NOTES ON SEPARATION AND IDENTIFICATION OF NORTH AMERICAN RIFFLE BEETLES (COLEOPTERA: DRYOPOIDEA: ELMIDAE)[1]

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ABSTRACT: Practical aids are provided for the sorting and identification of North American elmids which have proven to be difficult for the average person working with benthic or drift samples. Both larvae and adults are discussed and figured. Included are: *Gonielmis, Promoresia elegans, P. tardella, Dubiraphia quadrinotata, Optioservus immunis, O. trivittatus, O. fastiditus, O. ovalis, O. castanipennis, O. quadrimaculatus, O. seriatus, O. divergens, Heterlimnius corpulentus, H. koebelei, Ampumixis, Cleptelmis, Zaitzevia, Atractelmis,* and *Rhizelmis.* Distribution maps for *Atractelmis, Gonielmis, Promoresia elegans, P. tardella,* and *Rhizelmis* are presented. For *Atractelmis, Dubiraphia, Gonielmis, Heterlimnius, Optioservus, Promoresia,* and *Rhizelmis* a table lists associated elmid genera in descending order of frequency.

DESCRIPTORS: Riffle beetles, Elmidae, Dryopoidea, *Ampumixis, Atractelmis, Cleptelmis, Dubiraphia quadrinotata, Gonielmis, Heterlimnius, Optioservus, Promoresia, Rhizelmis, Zaitzevia,* identification aids, distribution maps.

Riffle beetles often occur in considerable numbers in both benthic and drift samples from flowing streams. With access to such keys as those of Leech and Chandler (1956), Leech and Sanderson (1959), and Brown (1976), most North American elmids can be classified with relative ease, at least to genus. (Specific identification is more difficult, since it may require extraction and mounting of male genitalia.) However, certain groups continue to pose problems, as attested by the frequency of incorrect listings in such things as environmental assessment reports. This paper is intended to assist those who have the task of sorting and identifying either adult or larval elmids–especially in the Appalachian and western mountain regions, which provide the greatest difficulties. Workers in the central states have a relatively easy job of it.

In the eastern states, the major problems involve *Promoresia* and *Optioservus,* with *Gonielmis* and *Dubiraphia* adding to the confusion.

Gonielmis enters the picture primarily because Sinclair (1964), in his otherwise very useful paper, mistook *Promoresia elegans* (Fig. 3) for *Gonielmis dietrichi* (Fig. 2). The sources of this error are quite understandable. For two species presumably not closely related, they are remarkably similar, both as larvae and as adults. The adults have big feet and claws,

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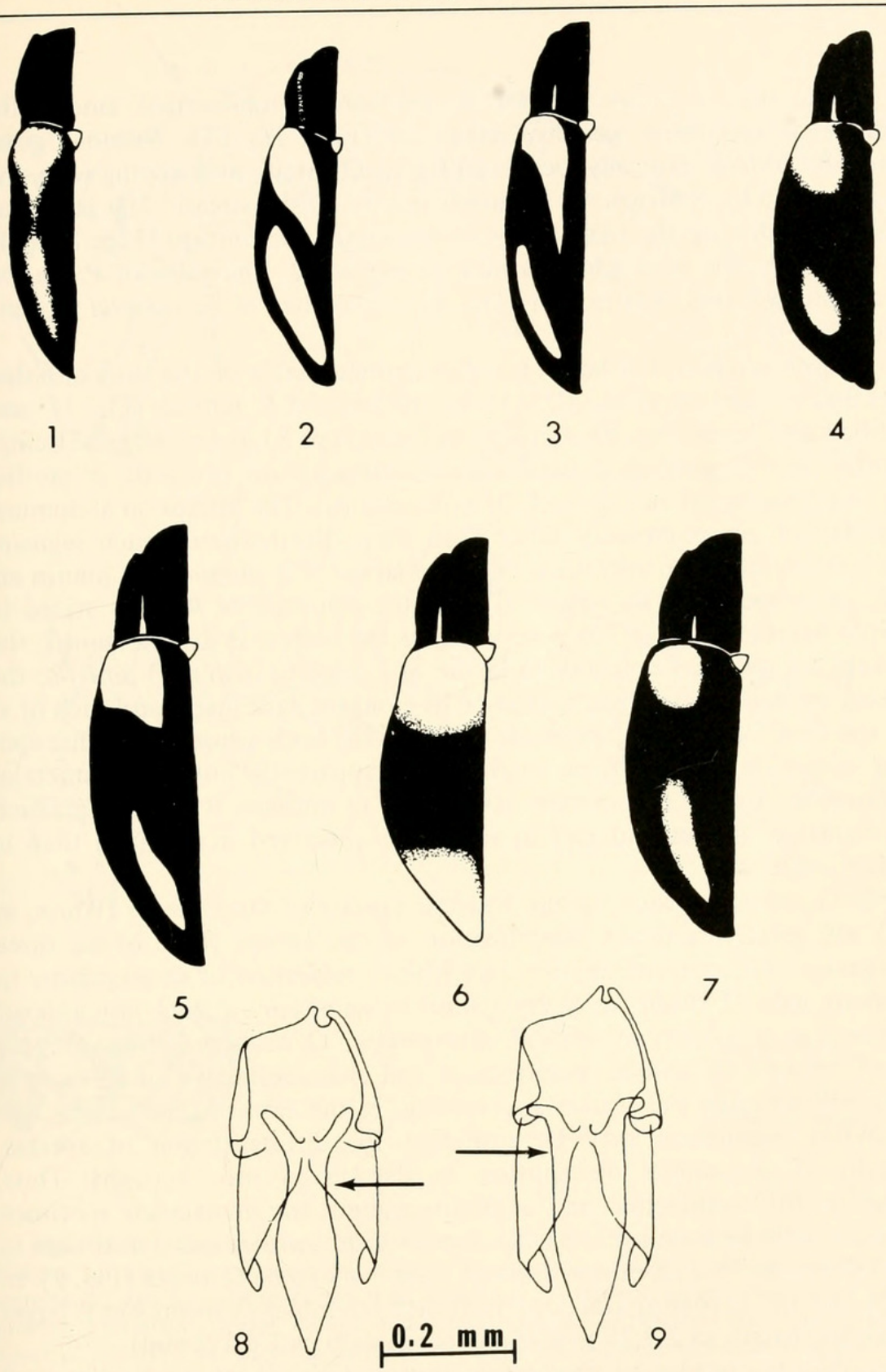
conspicuously oblique elytral markings (Figs. 2, 3), and are comparable in size. The larvae exhibit noticeable mid-dorsal humps on the abdominal segments and elongate dark markings on the thoracic segments (Fig. 10). Sanderson (1953-54), when he created the two genera, noted that . . ."*Gonielmis* appears to be unique among North American elmid larvae by having two longitudinal dark marks on each thoracic tergite." This may have been the clincher in Sinclair's identification of the larvae, though Sanderson had also mentioned that the larva of *Promoresia elegans* was unknown to him. One could hardly have anticipated that it would turn out to be so amazingly like that of *Gonielmis dietrichi.* Conveniently for the biologist, the two are unlikely to occur together. *Gonielmis* seems confined to the coastal lowlands bordering the Gulf of Mexico (Fig. 16), whereas *Promoresia elegans* is typically found in montane and foothill streams of the Appalachian and related mountains from northern Alabama and Georgia up into eastern Canada (Fig. 16). Adults of *Promoresia* differ from those of *Gonielmis* in possessing sublateral pronotal carinae and very dark legs. Larvae of *Promoresia* have the meso- and metapleuron each composed of but a single piece (Fig. 12), whereas these pleura in larvae of *Gonielmis* are composed of two parts: a long, slender anterior piece and a posterior piece twice as wide (Fig. 13). In small larvae and in those which are heavily encrusted, the pleurites may be very difficult to observe. The last abdominal segment is proportionately longer in the larva of *Gonielmis,* being conspicuously more than twice as long as it is high (Fig. 15); that of *Promoresia* is shorter and heavier, being only about twice as long as it is high (Figs. 10, 11).

