REVIEW OF EPHEMERELLA NYMPHS OF WESTERN NORTH AMERICA (EPHEMEROPTERA)*

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Studies by Eaton (1884), Dodds (1923) and Needham (1905, 1927) have contributed much to our knowledge of the nymphal forms of *Ephemerella* occurring in Western North America. Needham's recent paper on "The Rocky Mountain species of the Mayfly genus *Ephemerella*" contains a valuable discussion of the nymphs of that region and is the first attempt to treat of the species in a comparative manner.

Nymphal collections made by Dr. J. McDunnough in connection with his studies on the Mayfly fauna of Southern Alberta and the Montana and Yellowstone regions, have contained further undescribed nymphs pertaining to recently described species of *Ephemerella*, also many nymphs of the species described by Eaton, Dodds and Needham. The writer is indebted to Dr. McDunnough for permission to study this material and for the helpful suggestions he has made during the course of this study.

Of the thirteen species of *Ephemerella* described from Western North America the nymphs of ten have been studied. The nymph of *E. infrequens* McD. is not definitely known and both nymph and adult of *E. mollitia* Seemann, described from Southern California, are unrecognized but probably fall close to *inermis* Etn. Material of *E. grandis* Etn. has not been available for study but the descriptions of Eaton and Needham are sufficient to place the species readily.

The nymphs of this genus offer a variety of characters on which they may be distinguished. Of importance among these are the presence or absence of gills on the third abdominal tergite; the development of cephalic, thoracic and abdominal spines or tubercles; the presence or absence of a frontal shelf on the head; the degree of flattening and prolonging of the lateral region of the abdominal segments; the relative lengths of the setae and their ornamentation; the relative slenderness of the legs, particularly the shape and nature of the front femora; the spining of the tarsal claws. Color characters when judiciously used to supplement structural differences have proven valuable in separating closely allied species but the color pattern in some species (e. g. *inermis* and *coloradensis*) has been found to vary considerably. The structure of the mouth parts, employed so extensively by Morgan in the separation of certain eastern species of *Ephemerella*, has been found less valuable. A careful study of the mandibles has shown slight differences. The maxillae are in general very similar but the maxillary palpi provide some characters. The form of the labrum, labium and hypopharynx does not appear to vary appreciably except in distantly related species. While the mouth parts do provide some characters their structure has been given secondary importance in the present discussion in favor of more conspicuous modifications such as abdominal spining,, leg structure and form of head. Most of these latter characters are recognizable in the accompanying photographs which also indicate general form, relative size and color pattern. The finer structural details are depicted by line drawings.

*—Contribution from the Division of Systematic Entomology, Entomological Branch, Department of Agriculture, Ottawa.

Extensive nymphal modifications have led to the consideration of sub-generic units based on nymphal structures correlated with slight genitalic and venational characters in the adult. Needham (1927) gives a key to the sub-genera of *Ephemerella* as he has defined them. The genus *Chitonophora* Bengtsson, 1909, is considered synonymous with *Ephemerella* Wlsh., 1862. The nymph and adult of *E. aronii* Etn. are typical of *Ephemerella* (see description below). In other American forms the characters mentioned for *Chitonophora* intergrade so perfectly with those of *Ephemerella* as to establish a perfectly gradual series.

The following key based on full grown nymphs will separate the species discussed herein.

KEY TO WESTERN NORTH AMERICAN EPHEMERELLA NYMPHS

1. Gills borne on abdominal segments 4-7 ..... 2.
   Gills borne on abdominal segments 3-7 ..... 3.
2. Body greatly flattened; abdominal segments produced laterally and greatly prolonged posteriorly to form long saw-like teeth (Pl. III, fig. 4) ..... *hecuba* Etn.
   Body only moderately flattened; abdominal segments not greatly produced or prolonged (Pl. III, figs. 7, 8) ..... *margarita* Needh.
3. Abdominal tergites smooth, unmodified by spines, tubercles or projections 4.
   Several abdominal tergites with a median pair of spines or tubercles or with the posterior margin produced to form a median pair of slightly elevated projections ..... 5.
4. Face with a broad notched frontal shelf; abdomen with a ventral sucking disk; front femora toothed on anterior margin (Pl. III, figs. 5, 6) ..... *doddsi* Needh.
   Face without a broad notched frontal shelf; abdomen without a ventral sucking disk; front femora smooth (Pl. II, figs. 7, 8) ..... *inermis* Etn.
   ? *infrequens* McD.
5. Three setae of almost equal length ..... 6.
   Middle seta almost three times the length of the lateral ones (Pl. II, fig. 4) ..... *heterocaudata* McD.
6. Vertex with a pair of long spines or tubercles ..... 7.
   Vertex smooth or at most with very low elevations ..... 8.
7. Abdominal spines very gradually increasing in length from segments 2 to 9 ..... *grandis* Etn.
   Abdominal spines very long on segments 8 and 9, less than half as long on segments 2 to 7 (Pl. III, figs. 1, 2, 3) ..... *spinifera* Needh.
8. Front femora slender with anterior margin smooth ..... 9.
   Front femora stouter with anterior margin toothed or tuberculate ..... 10.
9. Abdominal segments expanded and flattened laterally with the posterior-lateral angles distinctly caudally produced; length of body 9-10 mm. (Pl. II, fig. 6) ..... *aronii* Etn
   Abdominal segments without lateral flattened expansions or caudal projections of the posterior-lateral angles; length of body 7-8 mm. (Pl. II, figs. 1, 2) ..... *tibialis* McD.

