AUSTRALASIAN SIMULIIDAE.

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Introduction.

On coming to New Zealand with the object of studying Diptera in general, I was asked by Professor Easterfield and Dr. R. J. Tillyard, of the Cawthron Institute, to direct my attention specially to the very aggressive " sandflies " of this country, and to try to gather as many facts as possible concerning their biology, which could eventually serve as a basis for a possible control of this pest.

I made, therefore, as many observations as I could during the summer of 1921–22 in the South Island of New Zealand, and these were continued in the North Island during a part of the summer of the following year. During this same summer, in the course of a sojourn of four months in Tasmania and the Australian mainland (parts of which I had previously visited), I had the opportunity of collecting, breeding and studying a fair number of species.

These investigations prove that, although not much was known concerning the SIMULIIDAE of the Australasian region, they are quite as numerous as in other parts of the world, both in the number of species and in the number of individuals.

In such a relatively short space of time I am, of course, far from having exhausted the question ; it is probable that more species are awaiting discovery, and that many more facts about their biology have yet to be brought to light. However, I think it is worth while publishing the results obtained so far, as they will help to clear the ground and give a basis for further study of these interesting Diptera. Twenty-one species are dealt with in this paper, of which fifteen are new, and the early stages of a good number have been studied in all their phases.

I am very much indebted to Dr. E. Ferguson, of Sydney, for the loan of specimens from New South Wales, to Mr. A. Musgrave and Mr. J. A. Nicholson for the loan of paratypes of Skuse's species, to Mr. A. Philpott and his friends, Messrs. R. Murrell, C. C. Fenwick and G. Jaquiery, who procured me New Zealand specimens from localities I had no opportunity of visiting myself, and to Mr. G. Archey for lending me specimens from Capt. Hutton's collection in the Canterbury Museum. My best thanks are due also to Mrs. M. Bisley and Mr. A. Philpott for reading through the text of this paper.

Localities Visited.—In the South Island, the neighbourhood of Nelson, which has been my place of residence, has been specially investigated ; then the West Coast as far down as the Waiho River ; along the road from Greymouth to Christchurch by way of the Otira Gorge and up the East Coast from Christchurch. Further material has been received from Dunedin, Central Otago, Invercargill and the Sounds District.

In the North Island, the Waitakerei Ranges north of Auckland and the vicinity of that town ; Te Aroha and the volcanic district near Rotorua and Wairakei ; Ohakune ; and Wellington.

In New South Wales : Narara, near Gosford, and Woy Woy. In the Blue Mountains, Wentworth Falls and Mt. Wilson. The material received from Dr. Ferguson contained also specimens from Canoblas, Bumberry, Dawson River and Sydney.

In Queensland : Eidsvold (coll. Ferguson).

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In Victoria : Fern Tree Gully and Sassafras on Mt. Dandenong.

In South Australia : Mt. Lofty (coll. Ferguson).

In Tasmania : An extensive portion of this island has been covered, the chief localities visited being the vicinity of Hobart and Mt. Wellington, Geeveston, the Hartz Mountains, the Tasman Peninsula, Bruny Island, the National Park and Mt. Field, the vicinity of Launceston, St. Patrick River, Burnie, Cradle Valley and different spots on the West Coast : King River, Mt. Farrel, Strahan, etc.

Historical.

Hitherto six species of SIMULIIDAE from Australasia have been described. First, in 1869, Schiner, in his report on the Diptera collected by the frigate "Novara" during her voyage round the world, mentioned one species under the name of *Simulia australensis*.* The very short and inadequate description was made from two rather defective female specimens collected near Auckland (N.Z.) and still preserved in the collection of the Vienna Museum. The same species is mentioned again by Hutton in his catalogue of New Zealand Diptera† under the wrongly modified name, *S. australiensis*, where he gives a simple translation of Schiner's description, but in his diagnosis of the genus he counts 11 joints in the antennae, although no New Zealand species has more than 10. In 1881 Mik described a second species under the name of *Simulium vexans*,‡ collected in the Auckland Islands, which are part of the New Zealand territory ; this form was as poorly described as that of Schiner, but seems to differ from it by the colouring of the legs.

In Australia Skuse found two species which he described under the names of *Simulium furiosum*§ and *S. ornatipes*.‖ These two forms are rather well described, and the types are still in the Sydney Museum and the Macleay collection. In an account of the known Dipterous fauna of Australia Skuse mentions erroneously one species of *Simulium* under the name of *molestum*,¶ meaning probably *S. furiosum*. He does not mention their blood-sucking habit, though the name he gave to the latter species undoubtedly suggests it.

Somewhat later G. V. Hudson, in his Manual of New Zealand Entomology (1892), gives under the heading of the family TIPULIDAE (?) an account of the life-history of a species that he assumed to be *Simulium australense*, but which might be any one of the six species of the country, his description of the early stages being too vague and his drawings not quite accurate. Besides, some errors have crept into the account ; the larvae are not, as he says, provided with two pairs of suckers, and they do not breathe through hind spiracles ; in fact, they do not differ from the forms found elsewhere except in very slight details of structure. The breathing organ of the pupa (Pl. vi, fig. 1*a*), if accurate, is of a type unknown to me, so that I am at a loss to say which species Hudson had before him when he made his description and drawings.

A few years afterwards Prof. P. Marshall returned to the question of the New Zealand sandfly.** His account of the life-history of *Simulium australense* is taken mostly from Hudson ; among the few original remarks two must be pointed out as not being true to fact ; the larvae are not carnivorous, and they do not make any discrimination in their food, simply swallowing what is caught in their mouth-fans.

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*Reise der Oesterreichen Fregatte Novara um die Erde. Zoolog. Theil., Band II. 1ste Abt. p. 15, 1868.

† Catalogues of the New Zealand Diptera, Orthoptera, Hymenoptera. Wellington, 1881, p. 19.

‡ Verh. zool. bot. Ges. Wien, xxxi, 1881, p. 201.

§ Proc. Linn. Soc. N.S.W. (2) iii, 1889, p. 1365.

‖ Ibid. v, 1890, p. 632.

¶ Rept. Second Meeting Austr. Assoc. Adv. Science, 1890, p. 528.

** Trans. N.Z. Inst., xxviii, 1895, p. 310.

Further he says : " A cocoon is formed before pupation of membranous or gelatinous material *which is afterwards eaten almost entirely.*" By what—by the pupa or the imago? Neither of them could do it, for they lack the adequate mouth-parts. His description of the adult fly is only a translation of the one by Schiner. However, after the diagnosis of the genus *Simulium* he mentions specially that *S. australense* differs by the number of antennal joints, which is 10 instead of 11.

In his report on a small collection of Diptera from the Southern Islands of New Zealand,* Capt. Hutton gives a translation of Mik's description of *S. vexans*, which species he himself collected in the Auckland Islands, and he notes that it is different from *S. australense.*

In 1906 E. Roubaud described a new species from Victoria† that was in the collection of the British Museum. As this approximately accurate description is based on the female sex only, and as the early stages are not yet known, it is difficult to be sure if this is a good species ; the females, and sometimes the males also, of most of the Australian species being so little different from each other, the description could apply to *S. furiosum.*

Under the curious heading " Phlebotomic Diptera "‡ F. H. Taylor describes a species, *S. bancrofti*, which is reported to bite man.

This was the extent of our knowledge of the Australasian SIMULIIDAE when I started their study at the end of 1921. Since then I have published a note§ on the manner in which the larvae progress and fix themselves to their supports, and how one of the New Zealand species builds its cocoon.

Bionomics.

The eggs of only one species were observed and hatched out. I refer them to *A. tillyardi*, sp.n., a New Zealand species which breeds mostly on river shingle. These eggs were found at the beginning of the spring (September) on the lower side of a good-sized stone at a depth of four inches of water ; the egg-batches were disposed on the stone in more or less rectangular plates of about 7 by 4 mm. ; the recently laid batches were yellow in colour, the oldest dark ochraceous ; they consisted of a single layer of eggs placed very regularly one beside the other, and all united and fixed to the stone by a transparent gelatinous mass. Each egg is more or less oval in shape, somewhat flattened and with a hump on one side which makes it appear triangular when seen on its broader face, the angles being, of course, very much rounded ; its dimensions are 0·126 by 0·189 mm. All the eggs hatched fourteen days after they had been collected. The hatching out of the young larva takes place through a slit that extends from the apex of the lateral hump to the narrower end of the egg.

The newly hatched larva differs but little from the full-grown one and behaves in exactly the same way as regards displacement and feeding. I have recently given an account of the manner in which the larva moves about and fixes itself to the stones or plants on which it lives. The attachment is effected, not by means of suckers as was supposed, but by means of a glutinous matter that the larva deposits on the crown of hooks at the end of its body each time it changes its place ; and this is probably true also for the species in other parts of the world. When the larva is moulting, the skin breaks round the neck and the detached old head-capsule is carried away by the current. The larva then fixes its head on the support, and simply walks out of its old skin.

* Trans. & Proc. N.Z. Inst. 1901, xxxiv, p. 169.
† Bull. Mus. Hist. nat. Paris, vii, p. 521.
‡ Austr. Zoologist, i, pt. 6, p. 167.
§ Ann. Biol. lac., Bruxelles, 1922.

Simuliid larvae are to be found either on stones or on aquatic plants, according to the species, but only where the speed of the current is about one foot per second. Some species thrive only in the rush of a waterfall or in the rapids of a river; but the larvae in their early stages do not seem to require such a strong current.

The lapidicolous species select in preference a clean stone without moss growth and seem to have a predilection for lighter-coloured stones.

The water cress (*Nasturtium officinale*) is a plant usually chosen by the herbicolous species as a support, and they generally fix themselves on the underside of the leaves; some aquatic grasses, the long blades of which are waving continuously under the action of the current, provide one of their favourite haunts; so, also, do the blades of ordinary grass or even the twigs of trees like weeping willows that dip into the water on the edge of the stream. Sometimes the larvae content themselves with dead leaves or bits of dead reeds and wood caught between the stones of a cascade.

Some herbicolous species do not seem to be able to adapt themselves to living on stones, at least I never happened to find them in such situations; but the contrary is not true, as some species that live on stones may occasionally be found on aquatic plants. The lapidicolous or herbicolous habit of the larvae is the great factor, together with the speed of the current, which influences the distribution of the species.

Most of the large streams of New Zealand and Tasmania have a rocky or shingly bottom without any aquatic vegetation; it is therefore almost exclusively in the small streams and rivulets that the herbicolous species are met with.

The larvae of SIMULIIDAE may be found all the year round in the streams and rivers of Australasia; they overwinter in that stage, but where the winter is mild enough, they go on breeding during that season. However, the relative scarcity of pupae found then shows that there is a serious retardation in their life-cycle.

During the warmest months these larvae are seen in innumerable quantities, especially the species living on stones, on which they are usually very regularly disposed; this arrangement is due to the fact that no larva tolerates one of its congeners in its immediate vicinity, and sweeps away with its head all that come within its reach. When an intruder settles within range of another larva, a fight takes place which may last quite a long time, each larva trying to make its opponent release its hold on the stone, chiefly by pinching it near the extremity of the body until the weaker one retreats.

The feeding of the larva is quite passive, and there seems to be no discrimination made in its food, which consists mainly of the miscellaneous particles in suspension in the water. When feeding, the larva remains motionless but for the vibrations caused by the action of the current; the body is so twisted that its ventral side is oriented dorsally in its anterior part; the mouth-brushes, being thus kept wide open by the current, retain all the particles that happen to run into them; then from time to time the fans are closed and cleaned with the mandibles, the whole catch being swallowed.

The duration of the whole life-cycle varies with the season. In New Zealand species, which have been watched closely, it appears to be on an average 6–7 weeks during the summer months, about 12 days being passed in the pupal stage. The number of larval moults has not been definitely ascertained, but it is certainly not less than four.

When ready to pupate the larva usually selects some sheltered spot, some hollow or crevice, or the underside of the stone. It seems then to show some sign of negative phototropism, but remains preferably where the current is strong. The larvae living on plants nearly always go on the underside of the leaves to pupate, but those fixed on the round stems of aquatic grass build their cocoons on the same spot where they have probably spent their whole life.

I have already described in detail the construction of the cocoon of one New Zealand species.* Since then some observations have been made on another species, the method of which differs noticeably, the cocoon being completely closed and only opened subsequently in front by means of the breathing organs of the pupa, which revolves several times on itself after metamorphosis. In such species as *Austrosimulium torrentium*, the cocoons of which are quite flat, and in others that are provided with one or two anterior projections, the method of building must differ considerably, and an exact account of their construction should prove highly interesting.

The time of day favoured by the larva for the building of the cocoon is about midday, during the warmest hours, and the emergence of the adults usually takes place about the same time.

When imagines are obtained from pupae by breeding, approximately equal numbers of males and females are observed to emerge, but in nature they are not met with in equal numbers. It is true that owing to the fact that the males are not bloodsuckers they are not attracted to man, but even when searching for them, with the exception of one or two species, they are always hard to find, and in some cases are never encountered. For instance, as regards New Zealand species, I have never found a single male in sweeping with the net on grass or plants along streams, although the females were frequent in such situations. All the males I have in my collection were obtained from pupae. Their life is not specially short, as I succeeded in keeping alive some of the bred specimens for two days ; therefore I think it very probable that they fly very high up immediately after emergence, and swarm and dance in the air out of the observer's reach, resting only on the tree-tops. The females are only on the wing during the day, their greatest activity being during the warmest hours, or before and after rain when the air is saturated with moisture. During the summer they are active after sunset in the twilight, but not during the night, even if it be a clear one. In New Zealand they are often observed in houses, provided that the rooms are not too dark ; they are never found in dense bush, but only on the edges, in the clearings and in large open spaces ; they sometimes wander very far from their breeding places and frequent preferably the banks of lakes, sea-beaches, or the high tussock plateaux up to 4,000–4,500 feet, which seems to be the altitude limit of their habitat. In New Zealand (and to a certain extent in Tasmania also) there is no open place where one can sit without being the object of their attacks at all times of the year in places where the winter is somewhat mild. All the New Zealand species may not be blood-suckers ; it happened once that when I was collecting larvae and pupae of a species (*A. multicorne*) in a small stream on the Mt. Arthur plateau (4,000 ft.), the adults were flying round me in great numbers ; several alighted on my bare arms but did not attempt to bite, although I gave them every opportunity of doing so ; the only specimen that did, when captured, proved to belong to another species, *Austrosimulium ungulatum*. In similar circumstances, when collecting the early stages of *A. laticorne* in South Westland, all the specimens captured in the act of biting were *A. ungulatum*, although the adults of the former must have also been about on account of the great number of hatched pupae. However, *A. ungulatum* is not the only New Zealand species which bites man, as many specimens were caught in the act of biting which belonged to the group with simple claws ; unfortunately I have been unable so far to differentiate them in the adult stage, and am therefore at a loss to discriminate between the biting and non-biting species of that group.

During the breeding experiments that I have been carrying out at the Cawthron Institute, I had an aquarium cage in which the emerged flies could sojourn in a rather large, well-aerated space ; but they never attempted to bite my arm, which I used to introduce into the cage through a sleeve, whatever length of time I left it in at

* Ann. Biol. lac. 1922.

any hour of the day ; the species in this case was *A. tillyardi*. However, I do not consider this fact conclusive, because it is well known that some biting insects, when kept in captivity, cannot be induced to bite. Another experiment was carried on with *A. australense* ; the flies emerging were set free in the laboratory, and although they were sometimes quite numerous on the window-panes, they did not attempt to bite me ; but in this case also the conditions were not quite normal. On the other hand, this same species was the only one I found in the river at Te Aroha in the vicinity of which the adults were very troublesome.

The literature contains the record of only one biting species in Australia, *A. bancrofti*, Taylor, although, as already stated, the name given by Skuse to another species, *A. furiosum*, seems to suggest a blood-sucking habit that he does not mention otherwise. No doubt can exist that a certain number of other species are also blood-suckers ; Dr. Ferguson's collection contained specimens of two, *S. terebrans*, sp.n. and *S. fergusoni*, sp.n., which were labelled " biting man," both coming from New South Wales ; and I was bitten myself by *S. terebrans* in Victoria. However, except perhaps in Queensland, whence I have no record, the species of SIMULIIDAE of the Australian mainland are not conspicuous by their thirst for human blood ; and the name of " sandflies " is there bestowed on some species of CERATOPOGONINAE. On the other hand, the flies known in Tasmania under that name are SIMULIIDAE and are said to be exceedingly troublesome in some parts, especially where *S. torrentium* lives. I was never bitten myself there, although engaged in researches on these flies, and therefore very often in places where they could be found and observed easily. On several occasions I collected specimens of *A. tasmaniense*, which were flying about my face and hands, but without making any attempt to bite. It is true that the summer I spent in Tasmania was so chilly and wet that my observations were not made under normal conditions, and so cannot be considered conclusive.

