Analysis of Asker Riverfly monitoring, 2019

INTRODUCTION

The Asker is a chalk stream originating from springs by Stancombe Farm and Eggardon Hill. It status as a chalk stream is evidenced by its high conductivity corresponding to moderately hard water, its relatively low temperature through the summer months and an alkaline pH (Table 1). The change in conductivity between above Askerswell Village and Folly Farm suggest a somewhat higher level of solutes dissolved the stream issuing from Eggardon Hill than that from Stancombe. The level of dissolved phosphate is a good indicator of pollution for instance from arable agriculture. The method used in the current work is adequate to detect levels of concern but not precise at the low concentrations detected in the Asker to date. The two sites can be characterised as Good to Moderate on a scale of i) High standard, ii) Good, iii) Moderate and iv) Poor;
https://www.wfduk.org/sites/default/files/Media/Environmental%20standards/River%20Phosphorus%20UKTAG%20Method%20Statement.pdf).

Chalk Rivers are globally rare with 85% occurring in the UK. The Asker is not currently listed among the chalk streams of the UK. In West Dorset only The Bride (Little Cheney Brook), The Wey and River Jordan (Osmington) are listed in addition to streams feeding the Frome, the Piddle and a number of chalk streams that flow south into Christchurch Harbour (http://assets.wwf.org.uk/downloads/wwf_chalkstreamreport_final_lr.pdf).

Table 1: *Left*, mean values for river Asker water quality measurements at two sites; *right*, the conductivity range characteristic of moderately hard water.

Variable	site	Mean	significance
Temperature	Askerswell	11.0± 0.91	NS
	Folly Farm	11.6 ± 0.91	
Conductivity	Askerswell	553 ± 10.5	P<0.05
	Folly Farm	591 ± 10.5	
pH	Askerswell	8.5 ± 0.04	NS
	Folly Farm	8.5 ± 0.04	
Phosphate µg/L	Askerswell	109 ± 30.4	NS
	Folly Farm	115 ± 30,4	
Values estimated for 6th July 2019			

Conductivity (µS/cm)	Hardness
0-140	Very Soft
140-300	Soft
300-500	Slightly Hard
500-640	Moderately Hard
640-840	Hard
Above 840	Very Hard
The unit of measurement is Siemens (S)	

ANALYSIS OF GROUP OF EIGHT SAMPLES

The analysis of the abundance of riverflies in this report uses the data available on the AMRI website for the Asker. Data for Milton Mill on the Mangerton River and Plottingham on the Brit in Bridport have been included in the data set. The data was re-analysed after data for Well Plot in Loders was provided. A statistical procedure, cluster analysis, has been used with all the invertebrate data to determine if any differences occur among the sites. Cluster analysis uses mathematical procedures on the data collected for each site into the same group (cluster) if more similar to each other than to those placed in other clusters. This suggests that the data is separable into three river sections (Figure 1). These three sections have been used for subsequent analysis which was completed before the Loders Well Plot data was to hand.

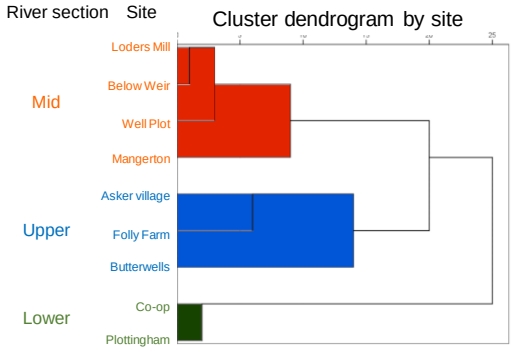


Fig 1: Cluster dendrogram for the Riverfly collections during 2019.

Differences among the clusters might relate to several factors possibly in combination such as river flow rates, river substrates, macrophyte densities or other factors.
The recorded score from the collection of invertebrates is clearly cyclical, falling from spring to mid-summer, perhaps in part due to emergence of adult insects (Fig 2i). There is also a difference in sites with that at Loders Mill providing a lower score than obtained above Askerswell Village (Fig 2ii).