10. Abdominal spines very small; legs short with femora and tibiae rather stout (Pl. II, fig. 3) ..... *flavilinea* McD.
Abdominal spines more produced; legs longer with femora and tibiae more slender (Pl. II, fig. 5) ..... *coloradensis* Dodds.

Ephemerella hecuba Etn.

Pl. III, fig. 4

This large (length 14 mm.) much flattened nymph is readily recognized by the long saw-like lateral expansions of the abdominal segments. The gills are lacking on the third segment (the right gill is missing from the fourth in the specimen illustrated in Pl. III, fig. 4) and the head is modified to form a broad, entire frontal shelf. The nymph has been described and figured by Eaton and Needham; the latter adds collecting notes. The adult is unknown but the nymph has been recorded from the following localities: Provo River, Utah, July 20; Lanier River, Yellowstone Park, Wyo., August 8, 1921 (Needham); Colorado (Eaton). The writer has studied material from Rocky Canyon, Bozeman, Mont., August 9, 1928 (J. McDunnough).

Ephemerella margarita Needh.

Pl. I, figs. 5a, 5b; Pl. III, figs 7, 8.

This is the only other species from this region which has the first pair of gills borne on the fourth segment. It is much smaller than the preceding species and lacks the huge lateral abdominal expansions and has no frontal shelf (Pl. I, fig. 5a) on the head. The front legs are slender and smooth and typically banded (Pl. I, fig. 5b). The abdominal color pattern varies somewhat, two color phases being shown in the accompanying photographs (Pl. III, figs. 7, 8). In mature specimens the tails have a dark cross band near the middle. The nymph has been taken by Needham in Utah "in Box-Elder (Brigham) Canyon, in Weber River at the Devil's Slide, at Wanship, and at several points along the Provo River." The writer has studied the following material: Firehole River, Lower Geyser Basin, Yellowstone National Park, Wyo., July 29, 1928; Rocky Canyon, Bozeman, Mont., Aug. 9, 1928; Belly River, Lethbridge, Alta., Aug. 15, 1928 (J. McDunnough). The Bozeman specimens are the ones illustrated. The adult of this species is not yet known.

Ephemerella doddsi Needh.

Pl. III, figs. 5, 6.

This large, stout bodied, uniformly colored nymph bears a large horse-shoe-shaped sucking disk on the ventral surface of the abdomen (Pl. III, fig. 5). The front femora are stout with their anterior margin tuberculate and the head bears a frontal shelf which is notched at the sides for the reception of the antennae. The dorsum is entirely without spines or tubercles and the gills are of the normal type placed on segments 3-7. The abdominal segments are slightly expanded laterally with their posterior-lateral angles very slightly caudally produced. The structure of the nymph of this species is fully treated by Eaton (1884) and Dodds (1923) under the name *E. grandis* adds further descriptive and collecting notes. Needham (1927) refers this species to the sub-genus *Eatonella* Needh. on the basis of the peculiar frontal shelf.

The species has been recorded from Colorado, Idaho (Eaton); Colorado (Dodds); Utah, Montana, Washington, California (Needham). The specimen illustrated in Plate III is from Sage Creek, Elkhorn Ranch, Gallatin Canyon, Montana, Aug. 4, 1928 (J. McDunnough) and specimens of full grown nymphs are also at hand from the Alberta localities, Pass Creek. Waterton, Aug. 21, 1928 (J. McDunnough), July 27, 1929 (J. H. Pepper); Banff, Aug. 29, 1928 (J. McDunnough).