Dubiraphia adults resemble those of *Gonielmis* and *Promoresia* in having large feet and claws, associated with the habit of clinging to roots and other submerged vegetation. They may also occur in the same streams as either of the two. *Dubiraphia* (Fig. 1) is readily distinguished, however, by its body shape and longitudinal rather than oblique elytral markings. The thorax is as wide as the abdomen, which is rather slender and parallel-sided. In most species the light-colored elytral markings form a conspicuous stripe or vitta, and the over-all body coloration may be quite light. Larvae of *Dubiraphia* are even more distinctive, with pleura on the first 8 abdominal segments and an extremely long, slender last (9th) abdominal segment. The larva of *Promoresia tardella* was described as that of *Dubiraphia quadrinotata* by West (1929) because such larvae taken at Ithaca, New York were reared by E.A. Richmond and the resulting adults were misidentified (by J.G. Needham?) as those of *Dubiraphia quadrinotata.* Conversely, we have encountered specimens of *D. quadrinotata* misidentified as *Promoresia.* As may be seen by comparing Figs. 1 and 4, the general body contours are quite different, and *Dubiraphia* lacks any trace of sublateral carinae on the pronotum.

The major difficulties in working with eastern montane streams involve *Optioservus* and *Promoresia,* which frequently occur together. Although there is a great range in size (Table 1), particularly in *P. tardella,* it is our opinion



Figs. 1-7. Dorsal aspect of adults, left half. (Not to scale.) 1, *Dubiraphia quadrinotata;* 2, *Gonielmis dietrichi;* 3, *Promoresia elegans;* 4, *Promoresia tardella;* 5, *Atractelmis wawona;* 6, *Heterlimnius corpulentus;* 7, *Optioservus ovalis.*

