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THE TROUT-FOOD INSECTS OF TASMANIA.

PART I.—A STUDY OF THE GENOTYPE OF THE MAYFLY GENUS
ATALOPHLEBIA AND ITS LIFE HISTORY.

By

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Plates I. and II.

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INTRODUCTION.

The study of the more important insects which serve as food for trout in any given country is, in these days of applied science, an indispensable preliminary to a full understanding of the methods by which a successful and permanent trout-fishery can be maintained in that country. For many years I have been interested in those groups of aquatic insects which are of most importance as trout-food. But I have never found, anywhere in Australia, any public realisation of their economic importance, and thus it comes about that, even to-day, when scientific ideas have penetrated further into the public mind than ever before, it still remains impossible for any work on such insects to be carried out officially. The alternatives are, either to leave the subject alone and let the knowledge gained die with one, or to work at the subject slowly in one's spare time, in the hope that something of value may come out of it in time to save the inland fisheries of Australia from deterioration due to lack of scientific knowledge.

It is my considered opinion that the time has now come when it is imperative that a scientific survey of the trout-food insects should be carried out in all the principal trout-fishing districts of the Commonwealth. These are to be found in New South Wales, Federal Capital Territory, Victoria,

and Tasmania. From a faunal point of view, the first three are closely united, and might well be studied as a single unit, though the number and variety of the streams included would make a thorough survey a lengthy and difficult task. Tasmania, however, needs to be studied separately, not only because it is an island, possessing marked peculiarities in its aquatic fauna, but also because, in Tasmania alone, of any part of the Commonwealth, there are present fresh-water lakes suitable for trout-fishing and, in many ways, superior to the rivers.

The present paper is planned to be the first of a series to be written for the Royal Society of Tasmania, dealing with the Trout-food Insects of that State. As the Order Plectoptera, or Mayflies, is the most important order of insects considered as trout-food, I propose to deal with them first, leaving the other aquatic orders for later treatment.

When one comes to study the Mayflies of Tasmania, one is met with the remarkable fact that only two species have so far been described from that island, and that one of these has not been recognised since it was last dealt with by Eaton (1884), nor does it appear ever to have been collected again since its original capture by Dr. Hooker in 1842! As this species was designated as the genotype of the genus *Atalophlebia* (Eaton), by that author, and as that genus contains the great majority of Mayflies found, not only in Tasmania, but also throughout Australia, it will readily be agreed that the first step in our study should be a thorough examination of this species and its life-history. This is the purpose of the present paper.

THE GENOTYPE OF THE GENUS ATALOPHLEBIA

(*Atalophlebia australis*, Walker).

The genus *Atalophlebia* was proposed by Eaton in 1881, the genotype being designated as *Ephemera australis* (Walker), from Tasmania. In this genus Eaton (1884) included a number of species from Ceylon, Australia, New Zealand, Japan, South Africa, and South America. Most of these had been previously placed by him (1881) in the genus *Leptophlebia*, Wwd., Series 1.

Walker's original description (1853) devotes only a few lines each to the male imago and the subimago, the latter being queried as possibly not belonging to the same species. His descriptions deal only with colour and measurements, and hence it is not possible to determine the species with

certainty from his descriptions, but only from an examination of the actual type series. There are, however, two outstanding colour-characters in the description, viz., that the abdomen of the male imago is red (an unusual character for this genus), and that the forewings of the subimago have the black veins clouded with brown, and show "two broad, irregular, interrupted and very oblique bands." Eaton, when re-examining the type-series, made it clear that Walker intended by these latter remarks to indicate a clear space as distinct from the general shaded condition of the wing, and he describes this space as "a lambda-shaped space free of cross-veinlets and colouring, the long stroke of the latter being represented by a narrow clearing describing a gentle curve from the apex to the anal angle of the wing, and the short stroke by another narrow clearing running out from the midst of the wing-roots to the former." He adds that in some specimens the long and short strokes of the letter are separated by a little colouring.

During a recent visit to Tasmania I set myself the task of trying to solve, in my spare time, the problem of what this species really was. Arguing that Dr. Hooker probably collected either near Launceston, or near Hobart, or on one of the rivers crossed by the road connecting the two cities, I tried first the South Esk and Macquarie Rivers. I learnt from my friend Mr. Eric Hudson, of Launceston, a keen angler, that there was a rise of large Mayfly on the Macquarie River known as the "red spinner." This species was most abundant in November and December, and my visit was in February. However, at our first visit to the river, in spite of inclement weather, we succeeded in securing two female imagos and a subimago of a species which agreed closely with the descriptions given by Walker and Eaton. Later still, the same species was found commonly on Lake Leake. The nymphs were found abundantly under stones and rocks near the edge of the lake. Subimagos were reared from nymphs and imagos from subimagos, so that the specific identity of all the stages has been assured.