Ephemerella inermis Etn.

Pl. II, figs. 7, 8.

This is a rather slender species having the head devoid of spines or tubercles, the front femora smooth and slender, the abdomen without dorsal spines but with its segments with their lateral margins expanded and flattened with the hind angles of the gill-bearing (3-7) segments prolonged. In mature specimens the legs and tails are blackish banded, the head and thorax mottled with light and dark and the abdomen brownish with paler markings most pronounced on tergites 5-6. The accompanying photographs (Pl. II, figs. 7, 8) illustrate two color phases of this rather variably patterned species.

The species has been recorded from Denver, Arkansas Canyon and Colorado Springs, Colorado (Eaton). The present identification is based on a series of full grown nymphs from Yellowstone Lake, Wyo., July 23, 1928 (J. McDunnough) taken at the same time and place as large series of adults of *inermis*.

It might be noted that the nymph of *infrequens* McD., which is unknown is probably very similar to *inermis* Etn. judging by the close structural resemblance in the adults. Needham's description of *inermis* nymphs may refer to *infrequens* since his determination is based on a misidentification of the adult (*vide* McDunnough, Canadian Entomologist, LX, 238, 1928); also Dodds *Ephemerella* nymph No. 2 may be *infrequens* McD. (*inermis* Needh. nec. Etn.).

Ephemerella heterocaudata McD.

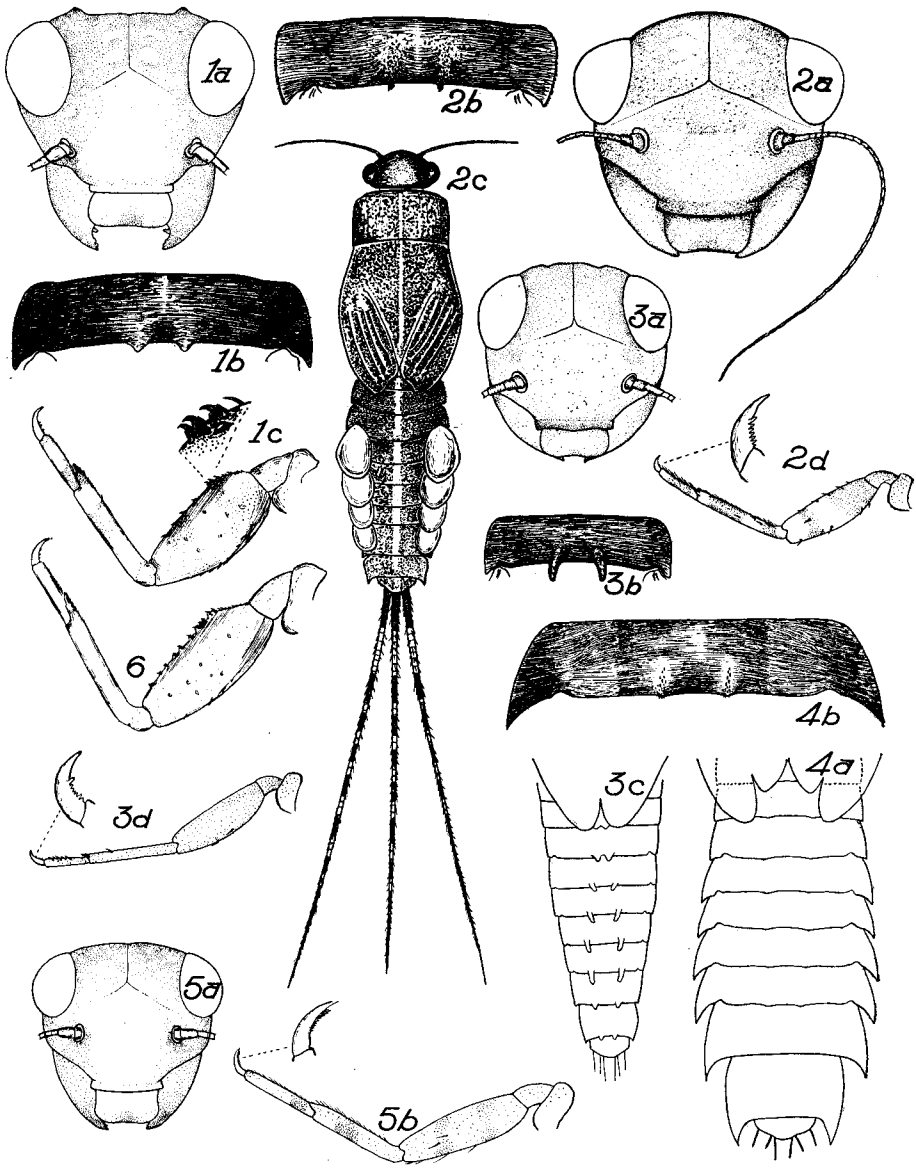
Pl. I, figs. 3a, 3b, 3c, 3d; Pl. II, figs. 4, 4a.