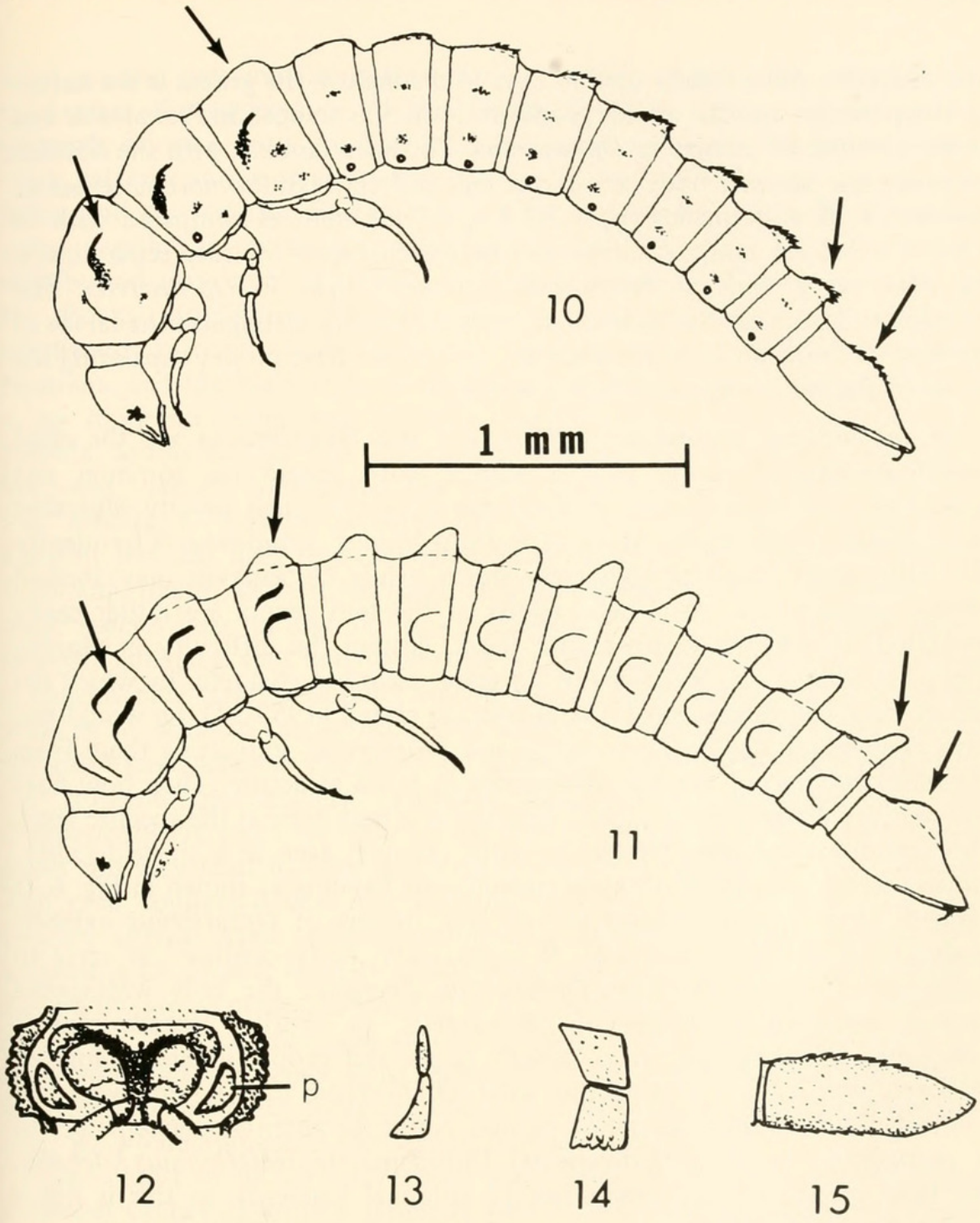
Figs. 8, 9. Male genitalia, dorsal aspect. 8, *Promoresia elegans;* 9, *Promoresia tardella.*

that there are only two species of *Promoresia* represented among the hundreds of specimens we have examined (Figs. 16, 17). Within a given stream, *P. tardella* typically occurs in the headwaters, overlapping with and being replaced by *P. elegans* in the lower reaches of the stream. The adults are readily separable on the basis of elytral maculation or contour (Figs. 3, 4). In case of doubt, the male genitalia may be examined. The penis of *P. elegans* has a distinct basal constriction (Fig. 8), while that of *P. tardella* is quite broad (Fig. 9).

For the most part, the larvae are also distinguishable on the basis of either coloration or contour (Figs. 10, 11). In the larva of *P. tardella* (Fig. 11; also described and figured by West, 1929, as larval type 8), the mid-dorsal humps are often so exaggerated as to render the larva almost pectinate in profile. They are reminiscent of the back of a *Stegosaurus.* The humps on abdominal segments 6-8 are commonly taller than long. Furthermore, each segment bears a dorso-lateral or sublateral bulge. In larvae of *P. elegans,* the humps are much more moderate in height. This is the opposite of what is stated in Brown's key (1972 or 1976, p. 63). Unless the cuticle is darkly tanned, the markings are more conspicuous in larvae of *P. elegans* than in *P. tardella:* the thoracic segments bear what appear to be elongate dark marks and each of at least the first 5 abdominal segments typically has both a supra-spiracular spot and a dorso-lateral spot. These markings are apparently not the products of pigmentation, but of subcuticular attachment of muscles. It is our impression that markings are less distinct in specimens preserved in formalin than in alcoholic material.

A forthcoming revision of the Nearctic species of *Optioservus* (White, in press) will greatly facilitate identification of this group. None of the three new species need concern us here, but White's relegation of *O. ampliatus* to synonymy with *O. ovalis,* of *O. cryophilus* to synonymy with *O. immunis,* of *O. pecosensis* to synonymy with *O. divergens,* of *O. ozarkensis* to synonymy with *O. sandersoni,* and his resurrection and characterization of *O. castanipennis* will simplify the matter appreciably. In the eastern states, body size and elytral maculation may be sufficient for differentiation of species, especially if geographic distribution is also taken into account. Thus, throughout the Appalachian and adjoining regions, any immaculate specimen may reasonably be presumed to be *O. immunis,* any with a mid-dorsal vitta to be *O. trivittatus,* and all others south of New York to be *O. ovalis* (Fig. 7). In Canada and the bordering states, *O. fastiditus* resembles *O. ovalis* but is larger (e.g., elytral length ca 2-2.25 mm as compared with ca 1.6-1.9 mm).