The next step was to gather information about the original type series, and also to have the new specimens compared with that series. I therefore wrote to Mr. D. C. Kimmins, of the British Museum, and sent him examples of the male imago in spirit. In his reply Mr. Kimmins states:

"Neither Walker nor Eaton actually fixed the type of the species. I am able, however, to recognise the imaginal example from which Eaton made his

figures for his 1871 paper, and, as far as I can tell, the other three imagines belong to the same species. . . . None of Walker's imagines have more than two tail-filaments, but Eaton quotes two measurements, so there were probably three."

Mr. Kimmins very kindly sent drawings of the hindwing and of a KOH preparation of the male genitalia, prepared from one of the examples of the type series of imagos. From these, I am able to state with certainty that the species taken on the Macquarie River and on Lake Leake, and known to anglers as the "red spinner," is the true *Atalophlebia australis* (Walker). It now remains to redefine the genus in the light of modern knowledge, to indicate the characters in which it differs from related genera, and to describe and figure the various stages of the type species. I suggest that Tasmanian anglers should adopt the name "Large Red Spinner" for the imago (both sexes), and the very distinctive name "Lambda Dun" for the subimago (both sexes).

Family LEPTOPHLEBIIDÆ.

Genus *Atalophlebia* Eaton, 1881.

Imago.—*Forewing* well supplied with cross-veins, including a complete, or nearly complete, set in the costal space. Along distal margin of wing there are no isolated veinlets, but each longitudinal vein ends either simply or with a short, curved posterior branch. CuP always strongly and more or less sigmoidally curved. *Hindwing* with the costal margin strongly arched before half-way, but never angulated, then bending down so as either to approach very close to Sc for some distance, or even to fuse with it. Sc also arched, but not so strongly. R, straight. *Legs*: In the elongated forelegs of the male, tibia and tarsus are each about half as long again as femur; first segment of tarsus very short and closely attached to end of tibia, the other tarsal segments long and slender, 2 and 3 both longer than 4, 5 shortest. Middle and hind tarsi in male and all tarsi in female shorter than tibia, and appearing only four-segmented owing to fusion of first segment with tibia; comparative lengths of segments variable for different species. Tarsal claws alike, or nearly alike, narrow, hooked at tip, and carrying a transparent flange. *Genitalia of male*: Limbs of the forceps three-segmented, the basal segment very long, the other two very short. Penis variable, more or less

deeply bilobed. *Caudal filaments* variable, some species having three, some two, and some being variable (including the genotype); cerci always very long, especially in the males.

Subimago.—Differs from imago chiefly in its opaque wings and shorter caudal filaments, of which there are usually three, rarely only two. In most species the subimaginal stage lasts for a considerable time, from one to nearly three days, but in some cases less.

Nymph.—Of the crawling type, found clinging to submerged rocks, stones, or logs; more or less flattened, capable of running quickly. *Head* fairly large, with eyes placed laterally, antennæ longer than width of head. *Labrum* more or less excavated in middle of free border. *Mandibles* with outer margins strongly curved, with two well-developed incisors; protheca present. *Hypopharynx* lobed, paragnaths strongly curved and spreading. *Maxillæ* with three-segmented palp and apically truncate inner lobe. *Labium* with three-segmented palps, broad paraglossæ and much smaller and narrower glossæ. *Legs* strong and stout, the femora rather broad, flattened, the tibia and tarsus slenderer, also flattened; *tarsal claws* denticulate. *Gills* seven pairs, on abdominal segments 1-7; each gill double, of very variable form. *Caudal filaments* three, the cerci long and stout, the appendix dorsalis usually well developed, but some times much weaker than the cerci.

Genotype.—*Atalophlebia australis* (Walker), from Tasmania. The curious form of the arched costa of the hindwing serves to distinguish this genus from all the others given by Eaton (1884). In the absence of any detailed knowledge of the genotype of *Atalophlebia*, it was, perhaps, unwise for later authors to have attempted the subdivision of this genus. Barnard (1932) separated off the South African species as a new genus, *Aprionyx*, on the character of the nymph possessing smooth tarsal claws. He did not know what the tarsal claws of the nymph of the genotype of *Atalophlebia* were like, since that nymph was then unknown. However, he argued that the Australian species were most likely to be similar to the New Zealand ones, which were known to have nymphs with denticulate tarsal claws!

