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New Species of Hydracarina, With a Description of the Life-History of Two.

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Abstract

SIX species of Hydracarina are described, all of which are regarded as new, *Hydrachna maramauensis, H evansensis H wainuiensis, Piona novae-zealandiae, Arrenurus rotoensis* and *A. lacus*. The three *Hydrachna* show a close relationship to the overseas *H. processifera* in several features, but on other characters would be placed in a different subgenus. The two *Arrenurus* species are closely allied and their nearest relative is probably *A fissipetiolatus*, an Australian species The life histories of two New Zealand species, belonging to two different genera, are described and shown to agree with the general pattern, except that the *Piona* species apparently has no parasitic stage. The method by which the larva hatches, its attachment to the host and the emergence of the nymph and adult are described for the first time in the genera Differences between the life-histories of the three species *Eylais waikawae, Hydrachna maramauensis* and *Piona novae-zealandiae* are discussed, especially the two methods by which the larvae hatch.

INTRODUCTION

A species of *Hydracarina* from New Zealand is described in another paper in this Journal, and six more new species are now added, making the total described from New Zealand up to eight. All of the species described in this paper have been collected in the Wellington Province with one also recorded from Otago. They all belong to cosmopolitan genera and subgenera, according to the zoogeographic distribution given by Lundblad (1941). It is probable that several more species are present in New Zealand, but they may all belong to established genera.

Order: ACARI
Suborder: TROMBIDIFORMES
Cohort: PROSTIGMATA
Subcohort: PARASITENGONA
Superfamily: HYDRACHNAE Muller, 1776 (in part); Viets, 1931
Family. HYDRACHNIDAE Leach, 1815; Kramer, 1877.
Subfamily: HYDRACHNINAE Piersig, 1896 (part Claus, 1880)
Genus. HYDRACHNA O. F. Muller, 1769, 1776

The characters of the Genus *Hydrachna*, as stated by Soar and Williamson (1925) and Viets (1936), are shown by three New Zealand species. The most diagnostic of the generic characters are the spherical body with the back strongly arched, the brownish red colour, the slender, long, beak-like rostrum which is arched downwards, and the palps fitting close to the rostrum. The three New Zealand species are closely related to *Hydrachna* (Rhabdohydrachna) *processifera* Koenike, agreeing with this species in the absence of a median eye and, in two species, in the presence of small round chitinous plates close to the eyes. The New Zealand species differ from *H. processifera* in the absence of any chitinous shields or borders on the front third of the back, which places them in another

subgenus, *Anohydrachna,* and are, as far as can be determined from the literature available, the only species in the subgenus *Anohydrachna* which agree with *H. processifera* in the characters mentioned. The three New Zealand species thus show a blending of the characters of two different subgenera.

The differences between the four species are set out in the following table:—

COMPARISON OF HYDRACHNA SPECIES

ANTERO-DORSAL PLATE:

PLATES NEAR EYES: *processifera*, large, broad and oval, situated at inside of eyes; *maramauensis*, smaller circular, at inside of eyes, *evansensis*, small, circular, behind eyes; *wainuiensis*, absent.

EYE CAPSULES:

THICKENING ABSENT FROM. *maramauensis*, inner ventral edge; *evansensis*, anterior and inner ventral edges; *wainuiensis*, posterior and inner ventral edges.

PROCESS: *maramauensis*, antero-lateral, short and sturdy, pointing medially ventro-posteriorly; *evansensis*, medial and antero-lateral, short, very broad and blunt, pointing medially ventro-anteriorly; *wainuiensis*, postero-medial, blunt and broad, pointing slightly ventrally

MOUTH PARTS.

GROUND PLATE *maramauensis*, longer than broad; *evansensis*, longer than broad; *wainuiensis*, broader than long.

SETAE ON PALPI:

P. I: one in all four species.

P. II: exterior surface: *processifera, maramauensis, evansensis*, five; *wainuiensis*, four.
towards inner surface: *processifera*, three; *maramauensis*, two; *evansensis*, one; *wainuiensis*, two.

P. III: extensor surface. *processifera*, two, *maramauensis, evansensis*, one; *wainuiensis*, absent.
flexor surface: *processifera*, absent; *maramauensis*, one; *evansensis, wainuiensis*, absent.

P. IV. extensor surface. *processifera*, one on distal end; *maramauensis, evansensis, wainuiensis*, absent.
flexor surface *processifera, maramauensis*, one on distal end; *evansensis*, one near middle, *wainuiensis*, one near distal end

P. V protrudences at end: *maramauensis*, four; *evansensis, wainuiensis*, three.

EPIMERA:

THIRD. *processifera*, outer margin thickened and looped subcutaneously; *maramauensis*, short spur extending posteriorly and inwards from inner margin; *evansensis*, thickened inner margin projecting anteriorly as a short blunt process; *wainuiensis*, no spur from inner margin.

FOURTH: *processifera, maramauensis, evansensis*, extends anteriorly lateral to third; *wainuiensis*, does not extend anteriorly lateral to third.

PROCESS FROM OUTER POSTERIOR ANGLE OF FOURTH *processifera, maramauensis, evansensis*, small and pointed; *wainuiensis*, absent

SWIMMING HAIRS ON LEGS

FIRST. *maramauensis*, femuri-collum, femur, *evansensis*, absent, *wainuiensis*, femuri-collum, femur and genu.

SECOND. *maramauensis*, femuri-collum, femur and genu, *evansensis, wainuiensis*, femuri-collum, femur, genu and tibia.

THIRD *maramauensis, evansensis, wainuiensis*, femuri-collum, femur, genu and tibia, with a second row on genu and tibia of *evansensis*

FOURTH *maramauensis, evansensis, wainuiensis*, femuri-collum, femur, genu and tibia, second row on genu and tibia of all three species, and on all four segments of *wainuiensis*

GENITAL AREA

FEMALE

SHAPE *processifera*, anterior cleft long; *maramauensis* shallow anterior cleft.

MALE:

RELATIONSHIP TO EPIMERA: *processifera*, between fourth, extending beyond them for one-third of its length; *maramauensis*, from almost anterior margin of third to along three-quarters of inner margin of fourth; *evansensis*, between third and fourth, extending for one-third of length posterior to fourth; *wainuiensis*, from in front of posterior margin of third to behind posterior margin of fourth.

SHAPE. *processifera*, cordate; *maramauensis*, ellipsoidal; *evansensis*, *wainuiensis*, approximately cordate.

ANTERIOR CLEFT: *processifera*, V-shaped, extending inwards one-third of length of plates; *maramauensis*, *evansensis*, shallow; *wainuiensis*, narrow, extending inwards one-quarter of length of plates.

ACETABULA: *processifera*, extend posteriorly two-thirds length of plates, absent from median area; *maramauensis*, extend posteriorly two-thirds length of plates; *evansensis*, extend posteriorly over half way except for narrow median strip; *wainuiensis*, cover anterior half except for median strip

TWO LARGE ACETABULA NEAR POSTERIOR MARGIN. *processifera*, absent; *maramauensis*, *evansensis*, *wainuiensis*, present.

LONG HAIRS. *processifera*, posterior to acetabular region; *maramauensis*, confined to posterior one-fifth of plates; *evansensis*, *wainuiensis*, posterior one-third of plates.

SHORT STUMPY HAIRS. *processifera*, *maramauensis*, absent. *evansensis*, present medially; *wainuiensis*, around two large acetabula.

PENIAL STRUCTURE: *processifera*, crowned with comb-like ridge, two strong branches curving laterally but not extending beyond bulbus, short lateral branches with large, hook-like process; *maramauensis*, groove nearly closed over dorsally and thickened anteriorly dorsally two broad lobes with narrow extensions to posterior edge of fused genital plates; *evansensis*, thickened slightly anteriorly with lateral processes, small plate posteriorly; *wainuiensis*, heavily chitinized central groove with lateral processes, usually two large antero-lateral processes curving inwards at their tips and two to three smaller posterior lateral processes

Hydrachna maramauensis n.sp.

ADULT. (Text-fig. I.)

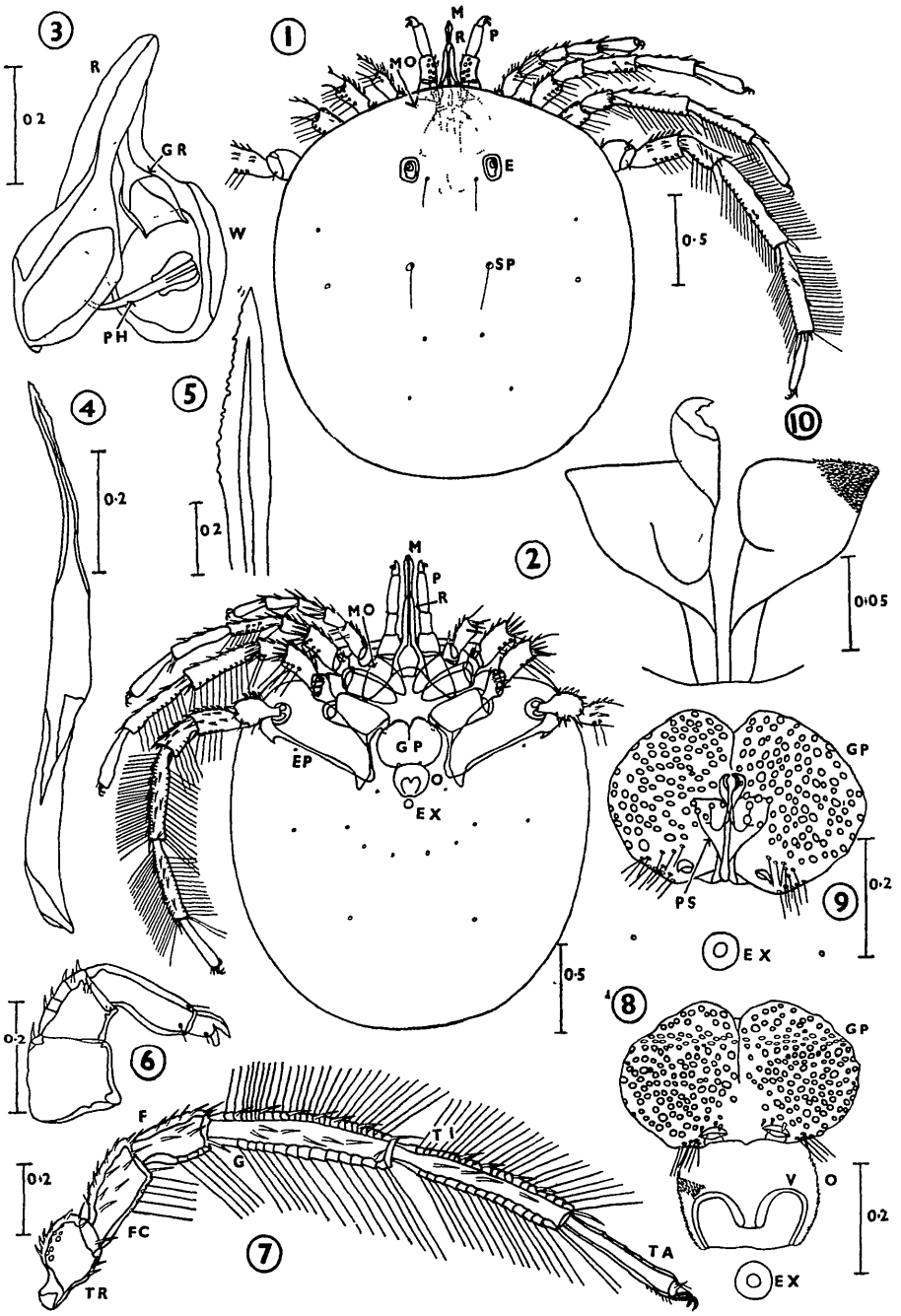
Female.

Body: Spherical (Fig. 1) the length and width subequal; colour, bright red. Dorsal plates and shields both absent. The diameter measures between 1·8 mm. and 2·4 mm, the majority being between 2 1 mm. and 2·2 mm.

Skin: Soft and papillose, with papillae of anterior part of body parallel-sided, rounded at the end, the height being equal to the breadth of the base, those of posterior portion about one-third as long again, conical, the tip directed posteriorly, while the papillae of middle part of body are of an intermediate form.

Anterodorsal plate absent. A pair of gland pores, placed 0 44 mm. apart, is situated transversely on the dorsal surface in a position nearly halfway from the anterior edge, surrounded by a small area which is more heavily chitinized and finely porous (Fig. 1, SP.) suggesting, as in *Hydrachna processifera*, a rudimentary form of small plate Near to inner side of each eye-capsule and close to posterior margin, is a circular gland-plate bearing a long, fine hair. The remaining gland pores on the body are small and inconspicuous.

Eyes: The double eyes lie in capsules, one on each side of the median line and approximately 0 4 mm apart (Fig. 1, E.). Each double eye-capsule is squarely oval, 0 13 mm. long and 0 11 mm. wide. The edges of each capsule are thickened except on inner ventral edge, and the thickened part of the anterior edge extends laterally into a short, sturdy process pointing ventrally and posteriorly towards the median line. The anterior eye is spherical and larger than the posterior eye, which is short and broad. There is no fifth or unpaired eye.



TEXT-FIG I.

Hydrachna maramaurensis n. sp.

FIG. 1.—Dorsal view of female. FIG. 2.—Ventral view of female. FIG. 3.—Maxillary organ and pharynx. FIG. 4.—Left mandible. FIG. 5.—Tip of mandible. FIG. 6.—Left palp. FIG. 7.—Left fourth leg. FIG. 8.—Female genital area and excretory pore, ventral view, chaetotaxy confined to a restricted area. FIG. 9.—Male genital area and excretory pore, dorsal view. FIG. 10.—Penal structure with anterior process on left side removed and chaetotaxy confined to a restricted area. Scale in mm.

INDEX TO TEXT-FIGS

AC, accessory claw; AP, anterior process, C, claw, CA, cauda; CAP, capitulum; DG, dorsal groove; DL, developing legs; DM, developing mouth parts; DP, dorsal process of maxillary organ; DPA, developing palps; E, eye; EP, epimera; EX, excretory pore; F, femur; FC, femuricollum; G, genu; GA, genital aperture; GP, genital plate; GR, "ground plate"; HO, host; LI, ligulate process; M, mandible; MO, maxillary organ; MU, process for muscle attachment; O, ovipositor; P, palp; PE, petiolus; PG, pygal lobe; PH, pharynx; PS, penial structure, R, rostrum; SD, sucking disc; SP, small plate, ST, stem, or leaf, of water plant; TA, tarsus; TI, tibia; TR, trochanter; UR, "urstigma"; V, semicircular valve, W, "wings" or flaps.

Mouth parts: These consist of a maxillary organ (Fig. 3) and a pair of mandibles (Figs 4 and 5). According to Vitzthum (1940), the maxillary organ ("hypostome" of André) in *Hydracarina* consists dorsally of the fused upper-side of the maxillae-coxae, and ventrally of the labrum completely fused with the hypostome and the underside of the maxillae-coxae. Each maxilla is divided into a weak chitinous mala interior and a generally stronger chitinous mala exterior (galea). The mouth parts of the New Zealand species appear to agree with Viets' (1936) description for the order and the genus, although his figure is not clear. Descriptions and figures of the maxillary organ for this genus in other works give little detail.

The maxillary organ (Fig. 3) consists posteriorly of a pair of broad flaps or "wings" (W.) thickened at the edges, which join along the mid-dorsal line leaving, however, a posteriorly dorsal bay. Anteriorly the maxillary organ is in the form of a cone-like rostrum (R.) which is slender and curved like a hook, extending to nearly half-way along the third segment of the palps (Fig. 1). Ventrally lies the "ground plate" (Viets, 1936) (Fig. 3, GR.) which starts from the base of the rostrum as a narrow stalk but suddenly broadens out to form a short plate, 0 11 mm. to 0 16 mm. long and 0 08 mm. to 0 11 mm. wide. The maxillary organ measures 0 57 mm in length.

The stylet-like mandibles (chelicerae of Vitzthum) (Fig. 4) lie inside the maxillary organ and follow its curve. They extend back into the body cavity for over half their length (Fig. 1, M) and are not divided into parts, being long and narrow, 0 99 mm to 1 1 mm. in length and approximately 0 08 mm. in breadth at widest part (Fig. 4). The proximal ends blunt and expanded, the distal ends more slender and the tip sharply pointed with a fine serrulation on the outer edge (Fig. 5).

Palpi: Each palp approximately 0 5 mm. to 0 6 mm. long, lying with the first segment fitting close to the maxillary organ (Fig. 2, P.). P.I and P.II are together longer than P.III (Fig. 6), and dorsally somewhat longer than half P.III, while P.III is less than three times as long as P.IV including its appendage. P.I is well developed, with dorsal and ventral margins nearly straight; P.II being also well developed, although not as broad as P.I, nearly straight and not tapering. P.III is long and slightly more slender, equal in length to about three-quarters of P.I and P.II combined. The short P.IV carries a small appendage which with the very short P V gives a pincer-like ending to the palp. There is one seta on the distal extensor surface of P.I, while P.II has five setae, shorter than that on P.I, irregularly disposed over the extensor surface and two more towards the flexor surface. P.III carries one small hair at the distal end of the extensor surface and another near the distal end of the flexor surface. P.IV has a small hair on the distal end of the flexor surface. There are four small, stumpy protrudences at the end of P.V.

Epimera: These increase in size from the first to the fourth and are combined into four groups, the first with the second and the third with the fourth on each side (Fig. 2, EP.). The edges of the epimeral plates are thickened. The first pair are of nearly equal breadth for the outer three-quarters of their length, but taper sharply to a point at the inner end, the second pair tapering and slightly overlapping the first pair. The first and second pairs together curve only slightly posteriorly. The third pair of epimera are of nearly equal breadth throughout, the anterior margin being only slightly longer than the posterior, and forming a rather blunt anterior angle. A short spur extends posteriorly and inwards from inner margin of the third pair, which measure 0·15 mm to 0 2 mm. in breadth and 0·35 mm. to 0 37 mm in length. The fourth pair of epimera much larger than the third, with their inner posterior angle drawn out into a short blunt process and their outer posterior angle into a short pointed process. Inner margins of third and fourth epimera slightly concave.

Legs: The four pairs of legs each have six segments named, proceeding proximally to distally, trochanter, femuricollum (basifemur), femur, genu, tibia, and tarsus (Viets, 1936) (Fig. 7). The first pair averages from 0·85 mm. to 1 2 mm. in length, the second pair from 1 3 mm. to 1 6 mm., the third pair from 1·6 mm. to 1 9 mm. and the fourth pair from 2 mm. to 2 25 mm. (Fig. 2). All four pairs carry numerous bristles on all segments, while the tarsus (Fig. 7, TA.) has two sickle-shaped claws at the distal end. Swimming hairs are present, increasing in number from the first to the fourth pair of legs. They occur on the femuricollum and femur of the first pair (Fig. 1); the femuricollum, femur and genu of the second pair, and the femuricollum, femur, genu and tibia of the third and fourth pairs, two rows being present on the genu and tibia of the fourth pair. The tarsus never carries swimming hairs, but has from two to eight very short bristles at the tip.

