Mr. J. B. Henderson, F.I.C., E. W. Bick seconding.

The following officers were elected for 1920:—

President: F. B. Smith, B.Sc., F.I.C.

Vice-Presidents: H. A. Longman, F.L.S. (*ex officio*); C. T. White, F.L.S.

Hon. Secretary: W. D. Francis.

Hon. Treasurer: J. Shirley, D.Sc.

Hon. Editor: H. A. Longman, F.L.S.

Hon. Librarian: W. H. Bryan, M.Sc.

Members of Council: F. Butler-Wood, D.D.S., B. Dunstan, E. H. Gurney, Prof. T. H. Johnston, M.A., D.Sc., Prof. H. C. Richards, D.Sc.

The newly-elected President was installed, and returned thanks for his election.

The retiring President delivered his Presidential Address on "Some Factors in Variation." At its conclusion, Professor T. H. Johnston moved a vote of thanks, which was seconded by Mr. C. T. White, and carried unanimously. Mr. Longman suitably responded.

Abstract of Proceedings, April 28th, 1920.

The Ordinary Monthly Meeting of the Royal Society was held on Wednesday, April 28th, 1920, at 8 p.m., in the Geology Lecture Theatre of the University.

Mr. F. B. Smith, B.Sc., F.I.C., President, in the chair.

The President referred to the death of the late Governor of Queensland, His Excellency Sir Hamilton Goold-Adams, G.C.M.G., C.B., etc., and the Secretary was instructed to convey a message of condolence to Lady Goold-Adams. The meeting expressed its sympathy by rising.

The minutes of the previous monthly meeting were read and confirmed.

Messrs. H. Tryon, A. Cayzer, B.Sc., and L. E. Cooling were elected to ordinary membership of the Society.

Mr. O. W. Tiegs, B.Sc., Walter and Eliza Hall Fellow in Biology, was proposed for ordinary membership of the Society.

Mr. B. Dunstan exhibited a series of specimens, illustrating the occurrence of precious opal in the basaltic country at Tintenbar, near Ballina, in New South Wales, comprising (1) Tripolite, which forms the source of the silica; (2) scoriaceous basalt containing amygdules of precious opal; (3) precious opals weathered out of the basalt; (4) "shin-cracker" or common opal formed from tripolite *in situ*; and (5) opal decomposed or devitrified to a white, earthy rock. References were made to the conditions under which the opal was formed, the peculiarities of the opal produced, and the prospects of obtaining similar opal on the Queensland side of the border.

Dr. J. Shirley, F.M.S., exhibited a remarkable band of eggs, lately received at the Queensland Museum, from Mr. Eric McConnel, of Mount Brisbane, of a vinaceous-pink colour and shaped like a gnomon: one arm 1300 mm. by 130 mm., the short arm 440 mm. by 170 mm. The eggs are in rows of 40 to 50 capsules, containing about 30 eggs each, and there are hundreds of rows. The band was found at Southport, and belongs to an unknown cephalopod.

From Mr. E. J. Banfield, of Dunk Island, were shown two wood-boring mollusks—*Martesia striata* Lin., and a *Xylophaga*, probably new. These had penetrated deeply into the timber of a damaged jetty. The methods of boring were referred to at length, and various theories, mechanical and chemical, advanced by leading conchologists, were compared.

In a late visit to Baffle Creek, Mr. C. T. White, Government Botanist, collected a few land shells, the principal being *Thersites parsoni* Cox and *Thersites bloomfieldi* Cox. These were commented upon by Dr. Shirley.

Mr. H. A. Longman, F.L.S., exhibited a *Pteropus poliocephalus* Temminck, which had been forwarded to the Queensland Museum by Mr. S. C. Smith, from Dulbydilla, beyond Mitchell, Western Queensland, this being a remarkable extension into the interior of the range of this "flying-fox."