The oblique maculae of *Promoresia elegans* (Fig. 3) set it apart from all species of *Optioservus,* but *P. tardella* (Fig. 4) is easily and often mistaken for *Optioservus ovalis* (Fig. 7). The two commonly occur together, though *P. tardella* is typically nearer the headwaters and in submerged moss or roots, whereas *O. ovalis* is generally farther downstream and in coarse sand or gravel.



Figs. 10-15. Distinguishing larval features. 10, *Promoresia elegans,* lateral aspect, showing no significant humps on anterior segments and very moderate dorsal humps posteriorly; also lateral and dorsolateral markings. 11, *Promoresia tardella,* lateral aspect, showing prominent dorsal humps and lateral bulges. 12, *Promoresia elegans,* ventral aspect of mesothorax, showing single pleurite (p) which ranges in shape from somewhat crescentic to triangular. 13, *Gonielmis dietrichi,* ventral aspect of left mesopleuron, showing two pleurities, of which the posterior one is subcrescentic to subtriangular. 14, *Heterlimnius koebelei,* ventral aspect of left mesopleuron, showing two rectangular pleurites. 15, *Gonielmis dietrichi,* lateral aspect of ninth abdominal segment, showing the length to be well over twice the height; the basal half of the ventral margin is also straight, rather than convex.

The character most widely used in keys to distinguish the genera is the nature of the posterior margin of the pronotum, which is smooth in *Promoresia* and finely toothed or crenate in *Optioservus.* To those familiar with the beetles, however, the slimmer body and larger legs and claws of *Promoresia* reveal its identity; it is also smaller (ca 1.7-2.4 x 0.8-1.2 mm, as compared with ca 2.4-2.6 x 1.2-1.4 mm). Another very useful character for easy separation is leg color—very dark in *Promoresia,* relatively light in *Optioservus.* The mid-dorsal humps on the abdominal segments readily distinguish the larvae of *Promoresia* from those of *Optioservus.* As yet we have no key separating the larvae of the various species of *Optioservus.*

In the western mountains, *Optioservus* and *Heterlimnius* are the chief trouble-makers, as larvae and as adults. Both genera are common and widespread, often occurring in the same stream—though usually separated altitudinally. In the Rocky Mountains, *Heterlimnius corpulentus* is frequently the only elmid found at higher elevations, while *Optioservus* may abound further downstream. As a rule, adults of the two genera are rather easily separated by persons familiar with them, despite the difficulty in pinning down key characters. We know of no good, clear-cut character by which the genera may be distinguished. As Sanderson stated (1953-54), he would not have created the genera *Optioservus* and *Promoresia,* extracting them from *Heterlimnius,* except for the differences in larval structure. Then how does one identify *Heterlimnius* adults? Perhaps it is best done at the specific level. The coloration of *Heterlimnius* is quite variable, even in a single locality, ranging from immaculate to such conspicuous banding as shown in Fig. 6. If banded, it is readily recognized, for no species of *Optioservus* exhibits transverse markings of this sort. If immaculate, body contour can serve to distinguish *Heterlimnius* from *Optioservus divergens,* the only widespread western immaculate species of *Optioservus.* In profile, *Heterlimnius* is noticeably hump-backed. It is usually larger and proportionately plumper *(H.corpulentus* is ca 1.25-1.45 mm wide, *O. divergens* ca 1-1.1 mm wide). If one feels the need for reassurance, he may count the antennal segments (10 in *H. corpulentus* vs. 11 in *O. divergens*). Unfortunately, *Heterlimnius koebelei,* the type species for the genus, has 11 antennal segments, so this is not a usable generic character.

Larvae of *Heterlimnius* differ from those of *Optioservus* in having the pleura of the mesothoracic and metathoracic segments divided into 2 rectangular pieces (Fig. 14) instead of single, rather triangular pieces (much like Fig. 12). In well-sclerotized specimens this is not too difficult to see, but in tiny or teneral larvae, these features are often impossible to observe. Patterns of coloration (e.g., spots in *Heterlimnius* larvae) may provide local means of separating the larvae.