Now that the nymph is discovered, it turns out that Barnard's surmise is correct. In most other respects, *Aprionyx* is very closely related to *Atalophlebia*. In imaginal characters, the only important difference that I can indicate is in the form of the penis, which is not bilobed as in *Atalo-*

phlebia, but either simple or, at most, notched at the tip. *Aprionyx* agrees with *Atalophlebia* in such important characters as the general venational scheme, including the shape of the arched costa in hindwing, in the form of the tarsal claws and genital forceps; also, amongst nymphal characters, in the general form of the antennæ and mouth-parts, notably in the broad truncated end of the inner lobe of the maxilla and the short distal segment of the palp, in the general form of the mandibles, hypopharynx and labium, though the latter has a much shorter distal segment on the palp in *Aprionyx*. The general form of the nymphs is much the same. If *Aprionyx* is to be accepted as a valid genus, it must be recognised that it is nevertheless extremely closely related to *Atalophlebia*.

Of the Chilean genus *Atalonella*, N. and M. (1924), I am unable to speak with certainty; but it appears to be distinguished from *Atalophlebia* by very slender characters. I do not regard the oblique pterostigmatic veinlets as a good generic character, since both oblique and nearly transverse types are found within the Australian species of *Atalophlebia*. *Atalonella* resembles *Atalophlebia* in the form of the penis, in having the tarsal claws of the nymph denticulate, and in other important characters. The chief distinguishing characters are to be found in the costal series of cross-veins being incomplete basally and in the different form of the hindwings.

What is really needed is a comprehensive monograph of all the forms originally included in the genus *Atalophlebia* (Eaton), with special attention to the differences exhibited by adults and nymphs in the different zoogeographical regions represented. The present paper is intended not only to clear up the situation as regards the genotype, but also to assist in laying the foundations for such a study, including a study of the abundant Australian and Tasmanian fauna.

ATALOPHLEBIA AUSTRALIS (Walker).

(Plate I., Figs. A and B; Plate II., Figs. 1-20.)

♂ *Imago* (Plate I., Fig. A).—*Total length* of body (dried), 8 to 11 mm.; *abdomen*, 5 to 7 mm. *Forewing*, 9.5 to 12 mm.

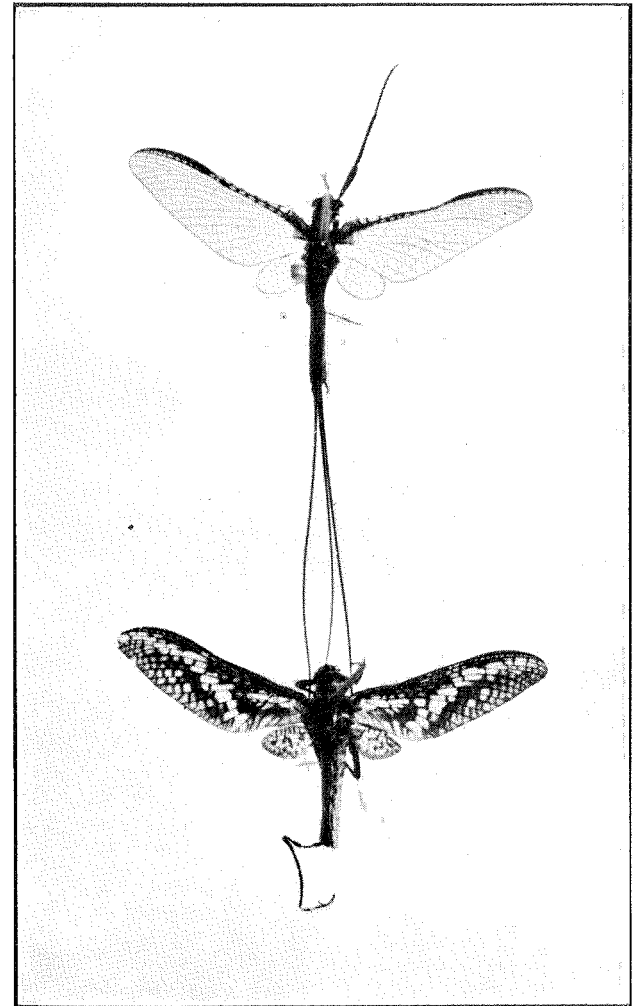
Head.—General colour black, with a touch of reddish-brown on the occiput; *antennæ* very short, dark brownish; *compound eyes*, with the large inner division brownish-grey, the smaller outer division grey; *ocelli* greyish-white; parts around the mouth reddish-brown.