A series of small blackish nymphs taken in the Firehole River, Yellowstone National Park, Wyo., July 22, 1928 (J. McDunnough) are referred to this species (*vide* McDunnough, Canadian Entomologist, LXI, 171, 1929). Though not bred from individual specimens the association of nymph and adult is quite certain since both stages present the much lengthened middle seta, a character apparently peculiar to this species. The full grown nymph is described as follows:

Length of body 6-7 mm.; lateral setae 3 mm.; middle seta 8 mm.

Head rounded and smooth as in *tibialis*. Maxillary palpus with three joints of equal length, the third more slender than basal two. Prothorax slightly more than twice as broad as long with lateral margins broadly arcuate. Legs rather short, femora more flattened than in *tibialis* but quite smooth; legs fringed with fine dusky hairs.. Gills on abdominal segments 3-7, the first pair normal, not forming an operculum. Tergites 2-9 each with a median pair of strong black slightly incurved blunt tubercles, becoming gradually longer and further apart from segments 2-7, shorter and closer together on 8-9, and all beset with fine black spines. Abdominal segments not flattened laterally and with the posterior-lateral

CAN. ENT. VOL. LXII. PLATE I.



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angles not at all produced (Pl. I fig. 3c). Middle seta almost three times the length of outer ones.

General color (in alcohol) dark brownish, the head blackish especially on the front. Legs brown throughout, not banded with pale as in *tibialis* and *aronii*. Abdomen dark brown above, the venter paler brown with a median fuscous streak and a row of narrower more sharply defined brownish dashes on either side. Setae brownish with the incisures darker.

Ephemerella spinifera Needh.

Pl. III, figs. 1, 2, 3.

This strikingly modified nymph is easily recognized by the long acute spines on the head, thorax and abdomen (Pl. III, figs. 1, 2, 3). Gills of the usual type are borne on abdominal segments 3-7 and the segments are laterally expanded and posteriorly produced. The nymph is recorded by Needham from Montana and Utah. The specimen illustrated is from Gardiner River, Yellowstone National Park, Wyo., July 26, 1928 (J. McDunnough). The species appears to be rare and the adult stage is unknown.

Ephemerella grandis Etn.

This species appears to be related to *spinifera* Needh. possessing a somewhat similar arrangement of spines. The characters mentioned in the above key will however readily separate the two forms. The Washington specimens figured by Eaton (1884, Pl. 38, figs. 11-15) to which Needham applies the name *grandis* would appear to differ slightly from the Utah specimens figured and described by Needham (1927) particularly in respect to the mesothoracic spining and it is possible that Eaton's nymphs represent a closely allied species.

Ephemerella aronii Etn.

Pl. I, figs. 4a, 4b; Pl. II, figs. 6, 6a.

Ephemerella Aronii Etn., Eaton in Esben-Petersen, Tromso Mus. Aarsh., 25, 149, 1908.
Chitonophora Aurivillii Bgtss., Bengtsson, Lunds Univ. Arsskr. N. F. Afd. 2.5., 6, 1909.
Chitonophora Aronii Etn., Esben-Petersen, Men. Ac. Sci. Petersbourg, 1916.
Chitonophora Aronii Etn., Ulmer, Stett. Ent. Zeit., 81, 120, 1920.
Ephemerella norda McD., McDunnough, Can. Ent., LVI, 223, 1924.

Adults of a species of *Ephemerella* bred from nymphs by Mr. W. J. Brown at Bradore Bay, Quebec Labrador, July 27, 1929, have been identified by Dr. J. McDunnough as conspecific with *E. norda* McD. known only from Nordegg, Alberta and the Pribiloff Islands, Alaska. Dr. P. Esben-Petersen on comparing the Bradore Bay material with a metatype of *aronii* Etn. from Europe, is of the opinion that the two are synonymous; also that *aurivillii* Bgtss. should fall to *aronii* Etn. in which latter view he is supported by Dr. G. Ulmer. The synonymy therefore will stand as above.

The description of the full grown nymph of *aronii* is as follows:

Length of body 9-10 mm.; length of setae 5-6 mm.