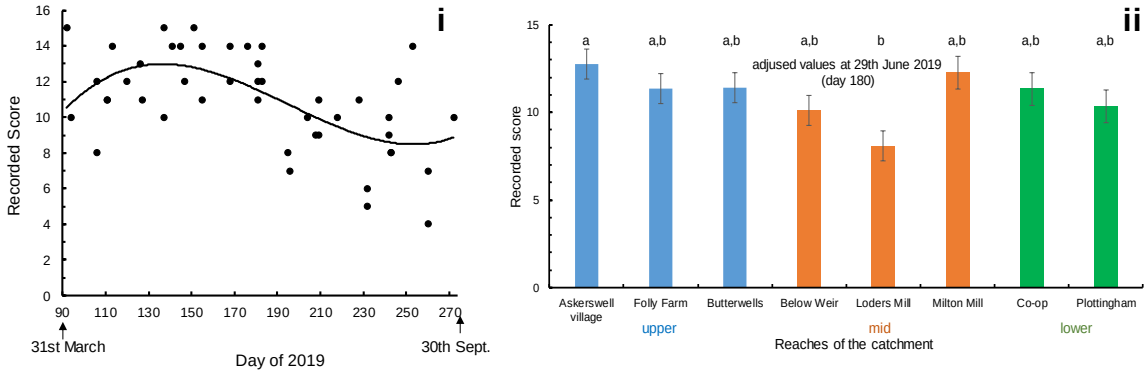


Fig 2: i) changes in recorded score with season with (ii) the overall mean value from Loders Mill being significantly less than that from Askerswell village.

Cluster analysis can also examine the co-abundance of the collected invertebrates. The analysis suggests three groups (Fig 3) which presumably reflect different environments along the river course.

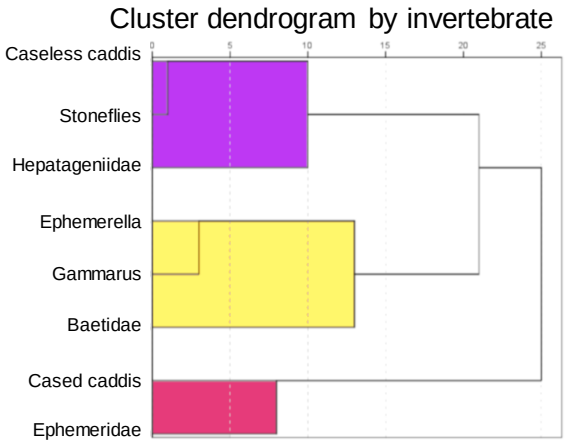


Fig 3: cluster analysis of all the group of eight invertebrates collected during the Riverfly monitoring indicating three different subgroups presumably relating to different environments along the river course.

Further analysis of the distribution of the invertebrates was carried out for each of the three sections of the river. As frequently done, the analysis is based on logarithmic values. The analysis indicates differences in abundance in some of the invertebrates collected. Cased Caddis are less abundant in the upper river than in the lower reaches, whereas *Gammarus* and Heptgeniidae are most abundant in that section of the river. Ephemeridae is more abundant in the middle segment of the river than either up or down stream of that region (Fig 4).

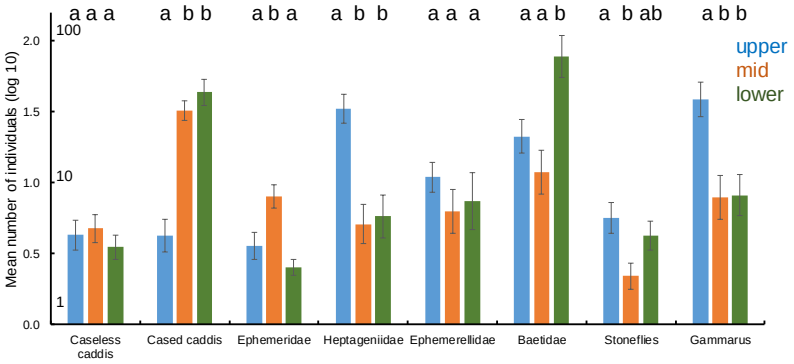


Fig 4: the mean number of the eight recorded invertebrates for the season in the upper middle and lower reaches of the Asker. Means that are statistically similar within each group share the same letter. For instance Cased Caddis are less abundant in the upper (a) than the other two regions of the river (both b).

Caseless Caddis clearly have an annual life cycle (univoltine) in the Asker upstream of Askerswell but emergence is not synchronised with a progressive fall of 95% over the collection season (Fig 5i). In contrast, the clear decline in Cased Caddis was only detected in the mid-regions of the Asker. These insects were similarly abundant as in the mid and lower reaches of the river but less numerous in the headwaters (Fig 5ii). Possibly the lack of synchrony arises because there is more than one species being recorded which may differ in their life-cycle strategies or timing of adult emergence.