The western species of *Optioservus* provide more headaches for those who

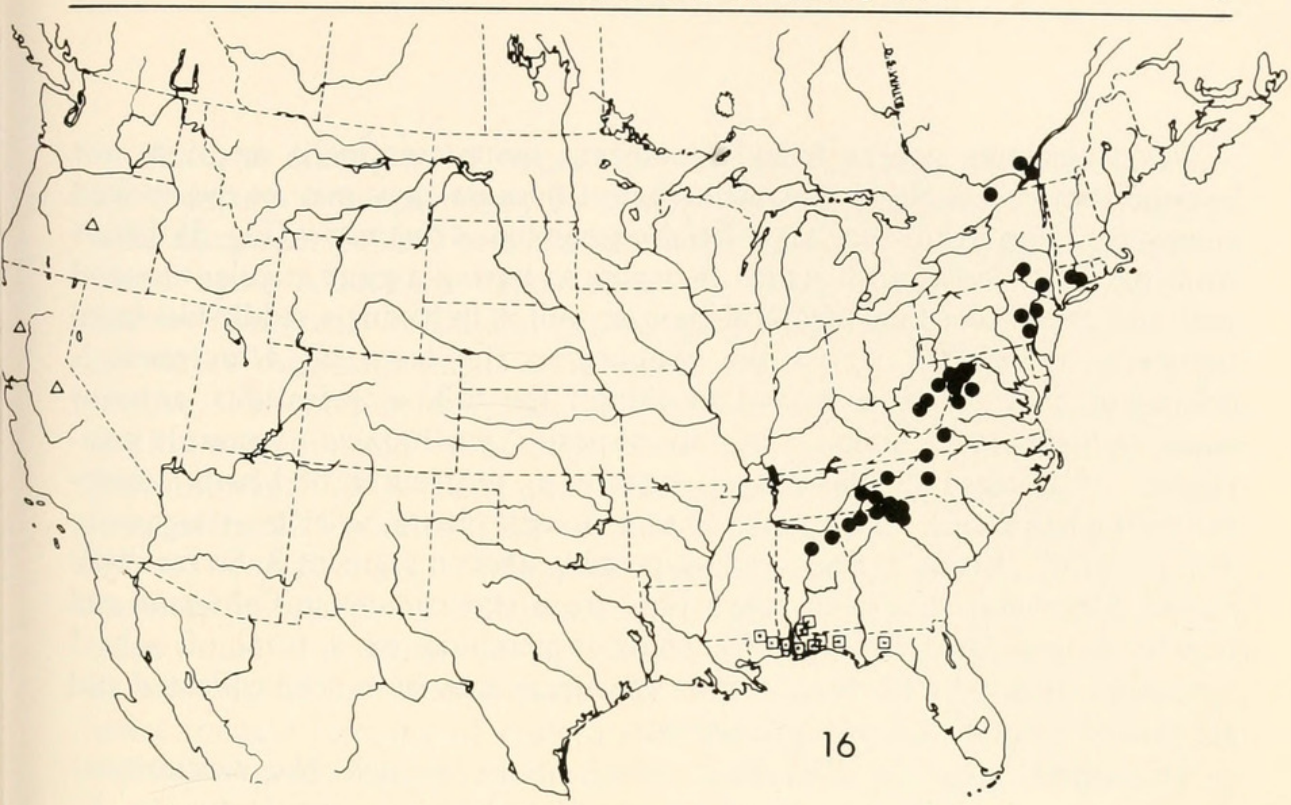
need specific determinations than do the eastern species. This will be true even after the appearance of White's forthcoming revision of the genus, primarily because there are 3 widespread and common species whose elytral color patterns and general aspects overlap: *O. castanipennis, O. quadrimaculatus,* and *O. seriatus.* Fortunately for the taxonomist, they do not often occur together in the same stream. Furthermore, knowledge of their known distribution may be of assistance. *O. castanipennis* is essentially a resident of the Rocky Mountains, occurring from eastern Arizona and New Mexico northward through Utah, Colorado, eastern Idaho, Wyoming, western Montana, and the Black Hills of western South Dakota. *O. quadrimaculatus* is a bit more northerly and westerly, ranging from central California and Nevada, southern Utah and Colorado northwestward through Oregon, Idaho, Wyoming, eastern Washington and western Montana into British Columbia and Alberta. *O. seriatus* is abundant in northern California and much of Oregon, but has also been reported from scattered localities in Colorado, Wyoming, Idaho, western Montana, and western Washington. Though all 3 of these species bear on each elytron a rounded humeral spot and a somewhat elongate subapical spot ranging in color from bright yellow to brick red, there is considerable variation among individuals. Typically, the spots are relatively small in *O. seriatus,* the humeral spot usually not extending medially beyond the third stria, whereas the spots are distinctly larger in *O. quadrimaculatus,* the humeral spot usually extending medially to the second stria. *O. castanipennis* is most variable of the three: the humeral spot ranges from small and very faint to large and bright, and the subapical spot may be large and even connected with the humeral spot, small and inconspicuous, or entirely absent. Aside, perhaps, from male genitalia, the best character for separating *O. seriatus* from *O. quadrimaculatus* is body contour: the sides of the elytra are typically subparallel in *O. seriatus* and hardly wider than the prothorax, but rounded and distinctly broader than the prothorax in *O. quadrimaculatus.* Though most populations of *seriatus* are distinguishable from *quadrimaculatus,* there are some specimens that seem to be intermediates. We would appreciate the opportunity to examine these.

Since most of us who have been identifying elmids in recent years have followed Collier (1969) in assuming that *O. castanipennis* (Fall, 1925) was synonymous with *O. divergens,* and since the vast majority of specimens of *O. castanipennis* are perceptibly maculate, most such specimens have been incorrectly diagnosed as either *O. quadrimaculatus* or *O. seriatus.* In correcting these errors, or in identifying new material, geographic distribution can provide a useful clue, as indicated above. The presence of reduced or absent subapical spots on the elytra of any individuals from a given locality will immediately suggest *O. castanipennis.* Members of this species are also somewhat larger than those of *O. quadrimaculatus* or *O. seriatus.* Any specimen resembling *O. seriatus* but occurring east of the coastal states should

be considered suspect; it is probably *O. castanipennis.* Approximate maximal measurements for *O. seriatus* are as follows: pronotal length 0.53 mm, pronotal width 0.81 mm, elytral length 1.72 mm, maximum width across elytra 0.97 mm. *O. castanipennis* may also resemble *O. quadrimaculatus,* with which it exhibits a considerable overlap of geographic range. Again, size may be a helpful adjunct in identification. Approximate maximal measurements for *O. quadrimaculatus* are: pronotal length 0.66 mm, pronotal width 0.84 mm, elytral length 1.8 mm, greatest width 1.2 mm. Only females would approach these dimensions.