Genital area: The genital plates lie medially between the combined third and fourth pairs of epimera, stretching almost from anterior margin of third pair to three-quarters along inner margin of fourth pair (Fig 2, GP). The plates are fused together on the median line and roughly in the form of an ellipse of approximately 0 44 mm. by 0 27 mm. (Fig. 8, GP.); the posterior edge slightly emarginate; the anterior edge, cleft. The finely porous plates have numerous small acetabula except in a small posterior central area There are three short, blunt hairs posteriorly on each side with, below them, a large acetabulum, one on each side, and several long, fine hairs The two plates nearly always differ, even in the same specimen, in the position and number of the acetabula and hairs. The ovipositor (O.) is formed of a distensible tube of skin covered with short spines, those nearest to the opening being broad at the tip, not pointed. The opening is closed by two semicircular valves (V.) with chitinous edges, hinged together at the medial end.

Excretory pore (usually referred to in systematic work as the anus). The centre is 0 15 mm. to 0 25 mm. behind posterior edge of genital plates, and the pore is surrounded by a thick, chitinous ring which slopes upwards towards the centre (Fig 8, EX.).

Male.

Agrees with the female except in the following characters —

Anterodorsal plate: Gland plates near to inner side of eye-capsules are absent.

Palpi: Similar to palps of female.

Epimera: Similar to epimera of female, the fourth pair extending posterior to genital plates

Genital area: The male genital plates (Fig 9, GP) are usually somewhat larger than those in the female, approximately 0·48 mm. by 0·31 mm., the short blunt hairs being absent. The posterior median portion of the fused genital plates has a chitinous groove which is nearly closed over dorsally and thickened anteriorly. Dorsal to this groove and covered with minute spines are two broad lobes bearing narrow extensions to the posterior edge of the fused genital plates (Fig. 9, PS.; Fig. 10).

Excretory pore: The centre of the pore lies only 0·12 mm. posterior to the genital plates. (Fig 9, EX.)

REMARKS

In comparing *H. maramauensis* with *Hydrachna processifera*, the latter, length about 3 mm., is somewhat larger and has the posterior papillae more sharply pointed than in *H. maramauensis*.

In *Hydrachna processifera* the gland-plates near the eyes are apparently larger and of more oval shape, while a pair of long oval plates situated centro-laterally on each side are not present in the New Zealand species

The palp in *Hydrachna processifera* differs from *H maramauensis* in that on P.II, besides the five setae irregularly disposed over the extensor surface there are three more, not two, towards the flexor surface. Also there is a hair at the proximal end of the extensor surface of P.III but no hair present near the distal end of the flexor surface, and on P IV a hair is carried on the distal extensor surface.

Hydrachna processifera has a short, subcutaneous process on the inner posterior margin of the second pair of epimera and the outer margin of the third pair is thickened and looped subcutaneously.

The legs of *Hydrachna processifera* carry the bristles only on the middle segments.

The female genital area of *Hydrachna processifera* is more regularly rounded than in *H maramauensis*, and there is a deep, narrow slit in the anterior edge reaching nearly to the centre of the plate.

In the males of *Hydrachna processifera* the palps are conspicuous by reason of a constriction on the proximal flexor surface of P.III

In male *Hydrachna processifera* the fourth pair of epimera extends only half way down the genital plates.

The genital area of *H. maramauensis* extends further forward in relation to the third epimera than it does in *Hydrachna processifera* and, unlike that species, lies well within the posterior margin of the fourth epimera The genital plates differ considerably in shape from those in *Hydrachna processifera*, being broader and shorter, with a shallower anterior cleft. The acetabula extend further back, and the hairs are confined to the posterior fifth of the plates, while the two large acetabula near the posterior margin do not occur in *Hydrachna processifera*. The penial structure and its groove is apparently entirely different in the two species.

EGG

Measuring on the average when laid 0 2 mm. to 0·28 mm. by 0·28 mm. to 0·31 mm. Spherical to slightly elliptical in shape, bright red in colour, enclosed by a thick, transparent membrane and very yolky, showing large oily globules.

LARVA (Text-fig VIII, Figs. 1–5.)

Length, 0 47 mm.; breadth, 0 17 mm. (Figs. 1 and 2); red in colour, with the body elongate-oval, dorso-ventrally somewhat flattened and the capitulum (CAP.) slightly more flattened; the back wholly covered by a porous chitinous plate, the epimera (EP.) heavily chitinised and porous, the capitulum covered dorsally with porous chitin. Several long hairs occur on the body, principally on the ventral surface, with one on each of the first and third epimera, and a small pair ventrally on the front of the capitulum.

The capitulum (CAP.) is large, 0 215 mm. in length and 0 15 mm at its greatest breadth. It is readily movable on the body and dorsally is posteriorly divided by a longitudinal groove. The capitulum contains two mandibles (Figs. 1 and 3, M.) as in the remaining free-living stages, the nymph and the adult, and there is a knife-like appendage lying in the midline and extending from base of palps to mouth opening. The mouth opens in the centre of a large sucking disc (SD.) placed ventrally on anterior edge of capitulum. The palps (P) are attached to the side of the capitulum near the middle, and their tips do not quite reach to the anterior edge. Each palp (Fig 4) has five segments, the distal end of the fourth segment being produced to form an appendage which, together with the fifth segment, gives a chelate ending to the palp, as in the nymph and adult The first segment is broad and almost as long as the total length of the remaining four segments. P.II, P.III and P.IV carry bristles.

On the body, double eyes (Fig 1, E) are present on each side on the anterior part of the dorsal surface, and are equipped with distinct horns of skin. The three pairs of epimera (Fig 2, EP) cover most of the ventral surface of the body All three pairs are of approximately the same length, but the third pair is about twice as broad as the second pair, which is the smallest. The epimera of the two sides nearly meet in the midline and are almost right-angled to it. On the medial edge the first and second pairs are at least as broad as on the lateral edge, but the third pair is nearly twice as broad The legs (Figs 2 and 5) have five segments similar in shape to the adult with a small number of bristles and even fewer short swimming hairs The distal segment is not reduced at the end, as it is in many other hydrachnid larvae, and carries one strong sickle-shaped claw, not two as in the later stages. Between the first and the second epimeral plates on each side and near to the lateral edge lies the so-called " urstigma " (or urpore or urtrachea, Viets) (Fig. 2, UR.). This is clearly seen as a small pore opening ventrally between the fused epimera. Its function is unknown, but there does not appear to be a movable lid such as Thor believed to be present in several species. The excretory pore (EX.) lies on a small chitinous plate placed in a shallow groove immediately posterior to the epimera in the ventral midline

NYMPH (Text-fig VIII, Fig. 9)

Resembles the adult, except in the epimera and genital area. The anterior inner angle of the third epimera is produced posteriorly into a short, blunt process. The process from the posterior inner angle of the fourth epimera is longer and narrower than in the adult, except at its distal extremity, where

it expands. The ovoid genital plates (GP.) are separated by about 0 04 mm., each being covered by numerous small acetabula There is no genital aperture

Locality

Maramau lagoon, South Wairarapa.

Occurrences.

Nymphophans occurred from March until November, nymphs from August until December, and adults from November until April.

Hydrachna evansensis n sp.

Only two adults were collected, both of them males

ADULT. (Text-fig. II)

Male.

Body: Spherical, red in colour; length and breadth subequal (Fig. 1); no dorsal plates or shields; diameter between 2 4 mm. and 2·75 mm

Skin. Soft, papillae apparently absent although present in the nymph In the genus *Hydrachna* it is rare for papillae to be absent from the skin.

Anterodorsal plate Absent. A pair of gland pores, placed 0 95 mm. apart, situated transversely on the dorsal surface over half way from the anterior end of the body, and each surrounded by a small, heavily chitinised, porous area (Fig. 1, SP.) suggesting a rudimentary form of small plate. Situated 0 06 mm. behind each eye-capsule is a small circular gland-plate, carrying a long, fine hair. The remaining gland pores are about the same size as this pair, and one of them is median and unpaired

Eyes: The double eyes lie in capsules, one on each side of the median line and approximately 0 58 mm. apart (Fig. 1, E.). Each capsule is squarely oval, 0 2 mm. long and 0 13 mm. broad The edges of each capsule are thickened except on the ventral anterior and inner edges. The unthickened anterior inner corner is produced into a short, broad, blunt process which extends slightly ventrally, as well as anteriorly and medially. The anterior eye is spherical and small, only about 0 06 mm. in diameter The posterior eye is shorter but as broad as the anterior eye There is no fifth or unpaired eye.

Mouth parts. The maxillary organ (Figs. 1 and 2, MO., Fig. 3) consists posteriorly of a pair of broad, squarish flaps or "wings" (Fig. 3, W.) with a narrow band of thickening at the edges. These are joined along the mid-dorsal line except for a deep posterior bay. Anteriorly the maxillary organ is in the form of a slender cone-like rostrum (R.) which is not greatly curved and extends to about three-quarters along the third segment of the palps (Fig. 1). The ventral "ground plate" (Fig. 3, GR) starts as a narrow stalk which suddenly broadens out into a short plate, 0 14 mm. long and 0 1 mm wide. The maxillary organ measures 0 66 mm to 0 8 mm. in length.

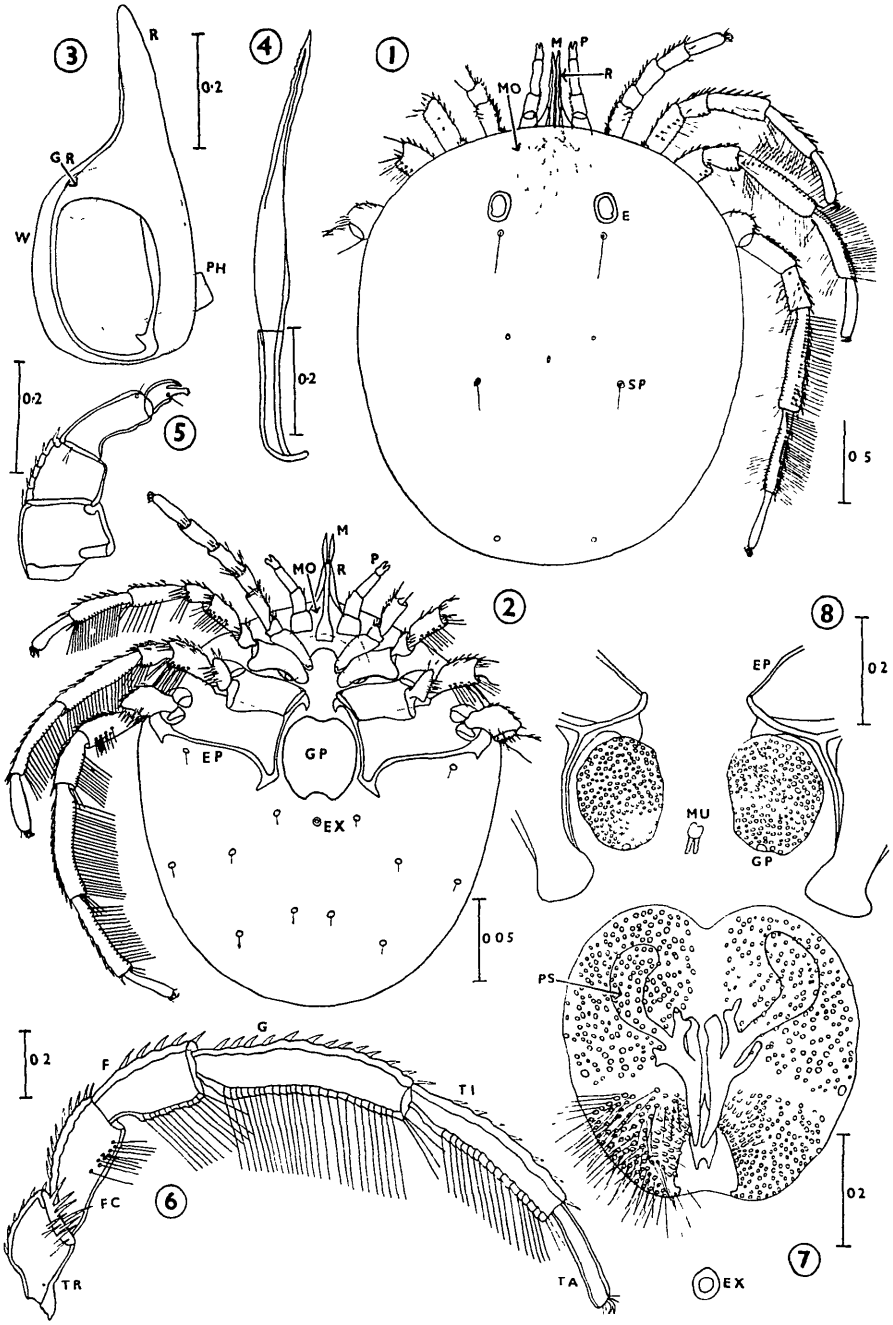
The mandibles (Figs 1 and 2, M ; Fig 4) are long and narrow, being 0 84 mm long and approximately 0 07 mm. in breadth at the widest part; stylet-like, they lie inside the maxillary organ, following its curve, and, extending back into the body for over half their length (Fig 1, M.) they are not divided into parts although the proximal portion is more heavily chitinised (Fig. 4). The proximal ends are blunt and expanded medially, the distal ends only slightly more slender than the proximal ends and the tip sharply pointed with a fine serrulation on the outer edge. The middle portion of the mandible is the widest.

Palpi: Each palp. approximately 0·5 mm long, lies with the first segment fitting close to the maxillary organ (Fig. 2, P). P I plus P.II approximately one and a-half times as long as P.III (Fig. 5). P.II dorsally about two-thirds as long as P.III, which is just over twice as long as P.IV, including its appendage. P I is well developed with the dorsal and ventral margins nearly straight. P.II is also well developed, not as broad as P.I, nearly straight and tapering slightly. The long and more slender P.III is equal in length to over three-quarters of P.I plus P.II The short P.IV carries a small appendage which with the very short P.V forms a pincer-like ending to the palp. One bristle occurs on the distal extensor surface of P.I. while P II has five bristles in a row on the extensor surface, all shorter than that on P.I, and one more towards the flexor surface. P.III has one small hair on the distal extensor surface, while P.IV carries a small hair in the middle of the flexor surface. P.V has three small protuberances at the distal end.

Epimera: Increase in size from the first to the fourth, and are combined into four groups, the first with the second and the third with the fourth, on each side (Fig. 2, EP.). The edges of the plates are thickened. The first epimera is slightly broader at the outer than at the inner part, tapering to a blunt inner end with the thickening of the posterior margin ending as an expanded bulb at the inner end The second epimera, which also tapers slightly, is expanded into a short, rounded process at the outer posterior angle and forms a rounded inner margin. The second epimera does not overlap the first. The first and second epimera together curve posteriorly. The third epimera is of nearly equal breadth throughout, with the anterior margin longer than the posterior and the thickened inner margin projecting anteriorly as a short, blunt process. A short spur extends posteriorly and inwards from the inner margin of the third epimera, which measures 0 2 mm. to 0 25 mm. in breadth and 0 42 mm. to 0 47 mm. in length. The fourth epimera is much larger than the third, with the inner posterior angle drawn out as a short, broad process expanding laterally at the end to form a postero-lateral point, and with a small, pointed process arising from the outer posterior angle. The outer posterior angle of the third epimera overlaps the fourth, and the inner margins of the combined third and fourth epimera are slightly concave

Legs: The first pair averages 1 2 mm. in length, the second pair 1 72 mm., the third pair 2 17 mm. and the fourth pair 2 7 mm. (Fig. 2). All four pairs carry numerous bristles on all segments (Fig. 6), while each tarsus (TA.) has two sickle-shaped claws at its distal end Swimming hairs are absent from the first pair but increase in number from the second to the fourth pairs of legs They occur on the femuricollum, femur, genu and tibia of the second, third, and fourth legs, there being two rows on the genu and tibia of the third and fourth pairs. The tarsus never carries swimming hairs, but has four to six very small bristles at the tip.

Genital area: The genital plates lie medially between the fourth pair of epimera, but for one-third of their length extend posterior to the epimera (Fig. 2, GP.). The plates are fused together on the midline, their outline being roughly cordate with a shallow anterior cleft (Fig. 7). They are approximately 0 54 mm. in length by 0 62 mm. in breadth. The finely porous plates have numerous acetabula on the anterior lobes, extending back to over half way except for a narrow median strip, with a slightly larger acetabulum near the side of the



TEXT-FIG. II.

Hydrachna evansensis n.sp.

FIG. 1.—Dorsal view of male. FIG. 2.—Ventral view of male. FIG. 3.—Maxillary organ and pharynx. FIG. 4.—Left mandible. FIG. 5.—Left palp. FIG. 6.—Left fourth leg FIG. 7.—Male genital area and excretory pore, dorsal view, hairs omitted from left side. FIG. 8.—Provisional genital area and adjacent epimera of nymph. Scale in mm.

posterior margin of each area. The posterior one-third is covered by long hairs arising from small plates with short, stumpy hairs medially. The two plates are nearly always different, even in the same specimen. The posterior median edge of the shield forms a deep pointed bay in which lies the tip of the penial organ. A chitinous groove runs down the midline of the penial organ (PS.) with the chitin bordering it slightly thickened anteriorly and sending out lateral processes on each side. These lateral processes are often different on the two sides. Posteriorly lies a small plate. with a posterior bay, ventral to the open ends of the groove.

Excretory pore: The centre of this pore lies in the midline 0 16 mm. behind the posterior margin of the genital plates, and is surrounded by a thick, chitinous ring sloping upwards towards the centre (Fig. 7, EX.).

Remarks

Compared with *Hydrachna processifera* and *H. maramauensis,* the body is larger than in *H. maramauensis* but smaller than in *H. processifera.*

The mid-dorsal pair of gland pores are situated further apart and further back than in the other two species, and the gland-plates in this case are behind the eye-capsules, whereas they are situated medial to the eye-capsules in the other two species. The plates in the centre of the back, present in *H. processifera,* are absent in this species, as in *H. maramauensis.*

The process from the ventral side of the eye-capsule differs from that in the other two species, and the anterior eye is smaller

The palp in *H. evansensis* is shorter than that in *H processifera,* but about the same length as that in *H. maramauensis* P II does not taper at all in *H. maramauensis,* but it does so slightly in this species. In *H. evansensis* P. II has only one bristle towards the flexor surface, whereas in *H. processifera* it has three and in *H. maramauensis* two. As in *H. maramauensis* there is no hair near the proximal end of the extensor surface of P III, or on the distal end of the extensor surface of P.IV. In this species P.V has only three protuberances at the distal end, *H. maramauensis* having four.