Head rounded, smooth, without dorsal or facial spines or tubercles and without a broad frontal shelf. Clypeal margin truncate. Maxillary palpus with basal joint slightly longer than two apical joints combined, the second joint shortest, half the length of the slender third. Prothorax slightly more than twice as broad as long, the lateral margins narrowly explanate. Legs similar in form to *tibialis*. Gills normal on segments 3-7. Tergites 2-7 each with median pair of

very slightly elevated minutely spined projections on posterior margin (Pl. I, fig. 4b). Abdominal segments 4-9 laterally expanded and flattened with their posterior-lateral angles produced (Pl. I, fig. 4a; Pl. II, fig. 6).

General color (in alcohol) rather light brown. Head with darker brown on face and somewhat mottled on vertex, a small pale area between compound eye and lateral ocellar spot. Femora pale brownish with apices narrowly pale, front and mid-femora with a faint incomplete pale sub-apical ring; tibiae with a broad sub-basal and narrower apical pale band, the hind tibiae with the sub-basal band very broad; tarsi with narrow basal and broader apical pale bands. Thorax light brown with a few small scattered darker brownish spots. Abdomen light brownish, each tergite with a pair of rather widely separated dark brownish quadrangular areas most prominent on segments 3-7. Flange-like margin of abdomen pale brownish with a dusky spot on the margin of each segment. Setae pale, a few segments obscurely darker and the apical 4 or 5 segments black.

Ephemerella tibialis McD.

Pl. I, figs. 2a, 2b, 2c, 2d; Pl. II, figs. 1, 2, 2a.

Nymphs of a rather slender, small, blackish species of *Ephemerella* taken at Banff, Alberta are associated with adults of *tibialis* McD. The nymph is described as follows:

Length of body 7-8 mm.; length of setae 4-5.5 mm.

Head rounded, smooth, without dorsal or facial spines or tubercles and without a broad frontal shelf. Clypeal margin entire, very broadly arcuate. Maxillary palpus with basal joint sub-equal to two distal joints combined. Prothorax twice as broad as long, lateral margins parallel. Legs rather short, front femora slender, smooth with a few scattered fine spines. Gills normal, on segment 3-7. Abdominal segments but weakly expanded at sides; posterior-lateral angles only slightly produced in segments 4-7, a little more so in 9. Tergites 2-9 each with a median pair of slightly elevated minutely spined projections (not distinct enough to be tubercles) on posterior margin (Pl. I, fig. 2b).

General color (in alcohol) dark brownish, the thorax and abdomen sometimes with a narrow median dorsal pale line (Pl. II, fig. 2). Legs brownish, femora with an apical and an incomplete sub-apical pale annulus and a small pale spot below at base; tibiae with a sub-basal and apical pale band; tarsi narrowly pale at base and apex. Thorax and abdomen dark brownish throughout. Setae alternately brown and pale annulate, the distinctness of the banding varying with maturity of the specimen.

This species resembles the nymph of *inermis* Etn. The latter, however, has the abdominal tergites entirely smooth. Adults have not been bred from the nymphs but full grown nymphs were found common in the Spray and Bow Rivers at Banff, Alberta, Aug. 29-30, 1928 (J. McDunnough) where adults were taken swarming a few days later, so the association appears reasonably certain. Nymphs are also at hand from Sage Creek, Elkhorn Ranch, Gallatin Canyon, Montana, Aug. 4, 1928 and Rocky Canyon, Bozeman, Montana, Aug. 9, 1928 (J. McDunnough. The illustrations are from the Bozeman material.

Ephemerella flavilinea McD.

Pl. I, figs. 1a, 1b, 1c; Pl. II, 3, 3a.

This species has not been bred from the nymph but full grown nymphs

have been taken in the Firehole River, Yellowstone National Park, Wyo., July 22, 1928 (J. McDunnough) and in the Yellowstone River, Yellowstone National Park, July 26, 1928 (J. McDunnough). A few days later subimagos of *flavilinea* were taken in the same places (*vide* McDunnough—Canadian Entomologist, LXI, 170, 1929).

These nymphs have been carefully compared with a co-typic nymph and a series of nymphs of *coloradensis* Dodds. The close relationship of the adults is borne out by a similar resemblance in the nymphs but constant characters for the separation of *flavilinea* may be found in the shorter abdominal spines, stouter legs (particularly the mid and hind pairs) and the shorter thumb (Pl. I, figs. 1c, 6). The full grown nymph of *flavilinea* is described as follows:

Length of body 9-10 mm.; length of setae 6 mm.