The geographical distribution of the species is a question that could only be adequately attempted with some degree of accuracy after many years of research ; consequently the following lines profess to give only a few general observations on the subject. Only two genera are considered in this paper, the world-wide *Simulium*, and a new one, *Austrosimulium*, which seems to be found only in the Indo-Australian region. The genus *Simulium* does not occur in New Zealand. Up to now no species have been found to be common to Australia and New Zealand, but a curious parallelism exists between the SIMULIIDAE of this latter country and those of Tasmania. In both countries about half a dozen species of *Austrosimulium* occur, which, except for one species in each case with toothed-clawed females, are practically indistinguishable from each other in the adult stage, whereas their pupal stages are easily distinguishable by the peculiarity of structure of the breathing organs, or often also by the conformation of the cocoon. However, in New Zealand the majority of the species are herbicolous, whereas in Tasmania they are lapidicolous. None is common to both countries. On account of this difficulty of distinguishing the species in the imaginal stage, the study of the geographical distribution of the SIMULIIDAE should be preferably based on the pupae, which are readily found in the streams, or on the larvae in their last stage, when they show the pupal breathing organ already sufficiently developed.

In New Zealand there are species that have not yet been found in the North Island ; these are *A. ungulatum* and *A. laticorne*, whereas all the known species inhabit the South Island (with the exception of *A. vexans*, peculiar to the Subantarctic Islands), but *S. australense* has not yet been found further south than the Kaikoura district. In a general way one can say that *S. australense* is the prevalent species in the North Island, whereas *A. ungulatum* is the prevalent one in the South Island.

Regarding Australia, it is more difficult to give accurate data on the distribution of species, so little being yet known about them. *S. aurantiacum* and *A. cornutum* have a range from New South Wales to Tasmania ; *A. crassipes* and *S. umbratorum*

have been found so far only in Victoria ; *S. fergusoni* and *S. ornatipes* only in New South Wales ; *S. bancrofti* only in Queensland ; whereas *S. terebrans* is common to Victoria and New South Wales, and *A. cornutum* to Victoria and Tasmania. The distribution of the Tasmanian species has been somewhat more closely surveyed. All the six species but one found there up to now seem to be peculiar to the island ; *A. tasmaniense* is the prevalent one and is recorded from all parts of the country and at all levels ; *A. cornutum* and *S. aurantiacum* are also widespread but rather uncommon ; this last is limited to the spots where the current of water is fast enough to suit the requirements of its larva. *A. torrentium* has only been found in the north, north-west and centre ; *A. weindorferi* in the centre and *A. simile* in the south.

Several species are, of course, often found in association, and I give hereafter a few of the observations I made on this point based on the pupae collected in the same spots.

In New Zealand :—

1. *A. australense, A. tillyardi*—Poor Man's Creek, Nelson.
2. *A. tillyardi, A. laticorne*—Maitai, Nelson.
3. *A. australense, A. longicorne, A. multicorne*—Ohakune.
4. *A. longicorne, A. australense*—Kaikoura.
5. *A. laticorne, A. multicorne, A. longicorne*—Waiho, large stream.
6. *A. laticorne, A. multicorne*—Waiho, small creek.

In Tasmania :—

1. *A. cornutum, A. tasmaniense*—St. Patrick River, small creek.
2. *A. tasmaniense, A. torrentium*—St. Patrick River.
3. *A. simile, A. tasmaniense*—Geeveston, Brown River.
4. *A. simile, S. aurantiacum*—Adventure Bay.
5. *A. cornutum, A. tasmaniense, S. aurantiacum*—Russell Fall and Crater Creek, Cradle Mt.
6. *A. torrentium, S. aurantiacum*—Mt. Farrel.
7. *A. weindorferi, A. tasmaniense, A. torrentium*—creek, Lake Lilla, Cradle Mt.

Adults.

With two or three exceptions the Australasian SIMULIIDAE do not present very well marked characters of differentiation between the species. First of all, their coloration is uniformly blackish grey in all parts of the body, only a couple of species showing some orange colouring on some parts of the legs, and another species being mostly bright orange. In the males the mesonotum is velvety black without bright silvery markings, as in holarctic species, and carries a golden, bronzy or sometimes brown, short pubescence, usually moderately dense ; in the females the notum is blackish grey with a uniform yellowish or silvery pubescence ; in one species only this pubescence is bi-coloured and disposed in bands. The anterior part of the pleurae is nearly always more or less silvery grey and more distinctly so in the males. The halteres are usually whitish, but sometimes also orange or brownish, according to the species. The conformation of the head in the males is the same throughout the species ; there is no gradual transition between the large-facetted region of the eyes and the small-facetted region, the limit between them being a horizontal line at the level of the base of the antennae. In the female the frons is more or less wide accord-

ing to species, and its sides are either parallel or divergent ; it presents sometimes a more or less well-marked median longitudinal furrow.

The antennae are either eleven or ten-jointed, these numbers being the same in both sexes of a given species ; the relative length of the different joints is often of some taxonomic importance ; in the males the third joint is always relatively longer than in the females, and so is the second in most cases ; in both sexes the fourth is small, whereas the following ones usually increase in length towards the extremity of the antennae ; the last joint is always more or less elongated with its extremity tapering in an ogive.

The palpi are composed of five joints, the relative lengths of which afford sometimes a good specific character ; the third joint, which carries an internal sense organ, is more or less incrassate and somewhat flattened laterally, especially in the female ; the fourth is always a little produced on the internal distal end, which overlaps the base of the fifth ; this one is usually thinner and longer than the others ; sometimes it is more or less club-shaped ; there seems to be no sexual dimorphism in the structure of the palpi.

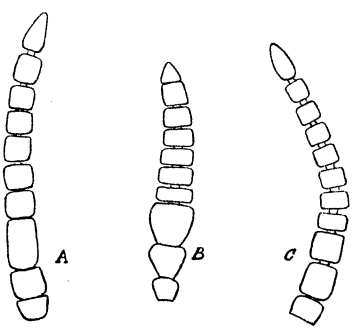

Fig. 1. Antennae of (A) *Austrosimulium tasmaniense*, sp. n. ; (B) *A. bancrofti*, Tayl. ; (C) *Simulium umbratorum*, sp. n.

The mouth-parts are more developed in the female, but are composed of the same parts in both sexes ; however, the labium of the male does not carry at its tip the two small groups of teeth which are to be found in the female ; on the other hand, although not a bloodsucker, its mandibles are relatively just as well developed, as are the galea, which are also delicately serrated on their edges ; the lacinia is not present in either sex.*

The vestiture of the head is little conspicuous, the face and frons carrying only a few mostly yellowish hairs and the vertex some black bristly hairs ; sometimes in the female the rather long hairs of the occiput are extremely dense.

The hairs of the mesonotum are short, adpressed, of a metallic nature and of uniform length, at least on the disk, those around the shoulders, on the sides and in front of the scutellum being sometimes longer ; the space in front of the scutellum carries besides some longer black hairs like those that are to be found on the edge of the scutellum.

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* What A. Peterson (Illin. Biol. Mon. iii, no. 2) describes as the lacinia in *Simulium* seems to be not a true appendage but a chitinous rod imbedded in the integuments and uniting the base of the palpi with the base of the hypopharynx.

The anterior legs of all the Australasian species are thin, neither the tibiae nor the tarsi being flattened or incrassate; the front tarsi are noticeably longer than the corresponding tibiae, whereas in the middle legs they are subequal to their tibiae; this difference is a little more marked in the male. The best taxonomic characters are given by the hind legs, which are conspicuously stouter and longer than the anterior ones, their metatarsi being always very elongated, nearly as long as the tibiae and always flattened; with one exception they are never wider than the tibiae; their distal end on their interior face is produced into a kind of flap, more or less developed and more or less wide according to the species; in some it is as wide as the metatarsus, but then there is always a notch more or less distinct dorsally at the base of this flap. The second joint of the hind tarsi presents nearly always an incision dorsally near its base in both sexes, but it is sometimes little marked.

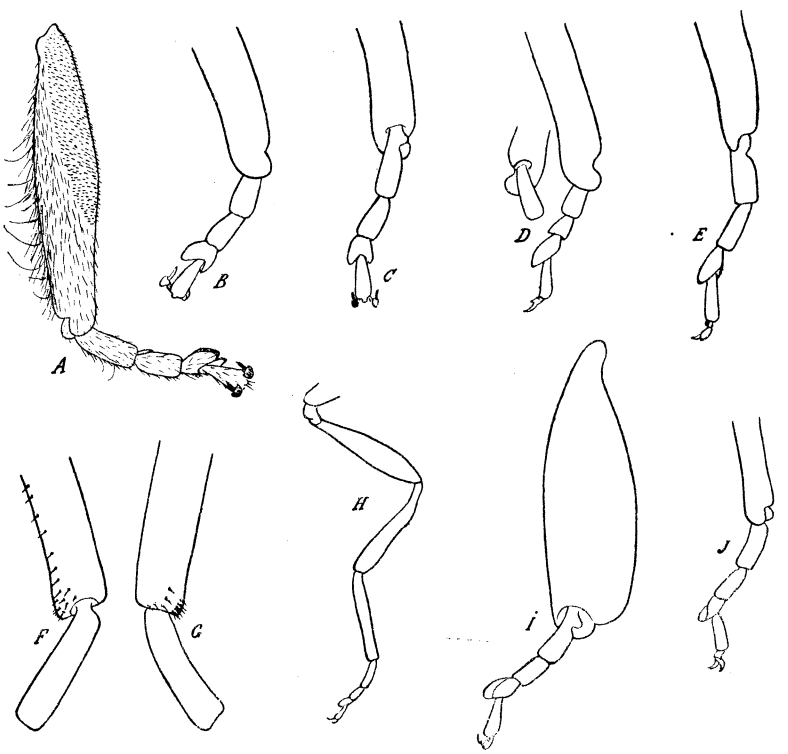

Fig. 2. Hind legs or metatarsi of (A) *Austrosimulium tasmaniense*, sp. n.; (B, C) *A. cornutum*, sp. n.; (D) *Simulium umbratorum*, sp. n.; (E) *S. ornatipes*, Skuse; (F. G. H) *S. fergusoni*, sp. n.; (I) *A. crassipes*, sp. n.; (J) *A. furiosum*, Skuse.

The claws of the female are either simple in the majority of cases or are provided with a large or small tooth. The claws of the male are similar all through the species; in some positions they may appear trifid, as mentioned by several authors for American or European species, but in fact they are provided at their base outwardly with a kind of striated chitinous cushion, the upper corners of which are toothlike (fig. 3, D, E). All the tibiae carry terminal spurs, one on the front pair and two on the posterior pairs, but sometimes one of these is so reduced that the tibiae seem at first sight to have only one terminal spur.

The abdomen is composed of the usual nine segments, the basal one being expanded at the sides in the form of lamellae carrying long tufts of hairs. In the female the tergites of the 3rd to 5th or 6th segments are reduced to rather small plates more or less chitinized.

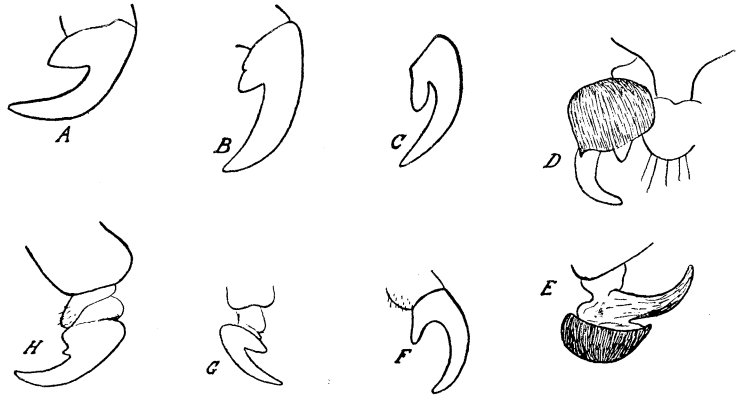

Fig. 3. Claws of (A) *Austrosimulium ungulatum*, sp. n. ♀; (B) *A. vexans*, Mik, ♀; (C) *Simulium aurantiacum*, sp. n. ♀; (D, E) *S. ornatipes*, Skuse, ♂; (F) *S. umbratorum*, sp. n. ♀; (G) *A. cornutum*, sp. n. ♀; (H) *A. terebrans*, sp. n. ♀.

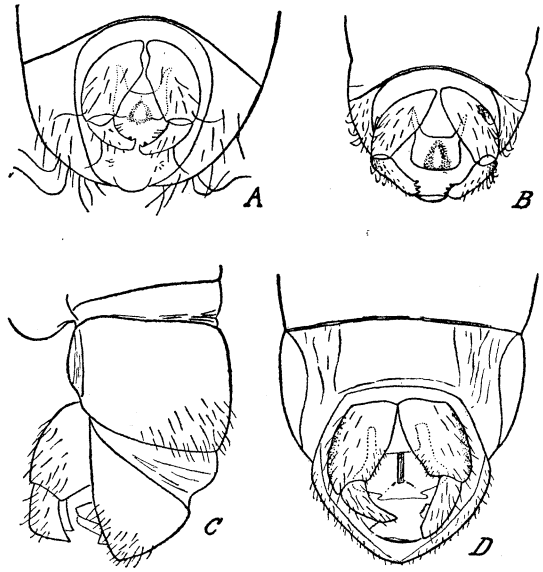

Fig. 4. Male hypopygia of (A) *Austrosimulium cornutum*, sp. n.; (B) *A. tasmaniense*, sp. n.; (C, D) *Simulium ornatipes*, Skuse.

The male genitalia are rather uniform in the shape of the side-pieces and claspers, which carry usually at their end two or three teeth, but this number does not seem to be constant in a given species, as sometimes one clasper is provided with two teeth

and the other with three ; the aedoeagus is also of rather uniform structure, but gives sometimes differentiating characters in cases where the claspers do not ; the little plates round the anus are useless for systematic purposes, as their conformation does not vary to any extent.

Larvae.

There is no essential difference between the morphology of the larvae of the Australasian SIMULIIDAE and those of the rest of the world, and, moreover, there are few characters for differentiating the Australasian species on which one can rely with certainty. Their coloration, generally of a greenish grey often variegated with blackish, does not seem constant in some species, which present sometimes melanic larvae. The black markings on the head-capsule are also rather variable in a given species ; in a well-marked specimen there is usually a median darkish line on the prefrons from the posterior border of the head to somewhat past its middle ; along

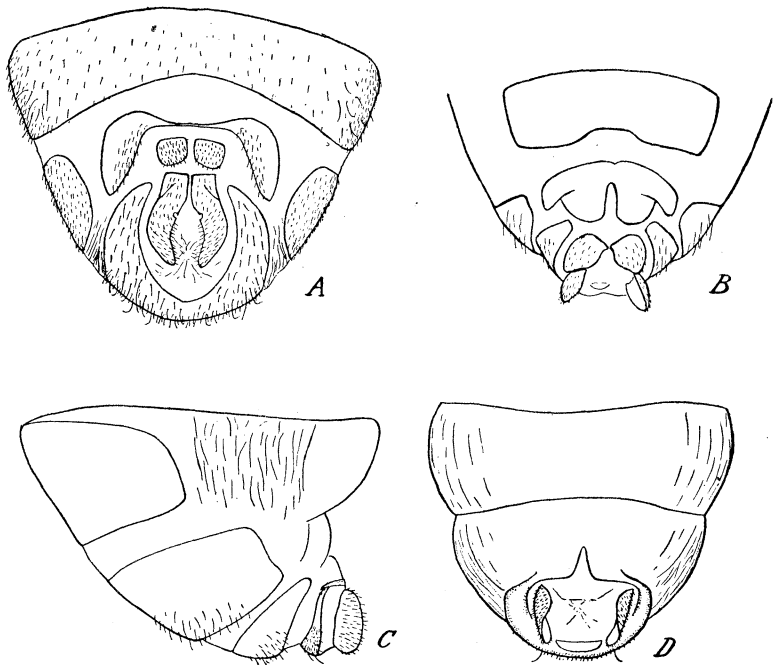

Fig. 5. Female genitalia of (A) *Simulium aurantiacum*, sp. n. ; (B) *Austrosimulium cornutum*, sp. n. ; (C. D) *S. ornatipes*, Skuse.

this line there are a few very shallow foveoles similar to those found also in the two smaller dark spots on either side of the middle of the median line ; there is also in some individuals a dark edge all round the base of the head-capsule, or else a general darkening of this capsule with the exception of the areas around the eyes, which are always formed of the two usual small black subcutaneous ocular spots.

The mouth-parts are absolutely uniform in their structure, only the disposition of the teeth of the mentum varies to some extent according to species (fig. 9), but

these teeth are always simple ; in all cases there is a larger median tooth and two large lateral ones ; the number of smaller teeth is variable, but in some groups of species the disposition is identical and the larvae cannot then be easily differentiated.