The features distinguishing the epimera of this species include the unequal breadth of the first epimera and the thickened and expanded bulb on the inner posterior angle; the longer third epimera, which overlaps the fourth, and the process from its inner margin.

The legs of this species are distinguished by the absence of swimming hairs from the first pair, their presence on the tibia of the second pair and the second row on the genu and tibia of the third pair.

The anterior cleft in the male genital plate of *H. processifera* is V-shaped, and extends inwards for about one-third of the length of the plates, while the small, stumpy hairs are absent in the male genital shield in both *H. processifera* and *H maramauensis.* The penial organ is different in all three species

Nymph

Attaining a length of at least 1 55 mm.; papillae present, the anterodorsal plates represented as in the male; eyes placed 0 32 mm. to 0 39 mm. apart; the palp and the first to the third epimera the same as in the male, but the process from the posterior inner corner of the fourth epimera rounded at the end, not pointed as in the male, and the process at the outer end of the posterior margin

is slightly larger, with a more rounded tip. The genital area is represented by a pair of provisional genital plates (Fig. 8, GP.) which are covered all over with small acetabula but no hairs The plates are roughly oval, rounded on the outer edge, and slightly straighter on the inner edge. There is no genital aperture, but its position is indicated (compare Soar and Williamson for *H. processifera*) by a process for muscle attachment (MU) showing through the skin between the plates. The centre of the excretory pore lies 0 16 mm. to 0·19 mm. posterior to the plates. In all other features the nymph agrees with the adult male.

Compared with *H processifera*, this nymph is smaller and has the eyes closer together. The third epimera does not extend laterally beyond the articulation of the third leg and the anterior inner corner does not extend inwards. Since the process at the outer end of the posterior margin of the fourth epimera is not pointed, it is not markedly thornlike. *H. processifera* has a few hairs on the provisional genital plates, but this nymph has none Also the excretory pore is closer to the plates in this species.

Locality

Small freshwater reservoir above the Evans Bay patent slip.

Occurrences

Nymphs were collected from May until October, 1951, but since then no adult hydrachnids have been present in this reservoir. Two of the nymphs kept in captivity metamorphosed into male adults late in October, 1951.

Hydrachna wainuiensis n.sp

ADULT. (Text-fig. III.)

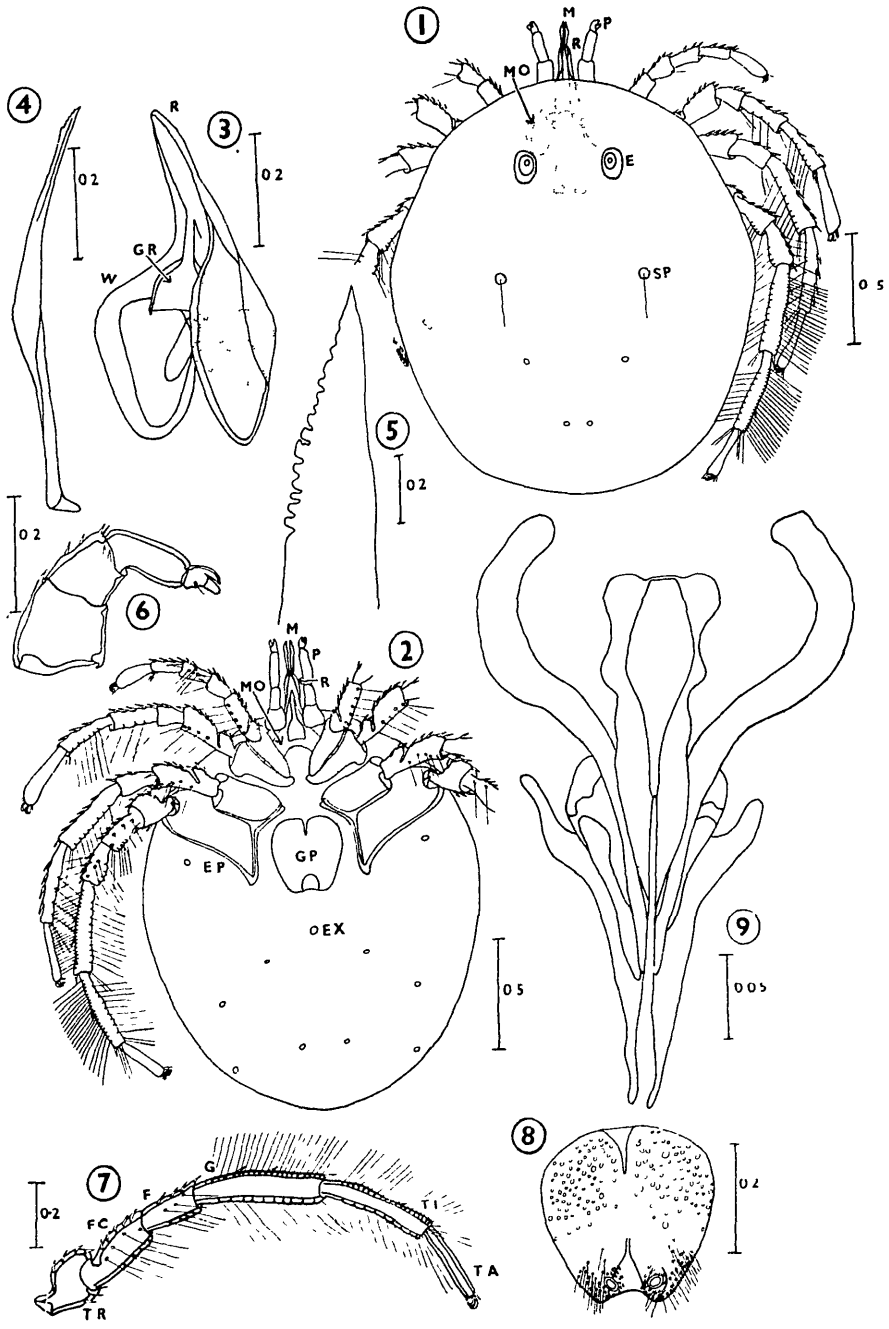
Male.

Body Spherical, bright red in colour, with length and width subequal; (Fig. 1, Fig. 2) , no dorsal plates or shields; the diameter between 1·6 mm. and 1 85 mm.

Skin: Soft and papillose, the papillae of the anterior part of the body like a flat cone with a broad base and rounded at the tip, with the height slightly less than the diameter of the base Those of the posterior part are conical, twice as high as they are broad at the base, and almost as sharply pointed as they are in *H processifera*, the tip being directed posteriorly. This latter kind extends anteriorly to about the posterior edge of the fourth epimera, with a small area containing papillae of intermediate form grading towards the papillae of the anterior part of the body.

Anterodorsal plate· Absent A pair of gland pores, placed 0·62 mm. apart, are situated transversely on the dorsal surface in a position nearly half way from the anterior edge (Fig. 1, SP.) and are surrounded by a small area, square with rounded corners, which is heavily chitinised and finely porous. There are no gland plates near the eyes and the remaining gland pores, which are small and inconspicuous, are fewer than in the other species.

Eyes The double eyes lie in capsules one on each side of the midline and approximately 0 31 mm apart (Fig. 1, E) Each capsule is squarely oval, 0·13 mm. long and 0 09 mm. broad. The edges of the capsules are thickened except for the ventral posterior and inner margins A broad, blunt process arises from the inner posterior corner, extending slightly ventrally The anterior eye is spherical, the posterior eye of the same width but only half as long There is no fifth or unpaired eye.



TEXT-FIG. III.

Hydrachna wainuiensis n.sp.

FIG. 1.—Dorsal view of male. FIG 2.—Ventral view of male FIG 3.—Maxillary organ, pharynx broken off FIG 4.—Right mandible. FIG. 5—Tip of mandible. FIG. 6.—Left palp. FIG. 7—Left fourth leg. FIG 8.—Male genital plate FIG 9—Penial structure of male. Scale in mm.

Mouth parts: The maxillary organ (Figs. 1 and 2, MO., Fig. 3) measures 0·5 mm. to 0 63 mm. in length, and consists posteriorly of a pair of broad flaps or "wings" (Fig. 3, W.), thickened at the edges and joining along the mid-dorsal line except for a posterior bay. Each flap has a very thin oval area near the midline and close behind the bay. Anteriorly the maxillary organ is in the form of a cone-like rostrum (R.) which is slender and slightly curved like a hook, extending about halfway along the third segments of the palps (Fig. 2, R.). The ventral "ground plate" (Fig. 3, GR.) starts as a narrow stalk but suddenly broadens out to form a small plate, 0 09 mm. long and 0 11 mm. broad.

The stylet-like mandibles (Figs. 1 and 2, M.; Fig 4) lie inside the maxillary organ and follow its curvature. They extend back into the body cavity for approximately half their length (Fig 1, M) and are not divided into parts (Fig. 4), being long and narrow 0 75 mm. in length and 0 05 mm. in breadth at the widest part. The thickened proximal ends are blunt and expanded slightly medially The distal end is only slightly more slender and is sharply pointed at the tip with a fine serrulation on the outer edge (Fig. 5).

Palpi: Each palp is approximately 0 4 mm. to 0 48 mm. long with the first segment close to the side of the maxillary organ (Fig. 2, P). P I and P.II are together much longer than P.III (Fig. 6) and P II is dorsally somewhat longer than two-thirds of P III, while P III is less than three times as long as P.IV including its appendage P.I is well-developed, with the ventral margin almost straight and the dorsal margin only very slightly curved P.II is less well developed than P.I and not as broad, tapering only very slightly. P.III is longer than P.II and slightly more slender, in length less than two-thirds of P.I plus P.II. The short P IV carries a small appendage which with the very short, blunt P.V gives a pincer-like ending to the palp There is one bristle on the distal extensor surface of P 1, while P II has four, shorter bristles on the extensor surface and two more towards the flexor surface There are no hairs on P.III, but P.IV has one small, fine hair near to the distal end of the flexor surface. Three small, stumpy protrudences occur at the end of P.V.

Epimera Increase in size from the first to the fourth and are combined into four groups (Fig 2, EP.) The edges of the plates are thickened The first epimera tapers slightly towards the inner margin forming a rounded point. The second epimera also tapers and slightly overlaps the first, being expanded on the outer posterior margin with the inner tip curving anteriorly The first and second epimera together point posteriorly but do not actually curve posteriorly. The third epimera is of nearly equal breadth throughout, with the anterior margin slightly longer than the posterior and forming a blunt anterior angle. The third epimera measures 0 16 mm in breadth and 0 28 mm. in length. The fourth epimera is much larger than the third, although it does not extend anteriorly lateral to the third. The inner posterior angle of the fourth epimera is drawn out into a very short process, but there is no process from the outer posterior angle. The inner margins of the third and fourth epimera are slightly concave

Legs The first pair averages 0 82 mm. in length, the second pair 1 18 mm., the third pair 1 48 mm., and the fourth pair 1 79 mm to 1 87 mm (Figs. 1 and 2). All four pairs carry numerous bristles on all segments (Fig 7) and each tarsus (TA) has two sickle-shaped claws at the distal end Swimming hairs

are present on the femuricollum, femur and genu of the first pair, and on the femuricollum, femur, genu and tibia of the second, third and fourth pairs, there being two rows on all these segments of the fourth pair. The number of swimming hairs increases from the first to the fourth pair of legs. The tarsus never carries swimming hairs and has only two to four very small bristles at the tip with the claws.

Genital area: The genital plates lie medially between the fourth pair of epimera, stretching anteriorly to just in front of the posterior margin of the third pair and posteriorly to just behind the posterior margin of the fourth pair of epimera (Fig. 2, GP.). The plates (Fig. 8) are fused together on the median line, approximately cordate in shape, 0 31 mm. in length and 0 33 mm. in breadth. The posterior edge is slightly marginate, the anterior edge has a narrow slit extending inwards for one-quarter of the length of the plate. The plates are finely porous with numerous acetabula on the anterior half, except on a central strip. A median transverse free area is followed posteriorly by an area with several small plates, each carrying a hair, posterior to which on each side are about 22 small hairs with blunt ends arranged around a single large acetabulum. The two plates are nearly always slightly different even in the same specimen. Dorsally lies a heavily chitinised central groove with lateral processes, the shape and even the number of which differ in different specimens and on different sides of the same specimen (Fig. 9). There are usually two large anterior lateral processes, curving inwards at their tips and two to three smaller posterior lateral processes. The groove opens on to a posterior dorsal bay in the fused genital plates.

Excretory pore The centre lies 0 18 mm. posterior to the genital plates (Fig. 2, EX.) and is surrounded by a chitinous ring.

Remarks

This species is closely related to *Hydrachna processifera, H. maramauensis* and *H. evansensis.*

The diameter of the body in the male is less than in the other three *Hydrachna* species, and the posterior papillae are intermediate between those of *H processifera* and of *H. maramauensis.*

The shape of the pair of gland pores in this species is distinctive, as is the absence of gland plates near to the eyes. The pair of long, oval plates in the centre of the back of *H. processifera* is absent from all New Zealand species.

The thickening of the eye-capsule and the process projecting from it are, in this species, the same as in *H evansensis* but different from *H. processifera* and *H. maramauensis.*

The distinguishing features of the maxillary organ in this species include the thin oval areas on the flaps and the shape of the "ground plate" which is broader than it is long The palp differs from the palp in the other three species in the shorter P.III, and the long dorsal surface of P.II. There are only four bristles on the extensor surface of P II, which in the other three species carries five bristles, and two on the flexor surface which has three in *H. processifera* and one in *H. evansensis.* The absence of bristles from P.II distinguishes this species from the other three, and the presence of only one bristle on P IV from *H. processifera.* This species agrees with *H. evansensis* in having three protrudences on P.V, but differs from *H. maramauensis,* which has four.

The distinctive features of the epimera include the curving of the tip of the second pair posteriorly, and the failure of the first and second pair to together curve posteriorly. The absence of a short spur from the inner margin of the third epimera or of an extension of the fourth lateral to it, as well as the great reduction of processes from the posterior margin of the fourth epimera are also distinctive features.

The legs are distinguished by the presence of swimming hairs on the genu of the first pair, the tibia of the second pair, and as a second row on the femuricollum and femur of the fourth pair

In the male genital plate the anterior slit is narrower and extends further inwards than in the other New Zealand species, but not as far as in *H. processifera*. The penial structure is entirely different from the penial structure in the other species.

Locality.

Waimui-o-mata Reservoir

Occurrences.

Males were present on March 19, 1951, although only three were collected, and none were obtained on a second collecting trip on May 5, 1952.

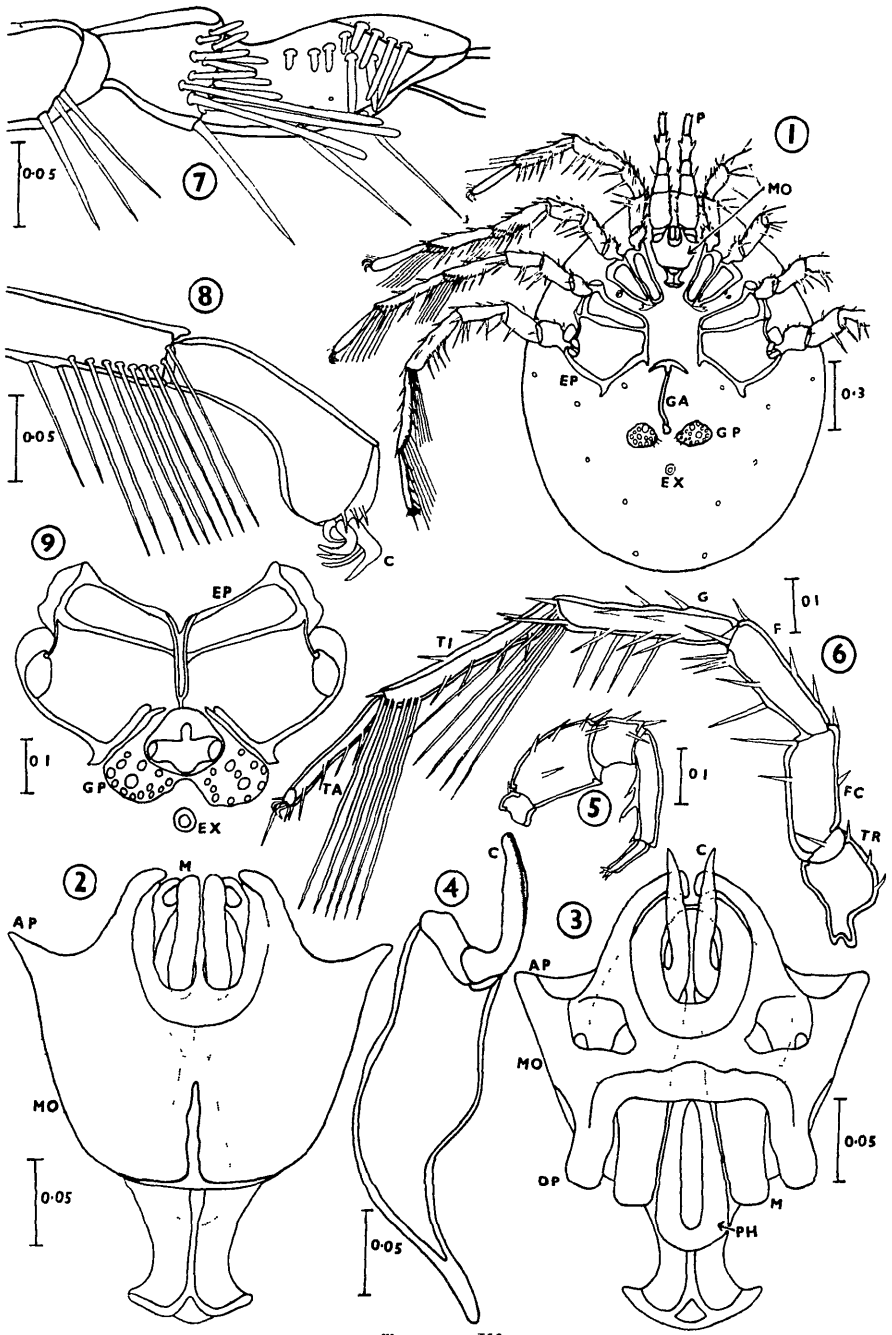
Superfamily · PIONAE Viets, 1930.
Family · PIONIDAE Sig Thor, 1900.
Subfamily PIONINAE Wolcott, 1905.
Genus: PIONA C. L. Koch, 1836.
Subgenus (based on the female) : PIONA s.s.