Thorax.—Shining black above, with two small, reddish-brown spots near posterior angle of mesonotum. Sides mottled in black and reddish-brown, with two very irregular patches of whitish, one close to the base of each wing, the white in each case more or less surrounding a dark brownish patch extending obliquely away from the wing-base. *Legs*: Forelegs (Fig. 4) 7-9 mm. long, blackish, tinged with brown at base of femora and on tarsi; tibia about equal to tarsus in length, and each of these half as long again as femur; comparative lengths of tarsal segments, in descending order, 2, 3, 4, 5, 1; middle and hind legs (Fig. 5) about 5 mm. long, reddish-brown; comparative lengths of the four visible segments (omitting 1), in descending order, 5, 2, 4, 3. *Tarsal claws* (Fig. 6) rather long, slender, similar, terminally hooked, and each carrying ventrally a transparent flange extending apically as far as base of hook, where it is strongly angulated.

Wings.—*Forewing* (Fig. 1) subtriangular, with tornus at about two-sevenths of wing-length. Costa nearly straight from brace to pterostigma, carrying a complete series of costal veinlets, 7 to 10 in number up to the bulla; pterostigma beginning not far distant from bulla, and carrying a large number of oblique veinlets, some simple, some distally forked, and a few connected by cross-struts. General colour of all veins reddish-brown, a part of C, R., and MA somewhat darker than the rest. Wing-membrane mostly hyaline, but base of wing up to brace suffused with yellowish-brown, and the costal and subcostal spaces appearing throughout also more or less suffused with pale reddish-brown owing to suffusion of the cross-veins in these areas; this suffusion is most marked in the pterostigma and on the whole of the cross-veins of the subcostal space; in particular, there is a dark suffused patch around the cross-vein below the bulla, and a much larger suffused patch for two cellules below the beginning of the pterostigma. The cross-venation is sparse between the branches of Rs, except distally, and also basally between the branches of MA, MP, and CuA. *Hindwing* (Figs. 2, 3) 2 to 3 mm. long, the costal margin strongly curved to about half-way, where it bends downwards so as almost to meet Sc, and then runs very close above it, finally meeting it at about four-fifths of the wing-length. Most of the broad portion of the costal space is devoid of cross-veins, but there are two or three present just as it begins to narrow, and usually several more in the extremely narrow part. In some of the specimens, particularly those of smaller

size, the costa meets Sc more quickly, at about two-thirds of the wing-length, and thus the narrowed portion of the costal space is much shortened (Fig. 3). Sc is evenly arched upwards from base to where it approximates to costa; thence onward it is nearly straight. R_1 is usually straight, forming, as Eaton put it, "the chord of the arc" above it. A complete series of cross-veins exists between Sc and R_1 , but the individual cross-veins are variable in position in different specimens. R_s is secondarily attached to MA, with or without a free piece of the original stem remaining basally; it carries a single triad. MA is either simple or with only a single terminal posterior branchlet. MP has a well-developed triad arising before half-way and usually a short terminal branchlet on MP_1 . Both CuA and CuP are fairly straight veins with well-developed terminal branchlets. 1A is a simple, curved vein. The wing is very broad in the middle, about two-thirds as wide as long, but distinctly narrow basally, the posterior margin from base to end of 1A being almost straight.

Abdomen.—Seg. 1 short, broad, blackish, closely attached to thorax; 2 short; from 3 to 7 the segments become progressively longer and somewhat narrower; 8 as long as 7, broadening slightly distally; 9 two-thirds as long as 8, slightly angulated or spined postero-laterally; 10 considerably shorter and a little narrower than 9. Segs. 2-10 generally deep reddish in colour, 2-3 slightly tinged with reddish-black above and on sides, 4-8 on sides only, 9-10 slightly darkened; some indication generally of a paler transverse band along posterior margin of 2-7, and in some specimens also of a paler mid-longitudinal line. *Genitalia* as in Figs. 7-8, the forceps-basis rather short and broad, slightly notched in middle of posterior border; forceps three-segmented, the first segment fairly broad basally, very long, the distal half of the inner margin somewhat narrowed or excavate; second and third segments very short, subequal in length, suboval in shape, the two taken together only about one-sixth the length of the basal segment. Penis broad at base, tapering distally by its sigmoidally curved sides to two diverging apical lobes separated by a deep subtriangular cleft; each apical lobe bears ventrally a curious structure which appears to be a sac or pocket of delicate chitin, the two pockets being just in contact on the middle line. Viewed in profile (Fig. 8) the penis is nearly straight, a little inclined upwards distally and narrowed for its distal third; the pockets can be clearly seen just projecting ventrally. In some specimens



ATALOPHLEBIA AUSTRALIS. (Walk.)