The antennae (fig. 8) are rather short ; in most cases they are about as long as the basal piece of the fan-like organ, and their relative length to that piece affords sometimes a specific character. In all known Australasian larvae the antennae are composed only of two joints ; the basal one is conico-cylindrical, whereas the terminal one is very slender, setiform, and of about the same length as the first ; the relative length of these two joints has very often a taxonomic importance. The last joint carries at its tip a diminutive sensitive cone.

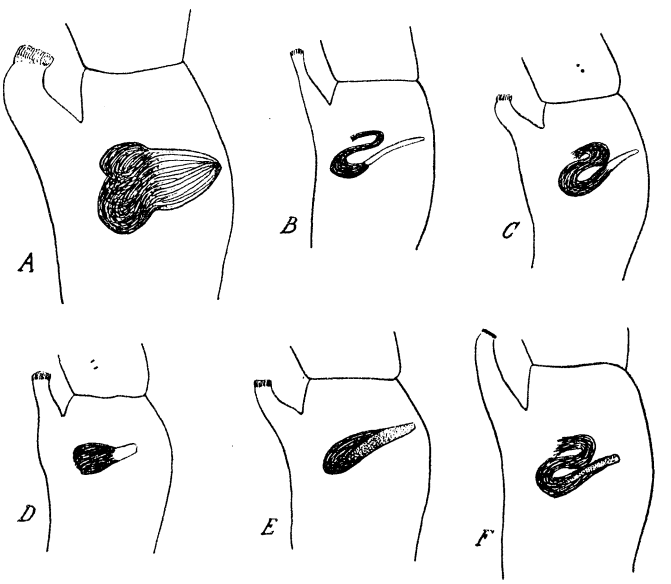

Fig. 6. Gill spots of larvae of (A) *Simulium aurantiacum*, sp. n. ; (B) *Austrosimulium simile*, sp. n. ; (C) *A. weindorferi*, sp. n. ; (D) *A. torrentium*, sp. n. ; (E) *A. tasmaniense*, sp. n. ; (F) *A. cornutum*, sp. n.

The anterior proleg and the segmentation of the body offer no clue whatever for identification. The thoracic spots of the completely mature larvae, which are formed by the pupal gills under the skin, offer, on the contrary, very often good characters of specific value. I give herewith (figs. 6, 7) the shape of this spot for each species, because in a colony one is almost always sure to find larvae in the last stage showing these spots, which afford means for a quick and sure identification, whereas the pupae are not always so readily found.

The anal gills, so far as they have been observed, are very uniform, being always composed of three subequal, simple digitations. The posterior crown of hooks is practically always composed of rows containing the same number of hooks, 12 to 15 ; in one case only this number is 35 to 40. The chitinous blackish armature (fig. 10) placed between the crown of hooks and the anus presents in some species a peculiar structure, especially on its dorsal part ; the branch it sends down on either side of the crown is sometimes straight, sometimes undulated, and ends bluntly or in a small fork ; in the case of all the New Zealand species there is a semicircular rod between

the end of each of these branches, so that here the armature makes the complete turn of the base of the crown of hooks. With one exception (*S. aurantiacum*), the two ventral papillae, placed a little above the posterior disk, are always present.

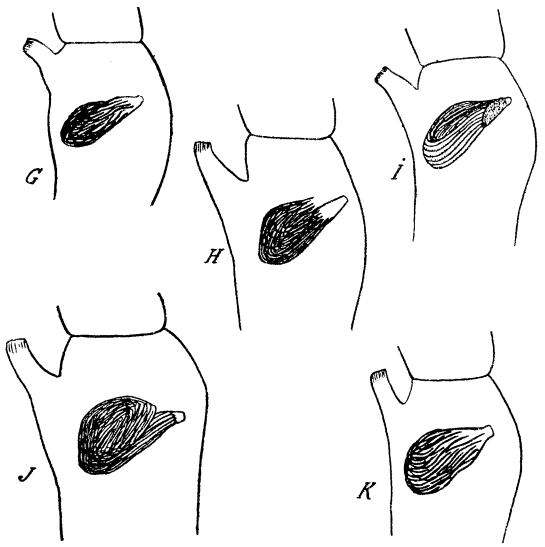

Fig. 7. Gill spots of larvae of (G) *Austrosimulium australense*, Schin. ; (H) *A. muiticorne*, sp. n. ; (I) *A. tillyardi*, sp. n. ; (J) *A. longicorne*, sp. n. ; (K) *A. laticorne*, sp. n.

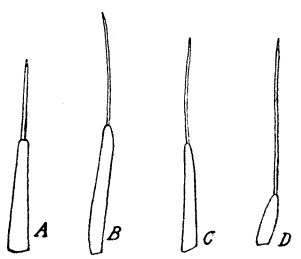

Fig. 8. Antennae of larvae of (A) *Simulium aurantiacum*, sp. n. ; (B) *Austrosimulium tasmaniense*, sp. n. ; (C) *A. weindorferi*, sp. n., ; (D) *A. australense*, Schin.

Pupae.

The shape and structure of the pupal breathing organs are very peculiar in each species as well as constant. In the species under consideration they are composed, with one exception, of a hard, chitinous, horn-like basal part more or less elongated, on which are inserted the breathing filaments ; this basal horn, which sometimes forms the most conspicuous part of the breathing organ, is either cylindrical or flattened, or spinulous at the end, or also spatulate, and when flattened the filaments may be inserted on its edge, on the whole surface or else on the tip only. The filaments vary very much in aspect according to their degree of thickness ; usually when they are thin they are also very flexible and float freely with the current ; on the contrary, when their diameter is larger they are also stiffer and their shape is not altered by the current ; in this latter case they are usually straight, but in some species they are

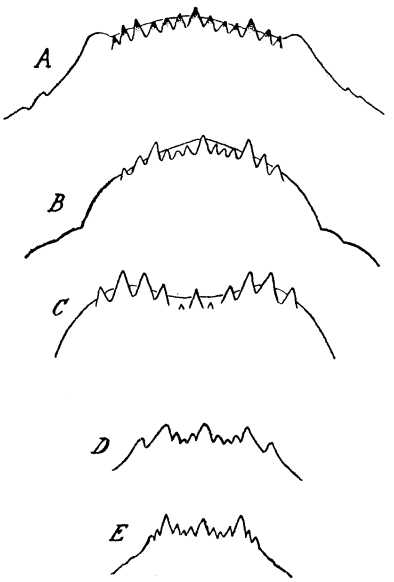

Fig. 9. Mentum of larvae of (A) *Austrosimulium tasmaniense*, sp. n. ; (B) *A. simile* ; (C) *A. cornutum*, sp. n ; (D) *Simulium aurantiacum*, sp. n. ; (E) *A. longicorne*, sp. n.

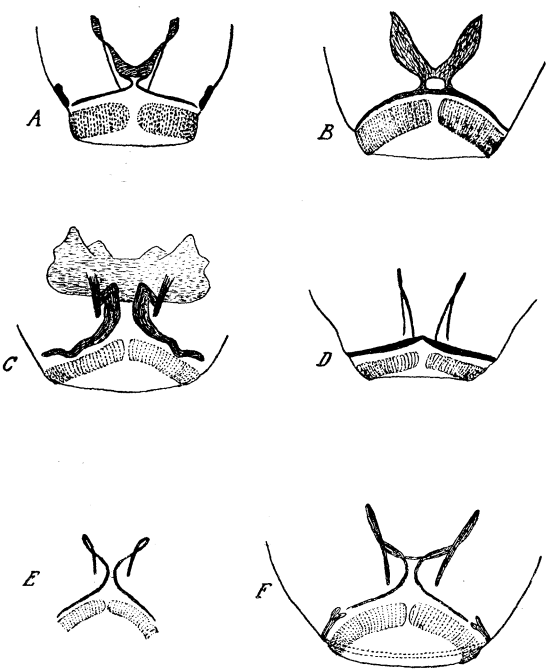

Fig. 10. Anal armature of larvae of (A) *Anstrosimulium australense*, Schin. ; (B) *Simulium aurantiacum*, sp. n. ; (C) *A. torrentium*, sp. n. ; (D) *A. tasmaniense*, sp. n. ; (E) *A. weindorferi*, sp. n. ; (F) *A. tillyardi*, sp. n.

completely curved backwards. These filaments are usually simple, in one case they are multi-branched (*S. aurantiacum*), and in some New Zealand species they are sometimes simply forked. The number of the filaments in each tuft varies greatly according to species from one dozen to about fifty, and their length in some cases is that of the pupal body, whereas in other cases it only reaches one-tenth of that length. Other features of the pupa are worthy of attention from a taxonomic point

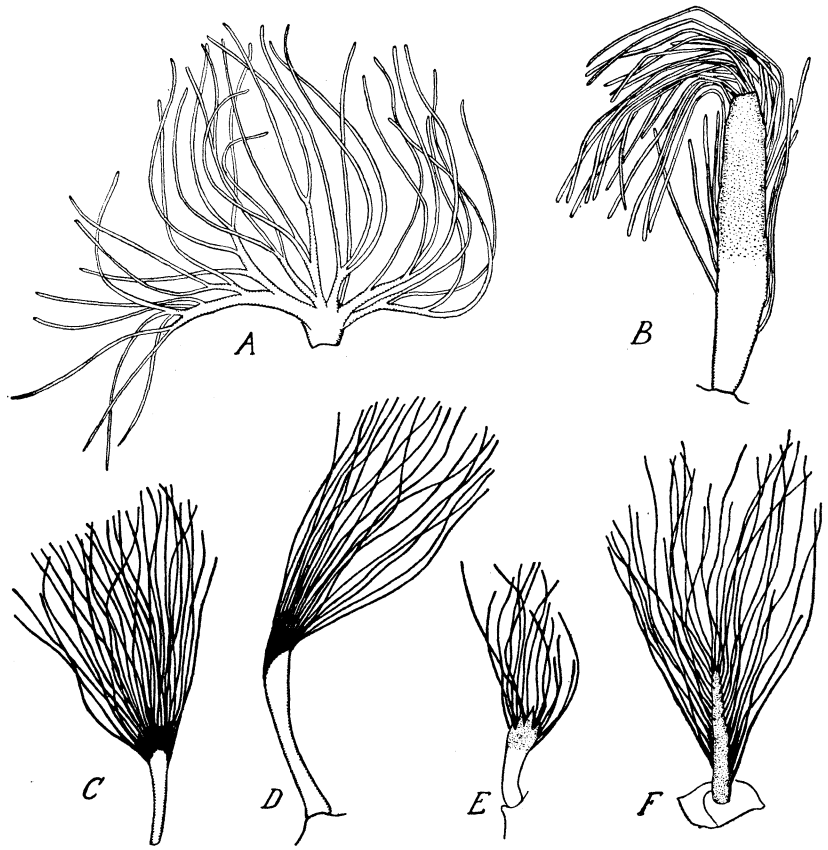

Fig. 11. Pupal gills of Australian species: (A) *Simulium aurantiacum*, sp. n.; (B) *Austrosimulium tasmaniense*, sp. n.; (C) *A. weindorferi*, sp. n.; (D) *A. simile*, sp. n.; (E) *A. torrentium*, sp. n.; (*F*) *A. cornutum*, sp. n.

of view; for instance, the integument of the dorsum of the thorax may be either smooth or granulated, and the head may present some small granulations and foveoles disposed in a peculiar way; the thorax carries usually a number of bristles either straight or hooked and sometimes strong little hooks, which serve to attach the pupa more firmly to the cocoon; also in some cases the small spines on the abdominal segments have to be taken into consideration.

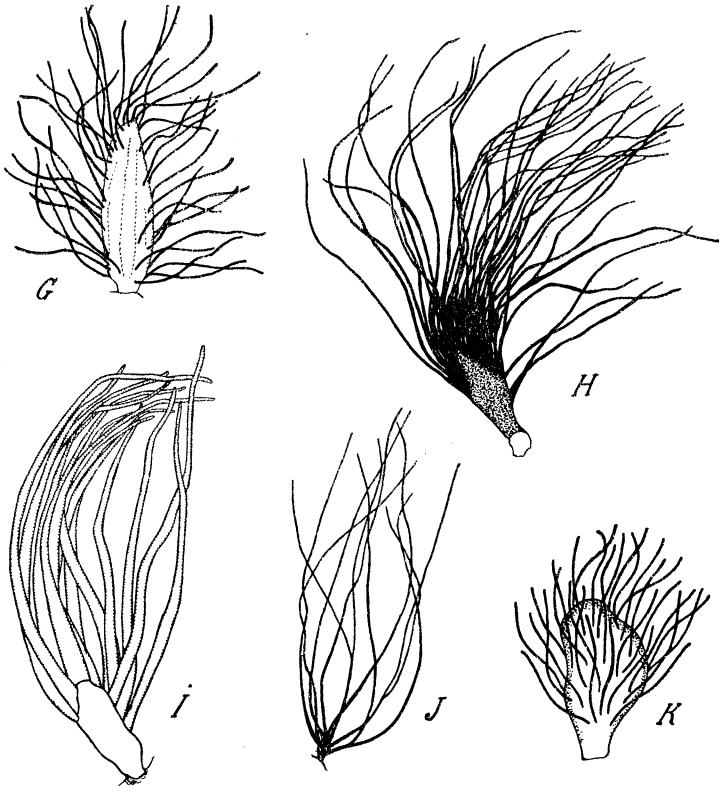

Fig. 12. Pupal gills of New Zealand species: 8(G) *Austrosimulium australense*, sp. n ; (H) *A. multicorne*, sp. n. ; (I) *A. tillyardi*, sp. n. ; (J) *A. longicorne*, sp. n. ; (K) *A. laticorne*, sp. n.

Cocoons.

In most cases the texture and shape of the cocoon afford a clue to the identity of the species. Its usual shape is that of a wall-pocket, more or less oval in shape, but sometimes it has a completely circular contour and is then much flattened ; in one case the pupa, instead of being enclosed in a cocoon, is lodged in a small excavation of the stone and is covered by a flat kind of lid with a round opening, leaving the head and a part of the thorax free. The size of the cocoon relatively to the pupa is not always the same ; the flat cocoons are much larger than the pupae, whereas the bag-shaped ones are closely adapted to the body of the pupa. In a given species there may be a certain amount of variation in the shape of the cocoon, which is due mainly to the nature of the base on which it is built ; for instance, the species with a roundish cocoon, when building it on a grass stem, have to make it much narrower, its shape being then very similar to the wall-pocket-shaped ones. In none of the Australian species known to me, with the exception of *S. aurantiacum*, is there a distinct cocoon-wall separating the ventral side of the pupa from the support ; in most cases the abdomen of the pupa is fixed to the support and to the cocoon by a few threads, but sometimes there is a beginning of a ventral wall in the inferior part of the cocoon, which forms there a pocket in which the tip of the abdomen of the pupa is lodged. The anterior opening of the cocoon is usually round, but in two instances it is provided on its rim dorsally with one or two long projections that, bending downwards, more or less protect the head or the breathing organs of the pupa. The texture of the

cocoon may be very smooth and uniform, no trace of thread whatever being visible ; it appears then as if made of a membranous matter ; this is, however, the exception, because usually some trace of the weaving is visible, and sometimes the texture of the cocoon is distinctly cellular and its outer surface rather rough. In rare instances the wall of the cocoon contains some foreign body interwoven with its silky material, like some filamentous algae or some bits of moss.

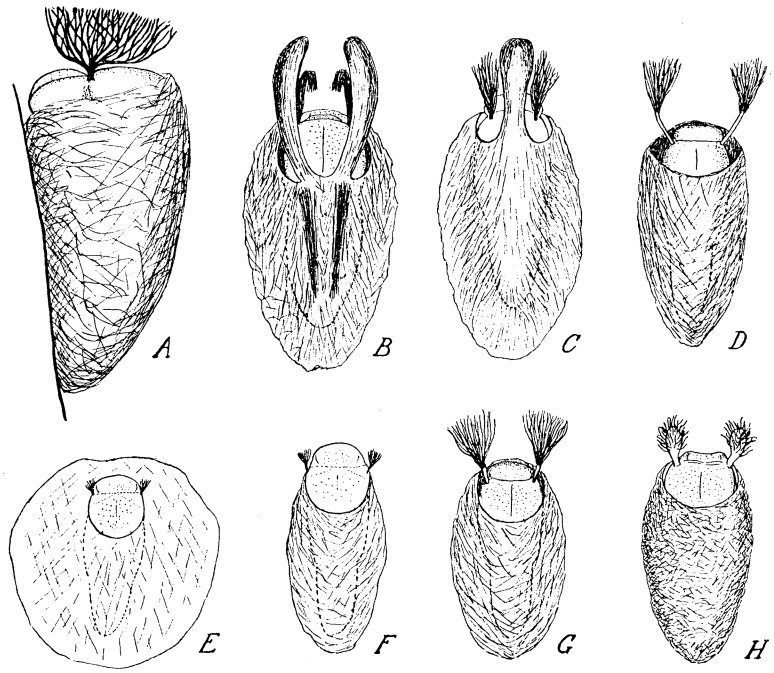

Fig. 13. Cocoons and pupae of (A) *Simulium aurantiacum*, sp. n. ; (B) *Austrosimulium tasmaniense*, sp. n. ; (C) *A. cornutum*, sp. n. ; (D) *A. simile*, sp. n. ; (E) *A. torrentium*, sp. n. ; (F) the same, narrow form ; (G) *A. weindorferi*, sp. n. ; (H) *A. laticorne*, sp. n.