In the Genus *Piona,* the first and second legs are not specially thickened, and do not have bristles present on the end The third and fourth legs of the male have the sixth segment of the third leg adapted for the carrying of sperm, and the fourth segment of the fourth leg as a hook-like raptorial appendage. The presence of two genital acetabular plates in the female places the New Zealand species in the subgenus *Piona* s.s. The New Zealand species agrees with *P. uncata* (Koenike), and as far as can be determined from the literature available with no other member of the subgenus, in the petal-like form and three lips of the genital aperture of the female, and the presence of two acetabula, larger than the others, on each disc-shaped female genital plate Species of this subgenus are described by Viets (1936), Soar and Williamson (1929), Marshall (1935, 1937), Marshall (1930—*P interrupta* Marshall and *P. socialis* Marshall), Lundblad (1946—the Madagascan species, *P. seyrigi* Ldbl., and *P. madagascariensis* Ldbl.), Lundblad (1947—the Australian species *P. uncatiformis* Ldbl.), and Lundblad (1949—*P. tridens* (Thor), *P. crassipes* Walter, and *P. angulata* var. *saskai* Ldbl.).

Piona novae-zealandiae n.sp

Female. ADULT (Text-fig IV.)

Body · Length up to approximately 1 75 mm , breadth up to approximately 1 5 mm. (Fig. 1) ; oval in outline but the posterior end rounder than the anterior end, and the dorsum highly arched. The thickened chitin of the appendages and epimera is a brownish purple and the chitin of the rest of the body colourless. However, the animal appears dark brown, with the excretory system showing through the dorsal surface as a bright yellow longitudinal median streak, forking



TEXT-FIG. IV.

Piona novae-zealandiae n.sp.

FIG. 1.—Ventral view of female. FIG. 2.—Mouth parts, ventral view. FIG. 3.—Mouth parts, dorsal view. FIG. 4.—Mandible, lateral view. FIG. 5.—Left palp. FIG. 6.—Right fourth leg of female. FIG. 7.—Fourth segment (genu) of fourth leg of male. FIG. 8.—Sixth segment (tarsus) of third leg of male. FIG. 9.—Genital area, third and fourth epimera and excretory pore of male. Scale in mm.

at the anterior end. This marking differs in different specimens, depending on the amount of excretory material present, and therefore cannot be used as a specific character.

Skin Soft and finely ridged There are no thickened glandular plates, and the glands are fairly small.

Eyes Two pairs, not in capsules, and there is no unpaired median eye The two pairs are situated transversely 0 3 mm. apart and 0 02 mm. from the anterior margin of the body

Mouth parts The maxillary organ is 0 27 mm. long, including the stem, and 0 23 mm. in breadth at the widest part (Figs. 1, 2 and 3, MO.). There is no rostrum, but the basal plate extends into a stem posteriorly. The dorsal plate has a thick chitinous transverse ridge joined medially with the chitin around the mouth opening and laterally with the anterior processes (Figs. 2 and 3, AP.) A pair of short, blunt posterior processes (DP.) arise from the lateral ends of the transverse ridge The broad ventral "basal" plate has a thickened ridge posteriorly in the mid-veneral line which spreads a short way along the posterior margin on each side The anterior processes (AP) are short and pointed. The mouth opening is roughly circular, approximately 0 085 mm in diameter and open anteriorly. Posteriorly the short stem, 0·08 mm. long, is expanded at the end and thickened on the mid-ventral line and posterior margin.

The pharynx (Fig. 3, PH.) lies inside the maxillary organ between the mandibles. It is approximately 0 11 mm long, thickened at the edges and anteriorly.

The mandibles (Figs 2 and 3, M , Fig. 4) are short and thick, 0.24 mm. long (excluding the claw) and 0 072 mm. at the greatest breadth, and lie inside the maxillary organ with their anterior ends protruding through the mouth opening The edges are thickened, especially the anterior edge which carries a strong claw (C) finely ridged along the mid-dorsal line Posteriorly the mandibles narrow rapidly and curve dorsally at the end as a thickened blunt appendage.

Palpi. Small, being approximately 0 52 mm. long (Fig 1, P , Fig 5). P.I is small and very short, while the large and broad P.II is nearly four times as long as P.I and nearly twice as broad P III is about half as long as P II and not as broad, but larger than P.I, and P IV is longer than P II but less than twice as broad. P V. is about the same length as P.III and narrower than P.IV. One small bristle is present at the distal end of the extensor surface of P.I, while P.II has four bristles on the extensor surface, as well as one slightly further towards the inner surface at the distal end and another further back half way towards the flexor surface There are two bristles on the distal half of the extensor surface of P.III and another further towards the flexor surface. P.IV bears two large papillae, each ending in a hair, on the flexor surface and at the distal end of the flexor surface a short, broad papilla with a pointed chitinous tip The distal end of P.V has four short, thick, pointed claws

Epimera : Lie in four groups, separated from one another medially by a wide space(Fig. 1, EP). They stand well back from the anterior and lateral margins of the body and increase in size from the first to the fourth pairs. The plates have a granulated surface and are thickened at the edges The combined first and second epimera point posteriorly at their inner ends and a process from their inner margin has two sharp points and is directed obliquely inwards and postero-laterally The first epimera is of approximately equal breadth throughout, the

second broader at the outer than at the inner margin. The third epimera is also of approximately equal width throughout except that the lateral margin is expanded anteriorly. The fourth epimera is broad, especially midway along its breadth, with a small process from the inner posterior corner and a larger process from the middle of the posterior margin.

Legs: Do not increase much in length from the first to the fourth pairs (Fig. 1). The length of the first pair is 1 2 mm., the second 1 32 mm., the third 1 38 mm. and the fourth 1 55 mm. Bristles are present on all pairs of legs and swimming hairs on the genu and tibia of each pair (Fig. 6), being fewer on the first pair. Each tarsus has two sickle-shaped claws at the distal end with a few short bristles near the bases of the claws. The tarsus (TA.) of the fourth leg carries in addition six bristles arranged along the posterior margin.

Genital area: Lying close to the epimera (Fig. 1). The long, narrow, genital aperture with a moderately long, slender, bow-like sclerite at its anterior end and a smaller sclerite of varying shape at its posterior end. On each side of the posterior end of the genital aperture lies a more or less circular plate (GP.), small in comparison to the rest of the body This plate carries approximately thirteen to fourteen acetabula, two of which are slightly larger than the others, and three to four fine hairs near to the inner posterior corner. There are no hairs in front of the plate.

Excretory pore. Surrounded by a chitinous ring, the centre lying approximately 0 19 mm. behind the genital aperture (Fig. 1, EX.).

Male.

Agrees with the female except in the following features.

Body: Smaller than the female, up to 0 87 mm. in length and 0 72 mm. in breadth

Epimera· The first two pairs similar to those of the female. The combined third and fourth epimera from each side (Fig. 9, EP.) approach one another medially much more closely than in the female, so that the fourth pairs are posteriorly joined at their inner margins with one another and with the genital area.

Legs: Like all the members of this genus, the third and fourth pairs of legs are modified in the male. The tarsus of the third leg (Fig. 8) is short and broad with an expansion at the tip for carrying sperm. It has two large, modified claws at the distal end, each split into two for about half their length. There are also three short bristles and one small curved spine at the thickened distal end of the tarsus.

The genu of the fourth leg (Fig. 7) is modified for clasping the legs of the female during copulation It is slightly bent, with a cup-like median ventral hollow. The thickened proximal end of the hollow has twelve setae, increasing in length towards the inner surface and rounded at their tips On the outer surface there are three pointed setae towards the middle and on the distal outer margin of the hollow, ten setae with rounded tips, increasing in length distally.

Genital area: The genital cavity (Fig. 9) is roughly trifoliate with an anterior lip having a short slit in the median edge and two small posterior lips, one on either side There is a small, thinly-chitinised area at each lateral edge of the genital cavity. The approximately rounded genital plates (GP.) are united

by a relatively broad bridge dorsal to the cavity and each carries 12 to 15 acetabula, of which two are usually larger than the rest.

Excretory pore: The centre is situated 0 08 mm. behind the genital aperture (Fig. 9, EX.).

REMARKS

Piona novae-zealandiae shows relationship with *Piona uncata* (Koen.), a widely spread species in which the colour is variable, ranging from green to yellow, with dark brown or red markings, and the chitinous parts blue grey.

The skin of *P. uncata* is apparently similar to the New Zealand species, and varies little throughout the genus.

There is no description of the eyes nor of the mouth parts in *P. uncata*.

The palpi of *P. uncata* differ from those of *P. novae-zealandiae* in the presence of several smaller papillae, as well as the two large papillae, on the flexor surface of P.IV.

P. uncata has no process from the inner posterior corner of the fourth epimera, and no swimming hairs on the first pair of legs, but apparently more on the other three pairs of legs; the genital aperture has no sclerite at the posterior end, each plate carrying 15 to 25 acetabula, more than in *P. novae-zealandiae*. A few hairs inserted into the skin slightly in advance of each genital plate, are absent in the New Zealand species.

The male of *P. uncata* measures about 1 2 mm. in length, and the posterior margins of the fourth epimera join with the genital area but not with one another.

Each claw on the tarsus of the third pair of legs in *P uncata* males has accessory claws, one with two and the other with three. No accessory claws are present in *P. novae-zealandiae*, which has ten long setae on the distal end of the fourth segment of the fourth pair of legs, whereas *P uncata* species has five. The genital plates in *P. uncata* have from twenty to twenty-four acetabula

EGG

Spherical, measuring on the average when laid 0 27 mm. in diameter In colour a pale, rather yellowish pink, with a thin transparent egg-case lacking the thick middle layer found in the *Eylais* eggs. The yolk is not as abundant as in the other two genera.

LARVA. (Text-fig. IX, Figs. 1 and 2.)

Length of the body 0 48 mm. and breadth 0 46 mm. (Fig. 1). The body is almost spherical, but flattened dorso-ventrally and pale brown with pale blue appendages. The skin is soft and not enclosed in chitinous plates, and there is no dorsal shield. The epimera (EP.) cover nearly all the ventral surface and the excretory pore (EX.) is surrounded by a triangular plate. There are numerous pairs of long hairs on the body and two pairs on the excretory plate. A pair of pores is present just in front of the excretory plate.

The capitulum (Fig. 1, CAP.; Fig. 2) is small and firmly attached to the body The maxillary organ encloses the small mandibles (M.) whose tips project out at the anterior end and a narrow food passage (PH.) runs up the middle. The capitulum carries the small palpi (P.) which are bent at their distal ends so that they do not extend in front of the capitulum. The distal segment of each palp is small and claw-like.

On the body, a pair of double eyes occur on the dorsal surface, situated wide apart and near to the anterior edge. The epimera (Fig. 1, EP.) are large, but they do not meet in the mid-line. The first epimera on each side is separate, although it lies close against the second The second and third are incompletely divided, since the division does not extend to the median edge. The posterior and lateral margins of the third epimera are not well defined. Each leg has five segments, and the distal end of the last segment carries three sickle-shaped claws. This is an unusual feature as there are normally two in both the adults and in the larvae of other genera. The legs bear bristles and swimming hairs. No "urstigma" is visible unless the two pores just in front of the excretory plate are "urstigma" in an unusual position, since "urstigma" normally occur laterally and in the anterior region of the body. The triangular plate which surrounds the excretory pore (EX.) has the apex pointing anteriorly and, as already mentioned, carries two pairs of hairs

This spherical larva differs in shape from the elongate larvae of the *Hydrachna* and *Eylais* species, and the appendages are smaller in comparison with the remainder of the body. The capitulum is firmly attached to the body as in the *Eylais*. The clothing of bristles and swimming hairs differs in all three genera, and the three sickle-shaped claws at the distal end of the last segment of each leg are a distinguishing feature of this species. The mouth parts differ in the three genera. This *Piona* larva is similar to that of *Piona carnea* as drawn by Soar and Williamson (1925)

NYMPH. (Text-fig IX, Fig. 3.)

Up to 0 78 mm. in length and 0 715 mm. in breadth, oval to rounded in outline The epimera (EP.) are the same as in the female. The legs carry fewer bristles and swimming hairs, but the distribution of these is similar to the adult. The first pair of legs measures 0 58 mm in length, the second 0 68 mm., the third 0 74 mm., and the fourth 0 85 mm. The provisional genital area is in the form of two plates (GP) lying obliquely to the midline, each plate with two large acetabula. The plates lie close together on the midline with, between them, a small, roughly circular, strongly chitinised muscular attachment In all other features the nymph agrees with the adult female.

The only description of the nymph of *P. uncata* states "provisional genital area with two plates, each with two acetabula" (Soar and Williamson, 1927). The nymphs of this genus are all very similar in their provisional genital area, and this description would probably apply to most of them

Localities.

Wainui-o-mata Reservoir; Maramau lagoon, South Wairarapa; Matthews' stream, South Wairarapa; Tahora pool, at the junction of two drains, South Wairarapa

Occurrences.

The adults occur throughout the year, but decrease in number during the summer. Nymphs appear in large numbers at the end of December and are still numerous until about September, surviving from then until the end of the year in reduced numbers. The species was only collected once from the pool at the junction of two drains, which is situated within a mile of the Maramau lagoon This species is the most widespread of all those collected, and was always the most abundant species at each collection from these localities.

Hydrachnids recently received from Miss Jolly, of the Otago Museum, seem to belong to this species. They were collected from Tomahawk Lagoon, Dunedin, and Lake Hayes, South Island.

Specimens of hydrachnids from the main Karori Reservoir, in the possession of the Wellington City Corporation, also appear to belong to this species, but preservation in formalin makes identification difficult.

Superfamily: ARRHENURAE Oudemans, 1902.
Family: ARRENURIDAE Sig Thor, 1900.
Subfamily: ARRHENURINAE Wolcott, 1905.
Genus: ARRENURUS Dugès, 1833.
Subgenus: ARRENURUS s.s.

In the Genus *Arrenurus,* the end of the palp is in the form of a pair of forceps, and the body of the female is roughly egg-like and not flattened. The line of separation between the armoured plates is clearly visible and not parallel to the side edge of the body. The body of the male has a tail-like appendage, often with corner angles, a small median stem, and a medial opening or indentation. The two New Zealand species both belong to the subgenus *Arrenurus* s.s. which has the cauda on the hind end of the body short and about as wide as the body, posterolateral corners produced into prominent pygal lobes and the petiolus large and conspicuous. They differ from all other species in the subgenus in the absence of a hyaline appendicula at the proximal end of the petiolus, and in the first species in the absence of a twisted bristle on each side of the petiolus.

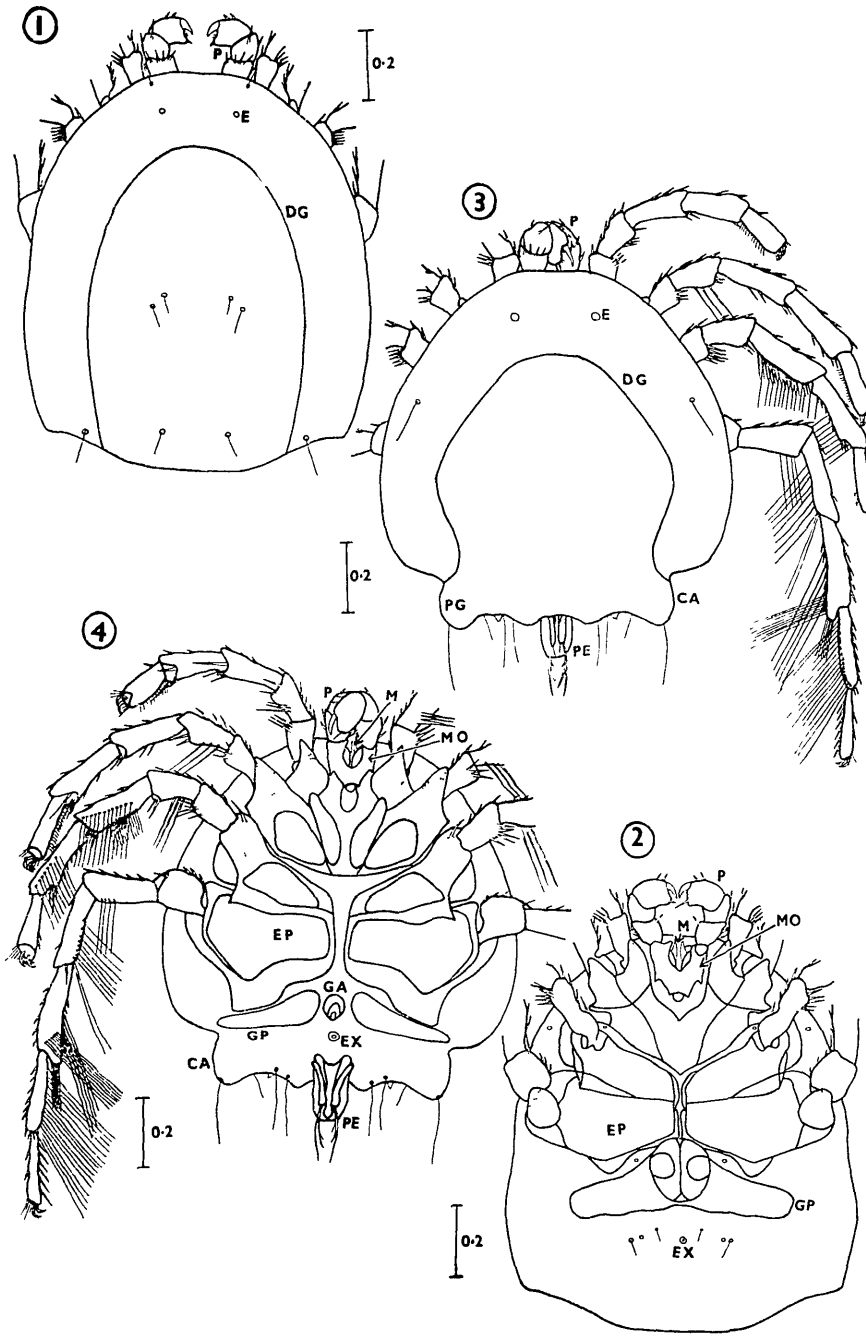
Arrenurus rotoensis n.sp.

ADULT. (Text-figs. V and VI.)

Male.

Body: Length, including petiolus, 1·12 mm., the greatest width, in the region of the fourth pair of legs, 1 09 mm. (Text-fig V, Figs. 3 and 4). The body is rounded anteriorly but narrows rapidly before the lateral expansions of the cauda (CA.). It is high behind the anterior edge and slopes down towards the posterior edge. The dorsal groove (DG.) stands well back from the anterior edge and from the sides of the body, turning laterally at the narrowest part of the body. The colour is a dark brown, with the appendages and epimera a lighter brown.