Head broad, face flattened between the eyes, vertex usually with a pair of very low tubercles and the face roughened slightly. Maxillae as in *heterocaudata*. Legs rather short; the front femora broadened flattened, the posterior margin with a few spines, the anterior margin with numerous tubercles each surmounted by a short stout spine, upper face of femora with scattered wart-like excrescences; tibiae more slender than in *coloradensis*. Prothorax twice as broad at anterior margin as long, lateral margins slightly diverging posteriorly with a shallow sinus just beyond middle. Gills on abdominal segments 3-7, the first pair of gills not forming an operculum. Abdominal segments with very narrow flat pleural expansions, the posterior angle developed, not prominent, slightly longer in 9. Tergites 2-8 each with a median pair of slightly elevated projections (scarcely tubercles) on the posterior margin.

General color (in alcohol) varying from light to dark brown, the paler specimens more mottled in appearance than the darker ones. Femora with indistinct broad pale basal, median and apical areas; tibiae more conspicuously banded with pale at base and apex; tarsi with a single median pale band. Cerci pale narrowly banded with blackish beyond middle and at apex.

Ephemerella coloradensis Dodds.

Pl. I, fig. 6; Pl. II, figs. 5, 5a.

This species has been described and figured by Dodds (1923) and by Needham (1927). The type locality is Tolland, Colo. and Needham mentions the species as common in Northern Utah and records having seen material from Yellowstone Park, Wyo., Pecos, N. Mex. and Volcano Co., Calif. The writer has studied a nymph from the type series and a long series of nymphs from Sage Creek and Spring Creek, Elkhorn Ranch, Gallatin Canyon, Mont., Aug. 4, 1928; Brackett Creek, Bozeman, Mont., Aug. 7, 1928; Spray River and Bow River, Banff, Alta., Aug. 29, 1928; Cameron Creek, Waterton, Alta., Aug. 17, 1929 (J. McDunnough).

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Eaton, E. A., 1884. Trans. Linn. Soc. Lond. (2) III, 124-134, pls. 37-40.
Needham, J. A., 1905. N. Y. St. Mus. Bull. 86: 41-47, pls. 9-10.
" " " 1927 Ann. Ent. Soc. Am., XX, 107-117.
" " " 1927a Utah Agr. Exp. Sta. Bull. 201.

PLATE I.

1.—*E. flavilinea,* 1a—head, 1b—sixth abd. tergite, 1c—front leg. 2—*E. tibialis,* 2a—head, 2b—sixth abd. tergite, 2c—dorsal view of entire body, 2d—front leg. 3—*E. heterocaudata,* 3a.—head, 3b.—sixth abd. tergite, 3c.—dorsal view of abdomen, 3d.—front leg. 4.—*E. aronii,* 4a.—dorsal view of abdomen, 4b.—sixth abd. tergite. 5.—*E. margarita,* 5a.—head, 5b.—front leg. 6.—*E. coloradensis,* front leg. (Above drawings not to same scale).

PLATE II.

1.—*E. tibialis.* 2, 2a.—color form of same. 3, 3a.—*E. flavilinea.* 4, 4a.—*E. heterocaudata.* 5, 5a.—*E. coloradensis.* 6, 6a.—*E. aronii.* 7.—*E. inermis.* 8.—Color form of same. (figures 1-8 greatly enlarged, same scale; figures 2a, 3a, 4a, 5a, 6a slightly less than natural size, same scale).

PLATE III.

1.—*E. spinifera.* 2.—head of same. 3.—lateral view of same. 4.—*E. hecuba.* 5.—*E. doddsi,* ventral view showing sucking disk. 6.—dorsal view of same. 7.—*E. margarita.* 8.—color form of same (figures 1-8 greatly enlarged, same scale as in Pl. II, figs. 1-8).

THE STATUS OF THE BARN SWALLOW BUG, OECIACUS VICARIUS HORVATH.