Mr. C. T. White, F.L.S., exhibited: (1) photographs showing variation in the bark of *Eucalyptus hæmastoma*, Sm., var. *micrantha* (D.C.) Benth., the common "white" or "scribbly gum," also a photograph of a stringy-barked form common on the ranges about Toowoomba, which he considered worthy of distinct varietal rank; (2) tubers of the "Weir Vine," *Ipomoea calobra*, Hill and F.v.M., gathered by Mr. Donald Gunn, M.L.A., between Goondiwindi and St. George. Mr. Gunn stated that the vines had the same effect on stock as the Darling Pea, or "Indigo" (*Swainsona*). The tubers, however, were used as food by people in the districts where the plant occurred. Mr. Gunn's account of the effect of the plant on stock was corroborated by other practical stockmen.

Mr. H. Tryon and Professors Richards and Johnston took part in the discussions on the exhibits.

Professor T. H. Johnston, M.A., D.Sc., read the following papers by himself and Miss M. J. Bancroft, B.Sc.: (*a*) "Experiments with Certain Diptera as Possible Transmitters of Bovine Onchocerciasis"; (*b*) "Notes on the Chalcid Parasites of Muscoid Flies in Australia." The papers were accompanied by an exhibit of specimens. The discussion was deferred to the monthly meeting of the Society.

Mr. J. B. Henderson, F.I.C., read a paper entitled :—" Notes on the Occurrence of Petroleum in Queensland." He also exhibited material obtained in the State and by means of apparatus demonstrated the effects of pressure on gas and oil in bores. The discussion on the paper was deferred to a later date.

Abstract of Proceedings, May 31st, 1920.

A Special Meeting of the Royal Society of Queensland was held on Monday, 31st May, 1920, at 8 p.m., in the Geology Lecture Theatre of the University.

Mr. F. B. Smith, B.Sc., F.I.C., President, in the Chair.

The Minutes of the previous meeting were read and confirmed.

After discussion the following alterations and additions to the rules of the Society were carried :—

Rule 21, line 2, delete " and " and insert " and under direction from the Council may take steps to recover arrears, he shall "

Rule 29, add " Authors shall receive 25 copies of their printed papers. Blocks for illustrations other than line blocks and the extra cost of printing of same shall be at the cost of the author."

It was also decided to reduce the number of the annual volumes of Proceedings of the Society printed each year from 400 to 300. This procedure and the addition to Rule 29, as above, were decided upon as temporary measures only, on account of the high cost of printing, etc.

Mr. O. W. Tiegs, B.Sc., Walter and Eliza Hall Fellow in Biology, was elected an Ordinary Member of the Society.

Mr. H. A. Longman, F.L.S., exhibited Queensland Museum skins of the common opossum, *Trichosurus vulpecula* Kerr, showing brown and fawn varieties, as well as the characteristic grey. These varieties have been tabulated by A. S. Le Souef (Australian Zoologist, I, p. 62, 1916), whilst the first-named corresponds with Ramsay's " *T. johnstonii.*"

Professor T. H. Johnston, M.A., D.Sc., read the following paper by himself and Miss M. J. Bancroft, B.Sc.: "The Life History of *Habronema* in relation to *Musca domestica*."

Mr. H. Tryon discussed the foregoing paper as well as the same authors' paper entitled "Experiments with Certain Diptera as possible Transmitters of Bovine Onchocerciasis" which was read at the previous monthly meeting.

Owing to the late hour, the following papers were taken as read :—

By. F. B. Smith, B.Sc., F.I.C., and C. T. White, F.L.S., "On the Occurrence of Cyanogenetic Glucosides in the Flowers of Some Proteaceæ."

By C. P. Alexander, "New or Little Known Australian Crane Flies" (Communicated by Professor Johnston).

The President referred to the departure of Professor Johnston to America in the near future, and on behalf of the Society wished him a successful and pleasant voyage. He also congratulated Miss M. J. Walker, M.Sc., upon her appointment as Lecturer in Biology at the University.

Abstract of Proceedings, June 30th, 1920.

The ordinary Monthly Meeting of the Royal Society was held in the Geology Lecture Theatre of the University, on the 30th June, 1920, at 8 p.m.

The President, Mr. F. B. Smith, B.Sc , F.I.C., in the Chair.

The Minutes of the previous meeting were read and confirmed.