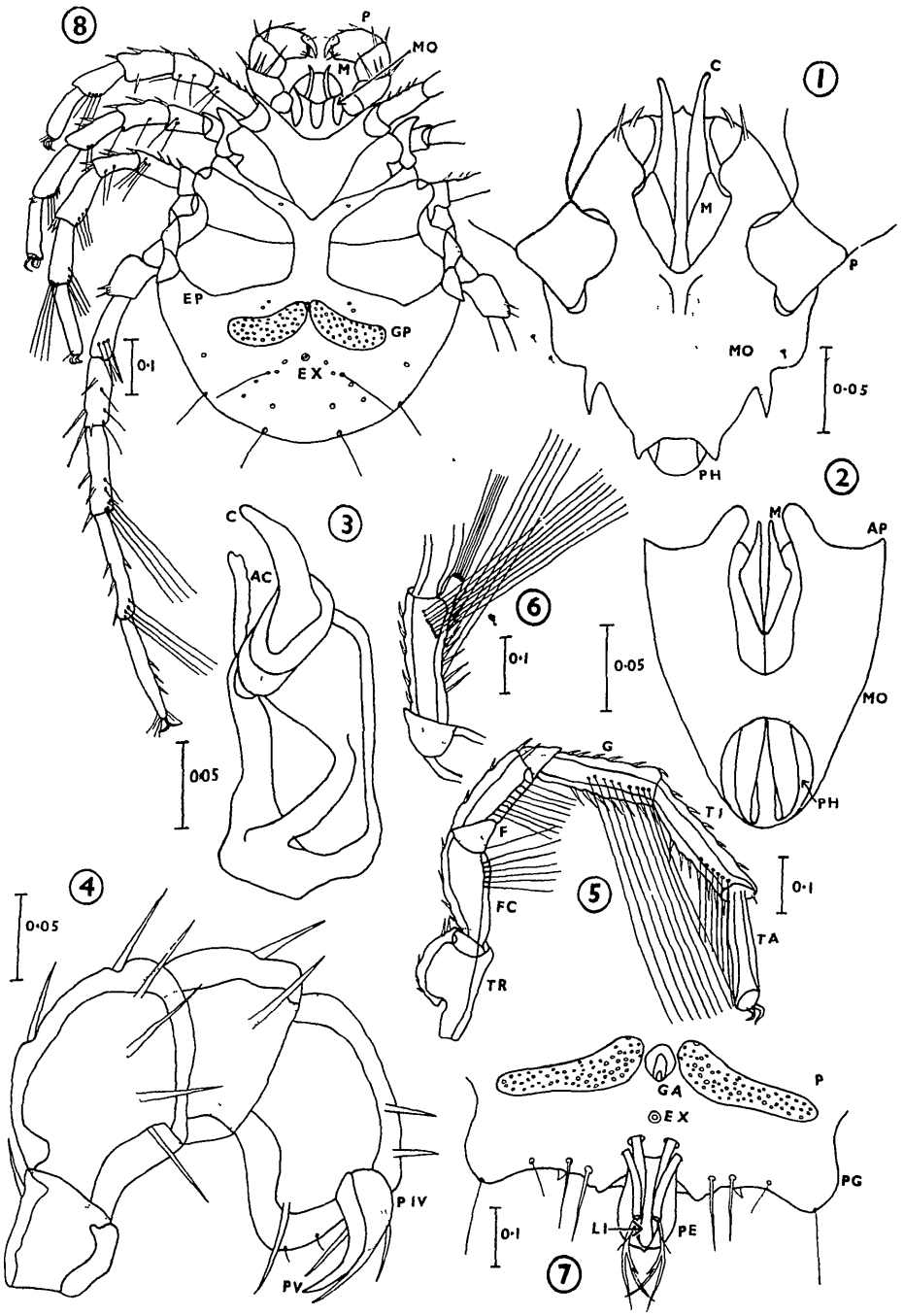
Cauda: Very short and about as wide as the body (Figs. 3 and 4. CA.), the petiolus (PE.) being large and conspicuous with no lateral processes at the end. The cauda expands slightly at the sides to form the pygal lobes (Text-fig. V, Fig. 3, PG.; Text-fig. VI, Fig. 7, PG.). Each lobe extends very little beyond the almost straight posterior margin and is tipped with a moderately long hair. There are two small lobes on either side of the petiolus with a smaller papilla lateral to each of them. Just anterior to these lobes arise two hairs, with a smaller hair on each side lateral to the papilla. The petiolus (PE.), about 0 17 mm long, is rounded at the distal end except for a small median point. It has no hyaline appendicula but possesses a ligulate process (LI.) rounded at the end and extending nearly to the posterior margin of the petiolus. On either side of the ligulate process there arises a strong, antler-like bristle, which divides into two about half way along its length, the median branch soon giving off a much smaller third branch. Alongside the base of this bristle, a small, fine hair is present.



TEXT-FIG. V.

Arrenurus rotoensis n.sp.

FIG. 1.—Dorsal view of female. FIG. 2.—Ventral view of female. FIG. 3.—Dorsal view of male, FIG. 4.—Ventral view of male. Scale in mm.



TEXT-FIG. VI.

Arrenurus rotoensis n sp

FIG. 1.—Mouth parts and attachment of the palps, ventral view. FIG 2.—Mouth parts dorsal view. FIG. 3.—Mandible, lateral view. FIG. 4.—Left palp. FIG. 5.—Left fourth leg. FIG. 6.—Fourth segment (genu) of fourth leg of male FIG. 7.—Cauda and genital area of male. FIG. 8.—Ventral view of nymph. Scale in mm.

Skin: with a thick chitinous armour pierced by large, closely set pores, the chitin of the appendages and epimera being more finely porous. A pair of gland hairs are placed laterally near to the widest part of the body.

Eyes: One pair (Fig. 3, E.), 0 025 mm. in diameter, situated anteriorly midway between the anterior margin of the body and the dorsal groove, and placed 0.23 mm. apart on either side of the midline.

Mouth parts· The maxillary organ (Text-fig. V, Fig. 4, MO.; Text-fig. VI, Figs. 1 and 2, MO.) measures 0 17 mm. to 0 21 mm. in length and 0 165 mm. in the greatest breadth. There is no true rostrum. The dorsal part of the maxillary organ is broad anteriorly, sloping gradually inwards towards the posterior end, where the round opening for the pharynx (PH.) is situated. The anterior dorsal edge bears a pair of short, rounded protuberances, one on each side of the mouth. The mouth opening is dorsally narrower than one-third of the width of the maxillary organ in that region and is rounded posteriorly. The ventral part of the maxillary organ extends forward anteriorly for some distance in front of the articulation of the palps as two broad, rounded protuberances on either side of the mouth opening, each carrying two setae. The mouth opening extends back to the level of the articulation of the palps, converging to a point posteriorly. Behind the articulation of the palps, the ventral part of the maxillary organ narrows to form a small protuberance on each side of the opening for the pharynx, giving off a small pointed process midway from the base of the palp.

The pharynx (PH), 0 09 mm. to 0 12 mm. long, extends to the edge of the maxillary organ and broadens out posteriorly. The lateral walls are thickened, especially dorsally.

The mandibles (Text-fig VI, Figs. 1 and 2, M ; Fig. 3) are short and broad, 0.17 mm. in length excluding the claw and approximately 0.09 mm. in width. Distally with a strong claw (C.), 0 085 mm. long, and a shorter accessory appendage (AC.) with an indented dorsal edge. The mandible is thickened at the edges, especially anteriorly, and for a strip down each side.

Palpi: Short and sturdy, the length being approximately 0 38 mm (Fig. 4). P.I is small, with P.II twice as long as P.I and nearly twice as broad, and arched on the extensor surface P III is about the same width as P II but slightly shorter and not as strongly arched. P.IV is about the same size as P II with the distal flexor corner expanded to abut against the short claw-like P.V. One bristle is present on the distal extensor surface of P.I, while P.II carries two bristles on the extensor surface and four more arranged along the distal dorsal edge. P III has one bristle on the extensor surface and another distally towards the flexor surface. There are two bristles on the extensor surface of P IV and a well-developed one towards the flexor surface, besides two small hairs on the distal end, both simple and not forked. P.V carries three bristles, two near the base and one half way towards the tip.

Epimera: Occupy most of the ventral surface (Text-fig. V, Fig 4, EP). They lie in three groups, the first two pairs on each side joined together and then fused medially with the opposite side, leaving no sign of the junction. The third and fourth pairs form a group on each side, the two groups lying close together medially, especially towards their posterior ends. The edges of the epimera are greatly thickened. The antero-lateral corners of the first two epimera are drawn out into strong, tooth-like appendages, while the antero-lateral corner of the third

epimera is drawn out as a broad process covering the first segment of the leg. The postero-lateral corner of the third epimera extends a short distance over the fourth epimera. The posterior margin of the fourth epimera is drawn out as a short broad process ending laterally in a low point. The first three epimera are broader at their outer than at their inner ends, but the fourth epimera is about the same width at its outer and inner edges. The first epimera are the smallest, the second and third slightly larger, and the fourth considerably broader.

Legs: Length of the first pair 0 82 mm , of the second 0 98 mm., of the third 1 01 mm. and of the fourth 1·25 mm. to 1 28 mm. (Text-fig VII, Fig 4; Text-fig. VIII, Fig. 5). The legs carry bristles and swimming hairs, bristles being present on all segments except the tarsi of the first and second legs. Swimming hairs are found on the femur of the second leg, and on the femur, genu and tibia of the third and fourth legs. There are small fine hairs on the inner surface of the tarsi of the first and second legs, the tarsi of the third and fourth legs carrying bristles on their inner surface. On the first three legs, each tarsus has at the distal end a pair of strong claws which are forked to give a small accessory projection near the base, but on the fourth legs (Text-fig. VI, Fig. 5) the claws are simple. Each tarsus has four to ten small fine hairs at the bases of the two claws.

In the males of this genus the fourth segment of the fourth leg is specially modified (Fig. 6). It is longer than the other segments and at the distal end of the flexor surface produced into a short, blunt-tipped spur which carries fine hairs, in this species six in number.

Genital area · Lies on the border between the body and the cauda (Text-fig. V, Fig. 4; Text-fig VI, Fig. 7). The genital aperture (GA) is small and narrow with thick lips A single pair of genital plates (GP.) extend from the genital aperture to the sides of the body. They are longer than the genital aperture and its lips at their inner ends, but narrow fairly abruptly and taper to a rounded point. The anterior edge of the plates is very close to the posterior process of the fourth pair of epimera. The acetabula on the plates are smaller than on the rest of the body and more numerous.

Excretory pore · Lies (EX.) 0 07 mm. behind the genital aperture, and about midway between the genital aperture and the base of the petiolus It is surrounded by a chitinous ring.

Female.

Agrees with the male except in the following characters:—

Body: Up to 1 14 mm in length, and 1 05 mm in breadth in the region between the fourth epimera and the genital plates (Text-fig V, Figs. 1 and 2). The body is rounded anteriorly but does not decrease in width towards the posterior margin, the postero-lateral corners being well marked and slightly broader than the remainder of the body. The posterior margin medially with a slight bulge. The body is high just behind the anterior margin and slopes towards the posterior margin, as in the male. The dorsal groove (DG.) lies well back from the anterior margin of the body. Colour dark brown, but the epimera and appendages are blue There is no cauda

Skin · A long hair is situated posteriorly on each side lateral to the dorsal groove and another shorter hair one-third of the way between the two sides of the groove There is also a pair of hairs on the anterior margin between the

palps and the first pair of legs, and two pairs placed almost side by side transversely just posterior to the middle of the body.

Epimera: The anterior margin of the fused first and second pairs has a median pointed groove, while the posterior margin expands slightly medially to form a small pointed process (Text-fig. V, Fig. 2, EP.). The two groups of third and fourth epimera lie closer together than in the male, especially anteriorly, so that they are almost touching except for a small bay opposite to the junction of the third with the fourth epimera. The process from the posterior margin of the fourth epimera is less well developed than in the male. The epimera are otherwise approximately similar to those in the male.

Legs: Same as in the male, except that the fourth segment of the fourth leg is normal. (Text-fig. VI, Fig. 5.)

Genital area. The genital aperture (Text-fig. V, Fig. 2, GA.) is guarded by large, rounded lip-fields. Each lip-field has on the front and hind end and for a narrow strip down the median edge a chitinous non-porous thickening called the "lip spot". On either side of the lip-fields lie the long wing-like genital plates (GP.) with many small acetabula. At their inner ends the genital plates are not as wide as the lip-fields, and they narrow slightly to end bluntly about 0 14 mm. medial to the lateral edge of the fourth epimera. The plates are slightly concave anteriorly and almost straight posteriorly. Immediately behind each plate lie three gland pores, of which the middle one is slightly larger and the outer two have fine hairs. In his diagnosis of the genus, Viets states that there are no gland pores immediately behind the acetabula plates, and this is the only respect in which the New Zealand species does not fit the description of the genus.

Excretory pore: The centre (Text-fig V, Fig. 2, EX.) lies 0 12 mm. posterior to the genital lip-fields, and therefore further back than in the male

Remarks

A well-known and widespread species of the subgenus described by Soar and Williamson (1929) and Viets (1936), *A. maculator,* is about the same length, but is emarginate between the antenniform bristles. It has a large conical protuberance on the dorsal side and a prominent tubercle on the side of the body close to the ends of the genital plates The colour is green or bluish-green. There are two hairs of unequal length at the tip of each pygal lobe, and the central part of the posterior margin curves slightly outwards over the petiolus. A hyaline appendicula is present at the proximal end of the petiolus, and a ligulate process extends a little beyond it. About the middle of the posterior margin of the cauda is a small, rounded double protuberance with a pair of bristles. None of these features are present in *A. rotoensis,* which also has a different distribution of the hairs.

No description of the skin nor of the eyes in *A. maculator* is given, but the armour is characteristic of the genus.

P II in *A. maculator* has five strong pectinate bristles on the inner surface, three near the flexor surface, one in the middle and one more towards the extensor surface, as well as two fairly long pectinate bristles near to the distal end of the extensor surface. The bristles in *A. rotoensis* are not pectinate. P V in *A. maculator* is larger than in *A. rotoensis* and ends in two or three teeth, absent in the New Zealand species.

The principal difference shown by the epimera of *A. maculator* is the drawing out of the anterior ends of the first two pairs into strong saw-like teeth. These appendages are not saw-like in *A. rotoensis.*

The description of the legs of *A maculator* is brief, but agrees with that of *A. rotoensis*

In *A maculator* the genital plates narrow much more abruptly close to their medial margins to become very short.

The "anus" of *A. maculator* is described as "lying near distal ventral end of cauda" (Soar and Williamson, 1929), which, in so far as it goes, agrees with the position in *A. rotoensis.*

In the female of *A maculator* the main difference is in the anterior part of the body, which contracts towards the antenniform bristles and is slightly emarginate.

Of the four pairs of long bristles on the posterior margin of the body of *A. maculator* only one is present in *A. rotoensis.*

A. maculator differs in that the interval between the fourth pair of epimera is rather more than the width of one of the genital lips, and thus broader than in *A. rotoensis.*

In *A. maculator* the genital plates are of about equal width throughout, with the ends rounded and extending only slightly beyond the posterior angle of the fourth epimera, although in *A. rotoensis* they extend some distance beyond this angle. The plates are slightly concave posteriorly in *A. maculator,* with the ends lying in a line about on a level with the posterior end of the genital aperture, thus further back than in *A rotoensis.* There are no gland pores posterior to the plates in *A. maculator*

NYMPH. (Text-fig. VI, Fig. 8.)

The length of the body is 1 05 mm., and the breadth 0 97 mm. Circular to oval in outline, the body almost colourless, with blue epimera and appendages. The skin is soft and finely ridged, lacking the armour of the adult, but the appendages and epimera are as strongly chitinised and finely porous as in the adult. Posteriorly lie several pairs of gland pores, some with hairs, and especially numerous posterior to the provisional genital plates.

The palpi (P.) are similar to those in the adult, except that the bristles on P.I, half way along the extensor surface of P.II and near the flexor surface of P II, are missing.

The epimera (EP.) are the same as in the adult but are not markedly thickened at the edges. The legs, especially the fourth pair, are longer compared with the rest of the body than in the adult and with fewer swimming hairs.

The provisional genital area, which is much nearer to the epimera than to the end of the body, comprises two wing-like plates (GP.), slightly concave on the anterior and convex on the posterior margin and rounded at both ends. These plates are joined in the midline except for where they are separated by a small, strongly chitinised sclerite for the attachment of the muscles. They slant only slightly to the ventral longitudinal midline, and each plate has about 40 small acetabula

The excretory pore (EX) lies 0 085 mm. posterior to the chitinised sclerite.

The nymph agrees with the adult in the remaining characters. No description of the nymph of *A. maculator* exists, and the nymphs of overseas species are in most cases not known.

Localities.

Maramau lagoon, South Wairarapa; a freshwater pond among sand dunes near the beach and cut off from the Waikawa River, near Manakau; a small pond in Ohariu Valley.

Occurrences.

At Maramau lagoon nymphs were collected in February, March and April and adults from August until April. At the Waikawa pond adults were collected in April and June, nymphs being absent at both these times. A female *Arrenurus* apparently belonging to this species was collected from a small pond in Ohariu Valley on May 31, 1952. The species of this genus are distinguished principally on the males, but this specimen agrees closely with the females from the other two localities.

No nymphophan stages were found, although insects and other possible hosts were searched at the time of each collection. It is likely that the species overwinters in the nymphophan stage, since neither nymphs nor adults were collected during the period from the middle of April until the beginning of August.

Subgenus: ARRENURUS s. str.

Arrenurus lacus n.sp.

The description is based on a single male adult and three nymphs.

ADULT. (Text-fig. VII.)

Male.

Body: Length, including petiolus, 1·15 mm., greatest width, in region between third and fourth pairs of legs, 0 94 mm. (Figs. 1 and 2). The body is almost circular, bluntly rounded anteriorly, with a shallow depression in the anterior margin and narrowing posteriorly before the lateral expansions of the cauda (CA.). It is high behind the anterior margin, sloping downwards gradually towards the posterior margin. The dorsal groove (DG.) stands well back from the anterior margin and from the sides of the body, turning laterally just before the cauda. Dark brown in colour with the appendages and epimera a slightly lighter brown.

