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*Reprinted from 'The Entomologist's Monthly Magazine,' Vol. lxxxv.*

*Date of publication; April 8th, 1949.*

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THE TAXONOMY OF THE NYMPHS OF THE BRITISH SPECIES OF THE  
GENUS *ECDYONURUS* (EPHEM.)

BY T. T. MACAN, M.A., PH.D., F.R.E.S.

(Laboratory of the Freshwater Biological Association, Wray Castle,  
Ambleside, Westmorland).

The taxonomy of the genus *Ecdyonurus* in Britain was in a state of some confusion until Kimmins (1942) published the results of a study of it. The list is now: *Ecdyonurus venosus* (F.), *E. torrentis* Kimmins 1942, *E. dispar* Curtis, and *E. insignis* Eaton.

Kimmins also examined the nymphs of the first three of these four species, and Table 1 summarizes his findings; the qualifying adverbs in the table are his. Of the four differences there was not one which he was prepared not to qualify. Clearly a further examination was desirable and the present paper presents the results.

TABLE 1.—DIFFERENCES BETWEEN THE NYMPHS OF 3 SPECIES OF  
*ECDYONURUS* ACCORDING TO KIMMINS (1942)

	Head	Projections of thorax	Tarsal markings	Number of teeth on claws
<i>venosus</i>	side margins usually rounded		usually darker at apex	generally two
<i>torrentis</i>	more quadrate, the sides being somewhat flattened		usually dark at base and apex	generally three
<i>dispar</i>	with the sides rounded not quadrate	possibly shorter in proportion	much as in <i>torrentis</i>	much as in <i>torrentis</i>

Comparisons are with *venosus*

The material consists of nymphal skins associated with the adults which had emerged from them. Much of the identification of the adults was done by Mr. D. E. Kimmins and I take this opportunity to thank him.

The sources of the material were:

*E. venosus*: R. Brathay, WL, 13; Troutbeck, WL, 4; R. Winstar, WL, 1; Black Beck, WL, 2; R. Eamont, CU, 9; R. Eden, CU, 1.

*E. torrentis*: Troutbeck, WL, 1; R. Winstar, WL, 2; seven small becks near Windermere, 34.

*E. dispar*: Windermere, WL, 10; Ullswater, CU, 17; R. Eden, CU, 24.

*E. insignis*: R. Eden, CU, 13.

It may be remarked here that the totals in Table 2 do not always amount to the same as these, for, as some specimens were damaged and there were occasional manipulative slips, it was not possible to examine all the characters of every specimen.

Rawlinson (1939) studied the taxonomy and biology of *E. venosus* in the River Alyn, Denbighshire. She figures eight different abdominal patterns in 36 specimens collected at random, and she found that pattern differences which had been used to distinguish species came well within the range of variation of what proved to be a single species. A preliminary examination showed that the present material was also very variable in this character and thereafter it was ignored. The characters which were examined are shown in Table 2.

TABLE 2.—DIFFERENCES BETWEEN THE NYMPHS OF *Ecdyonurus*

prothorax a—c	—5	—4	—3	—2.5	—2	—1.5	—1	—0.5	0	0.5	1	1.5	2	2.5	3	4	5			
<i>venosus</i>	1	2	4		2	2	5	2	9		3									
<i>torrentis</i>					2		1	4	17	2	8									
<i>dispar</i>											1	1	11	9	17	5	6			
<i>insignis</i>									2	4	2	1								
prothorax: b as % of c	over	under																		
	40	40	39	38	37	36	35	34	33	32	31	30	30							
<i>venosus</i>	13	3	2	6	1	3		1												
<i>torrentis</i>	3	4	5	6	9	4	2		1											
<i>dispar</i>						2	2	2	10	8	12	2	12							
<i>insignis</i>						2	1	1	3	1	1									
teeth on claws*	more than																			
	222	223	224	233	234	333	333													
<i>venosus</i>	8	8	1	5		2														
<i>torrentis</i>					2	1	17	9												
<i>dispar</i>				2		19	21													
<i>insignis</i>						3	4													
gills: first as % of largest	50—55	56—60	61—65	66—70	71—75	76—80	81—85	86—90	91—95	96—100										
<i>venosus</i>	5	11	3	1																
<i>torrentis</i>		6	16	6																
<i>dispar</i>			1			2	4	19	11	6	1									
<i>insignis</i>	1	1	1																	
teeth on left mandible	11	12	13	14	15	16	17	18	19	20										
<i>venosus</i>				6	6	5	9	1	1	1										
<i>torrentis</i>			2	18	5	4	5													
<i>dispar</i>	5	12	16	10	5	1														
<i>insignis</i>			3	4	3															
teeth on right mandible	5	6	7	8	9	10	11	12	12											
<i>venosus</i>			1	1	3	11	10	3	1											
<i>torrentis</i>				4	12	8	6	4												
<i>dispar</i>	2	2	22	17	4															
<i>insignis</i>					4	4	1	1												
bristles on left protheca	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21				
<i>venosus</i>					1	3	4	3	3	7	5	1			1	1				
<i>torrentis</i>		1	3	7	13	5	4	1												
<i>dispar</i>	1	1	12	11	6	5	4	2	3	1										
<i>insignis</i>				1		3		2												
bristles on right protheca	6	7	8	9	10	11	12	13	14	15	16	17								
<i>venosus</i>			2	2		8	8	4		2	1	2								
<i>torrentis</i>	3	5	9	9	6	1														
<i>dispar</i>	1	6	11	15	8	4	1	1												
<i>insignis</i>			1	1		2														
length in mm.	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19
<i>venosus</i>			2			4	4	4	1	5		3	3		1	2				
<i>torrentis</i>		2	2	4	4	6	7	3	3	1	1									
<i>dispar</i>			5	13	4	11	7	3	3	2			1	1						
<i>insignis</i>	1	1	2	2																1