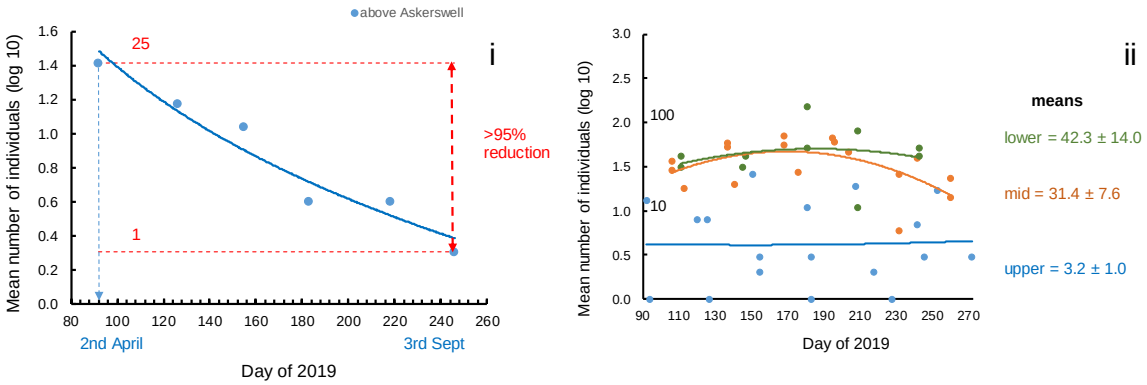


Fig 5: i) change in Caseless Caddis numbers recovered over the collecting season, ii) the greater abundance of Cased Caddis in the mid and lower reaches relative to the upper section of the river with a clear reduction in number over the collection period only evident for the mid region.

As expected Ephemera (Mayfly) and Ephemerella (Blue-winged olives, a member of the mayfly family) seem to be univoltine with a high proportion of emergence of the collecting period. Both insects showed a level of synchrony of loss from samples as summer progresses. This is assumed to be mainly due to adult emergence. Reductions were 20%, 50% and 80% on 17th June, 11th July and 7th August respectively (Fig 6 left, based on Probit analysis, details not provided).

The Heptageniidae (stone clingers) also seemed to be univoltine with 85% to greater than 90% reduction in abundance over the collection period. They were much more abundant (about 8.3x) in the upper Asker than the other two reaches of the river (Fig 6 right).

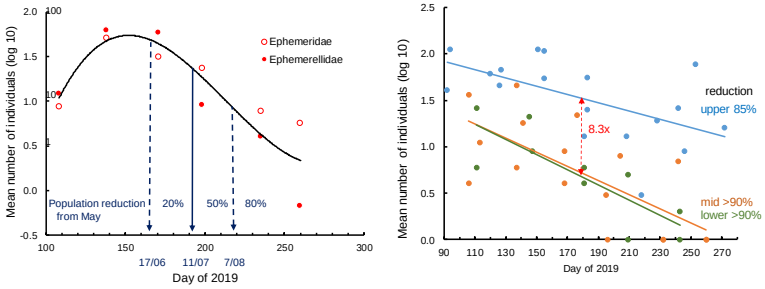


Fig 6: *left,* Seasonal variation in collected abundance of two forms of Mayfly over the growing season; *right*, changes in abundance of Heptageniidae (Stone clingers) over the collection period.

Baetidae were most abundant in the lower region of the river. This invertebrate shows a decline over the collection period with much of this reduction occurring by the end of June (Fig. 7).

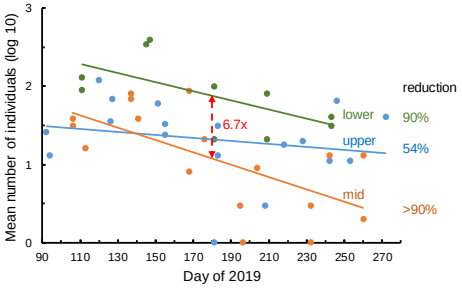


Fig 7: changes in abundance of Baetidae (Olives) over the collection period.

Stoneflies were not numerous in the mid lower reaches of the river and so analysis is restricted to the upper Asker (Fig 8 left). Again this insect was univoltine with approximately with an estimated 82% reduction in its abundance between early April and the beginning of July. The aquatic population recovered towards the likely overwintering density in the early autumn. There was no decline in *Gammarus* as the collecting season developed. There were approximately 5x as many of this amphipod recorded in the upper relative to the lower reaches of the river (Fig 8 right). The pattern of recovery for the mid region of the river was different with a reduction in numbers between spring and late summer. This effect was not limited to just one of the collection site in the river. It may indicate conditions are unfavourable for this invertebrate in midsummer for that region of the river.