Cauda. Very short (Figs. 1, 2 and 8, CA.) and not as wide as the body, the petiolus (PE.) being large and conspicuous with no lateral processes at the end. The anterior and lateral margins are greatly thickened. The cauda expands only very slightly at sides to form the pygal lobes (PG.) which are not well-developed and extend hardly at all beyond the almost straight posterior margin of the cauda. Each pygal lobe near the tip carries two hairs of unequal length. On either side of the petiolus is a long bristle with the tip turned towards the midline. Near to the posterior edge of the cauda, on each side of the petiolus, lie two hairs, the more median arising from the anterior thickening of the cauda and longer than the other, which arises slightly posterior to it. The petiolus (PE.), approximately 0 14 mm long, rounded at the distal end, has no hyaline appendicula but a ligulate process (LI) extending slightly beyond the petiolus and ending bluntly. The petiolus is covered with very small hairs, but there are no larger hairs or bristles on the ligulate process.

Skin: With a thick chitinous armour pierced by closely set large pores, the chitin of the appendages and epimera being more finely porous. A pair of gland hairs are situated close to the anterior margin in the region between the palps and the first pair of legs.

Eyes. One pair (Fig. 1, E.), 0 03 mm. in diameter, are placed 0 27 mm. apart on either side of the midline midway between the anterior margin of the body and the dorsal groove.

Mouth parts: The maxillary organ (Figs. 2, 3 and 4, MO.) measures 0 12 mm. to 0 17 mm. in length and the greatest breadth is 0 105 mm. There is no true rostrum The dorsal part broadens considerably anteriorly to form a short wide process on each side, bluntly rounded at the end, and narrows posteriorly towards the round opening for the pharynx The mouth opening is roughly semicircular in outline dorsally, with the diameter less than one-third the width of the maxillary organ in that region. The ventral part of the maxillary organ extends forwards only a short distance in front of the articulation of the palps (P.), carrying a short seta on either side of the mouth opening. Behind the articulation of the palps the ventral part narrows towards the opening for the pharynx (PH) The mouth opening extends back ventrally to midway along the base of P.I, narrowing suddenly halfway along its length and forming a small rounded posterior bay.

The pharynx (PH.) is 0 117 mm. long and of approximately the same width throughout. It extends to the posterior edge of the maxillary organ and the walls are thickened

The mandibles (Figs. 1, 2, 3 and 4, M.; Fig. 5) are short and broad, approximately 0 1 mm in length, excluding the claw, and 0 034 mm for most of their breadth increasing to 0 056 mm. at the proximal end. There is a median flap, partly thickened, and a strong claw (Fig 5, C.) distally about 0 055 mm. to 0·085 mm. long.

Palpi: Short and sturdy, in length approximately 0 26 mm. (Figs. 1 and 2, P.; Fig. 6). The very small P.I extends proximally into a short, blunt appendage. P.II is larger than P.I and broadens markedly towards its distal end, especially on the extensor surface. P.III is about the same width as the distal part of P.II and approximately the same length as P.II, being arched on the extensor surface P.IV has the same breadth as P III, but is nearly twice as long, expanded only very slightly on the distal flexor corner which abuts against the short, claw-like P.V. There are no bristles on P.I. On P.II two bristles are present on the extensor surface, the distal one being long and pectinate, two more occur on the distal margin towards the flexor surface, and one on the flexor surface. P.III has one bristle proximally midway between the extensor and the flexor surfaces, two more distally towards the extensor surface and one on the flexor surface halfway along the length of the segment. P.IV has a small bristle near to the distal end of the extensor surface, a strong spine on the distal flexor corner, and a small, fine hair on the distal end. P.V has one fine hair on the extensor surface

Epimera · Occupy most of the ventral surface and lie in three groups (Fig. 2, EP.) as in other species The posterior margin of the first group has a slight posterior curvature. The third and fourth epimera form a group on each side, the two groups lying close together medially The edges of the epimera are thickened especially at their outer ends The anterolateral corners of the first

two epimera are drawn out into tooth-like appendages. The posterolateral corner of the fourth epimera has a broad, blunt extension which slightly overlaps the first segment of the leg. The posterior margin of the fourth epimera is drawn out into a short, pointed process at its inner end and halfway along its length into a long apically rounded process extending posterolaterally inwards to below the genital plate. The first two epimera are of approximately equal breadth throughout, the third is broader at the outer edge, and the fourth, except for the two processes, of approximately equal breadth throughout. The first and second are about the same size and smaller than the third and fourth.

Legs: Length of the first pair, 0 7 mm.; the second, 0 82 mm.; the third, 0·82 mm.; and the fourth 0 98 mm. (Fig. 2; Fig. 7) The legs carry bristles on all segments except the tarsi of the second and third pairs Swimming hairs are present on the femuricollum, femur, genu and tibia of all the legs, increasing in number from the first to the fourth pairs. There are small, fine hairs on the inner surface of the tarsus of the first and fourth legs Each tarsus (Fig. 7, TA.) ends in two sickle-shaped claws, but no accessory claws are present. Four to ten small, fine hairs are present on the distal end of each tarsus. On the fourth segment of the fourth leg (G.) the process from the distal flexor corner carries four hairs.

Genital area: Lies on the border between the body and the cauda (Fig. 2; Fig. 8). The genital aperture (GA.) is small and narrow with thick lips. A single pair of genital plates (GP.) extends from the genital aperture almost to the sides of the body. The plates are about the same width as the genital aperture and its lips at their inner ends, but narrow towards their rounded outer ends The anterior edge of each plate is some distance from the posterior margin of the fourth epimera, but overlies part of the main posterior process of the latter. The acetabula are numerous and smaller than on the remainder of the body.

Excretory pore. Lies (Figs. 2 and 8, EX.) 0 07 mm. posterior to genital aperture and about halfway between it and the base of the petiolus. It is surrounded by a thin chitinous ring.

Remarks

This species differs from *A* (A.) *maculator* (Muller) principally in the same features as does *A.* (A) *rotoensis*, but it differs from the latter in that the body is more nearly circular in outline than in *A. rotoensis*, and the dorsal groove does not extend as close to the sides of the body.

In this species the cauda is narrower in comparison with the width of the rest of the body than in *A. rotoensis*, and the pygal lobes are less well developed. The hairs and the curved bristle agree with *A. maculator* but not with *A. rotoensis*. The lobes and papillae present on either side of the petiolus in *A rotoensis* are not developed in this species, and there is no median point of the petiolus. The ligulate process differs from *A. rotoensis* in extending beyond the petiolus and ending bluntly. The antler-like bristles and associated fine hairs on either side of the ligulate process of *A rotoensis* are absent in this species which, however, has small hairs covering the petiolus. The anterior and lateral edges of the cauda are not as greatly thickened in *A. rotoensis*, as they are in this species.

The gland hairs are differently placed in the two New Zealand species, being laterally near to the widest part of the body in *A rotoensis* and anteriorly close to the anterior margin of the body in *A lacus*.

The eyes are similar in the two New Zealand species.

The maxillary organ of this species differs dorsally from those in *A. rotoensis* due to the wider and more prominent anterior processes and the absence of protuberances on either side of the mouth. Ventrally the maxillary organ does not extend as far forward nor form the two broad rounded protuberances, and it carries only one seta. The mouth opening does not converge to a point posteriorly as it does in *A. rotoensis* which possess protuberances laterally between the articulation of the palps and the opening for the pharynx, absent in *A. lacus.* The pharynx in *A. lacus* does not broaden posteriorly and there is no increase in the thickening dorsally.

The mandible differs from *A. rotoensis* in the absence of an accessory appendage and the expansion of the proximal end.

The palp in this species differs from that in *A. rotoensis* in the following points: The presence of a proximal appendage on P.I, the smaller size and different shape of P.II, and the less strongly developed distal flexor corner of P.IV. Also the bristles are absent from P.I, less numerous on the distal edge of P.II, and more numerous towards the flexor surface of P.III. On P.IV there is only one bristle on the extensor surface, a strong spine on the distal flexor corner, and only one small hair at the distal end of the segment, while P.V. has only one seta.

The differences from the epimera of *A. rotoensis* are numerous, but most important are the presence of a process on the posterior margin of the fourth epimera and on its posterolateral corner and the weaker development of the third and fourth epimera

The differences in the legs from *A. rotoensis* include the presence of bristles on the tarsus of the third leg and their absence from the tarsus of the first leg, and the presence of swimming hairs on a greater number of segments. The small fine hairs are present on the tarsus of the first and fourth legs, not the first and second as in *A. rotoensis,* and there are no accessory claws. The distal flexor corner of the fourth segment of the fourth leg carries four hairs instead of six as in *A. rotoensis.*

The genital plates do not extend as far laterally as in *A. rotoensis* and are shorter at their inner ends. The anterior edge of each plate is further away from the fourth epimera than in *A. rotoensis.*

NYMPH. (Text-fig. VII, Fig. 9.)

Length of body, 0·64 mm.; breadth, 0·6 mm. The body is spherical and almost colourless, with blue epimera and legs. The skin is soft and finely ridged, lacking the armour of the adult, but the appendages are strongly chitinised and finely porous as in the adult. Posteriorly there are several large gland pores, especially numerous posterior to the provisional genital area and often with two pores to a plate.

The palpi are similar to those in the adult except that the two bristles on the distal end of P.II are absent.

The epimera are the same as in the adult male, except that the posterior processes are missing from the fourth pair, so that the posterior margin of the fourth pair is almost straight (EP.). The legs are relatively longer than in the male and carry fewer swimming hairs.

The provisional genital area lies close to the epimera and comprises two wing-like plates (GP.) which are slightly concave on the anterior and convex on the posterior margins, and rounded at both ends. They are separated in the midline only by a small, strongly chitinised sclerite for the attachment of muscles. The plates slant slightly to the ventral longitudinal midline and each has about 40 small acetabula.

The excretory pore (EX.) lies 0·08 mm. posterior to the chitinised sclerite.

The nymph agrees with the adult in the remaining characters. It differs from *A. rotoensis* in the same characters as those in which the adult males differ and in the greater number and larger size of the gland pores at the posterior end of the body.

Locality.

Wainui-o-mata Reservoir.

Occurrence.

The two collections made yielded two nymphs on March 19, 1951, and a male and one nymph on May 5, 1952.

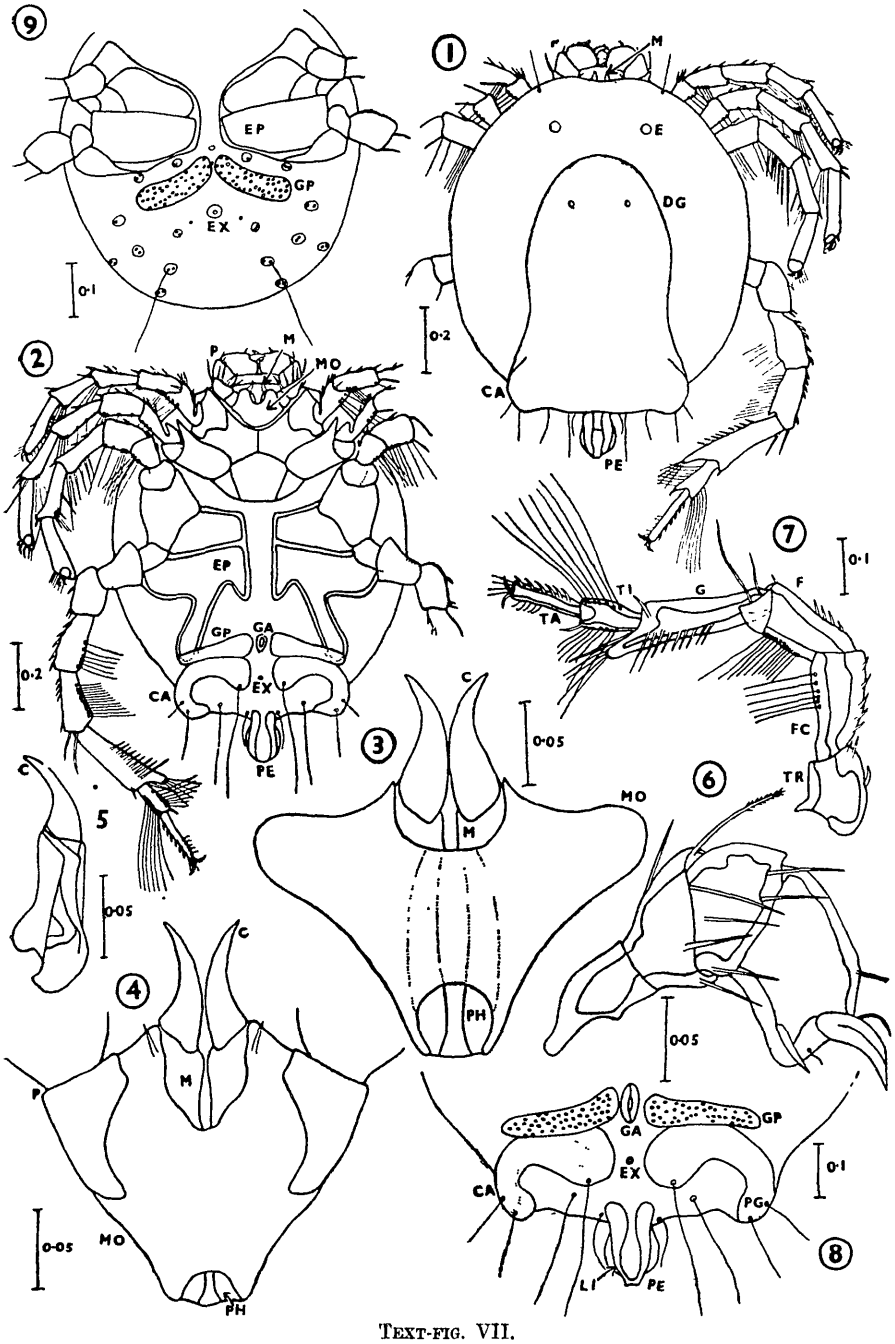
Discussion

That all the New Zealand species described are new is to be expected. Most hydrachnid faunas from separate areas are distinctive, as is illustrated for example by the faunas of South Africa, South America and North America, and although a single species may occur throughout Europe, European species are not found in North America. Most of the Australian species belong to new genera but no representatives of these genera have been collected in New Zealand. The New Zealand species belong to four large, well known and widely distributed genera, and the species in each genus are closely related but never more than one species of a genus is found in each locality. This is especially true in the Genus *Hydrachna* and the three New Zealand species are also closely related to *Hydrachna processifera* Koenike, a common European species. It is therefore possible that these three New Zealand species have originated from a single species very close to *H. processifera* The two species of *Arrenurus* are also closely related to each other and of overseas species are nearest to *A.* (A.) *fissipetiolatus* Lundblad from Australia.

Thus the species of hydrachnids so far collected in New Zealand show no strong relationship with those of Australia or any other region. They probably originated from the arrival in New Zealand of a single species of each of the four genera, and in one of these genera, *Piona*, the single species has spread widely, while in at least two of the remaining genera several different species have arisen.

III.—The Life History of *Hydrachna maramauensis* and *Piona novae-zealandiae*

A brief general account of development in the Hydracarina is given in my paper on *Eylais waikawae*. The postembryonic development of the Hydracarina, from the laid egg up to the hatched adult, is still a little treated sphere of investigation, especially the transitional stages. A good summary of the previous literature is given by Wesenberg-Lund (1918) who also adds some valuable observations of his own. In 1927 Lundblad gave an account of his observations on the life-history of several genera, including *Eylais*, *Hydrachna* and *Piona*, but, as with nearly all previous workers, the observations were on specimens collected by chance or hatched in aquaria rather than systematic accounts of the



TEXT-FIG. VII.

Arrenurus lacus n.sp

FIG. 1.—Dorsal view of male. FIG. 2.—Ventral view of male. FIG. 3.—Mouth parts, dorsal view. FIG. 4.—Mouth parts and attachment of palps, ventral view. FIG. 5.—Mandible, lateral view. FIG. 6.—Left palp. FIG. 7.—Right fourth leg. FIG. 8.—Cauda and genital area of male. FIG. 9.—Region of the third and fourth epimera and provisional genital area of the nymph. Scale in mm.

complete life history of any one species. Viets (1936) gives keys to the known eggs, larvae and nymphs, with very brief accounts of the transitional stages. His descriptions of the larvae and nymphs are the fullest published. Vitzthum (1940) gives a general account of the development in the Hydracarina from the anatomical or histological point of view. Recent accounts of the development in individual species are those of Marshall (1929) of a species of *Piona* and of Masuda (1934) of a species of *Hydrachna*. The latter has been particularly valuable for comparison, but Masuda's descriptions of the transitional stages are extremely brief.

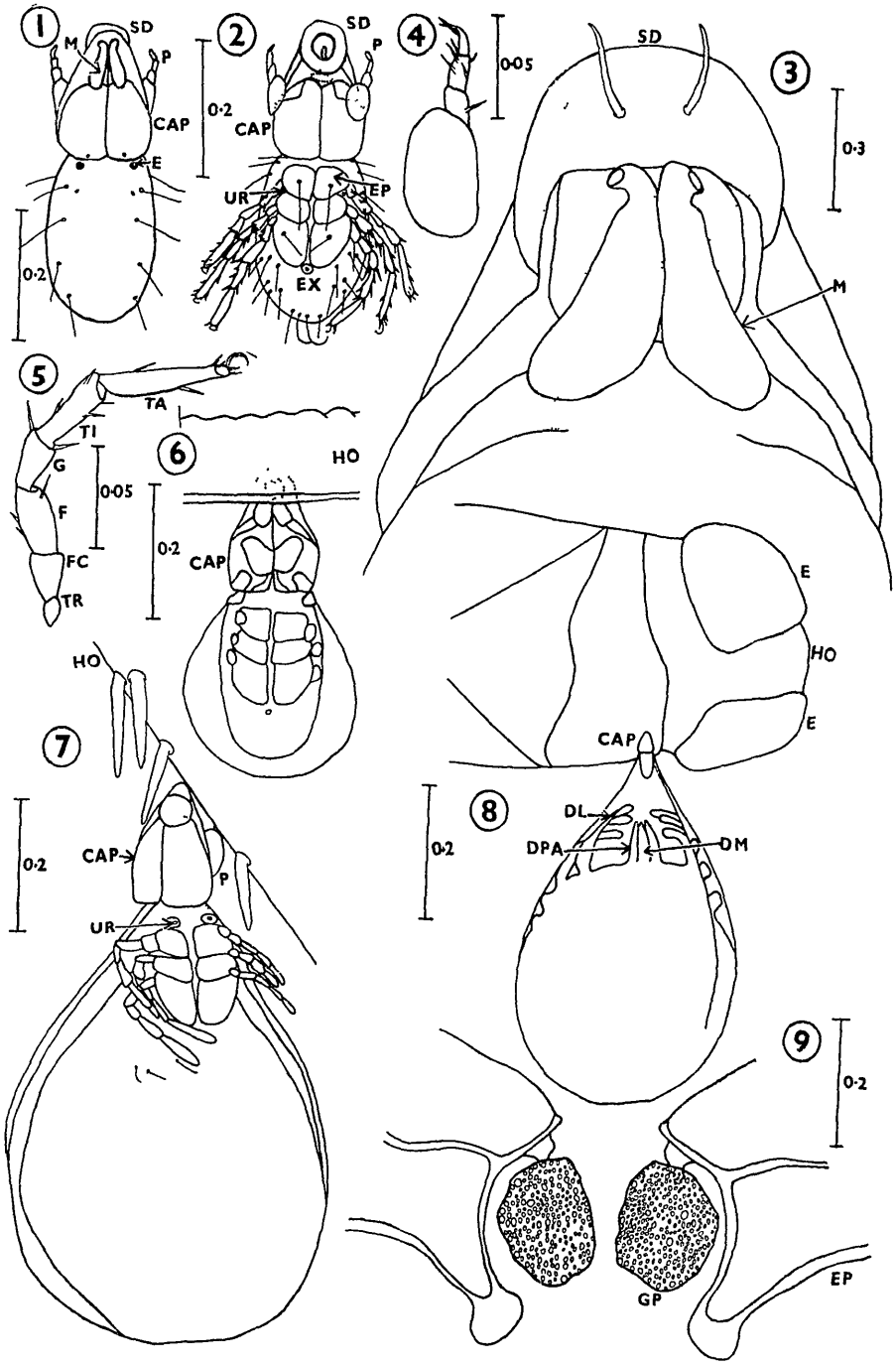
Description of the Life History of *Hydrachna maramauensis* n.sp.