\* See page 67.

half breadth of prothorax mm. $\times 10$	24	24	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	
<i>venosus</i>						1		2	1	3	5		3	1	2	1	3	4	1				3	
<i>torrentis</i>			1	2	2	3	5	2	4	3	5	1	2	2	2									
<i>dispar</i>	1	3	7	5	8	5	7	6	1	2	1	3	1											
<i>insignis</i>			2	3	1	1	2																	

Habitat	lake shores	rivers	becks
<i>venosus</i>		33	3
<i>torrentis</i>		3	4 <sup>2</sup>
<i>dispar</i>	45	87	
<i>insignis</i>		33	

Kimmins' distinctions may be taken first. All the specimens of *E. torrentis* have the sides of the head flattened, though this feature is not always quite as marked as is shown in Kimmins' figure. But only about half the heads of *E. venosus* are definitely round, and of those of *E. dispar* the proportion is less. The rest are slightly flattened at the sides; not as much as in nearly every example of *E. torrentis*, but sufficiently to make distinction difficult without rather a long series of examples for comparison

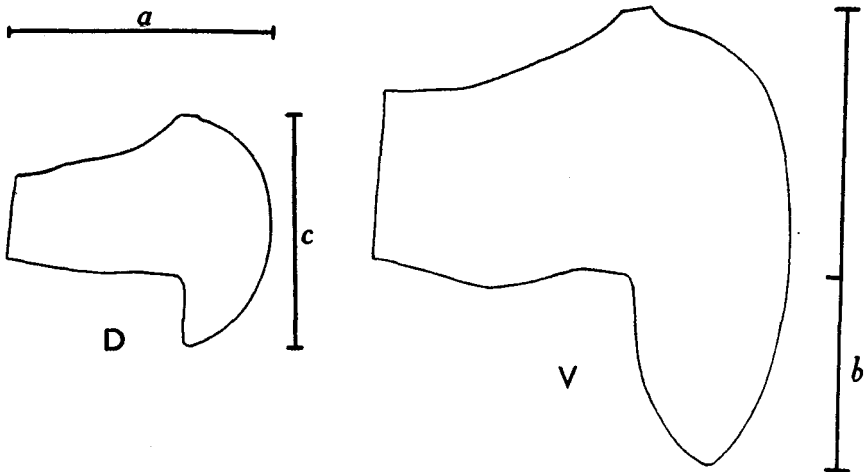


FIG. 1.—Right half of prothorax of: D, *Ecdyonurus dispar* Curtis and V, *E. venosus* (F.); a = breadth; b = length of posterior prolongation; c = length.

The next character can be measured. The prothorax on one side was dissected off and mounted flat under a cover slip; the assumption was made that, when the nymphal skin splits to allow the adult to emerge, it splits exactly down the median line. The prothorax of *E. dispar* and *E. venosus* is shown in fig. 1 and it will be seen that the outer margin of *dispar* (D) is more rounded than that of *venosus* (V). Consequently when measurements are made, it is found that the breadth, a, is greater than the length, c, and so  $a - c$  is always positive. In *venosus* a is rarely longer than c and usually it is of the same length or shorter so that  $a - c$  is often a negative amount. The differences, shown in Table 2, are presented for the sake of convenience in the arbitrary units of the micrometer eyepiece used. In fact one division was 0.072 mm. This difference nearly provides a complete distinction between *E. dispar* on the one hand and *E. venosus* and *E. torrentis* on the other.