Dr. H. I. Jensen was proposed for ordinary membership of the Society.

Mr. H. A. Longman, F.L.S., exhibited a number of marsupial crania showing variations in the perforations of the cribriform plate, and pointed out that members of the Polyprotodontia (*Perameles*, *Myrmecobius*, *Thylacinus*, *Sarcophilus*, *Dasyurus*, *Phascologale*, etc.) were characterised by the presence of two major perforations situated near the superior median margin.

Mr. C. T. White, F.L.S., exhibited (1) pieces of the stem of *Vitis acris* F.v.M. When collecting in the Rosedale district recently Mr. Schmieden had told him that when the stem of this vine was chewed, the tongue and lips became inflamed, the secretion of saliva was increased and intense pain ensued. (2) Seeds of *Macrozanomia macrocarpa* Cogn., collected in the Aru Islands by Mr. Snowden, who had forwarded them to Mr. M. J. Colclough, of the Queensland Museum. Mr. Snowden stated that these beautifully winged seeds were sometimes found floating about in the air 10 miles out to sea and not uncommonly fell on schooners' decks. The exhibitor stated that he had observed specimens on the road between Bioto and Mafulu, in Papua, while collecting in that region. The seeds had previously been described by the late F. M. Bailey in the Society's Proceedings (xviii, 3), as those of an unknown Bignoniaceous plant. For the correct identification Mr. White was indebted to the Director of the Royal Botanic Gardens, Kew (Lieut.-Colonel Sir D. Prain), who, in forwarding the determination, stated that an article on this interesting plant had been prepared for an early number of the Kew Bulletin.

The President and Mr. H. Tryon took part in the discussion on the exhibits.

Mr. W. D. Francis read a paper entitled : " The Origin of Black Coatings of Iron and Manganese Oxides on Rocks," which was discussed by Dr. Shirley, Messrs. Tryon, White, and Longman.

Abstract of Proceedings, July 26th, 1920.

The Ordinary Monthly Meeting of the Royal Society, was held in the Geology Lecture Theatre of the University, on the 26th July, 1920, at 8 p.m.

The President, Mr. F. B. Smith, B.Sc., F.I.C., in the Chair.

An apology was tendered by the President on behalf of Professor H. C. Richards, D.Sc., who was absent from Brisbane and proceeding to the Pan-Pacific Science Congress at Honolulu.

The Minutes of the previous meeting were read and confirmed.

Dr. H. I. Jensen was elected to Ordinary Membership of the Society.

Mr. J. B. Henderson, F.I.C., made some general remarks on the subject of Petroleum in Queensland, and exhibited apparatus demonstrating how oil or gas bearing strata may be bored through, and the oil or gas missed or only obtained in small intermittent quantities, also demonstrating conditions under which gas-flows in bores containing water may be stopped and started again.

Mr. W. H. Bryan, M.Sc., delivered a short lecture on "The Origin of Petroleum Deposits," and outlined the various hypotheses which have been advanced to explain petroleum deposits.

Mr. A. Moore, officer in charge of the Government Oil Bore, Roma, described some of the conditions prevalent at the Roma Bore.

Messrs. W. E. Cameron, L. C. Ball, and J. B. Henderson took part in the subsequent discussion.

Abstract of Proceedings, August 30th, 1920.

A Special Meeting of the Royal Society of Queensland was held in the Geology Lecture Theatre of the University on the 30th August, 1920, at 8 p.m.

The President, Mr. F. B. Smith, B.Sc., F.I.C., in the chair.

The President referred to the death of Sir Samuel Griffith, who was a life member of the Society, and the Secretary was instructed to convey the condolences of the Society to the bereaved relatives.

The minutes of the previous monthly meeting were read and confirmed.

On the motion of Dr. Shirley, seconded by Mr. Bick, the following sentence was deleted from Rule 10, paragraph 2, of the Society's Rules :—

"Any Member or Associate, who, after notification from the Secretary or Treasurer that his subscription is due, fails to pay it before the 1st of April, shall cease to receive any benefit from the Society, but may regain his privileges on payment of arrears."