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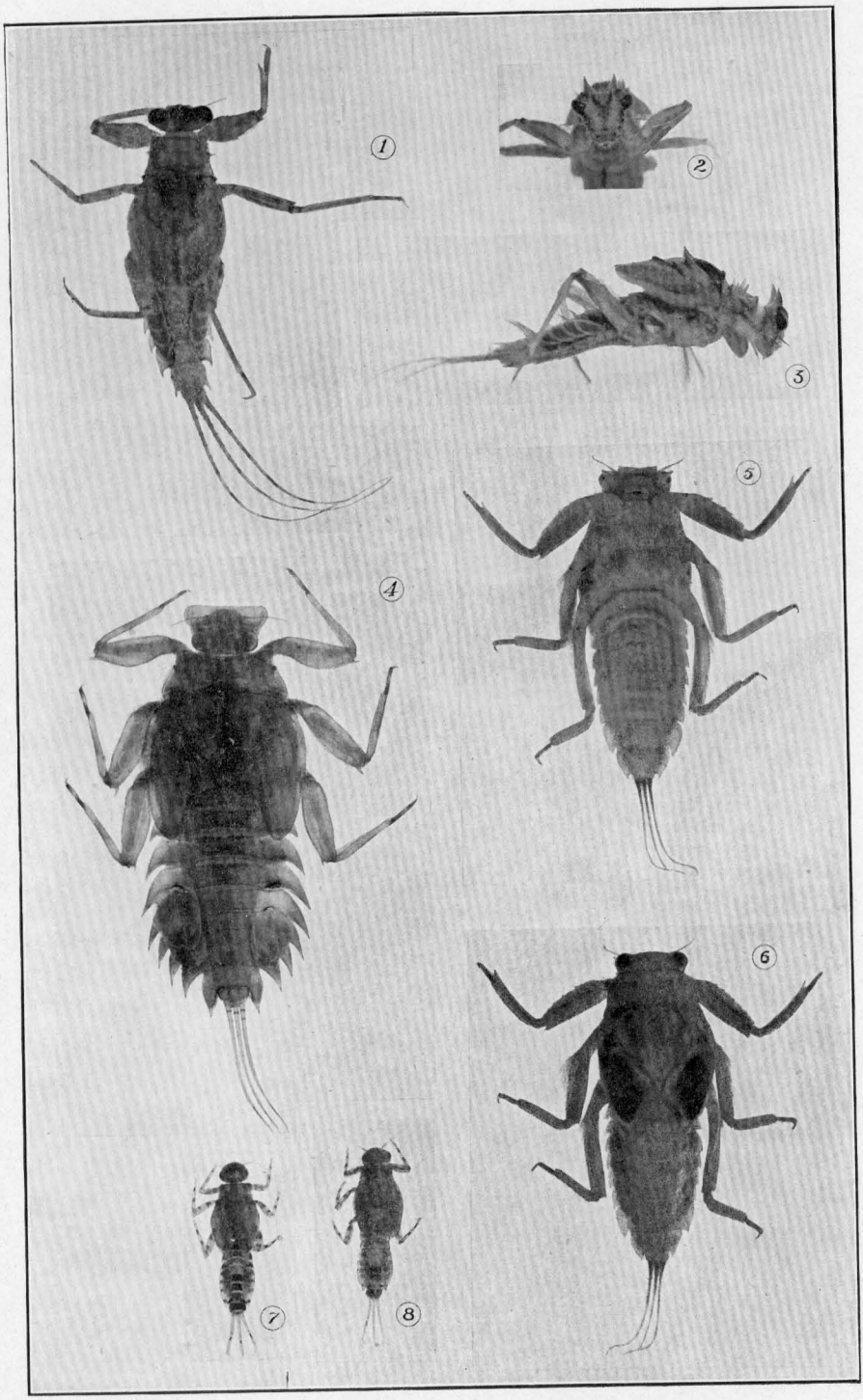
In 1909 I was interested to hear from a farmer in Ontario, that barn swallows are undesirable because they harbour bedbugs which spread from their nests to human habitations. Several times since I have heard the same complaint from various sources. In 1926 an instance cropped up in Vancouver where cliff swallows nests were systematically knocked down from some public buildings, for the same alleged reason.

In summer 1929 I received complaints from three men in the Chilcotin that cliff swallows always filled a house with bedbugs towards the end of the season. In one of the instances, the man systematically destroyed the nests of dozens of birds that were very persistent in building on his outbuildings. In all three cases I asked the men if the bugs so introduced, could be accused of actually "biting." Two claimed that they certainly did "bite" while the third stated that the bugs invaded the premises only after the birds had finished nesting for the season and had migrated, and that he personally, had never been "bitten." Owing to the fact that in the first two instances the homes of the men were in such conditions of neglect that practically any human parasite could (and probably did) flourish there, I was inclined to doubt their statements.