The length of the posterior prolongation of the prothorax, *b*, was also measured and in Table 2 it is shown as a percentage of the total length, *c*. *E. dispar* tends to have a relatively shorter prolongation than the other two, but there is more overlap than in the preceding character.

The tarsal markings, which are figured by Kimmins, proved to be the most constant difference in the series of specimens examined. All the specimens of *venosus* had darker pigment at the distal end only, and the specimens of *torrentis* and *dispar* had darker pigmentation at both base and apex of the tarsi. Unfortunately the contrast between light and dark was sometimes not at all clear, and there were a few specimens in which it was difficult to make out how the pattern was arranged.

Of the present series of specimens it may be said that any nymph having 2 teeth on all three claws of one side or even on two of the three claws is definitely *venosus*. If only one claw has 2 teeth it may be any of the species, and if each claw bears 3 teeth or more it is probably not *venosus*. In Table 2 the formula 223, for example, means no more than that one claw has 3 teeth, and the other two have 2; the claw with 3 teeth is not necessarily on the hind leg, but may be on any of them.

Only one character of real value not noticed by Kimmins was found. The first gill of *E. dispar* was large, and nearly always more than three-quarters of the length of the largest gill, which might be number 4 or 5. The first gill of *E. torrentis* and *E. venosus* was narrower and shorter and never exceeded 70% of the length of the biggest gill. Only one specimen overlapped and, as unexpectedly small gills, which had perhaps been damaged, were encountered not infrequently in all positions in the series, it is possible that the first gill in the present instance was such a damaged one. If this be so, then the relative size of the first gill is the first clear-cut distinction encountered.

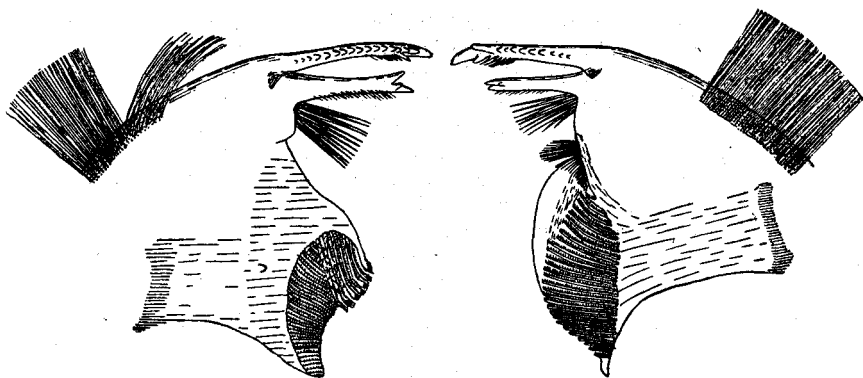


FIG. 2.—Mandibles of *Ecdyonurus*.

Fig. 2 shows the mandibles seen from above. Each has two rami and there is a row of teeth along the outer ramus. The number of these teeth on both sides tends to be greater in *venosus* than in *torrentis*, and in *torrentis* than in *dispar*, but the ranges overlap too much to make this of real value as a specific distinction. Inside the inner ramus of each jaw there is a tuft of bristles, which is said to represent the prostheca. *E. venosus* tends to have more bristles in the prostheca than the other two species but again the difference is only in the position of the modal point. The number of bristles is difficult to count accurately.

TABLE 3.—RELATION BETWEEN TOTAL LENGTH OF NYMPHAL AND

	24	25	26	27	28	29	30	31	32	33	34
length	1	3	1								
10.5			5	4	3			(2)			
11				1	1	1	1				
11.5				1	3	3	1	1			
12						2	5	2	(1)	(2)	(2)
12.5								2	1		(2)
13								1		(1)	1(1)
13.5										1	
14											
14.5											
15											
15.5											
16											
16.5											
17											
17.5											
18											
18.5											
19											1

There is much variation in the length of all species, and so, although *venosus* tends to be the largest, size is of no systematic value. Measurements of the length of a nymphal skin may legitimately be looked at askance, since there is a possibility of telescoping either inwards or outwards. In the penultimate section of Table 2, therefore, the breadth of half the prothorax is shown. There may be some distortion in preservative but the amount is likely to be the same in all specimens. This measurement shows a similar relationship between species and just as much size variation in each species.

It is interesting to compare the total length and the prothorax measurement as is done in Table 3. There is no wide scatter, and the conclusion is that, after all, the total length of the nymphal skin is reasonably accurate, at least as a relative measurement. The one exception is the specimen of *E. dispar* 19 mm. long. There can be little doubt that this figure is an error. It was not possible to discover the source of the error since the specimen was one of the first to be examined, and after measurement it was dissected and mounted in Canada balsam. Table 3 shows that for a given length *E. venosus* has a distinctly wider prothorax than *E. dispar*, which is the reverse of what might have been expected. *E. torrentis* is not shown in Table 3, but it occupies a position midway between the other two.