Prior to White's revision of the genus, we had the problem of distinguishing between two presumptive species of immaculate western *Optioservus: divergens* and *pecosensis.* Fortunately for all who faced the task, White has concluded that *pecosensis* is but a synonym, so the common, uniformly dark specimens of *Optioservus* ranging from the Mexican border up into Alberta and British Columbia can be identified as *O. divergens* with relative assurance. Minor exceptions are a small species resembling *O. immunis* in the mountains of central California, an isolated species in western Kansas, and some individuals of *O. castanipennis* with such faint elytral spots that they may be overlooked.

Occasionally, specimens of *Ampumixis* or *Cleptelmis* may be mistaken for *Heterlimnius,* since they are rather plump and their elytral coloration may resemble that of *Heterlimnius.* In fact, the elytral markings of *Ampumixis* are surprisingly like those of *Heterlimnius,* varying from immaculate to beautifully banded with red across the base and with or without a broad red apical spot. However, both *Ampumixis* and *Cleptelmis* have the elytral epipleuron uninterrupted by the sort of tooth which arises from the lateral margin of the fourth abdominal sternite in *Heterlimnius* to clasp the elytron, and both have characteristic pronotal configurations, such as the basally forked sublateral carina of *Cleptelmis.* They are also usually smaller than the *Heterlimnius* in whose company they may be found. These features will also serve to separate *Cleptelmis* from *Optioservus,* with which it may be found and which it may resemble in size and coloration. Specimens of *C. ornata* often look very much like *O. quadrimaculatus* or O. seriatus in color pattern, but the body is proportionately broader than even *O. quadrimaculatus.* The larvae of *Ampumixis* are distinctive among northwestern elmids in possessing mid-dorsal abdominal humps quite like those of *Promoresia* and *Gonielmis.* Being long and hemi-cylindrical in shape, the larva of *Cleptelmis* is unlikely to be confused with any other except that of *Zaitzevia* with which it often occurs). The easiest way to separate the two, though not mentioned in keys, is by the shape of the ninth (last) abdominal segment. In *Cleptelmis* it is smoothly rounded above, whereas in *Zaitzevia* it bears a distinct mid-dorsal carina.