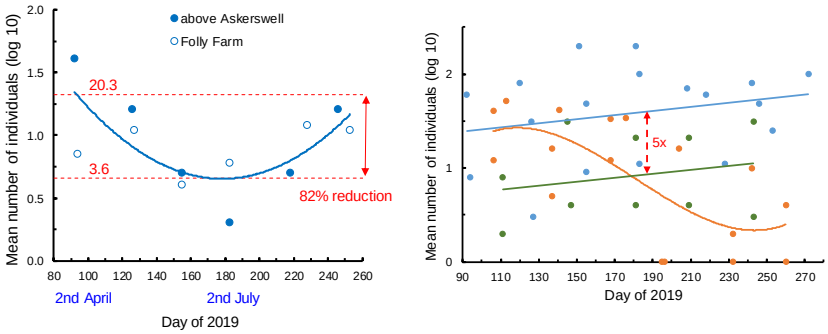


Fig 8 *Left*, changes in abundance of Stoneflies over the collection period in the upper Asker *right*, changes in abundance of *Gammarus* over the collection period in the Asker

EXTENDED RIVERFLY SCHEME

This was carried out for less sites than the group of eight collection. It has been analysed using both a standard approach of average score /taxon and the scores provided by the extended score working sheet. The average score/taxon is based on accumulating standard

scores of 1-10 for each group present (indicates their sensitivity to water quality) divided by the total number of groups present. The results are presented in Fig 9. It establishes differences in the sites with Folly Farm providing the highest values and the extended score providing further discrimination between sites. The two scoring systems provide concordance for all sites except Loders Mill race.

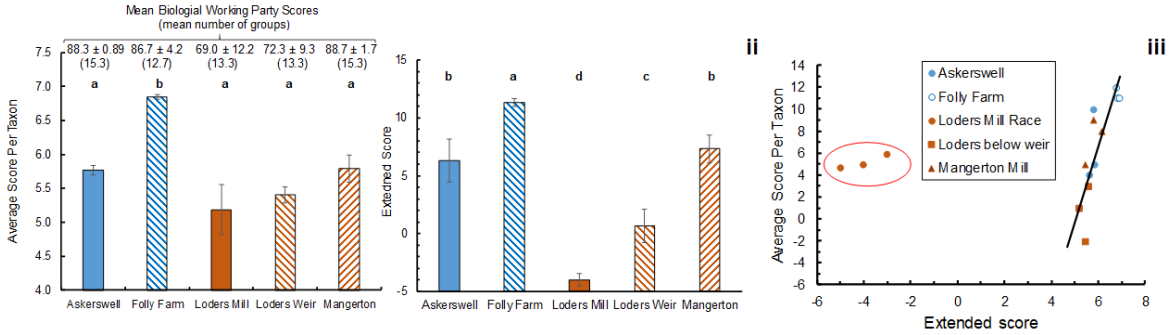


Fig 9: Comparison of extended Riverfly analysis for five sites in the catchment (i) average score/taxon; (ii) the extended Riverfly score and (iii) the relationship between the two measures. Within each graph, significantly different means do not share similar letters.

The mean Biological Monitoring Working Party (BWMP) and average score/taxon (ASPT) can be interpreted as indicating the biological and water qualities respectively of the sites (Table 2). This suggests BWMP and ASPT scores indicate fair to good biological and water quality at the sites studied.

Table 2: Standard interpretation of Biological Monitoring Working Party (BWMP) scores and Average Score per Taxon (ASPT).

BMWP			ASPT		
Score	Biological quality	Site	Score	Water quality	Site
Over 130	Very Good		Over 7	Very Good (Natural)	
81-130	Good	Askerswell V. Folly Farm Mangerton	6.0-6.9	Good	Folly Farm
51-80	Fair	Loders Mill Loders Weir	5.0-5.9	Fair	Askerswell V. Loders Mill Loders Weir Mangerton
11-50	Poor		4.0-4.9	Poor	
0-10	Very Poor		3.9 or less	Very Poor	

Values from https://oart.org.uk/our-work/projects/water-quality/biological-monitoring/

The nearest chalk river for which there is data on the Riverfly monitoring site is The Wey at Broadwey. It provided a mean recorded score of 13 ± 1. This is similar to the highest value on the Asker which was above Askerswell Village of 12.8 ± 0.86. The differences between any environment on the Asker and that at the site on the Wey is evident. The number of Caseless Caddis, and *Gammarus* is greater at the Wey site but means for Cased Caddis, and Ephemeridae are lower and Heptageniidae are similar to the mid and lower Asker but not the higher values of the upper Asker.