Dr. Shirley moved, Mr. White seconding, that the amended rules of the Society be printed and incorporated in the volume of proceedings at the end of the present year. Carried.

On the motion of Mr. Tryon, seconded by Dr. Shirley, it was decided to supply all new members with a copy of the rules.

Dr. J. Shirley, F.M.S., exhibited specimens of *Strombus labiosus* Gray, and *Strombus papilio* Chemnitz from Torres Strait; *Strombus columba* Lamarck from Rabaul, New Guinea, and *Strombus succintus* Linnæus from Manilla, and commented on the colouration, methods of progression, and perfect eyes of the species of this genus.

Mr. O. W. Tiegs, B.Sc., communicated a paper by Professor T. Harvey Johnston, M.A., D.Sc., and Miss M. J. Bancroft, B.Sc., entitled, "Notes on the Life History of Certain Queensland Tabanid Flies."

Mr. C. T. White, F.L.S., read a paper by himself and Dr,. R. S. Rogers, M.A., M.D., entitled "Contributions to the Orchidaceous Flora of Queensland," which was discussed by Mr. H. Tryon.

Abstract of Proceedings, September 27th, 1920.

The Ordinary Monthly Meeting of the Royal Society was held in the Geology Lecture Theatre of the University, on September 27th, at 8 p.m.

The President, Mr. F. B. Smith, B.Sc., F.I.C., in the Chair.

The Minutes of the previous meeting were read and confirmed.

Acknowledgments of letters of condolence from Lady Goold Adams and Lady Griffith were read.

The President referred to Professor Richards' return from the Pan-Pacific Science Congress at Honolulu.

Mr. W. E. Appleby and Dr. E. O. Marks were nominated for Ordinary Membership.

Mr. H. A. Longman, F.L.S., exhibited a specimen of the Phyllopod, *Lepidurus viridis* Baird, which had been found in a "melon hole" at Tara, Darling Downs, and forwarded to the Queensland Museum by Mr. Wm. Hewins. Although well-known in other Australian States and in New Zealand, this is apparently the first record for Queensland. Specimens referred to the allied species, *Apus australiensis*, Spencer and Hall, had been sent in recently from Barcarolle, W. Queensland, by Mr. F. L. Berney. Mr. Longman briefly referred to the way in which the eggs of these Phyllopods retain their vitality when transported in mud adhering to the feet of aquatic birds.

Dr. J. Shirley, F.M.S., exhibited a flowering specimen of *Ginkgo biloba*, L., showing male cones or rather catkins. This tree has leaves like the fronds of the maiden-hair fern, and so has been called the maiden-hair tree. A synonym is *Salisburia adiantiaefolia*. It is a native of Eastern Asia, and may be found planted about Buddhist temples in China and Japan. Recently it has been stated that its true habitat is in one of the ranges of E. China. Like plants of the order Cycadaceae, it is remarkable for producing spermatozoids, by which the ovules of the female cone are fertilized. The fruit is nut-like, one-seeded and edible.

Ten fossil plants, belonging to Gingkoales, have been reported from the Ipswich Beds of Denmark Hill, Queensland. Four are species of *Ginkgo*, and four belong to *Baiera*, and two are classified under *Stachopitys*.

Professor H. C. Richards, D.Sc., exhibited a hemispherical pebble of chalcedony from near Tripoli at the foot of Lebanon, Syria. The specimen was found by Mr. V. G. Harris, a member of the A.I.F.

The specimen which was one of many commonly termed "petrified olives," is hemispherical in shape and has the appearance of one half of a biaxial elliptical pebble which has been cut in two and polished on the sliced surface. It has a diameter of 35 mm. each way and a depth of 15 mm. The pebble has four or five concentric layers of chalcedony forming an outer coating which is about 5 mm. thick.

Mr. Harris states that the pebble is in its natural condition and that it was found loose on the surface of the ground and that he handled several specimens of the same size and shape from the same locality, and saw others further south, near Beelah.

The polished surface has the characteristics of a wind polished surface with minor dimples, pits and grooves as one might expect, and the edges of the "polished" area are quite sharp.