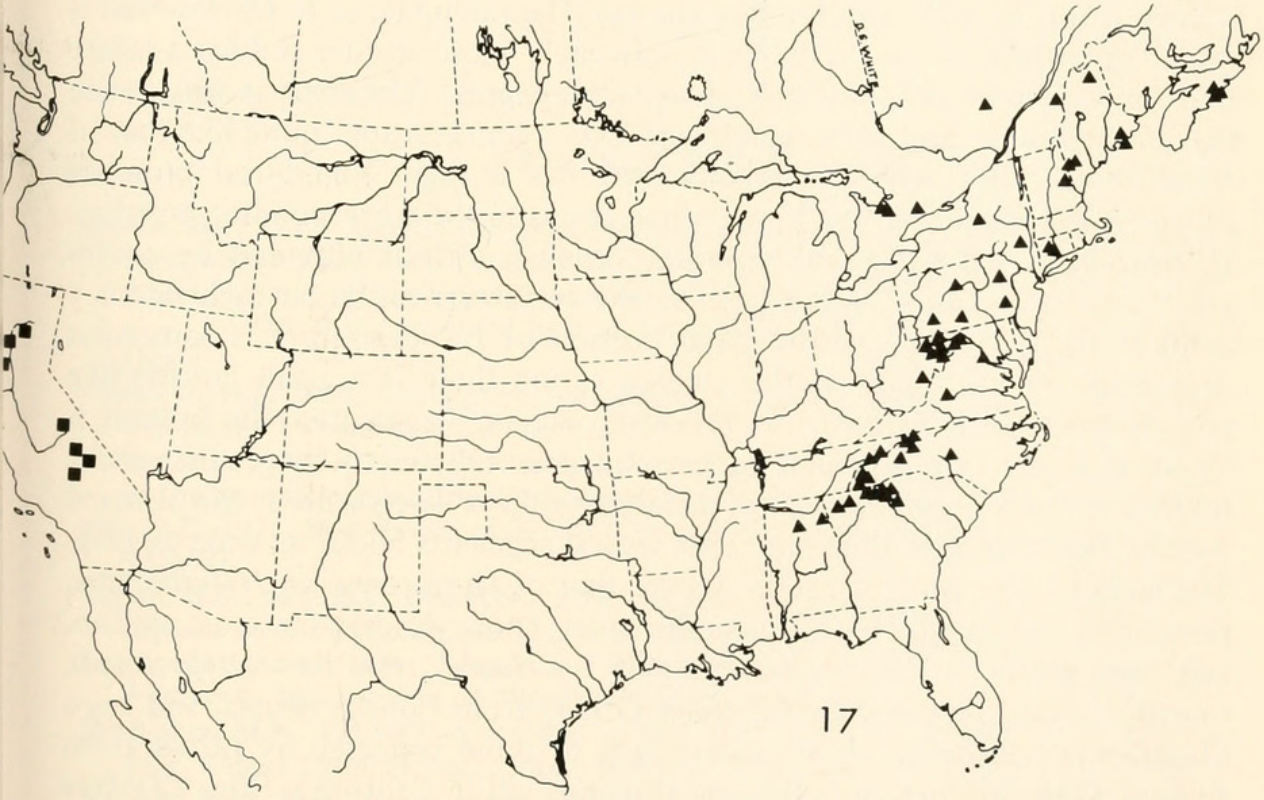


Fig. 16. Map showing distribution of specimens examined. *Atractelmis wawona,* hollow triangles; *Gonielmis dietrichi,* squares with a dot; *Promoresia elegans,* solid circles.

Fig. 17. Map showing distribution of specimens examined. *Promoresia tardella,* solid triangles; *Rhizelmis nigra,* solid squares.

Two remaining genera from far western mountains merit mention, not because they are likely trouble-makers, but because they may be overlooked among common forms they superficially resemble. *Atractelmis* (Fig. 5) differs from the *Optioservus* with which it occurs in having a more angular humeral spot and a very elongate subapical spot, as well as in having a saddle-like basal transverse depression across the pronotum. The larva of *Atractelmis* is unknown, but may be expected to exhibit the following features: anterior coxal cavities open behind (i.e., no posterior prothoracic sternum); postpleurite of prosternum consisting of 1 part (i.e., propleuron of 2 parts); meso- and metapleura each of 2 parts; abdomen with pleura on at least segments 1-6, probably also on segment 7, and possibly also on segment 8. So far as we know, *Atractelmis* has been taken only from two streams in California and one in central Oregon (Fig. 16), being represented by a total of only 5 specimens. It is quite likely that other specimens may have been collected and are tucked away in vials of *Optioservus*.

The other rarity is *Rhizelmis*, which looks enough like *Optioservus divergens* or immaculate specimens of *Heterlimnius corpulentus* to be mistaken for one of these common species. The resemblance to *Optioservus* is rather superficial, since the latter is noticeably more slender and has a rather uniformly convex pronotal disk. In general aspect, *Rhizelmis* is very much like *Heterlimnius*, and some specimens have a humeral spot quite like that of *Heterlimnius*. But whereas *Heterlimnius* has a slight mid-dorsal pronotal sulcus, *Rhizelmis* has a fine longitudinal carina in the corresponding position. In *Rhizelmis*, the sublateral pronotal carina is all but obscured by coarse punctures, and mesial to the base of the sublateral carina on each side is a depression; in fact, the entire basal portion of the pronotum is somewhat depressed; on each side of the median carina there is a small, button-like protuberance. In *Rhizelmis*, the maxillary palp is 3-segmented; the antenna is longer than the fore tibia and with each segment distinctly longer than wide. In *Heterlimnius corpulentus*, the maxillary palp is 4-segmented, the antenna shorter than the fore tibia and with several segments about as wide as long. The larva of *Rhizelmis* is totally unlike that of *Optioservus* or *Heterlimnius*, being long and slender with subparallel sides, hemicylindrical in cross section, and with pleura on abdominal segments 1-8. Aside from the few specimens (mostly larvae) reported by Chandler (1954) from Colusa, Shasta, and Inyo Counties in California, we are aware only of those collected by Brown from Fresno, Kern, Madera, and Tehama Counties, all in California (Fig. 17). It is likely that both adults and larvae have been taken by others in California and perhaps Oregon without coming to our attention, but the chances are very good that the adults are classified as *Heterlimnius*, rather than *Rhizelmis*. We should appreciate being informed of any records of either *Atractelmis* or *Rhizelmis*.

Since, as among other organisms, a riffle beetle may often be known by the company it keeps, it may be of help to list the consocies of the genera we have discussed. Table 2 presents such a list, in descending order of frequency, based upon collections deposited in the Stovall Museum of Science and History (University of Oklahoma). All genera listed are elmids, although other associated organisms might serve equally well, e.g., psephenid and dryopid beetles, trichopterans, mayflies, or stoneflies. An example will illustrate how the list was compiled: of 66 collections of *Optioservus* made east of the great plains in which at least one additional genus of elmid was taken, 53 included *Stenelmis,* 22 included *Oulimnius,* 17 *Promoresia,* 17 *Macronychus,* 16 *Microcylloepus,* and 11 *Dubiraphia.* The sequence, of course, is biased by the localities in which the collections were made. In the Ozarks, for example, there would be no *Oulimnius* or *Promoresia.* Regional lists of consocies would be more useful, but inappropriate for such a note as this. However, since an indiscriminate lumping of eastern and western material renders the data for *Dubiraphia* and *Optioservus* almost worthless, we have subdivided these two.

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REFERENCES CITED

Brown, H.P. 1972. Aquatic dryopoid beetles (Coleoptera) of the United States. Biota of Freshwater Ecosystems Identification Manual No. 6. Water Pollution Control Research Series, U.S. Environmental Protection Agency, Washington, D.C. 82 p.