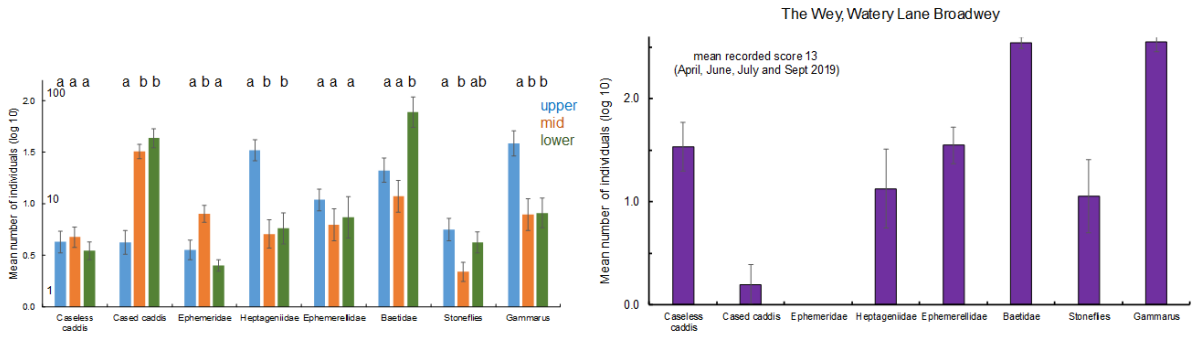


Fig 10: *left*, comparison of the mean group of eight on the three river sections of the Asker, *right*, one site on the Wey at Broadwey.

The extended Riverfly data provides insights into aspects of the river Asker using procedures applied at Yondover by the Environment Agency (see State of the Asker Report). One approach using the extended Riverfly set is to determine **spe**cies **a**t **r**isk from pollution (SPEAR). The number of invertebrates present for each group are logarithmically transformed. The ratio of these log values for those considered sensitive to pollution relative to all present provides the SPEAR value. It has been determined several times at Yondover by the Environment Agency. These values are given with the means derived from the Extended Riverfly monitoring in Fig. 11. The data suggests that pollution levels are not a concern for the Asker.

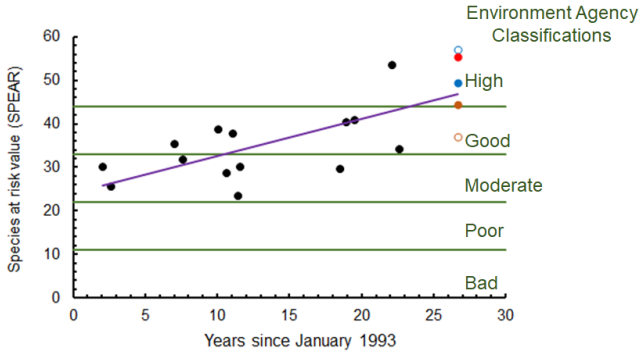


Fig. 11: SPEAR values. Environment Agency estimates (black symbols) with coloured symbols from Extended Riverfly monitoring (in descending SPEAR values, Folly Farm, Milton Mill, Askerswell Village, Loders Weir and Loders Mill (lowest value). Regression analysis establishes that the increase in SPEAR values with time is statistically significant ($P<0.001$).

A second way in which detailed values can be utlised is to estimate the proportion of sediment sensitive invertebrates (PSI) present at a site. It uses weighted values depending on this sensitivity and generates a proportion of sensitive groups present. These values have been determined for many years at Yondover by the Environment Agency and are given with those derived from the Extended Riverfly monitoring in Fig 12.

The results show a range of sedimentation levels at different sites which probably relates at least in part to the collection site being in riffles or where the water is flowing more slowly.