In October of this year, Mr. Alan Dustan of the Entomological Branch, Ottawa, wrote to me, citing an instance in Alberta where certain bugs from swallows' nests were invading a building and asking if I had any information as to the bugs attacking human beings. According to my findings up to that date, I was forced to declare the case "not proven." However, I wrote to Mr. Jenkins at Fishburn, Alta. whose house was mentioned, supplying what information I had and asking for full particulars of his infestation. He sent the following very explicit reply, exhibiting a most praiseworthy spirit of investigation:—

Sept. 3..... "I am sending five specimens of bugs which I believe to have been brought by swallows. All of these have bitten me. Two of them bit at night, the other three I found around the house and I put them on my arm and let them bite before putting them in the bottle. The white one, although he bit, did not get any blood for some reason."

"About the end of July we discovered these insects in the house and on



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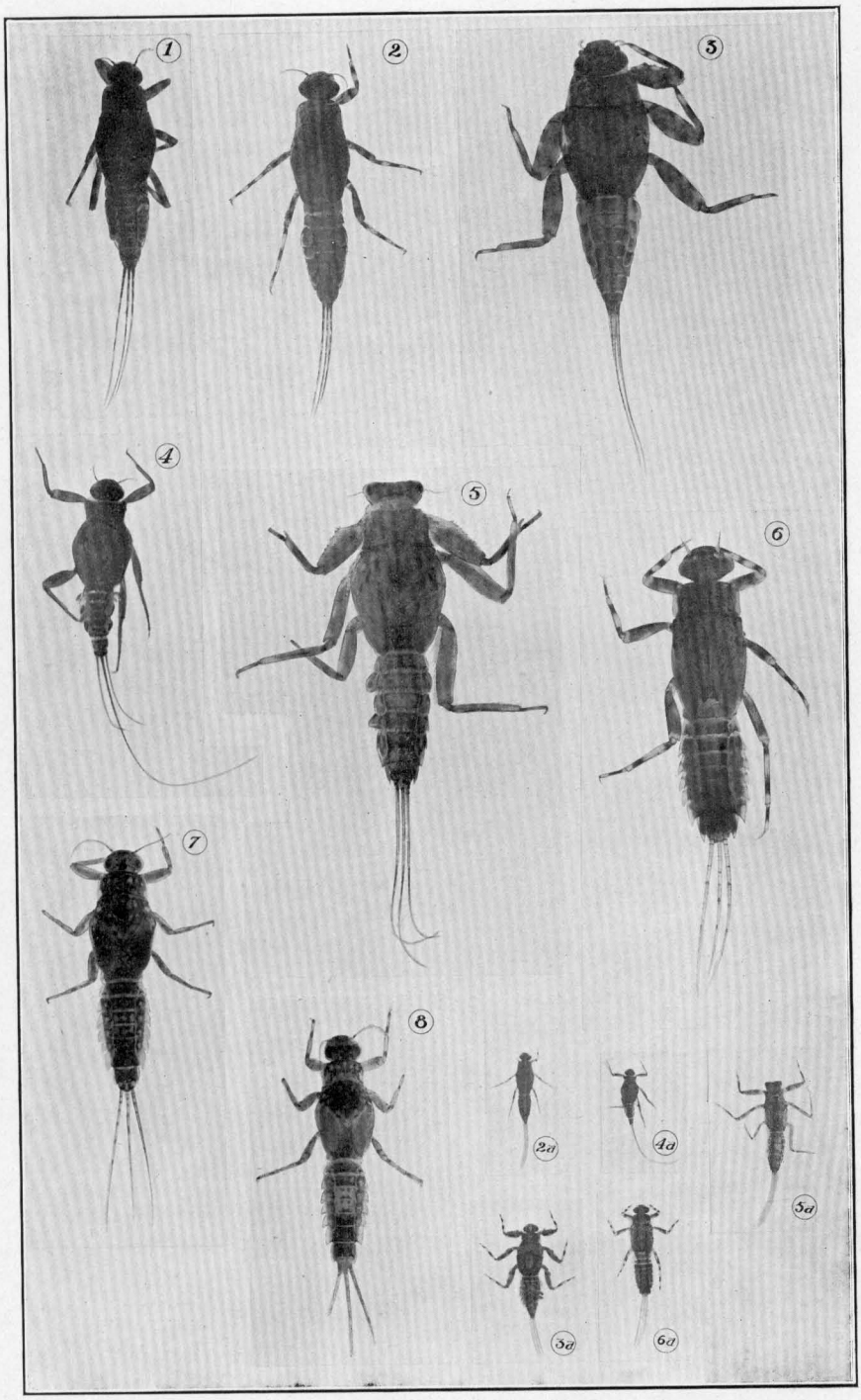

WESTERN EPHEMERELLA NYMPHS