Systematics.

Some time ago Dr. G. Enderlein* made a tentative effort to subdivide the old genus *Simulium* into a large number of genera. I think he failed to find the proper solution, our present knowledge of the world's species being still insufficient. Perhaps a subdivision into *Simulium* and *Prosimulium* would be advisable, if the generic character chosen for the latter be the forking of the radial sector, because the conformation of the hind tarsi as proposed by Roubaud does not afford a rational division, every degree of excision of the second joint being observable in the different species ; many would therefore remain of uncertain generic position.

As for Dr. Enderlein's other divisions, I do not propose to recognise them, because they seem to me quite unnatural, at least so far as the Australian species are concerned ; in fact, if one were to follow him they would have to be distributed in three or four of his genera, and thus some species be kept apart which are evidently very closely related. The shape of the female claws and their toothed condition are rather insecure characters, since all degrees of development of this tooth are to be found ; besides, the toothed claws occur or not in the species of *Prosimulium*, which

* Zool. Anzeig. liii, 1921, p. 43.

by their venation would otherwise form a rather compact group ; this shows that the condition of the claws must be considered as a secondary character.

All the Australian species belong to the group *Simulium*, the radial sector being simple, but they can be divided quite naturally into two subdivisions according to whether their antennae are either 11– or 10–jointed ; this character does not present any ambiguity.

For all species with 10–jointed antennae, which are the majority, I propose to erect the new genus *Austrosimulium*, the other species being left in the genus *Simulium*. The genotype of *Austrosimulium* is *S. australense*, Schin.

If Dr. Enderlein's excessive subdivisions were recognised, the species which I leave in the genus *Simulium* would have to go under his genera *Nevermannia* and *Wilhelmia*, whereas the species that I place in the new genus *Austrosimulium* would go in his genera *Cnetha*, *Nevermannia* and *Wilhelmia*.

I give hereafter tables for the adults, larvae and pupae, but they must be considered as only tentative, because certain data are still missing.

As regards the adults, the males of only 11 species out of 21 are known, and the female of one species is also unknown. On the other hand, the early stages of only nine species are known.

Table for the Adult Males.

1. Species with eleven-jointed antennae 2
   Species with ten-jointed antennae 3
2. Rather large species, mostly orange on thorax and appendages ; clasper with two teeth at the tip ... ... *S. aurantiacum*, sp. n., p. 234
   Smaller species of a velvety black coloration, the legs only with some parts orange ; clasper without teeth at the end ... *S. ornatipes*, Skuse, p. 232
3. Hind tibiae and metatarsi much swollen (fig. 2, I) *A. crassipes*, sp. n., p. 242
   Hind legs not very conspicuously swollen 4
4. Australian species 5
   New Zealand species 7
5. Distal internal lap of the hind metatarsus as wide as the metatarsus itself *A. cornutum*, sp. n., p. 243
   This lap only half as wide as the metatarsus 6
6. Third joint of the antennae nearly twice as long as wide ; larger species *A. tasmaniense*, sp. n., p. 245
   Third joint of antennae only very little longer than wide ; smaller species *A. torrentium*, sp. n., p. 247
   A. weindorferi, sp. n., p. 248
   A. simile, sp. n., p. 249
7. Pubescence of the mesonotum short, very dark bronzy, that of the rest of the body and legs also dark ... ... *A. australense*, Schin., p. 251
   Pubescence of the mesonotum longer, brassy yellow, that of the legs also lighter 8
8. Length of wing 2 mm. ... ... *A. tillyardi*, sp. n., p. 253
   A. laticorne, sp. n., p. 253
   Length of wing 2·5 mm. ... ... *A. longicorne*, sp. n., p. 254
   A. multicorne, sp. n., p. 254

Table for the Adult Females.

1. Species with eleven-jointed antennae 2
   Species with ten-jointed antennae 6
2. Large, nearly completely orange species ... *S. aurantiacum*, sp. n., p. 234
   Smaller, mostly blackish grey species 3

3. Distal end of the hind metatarsi without internal lap, and second tarsal joint not incised dorsally; claws toothless ... ... *S. fergusoni*, sp. n., p. 238
   Hind metatarsi with a distal internal lap 4
4. Tibiae orange in the middle; knees and part of the tarsi also orange; pubescence of the notum of two colours, forming longitudinal stripes; claws rather straight and with a conspicuous basal tooth *S. ornatipes*, Skuse, p. 232
   Legs brown or dark testaceous at most only lighter at the knees; pubescence of the thorax monochrome 5
5. Tarsal claws curved and with a conspicuous sharp tooth at the base; distal lap of hind metatarsi nearly as broad as the metatarsus; thorax partly ochraceous *S. umbratorum*, sp. n., p. 237
   Tarsal claws not much curved and with a very small tooth at their base; distal lap of hind metatarsi only half as wide as the metatarsus; thorax greyish brown ... ... *S. terebrans*, sp. n., p. 237
6. Australian species 7
   New Zealand species 10
7. Tarsal claws with a conspicuous tooth at base *A. cornutum*, sp. n., p. 243
   Tarsal claws simple 8
8. Base of antennae orange, their last joint scarcely as long as wide *A. bancrofti*, Taylor, p. 241
   Antennae completely brown, their last joint always distinctly longer than broad 9
9. Larger species, wing length 2·5 to 3 mm. ... *A. tasmaniense*, sp. n., p. 245
   A. victoriae, Roub., p. 240
   A. furiosum, Skuse, p. 239
   Smaller species, wing length 2 to 2·5 mm. *A. torrentium*, sp. n., p. 247
   A. weindorferi, sp. n., p. 248
   A. simile, sp. n., p. 249
10. Tarsal claws with a conspicuous tooth at the base 11
    Tarsal claws simple 12
11. Claws nearly straight, the basal tooth with a double blunt extremity; antennae completely dark ... ... *A. vexans*, Mik, p. 250
    Claws curved, the tooth larger and simple; base of third antennal joint red *A. ungulatum*, sp. n., p. 250
12. Larger species, wing 2·5 to 3 mm. ... ... *A. multicorne*, sp. n., p. 254
    A. longicorne, sp. n., p. 254
    Smaller species, wing 2 to 2·5 mm. ... ... *A. australense*, Schin, p. 251
    A. tillyardi, sp. n., p. 253
    A. laticorne, sp. n., p. 253

Table for the Larvae.

1. No ventral papillae near the posterior crown of hooks, the row of the latter with 30–40 hooks ... ... *S. aurantiacum*, p. 234
   Ventral papillae always present, the rows of the posterior crown containing 10 to 15 hooks 2
2. Antennae with the second joint about as long as the first; Australian species 3
   Antennae with the second joint from 1½ to 3 times as long as the first; New Zealand species 6
3. Indentation of the mentum as in fig. 9, C, with two large teeth on each side; gill spot showing the filaments curved in the form of an S *A. cornutum*, p. 243
   Indentation of the mentum as in fig. 9, B, with only one large tooth on each side 4
4. Anal chitinous armature issuing from a large basal plate (fig. 10, A); gill spot small, brush-shaped ... ... *A. torrentium*, p. 247
   Anal armature without basal plate 5
5. Anal armature as in fig. 10, D; gill spot club-shaped (fig. 6, E.) *A. tasmaniense*, p. 245

Anal armature as in fig. 10, E ; gill spot with the filaments curved in the form of an S (fig. 6, B) ... ... *A. simile*, p. 249
(fig. 6, C) *A. weindorferi*, p. 248
6. Antennae with the second joint less than twice as long as the first ... 7
The second joint twice or more than twice as long as the first 8
7. Gill spot showing the filament coiled in a spiral (fig. 7, J) *A. longicorne*, p. 254
Gill spot showing the filament simply curved (fig. 7, H) *A. multicorne*, p. 254
8. Second joint of antennae about twice as long as the first *A. laticorne*, p. 253
Second joint of antennae about three times as long as the first 9
9. Gill spot, fig. 7, G ... ... *A. australense*, p. 251
Gill spot, fig. 7, I ... ... *A. tillyardi*, p. 253

Table for the Pupae.

1. Breathing organ with filament branching several times and forming a rigid tuft ; cocoon in form of a cornet, its texture very rough *S. aurantiacum*, p. 234
Breathing organ with the filaments branching once at most 2
2. Breathing organ with a distinct basal horn on which are inserted the filaments 3
Filaments branching directly from a very short basal trunk ; cocoon wall-pocket-shaped, its texture smooth ... ... *A. longicorne*, p. 254
3. Cocoon with one or two projections inserted dorsally on the edge of the anterior opening 4
Cocoon without such projections 5
4. Cocoon with one projection ; breathing organ with 25 to 35 thin filaments forming a straight brush (fig. 12, F)... ... ... *A. cornutum*, p. 243
Cocoon with two projections ; breathing organ with about 30 filaments forming a tuft curved inwards ... ... *A. tasmaniense*, p. 245
5. Breathing organ short ; the filaments at most twice as long as the basal horn 6
Breathing organ about half as long as the pupal body or longer ; the filaments much longer than the basal horn 8
6. Horn of the breathing organ with spines at its extremity ; with about 17 thin filaments twice as long as the horn ; texture of the cocoon very smooth, its shape usually circular and very flat ... ... *A. torrentium*, p. 247
Horn without spines at the end 7
7. Basal horn flat and broad, more or less spatuliform, the filaments thin and not longer than the horn itself ; cocoon slipper-shaped *A. laticorne*, p. 253
Basal horn fusiform, its surface finely spinulous, with about forty filaments ; cocoon wall-pocket-shaped ... ... *A. australense*, p. 251
8. Basal horn long and slender, the filaments inserted at its end 9
Basal horn short, lance-shaped 10
9. Filaments about 20 in number and one-half longer than the horn ; cocoon wall-pocket-shaped... ... ... *A. simile*, p. 249
Filaments about 30 in number, more than twice as long as the basal horn ; cocoon wall-pocket-shaped ... ... *A. weindorferi*, p. 248
10. Filaments of the breathing organs thick, rigid, not exceeding fifteen in number ; cocoon slipper-shaped ... ... *A. tillyardi*, p. 253
Filaments thin, flexible, about 30 in number ; cocoon slipper-shaped *A. multicorne*, p. 254

Simulium ornatipes, Skuse.

The original specimens from which the description of this species was made by Skuse are preserved in the collection of the Australian Museum in Sydney, and I have had the opportunity of studying them carefully, thanks to the kindness of Mr. A. Musgrave.

The label " type " was affixed on a pin carrying four specimens from Darling River, N.S.W., two males and two females, pasted on a slip of cardboard ; no special type being therefore indicated, I selected one male specimen on which I took the following notes to complete Skuse's description, which I will first give here.

" ♂.—Length of antennae	...	0·017 inch	...	0·42 mm.
Expanse of wings	...	0·105 by 0·050	...	2·67 by 1·27
Size of body ...	...	0·090 by 0·030	...	2·27 by 0·76
♀.—Length of antennae	...	0·017 inch	...	0·42 mm.
Expanse of wings	...	0·120 by 0·055	...	3·04 by 1·39
Size of body ...	...	0·100 by 0·035	...	2·54 by 0·88

" ♂.—Antennae short, black or dark brown, lighter towards the tip, covered with a microscopic hoary pubescence ; the joints of the scapus usually fulvous, sometimes brown or black ; 2+9-jointed ; first flagellar joint larger than the second joint of the scapus ; the next seven joints short ; terminal joints narrower, ovate. Eyes, proboscis and palpi black, face hoary, with a silvery-white pubescence. Thorax velvety-black, with two indistinct lines, the lateral margins, a large patch at the humeri, and the posterior portion, covered with shining silvery and golden pubescence ; pleurae and metanotum black ; squama behind the halteres densely fringed with long golden-yellow hairs ; scutellum covered with silvery and golden pubescence. Halteres pale fulvous or ochreous, the stem brown. Abdomen black, anterior segments sparingly covered, and the last two or three marginal posteriorly, with golden pubescence. Fore coxae yellow, the intermediate and hind pairs yellow, black at the apex, with golden-yellow or silvery pubescence ; tibiae yellow in the middle, black at the base and apex, with golden pubescence ; tarsi black, the basal half of the metatarsal and second joints in the hind-legs usually yellow. In the hind-legs the metatarsus robust, longer than the remaining joints of the tarsi. Wings longer than the entire body, hyaline, with violaceous reflections ; costa, first two longitudinal veins and cross-vein brownish, the rest pale. Venation normal.

" ♀.—Differs from the ♂ as follows :—Head and front with a silvery-white pubescence. Thorax covered with silvery white pubescence, with three short, broad, dark stripes, the intermediate one traversed by a fine median silvery or golden line. Abdomen tolerably densely covered with silvery-white pubescence.

" *Hab.* Waterloo Swamps, near Sydney (*Skuse*), in June ; near Louth, Darling River, N.S.W. (*Helms*), several specimens in Coll. Australian Museum.

" *Obs.* This is the second species of the genus described from Australia. It is at once distinguished from *S. furiosum*, Sk., by the number of joints to the antennae, the clothing of the body and the coloration of the legs."

My notes on the types are as follows :—

Male.—The antennal scape is somewhat testaceous, the flagellum dark and the tip is not lighter. The mesonotum does not present two indistinct lines but a darker median band, on account of the metallic pubescence being of two colours : dark bronzy on the disc and in front of the notum and brassy or even slightly silvery on the shoulders, the sides and the posterior part of the notum as well as on the scutellum. The bronzy pubescence seems somewhat shorter. The whole surface of the mesonotum is covered with a metallic pubescence, and does not present any glabrous dark velvety space, although the integuments of the thorax are of that colour. The yellow hairs around the scutellum are long and numerous, and the pubescence of the pre-scutellar region is not silvery and golden but light yellow only. The pubescence of the abdomen is yellow and well developed, with the exception of the last segments, where it is situated on the posterior border of the segments only, the rest of the segments carrying a few short bronzy hairs. The anterior coxae yellow, the posterior ones dark, with the apex yellow (and not the contrary as stated by Skuse) ; femora yellow with dark apex. The anterior and middle tibiae have an antemedian yellow ring, but the hind

ones are also yellow at the base much more extensively than the others, which present only a yellowish point underneath.

Female.—The mesonotal pubescence of the female is very characteristic and differs noticeably from that of the male. It is chiefly of a slightly silvery grey colour, but on the disc, which presents three long oval spots of bronzy hairs, the hairs around the edge of these spots are yellow. The median spot or short band is divided by a narrow longitudinal line of grey hairs. The grey silvery pubescence of the abdomen is everywhere uniform, rather long and somewhat denser in the middle of the dorsum of each segment. The legs are not so dark as in the male ; the anterior ones present scarcely any dark markings on femora and tibiae, and on the posterior ones the yellow markings in the middle of the tibiae are more extensive.

The following morphological features are taken from a male and female from Burke and Wilcannia, N.S.W., Darling River floods, and are therefore from about the same locality as the type. They were lent to me to dissect and make microscopic mounts of them, so as to be able to study features that cannot be made out in the dry specimens. The male had the antennae a little lighter than in the type, their tips being slightly testaceous ; otherwise these two specimens correspond perfectly in all points with the type and allotype.

Male.—In the 11-jointed antennae, the first joint is noticeably shorter than the second, which is about as wide as long, the third cylindrical, twice as long as the fourth, 4–10 inclusive, decreasing slightly in size, the last one olive-shaped.

Palpi with the two basal joints as broad as long, the third rather thick when seen in profile and subequal to the fourth, the fifth thin and $2\frac{1}{2}$ times as long as the fourth.

Legs : the two anterior pairs are rather slender, the tarsi of the front ones $1\frac{1}{2}$ times as long as the tibiae ; the intermediate tarsi equal to their tibiae ; in both pairs the metatarsi are equal in length to the other tarsal joints together. The hind tibiae are nearly as thick as the femora, and their dorsum presents a very distinct depression in the middle. The hind metatarsi (fig. 2, E) are about three-fourths the length of the tibiae and about half their width. Their distal internal lap is only half the width of the metatarsus itself ; the second joint of the tarsi is rather deeply notched on the dorsum not far from the base, its length being a little less than a quarter of the metatarsus.

Hypopygium (fig. 4, C, D) : the terminal joint of the claspers is laterally flattened towards its extremity, and when seen in profile shows a truncate tip ; it does not carry any spines or teeth. Aedoeagus as in fig. 4, D.