The only feasible explanation that could be offered as to the origin of a number of pebbles of this shape is that it formed portion of a conglomerate which had been sheared so as to cut through the pebble and that the sheared surface had been subjected to wind erosion following on which the pebble had been weathered out of its matrix. This explanation might hold for an isolated pebble but cannot be offered as the cause of frequent specimens of a similar shape in different localities.

Professor H. J. Priestley, M.A., delivered a lecture entitled "The Einstein Theory." At its conclusion a vote of thanks was accorded the lecturer on the motion of Professor Richards and Dr. Shirley, supported by the President and Mr. Longman.

Abstract of Proceedings, October 25th, 1920.

The Ordinary Monthly Meeting of the Royal Society was held in the Geology Lecture Theatre of the University, at 8 p.m., on the 25th October, 1920.

The President, Mr. F. B. Smith, B.Sc., F.I.C., in the chair.

His Excellency the Lieutenant-Governor, the Hon. Wm. Lennon, Mrs. Lennon, Miss Lennon, and Captain Plant, A.D.C., were among the visitors.

The minutes of the previous monthly meeting were read and confirmed.

Mr. W. E. Appleby and Dr. E. O. Marks were elected to ordinary membership of the Society.

Professor H. C. Richards, D.Sc., delivered a lecture entitled "The Hawaiian Islands." The lecturer gave an account of the recent Pan-Pacific Scientific Conference at Honolulu and made some remarks on the origin, structure and character of the Hawaiian Islands. The lecture was illustrated by a large series of excellent lantern slides, a number of hand-colored photographs of the active volcano of Kilauea, and specimens collected from the recent lava flows.

A vote of thanks was accorded the lecturer on the motion of the Hon. A. J. Thynne, M.L.C., seconded by Mr. E. C. Barton. Professor Richards suitably responded.

Abstract of Proceedings, November 29th, 1920.

The Ordinary Monthly Meeting of the Royal Society was held in the Geology Lecture Theatre of the University, at 8 p.m., on the 29th November, 1920.

The President, Mr. F. B. Smith, B.Sc., F.I.C., in the Chair.

The Minutes of the previous Monthly Meeting were read and confirmed.

Mr. C. Morton, A.T.C.S.M., was proposed for Ordinary Membership.

The following papers were taken as read :—

"The Peach-leaf Poison Bush," by F. B. Smith, B.Sc., F.I.C., and C. T. White, F.L.S.

"Contributions to the Orchidaceous Flora of Queensland, No. 2," by Dr. R. S. Rogers, M.A., M.D., and C. T. White, F.L.S.

Dr. J. V. Danes delivered a lecture entitled "The Czecho-Slovakia Republic," which was illustrated by a large number of lantern slides. At its conclusion, His Excellency the Lieutenant Governor, Hon. Wm. Lennon, proposed, and Dr. J. Shirley seconded, a vote of thanks to the lecturer.

Publications are received in exchange from the following Institutions and Societies, and are hereby acknowledged.

AFRICA.

Government of the Gold Coast.
Natal Mueum, Pietermaritzburg, Natal.
South African Association for Advancement of Science.

AMERICA.

Brazil.

Instituto Oswaldo Cruz, Rio Janeiro.
Museu Paulista Suo Paulo.
Minesterio da Agricultura Industria and Commercio, Rio Janeiro.
Servio Geologio e Mineralogico de Brazil, Rio Janeiro.

Canada.

Dept. of Mines, Ottawa.
Institute of Natural Science, Nova Scotia.
Royal Astronomical Society of Canada, Toronto.
Royal Canadian Institute, Toronto.
Royal Society of Canada, Ottawa.

United States.