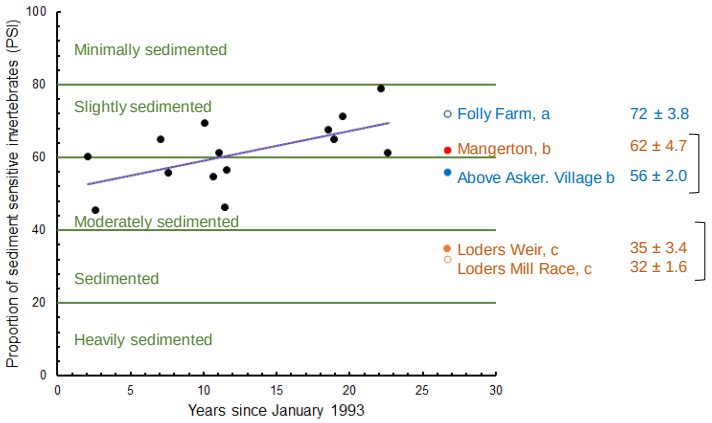


Fig. 12: The proportion of sediment sensitive invertebrates Values from Environment Agency data for the Asker (1993-2017; black symbols). There is a significant increase in these PSI values with time (P<0.024).
The current values from the Extended Riverfly monitoring not sharing the same letter (a, b or c) are significantly different (P < 0.05).

MAIN POINTS FROM RIVERFLY MONITORING, 2019

1. The Asker has a relatively good water and high biological quality. This conclusion is consistent with that of the Environment Agency (see *State of The Asker Report*). There would be value in extending water quality measurements to the mid and lower Asker in 2020.
2. Differences among the sample sites in the abundance of various invertebrates in part reflect differences in habitat at those locations for instance riffles (above Askerswell Village and Folly Farm sites) in contrast to any with finer deposits on the riverbed.
3. How many sites should be monitored in 2020 and should the site be retained or some altered to reflect all the habitats in the river?
4. There is a clear distinction in abundance of the eight invertebrates except Ephermerellidae between upper, mid and lower reaches of the Asker.
5. The most divergent site was Loders Mill and some examination or explanation of this would be of value.
6. It will be of interest to determine the density and variety of fish species present in the river. It may be that food availability is not a limiting factor whereas lack of aquatic plants (macrophytes) may be an issue of concern related to the extent to shading by trees close to the river. Could land owner permission and funding be gained to enhance direct sunlight falling on the water body?
7. Young crayfish that are probably non-native signal crayfish were collected monthly from May at Folly Farm and observed in the river just upstream of that location. In contrast, they were never recovered from above Askerswell Village. Possibly, the waterfall and Washingpool Green and the channelled stream through the village are a barrier to movement of this non-native, invasive species upstream. It is proposed that next year crayfish traps will be placed in both these locations by someone licensed to do this work. One outcome could be that above Askerswell Village could be recommended as an ARC site for the native white clawed crayfish which is increasingly rare in Dorset.
8. Would there be value in organising our own community-based effort to pull out Himalayan Balsam in the summer of 2020?
9. Can a case be made for this catchment being worthy of particular study for improvement as a relatively pollution free small chalk river?

POST-MEETING SUPPLEMENTARY ANALYSIS OF DORSET RIVERS

After the meeting, the ARMI data for Dorset rivers was analysed to determine if the indications for the River Asker have a wider validity within the county. Cluster analysis was again used but on this occasion a methodology was applied that provided statistical significance associated with the dendrogram. The values of particular interest are those in red in Fig 13. Values of > 0.95 correspond to significant probability values (P<0.05). On this basis it seems that the abundance of Stoneflies, Cased caddis and Ephemeridae do vary together and are enclosed in a red boundary. No other invertebrate clusters with another one or two of the group of eight at a statistically significant level.