_____. 1976. Ibid., reprinted by U.S. Environmental Protection Agency, Cincinnati, Ohio.

Chandler, H.P. 1954. New genera and species of Elmidae (Coleoptera) from California. Pan-Pacific Entomologist, 30(2): 125-131.

Collier, J.E. 1969. A taxonomic revision of the genus *Optioservus* (Coleoptera: Elmidae in the nearctic region. Unpublished doctoral thesis, University of Minnesota, St. Paul.

Fall, H.C. 1925. New species of *Helmis* (Coleoptera). Jour. New York Entomol. Soc. 33: 177-181.

Leech, H.B., and H.P. Chandler. 1956. Aquatic Coleoptera. *In:* R.L. Usinger (ed.). Aquatic insects of California. Univ. of California Press, Berkeley. 508 p.

Leech, H.B., and M.W. Sanderson. 1959. Coleoptera. *In* W.T. Edmondson (ed.). Freshwater biology. 2nd ed. Wiley, New York. 1248 p.

Sanderson, M.W. 1953-54. A revision of the nearctic genera of Elmidae (Coleoptera). Jour. Kansas Entomol. Soc., 26(4): 148-163; 27(1): 1-13.

Sinclair, R.M. 1964. Water quality requirements of the Family Elmidae (Coleoptera), with keys to the larvae and adults of the eastern genera. Tennessee Stream Pollution Control Board, Tenn. Dept. Public Health, Nashville. 14 p.

West, L.S. 1929. A preliminary study of larval structure in the Dryopidae. Ann. Ent. Soc. Amer., 22(4): 691-727.

White, D.S. In press. A revision of the nearctic *Optioservus* (Coleoptera: Elmidae), with descriptions of new species. Systematic Entomol.

Table 1.
Measurements of *Promoresia*

Species	Pronotal length	Pronotal width	Elytral length	Elytral width	Total length	Maximum width
elegans	0.5-0.7 mm	0.6-0.9 mm	1.6-2.1 mm	0.9-1.2 mm	2.1-2.8 mm	0.9-1.2 mm
tardella*	0.4-0.6 mm	0.5-0.9 mm	1.3-2.1 mm	0.8-1.2 mm	1.7-2.7 mm	0.8-1.2 mm

(*Note: by far the largest specimen of *tardella* was a paratype of *"Limnius subarcticus"* taken July 26, 1929 at Bradore Bay, Quebec by W.J. Brown, now in the Illinois Natural History Survey collection; in Brown's description, however, total length was given as 2.3-2.4 mm. Although the smallest specimens were from South Carolina and West Virginia, there appears to be no north-south relationship as to size. Instead, size differences may be related to time of cohort production.)

Table 2.
List of associated genera in descending order of frequency and abundance

	Atractelmis	Dubiraphia				Gonielmis	Heterlimnius
Typical habitat	Rather fast water in rocky streams	Usually on submerged vegetation of some sort: roots, stems, bark; occasionally on rocks or pebbles encrusted with algae				Submerged roots, etc. in clear cool streams	Rocky montane streams at high elevations
Geographic region covered	California (Mariposa Co.) Oregon (Crook Co.)	Eastern states	Great Basin states	Southwestern (Oklahoma, Texas)	Oregon	Lowland streams near the Gulf of Mexico	West of the great plains

Table 2. (Continued)

Associated genera of Elmidae	*Optioservus* *Zaitzevia* *Cleptelmis* *Heterlimnius* *Narpus* *Dubiraphia* *Microcylloepus*	*Stenelmis* *Macronychus* *Microcylloepus* *Optioservus* *Ancyronyx* *Promoresia* *Oulimnius* *Gonielmis*	*Optioservus* *Microcylloepus* *Stenelmis*	*Stenelmis* *Microcylloepus* *Macronychus* *Hexacylloepus* *Heterelmis* *Ancyronyx* *Neoelmis* *Elsianus* *Phanocerus*	*Optioservus* *Microcylloepus* *Heterlimnius* *Zaitzevia* *Cleptelmis* *Atractelmis*	*Stenelmis* *Ancyronyx* *Macronychus* *Microcylloepus* *Dubiraphia* *Oulimnius*	*Optioservus* *Zaitzevia* *Lara* *Narpus* *Ordobrevia* *Cleptelmis* *Microcylloepus* *Ampumixis* *Rhizelmis*

	Optioservus		**Promoresia**	**Rhizelmis**
Typical habitat	Gravel or coarse sand in fast, shallow water		On roots or moss in fast mountain streams	On roots or moss in fast mountain streams
Geographic region covered	East of the great plains	West of the great plains	Alabama and Georgia north to Maine	Central California (Kern, Fresno, Madera and Tehama Counties)
Associated genera of Elmidae	*Stenelmis* *Oulimnius* *Promoresia* *Macronychus* *Microcylloepus* *Dubiraphia*	*Narpus* *Zaitzevia* *Cleptelmis* *Ordobrevia* *Heterlimnius* *Microcylloepus* *Ampumixis* *Dubiraphia* *Heterelmis* *Rhizelmis* *Atractelmis*	*Oulimnius* *Optioservus* *Stenelmis* *Microcylloepus* *Macronychus* *Ancyronyx* *Dubiraphia*	*Optioservus* *Narpus* *Zaitzevia* *Ampumixis* *Lara* *Cleptelmis* *Heterlimnius* *Ordobrevia*