Imago and Subimago—Enlarged.

the median cleft does not reach as far as the pockets, in others it appears to pass well down below them. *Cerci* stout, 17-25 mm. long, blackish with reddish-brown tips; *appendix dorsalis* extremely variable, being entirely absent in some specimens, short and slender in others (from one-third to one-half as long as cerci), and, in others again, almost as long, though not as stout as the cerci; colour blackish.

♀ *Imago*.—Differs from the male in being of somewhat stouter build and often of darker colouration; the reddish-brown shading along the costal margin of forewing is more pronounced. Forelegs shorter than in male, 5 to 6.5 mm., tarsus with only four distinct segments, 1 being fused with tibia; comparative lengths of segments, in descending order, 5, 2, 3, 4; colour blackish. *Subgenital plate* entire; *subanal plate* deeply, almost semi-circularly, excised (Fig. 9). *Cerci* generally somewhat shorter than in male, 15 to 20 mm. long; *appendix dorsalis* equally as variable as in male.

Subimago (both sexes) (Plate I., Fig. B).—General appearance when freshly emerged, black, with the pattern of the folded wings blackish and very prominent. In the dried specimen, the body-colouring becomes black tinged with greyish, and the shaded areas of the wings dark fuscous, with a slight indication of brown along the costa. The general pattern of the forewings is brought about by the irregular placing of the cross-veins and their being more or less shaded with blackish. This pattern may best be described as a general rather mottled dark ground colour, with a hyaline space in the form of a Greek letter *lambda* or an inverted uncial Y. The long stroke of the *lambda* begins at the apex, and runs with a gentle curve concave to the outer margin, so as to end at a point a little beyond the tornus; the short stroke runs from the wing-base between MP and CuA, and usually, but not always, fails to meet the long stroke at about its lower third owing to the presence of two clouded cross-veins, one between MP₁ and MP₂, the other between MP₂ and CuA. The heaviest shading occurs along the margins of the *lambda*-mark, along the whole of the costa except near its middle, over the whole of the pterostigma and also below its middle portion. In the hindwing, all the cross-veins and terminal branchlets are heavily shaded. *Legs* blackish, with a touch of brown on femora. *Caudal filaments* much shorter and more weakly developed than in imago, greyish-brown.

Nymph (Figs. 10-20).—*Total length* (excluding tail-filaments), 9 to 11.5 mm. *Cerci*, 10 to 14 mm.; *appendix dorsalis* generally slightly shorter.

General form subcylindrical, broadest across mesothorax, the thorax and abdomen convex above, flattened beneath. General colour a rich brown. *Head* about as long as wide, broadest across the eyes, which are black and situated postero-laterally; in front of the eyes runs a pale transverse line indicating the suture between epicranium and frons; ocelli blackish, the two lateral ones set just behind the suture, in line with the anterior angle of the eyes; the median one well forward. *Antennæ* about half as long again as the head, very slender, pale semi-transparent brownish-yellow, set wide apart and just forward of the median ocellus. *Clypeus* and *labrum* much narrower than frons, the outer contour of the head laterally being completed by the broadly rounded outlines of the mandibles.

Mouth-parts.—*Labrum* (Fig. 13) about twice as wide as long, its lateral borders well rounded, with short hairs, middle portion of anterior border hollowed out, the sides of the hollow weakly crenulate; surface generally hairy, there being two sets of short, dense hairs arranged transversely, one on either side of the middle line, and two slightly curved rows of closely set sockets carrying longitudinally directed hairs, one row curving around the median incision of the free border, and a shorter row further basad, crossing the two sets of transverse hairs. *Mandibles* (Fig. 14) strong and stout, with very curved outer margins; incisors large and separate, each subdivided apically into two or more separate teeth; *prostheca* inserted close to inner incisor and consisting of a slender process, shorter than the incisor, smooth in the right mandible and apically crenulate in the left, together with a brush of hairs about twice as long (Fig. 15); molar areas with a grid formed of about a dozen transverse ridges or laminae, each fringed with minute, delicate hairs closely set; in the right mandible, the molar area ends in a very acute process, the two mandibles working together very asymmetrically. *Hypopharynx* (Fig. 16) very complex, consisting of a divided median lobe fairly strongly chitinised around the edges, and two slenderer, pointed processes of very thin, transparent chitin, longer than the median lobes; *paragnaths* large, transverse, strongly curved backwards, the anterior border with a complete fringe of hairs. *Maxillæ* (Fig. 17) with three-segmented palp, the basal segment subcylindrical, smooth, the middle segment narrowed basally, longer than the basal segment, and carrying a series of stiff setæ on the inner surface and scattered soft hair along the outer margin, the distal segment very