Academy of Natural Science, Philadelphia.
American Geographical Society, New York.
American Museum of Natural History, New York City.
American Philosophical Society, Philadelphia.
Californian Academy of Science, San Francisco.
Bureau of Standards Dept. of Commerce, Washington.
Florida Geological Survey, Tallahassee, Florida.
Illinois State Laboratory, Urbana, Illinois.
Indiana Academy of Science, Indianopolis, Indiana.
Kansas Academy of Science, Topeka, Kansas.
Librarian of Congress, Washington.
Librarian University of Michigan, Ann Arbor, Michigan.
Missouri Botanic Gardens, St. Louis, Missouri.
National Academy of Science and Smithsonian Institute, Washington.
Librarian Ohio State University, Columbus.
University of California, Berkeley.
University of Minnesota, Minneapolis, Minnesota.
Wilson Ornithological Club, Oberlin College Library, Oberlin, Ohio.

Oceania.

Bernice Pauahi Bishop Museum, Honolulu. Hawaii Islands.

Mexico.

Instituto Geologico de Mexico, Mexico.
Sociedad Cientifica.

ASIA.

India.

Director Agricultural Institute, Pusa, Bengal.
Board of Scientific Advice for India, Calcutta.
Director Geological Survey of India, Calcutta.
Superintendent of Govt. Printing, Calcutta.

Java.

Department van Landbrouw.

Philippine Islands.

Librarian Bureau of Science, Manilla.

AUSTRALASIA AND NEW ZEALAND.

New Zealand.

Auckland Institute, Auckland.
Dominion Laboratory, Wellington.
Geological Survey of New Zealand, Wellington.
New Zealand Institute, Wellington.
New Zealand Board of Science and Art.

Queensland.

Department of Mines, Brisbane.
Geological Survey of Queensland.
Queensland Museum, Brisbane.

New South Wales.

Australian Museum, Sydney.
Consul-General for the Czecho-Slovakia Republic, Sydney.
Director of Botanic Gardens, Sydney.
Department of Agriculture, Sydney.
Geological Survey of N.S.W., Sydney.
Linnean Society of N.S.W., Sydney.
Naturalists' Society of N.S.W., Sydney.
Royal Society of N.S.W., Sydney.
University of Sydney.

South Australia.

Geological Survey of South Australia, Adelaide.
Public Library of S. Australia, Adelaide.
Royal Geographical Society, Adelaide.
Royal Society of S. Australia, Adelaide.

Tasmania.

Geological Survey of Tasmania, Hobart.
National Park Board.
Royal Society of Tasmania.
University of Tasmania.

Victoria.

Advisory Council Science and Industry, Melbourne.
Australasian Institute of Mining Engineers, Swanston St., Melbourne.
Commonwealth Statistician, Melbourne.
Department of Agriculture of Victoria, Melbourne.

Department of Fisheries, Commonwealth, Melbourne.
Department of Mines.
Field Naturalists' Club of Victoria, Melbourne.
Royal Society of Victoria, Melbourne.
Scientific Australian, Melbourne.

WESTERN AUSTRALIA.
Geological Survey of W. Australia, Perth.
Royal Society of W. Australia, Perth.

EUROPE.

BELGIUM.
Société Royale de Botanique de Belgique.

ENGLAND.
Cambridge Philosophical Society, Cambridge.
Cambridge University Press, Cambridge.
Conchological Society, Blackpool.
Imperial Institute, S. Kensington, London.
Literary and Philosophical Society, Manchester.
Royal Botanic Gardens, Kew, London.
Royal Colonial Institute, London.
Royal Society of London.

FRANCE.
Le Prince Bonaparte, Paris.

ITALY.
Rassenga Monsile di Botanica, Catania.
Società Africana d'Italia, Naples.
Società Toscana de Scienze Naturale, Pisa.

PORTUGAL.
Academia Polytechnica, Porto.

SCOTLAND.
Royal Botanic Gardens, Edinburgh.
Royal Society of Edinburgh.

SPAIN.
Academia Real de Ciencias, Madrid.
Academia Real dell Ciencias y Artes, Barcelona.

SWEDEN.
Geological Institute, University of Upsala.

SWITZERLAND.
Naturforschende Gesellschaft, Zürich.
Sociètè de Physique et d'Histoire, Geneva.

List of Members.

CORRESPONDING MEMBERS.

‡ Danes, Dr. J. V.	Consulate-General for Czecho-Slovakia, Sydney.
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