Female.—The width of the frons is about one-seventh that of the head in its narrowest part, the inner border of the eyes divergent towards the vertex. Palpi as in the male, but the hind pair not so incrassate, and the tibiae only with a hint of a dorsal depression. Tarsi as in male ; claws rather strongly curved and with a conspicuous tooth at the base. Genitalia as in fig. 5, C, D. The hind border of the subgenital sternite deeply notched in an acute angle ; the terminal lamellae simple without notch.

Several specimens of this species have been recently collected in Sydney by Dr. E. Ferguson ; they are of smaller size, the length of the wing being 2 mm.

Simulium aurantiacum, sp. n.

A relatively large species distinguished from all other Australasian representatives of the family by its rather bright orange colouring, with the exception of the abdomen, which is blackish in the males and brownish in the females.

Male.—Length of body, 2–2·5 mm. ; wing, 3 mm.

Antennae dark orange, the first joint about as wide as long, the second distinctly longer ; the third $1\frac{1}{2}$ times the fourth ; the fourth to ninth subequal, wider than long,

the last two longer than wide, the last bluntly conical. Face greyish brown, palpi and mouth-parts brown, the first two palpal joints small and subequal, the second and third about three times as long as wide, the second distinctly thicker, the fifth $2\frac{1}{2}$ times the length of the fourth.

Thorax exceedingly arched on the dorsum, its profile being semicircular; mesonotum velvety orange darkened on the disc and more so along a median, rather broad band; seen from the front it shows a slight cinereous reflection. Pleurae orange, mesosternum brown, scutellum orange, post-scutellum orange with slight cinereous reflections in certain lights. Pubescence of thorax golden, short and adpressed, with the exception of the parts on the shoulders and before the wing space, where it is longer and somewhat erect; the pubescence of the scutellum is long, erect and mixed with a number of black hairs; a pleural tuft of hair golden. Legs mainly yellow-orange; coxae dark, with the exception of the anterior ones, which are light; the anterior legs are comparatively lighter in colour than the others, the tarsi only being brownish from the middle of the metatarsi onwards; middle legs with the femora darkened above distally, the tarsi also darkish; posterior legs with the femora, tibiae and metatarsi darkened on their distal half and chiefly on their dorsum, the rest of the tarsi dark; pubescence of the legs black and golden; it is mostly golden on the lighter parts and on their ventral face and black on the darker parts. The structure of the two anterior pairs of legs is similar, only the tarsi of the anterior ones are longer by one-half, but the relative length of the different joints remains the same. Hind legs stouter, the femora fusiform, the tibiae broadened; the metatarsi nearly as broad, more or less flattened sideways and only a little smaller than the tibiae, the extremity being produced interiorly into a long lap, which extends to about the two-thirds of the second joint, and at the level of the insertion of this last joint the metatarsi present dorsally a little notch; anterior border of the metatarsi with a regular row of small ciliae.

Wing with a slight yellowish tinge, and the membrane between *Sc* and R_1 thicker and more yellow, forming thus a kind of stigma; the tip with a slight blackish cloud; all veins orange. Venation as usual, but *Cu* moderately undulating. Halteres brownish with a somewhat lighter stem.

Abdomen velvety black, the first segment testaceous on the dorsum and the second on the sides; its pubescence golden and short, with the exception of the side-tufts of the base which are large, as usual.

Hypopygium with the terminal segment of the clasper slender, about half the length of the basal one and with two teeth at apex.

Female.—Body, 3·5 mm.; wing, 5 mm.

Eyes but narrowly separated by the frons, which is one-eleventh of the whole width of the head, its sides being parallel. Face, frons and vertex greyish with golden pubescence. Base of the antennae lighter than the flagellum; the three basal joints subequal in length; palpi as in male, but the third joint relatively longer and with its internal distal extremity somewhat produced.

The whole thorax bright orange, with the exception of the brownish metasternum; the mesonotum mat, its pubescence as in the male. Halteres yellow orange; legs of the same colour, the middle coxae, tip of posterior femora, all middle tibiae and the distal half of the posterior ones darkened; tarsi mostly brown, base of all the joints more or less yellowish, the last joint completely dark. Structure of the legs as in the male, but the hind pair relatively more slender; claws moderately curved, with a strong tooth at the base (fig. 3, C).

Abdomen brown but not velvety, basal segments with lighter part as in male; pubescence also similar.

Genitalia of the type shown in fig. 5, A; terminal lamellae with a little notch on the border a little before the middle.

Type from Mt. Wilson, Blue Mts., N.S.W., 19. xi. 1921. Allotype from Wentworth Falls, Blue Mts., 18. xi. 1921.

There is a great amount of variation in the colouring of the specimens, especially in the males, in which the mesonotum is sometimes reddish brown and the pleurae as well as the legs rather dark. The females are sometimes also much darker than the allotype, chiefly on the legs, which can be, however, completely orange ; the size varies also a great deal, the wing length in the smallest female being 3·5 mm. This species was collected by me in different localities of Australia, first in the Blue Mts. at Wentworth Falls and then on Mt. Wilson, N.S.W., in November ; the insects were captured in the proximity of waterfalls in both cases, where the pupae and larvae were found subsequently. The following year, in October, I found this species again in Victoria at Sassafras and Sherbrook Falls (Mt. Dandenong). Those obtained at Sassafras were not collected in the proximity of waterfalls, but near a creek where the flow of water was moderately swift. In Tasmania this species was met with in the National Park at the foot of the Russell Falls in December, and again in February in the Cradle Valley in a very swift-running creek running out of Crater Lake.

This species has never been observed biting by the writer or by other persons ; on Mt. Wilson it was particularly numerous, and although several hours were spent in that spot, none came flying in the proximity of the collectors. All the specimens were secured by sweeping with a net on plants ; males were obtained in the proportion of one for two females. This species was also collected in the larval or pupal stages in St. Patrick River, Burnie, Bruny Island, and on the West Coast of Tasmania on Mt. Farrell. It seems, therefore, to be well distributed all over that island.

Larva.—Length, 7·5–8 mm. ; a size that is never reached by any other Australasian species. The antennae are a little shorter than the basal piece of the fan, the second setiform joint being one-third shorter than the first. The mentum (fig. 9, D) is provided with three large teeth, the median one being separated from the lateral ones by three small teeth, the median of which is the smallest ; on the outer side of the lateral large tooth there is a smaller one placed at a lower level. The frons does not present any distinct pattern ; sometimes the whole head is pigmented, but usually only from around the eyes downwards, this dark pigmented region containing three roundish clear spots below the eyes. The colouring of the body is uniformly yellowish green without distinct markings. The gill spots (fig. 6, A) are triangular with two ventral lobes which are blackish in the mature larva, whereas the dorsal part is orange. The anal crown of hooks is rather wide and composed of exceedingly numerous rows of from 35 to 40 very small hooks placed very close to each other. The anal armature as in fig. 10, B. There are no anal papillae, but the extremity of the body is more swollen ventrally.

Pupa.—The gill tufts (fig. 11, A) contain over 40 rather rigid filaments proceeding from 6 or 7 main trunks, originating themselves on a rather wide but very short basal tube of the same nature as the filaments. The main trunks branch several times more or less regularly, the dorsal one being more developed and bearing a larger number of filaments. The dorsum of the thorax, which is much arched, carries on each side a row of very small bristles bent backwards and on the exterior side of this another pair of bristles equally small.

Cocoon (fig. 13, A).—This is in form of a cornet very narrowly applied to the body, and being rounded it is therefore usually fixed on the support by the middle of its ventral surface ; the anterior opening has a rather irregular edge and leaves the head and part of the thorax free. The texture of the cocoon is very coarse and rough and often contains some foreign matter, particularly bits of moss.

The localities where the early stages of this species have been found have been given above. It is nearly always in very swift-running water that they were observed on the stones of a fall or cascade, these stones being very often more or less covered with moss, on which the larvae fasten themselves and build their cocoons. They are,

however, found sometimes on bare stones, but in that case the cocoons are nearly always built on a broken surface of the stone. Often the cocoons are spun in a cluster of three or four together.

Simulium umbratorum, sp. n.

Female.—Head dark brown, with yellowish short pubescence and longer dark hairs, chiefly on the vertex and occiput ; antennae and palpi dark brown. Mesonotum brown, its anterior border, with exception of the middle, testaceous, as well as a part of the lateral border and an irregularly delimited area in front of the scutellum, which is also completely testaceous ; metanotum dark brown ; the remainder of the thorax is also testaceous with exception of the anepisternum and the mesosternum. Vestiture of the notum composed of short, brass-yellow hairs, also present on the scutellum ; pleural hair-tuft yellow. Legs testaceous, darker on the posterior femora and tibiae, their vestiture yellow but for a few longer dark hairs. Halteres with orange stem and yellowish white knob. Abdomen mat brown, the basal segment testaceous, with the long lateral hair-tufts yellow ; the rest of the abdomen with moderately dense, short, erect, yellow pubescence.

Antennae (fig. 1, C) with eleven joints ; the first one short, the second $1\frac{1}{2}$ times as long and very little longer than wide, the third a little shorter than wide, the fourth half as long as wide, the following ones gradually increasing in length, the tenth being as long as wide, the last one conical, twice as long as wide ; the whole antenna about as long as the head is wide.

Palpi of the usual structure, the three last joints subequal.

Frons one-quarter the width of the head, with its sides divergent backwards and with a very sharp middle furrow.

Anterior legs not incrassate in any of their parts ; in the front ones the tarsi are about one and a half times as long as the tibiae. Hind legs stouter ; the tibiae moderately wide ; the metatarsi not quite as wide and provided with an internal terminal lap as wide as the metatarsus itself but narrowed at its base dorsally so that the metatarsi present there a noticeable dorsal notch (fig. 2, D), the anterior border of the metatarsi carries a row of about ten very small bristles. Second hind tarsal joint not distinctly incised at its base dorsally. The claws rather strongly curved and provided with a conspicuous basal tooth pointing outwards (fig. 3, F).

Wings as usual, but with *Cu* practically straight.

Genitalia of the type shown in fig. 5, B.

Length of wing, 3 mm.

Type in the Cawthron Institute and three paratypes in the writer's collection from Fern Tree Gully, Mt. Dandenong, Victoria, 25. x. 1921 ; obtained by sweeping plants with the net ; not observed biting.

This species is readily distinguished from the other Australian species by the vein *Cu*, which is nearly straight, its testaceous legs and sides of thorax, and by the shape of the tooth of the tarsal claws. The early stages are unknown.

Simulium terebrans, sp. n.

A darkish medium-sized species similar to *A. furiosum*, but differing at first sight by the dark halteres.

Female.—Length of wing, 2·3 mm. Face and frons grey with yellow pubescence ; vertex and occiput also covered with the same sort of hairs. Vertex only with a few long black hairs. Antennae and palpi completely dark brown. Shoulders slightly reddish, mesonotum in certain positions slightly shining under its short pubescence ;

hairs and anterior part of scutellum yellowish, on its posterior border black, long and dark ; the post-scutellum seen from behind has a slight silvery gloss ; anepisternum with greyish reflection, the rest of the pleurae and sternum blackish brown, with some reddish under the base of the wing. Legs completely blackish, no trace of yellow underneath, their pubescence light yellowish with only a few blackish longer dorsal hairs. Wings as usual ; halteres with dark brown knob and stem somewhat testaceous. Abdomen mat brown, strongly reddish on the sides owing to the blood absorbed by the specimen ; the small tergal plate of segments 2–5 mat brown like the following segments and bare ; the last part of the abdomen with short adpressed yellowish pubescence and longer darker hairs ; lateral tuft of the three segments yellow.

Antennae composed of 11 joints ; the first small, the second twice as long and about as long as wide, the third a third shorter, the fourth twice as wide as long, the following ones gradually but slightly increasing in size, the tenth being only a little wider than long, and the last conical, about half as wide as long.

Palpi of the usual type, the first two joints very small, the last three subequal, the second incrassate, but more or less flattened laterally, the last slightly club-shaped. Frons rather narrow, equal to one-sixth of the width of the head with a slight median groove.

Wing venation as usual.

Legs : the front ones distinctly longer than the middle ones ; hind metatarsi about as broad as the tibiae and a little shorter only ; the distal lap about half the width of the metatarsus itself and as long as wide ; second joint deeply incised dorsally near its base. Claws with a very small tooth at the base (fig. 3, H).

Genitalia as in all the allied species, of the type shown in fig. 5, B.

Male unknown.

Type, a female from Sassafras, Victoria, 22. x. 1922 ; caught while biting the writer's hand ; the irritation caused by its bite was but small.

Four specimens (females) from Canoblas, New South Wales, 11. x. 1916 ; in the collection of the Board of Health, Sydney. They correspond very well with the Victorian specimen, their size being only somewhat larger ; wing, 3·2–3·4 mm. The antennae are very slightly longer, otherwise they agree with the type in its specially characteristic features, *i.e.*, the small tooth of the claws, the narrow frons and black halteres.

Simulium fergusoni, sp. n.

A large, blackish-grey species distinguished at first sight by the absence of the distal internal lap on the metatarsi.

Female.—Wing length, 3·5 mm. Completely greyish black, including the legs, with the exception of the halteres, which are testaceous ; pleurae uniformly greyish. Face with small, dull yellowish hairs, vertex besides with a few black longer ones ; the post-ocular vestiture dense and also yellowish, with a few black hairs intermingled. Pubescence of the mesonotum of a dull yellow colour, short, rather dense, and extending also on the scutellum, where there are besides some longer erect black hairs, especially on the margin. Pubescence of the legs completely yellow, also the longer dorsal hairs of the femora. Lateral basal tufts of the abdomen moderately developed, and yellowish as well as the rest of the vestiture of the abdomen ; that of the tergal plates small and scanty.

Frons with divergent sides, about one-fifth of the total width of the head and with a distinct median groove. Antennae with 11 joints ; the first half the length of the second, which is as long as wide ; the three following decrease in length, so that the

fifth is only half as long as wide ; the sixth and following ones gradually increasing in size, the tenth being as long as wide ; the last conical, not quite $1\frac{1}{2}$ times as long as wide.

Palpi about as long as the antennae ; the third joint is distinctly the longest and is noticeably produced at its distal end internally ; the fourth is half the size of the fifth, which is a little shorter than the third.

Wing venation as usual, but the curve of *Cu* somewhat more pronounced (for a female) than in other species.

Legs : the front tarsi not broader than the middle ones but slightly shorter (50 : 57). The hind legs only moderately incrassate, the dorsum of the hind tibiae slightly undulated (fig. 2, H), the hind metatarsi moderately wide, about half the greatest width of the tibiae (5 : 9) and little flattened ; there is no distinct internal distal lap (fig. 2, F, G) ; the anterior border of the external side of the metatarsus carries a row of little spinules, which are also present on the internal side but only at the tip of the metatarsus, where they are more numerous ventrally ; second hind tarsal joint not incised dorsally, rather elongated, about one-third of the metatarsus ; claws simple, a little swollen at base but without any tooth.

Genitalia as usual, of the type shown in fig. 5, B.

Male unknown.

Type and 11 paratypes (females) from Bumberry, N.S.W., 1. x. 1916. All these specimens carried the indication " biting man." They were taken in company with *A. bancrofti*, Taylor.

This species is easily distinguished from all the others by the absence of the lap on the metatarsi, the short fourth palpal joint, the small last antennal joint, and by the second hind tarsal joints not being incised dorsally.

Austrosimulium furiosum, Skuse.

Skuse's description, which is accurate, runs as follows :—

" ♀. Length of antennae, 0·42 mm. ; expanse of wings, 2·39+1·13 ; size of body, 2·02+0·62.

" Antennae short, black, densely covered with a microscopic hoary pubescence ; 2+8-jointed, second joint of the scapus twice the length of the first, first flagellar joint about as large as the second joint of the scapus, three following short, next three large, terminal joint elongate-ovate (fig. 1 B). Head, hypostoma, and palpi black, with a minute yellowish pubescence, very dense on the latter ; joints of the palpi as follows : First joint small, second twice the length of the first, stout, elongate-ovate, third somewhat shorter than the second, more slender, claviform, a little emarginate on the inner side near the apex, fourth joint somewhat longer than the second, slender, sub-cylindrical, a little dilated towards the apex. Eyes deep black. Thorax black, opaque, indistinctly divided by three striae, beginning below the anterior margin and terminating before the scutellum ; rather densely covered, more especially anteriorly, with a microscopic pale yellow pubescence ; pleurae, pectus, scutellum, and metathorax black, opaque. Halteres pallid, the base of the stalk black, with a minute pale pubescence. Abdomen black, opaque, the third to the seventh segment with a square median patch of intense black, densely clothed with short hairs. Legs brownish-black, with a pale yellow pubescence, interspersed with longer hairs ; genua yellow ; metatarsus of the hind-legs nearly twice the length of the four following tarsal joints, and longer than the tibiae of the intermediate—or fore-legs. Wings longer than the entire body, hyaline, brownish at the root ; costal vein black, auxiliary and first two longitudinal veins sordid yellowish-brown ; third, fourth, fifth and sixth longitudinal veins pale. First and second longitudinal combining with the costa before the tip

of the fourth longitudinal vein ; tip of the costal vein nearer the apex of the wing than the tip of the anterior branch of the fork of the third longitudinal ; marginal cross-vein about as long as the petiole of the second sub-marginal cell. Wing-fold between the third and fourth longitudinal veins furcate before joining the posterior border ; wing-fold between the fifth and sixth longitudinal veins nearer the former, bent abruptly forward at its tip, and joining the wing-border very close to the tip of the fifth longitudinal vein ; sixth longitudinal vein complete.