(Text-fig. VIII.)

It was this genus of the Hydracarina whose life-history was first observed, but, as noted by Lundblad (1927), knowledge of the life-history of the genus is still very inadequate. The egg-laying has been examined by Duges in 1834 and Wesenberg-Lund (1918) and the parasitic life, or nymphophan stage, by several authors (summarised by Wesenberg-Lund, 1918) of which the most important is Piatakov, in 1916, whose works appear only in the Russian language. The species which have been examined are *Hydrachna williamsoni, H. geographica, H. globosa,* and *H. gallica.* A paper by Masuda (1934) gives a more systematic account of the life history of a single species, *H.* (*Schizohydrachna*) *nova* Marshall

There are no accounts of copulation in this genus. In the New Zealand species, a male and a female have twice been observed to come together, but they part again on the slightest disturbance. They apparently lie with their ventral surfaces opposing and their anterior ends pointing in the same direction. This method of copulation is of the same type as that in *Midea orbiculata* recorded by Lundblad in 1929, and *Forelia cetrata* briefly described by Walter in 1922 and Motas in 1928 (Uchida, 1932). It is also similar to the method of copulation in *Eylais waikawae,* except that in the latter case the male and female face in opposite directions.

Unlike most Hydracarina, the eggs of the genus *Hydrachna* are laid in special galleries in the stems of water plants and lack any gelatinous covering. No eggs were laid by *Hydrachna maramauensis* until March. Two 10 cm. culture dishes were set up on February 28, 1952, one containing two females and a male and the other two females, and each with a small branch of *Potamogeton* and a small branch of *Anacharis canadensis.* Eggs were laid in the first of these dishes on March 2, 1952, in two rows inside the longitudinal galleries of the *Potamogeton* stem. Through the tissue of the stem, the eggs appeared a dark greyish-green, and there were five in one row and four in the other. On the following day, a female was observed laying another batch of eggs, at 10 a.m. and a temperature of 71°. The hydrachnid held on the *Potamogeton* stem with its legs and pierced the stem with its mandibles, pushing the whole rostrum downwards into the stem. It then turned round so as to face down the stem and pushed its rostrum up into the stem so that the divisions between the longitudinal gallery cells in the *Potamogeton* stem were broken for a short distance and a "tunnel" formed. The hydrachnid now hung on to the stem with its palps, its rostrum being anchored in the plant tissue, in a position such that the genital aperture lay against the opening in the stem. The last three pairs of legs were stretched



TEXT-FIG. VIII.

Life History of *Hydrachna maramaensis* n sp.

FIG. 1.—Larva, excluding legs, dorsal view. FIG. 2.—Larva, ventral view. FIG. 3.—Mouth parts of larva, dorsal view. FIG. 4.—Palp of larva, lateral view. FIG. 5.—Left third leg of larva, ventral view. FIG 6.—Young nymphophan on third leg of waterboatman, legs broken off. FIG. 7.—Older nymphophan on first leg of waterboatman. FIG. 8 —Advanced nymphophan showing the developing nymph, two days before hatching, on thorax of backswimmer. From a live specimen. FIG. 9.—Provisional genital area and part of third and fourth epimera of nymph. Scale in mm.

out stiff and motionless. The first pair of legs were bent up and appeared to be helping in moving the eggs, but the greater part of the laying was accomplished by means of the ovipositor inserted into the opening and perhaps the first pair of legs helped to push the eggs down the tunnel. This female laid two irregular rows of eight and ten eggs respectively, a fresh hole being pierced for the second row; the whole process taking about five minutes. The hydrachnid moved a short distance up the stem and rested there for about a minute, holding on with its four pairs of legs in the usual manner, and then swam away Wesenberg-Lund (1918) says that as far as he could see the rostrum is used to push the eggs down the tunnel. But, from observation under a hand-lens, it appears that in the present case the rostrum was all the time embedded in the stem of the plant. According to Masuda (1934), the *Hydrachna* make holes leading into the galleries " with their palp. (This agrees with the observation of Wesenberg-Lund)". But Wesenberg-Lund (1918) states "a mite gets hold of the stem of a leaf and pierces with the mandibles an orifice in it". My observations agree with those of Wesenberg-Lund, the mandibles being used for piercing the hole and the palpi for clinging on to the stem. Masuda mentions that the ovipositor is used to lay the eggs, which Wesenberg-Lund did not find, but which I also observed. Masuda also says that "when there are two rows of eggs in a stem, they can be said to be laid by two different individuals of the same species", but in *H. maramauensis* in most cases they are laid by the same individual.

Hydrachna cannot lay its eggs on or in *Anacharis,* which is prevalent in their natural habitat and used by the other genera for egg laying, but require a plant whose stem has longitudinal galleries and a thin outer layer The only suitable plant in their natural habitat is *Potamogeton,* which is not plentiful. If the suitable plant is not present, the gravid female does not lay her eggs and dies sooner than females which have been able to lay their eggs. The species of the Genus *Hydrachna* exhibit unusual behaviour in laying their eggs in and not on the plant.

A slice containing a column of four eggs, of which only three developed, was cut off the stem, leaving only a very thin layer of tissue surrounding the eggs One of these eggs was completely separated from the plant tissue, and the eggs were kept under observation in a watchglass. The water in the watchglass was changed occasionally.

After about eight days, the eggs appear dark in the centre with paler, blunt protrusions towards the outside The protrusions are at first shallow and irregular, but gradually they become longer and more clearly defined, about half a dozen on each side. These slowly form themselves into short stumpy appendages, the legs dividing into segments, and the rest of the body rounds off into a more definite shape. By the time that some of the legs have become fully divided into segments, others may still be stumps, while the mouth parts are much slower in their development than the legs. Loose cells, or leucocytes, can be seen just inside the outer skin of the egg and are more numerous than in *Eylais wakawae.* The eyes are also visible on about the sixteenth to the twentieth day, as well as the broad "sucking disc" (SD) at the anterior end The hind part of the body becomes darker than the rest The epimeral plates appear in another day or two and the mouth parts continue to develop. By 8/4/52 the larvae appeared to be fully developed, with a dark, round area at the posterior end The water in the watchglass was changed at 10 a.m., and the larva whose

egg-case was completely separated from the plant tissue started to move its legs early in the afternoon and hatched later in the afternoon, when the temperature was 65°. It is interesting to note that this larva hatched without the support of the plant stem, so that if the eggs became detached from the stem under natural conditions, the larva could still hatch. Of the other two larvae in the detached slice of stem, one was moving at 7 p.m. It moved around in its egg-case for two or three minutes but then lay still again, afterwards moving at intervals for a short space of time. The remaining larva first moved at about 9.30 p.m.

On April 21, at 10.30 a.m , since the larvae in the other columns had not yet hatched, the end of the *Potamogeton* stem containing a cluster of about 14 eggs was cut off. The stem, which was by now brown and rotten, was slit down the middle and parts cleared away to give a fairly clear view of the eggs, still resting on a layer of stem. Three of the larvae started to move immediately, and one of these eggs was removed from the stem and placed in a watchglass. The larva moved at frequent intervals, and at 10.57 a.m. ejected a dark, thick, apparently granular substance from the posterior ventral part of its body. This filled most of the egg-case except for the end where the head of the larva was situated. A number of apparently fatty globules were present in the fluid. The larva continued to move round at intervals, moving its legs vigorously, its head up and down, and its body on rarer occasions. At 11.32 a.m. the larva ceased to move, and eight minutes later one part of the egg capsule started to swell and stretch, and the larva inserted its head into this area. The granular material flowed towards the swelling, which continued to stretch. The larva moved vigorously and pushed its head against the area. Some of the dark granular material appeared outside the capsule and was then observed flowing out through the apex of the swelling The larva pushed the tip of its capitulum through the opening, pushed more, and eventually all of its head through. The first two legs on one side and one leg on the other slipped out, and the larva struggled vigorously, in a few seconds pulling its body through the opening It ran about half a centimetre forward, stopped and remained still for about one and a-half seconds, and then began to run vigorously round the watchglass. The larva thus does not eat its way out of the egg-case, and showed no sign of eating the case after it had hatched. Another larva had hatched almost simultaneously from the eggs still on the stem. This egg was near to the edge of the stem and practically free, and the larva also did not eat its case.

By 3 30 p m on the following day, several more larvae had hatched from the eggs on the piece of stem. One egg was dissected free from the stem, and the larva inside soon began to move round inside the case. At 3.45 p.m. the larva expelled a dark fluid similar to that observed the day before. This fluid was expelled from the posterior ventral part of the body, from the dark area previously noted The larva now remained still except for infrequent movements, until 4 30 p m , when the movements became more frequent and more vigorous Eight minutes later a slight swelling in the capsule burst, and the dark fluid flowed out This swelling was near to that end of the capsule in which was the animal's head, this end being slightly larger than the other. The burst area was in the vicinity of the larva's legs, two of which were pushed through the opening. The larva struggled, stretching itself with the tip of the capitulum pushed upwards against the egg-case and clawing with its palps at the membrane. After a short time the larva drew in its two legs and turned slightly so that the head was

much nearer the opening. It stretched again, clawing with its palps at the small piece of membrane remaining between the head and the opening and tore this very taut membrane with its palps. The larva rested for a second, pushed its head out of the opening, and swam away.

There is therefore apparently a large gland situated at the posterior end of the unhatched larva and containing a "hatching fluid" which causes the egg-case, probably always the slightly larger end, to swell and weaken, so that the larva is able to burst it. The larva fits loosely inside the egg-case and could not burst it only by stretching its legs. The fluid may be excretory in nature. It is necessary for the larva to emerge from the egg-case head foremost. There is no previous account of the hatching process of an hydrachnid larva; but the above strongly suggests hatching is based on an enzyme action.

Immediately after hatching, the larva (Text-fig. VIII, Figs. 1–5) swims round vigorously keeping principally to the sides or bottom of the container or to the surface of the water. It swims with a running movement of the legs, all moving rapidly. The finding and emergence out of the nymphophans of this species on *Arctocorisa arguta*, the waterboatman, and *Anisops wakefieldi*, the back-swimmer, had already established the host for the larva. One of the larvae was introduced to a waterboatman at frequent intervals during the next few days Although it would often swim right into the host, the larva showed no interest for the first two days, but at noon on the third day the larva swam to the host directly on being introduced into the same container. Approaching the waterboatman from the posterior end, the larva ran along the dorsal surface of the elytra, down one leg and up again and attached itself to the outside edge of an elytrum. The host immediately became very active, so the larva had probably then inserted its mouth parts. This waterboatman and its attached hydrachnid were kept alive in a 75-gallon tank, and the larva later hatched as a nymph.

Some other larvae attacked the hosts on the second day, others not until the fourth or fifth days. One larva showed no interest until the sixth day, when it crawled over the head of the host and the host rapidly pulled the larva towards its mouth and ate it. Many larvae fail to find a host, even when placed in the same dish, and several are probably eaten, so there must be a large mortality at this stage of the life-history. The larva dies if it does not attach itself to a host before about the eighth day after hatching.

Hydrachna larvae of this species have been found only on *Anisops wakefieldi* and *Arctocorisa arguta*. *Dytiscids* are the most common hosts of *Hydrachna* larvae overseas, but none of the members of this group examined, about 50 specimens, including *Dytiscus* and *Rantus*, carried any hydrachnid larvae. Both the species which act as hosts are native, and they are the commonest insects found in the freshwater pools examined.

The larvae will attach themselves to either nymphal or adult hosts, but the nymphs must have moulted recently, as Masuda observed. The place of attachment of the larva differs slightly according to the host species On the waterboatmen the greatest number of larvae (about 70%) are attached to the legs, and others to the elytra (20%), head (5%), and thorax (5%), out of nearly a hundred specimens examined. All hydrachnid nymphophans found underneath the elytra belonged to another genus, *Eylais*, and nymphophans of species belonging to the two genera may be present concurrently on the same host individual.

On the backswimmers a large number (about 45%) of the larvae attach themselves to the legs, but perhaps an even greater number (about 55%) to the underneath, or morphologically dorsal, surface of the host, mainly on the body (75%) and in lesser numbers on the head (25%), out of approximately 50 specimens examined.

The larva clings to the host with its palpi and pierces the chitinous exoskeleton with its mouth parts. It does not use the palps to tear the chitin, although Masuda stated this to be the case. The larva draws nourishment from the host when it first attaches itself and branching channels of affected tissue can be seen extending inwards through normal host tissue. Later these channels apparently harden, so the tissue affected is probably killed. Thus the relation between the hydrachnid and its host is one of parasitism, as Masuda has stated.

The hosts endeavour to remove the hydrachnids with the short first pair of legs when the nymphophan is attached to the head, or with the other pairs of legs when the nymphophan is attached anywhere else. This action has been noted at all stages during the development of the nymphophan, which when large is probably of considerable inconvenience to its host. It is noticeable that while some of the host specimens are completely free of hydrachnids and others may have several attached, often up to six hydrachnids at various stages of development, there are few with just one nymphophan attached, and in these few cases the hydrachnid is usually not far past the larval stage. It is possible that the presence of one or more hydrachnid nymphophans may make the host more susceptible to further attack.

The nymphophan develops on the host. After about a week the body of the larva begins to increase in size (Text-fig. VIII, Fig. 6), and gradually becomes pear-shaped (Fig. 7), so that the shape is very different from that of the nymphophan of *Eylais waikawae*. As soon as the body begins to swell the hydrachnid ceases to suck nourishment from the host. A very young nymphophan, showing a slight expansion of the body, was once observed to fall off its host (a backswimmer) and when examined the appendages and mouth parts were moving so that it probably retained the ability to attach itself to another host. The development of the nymphophan agrees with the general plan in the Hydracarina. The outer larval skin remains apparently intact with the nymphoderma closely applied to its inner surface, but the larval legs are usually partly or completely lost. Inside, the nymph begins to develop, at first as a central mass of cells. After a few months, when the pear-shaped body is over a millimetre in length, stumpy protrusions appear which gradually form themselves into limbs and mouth parts. The nymphoderma continues to grow or stretch throughout the duration of the nymphophan stage. As in the developing larva, the legs differentiate before the mouth parts, but the legs (Fig. 8, DL.), palpi (DPA.) and mouth parts (DM.) are all clearly visible about three days before the nymph emerges. The eyes can also often be seen at this stage. The whole of the inside of the nymphophan darkens slightly immediately previous to the emergence of the nymph. Most of the larvae will have hatched and attached themselves to hosts by the end of April, and the nymphs begin to emerge in the beginning of August, so that the average time spent in the nymphophan stage is about four months. The *Hydrachna* whose attack on the waterboatman was observed on April 24 emerged as a nymph on August 13, being one of the earliest to emerge. Most of the

nymphs emerge during September. In contrast, Masuda's species was never longer than 24 days in the nymphophan stage.

The nymph fits closely against the nymphoderma with its legs tucked in towards its sides. The legs begin to move slightly at irregular intervals, and within a few hours the movements become more vigorous. The nymph moves round inside the nymphoderma, which suddenly splits as a straight tear in an almost complete circle near to the posterior end, so that a cap is left. The nymph slips out easily, leaving the empty nymphoderma attached to the host by the larval mouth parts. Most of this empty skin is usually soon rubbed off. The emergence is thus accomplished by breaking or bursting the skin There is no previous description of the emergence of an hydrachnid nymph.

The newly emerged nymph is red like the adult, but the central parts of its legs are a very dark blue, and redden after a few hours. The nymph is quiescent for a time, sitting on a leaf or stem of an aquatic plant, and may remain thus until it enters the teleiochrysalis stage. But usually the nymph soon begins to swim actively and to lead a life similar to that of the adult. The length of time spent in the nymphal stage varies considerably depending on the amount of food available and the temperature. When food is plentiful and the temperature warm, the nymph may feed almost continuously for about a week and then become a teleiochrysalis. But if food is scarce, or the weather too cold, that is with an average below 65°, the nymph may continue to lead its active life without metamorphosing for as long as three or four months Nymphs collected in the beginning of June had not always metamorphosed in September.

Before undergoing the final metamorphosis, the nymph attaches itself to a plant, usually an *Anacharis* leaf, by means of its legs and palpi, which are clasped round the edge of the leaf, the leaf not being pierced at all The hydrachnid prefers a plant with a flattened leaf, and the serrations at the edge of the *Anacharis* leaf may be helpful for efficient anchoring. The hydrachnid has now entered the teleiochrysalis stage. The metamorphosis is carried out in accordance with the general hydrachnid plan and in a similar manner to the two previous metamorphoses. The teleioderma is formed closely opposing the inside of the nymphal skin and the animal becomes a teleiophan. The central mass of cells rapidly forms the body of the adult, which is fully developed in three to ten days One of the nymphs observed developed into an adult and emerged the third day after attaching itself to the leaf, others may take up to ten days, but the majority take about five to six days. Masuda's species generally took about ten days from the emergence of the nymph to the emergence of the adult The adult hatches, as does the nymph, by movements inside the taut skin, which tears near to the posterior end. After emergence, the adult swims actively at once without any preliminary quiescent period.

The eggs are not laid until near the end of the summer. In the laboratory the first were laid on March 2, 1952, others on March 3, and it was during March that intensive egg-laying took place, it being almost over by the end of the month. The larvae hatch just over a month to seven weeks later, that is most of them during April, and attach themselves to the host within two to four days. The next three or four months are passed in the nymphophan stage, from which the nymphs emerge principally during August, September and October, but also up until December. Some nymphs may develop into adults within a week or ten days, others, including all those emerging in August and the beginning of

September, may not metamorphose until the beginning of the year. This metamorphosis takes four to ten days. Thus both nymphs and adults are present throughout the summer. The adults die a few weeks after laying their eggs.