short, about half as long as the middle segment, and with plentiful soft hairs on its outer margin to tip; inner lobe broad and truncate, with a dense brush of curved hairs along the whole of its outer margin. *Labium* (Fig. 18) with three-segmented palp, the basal segment transverse, broad, the middle segment narrowed basally, not so wide, about as long as the basal one; the distal segment cornute, with short, stiff setæ along inner margin and a row of about six longer ones placed longitudinally on outer surface; glossæ small, close together, standing out almost at right-angles to the rest, and resembling the soles of a pair of feet standing together; in Fig. 18 they are shown as pressed down on a slide with cover-slip; *paraglossæ* large and broad, the outer margins strongly curved and very hairy, the inner margins forming almost a right angle with them, straight and almost touching the glossæ; distal half of surface very hairy.

Thorax strongly built, convex but not humped. *Prothorax* well developed, about as wide as head, less than half as long as wide, the anterior margin concave, the posterior straight, the lateral margins produced into a narrow, curved, transparent flange; colour dark-brown, with a pale mid-longitudinal line. *Pterothorax* (combined meso and meta-thorax) generally dark-brown, slightly mottled with paler patches, and having a pair of rather indistinct dark blotches near antero-lateral angles; the pale mid-longitudinal line of the pronotum is continued very faintly backwards for some distance on the mesonotum; wing-sheaths broad, reaching to end of third abdominal segment, dark brownish. *Legs* (Fig. 11) subequal, the middle pair slightly shorter than the other two, the fore pair with the femora slightly broader and tibiæ slightly longer than the others; femora broad, flattened, armed with numerous short, stiff setæ; tibiæ narrow, cylindrical, somewhat flattened, a little longer than femora in forelegs, a little shorter in the other two pairs, inner margin armed with fine hairs and setæ; tarsi about half as long as tibiæ, flattened cylindrical, slightly narrower, inner margin armed with short setæ; *tarsal claw* (Fig. 19) well developed, about half as long as tarsus, strongly hooked at apex, and carrying a series of fine denticles along its inner margin. Colour medium brown, banded with darker brown, as follows:—Femora with three bands, an indistinct one near base, and two fairly well defined bands, one across middle and one near apex; tibia with a rather narrow basal band and a

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Thorax strongly built, convex but not humped. *Prothorax* well developed, about as wide as head, less than half as long as wide, the anterior margin concave, the posterior straight, the lateral margins produced into a narrow, curved, transparent flange; colour dark-brown, with a pale mid-longitudinal line. *Pterothorax* (combined meso and meta-thorax) generally dark-brown, slightly mottled with paler patches, and having a pair of rather indistinct dark blotches near antero-lateral angles; the pale mid-longitudinal line of the pronotum is continued very faintly backwards for some distance on the mesonotum; wing-sheaths broad, reaching to end of third abdominal segment, dark brownish. *Legs* (Fig. 11) subequal, the middle pair slightly shorter than the other two, the fore pair with the femora slightly broader and tibiæ slightly longer than the others; femora broad, flattened, armed with numerous short, stiff setæ; tibiæ narrow, cylindrical, somewhat flattened, a little longer than femora in forelegs, a little shorter in the other two pairs, inner margin armed with fine hairs and setæ; tarsi about half as long as tibiæ, flattened cylindrical, slightly narrower, inner margin armed with short setæ; *tarsal claw* (Fig. 19) well developed, about half as long as tarsus, strongly hooked at apex, and carrying a series of fine denticles along its inner margin. Colour medium brown, banded with darker brown, as follows:—Femora with three bands, an indistinct one near base, and two fairly well defined bands, one across middle and one near apex; tibia with a rather narrow basal band and a

broader band covering about the first two-thirds of the distal half; tarsus with a broad band covering a little more than the basal half.