" *Hab.* Gosford and Berowra (Skuse). August and September."

The type of this species was examined by me in the collection of the Macleay Museum in Sydney, and I noted that the description applies very well to it, so far as one is able to judge from its rather bad state of preservation, the vestiture of the body having completely disappeared.

The claws are not toothed ; the hind metatarsi are a little shorter than the tibiae and are provided at their apical inner end with a small lap having only about half the width of the metatarsus itself ; the pubescence of the legs is yellowish. The three other paratypes (two of them being paratopotypes) also ♀♀, correspond well with the type ; one of them has the vestiture of the metanotum in good condition ; it is uniformly brass-coloured. There is a small ferruginous part at the extreme base of the tibiae, so that the knee may be said to be narrowly ferruginous.

One of the paratopotypes was dissected and mounted. Its frons is equal to a quarter of the width of the head ; the antennae 10-jointed ; the first joint is equal to half the second, which is about as long as wide, the third a little shorter, and the fourth a little shorter still, all the remainder being as long as wide. Palpi with the last joint only a quarter longer than the third, the fourth half as long as the third.

Venation as usual ; legs also, the lap of the hind metatarsi being half the width of these latter and reaching a little beyond the dorsal incision of the second joint ; the claws are simple.

The male is unknown.

In Sassafras, Victoria, I collected one female specimen (22. x. 1922) which does not seem to differ from *S. furiosum*, but it cannot with certainty be referred to this species, the locality being so distant from that of the type, and the species of *Austrosimulium* being so very much alike in the adult stage.

Austrosimulium victoriae, Roub.

Simulium victoriae, Roubaud, Bull. Mus. Hist. Nat. Paris, 1906, No. 7, p. 521.

This species was described by Roubaud from numerous female specimens in the collection of the British Museum, coming from an uncertain locality in Victoria. The description, although somewhat extensive, is too vague and does not mention some of the points of chief importance, such as the relative width of the frons and the relative length of the antennal and palpal joints ; it could consequently apply to most of the dark Australian species. As the number of joints in the antennae is also not mentioned, it is uncertain if it belongs to the genus *Simulium* or to *Austrosimulium*, but as Roubaud considers it to be the nearest species to *A. vexans*, Mik, which belongs to the latter genus, I think *A. victoriae* has also to be considered as an *Austrosimulium.**

* The type and other specimens of *S. victoriae*, Roub., in the British Museum have 10-segmented antennae, and therefore the species belongs to *Austrosimulium*. It is probably distinct from *A. tasmaniense*, because the terminal lap of the first hind tarsal segment is more than half as broad as the segment itself, which bears a few longish hairs dorsally ; there are also similar and more numerous hairs on the last four segments of the hind tarsi.

The species identified by Roubaud from Victoria as *S. vexans*, Mik, is not the same as the New Zealand form so determined in this paper. It is a true *Simulium*, apparently the same as *S. umbratorum*. Besides the specimens examined by Roubaud, others have recently been received from Beaconsfield, Victoria, 6.xi.1923 (*G. F. Hill*).—F. W. Edwards.

One specimen of this latter genus collected in Morisson, Victoria, in the collection of Dr. Ferguson, may be referred to this species, although without making a dissection it is impossible to say if it really differs from *A. furiosum*, *A. cornutum*, etc.

Roubaud's description runs as follows :—

" Femelle.—Entièrement noir terne, à pubescence d'un gris poussièreux. Sur le thorax une pilosité jaune pâle, clairsemée. Balanciers blanchâtres. Ailes à nervures noirâtres, toutes bien marquées.

" Pattes en entier brunâtres, plus claires que le thorax, fortement villeuses. Tibias et tarses antérieurs noirs, ces derniers grêles, non dilatés. Métatarses postérieurs aplatis, à bord antérieur légèrement arqué, inerme, sans épines saillantes ; le bord postérieur est fortement cilié ; l'expansion terminale forte atteignant l'échancrure du premier tarsien qui est nettement allongé et sensiblement linéaire. Griffes courtes et simples. Abdomen uniformément brun noirâtre, plus clair au ventre, revêtu de poils grisâtres ou foncès.

" Cette espèce, en raison de la longueur du premier article de ses tarses postérieurs, de ses nervures bien marquées aux ailes, de toute son apparence extérieure, parait appartenir au premier abord au sous-genre *Prosimulium* tel que nous l'avons défini.

" Voisine de *S. vexans*, Mik, elle s'en distingue par sa teinte beaucoup plus sombre, ses métatarses postérieurs inermes et ses griffes simples."

Austrosimulium bancrofti, Tayl.

Simulium bancrofti, Taylor, The Aust. Zool., i, 1918, p. 168.

Taylor's description runs as follows :—

" Female :—*Head* black with grey tomentum ; front with a well-defined median groove ; palpi black with black and pale pubescence, first joint pale, apex of second narrower than base, third strongly emarginate on the inner side towards the apex, fourth long, thin, cylindrical ; antennae nine-jointed, first two brownish, first shorter than second, latter about the length of the third, third to the apex black, third broadest and about twice the length of fourth ; proboscis black, apex with short, stout pubescence ; eyes coppery.

" *Thorax* : Black, tomentum grey, pubescence pale ; pleurae black with grey tomentum.

" *Abdomen* : First segment deep black, two to six deep black with median apical ash-grey spots, small on the second and increasing in size to the sixth, which is ash-coloured, except for a narrow basal and lateral margin of deep black, seventh ash-grey, with a narrow lateral deep black border, eighth ash-coloured, third to fifth also with apices of sides ash-coloured, pubescence black, pale on the pale areas ; venter grey with grey pubescence. Halteres pale creamy.

" *Legs* : Dark yellowish-brown, tibiae dark brown above, anterior tarsi black, except base of first yellowish-brown, mid and posterior tarsi yellowish-brown, second to fourth with their apices dusky, first posterior tarsi dusky beneath ; pubescence pale ; apex of tibiae with a stout spine ; apex of first posterior tarsi produced into a terminal expansion overlapping the second tarsals beneath.

" *Wings* : Clear, pale yellowish at the roots ; costa, auxiliary and first long veins paler than roots, remaining veins almost indistinguishable from wing membrane.

" Length, 2 mm. ; length of wing, 2 mm."

I have seen a good series of female specimens in the collection of Dr. Ferguson, some of them being paratopotypes and the others coming from Dawson River and Bumberry, N.S.W., 1. x. 1916.

They correspond well with the description so far as the coloration is concerned, but the account of some of the morphological features needs to be altered and supplemented as follow :—

The width of the frons is a little over a quarter of that of the whole head (12 : 40) ; the antennae (fig. 1, B) are rather short, a little less than three-quarters of the width of the head (27 : 40). They are composed of ten joints, but the last joint, which is small, is sometimes partly fused with the preceding one, so that the antennae may appear at first sight nine-jointed ; this explains Taylor's error on that point. The first three joints cyathiform, the first very small, the third nearly twice as broad and twice as long as the first, the second intermediate in size ; fourth joint not quite so wide as the third and very short, about 3 times as wide as long, the following joints gradually diminishing in width but increasing in length, so that the ninth is about as long as wide, the last conical, subequal to the preceding one.

Palpi five-jointed ; the first two joints small, as usual ; the third and fourth subequal to each other, the third fusiform but somewhat thinner at its distal end, the fourth with a truncate extremity (not emarginate) ; the fifth thin, cylindrical, $1\frac{1}{2}$ times as long as the fourth.

Legs : Front tarsi slightly dilated, without spinules ; middle tarsi with the first three joints carrying some spinules underneath, especially towards their extremity. Hind metatarsi about as long as the tibiae but only half as wide ; they do not carry setae on their anterior edge but are provided with an internal distal lap of only half their width ; this lap is rather short, as it does not reach the level of the dorsal incision of the second tarsal joint, which carries a few spinules on its plantar face. The claws do not present any tooth at their base and are little curved.

Genitalia of the usual type shown in fig. 5, B.

The wing venation as usual, only *Cu* with its bend placed more towards its extremity and more marked.

Austrosimulium crassipes, sp. n.

Male.—Face brown, with a few yellowish hairs and some longer black ones ; antennae and palpi black ; occiput very moderately pubescent. Mesonotum velvety black, with yellow-golden adpressed pubescence (longer anteriorly) on the sides and in front of the scutellum, where there are also some black erect longer hairs like those on the border of the scutellum, which carries besides a few small yellowish hairs. Space in front of the scutellum and metanotum with cinereous reflections when seen from behind ; anepisternum with a rather strong silvery gloss ; the rest of the pleurae and sternum brown, with only a slight greyish reflection in certain positions.

Legs completely dark, with mostly yellowish pubescence, the hairs on the dorsal part of the femora being blackish. Halteres with the stem and base of knob blackish, the distal part dark orange. Abdomen velvety black, with dull yellow adpressed and moderately long pubescence ; side-tufts of basal segment long and dark yellowish.

Antennae ten-jointed ; the first joint shorter than the second, which is about as wide as long ; the third is of the same length but somewhat more slender ; the following ones are subequal to each other and about as long as wide ; the last conical, elongated, and twice as long as wide.

Palpi with the first two joints small as usual, the third and fourth subequal, the third incrassate, the fifth thin and twice as long as the fourth.

Wing venation as usual.

Legs : anterior tarsi thin, the front ones $1\frac{1}{2}$ times as long as their tibiae, the middle ones subequal ; hind tibiae dilated and as broad as the femora ; hind metatarsi very

much swollen (fig. 3, I), a little wider than the tibiae and somewhat shorter ; they are provided at their internal distal end with a short lap about as wide as a third of the metatarsus itself ; second tarsal joint deeply incised dorsally near its base.

Hypopygium : claspers about half the length of the basal pieces and provided at the end with two small triangular teeth ; the aedoeagus ending in a process projecting rather conspicuously downwards between the two basal pieces of the claspers.

Type in the Cawthron Institute ; a single ♂ from Sassafras, Victoria, 22. x. 1922.

This species is distinguished at once by the very much incrassated hind tibiae and metatarsi. It is not impossible that this specimen may have to be referred to *A. furiosum*, Skuse, the male of which is not known. However, this latter species is not very well characterized and was found in a very far distant locality in New South Wales ; besides, there is some difference of coloration in the halteres, the knob of which is completely orange in *A. furiosum*, and also the knees are completely black. It is therefore safer to consider this male as belonging to a distinct species ; investigations at Gosford, N.S.W., the original locality of *A. furiosum*, will show sooner or later if this view is justified.

Austrosimulium cornutum, sp. n.

A middle-sized species easily distinguished by the toothed claws in the female and the relatively long second joint of the antennae in the male, and also in both sexes by the terminal lap of the hind metatarsi, which is of the same width as the metatarsus itself.

Male.—Face, antennae and palpi black, with dark pubescence, the row of hairs between the eyes and those on the vertex being rather long and black. Mesonotum velvety black, with golden, rather long but adpressed vestiture ; the region in front of the scutellum with slight cinereous reflections in certain lights. Scutellum velvety black, with only black erect hairs. Sides of the thorax brown, with greyish reflections in most positions and much stronger on the anepisternum ; pleural hair-tufts blackish. Halteres with a brown stem and bright orange knob. Legs black, with extreme base of the tibiae orange, and pubescence yellowish, especially on the ventral side of the femora and tibiae, dark on their dorsal and posterior sides, but the anterior tibiae almost completely covered with yellowish pubescence. Abdomen velvety black, with dark hair, also the large basal side-tufts composed of dark hairs.

Antennae with 10 joints ; the first longer than wide, subequal to the third, the second one-third longer, the fourth somewhat wider than long, the following ones gradually but slightly increasing in size, the last conical, rather elongated but not quite twice as long as the preceding one (5 : 3).

Palpi with the first two joints small, subequal, the third swollen subequal to the fourth, the fifth two-thirds longer than the fourth.

Legs : anterior tarsi not thickened, but one-half longer than the tibiae, the metatarsi equal to the four other joints together. Mid-femora and tibiae equal to the anterior ones, but the tarsi shorter, equal to the tibiae, the metatarsi equal to the four other joints. Hind femora and tibiae moderately swollen, subequal in width ; metatarsi flattened, two-thirds the width of the tibiae and nearly as long (32 : 36), produced at their internal distal end in a rounded lap nearly as wide as the metatarsus (fig. 2, B, C), which presents dorsally at the base of the lap a very slight notch ; the lap reaches downwards well over the deep basal incision of the second joint ; the last four joints about equal to half the metatarsus ; claws as usual, with the basal swollen pad.

Wing as usual ; *Cu* well curved.

Hypopygium (fig. 4, A): claspers ending in two small triangular teeth; aedoeagus shaped like a violin-bridge, with a median triangular pad, densely but finely hairy.

Length of wing, 2·5 mm.

Female.—Face and frons grey, with yellowish adpressed short pubescence and a few longer black hairs, which are more numerous on the vertex; the occiput also covered with short yellow hairs. Mesonotum black, densely covered with a dull golden-yellow adpressed pubescence, the hollow before the scutellum slightly greyish; scutellum black, with black erect hairs, the yellow pubescence localised only at its very base. Side of thorax brown with grey pruinosity, especially on the anepisternum but extending towards the base of the hind coxae. Pleural hair-tuft blackish. Legs as in the male, black with the extreme base of the tibiae orange, but the pubescence nearly all yellow, only the longer dorsal hairs blackish. Halteres with brown stem and white knob. Abdomen dull black, the tergal plates small and not very distinct from the rest of the integument; pubescence formed of sparse short yellow hairs and longer black ones, which are more conspicuous and longer towards the end of the abdomen; the large basal side-tufts yellowish.

Frons equal to one-fifth of the width of the head, its sides parallel in the lower half; antennae as in the male, but the second and last joints relatively a little shorter Palpal joints in the same proportion as in the male, the last joints only being somewhat longer, the third joint rather flattened laterally. Legs also as in the male, but the hind ones somewhat more slender. The hind metatarsi relatively a little shorter compared with the tibiae (34 : 40), but the conformation of the terminal lap and of the second joint identical. The disproportion between the anterior and middle tarsi not so great; claws strongly curved, bifid, or rather with a very large basal tooth half the length of the claw itself (see fig. 3, G). Wing as usual: *Cu* less curved than in the male. Genitalia of the usual type, as in fig. 5, B.

Length of wing, 3 mm.

Larva.—Length 7 mm., when full grown, and distinguished by the disposition of the teeth of the mentum, which is shown in fig. 9, C. The rest of the mouth-parts do not seem to differ from those of the other species. Antennae two-jointed; the first joint elongated, about six times as long as broad; the second setiform, one-half longer than the first; the whole antennae only a third longer than the basal piece of the fan. The thoracic spots formed by the nymphal gills seen through the skin are more or less rounded as a whole, but show the breathing filaments curved in the shape of an S (fig. 6, F). The rectal gills have not been observed. The markings of the fronto-clypeus are very inconspicuous and rather indefinite; they are composed of a faint median line broader nearer the posterior margin and extending forward to the level of the base of the antennae; on each side of the middle of this line is a small blackish spot. The dark markings of the body are indefinite in shape.

Pupa.—Characterised by its breathing organ (fig. 11, F), which is composed of a rather long hard chitinous brown horn, tapering towards the end and carrying from 25 to 35 thin nearly straight filaments, which are on an average twice as long as the basal horn and inserted on it from a little above its base to its end. The nymphal integuments do not present any granulation on the head and thorax; on the notum of the thorax are to be found two rows of four bristles, the anterior pair very thin, straight and inconspicuous, the three others stouter, longer, not tapering towards the end but curved into a hook. Exteriorly to the anterior small bristles there is on each side a stouter and larger straight one.

Cocoon.—Rather large (fig. 13, C), about 4 mm. long, its outline oval, the middle of the border of the anterior opening provided with a long projection curving downwards so as to protect the head of the nymph; this projection is somewhat wider at its end, which is rounded.