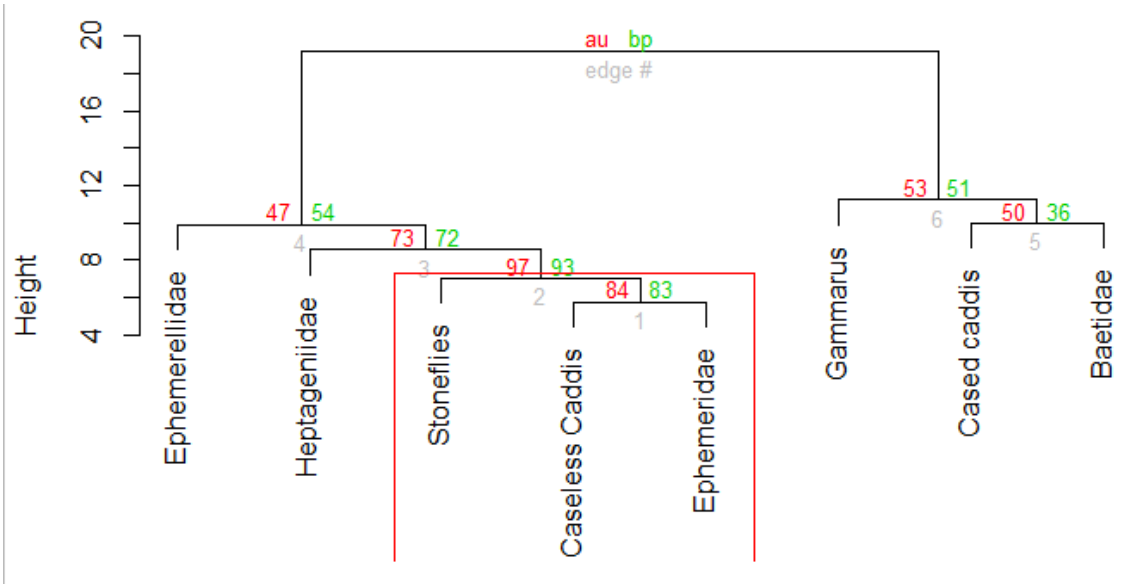
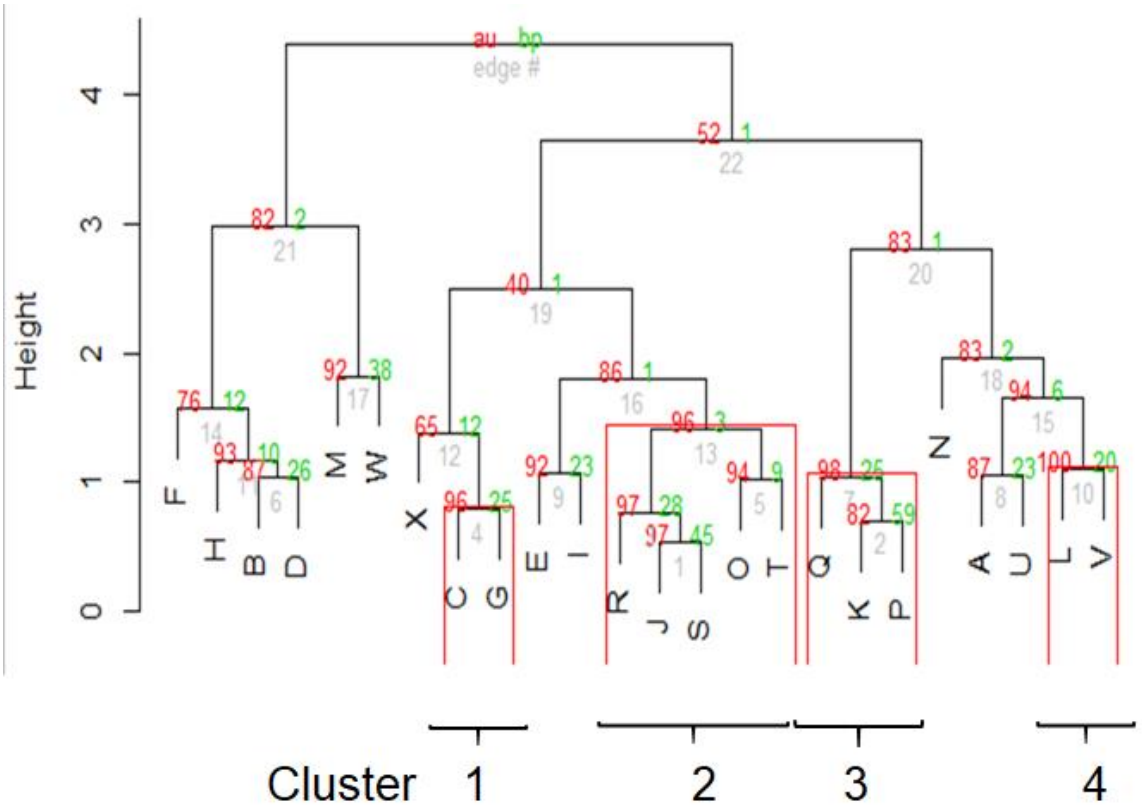


Fig 13: Cluster analysis of the group of eight invertebrates as recorded for 2019 in the ARMI dataset for rivers in Dorset. Values in red >0.95 indicate a statistically significant cluster. The one reaching that level of significance is outlined by red lines and includes Stoneflies, Cased Caddis and Ephemeridae.