Abdomen convex above, flattened beneath, tapering gradually from base to apex; the segments lengthening from 1 to 8, but 8 only slightly longer than 7; 9 markedly shorter than 8 and slightly narrower; 10 much shorter and narrower than 9. Segment 1 has no lateral flange, and its postero-lateral angles are almost right-angles; segments 2 to 9 carry lateral flanges produced postero-laterally into sharp, backwardly directed spines; the spines of segment 2 are the smallest, those of succeeding segments becoming larger up to segments 7 and 8, that of segment 9 smaller again; segment 10 has the postero-lateral angles slightly prominent, rounded. Colour of abdomen dark-brown, with a pale, whitish, subtriangular spot covering the middle of each suture from 1-2 to 8-9; a pair of small, oval, pale-brown spots placed antero-laterally on segments 2-9, the dark-brown surrounding them running out on to the flange beyond them; less distinct but larger pale areas are indicated postero-laterally but closer together, but these are only at all well indicated on segments 4 to 9; segment 10 darkest at sides and posteriorly. On the flanges of segments 2 to 7 there is an oblique blackish patch near the insertion of each gill; tips of all lateral spines slightly darkened. *Gills* (Fig. 20) seven pairs, each gill consisting of a pair of lamellæ prolonged into three slender, pointed, digitate processes; the outer and upper lamella is somewhat narrower than the inner and lower, and has a stout tracheal trunk which gives off short weak branches basally followed by strong branches into each of the three digitate processes; the inner and lower lamella is broadened on one side, and the three tracheæ running into the processes arise separately from near the base of the lamella. In the natural position, the upper lamella partly conceals the lower; in Fig. 20 they have been separated to show their full outlines. The largest gills are on segments 2 to 5, those of segments 1 and 6 are smaller, about equal; those of segment 7 the smallest and shortest of all.

Types.—In reply to a letter inquiring about the type series in the British Museum, Mr. D. E. Kimmins has very kindly supplied the following information:—"As the type of the species has not been fixed, I would suggest that you designate the imago figured by Eaton as the type (it is the most complete)." This course would seem to be a wise one,

and I therefore adopt it here, designating the specimen indicated by Mr. Kimmins as the *holotype* male imago of the species. The remaining male imagos thus become paratypes. A female imago from my own collection is designated as the allotype.

The problem of the subimago described by Walker is not so easy, since it will be remembered that he attached a query to the word in his description, thereby indicating his doubt as to whether it really belonged to this species. It appears, therefore, wiser to make quite certain by designating a good specimen of the subimago from my own collection as type subimago, and a specimen of the nymph, also from my own collection, as type nymph. In order that these may all be readily accessible to students, they are being presented to the British Museum Collection.

Localities.—Macquarie River and Lake Leake, Tasmania (February, 1933). The specimens taken on the Macquarie River are generally somewhat smaller than those from the lake, where the conditions are exceptionally favourable for the nymphs.

Habits.—The nymphs are found under logs, rocks, or stones submerged in the water, either along the edge of the river or close to the shore of the lake. It evidently feeds on humus and decayed vegetable matter. On opening the mouth of a captured nymph, it will be found to be full of minute particles of vegetable material brushed off and collected by the action of the mandibles and maxillæ. The nymph is a sluggish creature, but can run fairly quickly when attempting to escape.

The few subimagos captured were all taken on cold, windy days, either clinging to reed-stems near the margin of the river, or resting on the ground some way back from the lake, during a strong gale. The lambda-pattern of the wings is very conspicuous in the resting position, and makes this subimago comparatively easy to recognise, though those of certain other as yet undescribed Tasmanian species approach it fairly closely.

The imagos were taken, in the case of the Macquarie River specimens, either drowned and floating on the water, or by rearing from subimagos. At Lake Leake, in spite of the high wind, they were caught flying strongly against the wind, along the shore of the lake. Every time the wind

abated slightly, the Mayflies would be on the wing at once, buffeted about as they were, until compelled again to take shelter by resting on the ground, or on rocks or the trunks of near-by trees.

VALUE AS TROUT-FOOD.

Mr. E. Hudson informs me that there is a big rise of this Mayfly on the Macquarie River in November and December, and that the trout feed on it readily. Observations are required concerning the method of disclosure of the subimago from the nymphal skin; especially whether any considerable number of nymphs emerge quite close to the banks, or whether most of them rise well out into the stream, so that the floating subimago or "lambda dun" becomes an attractive bait for the rising trout while it is drifting towards the shore. Further observations should also be made to determine the dates of the first and last appearances of this Mayfly during the season. It is known already that it lasts from November to the end of February, and it evidently constitutes one of the most important articles of food for trout in the Macquarie River.