This species overwinters mostly in the nymphophan stage, and the considerable length of time spent in this stage may be correlated with the adverse conditions pertaining during its existence.

The hydrachnid nymphophan is carried by the insect host when it travels from pond to pond, and may thus hatch out in new habitats some distance from where the egg was laid. This means of dispersal is undertaken by most hydrachnids. The nymphs and adults of *Hydrachna* are also to some extent resistant to desiccation and will survive completely out of water and under the heat of a microscope lamp for at least ten minutes. It is possible that these stages may be transported among moist vegetation. The transportation of the plant in which the eggs were laid or on which the teleiophan is developing is also possible.

DEVELOPMENT IN OTHER NEW ZEALAND SPECIES OF *Hydrachna*

The development from the nymphophan stage onwards in *Hydrachna evansensis* has also been observed. The host is the backswimmer, *Anisops wakefieldi*, and waterboatmen are absent from this locality. The development is very similar in all the features observed to that of the species already described. The old larval skin is different, but parts of it are always absent. The teleiophan stage was passed in the laboratory on *Anacharis* leaves although this plant is not present in the natural habitat. No nymph attached itself to water cress, the only plant available in the natural habitat, and if *Anacharis* was not present the nymphs died without metamorphosing. The population of this reservoir is very small and may have died out during the 1951-52 summer, so it may be maintained only by nymphs hatched from off backswimmers which have flown to the reservoir from some other pond where the species breeds. Although all known ponds were searched in the Wellington area, the species was not collected at any other locality.

It is probable that the general plan of development is quite similar in all three species of *Hydrachna* found in New Zealand.

DESCRIPTION OF THE LIFE HISTORY OF *Piona novae-zealandiae* n.sp. (TEXT-FIG. IX)

Although the Pioninae is one of the largest subfamilies of the Hydracarina, no study has been made of the complete life-history of any of the common species, and the only account of the life-history of a species of *Piona* is Dr. Marshall's paper in 1929. This account is incomplete, containing descriptions only of the nymph, copulation, egg masses, time of emergence of the larvae and the external morphology of the larva. The subsequent history of the larvae in this species is not known. Wesenberg-Lund gives an account of observations on the life-history of this genus prior to 1918, which include that the eggs take 10 to 17 days to hatch according to the species, the larvae are parasitic upon different water insects and the teleiophan stage takes place upon water plants. Soar and Williamson (1925) mention several individual observations on the development in this genus, including the remark that in some species, such as *Piona rotunda, P. fuscata*, the development from egg to nymph takes place inside the egg-case and takes 10 to 17 days according to the species.

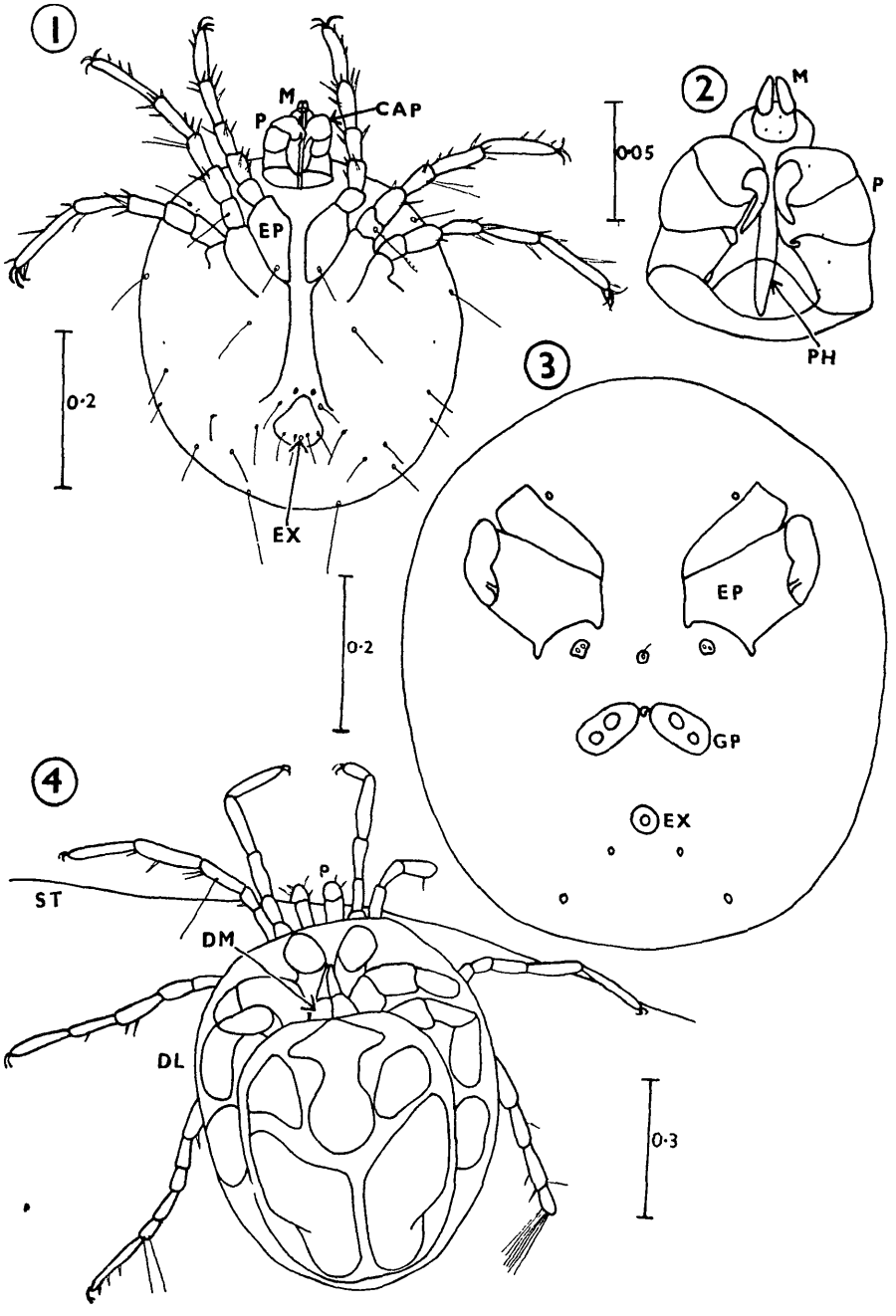
Copulation has been described in several species of *Piona,* and a complete account is given by Uchida (1932). The male and female come together to form a right angle, with their ventral surfaces forming the inner sides of the angle and the anterior end of the female coming into contact with the posterior part of the male. The male takes hold of the bases of the first or second pair of legs of the female with its own specially modified fourth pair of legs. The hook on the fourth segment, the genu, of the fourth pair of legs fits over the first segment of the first or, usually, the second pair of legs of the female. The male uses the club-shaped sixth segment, the tarsus, of its third pair of legs to transfer the sticky spermatophores from its own genital opening to that of the female. Copulation in the New Zealand species agrees with Uchida's description and occurs principally in October, but also in November.

In 1924 and 1925, Sokolow described in detail the act of spawning in *P. carnea,* and his account is included by Viets (1936, p. 507). The female rests on a submerged leaf of a water plant, in the New Zealand species always *Anacharis canadensis,* and makes strong swimming movements with the fourth pair of legs It then swings the hind part of its body from side to side in a rapid pendulum motion. A first row, usually of four eggs, is laid from right to left, then the female, without shifting its position, lays a second row from left to right and a third row from right to left. Thus, according to Sokolow's account, 32 eggs were laid in a zig-zag line in the space of about six minutes. None of the *P. novae-zealandiae* females ever laid more than two or three rows at a time The female swims away immediately the eggs have been laid.

The eggs are surrounded by a transparent layer of colourless gelatinous material, each division of which encloses a single egg. This material is secreted by the female around each egg as a very thin wrapping which absorbs water and swells greatly so that the wrappings surrounding adjacent eggs come into contact with each other. The egg-laying observed in *P. novae-zealandiae* agreed with Sokolow's account. The size of the cluster varied from one with a double row of 20 eggs, 4 0 mm. long, to some with six eggs or less, not more than half as long, and one cluster containing only two eggs.

In the New Zealand species the eggs were always laid on *Anacharis canadensis,* which is usually abundant in the natural habitat. The *P. carnea* female observed by Sokolow laid its eggs on a submerged leaf of *Ranunculus cassubicus,* but the New Zealand species never laid eggs on *Ranunculus macropus.*

A cluster of eggs was removed from the plant and the development of the schadonophan watched through the transparent gelatinous covering. This development followed a similar pattern to that in the other two genera, but it was much more rapid. In about four days, clearer areas began to appear towards the outside case of the egg and soon two dark reddish brown spots, the developing eyes, were visible. Leucocytes were not abundant. On the fifth day rounded protrusions were visible extending outwards from the dark brown central area. Some of these protrusions gradually became segmented and developed into limbs by about the ninth day, others into mouth parts about a day later The legs usually all developed simultaneously and were a transparent pale blue, the rest of the body being a darker brown. The epimera were not visible until shortly before hatching. On one occasion only two epimera were formed, the first two pairs of legs being attached to the first pair of epimera. The legs began to move on the ninth or tenth day, and the first larva may hatch on the tenth day. The



TEXT-FIG. IX.

Life History of *Piona novae-zealandiae* n sp.

FIG. 1.—Larva, ventral view. FIG. 2.—Capitulum of larva, ventral view. FIG. 3.—Provisional genital area and third and fourth epimera of nymph. FIG. 4.—Teleiophan, on *Anacharis* leaf. Scale in mm.

larvae moved freely, inside the egg-case, but not continuously, often for about 24 hours and sometimes jostling into their neighbours.

The larvae hatch on the tenth to the sixteenth day and there may be five or six days between the hatching of the first and the last larvae of the same laying. In this species the larvae hatch in quite a different manner to those in the other two species observed, for in order to hatch, the larva must make a way through not only the egg-case but also a thick gelatinous covering. It first eats a hole in the egg-case and then in the gelatinous covering. In one of the instances observed, the first larva to hatch ate quite a large hole from its cell to the outside, through which it could easily crawl out. The movements of the legs were uncertain and shaky at first and the larva crawled around on the egg cluster before venturing on to the leaf and finally swimming away. The swimming was accomplished with the same running movement as in the other species, but was more efficient in this species and progression through the water was faster. The larva in the neighbouring egg-case hatched the next morning. It worked its way, partly by eating and partly by movements of the legs, through the intervening egg-case and into the empty cell from which the first larva had hatched, emerging through the hole already made. This larva also walked round the top of the egg cluster and on to the leaf before swimming away. The remaining larvae in this cluster were by now moving around vigorously, and all of them hatched within the next day or two. Some ate new holes through the gelatinous covering, while others used holes already made.

When placed in a culture dish which had been thoroughly searched and any form of animal life visible removed, the further activities of the minute, almost colourless larva could not be followed, but in about a week to ten days nymphs were present. No sign of the nymphophan stage had been found on the vegetation or on the sand at the bottom of the dish, so this stage must be very small and inconspicuous. The larvae died when placed with a branch of *Anacharis canadensis* in a watchglass where their activities could be more readily followed. No sign of any nymphophan stage of this genus has ever been observed on any of the numerous kinds of freshwater life and aerial insects examined. When three waterboatmen, two adults and one nymph, four backswimmers, two adults and two nymphs, several waterstriders and a Syrphid larva were placed in the culture dish for a day and then examined and removed to another culture dish, none of these animals carried parasitic larvae and no nymphs emerged from them subsequently, but the *Piona* nymphs emerged in the original culture dish. It therefore appears that the nymphophan stage is passed attached probably to aquatic plants and is very short, and that no parasitic stage is present in the life-history of this species.

The only information on the occurrence of *Piona* nymphophans as parasites on other animals is a statement by Wesenberg-Lund (1918) that "Piersig (1900, p. 96–108) indicates that the larvae are parasitic upon different aquatic insects of 'Wasserkäferlarven', further that the second pupa stage takes place upon water plants. All more thorough investigations are wanting. Only with regard to *Piona carnea* he reports that the pupa is ball-shaped and that *P. longipalpis* can occur in great numbers". In other species, *P. nodata, P. rotunda* and *P fuscata,* the hydrachnid is said to hatch from the egg-case as a nymph, omitting the larval and parasitic stages (Wesenberg-Lund, 1918, Soar and Williamson, 1925, and Viets, 1936). But Lundblad (1927) proves that *P. fuscata* does not develop

directly to the nymph inside the egg-case. At the beginning of June (in Europe), larvae hatched from eggs in his aquarium and by the middle of June Lundblad found in the aquarium 23 small nymphs and a pair of nymphophans, the latter lying on the bottom with their legs spread out. Lundblad maintains that this proves that *P. fuscata* neither parasitises another animal nor leaves the water Only a few small ostracods were present in the aquarium. Lundblad in his description of the life-history of *P. clavicornis* (O. F. Müll.) points out that the omission of the larval stage must be a last resort. This, and several other *Piona* species, lives in temporary pools and the nymph oversummers and overwinters on the grass at the bottom and develops into an adult in the following spring. Therefore Lundblad's observations agree with those on the New Zealand species, the hydrachnid hatching as a larva but not passing through a parasitic stage. It is not proved that the nymphophan stage is passed on the bottom of the freshwater body in the natural state, and it would seem that this is unlikely when there is any flow.

The habits of the nymph are similar to those of the adult and, as in the other genera, the length of time spent in this stage varies greatly. Occasionally a nymph will metamorphose into an adult in about a week but this is unusual, and in most cases the metamorphosis does not take place for several weeks or even months The final metamorphosis takes place under similar conditions to those described for the other two genera. The nymph attaches itself to an *Anacharis* leaf by looping the first two pairs of legs and the palps over the edge of the leaf (Text-fig. IX, Fig. 4) The last two pairs of legs rest freely against the side of the leaf.

The development of the teleiophan follows the usual pattern and takes only two or three days. On the second day the adult can be seen inside the nymphal skin and teleioderm, with the spherical body and distinct, but almost unsegmented, legs (DL.) and the incipient mouth parts (DM.) visible. The adult emerges, as in the other genera, by moving and stretching its legs. The female adult is much larger than the nymph and the taut skin bursts immediately the adult moves, but the male is smaller and often about the same size as the nymph. The adult swims away as soon as it has emerged.

The eggs are laid principally in the last ten days of October and during November, and usually no more are laid after the first week of December. The larvae hatch in nine days to three weeks, but most of them in about a fortnight. Usually they have all hatched by about the middle of December. Most of the nymphs appear about ten days to a fortnight after the larvae have hatched, that is about a month after the eggs were laid. Nymphs are present throughout the year but their numbers decrease during September, when most of them metamorphose into adults and increase again at the end of the year when the next generation emerges. Adults are also present throughout the year, their numbers increasing in September and October and decreasing markedly during the summer, when most of the adults die after having laid their eggs An adult which has emerged from the teleiophan stage in March will live until the following spring, a period of about seven months The species lives through the winter in both the nymphal and the adult stage.

The absence of a parasitic stage might be thought to impose a limiting factor on the dispersal of this species, but this is the most widely distributed of all New Zealand species of hydrachnids. It is to a considerable extent resistant

to desiccation and can remain alive out of the water for several hours. In damp vegetation or damp mud the animals can survive much longer.

On one occasion a female *Piona novae-zealandiae* which had been isolated for a month, laid a cluster of eggs which developed normally. It is possible that fertilisation may occasionally take place some time before the eggs are laid. Parthenogenesis has not been recorded in the Hydracarina and is very rare in the Acarina.

On another occasion a female *Piona novae-zealandiae* killed and ate a much smaller male, and laid its eggs the same evening. It is not known whether or not copulation had previously taken place between the two animals.

The life-history of this species differs greatly from that in the two other species, and most Hydracarina. in the omission of a parasitic stage, and the time taken for the development is considerably shorter than the average. The method used for the hatching of the nymph also is different from that in the other two species.

Discussion

The three life-histories described show a different pattern, especially the life-history of the *Piona* species. These differences are most evident in the place in which the eggs are laid, the time taken for the development of the larvae, the hatching process of the larva, the conditions under which the nymphophan stage is passed and the length of time spent in this stage, as well as the time of year during which the various stages occur. It is of particular interest that the hatching process, here observed for the first time, should take place in two such different ways. A possible reason lies in the fact that the gelatinous layer around the eggs is thick in *Piona* and possibly too thick for a "hatching fluid" to dissolve.

The nymphophan stage, in the two species in which it is parasitic, has become adapted to native hosts, but these hosts are of only two species and the nearest relations to many overseas hosts, such as *Rantus,* and the damsel-flies and dragon-flies, are free from hydrachnids. The *Anacharis* is a widespread species, and used by hydrachnids elsewhere for egg-laying. *Potamogeton* is a widely distributed genus and it is not known if the species is native or not. The hydrachnids have evidently been able to adapt their life history to native species of the fauna and flora when this has been necessary.

IV.—Discussion

The seven New Zealand species described here and in my previous paper show a general agreement with Hydracarina elsewhere. Although the species are apparently new, and it is possible that any species subsequently described in New Zealand will be new, they do not display any characters which are outstandingly different from those of other hydrachnids and they are in most cases closely related to overseas species. The close relationship within each genus in New Zealand suggests that they have radiated from a single species in the genus. The life-histories of at least three species agree with observations made overseas, but the parasitic stages of at least two of the species are passed on native hosts. The native hosts include both Corixidae and Notonectidae as are attacked overseas, but apparently in New Zealand Dytiscidae and Odonata are not parasitised, although these families are especially favoured in other countries.

The plants used for egg-laying and the metamorphosis from nymph to adult are regarded as introduced species, *Anacharis* is abundantly used elsewhere, as it is in New Zealand, but in other countries the *Hydrachna* species favour *Alisma* while in New Zealand they do not lay their eggs in this plant but require *Potamogeton*. When further work has been done on the life-histories of overseas species it will probably be found that several species of *Piona* have a life-history similar to that described by Lundblad for two Swedish species and in this paper for *Piona novae-zealandiae*. Thus in so far as can be determined at present the principal differences in the life-histories of the New Zealand species from those of other hydrachnids are in the hosts of the parasitic stages. The food eaten by New Zealand hydrachnids is of the same kind as that eaten by species of the same genera in other countries, although at least in the case of carnivorous hydrachnids the species of animal eaten is probably different. The New Zealand species may be more restricted in their local distribution than are species of the same genera in other countries for they seem to be dependent on the presence of a restricted range of vegetation, especially *Anacharis*. This dependence on the vegetation has not been noted overseas where it is possible that there is a wider range of suitable plants

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