And so an examination of more material has not made it possible to modify any of the qualifications which Kimmmins found himself bound to insert. But, when all the differences are considered, clear cut distinctions between the species are possible because, in all the specimens, where there is an overlap of one character there is no overlap of other characters. For example in one specimen of *dispar* the a—c measurement is only 1, a figure which may be attained by *torrentis* or *dispar*. But in this specimen b is 32% of c, and the length of the first gill is 84% of that of the largest; and on these two characters it is quite distinct. At the same time it must be pointed out that the specimens examined are from rather a limited part of the country.

Of the three closely related species *E. dispar*, *E. torrentis*, and *E. venosus*, the first-named is the most distinct. The widely rounded sides

SKIN, AND BREADTH OF PROTHORAX IN *Ecdyonurus dispar*  
*E. venosus*

		half breadth of prothorax in mm. $\times 10$											
35	36	37	38	39	40	41	42	43	44	45	46		
												Figures for <i>E.</i> <i>venosus</i> in brackets	
1	(3)												
		(1)											
			(2)	(1)	(2)								
1					(1)	(2)	(1)						
1						(2)							
												(1)	
												(2)	

of the prothorax, the greater breadth of the prothorax relative to its length, the shortness of the posterior prolongation of the prothorax, and the large first gill are all characters in which *E. dispar* differs from the other two. The separation of *torrentis* and *venosus* is less easy. *E. torrentis* has the sides of the head flattened; in *venosus* they are round or slightly flattened but, as has been mentioned, there are some individuals which cannot readily be separated on this character. The tarsi of *venosus* are pigmented at the distal ends only, those of *torrentis* at both ends, and this character, provided that the contrast between light and dark is clear which it sometimes is not, is the easiest distinction between the two. *E. torrentis* has usually at least three teeth on each claw and *venosus* usually has fewer than this. *E. torrentis* tends to have fewer bristles to the prostheca of both jaws.

*E. insignis* has not so far been mentioned. Other authors distinguish it by a simple character. Its seventh gill comprises both a plate and a tuft of filaments; in other species only the first six gills are like this, and the seventh is a plate only with no tuft of filaments. Twelve specimens of the present series had the last gills intact. In one of them there was no tuft of filaments. It may have been knocked off, but there was no sign of injury and the possibility that absence of the tuft of filaments may come within the normal range of variation cannot be ruled out entirely. Apart from this *E. insignis* resembles *E. dispar* rather closely except that its first gill is small.

One final difference not yet mentioned is the ecological difference. It is shown in Table 2 in the last section, which includes material not incorporated in the descriptive part because the nymphal exuviae were absent or damaged. The difference is marked. *E. torrentis* is almost confined to becks and *E. venosus* is almost confined to rivers. An elucidation of the precise ecological factors involved is an interesting problem awaiting solution. For the present it can only be said that water flowing in a channel less than about 5 or 6 feet across is a beck and when it gets bigger than this it becomes a river, as far as *Ecdyonurus* is concerned. *E. venosus* has been taken from the R. Eden which is moderately calcareous. *E. dispar* was very abundant in this river and *E. insignis* has not been found anywhere else.

Visits to the Eden were paid in May, 1940, and July and August, 1947. *E. insignis* was taken only in July, so it may have rather a short emergence period. The others apparently emerge in all the summer months. Present records suggest that the peak emergence period is July for all species except *venosus*, in which it is about a month earlier; but this statement is put forward tentatively as collections not made at regular intervals can easily lead to false conclusions about emergence times.

The differences between the species of *Ecdyonurus* may be summarized in a key:

1. All seven gills comprising a plate and a tuft of filaments ..... *insignis* Eaton.
- Last gill without a bunch of filaments ..... 2.
2. Sides of thorax widely rounded; half breadth of thorax exceeding length by at least 0.072 mm.; posterior prolongation of prothorax usually less than  $\frac{1}{3}$  of total length (fig. 1, D); length of first gill three quarters or more of the length of the largest gill ..... *dispar* Curtis.
- Sides of thorax flatter; half breadth of thorax exceeding length by less than 0.072 mm., and often not exceeding it at all; posterior prolongation of prothorax usually more than  $\frac{1}{3}$  of total length (fig. 1, V); length of first gill less than three quarters that of the largest gill ..... 3.
3. Sides of head flattened; tarsi darker at base and apex; claws of all legs usually with at least three teeth ..... *torrentis* Kimmins.
- Sides of the head round or slightly flattened; tarsi darker at apex only; rarely three teeth on claws of all legs ..... *venosus* (F.).

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Wray Castle, Ambleside, Westmorland.  
June 30th, 1948.