A second approach is to analyse the abundance of each of the group of eight invertebrates against the collection site in Dorset on the ARMI data set for 2019. This suggests four statistically significant clusters involving a total of 12 sample sites of the total of 24 sites with at least 4 readings in 2019 collection season (Fig. 14). In this case Cluster 1 is the two sites by the weir at Loders, Cluster 2 is a sub-set of 4 sites on the Stour plus 1 on the Piddle, Cluster 3, is 2 sites on the Cale and Cluster 4, one site each on the Frome and the Stour.



code	Site	Catchment	River
B	Asker Village	Brit	Asker
C	Loders below weir	Brit	Asker
D	Asker Butterwells	Brit	Asker
E	Asker Coop	Brit	Asker
F	Asker Folly Farm	Brit	Asker
G	Loders mill race	Brit	Asker
I	Brit Plottingham	Brit	Brit
H	Millton Mill	Brit	Mangerton
L	Kingfisher bridge	Frome	Frome
N	Moreton Ford	Frome	Frome
U	Sutton Poynz	Jordan	Jordan
O	Rempstone	Piddle	Frome
P	site 1 beach	Stour	Cale
Q	site 3 A3030	Stour	Cale
M	Moors Valley	Stour	Crane
J	Castleman Trail	Stour	Moors River
R	Stour Barn	Stour	Stour
S	Stour Valley LNR1	Stour	Stour
T	Stour Valley LNR2	Stour	Stour
V	Walford Mill	Stour	Stour
X	White Mill Bridge	Stour	Stour
A	Ameysford	Stour	Uddens
K	Holt Heath	Stour	Uddens
W	Watery Lane	Wey	Wey

Cluster 1
Cluster 2
Cluster 3
Cluster 4

Fig 14: Cluster analysis of the 24 sites in the ARMI 2019 dataset for rivers in Dorset with four or more entries. Values in red >0.95 indicate a statistically significant cluster. There are four statistically significant clusters outlined by red lines.

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One characteristic of Cluster 1 is a higher abundance of Cased caddis and Ephemeridae; Cluster 2, a high abundance of Baetidae, Cluster 3, a low abundance of many of the group of eight and Cluster 4, a high abundance of *Gammarus* (Fig. 15). Some of these differences are likely to relate to the particular environmental conditions at the site. More detailed analysis may enable factors to be determined such as the suitability of a river section around that location for particular fish species.

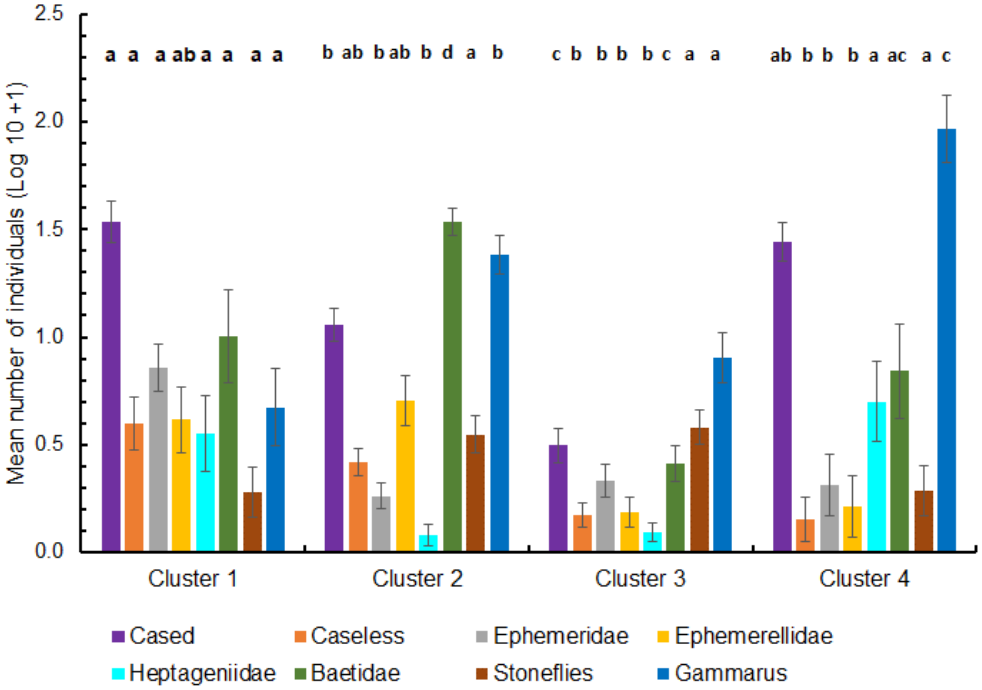

Fig 15: the mean abundance of each of the group of eight invertebrates recorded for the subsets of sites clustered differ significantly ($P<0.05$; one-way ANOVA). Some means belong to more than one group.

HJA: 07/11/2019