As regards Lake Leake, I was not able to go out on the lake and dredge the bottom for nymphs, nor did I see any rise of the Mayfly during the hour or so that I was there. All the nymphs that I found were clustered on the undersides of submerged stones, rocks, and logs along the edges of the lake; in these places they were very abundant, twelve full-grown nymphs being taken from beneath one small submerged stone. The value of the species to anglers on the lake depends largely on how frequently the nymphs rise to the surface well out from the shore, so that the "lambda duns" have to drift on the surface of the lake before reaching shelter, and also on whether or not the imagos or "large red spinners" do normally, in bright sunny weather, fly over the lake in such a way as to attract the trout to rise at them.

It would manifestly be unwise to disturb the balance of nature on Lake Leake by the introduction of other species of Mayflies until such time as the above observations have been carefully made. Further, a complete survey of the Mayfly fauna of the lake is required, including the life-histories and distribution throughout Tasmania of the species found there. When that has been done, the value of such an experiment as the introduction of the nymphs of

the "Penstock Brown" or other species of Mayfly can be scientifically calculated, and it may well be that such introductions may then be shown to be desirable for the improvement of the trout-fishing.

In the meanwhile, I think that the supply of this Mayfly in the Macquarie River could be augmented, or at any rate prevented from dropping, by a judicious use of more or less decayed timber, such as rotten logs. When old willows or gum-trees are cleared away near the river, they might be cut into convenient lengths, and placed in various parts of the river in such a way that they are not likely to become snags for the anglers. The Mayfly nymphs will find their way to these logs in large numbers, and, hiding in their cracks and crannies, proceed to obtain a rich living from the vegetable material which collects on them and from the products of their decay. In Lake Leake there would appear to be already a plentiful supply of decaying wood, since part of the area submerged to form this lake was originally forest. This is probably one of the chief reasons for the abundance and large size of *Atalophlebia australis* on this artificial sheet of water.

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LEGENDS OF FIGURES, PLATE II.

FIGS. 1-9. *Atalophlebia australis* (Walk.).

Imago, parts.

- FIG. 1. Forewing, with New Notation of Venation. A_1 , A_2 , A_3 , the three convex anal veins. IA the interpolated concave anal vein; CuA, anterior cubitus, convex; CuP, posterior cubitus, concave; MA, anterior median, convex; MA_1 , MA_2 , its branches; IMA, interpolated concave sector of triad; MP, posterior median, concave; MP_1 , MP_2 , its branches; IMP, interpolated convex sector of triad; pt pterostigma; R_1 , radius; Rs , radial sector; R_2 to R_{4-5} , its branches; IR_2 , IR_{3a} , IR_{3b} , interpolated convex sectors of triads; Sc, subcosta (x 10).
- FIG. 2. Hindwing of same specimen as Fig. 1, enlarged twice as much (x 20). Lettering as in Fig. 1.
- FIG. 3. Hindwing of holotype male, from drawing sent by Mr. D. O. Kimmins.
- FIG. 4. Tarsus of foreleg of male (x 20), with portion of tibia.
- FIG. 5. Tarsus of hindleg of male (x 20), with portion of tibia.
- FIG. 6. Tarsal claws from hindleg of male (x 100).
- FIG. 7. Genitalia of male, dorsal view after removal of tenth tergite and appendages (x 50). gp lateral gonapophysis or forceps-basis; pe penis; st gonostyle.
- FIG. 8. The same, viewed laterally. Lettering as in Fig. 7.
- FIG. 9. Subanal plate of female imago (x 40).

FIGS. 10-12. *Atalophlebia australis* (Walk.).

Nymph and parts.

- FIG. 10. Nymph (x 10). Colour-pattern omitted except on abdominal segments 5-8; gills only represented on left side, so as to show shape of abdominal segments on right; caudal filaments cut short.
- FIG. 11. Middle leg (x 32).
- FIG. 12. Basal segments of cercus (x 100).

FIGS. 13-20. *Atalophlebia australis* (Walk.).

Parts of nymph.

- FIG. 13. Labrum (x 50).
- FIG. 14. Mandibles, dorsal view (x 50).
- FIG. 15. Prosthema of left mandible (x 100).
- FIG. 16. Hypopharynx and paragnaths (x 50).
- FIG. 17. Maxilla (x 50).
- FIG. 18. Labium (x 50).
- FIG. 19. Tarsal claw (x 100).
- FIG. 20. Pair of gills from second segment of abdomen, with the two lamellæ well separated to show their complete forms; the outer and upper lamina above the inner and lower lamina below (x 30).