Type from Sassafras, Victoria, 22.x.1922. Paratypes from :—

NEW SOUTH WALES : Wentworth Falls, Blue Mts., 16.xi.22, 1 ♀. VICTORIA : Sassafras, 27.x.22, 6 ♂ 6 ♀. TASMANIA : Burnie (N.W.), 26.x.22, 4 ♀; St. Patrick River (N.), 4.xi.22, 1 ♂ 1 ♀, reared from larvae ; National Park (C.), 15.xii.22, 2 ♀ ; King River (W.), 1.ii.23, 1 ♀ ; Strahan (W.), 5.ii.23, 9 ♀.

The larva and nymph have also been found in the following Tasmanian localities : St. Patrick River, National Park, Fern Tree (Mt. Wellington), Cradle Mt., Eagle-Hawk Neck (Tasman Peninsula).

This species has not been observed biting. I found it for the first time in sweeping plants with a net at Sassafras, Victoria, along a gully at the end of October, and later on in different parts of Tasmania, but no specimens were ever observed flying around me. In the beginning of the season the males were apparently as numerous as the females, but later, in Tasmania, I did not find any except one obtained by rearing. The larvae were sometimes very difficult to detect, and on some occasions impossible to find, although the flies were numerous, as in Sassafras and Strahan, where no trace of them could be found after several hours of search in the stream. The pupae were found fastened only on stones, with one exception, where they were observed on a bit of reed dipping into the current. On several occasions they were in company with those of other species such as *A. torrentium*, *A. tasmaniense*, *A. weindorferi* and *A. simile*, spp. n., but were always rather scattered, never in colonies ; they seem to require a swifter current of water than the other Australian species, except *S. aurantiacum*, sp. n.

Austrosimulium tasmaniense, sp. n.

Male.—Face, antennae and palpi dull black, with dark hairs ; occiput with a very long and dark pubescence. Mesonotum velvety black, with brown, adpressed and rather long pubescence ; prescutellar depression with very slight greyish reflection, carrying, as well as the scutellum, only long erect black hairs. Pleurae dark brown with the exception of the anepisternum, which presents a rather intense silvery pruinosity ; the region below the base of the wing is somewhat ferruginous ; the pleural tuft of hairs is black. Halteres blackish brown, only the extremity of the knob slightly orange dorsally. Legs completely dark as well as the pubescence. Abdomen velvety black, the pubescence dark brown, also the basal side-tufts.

Antennae ten-jointed (fig. 1, A) ; the first joint smaller by one-third than the second, which is about as long as wide ; third joint relatively long, equal to the first two together ; the following joints as long as wide ; the last conical, 1½ times as long as wide.

Palpi with the first and second joint small, as usual, the third and fourth subequal, the last longer than the fourth (8 : 6).

Venation as usual.

Anterior legs not dilated in any of their parts ; hind legs rather stout, the metatarsi (fig. 2, A) a little smaller than the tibiae and without setae or bristles on the anterior edge ; their interior terminal lap is only half as wide as the metatarsus ; second tarsal joint rather deeply incised dorsally near its base.

Hypopygium : claspers provided with three teeth at their extremity, aedoeagus in the form of a violin bridge (fig. 4, B).

Length of body, 2·5 mm. ; wing, 2·5 mm.

Female.—Head grey, with short yellowish pubescence and a few longer dark hairs. Antennae and palpi black, the latter with dark pubescence. Mesonotum mat, blackish grey, and presenting three rather indistinct darker bands when seen from behind ; it is covered with a very short, adpressed, moderately dense, pale yellow pubescence,

which extends on the middle of the prescutellar depression and the base of the scutellum ; the rest of both these parts carrying long erect black hair. Pleurae blackish grey, the anepisternum being more greyish than the rest but not so light by far as in the male ; the region under the wing's base ferruginous ; pleural tuft of hairs black. Legs completely black, with short yellowish pubescence and a few longer black hairs dorsally. Halteres with the stem blackish and the knob whitish. Abdomen dull blackish grey, the tergal plates of segment 3–6 relatively small, with very short and scanty yellowish pubescence ; some longer dark hairs on the sides and tip of the abdomen, the basal side-tufts long and yellowish.

Antennae with the first joint shorter than the second joint, which is subequal to the third ; the fourth distinctly wider than long, but the following joints gradually narrower, so that the ninth is as long as wide ; last joint conical, twice as long as wide. Palpi as in male.

Width of the frons a little less than a quarter of the whole width of the head and with a distinct median furrow. Legs as in the male ; the claws simple.

Genitalia of the type shown in fig. 5, B.

Size very little larger than in the male.

Type from Cradle Valley, Tasmania, bred from pupa 13.i.1923, in the collection of the Cawthron Institute ; allotype from the same locality. This species was also found in Tasmania in the following localities : St. Patrick River, end of October and beginning of November, both sexes at the same time ; Mt. Wellington in November, females only ; Geeveston, 7th December, females only ; Hartz Mts. 3,000 ft., 9th December, females only ; Mt. Field, 3,500 ft., 20th–21st December, females only.

The larvae and pupae were observed besides in the Brown River, Hobart, in December, and in Russell Fall, National Park, in December. This species seems thus to be spread all over Tasmania, with exception of the West Coast and the North-West. So far it has not been found on the Australian mainland.

Several times I have caught female specimens of this species hovering round my face or hands, but without making any attempt to bite.

Among the bred male specimens I found several anomalies which are worth being recorded here. In one case one side of the hypopygium was normal, whereas the other was composed of a stunted clasper and a small female lamella, all other parts of the body seeming normal. Two other specimens presented an abnormal segmentation of the antennae, several joints being irregularly fused together, so that one antenna was composed sometimes of six irregularly-shaped joints and the other of eight, the antennae retaining, however, their normal length. The hypopygium of another specimen had one branch of the claspers with two terminal teeth and the other with three.

Larva.—Length 5–6 mm. Antennae rather short (fig. 8, B), equal in length to the basal piece of the mouth-fan, the second joint very little shorter than the first. Indentation of mentum as in fig. 9 A ; the three teeth on either side of the middle one do not differ so much in size from the latter and the two larger external ones. The markings of the frons are rather indistinct and offer no clue for a certain identification. Gill spot (fig. 6, E) transverse, elongated, the filaments folded upwards closely against the basal horn of the breathing organ. The rows of the anal crown contain from 12 to 15 hooks. Black anal armature as represented in fig. 10, C.

Pupa.—The dorsum of the thorax of the pupa is granulated and carries about its middle a pair of small hooked bristles with their point turned inwards. Gill-tufts (fig. 11, B) containing an average of 30 filaments inserted on the edge of a rather long, hard and somewhat flattened horn, the surface of which is finely granulated. As a rule the filaments are as long as the horn itself and form a compact tuft curved inwards. These filaments are rather thinner than usual and present a strong segmented appearance.

Cocoon (fig. 13, B).—Elongated oval, its edge irregular and its texture rather coarse. The border of the anterior opening presents dorsally two long projections curved downwards so as to protect the two gill-tufts; the dorsum of the cocoon is distinctly carinated in prolongation of the base of these projections.

The larvae and pupae of this species live on the stones of small and medium-sized cracks; they have, however, been found occasionally on grass blades dipping in small rivulets. They seem to require only a moderately swift current of water.

Austrosimulium torrentium, sp. n.

Male.—Colour of body and vestiture exactly as in *A. tasmaniense,* with the exception of the knob of the halteres, which is entirely very dark ferruginous.

Antennae 10-jointed, first joint about half as long as the second, which is as long as wide; the third not longer than the second but a little narrower; the following joints not quite as long as wide and subequal to each other; the last joint conical, not quite twice as long as wide. Palpi: third joint longer than the fourth by one quarter, fifth joint subequal to the third and somewhat fusiform. Legs exactly as in *A. tasmaniense,* including the structure of the hind metatarsi. Hypopygium: Claspers subequal in length to the side-pieces and provided at their extremity with two short teeth, aedoeagus as in *A. tasmaniense.*

This species is distinctly smaller than the two preceding ones, the size of the wings being only 2 mm.

Female.—Colouring of body and vestiture as in *A. tasmaniense,* including the halteres.

Antennae relatively shorter; the fourth joint twice as long as broad, the following ones slightly increasing in length aad diminishing in width, the ninth being thus almost as wide as long; the last joint relatively longer than in the male. Legs as in *A. tasmaniense,* the tarsal claws simple. Genitalia of the type given in fig. 5, B.

Length of wing 2 mm.

Type in the collection of the Cawthron Institute, obtained from a pupa collected at St. Patrick River, Northern Tasmania, 4.xi.1922. Allotype from the same locality and date.

Larva.—Length 4 mm. when full grown. It is more distinctly marked than that of the other Tasmanian species, the body being ornamented with blackish rings of ill-defined limits and position. Antennae one quarter longer than the basal piece of the mouth-fans; their second joint is one third shorter than the first. Indentation of mentum as shown in fig. 9, B, the median and antepenultimate teeth on each side being conspicuously larger than the intermediate and terminal ones. Black gill spots small (as in fig. 6, D); only the longer filaments are folded upwards. The three anal gills are simple and of moderate length. Anal crown of hooks as in the preceding species, there being only 12 to 15 hooks in each row. The black anal armature (as in fig. 10, C) is much developed and has a quite peculiar shape, its base being in the form of a plate on which are inserted the two lateral undulated branches.

Pupa.—The anterior dorsal part of the pupal body is so shaped as to fit the circular opening of the cocoon like a flat operculum; the dorsum of the head and only the anterior dorsal part of the thorax are delimited by a carina, which causes this lid to close tightly the opening of the cocoon from which the two small breathing tufts protrude. The dorsum of the head and of the exposed part of the thorax presents a kind of granulation, formed by small groups of very minute points; against the posterior edge of the opening of the cocoon the thorax carries a pair of small but rather strong hooks pointing backwards. The gill tufts (fig. 11, E) are very small; they do not overlap the anterior border of the head. They are composed of a basal

piece, orange in its proximal half, blackish on its distal part, and ending in three or four rather conspicuous dark spines, between and around which are inserted the breathing filaments. Their average number is 17, and their length 1½ times that of the basal horn ; only a few filaments are of the same length as the horn.

Cocoon (fig. 13, E).—Its contour is usually circular, and it is very flat, the larva selecting, wherever possible, an indentation in the stone, which the cocoon closes like a flat lid. Sometimes the cocoon is of very reduced oblong shape, as shown in fig. 13, F ; this form has been found in the cataract gorge of Launceston, where the tremendous force of the current is very likely responsible for this modified shape.

A. torrentium in its early stages, and as an adult, has so far only been found in Tasmania in the following localities :—

Burnie (North-West) in October ; rather numerous larvae in the Emu River on stones ; one ♂ adult was then obtained from a pupa ; in the same locality in February the larvae and pupae were very numerous, but the adults were not observed.

Launceston (North), in the cataract gorge of the Esk River, several males and females were captured by sweeping plants in October. In November and January larvae and pupae were obtained from the river, and several imagines bred from them ; this species seems to be the only one existing in the Launceston gorge.

St. Patrick River. In November numerous larvae and a fair number of pupae were obtained from the river shingles, and several imagines were bred. This species was not found in the small neighbouring creeks.

Cradle Valley (N.W.) in January. The early stages were observed in Lilla Lake creek in company with other species ; also in numbers in the Dove River, where it seems to be the only species .

Mt. Farrel (W.). In February the larvae were seen in very great numbers on the stones of the Mackintosh River, but the pupae were then rather scarce.

This species was never met with in the south of Tasmania ; it seems to require a rather large stream to thrive well.

Austrosimulium weindorferi, sp. n.

In the adult stage this species in both sexes does not seem to differ from the preceding one ; the coloration and pubescence is exactly the same, as well as the relative lengths of the antennal joints and the conformation of the legs. Only the relative lengths of the palpal joints present some very slight differences, the third and fourth joints being equal and the fifth a little longer in this species, whereas in *torrentium* usually, and especially in the male, the third and fifth are subequal and the fourth is somewhat smaller. These differences are, however, not much to rely upon for certain identification.

All my specimens, 5 males and 19 females, were obtained from pupae collected in January on stones of Lilla Lake creek in the Cradle Valley, in company with the larvae and pupae of *A. tasmaniense* and *A. torrentium.*

Type in the collection of the Cawthron Institute,

Larva.—Length about 5 mm. when full grown. The blackish markings of the body very little conspicuous, as also those of the head. The two joints of the antennae subequal to each other and together longer by one-fourth than the basal piece of the mouth-fan. Indentation of the mentum as in the preceding species. Gill spots rather large (fig. 6, C), the filament tufts curved in the form of an S, the upper curve of the S touching the base of the filaments. Anal gills composed of three simple digitations. Anal hooks disposed in rows of about 12. The anal chitinous black armature (fig. 10, E) composed of two thin, very much twisted rods.

Pupa.—Dorsum of thorax distinctly granulated, the dorsum of the head also, but more finely, and presenting besides a number of small foveoles arranged in the form of a Y. The dorsum of the thorax carries posteriorly a pair of small, erect and rather stout hooked bristles, and before them a transverse concave row of six longer setae more or less undulated ; furthermore, in front there is another pair of similar setae. Gills (fig. 11, C) composed of a cylindrical, rather short basal horn, orange on its basal half and blackish on its distal part, with the end blunt ; the rather thin breathing filaments, which are about 30 in number, are about twice as long as the basal horn, and they are inserted all over the surface of the last part of this horn.

Cocoon (fig. 13, G).—Shape like a simple wall-pocket, and not provided with a wall between the support and the pupa ; the anterior opening is circular and is not tightly adapted to the pupa ; the texture of the cocoon is rather rough and sometimes intermingled with some filamentous algae (*Cladophora* sp.).

The early stages of this species were found only in the creek running out of Lake Lilla in the Cradle Valley, but not in the River Dove into which it runs, nor in the other small neighbouring creeks, such as the one coming out of Crater Lake. The optimum conditions required by the species seem therefore rather restricted.

As all the adults were obtained by breeding, no observations have been possible as to their biting habits.

Austrosimulium simile, sp. n.

Only the female of this species is known to me ; the relative lengths of the antennae and palpal joints are exactly the same as in *A. weindorferi*, as well as the other morphological features. I am therefore unable to differentiate between these two species, except in their early stages, which present some morphological differences, and different habits, chiefly in the pupal stage.

Larva.—When full grown it reaches 5 to 5·5 mm. The dark markings of the body are very little conspicuous ; those of the head also are of the usual pattern ; one median line with one spot on each side at the middle and another ill-defined spot between this and the base of the antennae on the suture of the prefrons. Antennae rather elongated, one half longer than the basal piece of the mouth-fans, the second joint subequal to the first. Mentum as in the preceding species (fig. 9, B). Gill spots elongated, as shown in fig. 6, B ; the filaments curved in an S. Three simple anal gills moderately developed. The rows of the posterior crown contain about 12 hooks each. The anal black chitinous armature is exactly like that of *A. weindorferi.*

Pupa.—About 3 mm. long. The dorsum of the thorax is very distinctly granulated and the dorsum of the head more finely so ; the peculiar pattern of foveoles on the head is the same as in *A. weindorferi*, and also the hairs and bristles of the thorax. The gills (fig. 11, D) are composed of a long, thin, orange horn, slightly curved inwards, on which extremity only are inserted about 20 filaments. These are rather thin and not quite twice as long as the basal piece.

Cocoon (fig. 13, D).—Wall-pocket-shaped, without any projection round its opening; its texture is rather rough and there is not any wall present between the abdomen of the pupa and the support, which is always of a vegetable nature.

Only five adult specimens, all females, were obtained by breeding from pupae collected in the different small creeks around Eagle-Hawk Neck, Tasmania, in November.

Pupae and larvae of this species were also obtained in the river at Geeveston, in Brown River near Hobart in December, and in Bruny Island in January. All these localities are in the South-East of Tasmania, to which this form seems to be restricted.

With one or two exceptions the early stages were found only on leaves, grass blades or bits of reeds dipping into the water.

Austrosimulium vexans, Mik.

Simulium vexans, Mik, Verh. zool.-bot. Ges. Wien, xxxi, p. 201 (1881).

Mik's description as given by Hutton (*) runs as follows :—

Female: "Nigro fuscum, polline cinerascenti obtectum, fronte thoracisque dorso orichalceo-pilosulis; halteribus pallidis, pedibus fuscis, geniculis metatarsisque posticis pallidis. Alarum venis posterioribus sat crassis. Long. corp. 3 mm., long. alar. 3·3 mm."

According to information kindly given by Dr. Zerny, Mik's type seems to be lost, as it cannot be traced in the famous dipterist's collection. Captain Hutton found a few more specimens of this species in the Auckland Islands, the locality of the type; they are still preserved in the collection of the Canterbury Museum, and through the kindness of Mr. G. Archey I have been able to examine them and to make some microscopic slides.

The description has to be completed as follows :—

Female.—Head with its appendages dark blackish grey, as well as the mesonotum, both with rather sparse yellow pubescence; some longer black erect hairs in front and on the scutellum. Pleurae with grey tomentum and with a chestnut area under the wing base and on the mesosternum. Halteres pale yellow, the stem darker. Legs chestnut-brown; all the knees orange, the hind ones more extensively so; anterior tibiae yellowish orange on their inner side centrally; hind metatarsi and second tarsal joint also lighter, but especially on their internal side, anterior metatarsi somewhat lighter on their basal half; pubescence of the legs brown. Abdomen blackish brown with darkish pubescence, the lateral basal tufts yellowish; the tergal plates of the segments 3–5 rather small and chestnut on the disk.

Frons one-quarter the width of the whole head (7 : 30).

Antennae ten-jointed; the first joint half as long as the second, which is subequal to the third and as long as wide; fourth joint nearly twice as wide as long, the following ones gradually increasing in size, the ninth being as wide as long; last joint conical, twice as long as wide.

Palpi with the first two joints short, the third equal to the fifth and the fourth one-third shorter.

Wing venation as usual.

Legs: front tarsi not dilated, only a little longer than the middle ones; hind legs moderately incrassate, the metatarsi not so wide as the tibiae, and provided with an internal distal lap which is as wide as the metatarsus itself and reaches the first third of the second tarsal joint; the latter is narrow at its base but does not present a very distinct dorsal incision. Claws with a moderately large tooth at the base (fig. 3, B).

This species is quite distinct from all those from New Zealand; on account of its toothed claws it can only be compared with *A. ungulatum,* from which it differs in the shape of the claws (which are not so much curved), in the smaller tooth, the wider lap at the extremity of the hind metatarsi, and the completely dark antennae.

Austrosimulium ungulatum, sp. n.

Female.—Antennae dark brown with the base of the third joint red. Head and mesonotum blackish brown with very short dense golden pubescence, which does not extend on the scutellum; pleurae with grey reflection; the little pleural tuft of hairs black. Halteres with whitish yellow knob and dark stem. Legs brown, with some dark ochraceous parts, namely, the extreme base of all the tibiae, the ventral

(*) Trans. N.Z. Inst. xxxiv, 1901, p. 169.

part of the front tibiae, the proximal half of the front and middle metatarsi, and nearly all the hind metatarsi except the tip and the ventral edge. Pubescence of the legs completely yellow. Abdomen dull black with very inconspicuous dark pubescence, the tufts of the basal segment yellow.

Antennae 10-jointed; the relative lengths of the joints about as in *A. vexans*. Palpi also similar, the last joint only being a little longer. Frons equal to a fourth of the whole width of the head. Venation as usual. Front and middle tarsi not dilated, the former a little longer than the latter. Hind metatarsi with a terminal lap nearly as wide as themselves, second tarsal joint with a very shallow incision at its base dorsally. Claws well curved, with a very conspicuous simple basal tooth (fig. 3, A). Genitalia as shown in fig. 5, B. Length of wing 3 mm.

Male unknown.

Type in the collection of the Cawthron Institute, collected at Reefton, 13.i.1922.

This wide-spread and frequent species has been found in the following localities in the South Island:—Nelson, all the year round; Mt. Arthur, 4,500 ft., December; Pokororo, December; Waiho, South Westland, January; Otira, Southern Alps, February; Lake Brenner, February; Kaikoura, East Coast, February; Dunedin, October; Kingston, September; Lake Manapuri, September, October; Doubtful Sound, September.

It has not yet been recorded from the North Island; it is a fierce biter.

It is very closely related to *A. vexans;* the points of difference between them have been given under the latter species.

Although this is one of the most common species, I did not succeed in obtaining its early stages even by breeding through a great number of larvae from the vicinity of Nelson, where *A. ungulatum* is frequently met with.

Austrosimulium australense, Schin.

Simulium australense, Schiner, Reise Fregatte Novara, Zool. ii, p. 15.

Schiner's description runs as follows:—

"Schwarzbraun, Ruckenschild heller bestäubt, um die Schulterecken gelb. Schenkel an der basis, die Beine um die Metatarsen gelblich. Flügel rein glashelle; die Randader welche die Flügelspitze bei weitem nicht erreicht, intensiv schwarz, die übrigen Adern bräunlichgelb; Discoidalader bis zur Querader dick, dann sehr unscheinbar, ihre Gabel kurz gestielt; Postical und Analader unscheinbar. $\frac{3}{4}$'''.—Auckland."

This description, which Schiner himself recognises as insufficient, could be applied to any of the six species found on the main islands of New Zealand.

Through the kindness of Dr. Zerny, I have been able to examine the type, which is preserved in the Vienna Museum. This female specimen, which was already in bad condition when in Schiner's hands, has now lost its head and abdomen. The thorax is without vestiture, and the wings and legs that remain do not give enough characters to arrive at a certain identification.

I am therefore giving below the description of both sexes of a species obtained from pupae collected in the vicinity of Auckland, the locality of the type.

Male.—Length of wing 2 mm. Body and appendages completely dark, blackish brown; the dorsum of the thorax and the abdomen velvety; the extreme base of the tibiae slightly ochraceous. Halteres completely black. Pubescence of the mesonotum of a very dark bronzy colour, short, adpressed, very dense and regularly distributed, not extending on the scutellum, which carries the usual longer erect black hairs as well as the prescutellar region. The pubescence of the abdomen and legs is also blackish.

Antennae ten-jointed ; the first joint half the size of the second, which is as wide as long, and so is the third ; the following ones are subequal in length, but their width gradually diminishes towards the extremity of the antennae, the last joint rather pointed, more than twice as long as wide.

Palpi with the third joint very little longer than the fourth, and somewhat shorter than the last ($5 : 4\frac{1}{2} : 6$).

Venation as usual.

Legs : front and middle tarsi not dilated, the middle ones longer ; hind legs somewhat incrassate, the metatarsi without a row of bristles but provided with a rounded internal terminal lap which is but little narrower than the metatarsus itself ; it reaches a little over the dorsal incision of the second tarsal joint.

Hypopygium with the claspers subequal in length to the side-pieces, and provided at their extremity with two or three teeth ; very often two on one side and three on the other. The aedoeagus is, as usual, in the shape of a violin bridge.

Female.—Same size as the male ; greyish black ; antennae, palpi and legs brown ; knob of halteres yellowish; pubescence of metanotum and legs yellowish, that of the abdomen brown with exception of the basal side-tufts, which are light.

The width of the frons is one-quarter that of the whole head. Antennae with the middle joints relatively shorter than in the male, being therefore distinctly wider than long. Palpi with the third and fourth joints subequal to each other, the fifth more than one half longer ($5 : 8\frac{1}{2}$). Wings and legs as in the male ; the claws simple. Genitalia of the usual type.

Larva.—The larva of this New Zealand species does not differ from the majority of those of Australia. The dark markings of the body are little distinct, whereas those of the frontoclypeus are nearly always rather conspicuous ; they are composed of a median line ending anteriorly in a series of dark points, and of a group of three points on each side of the middle of the median line, so that when seen at a low magnification the head seems to be provided on its basal two-thirds with a dark cross besides the dark edging round its base. The antennae (fig. 8, D) are distinctly longer than the basal piece of the mouth-fan ; their very thin second joint is three times as long as the first cylindroconical joint. Thoracic gill spot as in fig. 7, G. The indentations of the mentum practically do not differ from those of most of the Australian species, *A. cornutum*, *A. torrentium*, etc., as shown in fig. 9, B. The anal gills are also composed of three simple, moderately long digitations. The anal armature on the dorsal side is as shown in fig. 10, A ; it sends along the crown of hooks on each side a rod which stops in front of a small chitinous plate of variable shape, but generally triangular ; these two small plates are united by a thin black rod at the base of the crown of hooks on the ventral side. The rows of the anal crown contain from ten to twelve hooks.

Pupa.—Dorsum of the thorax very finely granulated and carrying three pairs of very inconspicuous hairs. Breathing organs (fig. 12, G) composed of a long dark brown horn, flattened ventro-dorsally, and with subparallel sides in its basal half, its distal end tapering. The upper face of this horn carries longitudinal rows of very fine spinules that are also to be found on the sides. The breathing filaments number about 40 and are inserted especially on the edge of the horn and on its ventral face ; these filaments are thin and flexible and vary in length from that of the horn to one-and-a-half times that length.

Cocoon.—The texture is moderately rough ; it is in the shape of a wall-pocket with a rather tapering inferior end when it is built on some narrow support like a grass blade, but when built on a leaf it is much flatter and its contour is nearly circular.

Besides the specimens obtained at Auckland, this species has also been met with in the North Island at Te Aroha, Rotorua, Wairakei, Ohakune, and in the South Island at Nelson.

A. australense seems to go on breeding the whole year round. In its early stages this species is to be found only on the aquatic vegetation of small rivulets; they favour especially watercress leaves, but they also breed on ordinary grass-blades or any other plant leaves dipping into the water. As mentioned in the chapter on the bionomics, this is a man-biting species, and its habitat seems to be chiefly the North Island of New Zealand.

Austrosimulium tillyardi, sp. n.

Male.—In the adult stage this species differs very little from the preceding one, *A. australense*; some details of coloration, however, make differentiation possible. The legs are lighter, the base of the femora, the tibiae and part of the tarsi being of a dark ochraceous colour; the legs seem lighter also on account of their short pubescence being completely bronzy yellow. The pubescence of the mesonotum is brassy yellow and distinctly longer than in *A. australense*; that of the abdomen is also lighter. The knob of the halteres is of a dark ochraceous colour.

The antennae, palpi and legs present practically no difference in the relative lengths of their joints from those of the preceding species. The genitalia are also exactly the same, the claspers being sometimes provided with two or three teeth at their extremity.

Female.—Similar and scarcely distinguishable from *A. australense.* The pubescence of the mesonotum is somewhat coarser, longer and less dense. The legs are slightly lighter, their integument being of a dark ochraceous colour at base of femora, tibiae and metatarsi; the pubescence, which is somewhat coarser and brighter, makes them also appear lighter.

Larva.—Similar to that of *A. australense,* from which it can only be distinguished when full grown by the shape and structure of the gill spots showing through the skin (fig. 7, I). The markings of the head are practically always so faint that no definite pattern can be made out. Anal armature as in fig. 10, F.

Pupa.—Dorsum of thorax coarsely granulated; that of the head finely but very densely. Breathing organs (fig. 12, I) composed of a rather short, dark basal horn on the edge of which are inserted about fifteen rigid, rather thick filaments forming a compact tuft slightly bent inwards and about four times as long as the basal horn.

Cocoon.—Of a rather smooth texture; it presents the shape of a slipper and is always closely adapted to the body of the pupa.

The *type* and allotype were obtained from pupae collected at Nelson in the Maitai River, where *A. tillyardi* in its early stages is to be found in great numbers all the year round on the shingles. I have collected this species in its early stages also in Aniseed Valley (Nelson district), Reefton (West Coast), on the Banks Peninsula (Little River, Purau Creek), and in the vicinity of Wellington. It has not been possible to ascertain if this species bites man.

Austrosimulium laticorne, sp. n.

In the adult stage and in both sexes this species is so exactly similar to *A. tillyardi* that it cannot be differentiated from it unless it be obtained through breeding from pupae, which in the structure of their breathing organs differ noticeably from the other species.

Several males and females were hatched from pupae collected at Waiho (West Coast, S.I.). They were found on some aquatic plants in a swift-flowing rivulet in company with *A. longicorne* and *A. multicorne*. A few pupae were also encountered on the shingle of the Maitai River at Nelson. This species seems therefore not to be restricted in its habitat.

Larva.—The larva is similar to those of the two preceding species ; the markings of the head are as in *A. australense* but not nearly so distinct ; the second bristle-like joint of the antennae is only about twice as long as the first in the full-grown larva. The gill spots are as shown fig. 7, K ; the basal horn of the gill constitutes nearly the entirety of this spot, the filament being folded on it and scarcely overlapping its edges.

Pupa.—The pupa is characterized by its breathing organs (fig. 12, K), which are of a type related to those of *A. australense*, but here the black basal horn is much shorter and broader, more or less spatuliform ; strongly flattened ventro-dorsally, its surface is very finely granulated but not spinulous ; the filaments, which number 40 to 45, are short and thin, and inserted rather regularly over the whole surface of the horn dorsally and ventrally. The dorsum of the thorax is coarsely granulated as in *A. tillyardi*.

Cocoon (fig. 13, H).—In the shape of an oblong wall-pocket, and of a rather coarse cellular structure ; it is always of a narrow shape, even when built on a flat surface.

Type and allotype from Waiho in the collection of the Cawthron Institute. This species was observed in numbers during January, but I have collected isolated pupae in Nelson towards the end of the winter. It is not certain that it bites man.

Austrosimulium multicorne, sp. n.

In the adult stage this species is exactly similar to the two preceding ones, but its size is somewhat larger, the wing length of the male being 2·5 mm. and that of the female 3 mm. It has been obtained from pupae differing widely from that of the other species in the conformation of their breathing organs.

Larva.—Length when full grown 6·5 mm. Markings of the head little distinct and when present of the same pattern as in the preceding species ; the second joint of the antennae is only one-half longer than the first, which is about six times as long as broad. The gill spot is characterised by the tuft of numerous filaments curved upwards (fig. 7, H).

Pupa.—With dorsum of thorax rather coarsely granulated ; breathing organs (fig. 12, H) composed of a short dark basal lance-shaped piece, on the edge of which are inserted distally about 35 long, thin, flexible breathing filaments ; they are usually simple, but sometimes a few may be furcated towards the middle of their length. The cocoon, of smooth texture, is in the shape of a slipper.

Type and allotype obtained from pupae collected on Mt. Arthur tableland (4,000 ft.) in the collection of the Cawthron Institute ; a good series of paratypes was obtained from the same locality, where the larvae and pupae were rather abundant on some aquatic grass in a small rivulet. Pupae of this species were also collected in the same kind of habitat at Waiho (West Coast, S.I.), Lake Brunner, Otira, on the East Coast at Kaikoura, and in the North Island at Ohakune from December till March.

Austrosimulium longicorne, sp. n.

The male and female of this species do not seem to differ from those of the preceding one, *A. multicorne* ; they are also of the same size.

Larva.—Identical with that of *A. multicorne*, including the conformation of the antennae and the markings of head and body. The gill spots (fig. 7, J) are rather large and show the long filament coiled in a spiral.

Pupa.—Dorsum of thorax rather smooth, with a pair of small bristles. Breathing organ (fig. 12, J) composed of 10 to 15 slender flexible filaments nearly as long as the pupal body itself and branching from a very short common stem that is not strongly chitinous and cannot therefore be compared with the basal horns of the other New Zealand species. The number of these filaments varies according to individuals, and is often not the same on both sides; sometimes one of the filaments, or very rarely two, may be bifurcated.

Cocoon.—Of smooth texture and in the shape of a wall-pocket; that is to say, the inferior edge of the circular anterior opening touches the support.

The *type* and allotype of this species, which are in the collection of the Cawthron Institute, were obtained with a good series of paratypes from pupae collected at Kaikoura (East Coast, S.I.) in February. A few others were collected also at Waiho (West Coast), Ohakune and at Nihotapu (North Auckland). In all cases the early stages were found in small rivulets, either on aquatic grasses, watercress leaves, or on ordinary grass-blades dipping into the water. It has not been ascertained if this species bites man.

Summary.

1. In this paper five species of *Simulium* and 16 species of *Austrosimulium* are dealt with.

2. The new genus *Austrosimulium* differs mainly from the former in the number of joints in the antennae, which are ten instead of eleven; it seems to be restricted to the Indo-Australian region.

3. In many cases the species of *Austrosimulium* cannot be differentiated from each other in the adult stage, although they are perfectly different in their early stages and especially in the pupal stage.

4. Seven species of *Austrosimulium* occur in New Zealand: *A. vexans*, Mik, *A. ungulatum*, sp. n., *A. australense*, Schin., *A. tillyardi*, sp. n., *A. longicorne*, sp. n., *A. multicorne*, sp. n., *A. laticorne*, sp. n. Only the first two of these are distinguishable from the others in the adult stage; the remainder can only be differentiated in the pupal stage or the late larval stage.

5. Five out of these seven New Zealand species are known in their early stages.

6. In Australia (including Tasmania) five species of *Simulium* and nine of *Austrosimulium* are known to the writer, *i.e.*: *S. aurantiacum*, sp. n., *S. fergusoni*, sp. n., *S. ornatipes*, Skuse, *S. umbratorum*, sp. n., *S. terebrans*, sp. n., *A. crassipes*, sp. n., *A. cornutum*, sp. n., *A. tasmaniense*, sp. n., *A. victoriae*, Roub., *A. furiosum*, Skuse, *A. bancrofti*, Taylor, *A. torrentium*, sp. n., *A. simile*, sp. n., *A. weindorferi*, sp. n.

The two species *A. victoriae*, Roub., and *A. furiosum*, Skuse, have not been identified with certainty, so that further investigation may show that one or two of the new species are synonymous with them.

7. The early stages of one species of *Simulium* and five of *Austrosimulium* from Australia are here described.